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OFFICE OF MANNED SPACE FLIGHT

APOLLO PROGRAM

FINAL FLIGHT EVALUATION REPORT
APOLLO 6 MISSION

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ABSTRACT

THIS DOCUMENT IS THE FINAL FLIGHT EVALUATION REPORT PREPARED FOR NASA HEADQUARTERS ON THE APOLLO 6 MISSION. IT INCLUDES DATA FROM THE MSC, MSFC, AND KSC MISSION REPORTS. A DESCRIPTION OF THE MISSION IS PROVIDED, GIVING A SUMMARY OF PLANNED MISSION EVENTS AND DETAILS OF THE MISSION AS IT WAS FLOWN. THE IMPACT OF THIS MISSION, THE DEGREE OF OBJECTIVE ACCOMPLISHMENTS, AND THEIR EFFECT ON FUTURE APOLLO MISSIONS IS DISCUSSED. SIGNIFICANT MISSION ANOMALIES ARE PRESENTED FOR CARRY-OVER INTO SUBSEQUENT FLIGHT READINESS REVIEWS. FOLLOWING THE LIST OF SIGNIFICANT ANOMALIES, ALL ANOMALIES RESULTING FROM THIS MISSION ARE LISTED IN A SEPARATE SECTION AND NUMBERED ACCORDING TO SPACECRAFT, LAUNCH VEHICLE, AND GROUND SYSTEMS. WHERE FURTHER CLARITY WAS DEEMED NECESSARY, SUPPORTING MATERIAL HAS BEEN INCLUDED, GIVING THE ANOMALY BACKGROUND, A DETAILED DESCRIPTION, THE CAUSE, AND CORRECTIVE ACTIONS TAKEN.

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KEY WORDS

FLIGHT EVALUATIONS
MISSION REPORTS
ANOMALY
IMPACT
OBJECTIVES
SIGNIFICANT MISSION ANOMALIES
SUBSEQUENT MISSIONS

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APOLLO 6

1.0 INTRODUCTION

APOLLO 6 IS THE SECOND FLIGHT OF THE SATURN V LAUNCH VEHICLE. THE BASIC PURPOSE OF THE FLIGHT IS TO DEMONSTRATE THE COMPATIBILITY AND PERFORMANCE OF THE LAUNCH VEHICLE AND THE APOLLO COMMAND AND SERVICE MODULES (CSM) FOR A FUTURE MANNED FLIGHT.

1.1 PLANNED MISSION DESCRIPTION - THIS MISSION DESCRIPTION IS TAKEN DIRECTLY FROM THE MISSION OPERATION REPORT NO. M-932-68-06

THE APOLLO 6 MISSION IS THE SECOND MISSION PLANNED TO QUALIFY THE SATURN V SPACE VEHICLE FOR MANNED FLIGHT. THIS FLIGHT WILL OBTAIN ADDITIONAL DATA ON THE STRUCTURAL INTEGRITY AND COMPATIBILITY OF THE SATURN V LAUNCH VEHICLE (SA-502) AND THE APOLLO SPACECRAFT (CSM 020/LTA-2R). THIS UNMANNED FLIGHT WILL SUBJECT THE COMMAND MODULE HEAT SHIELD TO A HIGH HEAT LOAD AND HEAT RATE SIMULATING LUNAR RETURN VELOCITY CONDITIONS. THE FIRST FLIGHT TEST DATA WILL BE OBTAINED ON THE SPACE VEHICLE EMERGENCY DETECTION SYSTEM (EDS) OPERATING IN A CLOSED LOOP MODE. THE COMMAND MODULE UNIFIED, QUICK OPERATING, HATCH WILL BE FLOWN FOR THE FIRST TIME ON THE APOLLO 6 MISSION.

DURING LAUNCH, THE S-IC STAGE WILL PROVIDE THRUST FOR APPROXIMATELY 2 1/2 MINUTES BEFORE SEPARATION FROM THE S-II STAGE. THIRTY-FIVE SECONDS AFTER S-IC SEPARATION, THE LAUNCH ESCAPE SYSTEM (LES) WILL BE JETTISONED. THE S-II STAGE ENGINES WILL OPERATE FOR APPROXIMATELY 6 MINUTES BEFORE S-II SEPARATION FROM THE S-IVB STAGE. THE S-IVB/IU/LTA/CSM COMBINATION WILL BE INSERTED INTO A 100-NAUTICAL MILE CIRCULAR PARKING ORBIT ABOUT 11 MINUTES AFTER LIFT-OFF.

THE S-IVB STAGE ENGINE WILL BE RESTARTED AT THE END OF THE SECOND REVOLUTION TO INJECT THE VEHICLE INTO A TRAJECTORY SIMILAR TO A TYPICAL LUNAR TRANSFER TRAJECTORY. AT THE COMPLETION OF THE TRANSLUNAR INJECTION (TLI) BURN, THE VEHICLE WILL BE TURNED AROUND, THE CSM WILL BE SEPARATED, AND A RETRO-GRADE SERVICE PROPULSION SYSTEM (SPS) BURN WILL BE PERFORMED TO BRAKE THE CSM INTO A NEAR-EARTH ORBIT WITH AN APOGEE OF 12,000 N.MI. THE S-IVB/IU/LTA COMBINATION WILL CONTINUE ON THE SIMULATED TRANSLUNAR TRAJECTORY.

DURING CSM DESCENT, A POSIGRADE SPS BURN WILL BE PERFORMED TO ACCELERATE THE SPACECRAFT TO A VELOCITY THAT WILL SIMULATE LUNAR RETURN ENTRY CONDITIONS. THE DROGUE PARACHUTES WILL BE DEPLOYED AT AN ALTITUDE OF APPROXIMATELY 23,500 FEET, WITH THE MAIN PARACHUTES BEING DEPLOYED AT AN ALTITUDE OF ABOUT 10,200 FEET. THE PLANNED LANDING POINT IS NORTH-NORTHWEST OF HAWAII IN THE MID-PACIFIC RECOVERY ZONE.

1.2 MISSION SUMMARY AS FLOWN

THE APOLLO 6 SPACE VEHICLE (AS-502) WAS LAUNCHED FROM LAUNCH COMPLEX 39A AT CAPE KENNEDY ON APRIL 4, 1968, WITH LIFT-OFF OCCURRING AT 07:00:01 EST. PRE-LAUNCH CONDITIONS, LAUNCH, S-IC BURN, S-II IGNITION, AND TOWER JETTISON APPEARED TO BE NOMINAL. APPROXIMATELY 260 SECONDS AFTER S-II IGNITION, ENGINES 2 AND 3 CUT OFF PREMATURELY. THE REMAINING ENGINES MAINTAINED VEHICLE CONTROL THROUGH THE SUBSEQUENT PORTION OF THE S-II BURN. THIS MALFUNCTION CAUSED THE S-II STAGE TO BURN 58 SECONDS LONGER THAN THE NOMINAL TIME. THE FIRST S-IVB BURN WAS 29 SECONDS LONGER THAN NOMINAL DUE TO THE S-II MALFUNCTION AND THE SUBSEQUENT AUTOMATIC ATTEMPT TO ACHIEVE THE PROPER ORBIT CONDITIONS.

THE S-IVB/CSM WAS INSERTED INTO A 96 BY 198-NM ORBIT AT 07:12:37 EST. DESPITE THE USAGE OF MORE PROPELLANTS THAN PLANNED DURING THE FIRST S-IVB BURN, A TRANSLUNAR INJECTION BURN WAS STILL POSSIBLE. THE IGNITION SEQUENCE SEEMED NORMAL, BUT THE S-IVB FAILED TO RE-IGNITE. AN ALTERNATE MISSION WAS THEN INITIATED, AND AN SPS BURN PUT THE CSM INTO A 12,020 NM APOGEE ELLIPSE. INSUFFICIENT PROPELLANTS REMAINED FOR ACCOMPLISHING THE SECOND SPS BURN TO ACHIEVE LUNAR MISSION ENTRY CONDITIONS. CM/SM SEPARATION AND ENTRY WERE NOMINAL FOR THE ALTERNATE MISSION ENTRY CONDITIONS, WITH SPLASHDOWN 49 NM UPRANGE FROM THE TARGETED LANDING POINT FOR THE ALTERNATE MISSION.

1.3 APOLLO PROGRAM IMPACT

DURING THE S-IC BOOST PHASE OF THE APOLLO 6 FLIGHT TWO MAJOR ANOMALIES WERE ENCOUNTERED. A STRUCTURAL FAILURE OCCURRED ON THE SLA, AND A COUPLING OF THE LAUNCH VEHICLE STRUCTURAL SYSTEM WITH S-IC PROPULSION DYNAMICS WAS ENCOUNTERED CAUSING LARGE LATERAL LOADS IN THE SPACECRAFT. ENGINE ANOMALIES WERE EXPERIENCED DURING SECOND STAGE FLIGHT, ALTHOUGH THE LAUNCH VEHICLE SATISFACTORILY INSERTED THE SPACECRAFT INTO ORBIT. AN ATTEMPT TO REIGNITE THE S-IVB ENGINE FOR THE TRANSLUNAR INJECTION FIRING WAS UNSUCCESSFUL. THE OVERALL PERFORMANCE OF THE COMMAND AND SERVICE MODULES WAS EXCELLENT.

BECAUSE OF THE PROBLEMS EXPERIENCED ON APOLLO 6, THERE WAS CONCERN FOR THE ORDERLY DEVELOPMENT OF THE CONTINUING APOLLO PROGRAM. HOWEVER, ALL THE REQUIRED ANALYSIS, ENGINEERING AND TESTING TO PROVIDE THE NECESSARY CORRECTIVE ACTION WERE MADE TO THE SPACE VEHICLE HARDWARE WITHOUT IMPACTING THE PROGRAM SCHEDULE FOR SUBSEQUENT FLIGHTS. THE CORRECTIVE ACTIONS ARE DISCUSSED IN THE WRITE UP OF THE ANOMALY.

1.4 SUMMARY OF MISSION ACCOMPLISHMENTS

THE MISSION INCLUDED 31 OBJECTIVES FOR THE SPACECRAFT AND 15 FOR THE LAUNCH VEHICLE. THESE DETAILED TEST OBJECTIVES ARE TAKEN FROM THE MISSION REQUIREMENTS DOCUMENT, NAS 9-4810 WHICH SUPPORTS THE MISSION ASSIGNMENTS DOCUMENT, M-D MA 500-11.

	OBJECTIVE	ACCOMPLISHMENT
I.	SPACECRAFT TEST OBJECTIVES	
P3.1	EVALUATE THE THERMAL AND STRUCTURAL PERFORMANCE OF THE BLOCK II THERMAL PROTECTION SYSTEM, INCLUDING EFFECTS OF COLD SOAK AND MAXIMUM THERMAL GRADIENT WHEN SUBJECTED TO THE COMBINATION OF A HIGH HEAT LOAD AND A HIGH HEATING RATE REPRESENTATIVE OF LUNAR RETURN ENTRY.	THIS SYSTEM SUCCESSFULLY DEMONSTRATED. THE TEMPERATURE DATA WERE WITHIN DESIGN LIMITS FOR THE FLIGHT, ALTHOUGH THE ABLATOR TEMPERATURE RISES WERE HIGHER THAN FOR THE APOLLO 4.
P3.8	EVALUATE THE THERMAL PERFORMANCE OF A GAP AND SEAL CONFIGURATION SIMULATING THE UNIFIED CREW HATCH DESIGN FOR HEATING CONDITIONS ANTICIPATED DURING LUNAR RETURN ENTRY.	PERFORMANCE WAS SUCCESSFULLY DEMONSTRATED.

OBJECTIVE		ACCOMPLISHMENT
P1.1a	DEMONSTRATE CSM/SLA/LTA/ SATURN V STRUCTURAL COMPATIBILITY AND DETERMINE SPACECRAFT LOADS IN A SATURN V LAUNCH ENVIRONMENT.	THE OBJECTIVE WAS ONLY PARTLY ACCOMPLISHED. AT 133 SECONDS PIECES OF THE SLA SEPARATED FROM THE SPACE VEHICLE.
P1.2	DETERMINE THE DYNAMIC AND THERMAL RESPONSES OF THE SLA/CSM STRUCTURE IN THE SATURN V LAUNCH ENVIRONMENT.	THE OBJECTIVE WAS ACCOMPLISHED, BUT A SEPARATION TRANSIENT OCCURRED INDICATING THAT THE MOTION OF THE TWO VEHICLES WAS MOMENTARILY COUPLED.
P1.4	DETERMINE THE FORCE INPUTS TO THE SIMULATED LM FROM THE SLA AT THE SPACECRAFT ATTACHMENT STRUCTURE IN A SATURN V LAUNCH ENVIRONMENT.	LOADS AT LIFT-OFF, MAX Q , AND END OF 1ST STAGE BOOST WERE LESS THAN LM DESIGN CONDITIONS.
P4	EVALUATE THE PERFORMANCE OF THE SPACECRAFT EMERGENCY DETECTION SUBSYSTEM (EDS) IN THE OPEN LOOP CONFIGURATION.	AT APPROX. 00:02:13, ONE OF THE THREE EDS HOT-WIRE AUTOMATIC ABORT VOTING CIRCUITS BECAME DE-ENERGIZED DUE TO A BREAK IN THE WIRE BETWEEN THE EDS DISTRIBUTOR IN THE IU AND THE CM UMBILICAL.

OBJECTIVE	ACCOMPLISHMENT
P1.5 OBTAIN DATA ON THE ACOUSTIC AND THERMAL ENVIRONMENT OF THE SLA/SIMULATED LM INTERFACE DURING A SATURN V LAUNCH.	LOADS AT LIFT-OFF, MAX Q , AND END OF FIRST-STAGE BOOST WERE LESS THAN LM DESIGN CONDITIONS. HOWEVER, AT APPROXIMATELY 00:01:50 (BETWEEN MAX Q AND THE END OF FIRST-STAGE BOOST), AXIAL AND LATERAL ACCELERATIONS OF 5 Hz BEGAN IN THE LTA-2R, LASTING UNTIL 00:02:13 WHEN A MAJOR CHANGE IN CHARACTER OCCURRED.
P1.7 DETERMINE VIBRATION RESPONSE OF LM DESCENT STAGE ENGINE AND PROPELLANT TANKS IN A SATURN V LAUNCH ENVIRONMENT.	VIBRATION LEVELS OF THE LTA-2R OXIDIZER TANK EXCEEDED THE EXPECTED MISSION LEVELS IN NARROW FREQUENCY BANDS.
P3.2 DEMONSTRATE AN SPS NO ULLAGE START.	THIS OBJECTIVE WAS SATISFACTORILY ACCOMPLISHED.
P3.5 VERIFY THE PERFORMANCE OF THE SM/RCS THERMAL CONTROL SUBSYSTEM AND ENGINE THERMAL RESPONSE IN THE DEEP SPACE ENVIRONMENT.	THE THERMAL CONTROL SYSTEM FOR THE SERVICE MODULE REACTION CONTROL SYSTEM MAINTAINED THE ENGINE MOUNTING STRUCTURE AND INJECTOR HEAD TEMPERATURES AT SATISFACTORY LEVELS FOR QUADS A, B, AND D. QUAD C DISPLAYED ANOMALOUS TEMPERATURES DURING THE EARLY PORTION OF THE COLD-SOAK PHASE OF THE MISSION.

OBJECTIVE		ACCOMPLISHMENT
P3.6	VERIFY THE THERMAL DESIGN ADEQUACY OF THE CM/RCS THRUSTERS AND EXTENSIONS DURING SIMULATED LUNAR RETURN ENTRY.	THE SYSTEM ADEQUATELY WITHSTOOD THE EFFECTS OF A HIGH HEATING LOAD ENTRY AFTER HAVING BEEN SUBJECTED TO AN EXTENDED COLD-SOAK PERIOD.
P3.9	VERIFY OPERATION OF THE HEAT REJECTION SYSTEM THROUGHOUT THE MISSION.	THE ENVIRONMENTAL CONTROL SYSTEM PERFORMED SATISFACTORILY THROUGHOUT THE MISSION BUT DUE TO LOSS OF ACCURATE DATA AT 00:01:28, IT COULD NOT BE DETERMINED WHEN ACTIVE COOLING WAS INITIATED.
P5.6	MEASURE THE INTEGRATED SKIN AND DEPTH RADIATION DOSE WITHIN THE COMMAND MODULE UP TO AN ALTITUDE OF AT LEAST 2000 NAUTICAL MILES.	THE TWO DOSE RATE MEASUREMENTS OF THE VAN ALLEN BELT DOSIMETER RANDOMLY SWITCHED BETWEEN LOW RANGE AND HIGH RANGE.
P3.3	DETERMINE PERFORMANCE OF THE SPS DURING A LONG DURATION BURN.	THIS OBJECTIVE WAS SATISFACTORILY ACCOMPLISHED.
P5.2b	DEMONSTRATE THE PERFORMANCE OF CSM/MSFN S-BAND COMMUNICATIONS.	THE S-BAND TELEMETRY PERFORMANCE ANALYSIS INDICATED AN INTERMITTENT PROBLEM FROM 00:01:28 TO 00:08:20 AND DURING THE COAST ELLIPSE PHASE.

OBJECTIVE		ACCOMPLISHMENT
S4	DETERMINE AND DISPLAY, IN REAL TIME, VAN ALLEN BELT RADIATION DOSE RATE AND INTEGRATED DOSE DATA AT THE MISSION CONTROL CENTER, HOUSTON, TEXAS.	AN INTERFERENCE PROBLEM DURING DESCENT FROM APOGEE PREVENTED REAL-TIME OBSERVATION OF THE DATA; HOWEVER, THE INFORMATION WAS RECOVERED BY POSTFLIGHT DATA REDUCTION.
S3.2d	VERIFY OPERATION OF THE PGS IN THE SPACE ENVIRONMENT AFTER S-IVB SEPARATION.	THIS PRIMARY GUIDANCE SYSTEM OBJECTIVE WAS SATISFACTORILY DEMONSTRATED.
S2	DEMONSTRATE SATISFACTORY OPERATION OF CSM COMMUNICATION SUBSYSTEM USING THE BLOCK II TYPE VHF OMNIDIRECTIONAL ANTENNAS.	THIS SUBSYSTEM WAS SUCCESSFULLY DEMONSTRATED.
S3.3c	VERIFY OPERATION OF THE G&N/SCS DURING ENTRY AND RECOVERY.	THIS SYSTEM WAS SUCCESSFULLY DEMONSTRATED.
S3.1d	VERIFY OPERATION OF PGS AFTER BEING SUBJECTED TO THE SATURN V LAUNCH ENVIRONMENT.	THIS PRIMARY GUIDANCE SYSTEM WAS SUCCESSFULLY DEMONSTRATED.
S6	GATHER DATA ON THE EFFECTS OF A LONG DURATION SPS BURN ON SPACECRAFT STABILITY.	PERFORMANCE OF THE SERVICE PROPULSION SYSTEM THRUST VECTOR CONTROL LOOP WAS AS PREDICTED.

OBJECTIVE	ACCOMPLISHMENT
S3.3a VERIFY OPERATION OF THE CM/RCS DURING ENTRY AND RECOVERY.	THIS OPERATION WAS SATISFACTORILY DEMONSTRATED.
S3.3e VERIFY OPERATION OF THE ELS DURING ENTRY AND RECOVERY.	THE PERFORMANCE OF THE EARTH LANDING SYSTEM WAS SATISFACTORY WITH ALL COMPONENTS OPERATING AS PLANNED.
S3.2d VERIFY OPERATION OF THE ELECTRICAL POWER SYSTEM IN THE SPACE ENVIRONMENT AFTER S-IVB SEPARATION.	FUNCTIONED NORMALLY THROUGHOUT THE MISSION. CIRCUIT BREAKER 100 TRIPPED CAUSING AC BUS TRANSFER OF ESSENTIAL LOADS.
S3.1c VERIFY OPERATION OF THE G&N SYSTEM AFTER SUBJECTION TO THE SATURN V BOOST ENVIRONMENT.	NO DATA AVAILABLE FROM 01:24:00 TO 08:16:00. PERFORMANCE OF THE INERTIAL SYSTEM WAS EXCELLENT AND WELL WITHIN PREFLIGHT PREDICTIONS.
S3.3d VERIFY OPERATION OF THE ELECTRICAL POWER SYSTEM DURING ENTRY AND RECOVERY.	DURING ENTRY, BUS 2 PHASE B VOLTAGE INCREASED OVER NORMAL 117.3 VOLTS PRIOR TO SM/CM SEPARATION FOR 15 MINUTES.
S3.2a VERIFY OPERATION OF THE G&N IN THE SPACE ENVIRONMENT AFTER S-IVB SEPARATION.	THIS OBJECTIVE WAS SATISFACTORILY DEMONSTRATED.
S3.1d VERIFY OPERATION OF THE EPS AFTER BEING SUBJECTED TO THE SATURN V LAUNCH ENVIRONMENT.	THE ELECTRICAL POWER SYSTEM FUNCTIONED NORMALLY DURING LAUNCH
S1 DETERMINE THE RADIATION SHIELDING EFFECTIVENESS OF THE CM.	ALL INSTRUMENTATION OPERATED PROPERLY BUT NO DEFINITE DATA IS AVAILABLE YET.

	OBJECTIVE	ACCOMPLISHMENT
S7	OBTAIN DATA ON THE TEMPERATURE OF THE SIMULATED LM SKIN DURING LAUNCH.	DATA WERE OBTAINED.
S5	OBTAIN DATA VIA CSM-A/RIA COMMUNICATIONS.	THE ARIA AT BERMUDA SUPPORTED THE MISSION IN EXCELLENT FASHION.

LAUNCH VEHICLE (LV) DETAILED TEST OBJECTIVE, COME FROM THE SATURN V MISSION IMPLEMENTATION PLAN DOCUMENT FROM MARSHALL SPACE FLIGHT CENTER WHICH SUPPORTS APOLLO FLIGHT MISSION ASSIGNMENTS DOCUMENT, M-D MA 500-11.

	OBJECTIVE	ACCOMPLISHMENT
II.	LAUNCH VEHICLE TEST OBJECTIVES	
1.	DEMONSTRATE STRUCTURAL AND THERMAL INTEGRITY OF LAUNCH VEHICLE THROUGHOUT POWERED AND COASTING FLIGHT, AND DETERMINE IN-FLIGHT STRUCTURAL LOADS AND DYNAMIC CHARACTERISTICS. (P)	PARTIALLY ACCOMPLISHED. S-IC FIN VIBRATION LEVELS EXCEEDED THE RANGE OF ACCELEROMETERS NEAR MAXIMUM DYNAMIC PRESSURE, AND OSCILLATORY COUPLING OCCURRED BETWEEN THE STRUCTURE AND S-IC ENGINES. AVAILABLE DATA SHOW THERMAL AND PRESSURE ENVIRONMENTS IN S-IC FORWARD SKIRT DURING S-IC/S-II SEPARATION HIGHER THAN DESIGN.
2.	DETERMINE IN-FLIGHT LAUNCH VEHICLE INTERNAL ENVIRONMENT. (P)	SATISFACTORILY ACCOMPLISHED.
3.	VERIFY PRE-LAUNCH AND LAUNCH SUPPORT EQUIPMENT COMPATIBILITY WITH LAUNCH VEHICLE AND SPACECRAFT SYSTEMS. (P)	SATISFACTORILY ACCOMPLISHED.
4.	DEMONSTRATE THE S-IC STAGE PROPULSION SYSTEM AND DETERMINE IN-FLIGHT SYSTEM PERFORMANCE PARAMETERS. (P)	SATISFACTORILY ACCOMPLISHED. ALTHOUGH OSCILLATORY COUPLING OCCURRED BETWEEN THE ENGINES AND SPACE VEHICLE STRUCTURE.

OBJECTIVE	ACCOMPLISHMENT
5. DEMONSTRATE THE S-II STAGE PROPULSION SYSTEM, INCLUDING PROGRAMMED MIXTURE RATIO SHIFT AND THE PROPELLANT MANAGEMENT SYSTEMS, AND DETERMINE IN-FLIGHT SYSTEM PERFORMANCE PARAMETERS. (P)	THE S-II PROPULSION SYSTEM DEMONSTRATION OPERATED SUCCESSFULLY UNTIL PREMATURE SHUTDOWN OF ENGINES NO. 2 AND 3 OCCURRED AT 412.92 SECONDS AND 414.18 SECONDS, RESPECTIVELY; INSTEAD OF CUTOFF AT NOMINAL TIME OF 517.69 SECONDS. THE PROPELLANT MANAGEMENT SYSTEM PERFORMANCE WAS SATISFACTORY. THE PROGRAMMED MIXTURE RATIO SHIFT WAS SUCCESSFULLY DEMONSTRATED; HOWEVER, IT OCCURRED SUBSTANTIALLY LATER THAN PREDICTED BECAUSE THE PREMATURE SHUTDOWN OF TWO ENGINES CAUSED VEHICLE ATTITUDE SHIFTS WHICH DISTURBED THE NORMAL PROPELLANT LEVEL RELATIONSHIPS.
6. DEMONSTRATE THE LAUNCH VEHICLE GUIDANCE AND CONTROL SYSTEM DURING S-IC, S-II, AND S-IVB POWERED FLIGHT. ACHIEVE GUIDANCE CUTOFF AND EVALUATE SYSTEM ACCURACY. (P)	THE PERFORMANCE OF THE GUIDANCE AND NAVIGATION SYSTEM WAS AS PREDICTED FROM LIFTOFF TO 412.92 SECONDS. GUIDANCE COMPUTATIONS RESPONDED TO VARIATIONS IN ALTITUDE AND VELOCITY CAUSED BY THE DECREASE IN THRUST DURING THE S-II BURN PERIOD. DUE TO THE TWO-ENGINE-OUT PERTURBATION, FLIGHT PATH ANGLE AND VELOCITY WERE NOT OPTIMUM AT THE TIME GUIDANCE COMMANDED S-IVB ENGINE CUTOFF (ECO). ALL ORBITAL GUIDANCE MANEUVERS WERE SATISFACTORILY PERFORMED. IU COMMANDS WERE PROPERLY EXECUTED FOR S-IVB

OBJECTIVE	ACCOMPLISHMENT
6. CONTINUED	RESTART, BUT THE ENGINE DID NOT REIGNITE. SINCE ACCELERATION TEST CONDITIONS WERE NOT MET, TIME BASE 7 (T_7) WAS INITIATED AND A CUTOFF COMMAND WAS ISSUED TO THE S-IVB STAGE. THE AS-502 FLIGHT CONTROL COMPUTER (FCC), THRUST VECTOR CONTROL (TVC), AND AUXILIARY PROPULSION SYSTEM (APS) SATISFIED ALL REQUIREMENTS FOR ATTITUDE CONTROL AND STABILITY OF BENDING AND PROPELLANT SLOSH MODES IN BOTH THE BOOST AND ORBITAL COAST MODES OF OPERATION.
7. DEMONSTRATE S-IC/S-II DUAL PLANE SEPARATION. (P)	SATISFACTORILY ACCOMPLISHED.
8. DEMONSTRATE S-II/S-IVB SEPARATION. (P)	SATISFACTORILY ACCOMPLISHED.
9. DEMONSTRATE LAUNCH VEHICLE SEQUENCING SYSTEM. (P)	SATISFACTORILY ACCOMPLISHED.
10. DEMONSTRATE COMPATIBILITY OF THE LAUNCH VEHICLE AND SPACECRAFT. (P)	PARTIAL ACCOMPLISHED. THE STRUCTURAL-PROPULSION COUPLING (POGO) PHENOMENON OCCURRED BETWEEN 110 AND 140 SECONDS AS EVIDENCED BY A BUILDUP AND DECAY OF LONGITUDINAL ACCELERATION. VIBRATION COUPLING OCCURRED BETWEEN LONGITUDINAL AND LATERAL MODES.
11. EVALUATE PERFORMANCE OF THE EMERGENCY DETECTION SYSTEM (EDS) IN A CLOSED-LOOP CONFIGURATION. (P)	SATISFACTORILY ACCOMPLISHED ON THE L/V.

OBJECTIVE	ACCOMPLISHMENT
12. DEMONSTRATE THE CAPABILITY OF THE S-IVB AUXILIARY PROPULSION SYSTEM DURING S-IVB POWERED FLIGHT AND ORBITAL COAST PERIODS TO MAINTAIN ATTITUDE CONTROL AND PERFORM REQUIRED MANEUVERS. (P)	SATISFACTORILY ACCOMPLISHED.
13. DEMONSTRATE THE ADEQUACY OF THE S-IVB CONTINUOUS VENT SYSTEM WHILE IN EARTH ORBIT. (P)	SATISFACTORILY ACCOMPLISHED.
14. DEMONSTRATE THE S-IVB STAGE RESTART CAPABILITY. (P)	NOT ACCOMPLISHED. THE CONDITIONS FOR RESTART WERE NOMINAL EXCEPT FOR A HOT START OF THE GAS GENERATOR AND LACK OF MAIN CHAMBER IGNITION. CAUSE OF RESTART FAILURE WAS A FAILED ASI FUEL LINE.
15. DEMONSTRATE THE MISSION SUPPORT CAPABILITY REQUIRED FOR LAUNCH AND MISSION OPERATIONS TO HIGH POST-INJECTION ALTITUDES. (P)	MISSION SUPPORT CAPABILITY WAS ADEQUATELY DEMONSTRATED DURING THE PORTION OF THE MISSION COMPLETED. DUE TO FAILURE OF S-IVB RESTART, HIGH POST INJECTION ALTITUDES WERE NOT ACHIEVED.
16. DEMONSTRATE THE S-IVB STAGE PROPULSION SYSTEM INCLUDING THE PROPELLANT MANAGEMENT SYSTEM, AND DETERMINE IN-FLIGHT SYSTEM PERFORMANCE PARAMETERS. (P)	THE PROPULSION SYSTEM MET ALL OPERATIONAL REQUIREMENTS DURING FIRST BURN AND ORBITAL COAST; HOWEVER, AN ASI FUEL LINE FAILURE DURING FIRST BURN PREVENTED RESTART. THE S-IVB LOX MASS BRIDGE ERRONEOUSLY INDICATED 100 PERCENT LOX FROM 11091 SECONDS TO THE END OF THE MISSION. THE ENGINE WOULD HAVE RUN AT 5.5:1 MIXTURE RATIO AFTER RESTART HAD THIS CONDITION PERSISTED.

OBJECTIVE	ACCOMPLISHMENT
17. DETERMINE LAUNCH VEHICLE POWERED FLIGHT EXTERNAL ENVIRONMENT. (S)	SATISFACTORILY ACCOMPLISHED.
18. DETERMINE ATTENUATION EFFECTS OF EXHAUST FLAMES ON RF RADIATING AND RECEIVING. SYSTEMS DURING MAIN ENGINE, RETRO, AND ULLAGE MOTOR FIRINGS. (S)	SATISFACTORILY ACCOMPLISHED.

SEQUENCE OF EVENTS

PRE-LAUNCH

NO LAUNCH VEHICLE PROBLEMS IMPACTING THE COUNTDOWN OCCURRED DURING THE PRE-LAUNCH OPERATIONS. ALL COUNTDOWN EVENTS WERE ACCOMPLISHED ON TIME.

EVENT	TIME (HR:MIN:SEC:)
START COUNTDOWN CLOCK	24:00:00
LAUNCH VEHICLE FINAL POWER ON	18:45:00
MOVE MOBILE SERVICE STRUCTURE	17:00:00
SPACECRAFT CLOSEOUT COMPLETE	8:30:00
RETRACT APOLLO ACCESS ARM	8:00:00
BUILT-IN 6-HOUR HOLD	8:00:00
START LAUNCH VEHICLE CRYOGENICS LOAD	7:00:00
LAUNCH VEHICLE CRYOGENICS LOAD COMPLETE	0:55:00
BEGIN TERMINAL COUNT PHASE (SC)	0:45:00
SPACECRAFT TRANSFER TO INTERNAL POWER	0:15:00
REMOVE Q-BALL COVER	0:12:00
ARM LAUNCH ESCAPE SYSTEM	0:10:00
START AUTOMATIC SEQUENCE	0:03:07
LAUNCH VEHICLE TRANSFER TO INTERNAL POWER	0:00:50
S-IC ENGINE START SEQUENCE COMMAND	0:00:08.8
LIFT-OFF	0:00:00

LAUNCH AND MISSION

EVENT	PLANNED (HR:MIN:SEC)	ACTUAL (HR:MIN:SEC)	DIFFERENCES (SEC)
LIFT-OFF	00:00:00.8	00:00:00.7	- 00.1
MAXIMUM DYNAMIC PRESSURE	00:01:19.8	00:01:15.2	- 04.6
S-IC CECO	00:02:24.4	00:02:24.9	00.5
S-IC OECO	00:02:27.3	00:02:28.4	01.1
S-II ULLAGE IGNITION	00:02:27.8	00:02:28.9	01.1
S-IC RETROROCKET IGNITION	00:02:28.0	00:02:29.1	01.1
S-IC/S-II SEPARATION	00:02:28.0	00:02:29.1	01.1
S-II IGNITION	00:02:28.7	00:02:29.8	01.1
S-II SECOND PLANE SEPARATION	00:02:58.0	00:02:59.1	01.1
JETTISON LET	00:03:03.7	00:03:04.8	01.1
JETTISON S-II CAMERAS	00:03:05.3	00:03:06.4	01.1
S-II ENGINE #2 CUTOFF	- -	00:06:52.9	-
S-II ENGINE #3 CUTOFF	- -	00:06:54.2	-
GUIDANCE-SENSED MIXTURE RATIO SHIFT	00:06:52.5	00:08:10.8	78.3
S-II ENGINE CUTOFF	00:08:37.5	00:09:36.3	58.8

EVENT	PLANNED* (HR:MIN:SEC)	ACTUAL (HR:MIN:SEC)	DIFFERENCES (SEC)
S-IVB ULLAGE ROCKET IGNITION	00:08:38.2	00:09:37.0	58.8
S-II/S-IVB SEPARATION	00:08:38.3	00:09:37.1	58.8
S-IVB ENGINE IGNITION	00:08:38.5	00:09:37.3	58.8
S-IVB ULLAGE CASE JETTISON	00:08:50.3	00:09:49.1	58.8
S-IVB CUTOFF	00:10:59.0	00:12:27.0	88.0
PARKING ORBIT INSERTION	00:11:09.0	00:12:37.0	88.0
S-IVB RESTART COMMAND	03:10:11.2	03:13:34.7	203.5
S-IVB CUTOFF COMMAND	03:15:27.9	03:13:50.3*	- 97.6
SLA/CSM SEPARATION	03:14:26	03:14:27.8	1.8
FIRST SPS IGNITION	03:16:16	03:16:06.2	10.2
FIRST SPS CUTOFF	03:23:27	03:23:27.9	0.9
CSM APOGEE	06:28:24	06:28:58	34.0
CM/SM SEPARATION	09:37:01	09:36:56.6	- 4.4
DROGUE CHUTE DEPLOYMENT	09:51:00	09:51:27.4	27.4
MAIN CHUTE DEPLOYMENT	09:51:49	09:52:13.4	24.4
CM SPLASH	09:57:14	09:57:19.9	5.9

* PLANNED TIMES AFTER S-IVB CUTOFF COMMAND AT 03:13:50.3 ARE THOSE UPDATED IN REAL-TIME FOR THE ALTERNATE MISSION.

2.0 ANOMALY LISTING

THE FOLLOWING TABLE CONTAINS A DESCRIPTION OF SIGNIFICANT ANOMALIES WHICH WERE REVIEWED PRIOR TO THE APOLLO 8 FLIGHT READINESS REVIEW. FOLLOWING THE LIST OF SIGNIFICANT ANOMALIES, ALL ANOMALIES RESULTING FROM THE MISSION ARE NUMBERED AND DESCRIBED ACCORDING TO SPACECRAFT (2.1), LAUNCH VEHICLE (2.2), AND GROUND SYSTEMS (2.3.). WHERE CLARITY IS REQUIRED, SUPPORTING MATERIAL IS INCLUDED, GIVING THE ANOMALY BACKGROUND, A DETAILED DESCRIPTION, THE CAUSE AND STATUS OF CORRECTIVE ACTIONS.

(*) THESE ANOMALIES ARE CONSIDERED SIGNIFICANT FOR FUTURE MISSIONS.

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ANOMALY REPORT

NO. 2.1.1 TITLE: UNEXPECTED STRUCTURAL INDICATIONS DURING LAUNCH PHASE

SYSTEM: SPACE VEHICLE

MISSION: APOLLO 6

SUBSYSTEM: STRUCTURES

EVENT TIME: 00:01:20

DESCRIPTION: AT APPROXIMATELY 00:02:13, ABRUPT CHANGES OF STRAIN, VIBRATION, AND ACCELERATION MEASUREMENTS OCCURRED IN THE S-IVB, IU, SLA, LTA AND CSM. PHOTOGRAPHS SHOW THAT PIECES FELL FROM THE SLA AT THIS TIME. STRAIN GAGE MEASUREMENTS ON THE 16 LTA SUPPORT STRUTS AND ON EIGHT OF THE S-IVB FORWARD SKIRT STRINGERS SHOWED A SHIFT IN THE INERTIAL LOAD BALANCE. SHIFTS ALSO OCCURRED IN DYNAMIC PARAMETERS SUCH AS VIBRATIONS, ACCELERATIONS, AND ANGULAR RATES. OTHER ANOMALOUS EVENTS OCCURRED FROM 00:10:20 TO 00:02:15.

STATUS: THE DYNAMIC ENVIRONMENT DURING S-IC BOOST EXCEEDED THE SPACECRAFT DESIGN REQUIREMENTS. A STRUCTURAL FAILURE OF AT LEAST THE SLA OCCURRED AT ABOUT 00:02:13; HOWEVER, IT WAS OF SUCH A NATURE THAT THE FLIGHT LOADS WERE SUSTAINED FOR THE REMAINDER OF THE LAUNCH PHASE. THE EVIDENCE INDICATES THAT THE INNER FACE SHEET OF THE MINUS Z PANEL ON THE SPACECRAFT/LAUNCH VEHICLE ADAPTER FAILED MASSIVELY AND PROBABLY EXPLOSIVELY, THAT THE MOST PROBABLE INITIATOR WAS A SPLICE PLATE BOND VOID, AND THAT THE FAILURE WAS INDEPENDENT OF THE HIGH-LEVEL, LOW-FREQUENCY OSCILLATIONS BEING EXPERIENCED AT THE TIME.

ORGANIZATION: 5-2464

REFERENCES: LISTED ON SUBSEQUENT PAGE.

RESOLUTION: CLOSED

DATE:

REV: C

DETAIL SHEET

ANOMALY 2.1.1

TITLE: UNEXPECTED STRUCTURAL INDICATIONS DURING LAUNCH PHASE

A. EARLY EVENTS

ALTHOUGH A MAJORITY OF THE EVENTS OCCURRED AT ABOUT 02:13, MANY SIGNIFICANT EVENTS OCCURRED PRIOR TO THIS TIME.*

00:01:20	HIGHEST DYNAMIC STRAINS RECORDED IN S-IVB FORWARD SKIRT.
00:01:26	REVERSAL OF ROLL AND YAW ATTITUDE OFF-SETS. LUNAR MODULE TEST ARTICLE MICROPHONE "CLICK." VIBRATION AND ACOUSTIC TRANSIENTS IN COMMAND MODULE.
00:01:28	ERRATIC OPERATION OF PCM TELEMETRY AND ONBOARD DATA RECORDER. LET OSCILLATION ± 6 INCHES.
00:01:30	S-IVB STRINGERS 41, 68 AND 95 BEGAN CARRYING MORE LOAD THAN ON APOLLO 4.
00:01:32	REVERSAL OF PITCH ATTITUDE OFF-SET.
00:01:47	SUDDEN LOAD SHIFT IN S-IVB STRINGER 95. LET OSCILLATION ± 3 INCHES.
00:01:56	REVERSAL OF ROLL AND YAW ATTITUDE OFF-SET.
00:01:56	PITCH ATTITUDE OFF-SET INCREASED TO 1 DEGREE.
00:01:58	CSM RATE GYRO DATA BEGAN A SLOWLY INCREASING PITCH OSCILLATION.

B. ATTITUDE OFF-SET REVERSALS

ATTITUDE OFF-SETS ARE DERIVED FROM THE DIFFERENCES IN THE ATTITUDES INDICATED BY THE CM INERTIAL MEASUREMENT UNIT AND THE IU INERTIAL MEASUREMENT UNIT. A COMPARISON OF CSM AND IU INERTIAL MEASUREMENT UNIT DATA WAS MADE THROUGHOUT THE ASCENT PHASE. FROM LIFT-OFF UNTIL 00:01:26, ALL INDICATIONS WERE NORMAL AND COMPARABLE TO APOLLO 4 DATA. AT 00:01:26, A ROLL OFF-SET REVERSAL WAS NOTED BETWEEN THE CSM AND IU, FOLLOWED BY A PITCH OFF-SET REVERSAL AT 00:01:32, RETURNING TO NEARLY THE ORIGINAL VALUE BY 00:01:38. A SIMILAR TEMPORARY OFF-SET REVERSAL OCCURRED IN ROLL AND YAW AT 00:01:56. THE PITCH DID NOT REVERSE AT THIS TIME, BUT INCREASED APPROXIMATELY ONE DEGREE. SMALL OFF-SET VARIATIONS CONTINUED IN ALL THREE AXES UNTIL S-IC STAGE CUTOFF. THE RESPECTIVE OFF-SETS

*THE MSC ANOMALY STATUS REPORT OF AUGUST 20 STATES THAT THE UNEXPLAINED EVENTS PRIOR TO 00:02:13 WERE NOT ASSOCIATED WITH THE SLA STRUCTURAL FAILURE.

TITLE: UNEXPECTED STRUCTURAL INDICATIONS DURING LAUNCH PHASE

B. ATTITUDE OFF-SET REVERSALS (CONT'D)

RETURNED TO NEARLY THE INITIAL VALUES AFTER S-II STAGE IGNITION AND APPEAR NORMAL UNTIL LOSS OF THE TWO S-II ENGINES. THE INITIAL IMPLICATION THAT THE ELASTIC CHARACTERISTIC OF THE STRUCTURE BETWEEN THE TWO PLATFORMS WAS ALTERED, POSSIBLY BY SOME STRUCTURAL FAILURE THAT COULD HAVE OCCURRED AS EARLY AS 00:01:26, HAS SINCE BEEN REFUTED.

C. PHOTOGRAPHIC EVIDENCE OF ANOMALOUS EVENTS

A FRAME-BY-FRAME REVIEW OF THE APOLLO 6 FLIGHT FILMS SHOWS THE FOLLOWING:

SEVERE OSCILLATIONS OF THE LAUNCH ESCAPE TOWER WERE OBSERVED AT 01:28, 01:44, 01:47, AND 01:48. THE MOST SEVERE OSCILLATIONS OCCURRED AT 01:28.

BULGING ON THE PLUS Z AXIS AND INDENTATIONS ON THE MINUS Z AXIS OF THE ADAPTER SURFACE WERE FIRST OBSERVED AT 02:13:15, AND INTERMITTENTLY FOR ABOUT ONE SECOND. LATERAL DEFLECTIONS ALONG THE VEHICLE WERE OBSERVED TO ACCOMPANY THE BULGING AND BUCKLING.

A DARK AREAS WHICH APPEARS ON THE SLA AT 00:02:13 IS SHOWN SCHEMATICALLY IN FIGURE 2.1.1-1. THE DARK AREA IS MORE THAN TWICE THE AREA OF THE PIECES SEEN FALLING FROM THE SLA; CONSEQUENTLY, THE REMAINDER OF THE DARK AREA MUST HAVE BEEN LACK OF REFLECTION FROM A PERMANENT DEFORMATION OF THE SLA SURFACE. DENSITOMETER CONTOURS OF FAILED AREA WERE STUDIED. BECAUSE OF THE SHAPE OF THE TERMINATORS IT MAY BE PRESUMED THAT CONTOURS REPRESENT INWARD BUCKLING.

SEPARATION OF THREE SMALL AND FIVE OR SIX LARGE PIECES OF SHEET MATERIAL FROM THE SURFACE OF THE ADAPTER WAS OBSERVED FROM 02:13.31 TO 02:13.68. THE APPROXIMATE POSITIONS OF THE LARGEST OF THESE PIECES ARE SHOWN IN FIGURE 2.1.1-2, ALONG WITH THE CORRESPONDING RANGE TIME FOR EACH POSITION. SOME PIECES BROKE UP INTO SMALLER PIECES WHEN PASSING THROUGH THE MORE TURBULENT AREAS. AT LEAST ONE SURFACE OF EACH PIECE WAS HIGHLY LIGHT-REFLECTIVE.

TRAJECTORY ANALYSIS WAS USED TO ESTIMATE THE MATERIAL PROPERTIES OF TWO OF THE PIECES OBSERVED FALLING FROM THE SLA. IT HAS BEEN CONCLUDED THAT THEY WERE PIECES OF ALUMINUM STRUCTURE.

TITLE: UNEXPECTED STRUCTURAL INDICATIONS DURING LAUNCH PHASE

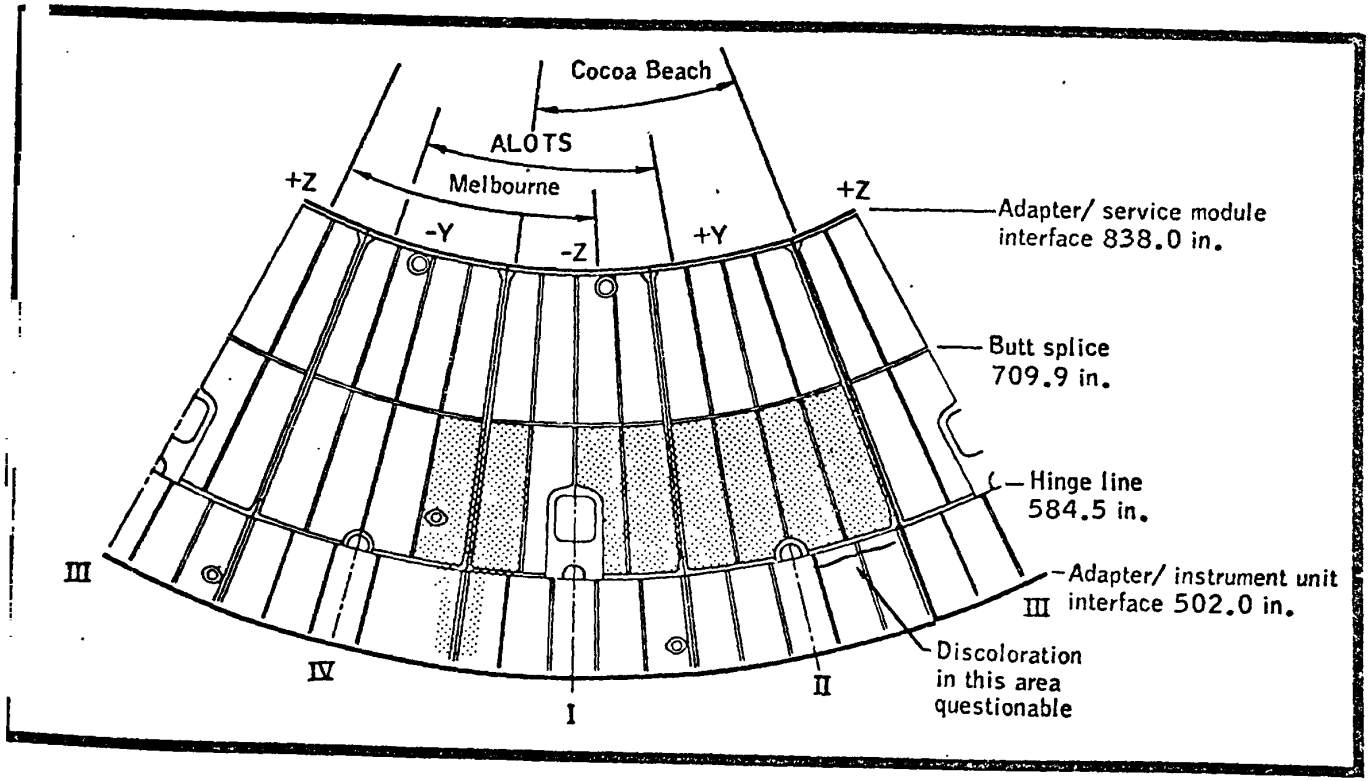


Figure 2.1.1-1. Photographic Coverage of SLA Showing Approximate Area of Color Change

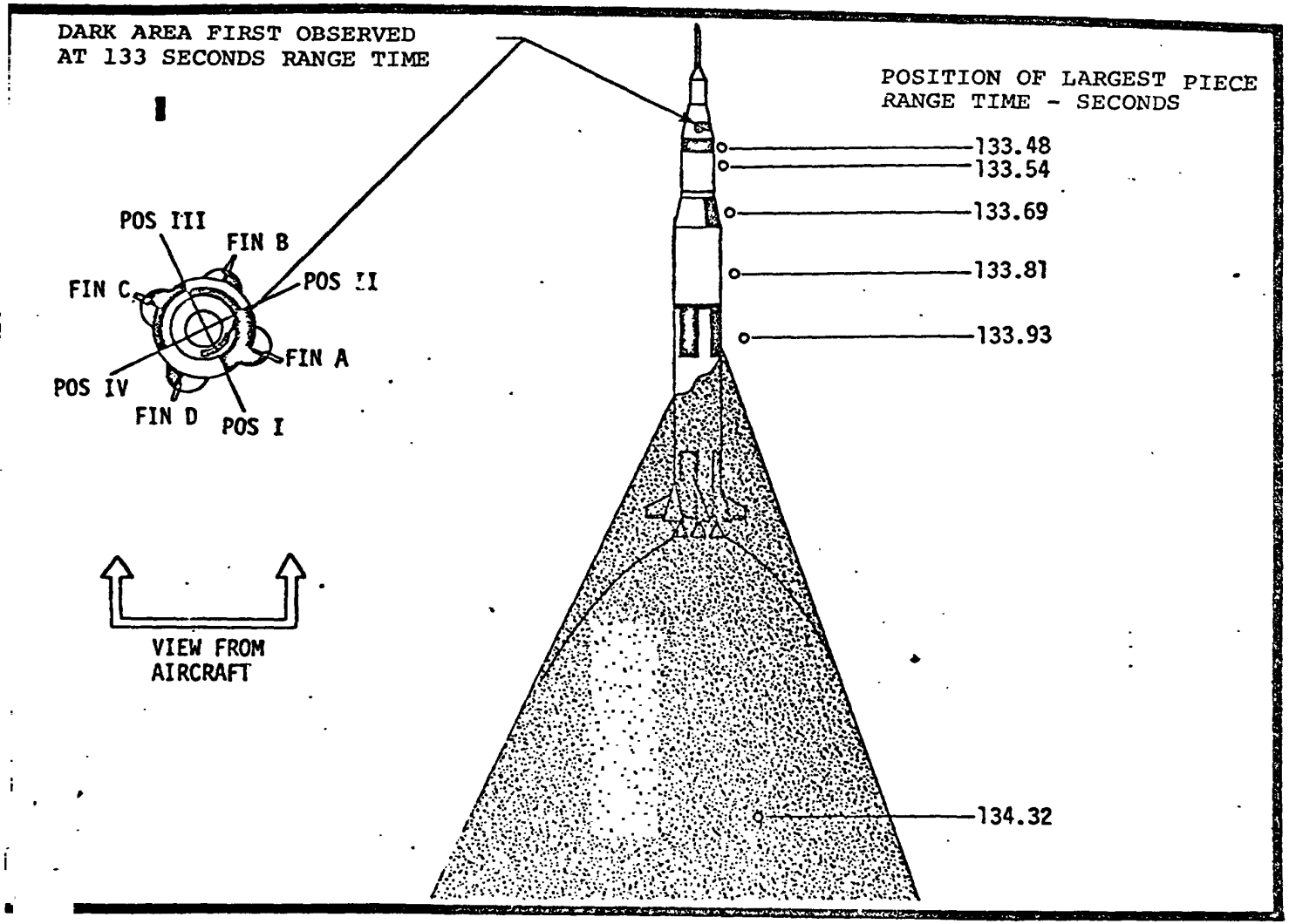


FIGURE 2.1.1-2 PLOT OF LARGEST PIECE - ALOTS 70 MM FILM - 133 TO 135 SECONDS RANGE TIME

TITLE: UNEXPECTED STRUCTURAL INDICATIONS DURING LAUNCH PHASE

D. OTHER UNEXPECTED EVENTS

ADDITIONAL EVIDENCE THAT ALUMINUM SURFACE MATERIAL FELL OFF THE ADAPTER IS PROVIDED BY THE CHANGE IN RF SIGNAL STRENGTHS AT THE RECEIVING STATIONS. SIGNALS FROM THE TWO LTA ANTENNAS LOCATED BELOW THE SLA PANELS SHOWED MOMENTARY DROPS OF MORE THAN 50 DB FROM 00:02:13.344 TO 00:02:13.360. ABOUT 12 MILLISECONDS LATER, RF ATTENUATIONS OF 10 TO 15 DB FROM THE IU AND 8 DB FROM THE S-IVB WERE ALSO NOTED. ANTENNA PATTERN PERTURBATIONS CREATED BY LARGE METALLIC SURFACES PASSING BETWEEN THE ANTENNAS AND THE RECEIVING STATIONS WOULD CAUSE SIMILAR RF ATTENUATIONS.

THE CHARACTERISTICS OF THE LTA WERE AS EXPECTED FOR THE ENVIRONMENT ENCOUNTERED UNTIL APPROXIMATELY 00:02:13, WHEN AN UNEXPECTED CHANGE IN MEASUREMENT CHARACTERISTICS WAS NOTED IN ALL STRUT LOADS AND ACCELEROMETER MEASUREMENTS. THREE MEASUREMENTS POWERED THROUGH THE SAME FUSE WERE LOST AT 00:02:13.3. BETWEEN 02:13.26 AND 02:13.28, THE LTA/SLA ATTACHMENT LOAD PATTERN STARTED CHANGING TO A LARGE INWARD ACTING LOAD AT THE MINUS Z APEX FITTING, OUTWARD ACTING RADIAL LOADS AT THE $\pm$ Y APEX FITTINGS, AND TANGENTIAL LOADS IN THE MINUS Z DIRECTION AT THE $\pm$ Y APEX FITTINGS. THESE LOADS REMAINED CONSTANT UNTIL S-IC STAGING, AT WHICH TIME THE LOADS DECREASED. THIS LOAD PATTERN COULD BE CAUSED BY A DEFORMATION OF THE SLA.

AT 00:02:13.3, 10 SLA STRAIN MEASUREMENTS FAILED ALONG WITH 2/3 OF THE TEMPERATURE MEASUREMENTS. THE FOUR MEASUREMENTS WHICH CONTINUED TO OPERATE RECEIVED POWER THROUGH WIRES SEPARATE FROM THOSE SUPPLYING THE FAILED MEASUREMENTS. OPEN POWER WIRING IS THE MOST LIKELY CAUSE OF THE FAILURE OF THE 10 MEASUREMENTS.

THE STRAIN GAGES ON THE S-IVB AFT SKIRT STRINGERS SHOWED NO UNUSUAL CHARACTERISTICS DURING THE PERIOD OF THE ANOMALY. THE FIRST INDICATION OF UNUSUAL BEHAVIOR IN THE S-IVB OCCURRED AT 00:01:47 WHEN A SHARP INCREASE OF LOAD WAS EXPERIENCED IN STRINGER 95. THE STRINGER BENDING MOMENT ALSO REVERSED, INDICATING A CHANGE IN THE LOAD DISTRIBUTION. THE S-IVB FORWARD SKIRT LOADS INCREASED UNTIL 00:02:13 AT WHICH TIME A SIGNIFICANT INCREASE IN AXIAL LOAD ACCOMPANIED BY A REVERSAL OF THE BENDING MOMENT OCCURRED IN SEVERAL FORWARD SKIRT STRINGERS.

ANOMALY 2.1.1

TITLE: UNEXPECTED STRUCTURAL INDICATIONS DURING LAUNCH PHASE

ONE OF THE TWO PHYSICAL SEPARATION DISTANCE MONITORS BETWEEN THE SM AND THE SLA SHOWED A DISPLACEMENT BETWEEN THE STRUCTURES. THE INSTRUMENTS ARE EXTENSOMETERS MOUNTED ON THE AFT END OF THE SM, WITH A TAPE EXTENDING DOWN INSIDE THE WALL OF THE SLA AND ATTACHED NEAR THE SLA PANEL HINGE LINE. A DISCRETE INDICATION WHICH NORMALLY OCCURS AT A SEPARATION DISTANCE OF 3 INCHES WAS RECEIVED FROM THE EXTENSOMETER LOCATED IN THE PLUS Y MINUS Z QUADRANT AT 00:02:13, INDICATING A PULL ON THE TAPE.

AT APPROXIMATELY 00:02:13, ONE OF THE THREE EDS HOT-WIRE AUTOMATIC ABORT VOTING CIRCUITS BECAME DE-ENERGIZED. BETWEEN LIFT-OFF AND LET JETTISON, TWO SUCH VOTES ARE REQUIRED TO CAUSE AN AUTOMATIC ABORT. POST-FLIGHT TESTS HAVE VERIFIED THE INTEGRITY OF THE CM WIRING FOR THE EDS TELEMETRY SIGNAL AND THE EDS ABORT LOGIC.

ANOMALY 2.1.1

TITLE: UNEXPECTED STRUCTURAL INDICATION DURING LAUNCH PHASE

CORRECTIVE ACTION

APOLLO 7

VENT HOLES WERE DRILLED IN THE SLA HONEYCOMB PANELS.

INSPECTION THROUGH THE VENT HOLES HAS ALLEVIATED CONCERN ABOUT CORROSION WITHIN THE HONEYCOMB PANELS OF SLA-5.

ADDITIONAL SLA-5 PORTA-PULL TESTS WERE MADE TO ADD CONFIDENCE TO BOND ADEQUACY.

THE LOADS AND TEMPERATURES WERE LESS STRENUOUS ON APOLLO 7 (S-IB) THAN EXPERIENCED ON APOLLO 6 (SAT V).

APOLLO 8

A CORK COVERING WILL BE ADDED TO THE ADAPTER EXTERNAL SKIN TO DECREASE FACE SHEET TEMPERATURES, AND VENT HOLES WILL BE DRILLED IN THE INNER FACE SHEET TO DECREASE PRESSURE BUILDUP. ADDITIONALLY, EDDY-SONIC INSPECTION FOR BOND VOIDS WILL BE PERFORMED AFTER DELIVERY OF THE ADAPTERS TO KENNEDY SPACE CENTER.

ANOMALY 2.1.1

TITLE: UNEXPECTED STRUCTURAL INDICATIONS DURING LAUNCH PHASE

REFERENCES:
7-DAY FEWG MEETING, APRIL 12, 1968;
AS-503 SEMI-DCR/AS-502 EVALUATION MEETING, APRIL 21, 1968;
14-DAY FEWG MEETING, APRIL 25, 1968;
MSC 10-DAY REPORT, APRIL 15, 1968;
AS-503 PROGRAM ACTIONS REVIEW, MAY 2, 1968;
MSC 30-DAY REPORT, P. 5;
MSFC 30-DAY REPORT, ITEM 12;
MSFC 30-DAY REPORT, REVISION A, ITEM 12.
BOEING SLA INCIDENT INVESTIGATION MEETING, MAY 28-29, 1968;
MSC 60-DAY REPORT, PP. 13, 2-1, 4-1, 5.1-1, 5.1-6, 12-5;
AS-503 PROGRAM ACTIONS REVIEW, JULY 15, 1968.
MSC ANOMALY STATUS REPORT, AUGUST 20, 1968, P. 4.
AS-503 PROGRAM ACTION REVIEW, SEPTEMBER 11, 1968;
APOLLO 7 MISSION READINESS ASSESSMENT BOARD MEETING, SEPTEMBER 26, 1968;
APOLLO S/C TECH. EVAL. FOR APOLLO 7 FRR
MSC ANOMALY STATUS REPORT, NOVEMBER 5, 1968

ANOMALY REPORT

NO. 2.1.2 TITLE: COMPUTER UPDATE ALARMS

SYSTEM: CM MISSION: APOLLO 6

SUBSYSTEM: PRIMARY GUIDANCE, NAVIGATION AND CONTROL SYSTEM (PGNCS) AND TELECOMMUNICATIONS EVENT TIME: LAUNCH AND ORBIT

DESCRIPTION: AN EXCESSIVE NUMBER OF COMPUTER UPDATE ALARMS OCCURRED DURING THE MISSION FROM APPROXIMATELY 00:01:30 TO 07:10:53. THE PATTERN OF THESE ALARMS INDICATES THAT THE PROBLEM BECAME MORE SEVERE AS THE FLIGHT PROGRESSED; HOWEVER, THERE IS NO CORRELATION WITH MISSION EVENTS WHICH WOULD EXPLAIN THIS INCREASE IN SEVERITY. SEVERAL GROUND UPDATES WERE REJECTED BY THE COMPUTER WITH THE ACCOMPANYING ALARM, INDICATING FAILURE OF THE WORD VALIDITY (K$\overline{\text{R}}$K) CHECK. THE FACT THAT NUMEROUS "CLEAR" COMMANDS WERE PROCESSED INDICATES THAT THE COMPUTER WAS PERFORMING AS PROGRAMMED. THE ALARMS OCCURRED BOTH WITH AND WITHOUT GROUND UPDATE ACTIVITY IN PROGRESS, WHICH INDICATES THAT EXTRANEOUS BITS WERE BEING INTRODUCED INTO THE COMPUTER INPUT REGISTER.

STATUS: POWER-ON TESTS OF ALL THE COMMAND MODULE SYSTEMS WERE PERFORMED TO DETERMINE THE CAUSE OF THE K$\overline{\text{R}}$K ALARMS. AS OF THIS TIME, THE ANOMALY HAS NOT BEEN DUPLICATED. THE UP-DATA LINK EQUIPMENT HAS BEEN THOROUGHLY BENCH-TESTED, INCLUDING QUAL AND POGO VIBRATION, AND IT OPERATED WITHIN SPECS AT ALL TIMES. NUMEROUS COMPUTER UPDATE ALARMS HAVE OCCURRED DURING TESTING OF OTHER SPACECRAFT BECAUSE OF ELECTROMAGNETIC INTERFERENCE. FOR APOLLO 7, THE UPDATA LINK WILL BE DE-ACTIVATED WHEN IT IS NOT REQUIRED. FOR SPACECRAFT 104 AND SUBS., A RELAY WILL BE USED TO DE-ENERGIZE THE GSE COMPUTER UPLINK LINES IN FLIGHT AND WHEN NOT REQUIRED IN CHECKOUT. THE RELAY WILL NOT BE USED FOR SPACECRAFT 103 UNLESS A PROBLEM OCCURS DURING THE APOLLO 7 MISSION. THIS ANOMALY HAS BEEN CLOSED BY MSC.

ORGANIZATION: S-2464 RESOLUTION: CLOSED DATE:

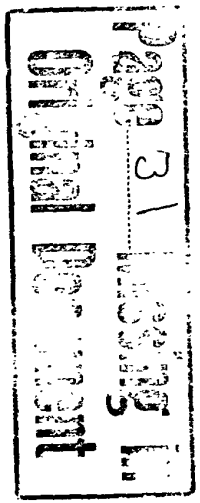
REFERENCES: MSC 3-DAY REPORT, P. 11;
MSC 10-DAY REPORT, P. 16; REV: C
MSC 30-DAY REPORT, P. 3;
MSC 60-DAY REPORT, PP. 5.16-7, 12-3 AND 12-13.
MSC ANOMALY STATUS REPORT, SEPTEMBER 17, 1968, P. 2.

DETAIL SHEET

ANOMALY 2.1.2

TITLE: COMPUTER UPDATE ALARMS

RECURRENCE OF COMMAND REJECTIONS FOR APOLLO MISSIONS



APOLLO 6

COMPUTER UPDATE ALARMS (KKK) WERE RECEIVED THROUGHOUT THE MISSION, WITH OR WITHOUT UPLINK ACTIVITY. NO CORRELATION CAN BE ESTABLISHED BETWEEN THE UPDATA BLOCKS, ERRATIC PCM DATA, AND DOSIMETER RANGE SWITCHING. AFTER THE MISSION, THE COMPUTER AND UPDATA LINK WERE TESTED INDIVIDUALLY AND IN COMBINATION WITH OTHER SPACECRAFT SYSTEMS, AND THE FLIGHT PROBLEM COULD NOT BE DUPLICATED. THE TESTS, HOWEVER, DID NOT INCLUDE THE WIRING FROM THE UPDATA LINK THROUGH THE SERVICE MODULE TO THE CHECKOUT EQUIPMENT (APPROXIMATELY 40 FEET OF WIRE). NUMEROUS COMPUTER UPDATE ALARMS HAVE ALSO BEEN NOTED DURING TESTING OF OTHER SPACECRAFT. THESE PROBLEMS WERE CAUSED BY ELECTROMAGNETIC INTERFERENCE COUPLED THROUGH THE GROUND SUPPORT EQUIPMENT AND WERE A DIRECT RESULT OF IMPROPER GROUNDING OR SHIELDING OF THE COMPUTER UPLINK LINES. (REFERENCE SOURCE: MSC ANOMALY STATUS REPORT, SEPTEMBER 17, 1968.)

APOLLO 5

PROBLEMS WERE EXPERIENCED GETTING DESIRED COMMANDS INTO THE LUNAR MODULE DUE TO LOW SIGNAL POWER AT THE LM DIGITAL COMMAND ASSEMBLY RECEIVER. MSC ISOLATED THE FAULT TO THE FLIGHT HARDWARE; SPECIFICALLY, TO EITHER THE RF STAGE OF THE DIGITAL COMMAND ASSEMBLY OR TO THE COAXIAL CABLE ASSEMBLY CONNECTING THE UHF DIPLEXER AND THE DIGITAL COMMAND ASSEMBLY. MSC STATES NO CORRECTIVE ACTION PLANNED, EXCEPT TO IMPLEMENT PLANS WHICH EXISTED PRIOR TO LM-1 MISSION FOR NEW VIBRATION ACCEPTANCE TEST LEVELS. IN A LABORATORY TEST, 30 TO 40 DB ATTENUATION OCCURRED WHEN METAL-TO-METAL CONTACT WAS INTERRUPTED AT THE DIGITAL COMMAND ASSEMBLY CABLE CONNECTION POINT, WHICH DUPLICATES THE 40-DB DROP IN SIGNAL POWER EXPERIENCED DURING FLIGHT. (REFERENCE SOURCE: D2-117017-2 AND MSC-TIE ANOMALY NOT #5.)

APOLLO 4

COMMAND REJECTIONS OCCURRED, BUT THEY WERE NOT CAUSED BY INTERNAL SPACECRAFT EQUIPMENT MALFUNCTION.

ANOMALY REPORT

NO. 2.1.3 TITLE: ERRATIC DATA

MISSION: APOLLO 6

SYSTEM: CSM

EVENT TIME: 00:01:28

SUBSYSTEM: TELECOMMUNICATIONS

DESCRIPTION: THE PCM TELEMETRY, FLIGHT QUALIFICATION RECORDER (FQR), CENTRAL TIMING EQUIPMENT (CTE), AND SM HIGH-LEVEL COMMUTATOR OPERATED ERRATICALLY FROM 00:01:28 TO 00:08:20, AND DURING PORTIONS OF THE SECOND AND THIRD REVOLUTIONS.

STATUS: ACCEPTABLE CSM VIBRATION DATA WERE EXPECTED TO BE RECOVERED FROM THE NOISY FQR DATA BUT RESULTS ARE UNAVAILABLE. FACILITIES AND TECHNIQUES WILL BE AVAILABLE TO PROVIDE TIMELY REDUCTION OF AS-503 FQR DATA. DURING THE CHAMBER TESTS OF SPACECRAFT 101, ELECTROMAGNETIC INTERFERENCE (EMI), WHICH WAS GENERATED BY CORONA DISCHARGE IN THE POWER SUPPLY FOR THE SM CRYOGENIC TANK VAC-ION PUMPS, CAUSED ERRATIC OPERATION OF THE PCM TELEMETRY AND THE CTE SIMILAR TO THAT EXPERIENCED ON CSM 020 DURING THE APOLLO 6 MISSION. SEVERAL OTHER POWER SUPPLIES HAVE ALSO SHOWN CORONA DISCHARGE DURING SIMULATED ALTITUDE TESTS. FOR SPACECRAFT 101, 103 AND 104, THE PUMPS WILL NOT BE OPERATED. ON SUBSEQUENT SPACECRAFT, THE PUMPS IN THE HYDROGEN TANKS WILL NOT BE OPERATED, AND A DISABLING SWITCH IN THE CABIN WILL BE PROVIDED FOR THE PUMPS IN THE OXYGEN TANKS. POTTING AND SHIELDING OF THE PUMPS AND ASSOCIATED WIRING WILL ALSO BE IMPROVED.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSC 3-DAY REPORT, P.11;
MSC 10-DAY REPORT, PP. 16, 17;
MSC 30-DAY REPORT, PP. 2,3;
MSC 60-DAY REPORT, PP. 5.14-1 TO 5.14-3, 5.15-1 TO 5.15-6, AND 12-2;
MSC ANOMALY STATUS REPORT, SEPTEMBER 17, 1968, PP. 1 AND 2

REV: C

DETAIL SHEET

ANOMALY 2.1.3

TITLE: ERRATIC DATA

A. PCM TELEMETRY DATA

BOTH TELEMETERED AND ONBOARD-RECORDED PCM DATA WERE UNUSABLE FROM 00:01:28 TO 00:08:29. THE RF LEVELS APPEAR NORMAL, BUT MODULATING SIGNALS DISPLAY ABNORMAL CHARACTERISTICS. THE PCM DATA LOSSES ARE ALMOST PERIODIC, WITH ABOUT ONE HALF-SECOND OF GOOD DATA FOLLOWED BY ABOUT ONE HALF-SECOND OF UNUSABLE DATA. PCM DATA LOSSES WERE ALSO EXPERIENCED FOR SHORT PERIODS DURING THE SECOND AND THIRD REVOLUTIONS.

DURING POWER-ON POST-FLIGHT TESTS, THE PCM TELEMETRY PERFORMED NORMALLY AND THE INTERMITTENT DATA LOSSES THAT OCCURRED DURING LAUNCH COULD NOT BE REPRODUCED. CONTINUITY CHECKS OF POWER AND GROUND WIRING HAVE BEEN PERFORMED, BUT THE RESULTS WERE INCONCLUSIVE. THE PCM TELEMETRY EQUIPMENT WAS TESTED AT THE VENDOR'S FACILITY AND IT OPERATED SATISFACTORILY WITHIN THE DESIGN SPECIFICATION, WITH THE EXCEPTION OF ONE EVENT GATE AND ONE SET OF FIVE ANALOG INPUT GATES. THE PCM ALSO PERFORMED SATISFACTORILY UNDER QUALIFICATION AND "POGO" VIBRATION LEVELS. TESTS REVEALED THAT RANDOM NOISE IN EXCESS OF 4.0V PEAK TO PEAK ON THE 1 PPS TIMING INPUT OR RANDOM NOISE IN EXCESS OF 2.0V PEAK TO PEAK ON THE 512 KHZ TIMING INPUT WOULD PRODUCE INTERMITTENT BREAKING UP OF THE DATA AS EXPERIENCED DURING THE FLIGHT.

B. CENTRAL TIMING EQUIPMENT ERRATIC

THE TIME ACCUMULATOR IN THE CENTRAL TIMING EQUIPMENT (CTE) JUMPED TWO MINUTES AHEAD AT 00:02:24.7 AND OPERATED ERRATICALLY UNTIL 00:55:12.7, AT WHICH TIME IT WAS 810 SECONDS AHEAD. IT ALSO OPERATED ERRATICALLY FROM 03:29:35.7 TO 09:29:43.5, AT WHICH TIME IT HAD JUMPED AHEAD 19 TIMES AND WAS 141,956 SECONDS AHEAD. TIMING INFORMATION HAS BEEN DUBBED ON THE DATA RECORDS FOR DATA REDUCTION.

THE CTE WAS REMOVED, AND WHEN ACCEPTANCE TESTS WERE CONDUCTED BY THE VENDOR, NO ANOMALIES OCCURRED. DURING QUAL. LEVEL VIBRATION TESTING, THE TIME ACCUMULATOR ADVANCED TWO HOURS DURING ONE RUN AND FOUR HOURS DURING ANOTHER RUN. IT WAS BELIEVED THESE ADVANCES WERE CAUSED BY FAULTY TEST CABLES. THE VIBRATION TESTS WERE RE-RUN WITH BOTH THE ORIGINAL TEST CABLES AND ALSO WITH A NEW SET OF TEST CABLES; HOWEVER, THE ANOMALIES DID NOT RECUR. THE VENDOR IS PERFORMING A FAILURE ANALYSIS TO DETERMINE IF THE ANOMALY ORIGINATED WITHIN THE CTE OR WAS CAUSED BY THE TEST EQUIPMENT.

TITLE: ERRATIC DATA (CONTINUED)

C. FLIGHT QUALIFICATION RECORDER (FQR) DATA

DURING THE LAUNCH PHASE, THE TIME-CODE GENERATOR (4-SECOND TIMER) FOR THE FLIGHT QUALIFICATION TAPE RECORDER EXPERIENCED TWO ANOMALIES. AT 00:01:04.5, THE EXPECTED TIMING PULSES DID NOT OCCUR FOR 0.6 SECOND. THE FOLLOWING EXHIBITED TIME DISPLAYED A GAIN OF 10 MINUTES, 25.85 SECONDS. THE TIME-CODE GENERATOR PERFORMED NORMALLY THEREAFTER UNTIL 00:01:26.4 WHEN AN EXTRANEOUS PULSE OCCURRED. FALSE COUNTS WERE GENERATED BY THE TIMER FOR THE NEXT 2.23 SECONDS. THE TIMER OUTPUT WAS UNUSABLE FROM 00:01:28.5 UNTIL THE TAPE RECORDER WAS TURNED OFF AT 00:03:04.84. DURING ENTRY, THE TIME-CODE GENERATOR PERFORMED NOMINALLY FROM THE TIME THE TAPE RECORDER WAS TURNED ON AT 09:36:55 UNTIL THE TAPE RECORDER WAS TURNED OFF AT 09:57:32 AFTER CM LANDING. THESE ANOMALIES WERE NOT DETRIMENTAL TO THE RECOVERY OF THE FQR DATA.

CSM VIBRATION DATA IS RECORDED ON THE FQR WHICH RECORDS ONLY DURING THE BOOST AND ENTRY PHASES OF THE MISSION. APOLLO 6 DATA HAD HIGH NOISE LEVELS AT FREQUENCIES OF 20 TO 30 HZ AND 80 TO 90 HZ. THE NOISE WAS APPARENT DURING THE CALIBRATION RUN JUST PRIOR TO LAUNCH AND INCREASED AFTER LAUNCH. THESE HIGH NOISE LEVELS HAVE BEEN ATTRIBUTED TO TAPE RECORDER FLUTTER AND TO THE INCREASE OF THIS FLUTTER IN THE POST LAUNCH VIBRATION ENVIRONMENT. A 50KHZ SIGNAL IS RECORDED ON ONE OF THE TAPE RECORDER CHANNELS TO COMPENSATE FOR THIS FLUTTER NOISE DURING DATA REDUCTION, BUT FACILITIES AND TECHNIQUES FOR EFFECTIVE SIGNAL UTILIZATION WERE NOT AVAILABLE AT MSC UNTIL RECENTLY. ACCEPTABLE CSM VIBRATION DATA IS EXPECTED TO BE RECOVERED IN THE NEAR FUTURE, AND THESE FACILITIES AND TECHNIQUES WILL BE AVAILABLE TO PROVIDE TIMELY REDUCTION OF THE APOLLO 8 DATA.

A PROPOSAL TO SHOCK MOUNT THE TAPE RECORDER IN CSM-101 AND CSM-103 WAS TURNED DOWN BY MSC AND NO OTHER CHANGES IN THE TAPE RECORDER ARE PLANNED. MSC HAS CONCLUDED THAT THE FLUTTER WAS CAUSED BY THE TAPE RECORDER'S SENSITIVITY TO THE POGO FREQUENCY AND ITS HARMONICS, AND THAT POGO FIXES WILL PRECLUDE A RECURRENCE ON AS-503/CSM-103. HOWEVER, THE FLUTTER NOISE EXPERIENCED ON THE CSM-020 VIBRATION DATA WAS NOT A SIGNIFICANT PROBLEM AND A RECURRENCE OF TAPE RECORDER FLUTTER ON SUBSEQUENT CSM FLIGHTS WILL NOT PRECLUDE THE RECEIPT AND RECOVERY OF ACCEPTABLE CSM VIBRATION DATA. THE FQR WILL BE USED ONLY ON CSM 101 AND 103.

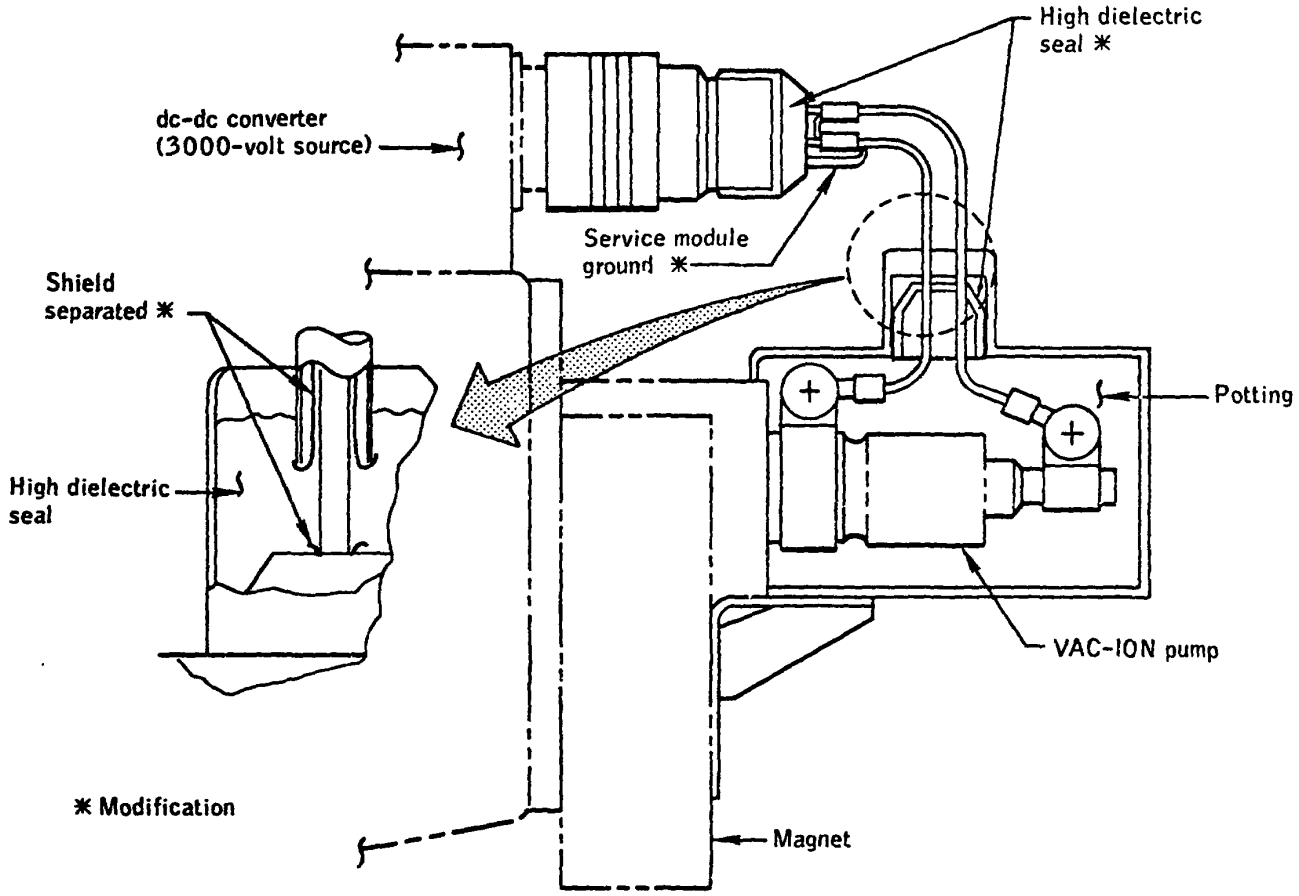
DETAIL SHEET

ANOMALY 2.1.3

TITLE: ERRATIC DATA (CONTINUED)

D. SERVICE MODULE HIGH-LEVEL COMMUTATOR ERRATIC

THE HIGH-LEVEL COMMUTATOR NO. 2, WHICH WAS MOUNTED ON THE SM, PROCESSED 16 STRAIN MEASUREMENTS, 15 TEMPERATURE MEASUREMENTS, AND 3 SERVICE PROPULSION SYSTEM TEMPERATURE MEASUREMENTS. THIS COMMUTATOR EXHIBITED ERRATIC PERFORMANCE DURING THE LAUNCH PHASE. THE DATA FROM 00:01:28.68 UNTIL THE TAPE RECORDER WAS TURNED OFF AT 00:03:06.55 WERE UNRECOVERABLE BY NORMAL DATA PROCESSING METHODS. INDICATIONS WERE THAT THE INTERNAL CLOCK OF THE COMMUTATOR LOST SYNCHRONIZATION AND THE WAVE TRAIN BECAME LESS THAN THE NOMINAL 88 DATA PULSES AND MASTER PULSE TRAIN. THIS PROBLEM WAS COINCIDENT WITH THE PROBLEM OF THE FLIGHT QUALIFICATION TAPE RECORDER TIME-CODE GENERATOR, AS WELL AS COINCIDENT WITH THE LOSS OF PCM DATA. A REVIEW OF THE COMMUTATOR WAVE TRAIN FOR THIS PERIOD INDICATED THAT REALISTIC INDICATIONS OF GROSS MEASUREMENT OPERATION CAN BE DETERMINED. THE REVIEW ALSO INDICATED A SIMULTANEOUS FAILURE OF 19 MEASUREMENTS, ALL COMMON TO THE SAME PRIMARY POWER SOURCE. THIS APPARENT FAILURE WAS AT APPROXIMATELY 00:02:13. THE COMMUTATOR PERFORMED SATISFACTORILY FOR THE APPROXIMATELY ONE-SECOND PERIOD FROM TURN-ON OF THE FLIGHT QUALIFICATION RECORDER UNTIL CM/SM SEPARATION.



VAC-ION pump assembly.

Figure 2.1.3-1

ANOMALY REPORT

NO. 2.1.4 TITLE: CENTRAL TIMING EQUIPMENT ERRATIC

SYSTEM: CM MISSION: APOLLO 6

SUBSYSTEM: TELECOMMUNICATIONS EVENT TIME: 00:02:24.6

DESCRIPTION: THE TIME ACCUMULATOR IN THE CENTRAL TIMING EQUIPMENT (CTE) OPERATED ERRATICALLY FROM 00:02:24.644 THROUGH THE REMAINDER OF THE MISSION.

STATUS: INCORPORATED INTO ANOMALY 2.1.3, "ERRATIC DATA."

ORGANIZATION: 5-2464 RESOLUTION: INCORPORATED INTO ANOMALY 2.1.3 DATE:

REFERENCES: MSC 3-DAY REPORT, P. 11
MSC 10-DAY REPORT, P. 17. REV: C

ANOMALY REPORT

NO. 2.1.5 TITLE: AC LOAD TRANSFER

SYSTEM: CSM

SUBSYSTEM: ELECTRIC POWER

MISSION: APOLLO 6

EVENT TIME: 03:14:32

DESCRIPTION: THE ESSENTIAL LOAD TRANSFER CIRCUIT TRANSFERRED ESSENTIAL NON-REDUNDANT LOADS FROM AC BUS NO.1 TO AC BUS NO.2, WHERE THEY REMAINED FOR THE REST OF THE FLIGHT. THE DATA SHOWS A VOLTAGE DROP OCCURRED ON ALL THREE PHASES OF AC BUS NO.1 SIX SECONDS BEFORE THE LOADS WERE TRANSFERRED AND AT THE TIME OF TRANSFER. ALL SYSTEMS FUNCTIONED SATISFACTORILY AFTER THE TRANSFER. THE CIRCUIT BREAKER IN THE CM THAT SUPPLIES AC BUS 1, PHASE A, POWER TO THE FANS FOR NO.1 CRYOGENIC OXYGEN AND HYDROGEN TANKS WAS FOUND OPEN DURING THE POST-FLIGHT INSPECTION.

STATUS: THE PROBABLE CAUSE OF LOAD SWITCHING WAS A SINGLE-PHASE FAULT TO GROUND IN A FAN MOTOR IN OXYGEN TANK 1, WHICH WAS CLEARED BY THE CIRCUIT BREAKER. THE BLOCK II CRYOGENIC TANK FANS ARE OF AN IMPROVED DESIGN WITH GREATER RELIABILITY. FOR CSM 103, 104, 106 AND SUBSEQUENT, EACH INDIVIDUAL FAN MOTOR HAS FUSE PROTECTION IN EACH PHASE TO PREVENT A FAULT IN ONE FAN MOTOR FROM CAUSING THE CIRCUIT BREAKER POWERING FOUR FANS TO OPEN. THIS ANOMALY HAS BEEN CLOSED BY MSC.

ORGANIZATION: 5-2464

RESOLUTION: CLOSED

DATE:

REFERENCES:
MSC 3-DAY REPORT, P. 10;
MSC 10-DAY REPORT, P. 13;
MSC 30-DAY REPORT, P.2;
MSC 60-DAY REPORT, PP. 5.7-2 AND 12-1;
MSC-TIE MEMO NO. 5-2713-HOU-01-004, JUNE 12, 1968;
MSC ANOMALY REPORT NO. 1.

REV: C

DETAIL SHEET

ANOMALY 2.1.5

TITLE: AC LOAD TRANSFER

DESCRIPTION

THE ESSENTIAL LOAD TRANSFER CIRCUIT SWITCHES THE ESSENTIAL NON-REDUNDANT LOAD FROM AC BUS 1 TO AC BUS 2 WHENEVER EITHER AN OVERVOLTAGE OR AN UNDERVOLTAGE CONDITION OCCURS ON BUS 1. IN THE EVENT OF AN OVERVOLTAGE CONDITION, INVERTER NO. 1 IS ALSO DISCONNECTED FROM AC BUS 1, AND INVERTER NO. 3 IS CONNECTED. WHEN AN UNDERVOLTAGE CONDITION OCCURS, THE INVERTERS ARE SWITCHED ONLY IF THE UNDERVOLTAGE STILL EXISTS EIGHT SECONDS AFTER THE TRANSFER OF THE ESSENTIAL NON-REDUNDANT LOADS. THE INVERTER TEMPERATURE HISTORIES SHOW THAT INVERTER NO. 3 DID NOT REPLACE INVERTER NO. 1; THEREFORE, THE LOAD TRANSFER WAS APPARENTLY CAUSED BY AN UNDERVOLTAGE CONDITION ON AC BUS 1, WHICH RETURNED TO NORMAL WITHIN EIGHT SECONDS.

POST-RECOVERY INSPECTION OF THE COMMAND MODULE SHOWED THAT CIRCUIT BREAKER 100 HAD TRIPPED DURING THE MISSION. THIS 2-AMPERE CIRCUIT BREAKER SUPPLIES AC BUS 1 PHASE A POWER TO THE TWO OXYGEN AND THE TWO HYDROGEN CRYOGENIC TANK NO. 1 FANS (FIGURE 2.15-1). AT 03:14:26, AC BUS 1 EXPERIENCED A TRANSIENT VOLTAGE DROP. PHASES B AND C RECOVERED IMMEDIATELY; HOWEVER, PHASE A DID NOT RECOVER COMPLETELY UNTIL THE ESSENTIAL LOADS HAD BEEN TRANSFERRED. DURING A CRYOGENIC OXYGEN TANK HEATING CYCLE AFTER THE TRANSFER, THE VOLTAGE ON AC BUS 1, PHASE A, INCREASED WHILE PHASES B AND C DECREASED. THIS OCCURRENCE WOULD BE EXPECTED WITH AN OPEN CIRCUIT BREAKER IN PHASE A AND OPERATION OF THE FANS ON PHASES B AND C ONLY.

CONCLUSION

THE ESSENTIAL AC LOADS WERE TRANSFERRED FROM AC BUS 1 TO AC BUS 2 AS A RESULT OF A SHORT IN THE CRYOGENIC TANK NO. 1 CIRCUIT. THE MOST PROBABLE CAUSE WAS A FAULT TO GROUND IN PHASE A OF THE OXYGEN TANK NO. 1 FAN MOTOR CIRCUIT.

CORRECTIVE ACTION

NO CORRECTIVE ACTION IS REQUIRED. BLOCK I FAN MOTORS HAD SEVERAL FAILURES BECAUSE OF PHASE-TO-GROUND FAULTS. THE BLOCK II FANS WERE REDESIGNED TO PREVENT THIS OCCURRENCE BY CHANGING THE WIRE LENGTH AND ROUTING, IN ADDITION TO OTHER DESIGN CHANGES. ALL EIGHT FANS (TWO FANS PER TANK) IN CSM 103, 104, 106, AND SUBSEQUENT WILL BE PROTECTED BY INDIVIDUAL FUSES IN EACH PHASE OF THE MOTOR SO THAT A FAULT IN ONE MOTOR WILL NOT RESULT IN AN OPEN CIRCUIT BREAKER THAT WOULD CAUSE LOSS OF POWER TO FOUR FAN MOTORS.

DETAIL SHEET

ANOMALY 2.1.5

TITLE: AC LOAD TRANSFER (CONTINUED)

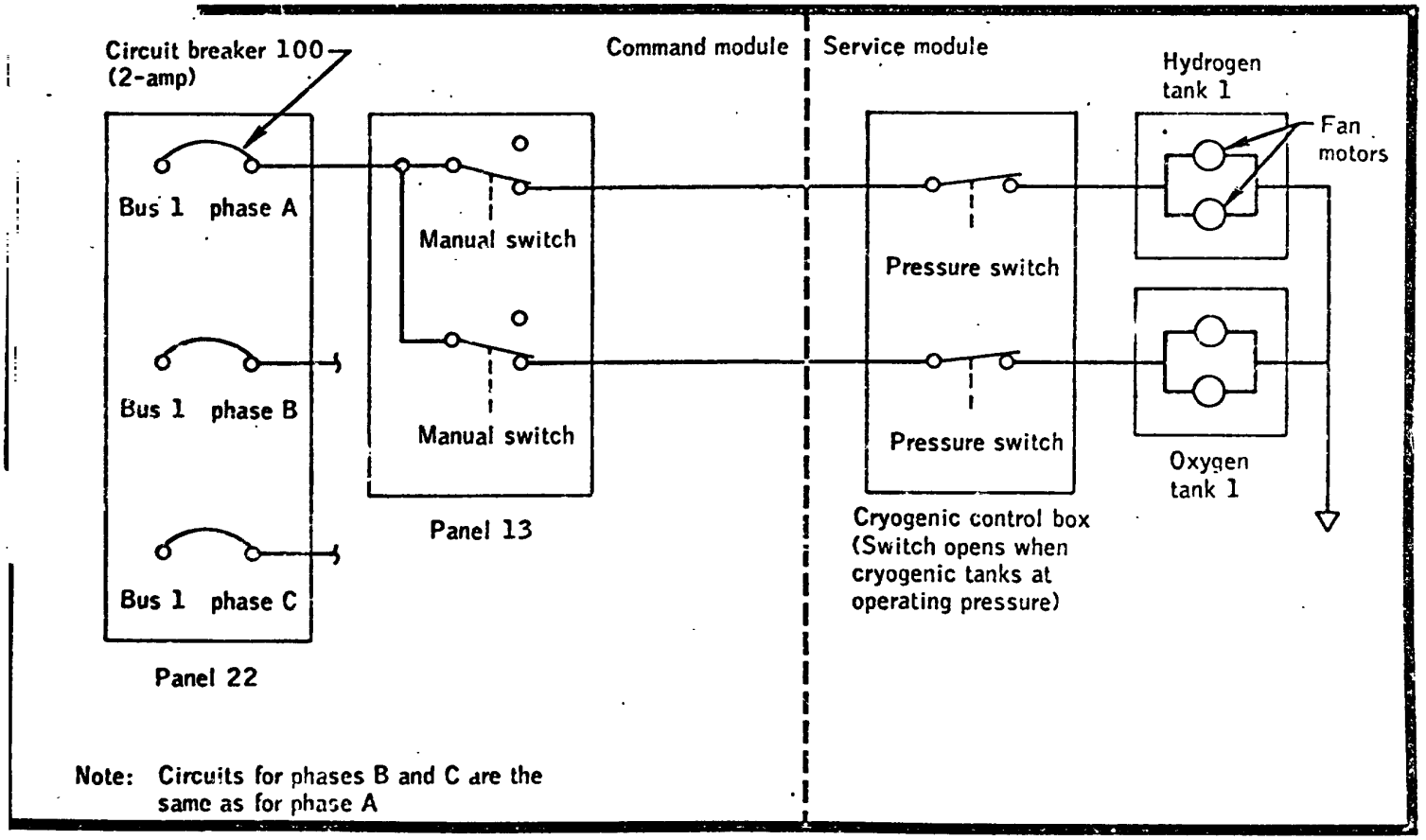


Figure 2.1.5-1. Fan motor circuit for hydrogen and oxygen tank 1.

ANOMALY REPORT

NO. 2.1.6 TITLE: AC BUS NO. 2 VOLTAGE

SYSTEM: CM

SUBSYSTEM: ELECTRIC POWER

MISSION: APOLLO 6

EVENT TIME: 09:36:54.8

DESCRIPTION: 1.8 SECONDS PRIOR TO CM/SM SEPARATION, PHASE B OF AC BUS NO. 2 SUDDENLY INCREASED FROM 115 TO 120.3 VOLTS. DURING THE ENTRY PERIOD, THE VOLTAGE GRADUALLY DECREASED TO 115 VOLTS. ALL OTHER ELECTRIC POWER PARAMETERS APPEARED NOMINAL DURING THIS PERIOD. THIS VOLTAGE RISE IS WITHIN THE LIMITS OF THE INVERTER SPECIFICATION; HOWEVER, IT IS A DISTINCT DEPARTURE FROM THE OUTPUT CHARACTERISTICS OF THE OTHER FIVE AC PHASES. NO SIMILAR VOLTAGE SHIFT OCCURRED DURING THE APOLLO 4 MISSION.

STATUS: 100 HOURS OF TESTING HAVE BEEN ACCOMPLISHED ON TH[illegible] INVERTER SINCE THE FLIGHT, WITH NO EVIDENCE OF A SIMILAR VOLTAGE SHIFT. MSC DOES [illegible]T CONSIDER THIS TO BE AN ANOMALY.

ORGANIZATION: 5-2464

RESOLUTION: CLOSED

DATE:

REFERENCES: MSC 10-DAY REPORT, P. 14;
MSC-TIE MEMO NO. 5-2713-HOU-3-001, MAY 14, 1968;
MSC 60-DAY REPORT, P. 5.7-1.

REV: C

ANOMALY REPORT

NO. 2.1.7 TITLE: ECS WASTE WATER USAGE

SYSTEM: CM MISSION: APOLLO 6

SUBSYSTEM: ENVIRONMENTAL CONTROL SYSTEM (ECS) EVENT TIME: 00:08:30

DESCRIPTION: THE WASTE WATER QUANTITY MEASUREMENT READING, CF0009Q, WAS 100.9% AT LAUNCH. THE READING FLUCTUATED SIGNIFICANTLY ALONG WITH THE OTHER INSTRUMENTATION DURING THE BOOST PHASE. IT STABILIZED AT APPROXIMATELY 40% AT 00:08:30 AND THEN DECREASED SLOWLY TO 1% JUST PRIOR TO ENTRY. IF THE WASTE WATER IS DEPLETED, THE SYSTEM WILL AUTOMATICALLY SWITCH TO THE POTABLE WATER TO SUPPLY THE WATER EVAPORATOR FOR CM COOLING.

STATUS: DURING TESTING TO INVESTIGATE THE COMPUTER KRK ALARMS, A PROCEDURAL ERROR RESULTED IN DUMPING THE WASTE AND POTABLE WATER OVERBOARD, AND THE ACTUAL CONTENT OF THE TANKS AT THE END OF THE MISSION CANNOT BE DETERMINED. POST-FLIGHT TESTING OF THE WASTE WATER TANK QUANTITY SHOWED THAT IT IS STILL WITHIN THE ACCEPTANCE TEST LIMITS. IT HAS BEEN CONCLUDED THAT THE DECREASE IN THE INDICATED QUANTITY DURING LAUNCH WAS CAUSED BY A MALFUNCTIONING TELEMETRY MULTIPLEXER GATE AND NOT BY AN ACTUAL WATER LOSS. MSC DOES NOT CONSIDER THIS TO BE AN ANOMALY.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSC 10-DAY REPORT, PP. 17 AND 21; REV: C

MSC 60-DAY REPORT, PP. 5.15-2, 5.15-11, 5.19-2, 5.21-3, 12-14.
MSC-TIE MEMO NO. 5-2713-HOU-01-020, SEPTEMBER 3, 1968.

ANOMALY REPORT

NO. 2.1.8 TITLE: OXYGEN CHECK VALVE FAILURE

MISSION: APOLLO 6

SYSTEM: CM

EVENT TIME: ORBIT

SUBSYSTEM: ENVIRONMENTAL CONTROL SYSTEM (ECS)

DESCRIPTION: THE PRESSURE IN THE ECS OXYGEN SURGE TANK WAS OBSERVED TO VARY IN PHASE WITH THE PRESSURE IN CRYOGENIC OXYGEN SUPPLY TANK 2. THIS INDICATES THAT ONE OR BOTH OF THE OXYGEN INLET RESTRICTOR ASSEMBLY CHECK VALVES FAILED TO SEAT WHEN THE CRYOGENIC TANK 2 PRESSURE DECREASED BELOW THE SURGE TANK PRESSURE. THE ECS PERFORMANCE WAS NOT ADVERSELY AFFECTED BECAUSE THERE WAS NO FAILURE IN ANY OTHER PORTION OF THE SYSTEM.

STATUS: DURING POST-FLIGHT BENCH TESTING, BOTH OF THE CHECK VALVES LEAKED IN THE REVERSE DIRECTION AT DIFFERENTIAL PRESSURES LESS THAN 25 PSI. THERE WAS NO EVIDENCE OF CORROSION OR CONTAMINATION. A HISTORY OF SIMILAR FAILURES ON BLOCK I CHECK VALVES HAS RESULTED IN A DESIGN CHANGE FOR BLOCK II CHECK VALVES. THE BLOCK I CHECK VALVE SEATING IS ACCOMPLISHED BY A DIAPHRAGM OPERATED BY DIFFERENTIAL PRESSURE; FOR BLOCK II VALVES, THE DIAPHRAGM SEATING HAS BEEN AUGMENTED BY THE ADDITION OF A SPRING TO ASSURE SEATING UNDER LOW DIFFERENTIAL PRESSURE (SEE FIGURE 2.1.8-1). THIS ANOMALY HAS BEEN CLOSED BY MSC.

ORGANIZATION: 5-2464

RESOLUTION: CLOSED

DATE:

REFERENCES:
MSC 3-DAY REPORT, P. 14;
MSC 10-DAY REPORT, P. 21;
MSC 30-DAY REPORT, PP. 4, 5;
MSC 60-DAY REPORT, PP. 5.19-3, 12-4, AND 12-14;
MSC ANOMALY REPORT NO. 5;
MSC ANOMALY STATUS REPORT, SEPTEMBER 3, 1968, P. 3.

REV: C

DETAIL SHEET

ANOMALY 2.1.8

TITLE: OXYGEN CHECK VALVE FAILURE

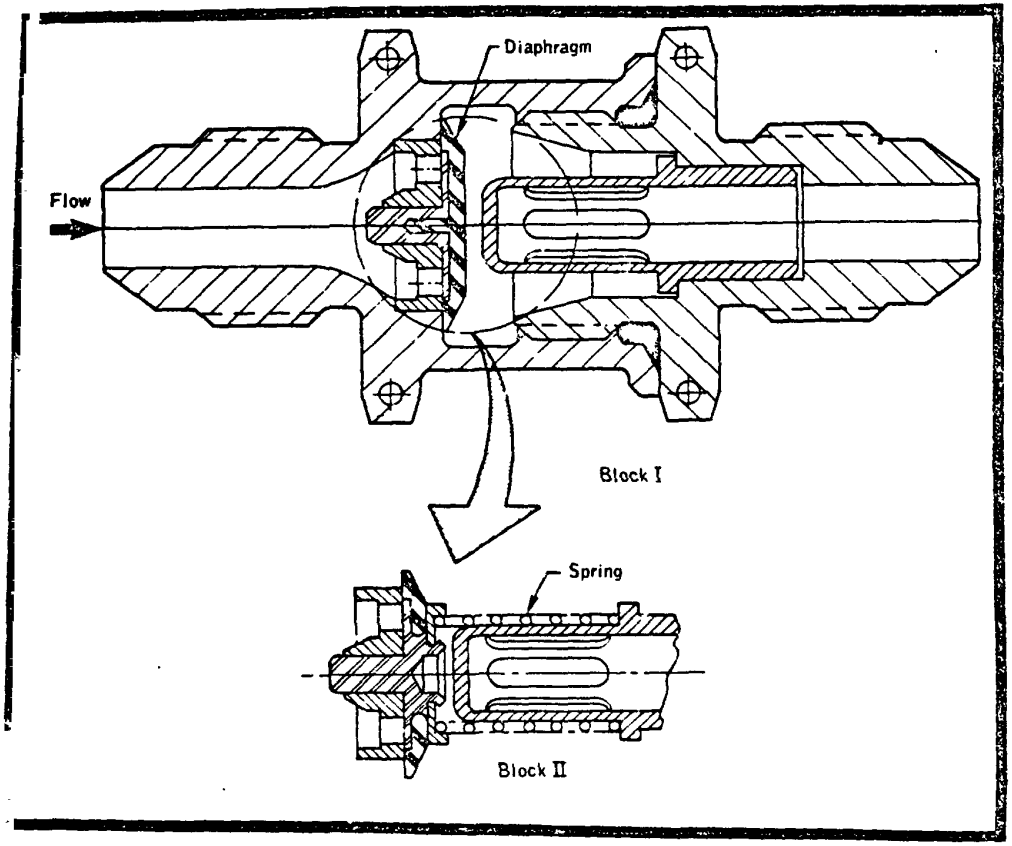


Figure 2.1.8-1. OXYGEN CHECK VALVE

ANOMALY REPORT

NO. 2.1.9 TITLE: HIGH WATER/GLYCOL PUMP PRESSURE

SYSTEM: CM MISSION: APOLLO 6

SUBSYSTEM: ENVIRONMENTAL CONTROL SYSTEM (ECS) EVENT TIME: ORBIT

DESCRIPTION: DURING ASCENT, THE WATER/GLYCOL PUMP DISCHARGE PRESSURE MEASUREMENT (MEAS. NO. CF0016P) DID NOT DECREASE AS THE CABIN PRESSURE DECREASED. DURING THE MISSION, THE PRESSURE READINGS WERE APPROXIMATELY 8 TO 10 PSI HIGHER THAN THE EXPECTED VALUES FOR 6.0 PSIA CABIN PRESSURE. THESE ARE SIMILAR TO THE READINGS THAT WOULD BE OBTAINED DURING SEA-LEVEL OPERATION.

STATUS: PROPER WATER/GLYCOL PUMP OPERATION WAS VERIFIED FROM FLOW CALIBRATION CURVES FOR THE BRANCH 2 COLDPLATE NETWORK AND BY RELATED TEMPERATURE MEASUREMENTS. POST-FLIGHT TESTING OF THE PUMP OUTLET TRANSDUCER SHOWED THAT THE ANEROID REFERENCE CHAMBER PLUG HAD FAILED, CAUSING THE TRANSDUCER TO INDICATE GAGE PRESSURE INSTEAD OF ABSOLUTE PRESSURE. THE SYSTEM CHECKOUTS AT THE CONTRACTOR'S FACILITY AND THE LAUNCH FACILITY WERE CONDUCTED AT STANDARD ATMOSPHERIC CONDITIONS WHICH WOULD PREVENT THE RECOGNITION OF THIS CONDITION. A GAGE-TYPE TRANSDUCER WILL BE USED ON ALL BLOCK II VEHICLES. THIS IS NOT CONSIDERED AN ANOMALY BY MSC.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSC 3-DAY REPORT, P. 13;
MSC 10-DAY REPORT, P. 21;
MSC 60-DAY REPORT, PP. 5.15-2 AND 5.19-2.
MSC-TIE MEMO NO. 5-2713-HOU-01-020, SEPTEMBER 3, 1968.

REV: C

ANOMALY REPORT

NO. 2.1.10 TITLE: S-BAND PHASE LOCK INTERRUPTION

SYSTEM: CSM MISSION: APOLLO 6

SUBSYSTEM: TELECOMMUNICATIONS EVENT TIME: ORBIT

DESCRIPTION: THE CSM USED ONE PAIR (PAIR B) OF THE S-BAND OMNI-DIRECTIONAL ANTENNAS. THE RECEIVED S-BAND UPLINK CARRIER POWER AVERAGED 10 DB BELOW PRE-MISSION PREDICTIONS USING NOMINAL SPACECRAFT ATTITUDES AND TRAJECTORY. WEAK S-BAND UPLINK SIGNALS FROM ASCENSION COMBINED WITH ANTENNA LOOK ANGLE DETERIORATION NECESSITATED AN UNSCHEDULED S-BAND HANDOVER FROM ASCENSION TO CANARY AT APPROXIMATELY 03:55:44. ASCENSION RESUMED TWO-WAY LOCK LATER IN THE MISSION. WHEN THE S-BAND VOICE RF CARRIER LOCK IS LOST, THE NOISE EXCEEDS THE ASTRONAUT TOLERANCE LEVEL.

STATUS: THE DATA INDICATE NOMINAL PERFORMANCE OF THE S-BAND OMNI-DIRECTIONAL ANTENNAS. THE DETERIORATION OF S-BAND SIGNAL STRENGTH THAT OCCURRED WAS EXPECTED, ESPECIALLY DURING THE HIGH-ALTITUDE ELLIPTICAL ORBIT, BECAUSE OF THE CSM ANTENNA CONFIGURATION. THE PROBLEM MAY HAVE BEEN AGGRAVATED BY INCORRECT ANTENNA POLARIZATION AT SOME GROUND STATIONS. BLOCK II SPACECRAFT, WITH THE DIRECTIONAL S-BAND HIGH-GAIN ANTENNA, HAVE THE NECESSARY ANTENNA CONFIGURATION TO PREVENT THIS PROBLEM. CSM 101 (APOLLO 7) WILL NOT HAVE THE HICH-GAIN ANTENNA; HOWEVER, COMMUNICATION AND TRACKING DIFFICULTIES WILL NOT BE EXPERIENCED BECAUSE THIS MISSION WILL INCORPORATE ONLY LOW-ALTITUDE ORBITS. MSC DOES NOT CONSIDER THIS PROBLEM TO BE AN ANOMALY.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSC 10-DAY REPORT, P. 16;
MSC-TIE MEMO NO. 5-2713-HOU-01-004, JUNE 12, 1968;
MSC 60-DAY REPORT, PP. 5.14-1 TO 5.14-8.

REV: C

ANOMALY REPORT

NO. 2.1.11 TITLE: NOISY CM TAPE RECORDER DATA

SYSTEM: CM MISSION: APOLLO 6

SUBSYSTEM: TELECOMMUNICATIONS EVENT TIME: LAUNCH

DESCRIPTION: DURING LAUNCH PHASE, THE RECORDER INTERNAL TIMER BECAME ERRATIC. DATA FROM THE TAPE RECORDER ALSO SHOWED EVIDENCES OF EXCESSIVE WOW AND FLUTTER DURING LAUNCH PHASE.

STATUS: INCORPORATED INTO ANOMALY 2.1.3, "ERRATIC DATA."

ORGANIZATION: 5-2464 RESOLUTION: INCORPORATED INTO ANOMALY 2.1.3. DATE:

REFERENCES: MSC-TIE MEMO NO. 5-2710-HOU-133R6, MAY 21, 1968. REV: C

ANOMALY REPORT

NO. 2.1.12 TITLE: CROSSWIRING OF CM RCS VALVES

SYSTEM: CM

SUBSYSTEM:

MISSION: APOLLO 6

EVENT TIME: POST-FLIGHT TESTING

DESCRIPTION: DURING THE DE-ACTIVATION OF THE CM REACTION CONTROL SYSTEM, THE CONNECTOR FROM THE REACTION CONTROL SYSTEM CONTROL BOX TO THE ENGINE VALVES WAS REMOVED AND RECONNECTED TO GROUND SUPPORT EQUIPMENT FOR VALVE ACTUATION. WHEN THE MINUS YAW AND THE PLUS YAW FUEL VALVES WERE OPENED, BROWNISH-RED VAPOR CLOUDS AND LIQUID DROPLETS INDICATIVE OF OXIDIZER WERE OBSERVED. FUEL WAS NOTED WHEN THE MINUS YAW AND THE PLUS YAW OXIDIZER VALVES WERE ACTIVATED. A PRE-FLIGHT GAS FLOW CHECK NORMALLY DEMONSTRATES ENGINE OPERATION, BUT THE VALVES ARE NOT CHECKED INDIVIDUALLY.

STATUS: A POST-FLIGHT TEST HAS SHOWN THAT THE ELECTRICAL WIRES TO THE FUEL AND OXIDIZER VALVES WERE CROSSED ON ALL FOUR YAW ENGINES AS SHOWN IN FIGURE 2.1.12-1. THE WIRES TO THE VALVES WERE THE SAME COLOR, CAME FROM THE SAME AREA, AND WERE NOT SEPARATELY IDENTIFIED. THE CROSSED WIRES WERE BETWEEN THE TWO VALVES ON EACH ENGINE, NOT BETWEEN VALVES ON DIFFERENT ENGINES. VALVE WIRING WAS NOT INDEPENDENTLY VERIFIED AFTER INSTALLATION. THE RCS OPERATED SATISFACTORILY IN FLIGHT BECAUSE THE OXIDIZER AND FUEL VALVES ARE WIRED IN PARALLEL AND RECEIVE A COMMON COMMAND SIGNAL. ON THIS MISSION, THE PROPELLANTS WERE DUMPED BEFORE LANDING AND ONLY VAPOR REMAINED IN THE TANKS AT DE-ACTIVATION. ON APOLLO 7, AND POSSIBLY OTHER MISSIONS, THE PROPELLANTS WILL NOT BE DUMPED BEFORE LANDING AND MIXING OF PROPELLANTS IN THE COLLECTION TANKS COULD OCCUR. A SPECIAL FUNCTIONAL TEST OF INDIVIDUAL VALVE ACTUATION WILL BE PERFORMED ON ALL BLOCK II SPACECRAFT. PROPER WIRING HAS BEEN VERIFIED ON CM 101 (APOLLO 7), 103 AND 104. IN ADDITION, ON CM 102, 106 AND SUBS., THIS WIRING WILL HAVE IDENTIFICATION SLEEVING. THIS ANOMALY HAS BEEN CLOSED BY MSC.

ORGANIZATION: 5-2464

REFERENCES: MSC 30-DAY REPORT, P. 7;
MSC 60-DAY REPORT, PP. 5.17-8 AND 12-7;
MSC ANOMALY STATUS REPORT, AUGUST 13, 1968, P. 5;
MSC ANOMALY REPORT NO. 9.

RESOLUTION: CLOSED

DATE:

REV: C

DETAIL SHEET

ANOMALY 2.1.12

TITLE: CROSSWIRING OF CM RCS VALVES

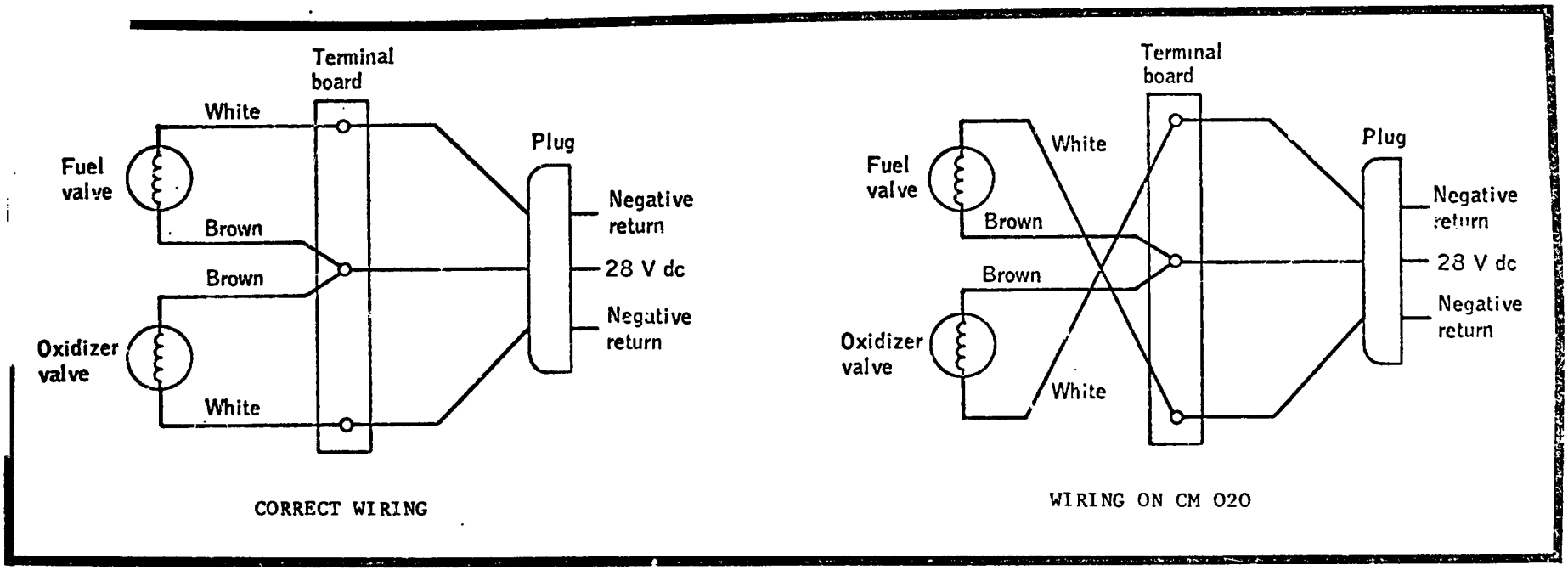


Figure 2.1.12-1. YAW ENGINE WIRING

ANOMALY REPORT

NO. 2.1.13 TITLE: EXCESSIVE CABIN-TO-AMBIENT DIFFERENTIAL PRESSURE

SYSTEM: COMMAND MODULE MISSION: APOLLO 6

SUBSYSTEM: ENVIRONMENTAL CONTROL SYSTEM (ECS) EVENT TIME: 00:00:52 TO 00:02:40

DESCRIPTION: PRIOR TO LAUNCH, THE CM WAS PRESSURIZED TO 15.68 PSIA WITH NITROGEN. THE PEAK DIFFERENTIAL BETWEEN CABIN PRESSURE AND AMBIENT PRESSURE EXPECTED DURING LAUNCH WAS 6.2 PSI. THIS DIFFERENTIAL WAS EXCEEDED FROM THE TIME THE CABIN PRESSURE RELIEF VALVE BEGAN RELIEVING AT APPROXIMATELY 00:00:52 UNTIL 00:02:40. AT 00:01:30, THE MAXIMUM DIFFERENTIAL OF 9.4 PSI WAS REACHED, WHICH EXCEEDED THE MAXIMUM DESIGN PRESSURE OF 8.6 PSI. THE CABIN PRESSURE STABILIZED AT 6.0 PSIA BY 00:08:30, AFTER THE CABIN PRESSURE RELIEF VALVES RE-SEATED.

STATUS: THERE IS A DESIGN MARGIN OF SAFETY OF 1.5 AT 8.6 PSI; 9.4 PSI REPRESENTS A FACTOR OF 1.36. THIS CONDITION COULD RESULT FROM RESTRICTED GAS FLOW IN EITHER THE CABIN PRESSURE RELIEF VALVE OR THE ECS WATER BOILER VENT (STEAM VENT). THE CABIN PRESSURE RELIEF VALVE, CABIN PRESSURE TRANSDUCER AND BAROMETRIC PRESSURE TRANSDUCER WERE TESTED AFTER THE MISSION AND EACH OPERATED PROPERLY. IT HAS BEEN CONCLUDED THAT THE MOST LIKELY CAUSE OF THE EXCESSIVE CABIN-TO-AMBIENT DIFFERENTIAL PRESSURE WAS ABSENCE OF THE STEAM DUCT VENT HOLE IN THE BOOST PROTECTIVE COVER. FOR FUTURE MISSIONS, MANDATORY INSPECTION OF BOOST PROTECTIVE COVER INSTALLATION, AS WELL AS FLOW CHECKS, WILL BE MADE DURING FINAL LAUNCH PREPARATIONS. THIS ANOMALY HAS BEEN CLOSED BY MSC.

ORGANIZATION: E-2464

REFERENCES: MSC 30-DAY REPORT, P. 4; RESOLUTION: CLOSED DATE:

MSC 60-DAY REPORT, PP. 5.19, 12-3 AND 12-14; REV: C

MEETING WITH MR. D.D. ARABIAN, MSC, SEPTEMBER 12, 1968;
MSC ANOMALY STATUS REPORT, SEPTEMBER 17, 1968, PP. 2 AND 3.

DETAIL SHEET

ANOMALY 2.1.13

TITLE: EXCESSIVE CABIN-TO-AMBIENT DIFFERENTIAL PRESSURE

DISCUSSION:

THE CABIN PRESSURE TRANSDUCER AND THE BAROMETRIC PRESSURE TRANSDUCER HAVE BEEN TESTED AND BOTH UNITS WERE WITHIN SATISFACTORY CALIBRATION LIMITS.

THE CHARACTERISTICS OF THE PRESSURE VARIATIONS WITH TIME DURING THE FLIGHT SHOW THAT CABIN PRESSURE RELIEF VALVE AND THE ASSOCIATED PILOT VALVE MECHANISMS OPERATED PROPERLY. POSTFLIGHT TESTS WERE PERFORMED ON THE CABIN PRESSURE RELIEF VALVE WITH NO INDICATION OF IMPROPER VALVE OPERATION. THREE-AXIS RESONANT VIBRATION TESTS WERE CONDUCTED, AND MISSION PROFILE FLOW TESTS WERE PERFORMED, BOTH WITH AND WITHOUT VIBRATION. NO FLOW RESTRICTIONS OCCURRED.

TESTS CONDUCTED BY NR INDICATE THAT THERE MAY HAVE BEEN NO HOLE IN THE BOOST PROTECTIVE COVER, THEREBY RESTRICTING FLOW THROUGH THE STEAM DUCT. A BOOST PROTECTIVE COVER WAS FOUND WHICH HAD NO HOLE TO VENT STEAM DUCT FLOW, THOUGH ALL DOCUMENTATION INDICATED THAT THE HOLE SHOULD BE PRESENT. TESTS SIMULATING THE EFFECT OF THIS CONDITION MATCHED THE FLIGHT DATA FROM APOLLO 6 (SEE FIGURE 2.1.13-2).

CORRECTIVE ACTION:

INSPECTION OF THE CSM-101 STEAM DUCT AND BOOST PROTECTIVE COVER PROVIDES A HIGH DEGREE OF ASSURANCE THAT THE PROBLEM WILL NOT REOCCUR ON APOLLO 7. MSC STRUCTURES STATE THAT A POSITIVE SAFETY FACTOR EXISTS EVEN WITH NO VENTING DURING BOOST FOR THE NOMINAL MISSION.

ANOMALY 2.1.13

TITLE: EXCESSIVE CABIN-TO-AMBIENT DIFFERENTIAL PRESSURE

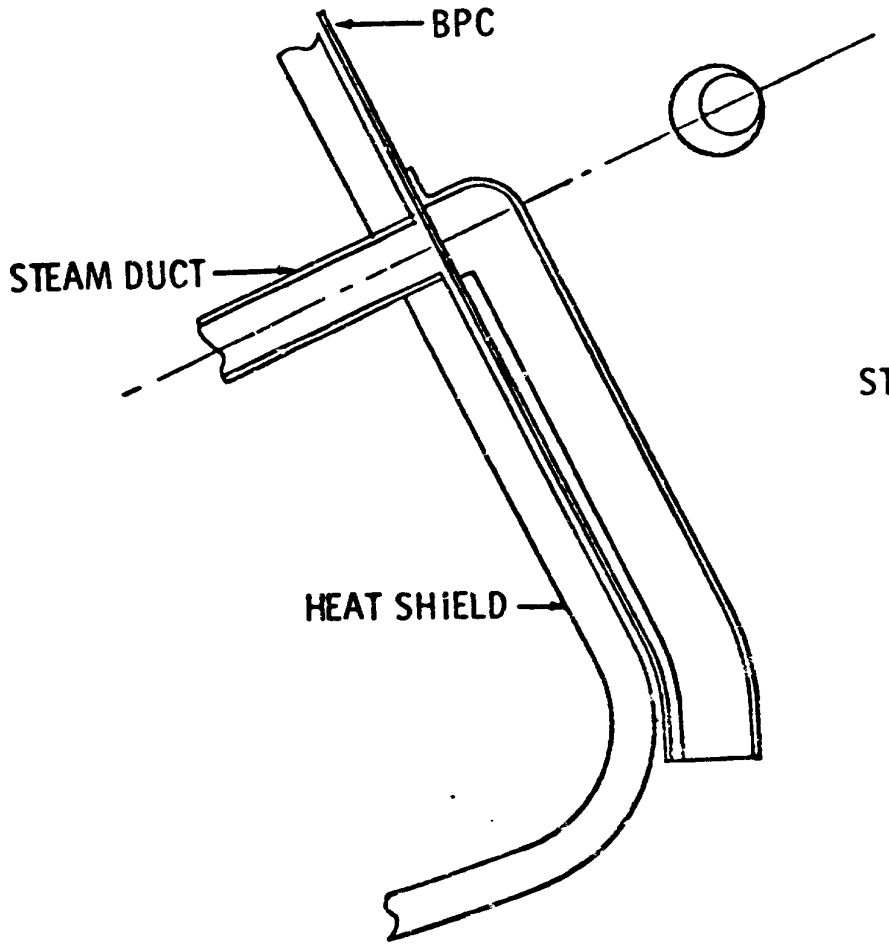


Figure 2.1.13-1
STEAM DUCT VENT THROUGH BPC

DETAIL SHEET

ANOMALY 2.1.13

TITLE: EXCESSIVE CABIN-TO-AMBIENT DIFFERENTIAL PRESSURE

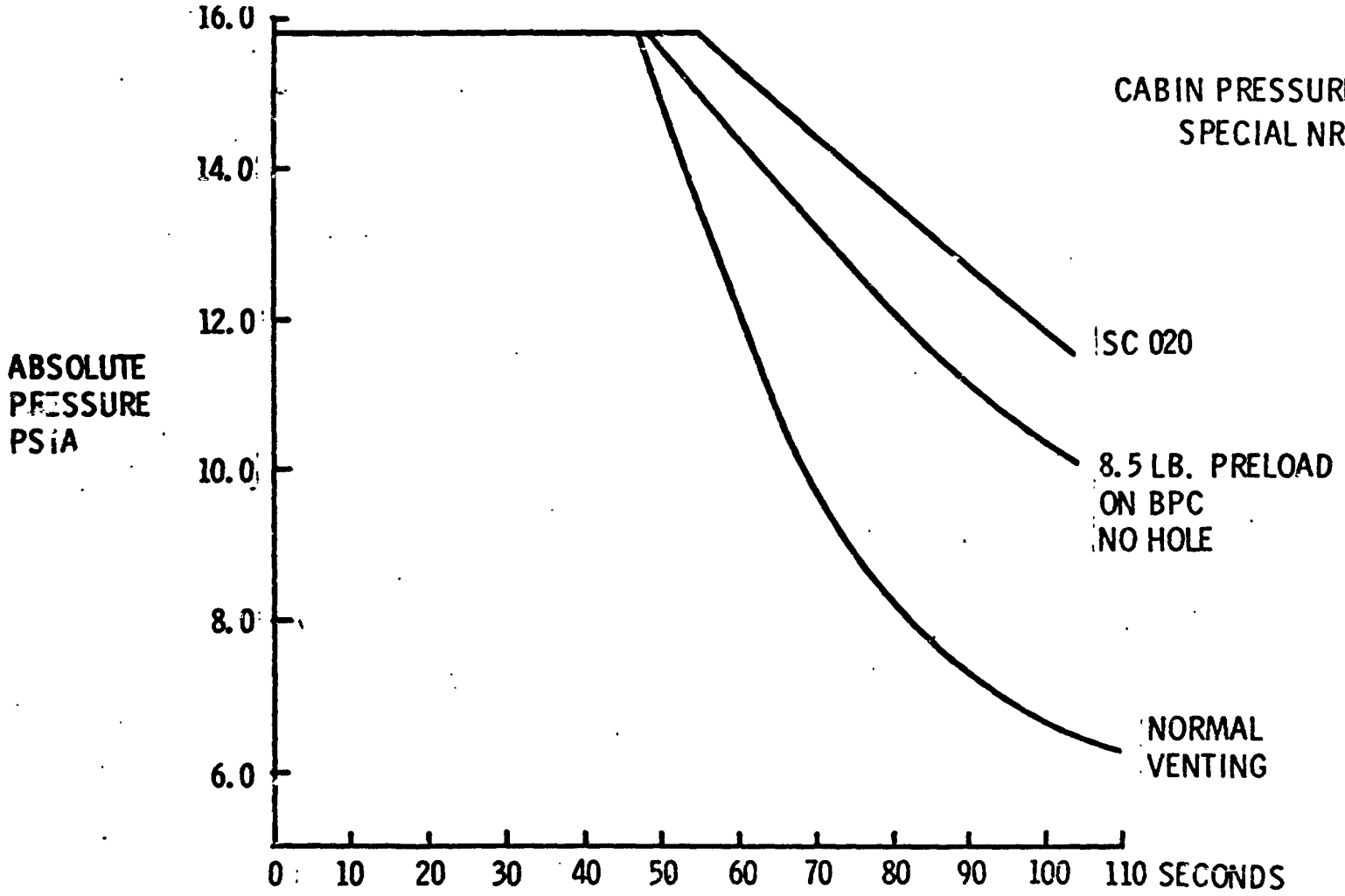


Figure 2.1 13-2

ANOMALY REPORT

NO. 2.1.14 TITLE: FAILURE TO RECEIVE VHF SURVIVAL BEACON SIGNAL

SYSTEM: CM MISSION: APOLLO 6

SUBSYSTEM: TELECOMMUNICATIONS EVENT TIME: RECOVERY

DESCRIPTION: ON MANNED MISSIONS, THE VHF RECOVERY BEACON IS USED, WITH BACKUP PROVIDED BY THE DUAL VHF TRANSCEIVERS AND THE VHF SURVIVAL BEACON/TRANSCEIVER. BOTH THE RECOVERY BEACON AND THE SURVIVAL BEACON, WHICH OPERATE ON THE SAME FREQUENCY, WERE USED SIMULTANEOUSLY ON THIS MISSION. FOLLOWING THE COMMAND MODULE LANDIN , CONFLICTING REPORTS WERE RECEIVED BY THE LANDING AND RECOVERY DIVISION CONCERNING SIMULTANEOUS OPERATION OF THE VHF RECOVERY BEACON AND THE VHF SURVIVAL BEACON. THE RECOVERY HELICOPTERS REPORTED BOTH BEACONS OPERATING, BUT THE RESCUE AND ARIA AIRCRAFT REPORTED THAT ONLY ONE BEACON SIGNAL WAS RECEIVED.

STATUS: BOTH BEACONS WERE TESTED TO DETERMINE ANTENNA RF OUTPUT, RF FORWARD AND REVERSE POWER, DUTY CYCLE ON AND OFF TIMES, AND 1 kHz MODULATION. THE RECOVERY BEACON INPUT VOLTAGE AND CURRENT WERE ALSO MEASURED. BOTH BEACONS AND THE MISSION CONTROL PROGRAMMER WHICH SWITCHED THEM ON OPERATED SATISFACTORILY DURING THE TESTS. COMPARISON OF THE SIGNAL RECORDED BY ONE RECOVERY AIRCRAFT WITH THE SIGNALS OF THE TWO BEACONS SHOWED THAT THE RECOVERY BEACON WAS THE ONE RECEIVED. THE REASON FOR THE FAILURE TO RECEIVE THE SURVIVAL BEACON SIGNAL CANNOT BE ESTABLISHED. BASED ON THE HELICOPTER REPORTS AND THE FACT THAT THE SURVIVAL BEACON OPERATED SATISFACTORILY DURING POST-FLIGHT TESTING, THE SURVIVAL BEACON DID OPERATE. THIS ANOMALY HAS BEEN CLOSED BY MSC.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES:
MSC 10-DAY REPORT, P. 26;
MSC 30-DAY REPORT, P. 6;
MSC 60-DAY REPORT, PP. 5.14-3, 9-17 to 9-21, 12-5, and 12-13;
MSC ANOMALY STATUS REPORT, AUGUST 1968, P. 1.
MSC ANOMALY REPORT NO. 7

REV: C

DETAIL SHEET

ANOMALY 2.1.14

TITLE: FAILURE TO RECEIVE VHF SURVIVAL BEACON SIGNAL

DISCUSSION: THE VHF RECOVERY BEACON OPERATES ON A FREQUENCY OF 243.0 MHz, WITH AN OUTPUT OF 3 WATTS. THE SIGNAL IS AMPLITUDE MODULATED BY A 1000 Hz SQUARE WAVE, AND THE BEACON HAS A DUTY CYCLE OF 2 SECONDS ON/3 SECONDS OFF. THE VHF SURVIVAL BEACON OPERATED SIMILARLY EXCEPT THAT ITS OUTPUT IS 2 WATTS AND THE SIGNAL IS MODULATED BY A 1000 Hz SINE WAVE. THE TWO UNITS WERE TO BE TURNED ON SIMULTANEOUSLY 20 SECONDS AFTER BAROSTAT OPERATION AT 11,000 FEET, AND THEY WERE TO OPERATE UNTIL TURNED OFF MANUALLY.

TWO RECOVERY HELICOPTERS AT 8000 FEET ALTITUDE AND APPROXIMATELY 100 NAUTICAL MILES FROM THE LANDING POINT REPORTED RECEIVING BOTH SIGNALS. FOUR OTHER RECOVERY AIRCRAFT, TWO HC-130's, AND TWO C-135 APOLLO RANGE INSTRUMENTED AIRCRAFT (ARIA) REPORTED RECEPTION OF ONLY ONE SIGNAL. THESE AIRCRAFT, AT ALTITUDES OF 25,000 FEET AND 35,000 FEET, WERE 63 TO 320 NAUTICAL MILES FROM THE LANDING POINT. ALL AIRCRAFT WERE WITHIN RANGE TO RECEIVE BOTH SIGNALS. THE HELICOPTERS AND HC-130's HAD NO RECORDING EQUIPMENT ABOARD. RECEIVED SIGNAL STRENGTH RECORDINGS FROM BOTH ARIA SHOW ONLY ONE SIGNAL. (IF TWO SIGNALS HAD BEEN RECIEVED, THE ON/OFF TIMES OF THE SIGNALS WOULD HAVE OVERLAPPED.)

BOTH BEACONS AND THE MISSION CONTROL PROGRAMMER WHICH SWITCHED THE BEACONS ON OPERATED NORMALLY DURING POST-FLIGHT TESTING. MEASURED BEACON CHARACTERISTICS WERE:

PARAMETER	RECOVERY BEACON	SURVIVAL BEACON
RF FREQUENCY, MHz	242.994	243.004
RF POWER OUTPUT, W	4.05	1.4
MODULATION FREQUENCY, Hz	1011	863
DUTY CYCLE, SEC	2 ON/3 OFF	2.6 ON/3.0 OFF

DETAIL SHEET

ANOMALY 2.1.14

TITLE: FAILURE TO RECEIVE VHF SURVIVAL BEACON SIGNAL

THE SIGNAL RECORDED ABOARD THE ARIA HAD THE FOLLOWING CHARACTERISTICS:

MODULATION FREQUENCY, Hz	1015
DUTY CYCLE, SEC	2.04 ON/3.07 OFF

CONCLUSION: BASED ON A COMPARISON OF THE FLIGHT AND POST-FLIGHT DATA, THE VHF BEACON SIGNAL WAS THE ONE RECEIVED BY THE ARIA. NO CONCLUSION CAN BE REACHED REGARDING THE FAILURE OF THE ARIA TO RECEIVE THE SURVIVAL BEACON. BASED ON THE HELICOPTER REPORTS AND THE FACT THAT THE SURVIVAL BEACON OPERATED SATISFACTORILY DURING POST-FLIGHT TESTING, THE SURVIVAL BEACON DID OPERATE. BOTH UNITS OPERATED PROPERLY ON SPACECRAFT 009, 011, AND 017 AND DURING POST-FLIGHT TESTS OF COMMAND MODULE 020. NO CORRECTIVE ACTION IS REQUIRED.

ANOMALY REPORT

NO. 2.1.15 TITLE: ERRATIC DOSIMETER MEASUREMENTS

SYSTEM: COMMAND MODULE MISSION: APOLLO 6

SUBSYSTEM: INSTRUMENTATION EVENT TIME: ORBIT

DESCRIPTION: DURING PASSAGE THROUGH THE VAN ALLEN RADIATION BELT, THE TWO DOSE RATE MEASUREMENTS OF THE VAN ALLEN BELT DOSIMETER (CK1051K AND CK1052K) RANDOMLY SWITCHED BETWEEN LOW RANGE AND HIGH RANGE, ALTHOUGH THE OUTPUTS OF THE DOSIMETER WERE ALWAYS BELOW THE LEVEL AT WHICH THE RANGE SHOULD HAVE SWITCHED. THIS SWITCHING OCCURRED IN ISOLATED INSTANCES DURING THE ASCENT TO APOGEE, BUT NOT FREQUENTLY ENOUGH TO BE A PROBLEM. DURING THE DESCENT FROM APOGEE, THE ERRATIC LOW/HIGH RANGE SWITCHING PREVENTED REAL-TIME OBSERVATION OF THE DOSE RATES; HOWEVER, THE INFORMATION WAS RECOVERED BY POST-FLIGHT DATA REDUCTION.

STATUS: POST-FLIGHT TESTING OF THE DOSIMETER WITH OTHER SPACECRAFT SYSTEMS POWERED UP REVEALED THAT THE ANOMALY WAS CAUSED BY NOISE IMPRESSED ON THE DOSIMETER OUTPUT SIGNALS BY ELECTROMAGNETIC INTERFERENCE (EMI). (SEE ANOMALY 2.1.16, "ELECTROMAGNETIC INTERFERENCE.") THE DOSIMETER WILL NOT BE USED ON APOLLO 7 (AS-205). NO CHANGES WILL BE MADE ON CM 103 UNLESS A PROBLEM IS ENCOUNTERED DURING CHECKOUT AT KSC. ON CM 104, 106 AND SUBSEQUENT, THE DOSIMETER OUTPUTS WILL BE CAPACITIVE-FILTERED TO REDUCE THE MAGNITUDE OF EMI-GENERATED NOISE. THIS ANOMALY HAS BEEN CLOSED BY MSC.

ORGANIZATION: 5-2464

REFERENCES: MSC 30-DAY REPORT, P. 6;
MSC 60-DAY REPORT, PP. 5.15-3, 10-1, 10-2, 12-6;
MSC ANOMALY STATUS REPORT, SEPTEMBER 17, 1968, P. 3.

RESOLUTION: CLOSED DATE:

REV: C

ANOMALY 2.1.15

TITLE: ERRATIC DOSIMETER MEASUREMENTS

STATUS: POST-FLIGHT TESTS SHOWED THAT THE DOSIMETER WAS OPERATING PROPERLY. RANGE SWITCHING NORMALLY OCCURS WHEN THE DOSIMETER OUTPUT EXCEEDS THE PRESET SWITCHING POINT OF APPROXIMATELY 4.7 VOLTS. THIS ANOMALOUS SWITCHING BEGAN WHEN THE MAXIMUM DOSIMETER OUTPUT WAS 1.9 VOLTS, INDICATING THAT ELECTRICAL NOISE WITH A MINIMUM POSITIVE AMPLITUDE OF 2.8 VOLTS WAS SUPERIMPOSED ON THE MEASUREMENT OUTPUT. POST-FLIGHT TESTING OF THE DOSIMETER EQUIPMENT WITH OTHER SPACECRAFT SYSTEMS POWERED UP REVEALED ELECTRICAL NOISE PRESENT ON THE OUTPUT SIGNAL OF ONE DOSIMETER MEASUREMENT WITH SUFFICIENT AMPLITUDE TO CAUSE THE SWITCHING ANOMALY. THIS NOISE WAS NOT OBSERVED ON THE OUTPUT OF THE OTHER DOSIMETER MEASUREMENT. THE SOURCE OF THIS NOISE WAS INDICATED TO BE A CROSS-COUPLING EFFECT BETWEEN THE INERTIAL MEASUREMENT UNIT SINE ANGLE MEASUREMENT AND THE DOSIMETER MEASUREMENT, WHICH ARE SAMPLED BY THE SAME PCM DATA SYSTEM SEQUENCER GATE. THE DOSIMETER SIGNAL WIRES FROM THE DATA DISTRIBUTION PANEL TO THE PCM TELEMETRY EQUIPMENT ARE NOT SHIELDED.

THIS NOISE WAS ALSO OBSERVED ON THE ENGINE VALVE ACTUATION TANK PRESSURE MEASUREMENT SP0601P, BUT WAS NOT OBSERVED ON THE MEASUREMENT INPUTS TO THE PCM DATA SYSTEM.

THESE MEASUREMENTS ARE OPERATIONAL CATEGORY NO. 2. THEY ARE USED FOR MISSION CONTROL AND SURVEILLANCE OF IN-FLIGHT CONDITIONS.

ANOMALY REPORT

NO. 2.1.16 TITLE: ELECTROMAGNETIC INTERFERENCE

SYSTEM: SPACECRAFT MISSION: APOLLO 6

SUBSYSTEM: ALL ELECTRONIC AND ELECTRICAL SUBSYSTEMS EVENT TIME: ENTIRE MISSION

DESCRIPTION: INVESTIGATION TO DATE INDICATES THE REJECTION OF PGNCS UPDATE COMMANDS, ANOMALY 2.1.2, ERRATIC DATA, ANOMALY 2.1.3, AND ERRATIC DOSIMETER MEASUREMENTS, ANOMALY 2.1.15, WERE CAUSED BY ELECTROMAGNETIC INTERFERENCE (EMI) WITHIN THE SPACECRAFT. NUMEROUS DISCREPANCIES ALSO HAVE BEEN REPORTED DURING CSM 101, 103, 2TV-1 AND LM-3 TESTING BECAUSE OF EMI. ABOUT 25 PERCENT OF ALL DISCREPANCY REPORTS ARE EMI IN NATURE. AN INVESTIGATION HAS SHOWN THAT MANY ITEMS OF SPACECRAFT EQUIPMENT HAVE NOT BEEN EMI-QUALIFIED, AND THAT THE SUSCEPTIBILITY OF FLIGHT-CRITICAL CIRCUITS TO EMI HAS NOT BEEN ESTABLISHED (BOEING DOCUMENT D2-117038-2, "ELECTROMAGNETIC COMPATIBILITY ASSESSMENTS OF SPACECRAFT INTERFACES WITH THE LAUNCH VEHICLE AND LAUNCH COMPLEX").

STATUS: AN OVERALL SPACECRAFT EMI PROBLEM EXISTS. ACTION IS BEING TAKEN TO FIX SPECIFIC KNOWN PROBLEMS AND OVERALL SOLUTIONS SHOULD BE IMPLEMENTED TO PREVENT SIMILAR PROBLEMS FROM OCCURRING IN OTHER SPACECRAFT EQUIPMENT. NEW EMI PROBLEMS CAN BE EXPECTED DURING TESTING AND FLIGHT. THE ULTIMATE EXTENT OF SYSTEM DEGRADATION CANNOT BE PREDICTED, HOWEVER, THE PROBABILITY OF EXPERIENCING SUFFICIENT FAILURES TO COMPROMISE REDUNDANCY AND RESULT IN LOSS OF CREW IS CONSIDERED REMOTE.

ORGANIZATION: 5-2464

REFERENCES: MSC 30-DAY REPORT, PP. 3 AND
MSC 60-DAY REPORT, SECTIONS 5-14, 5-15, 5-16
MSC ANOMALY STATUS REPORT, SEPTEMBER 17, 1968, PP. 1-4

RESOLUTION: GENERAL PROBLEM

DATE:

REV: C

DETAIL SHEET

ANOMALY 2.116

TITLE: ELECTROMAGNETIC INTERFERENCES

DURING CHAMBER TESTS OF SPACECRAFT 101, ELECTROMAGNETIC INTERFERENCE WAS GENERATED BY INADVERTENT DISCHARGE OF THE 3000-VOLT SUPPLY OF THE VAC-ION PUMPS IN THE SERVICE MODULE CRYOGENIC TANKS, AND DATA WERE ERRATIC IN THE SAME MANNER AS IN THE APOLLO 6 MISSION. THE RADIATION FROM SUCH A DISCHARGE PROBABLY CAUSED THE ERRATIC DATA, SINCE THE RESULTS WERE COMPARABLE TO THE SPACECRAFT 101 PROBLEM. SEVERAL PUMPS HAVE DEMONSTRATED A BREAKDOWN AND DISCHARGE OF THE 3000-VOLT POTENTIAL UNDER ALTITUDE CONDITIONS INVESTIGATED AFTER THE PROBLEM ON SPACECRAFT 101. FOR SPACECRAFT 101, 103, AND 104, THE PUMPS WILL NOT BE OPERATIVE. FOR SUBSEQUENT SPACECRAFT, THE PUMPS IN THE HYDROGEN TANKS WILL NOT BE OPERATIVE DURING THE MISSION, AND A CIRCUIT BREAKER IN THE CABIN WILL BE PROVIDED FOR THE PUMPS IN THE OXYGEN TANK. ALSO, POTTING AND SHIELDING OF THE PUMPS AND ASSOCIATED WIRING WILL BE IMPROVED.

ANOMALY REPORT

NO. 2.1.17 TITLE: SM RCS TEMPERATURE EXCURSIONS

SYSTEM: SM MISSION: APOLLO 6

SUBSYSTEM: REACTION CONTROL SYSTEM (RCS) EVENT TIME: 03:45:00 TO 05:32:00

DESCRIPTION: DURING THE COLD-SOAK PERIOD, THE SERVICE MODULE REACTION CONTROL SYSTEM (RCS) EXHIBITED RAPID EXCURSIONS IN THE INDICATED TEMPERATURE OF THE QUAD C CLOCKWISE ROLL ENGINE INJECTOR. DURING FOUR INTERVALS BETWEEN 03:45:10 AND 05:32:15, THE INDICATED TEMPERATURE DECREASED RAPIDLY, AND SEVERAL TIMES IT DROPPED BELOW THE LOWER LIMIT OF THE INSTRUMENTATION (0°F). RATES OF CHANGE AS HIGH AS 55°F PER SECOND WERE OBSERVED. BECAUSE OF THE RATE OF THERMAL FLUCTUATION AND THE MASS OF THE INJECTOR, THIS PHENOMENON COULD NOT HAVE RESULTED FROM AN INTERNAL INJECTOR PROBLEM SUCH AS A PROPELLANT VALVE LEAK THROUGH THE INJECTOR.

STATUS: THE PCM DATA HAVE BEEN VERIFIED TO BE ACCURATE. SIMILAR ANOMALOUS TEMPERATURE INDICATIONS HAVE BEEN OBSERVED DURING TESTS WITH THE SAME TYPE OF TEMPERATURE TRANDSUCER. A FAILURE MODE ANALYSIS WAS PERFORMED ON THE TRANSDUCER AND SIGNAL CONDITIONER WITH NEGATIVE RESULTS. THE CAUSE OF THE ANOMALY IS UNKNOWN. THIS MEASUREMENT IS NOT MANDATORY FOR APOLLO 7. MSC HAS CLOSED THIS ANOMALY.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSC 60-DAY REPORT, PP. 5.17-3 THROUGH 5.17-5, 5.17-27, 12-7.
MSC ANOMALY STATUS REPORT, SEPTEMBER 17, 1968, P. 4.

REV: C

ANOMALY 2.1.17

TITLE: SM RCS TEMPERATURE EXCURSIONS

BACKGROUND: THE THERMAL CONTROL SYSTEM ON APOLLO 6 WAS IDENTICAL TO THAT USED FOR APOLLO 4 WITH ONE EXCEPTION. THE APOLLO 4 HEATERS WERE BOTH BONDED AND MECHANICALLY CLAMPED TO THE ENGINE MOUNTING STRUCTURES. THE APOLLO 6 HEATERS WERE ONLY BONDED TO THE ENGINE MOUNTING STRUCTURES, AS THEY WILL BE ON BLOCK II SPACECRAFT. THE TEMPERATURES OF THE ENGINE MOUNTING STRUCTURES OF EACH OF THE FOUR QUADS WERE MONITORED FROM LAUNCH THROUGH CM/SM SEPARATION. THE TEMPERATURES OF THE INJECTORS OF THE FOLLOWING ENGINES ALSO WERE MONITORED: NEGATIVE PITCH ENGINE IN QUAD A, POSITIVE YAW ENGINE IN QUAD B, CLOCKWISE ROLL ENGINE IN QUAD C, AND COUNTERCLOCKWISE ROLL ENGINE IN QUAD D.

DESCRIPTION: DURING THE 5.9-HOUR COLD SOAK, THE CSM WAS ORIENTED SUCH THAT QUADS B AND C WERE COMPLETELY SHADED AND QUADS A AND D HAD SUN EXPOSURE AT AN OBLIQUE ANGLE. THE QUAD A AND D HEATERS UNDERWENT MULTIPLE CYCLES AND MAINTAINED THE ENGINE MOUNTING STRUCTURES AND THE INSTRUMENTED INJECTOR HEADS AT SATISFACTORY TEMPERATURE LEVELS.

AFTER THE ENGINE ACTIVITY ASSOCIATED WITH CSM/S-IVB SEPARATION AND THE CSM ORIENTATION TO COLD-SOAK ATTITUDE, THE QUAD B MOUNTING STRUCTURE AND THE PLUS YAW ENGINE INJECTOR COOLED RAPIDLY UNTIL THE QUAD HEATERS WERE ACTUATED "ON" AT APPROXIMATELY 03:45:00. THE HEATERS REMAINED ON THROUGHOUT THE REMAINDER OF THE COLD-SOAK PERIOD. THE MOUNTING STRUCTURE TEMPERATURE QUICKLY ROSE TO 136.5°F AND THEN UNDERWENT A GRADUAL DECREASE, REACHING A MINIMUM TEMPERATURE OF 104°F AT THE TERMINATION OF THE COLD-SOAK PERIOD. THE TEMPERATURE OF THE PLUS YAW INJECTOR REMAINED 20° TO 25°F BELOW THE MOUNTING STRUCTURE TEMPERATURE DURING THIS PERIOD.

THE QUAD C HEATERS WERE ACTUATED "ON" AT APPROXIMATELY 03:50:00 AT A MOUNTING STRUCTURE TEMPERATURE OF 114°F AND REMAINED ON THROUGHOUT THE ENTIRE COLD-SOAK PERIOD. THE MOUNTING STRUCTURE TEMPERATURE QUICKLY INCREASED TO 122.5°F THEN UNDERWENT A GRADUAL DECLINE, REACHING 86.°F AT THE TERMINATION OF THE COLD-SOAK PERIOD. IN GENERAL, THE INJECTOR TEMPERATURE REMAINED 4° TO 6°F ABOVE THE MOUNTING STRUCTURE TEMPERATURE. DURING FOUR PERIODS BETWEEN 03:45:00 AND 05:32:00, HOWEVER, THE INDICATED TEMPERATURE OF THE CLOCKWISE ROLL ENGINE INJECTOR (THE ONLY ONE INSTRUMENTED IN THE QUAD) DECREASED SHARPLY (SEVERAL TIMES GOING BELOW 0°F), AND THEN RECOVERED TO ITS ORIGINAL TEMPERATURE AT ESSENTIALLY THE SAME RATE. AN EXAMPLE OF THIS BEHAVIOR BETWEEN 04:55:00 and 05:05:00 IS SHOWN IN FIGURE 2.1.17-1.

DETAIL SHEET

ANOMALY 2.1.17

TITLE: SM RCS TEMPERATURE EXCURSIONS

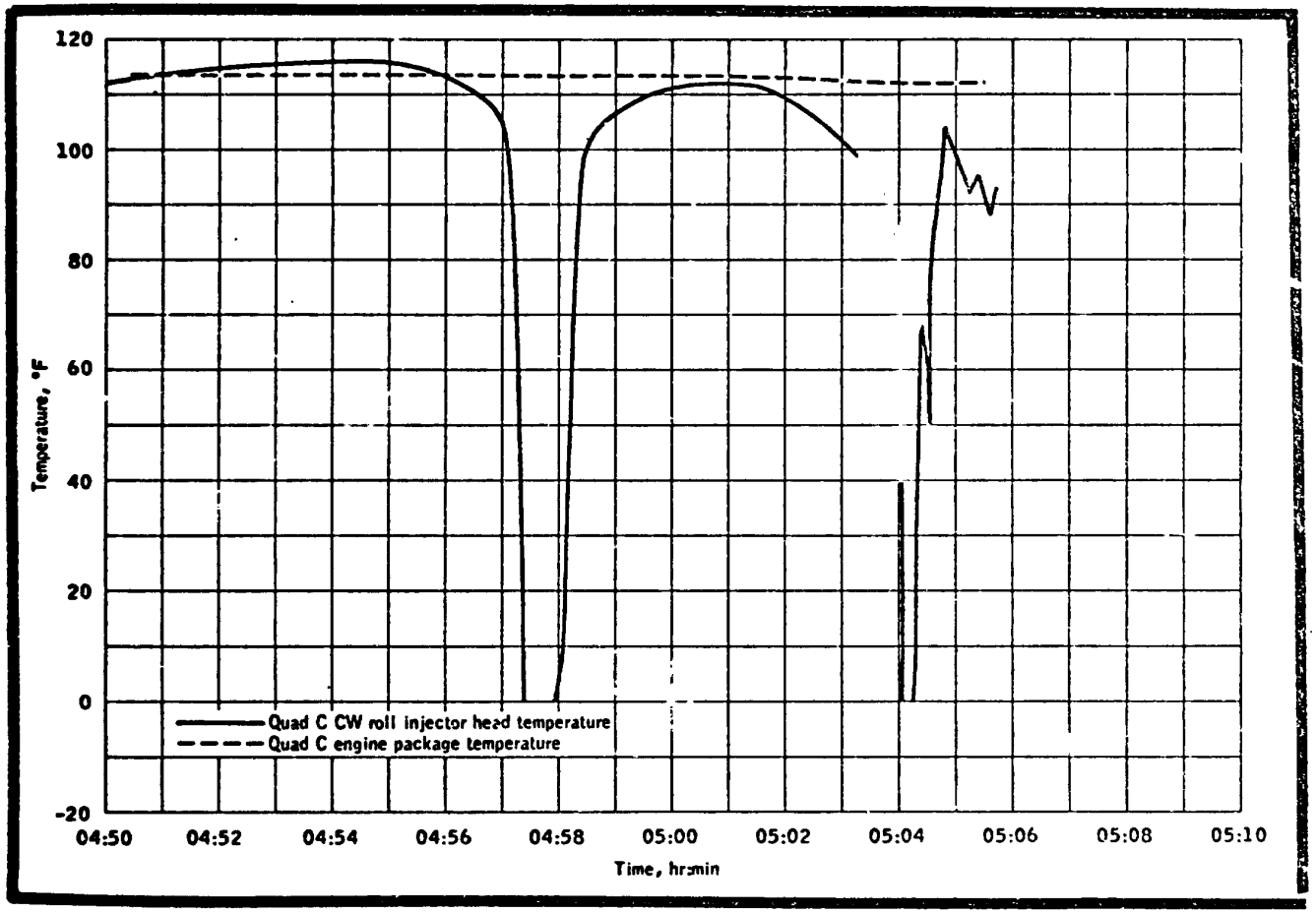


Figure 2.1.17-1. Typical Quad C Temperature Excursions

ANOMALY REPORT

NO. 2.1.18 TITLE: CSM/S-IVB SEPARATION TRANSIENT

SYSTEM: SPACECRAFT MISSION: APOLLO 6

SUBSYSTEM: STRUCTURE EVENT TIME: 03:14:27

DESCRIPTION: A PITCH BODY RATE TRANSIENT EQUIVALENT TO A DISTURBANCE TORQUE OF APPROXIMATELY 900 FT-LB OCCURRED AT SEPARATION OF THE CSM FROM THE S-IVB/IU/SLA. THE PITCH TRANSIENT AT SEPARATION WAS 1 DEG/SEC OVER A 0.1-SECOND PERIOD, WHICH IS LARGER THAN HAS BEEN OBSERVED ON PREVIOUS MISSIONS, AND CONTAINED A MOMENTARY REVERSAL 0.04 SECOND AFTER INITIATION. THE TRANSIENTS IN ROLL AND YAW WERE LESS THAN 0.5 DEG/SEC. THE SERVICE MODULE PLUS X CONTROL ENGINES WERE OPERATING AT THAT TIME WITH ATTITUDE CONTROL INHIBITED. THE PATTERN OF DISTURBANCE TORQUES APPEARED NORMAL AFTER THE INITIAL TRANSIENT, THUS INDICATING PROPER ENGINE OPERATION. A PITCH EXCURSION IN PHASE WITH THE CSM WAS ALSO PRESENT IN THE S-IVB/IU/SLA AT THAT TIME. A SHARP REVERSAL OCCURRED AT 03:14:27.92, 0.07 SECOND AFTER SEPARATION, INDICATING THAT THE MOTION OF THE TWO VEHICLES WAS COUPLED AT LEAST UNTIL THAT TIME. THE CSM CONTROL SYSTEM PARAMETERS FOR THIS PERIOD ARE SHOWN IN FIGURE 2.1.18-1.

STATUS: THE MOST PROBABLE CAUSE OF THE HANGUP WAS DAMAGE TO THE SLA ASSOCIATED WITH STRUCTURAL FAILURE DURING LAUNCH. OTHER POSSIBLE CAUSES ARE FAILURE OF THE SM UMBILICAL TO DISCONNECT OR PHYSICAL HANGUP OF A DEPLOYING SLA PANEL.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSC 60-DAY REPORT, PP. 5.16-2, 5.16-20, 12-8.
MSC ANOMALY STATUS REPORT, AUGUST 20, 1968, P. 5.
MSC ANOMALY STATUS REPORT, NOVEMBER 5, 1968, P. 3

REV: C

TITLE: CSM/S-IVB SEPARATION TRANSIENT

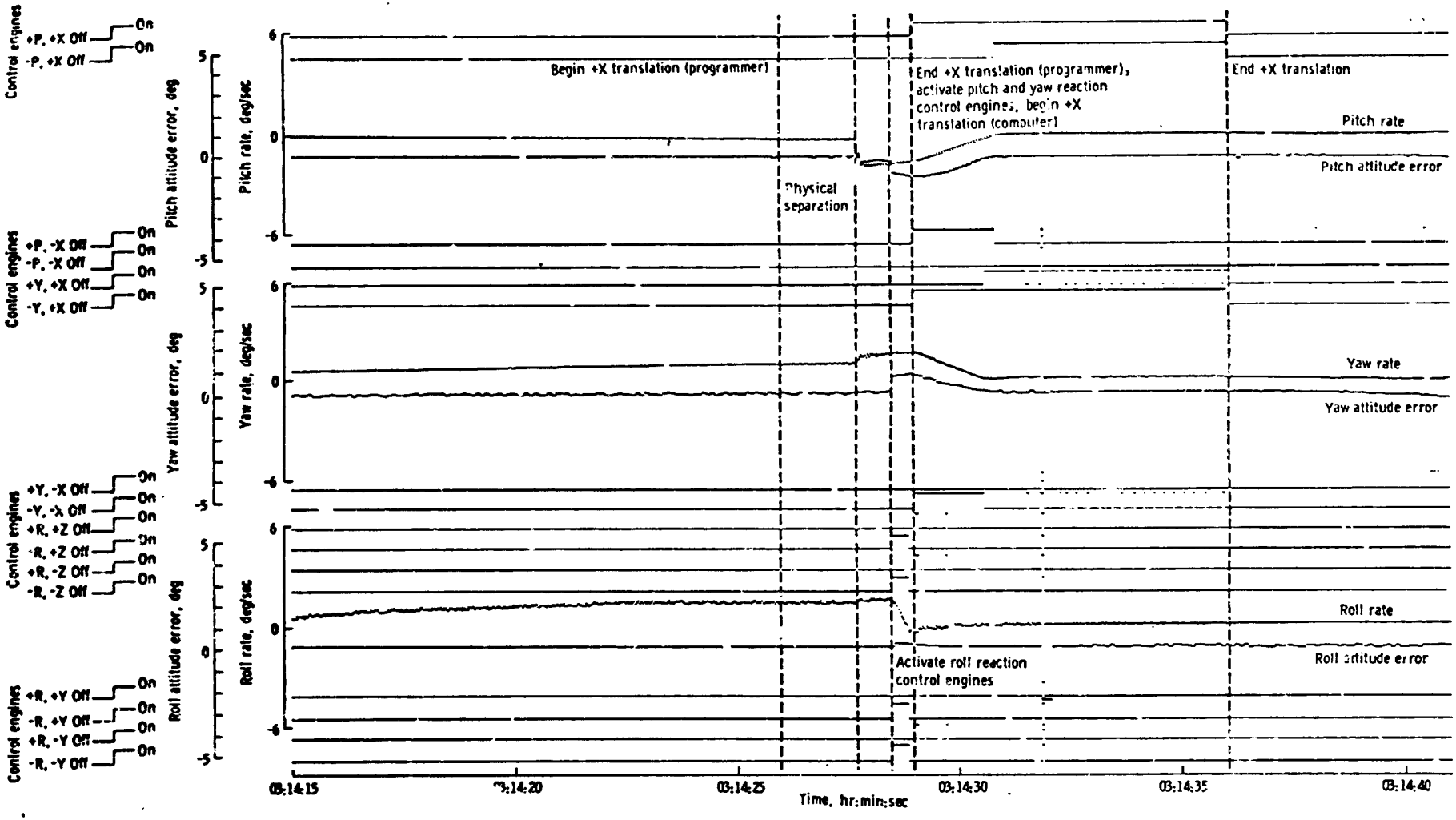


Figure 2.1.18-1. Dynamics During CSM/S-IVB Separation

ANOMALY REPORT

NO. 2.1.19 TITLE: CM BATTERIES INTERNALLY SHORTED

SYSTEM: CM MISSION: APOLLO 6

SUBSYSTEM: ELECTRIC POWER EVENT TIME: POST-FLIGHT TESTING

DESCRIPTION: DURING POST-FLIGHT TESTS, IT WAS DISCOVERED THAT ONE OF THE ENTRY AND POST-LANDING BATTERIES WAS COMPLETELY DISCHARGED AND THAT THE OTHER FOUR BATTERIES APPEARED TO HAVE INTERNAL SHORTS. THE BATTERY WIRING WAS CHECKED AND WAS FOUND TO BE NORMAL. ONE OF THE BATTERIES EXHIBITED ABNORMAL VOLTAGE DURING DISCHARGE OF RESIDUAL CAPACITY. THE FOUR OTHER BATTERIES, WHEN RECHARGED, FAILED TO ACHIEVE NOMINAL CHARGE VOLTAGES OR TO MAINTAIN NOMINAL OPEN-CIRCUIT VOLTAGE AFTER THE RECHARGING WAS CONCLUDED. THESE OCCURRENCES ARE INDICATIVE OF SHORTED CELLS.

STATUS: DISASSEMBLY AND INSPECTION CONFIRMED THAT EACH OF THE BATTERIES CONTAINED SEVERAL SHORTED CELLS. NO MANUFACTURING DEFECTS WERE NOTED. A HEAVY DEPOSIT OF SILVER WAS OBSERVED IN THE SEPARATOR MATERIAL AS WELL AS TRACES OF ZINC SLUDGE BETWEEN THE SEPARATOR LAYERS. BOTH OF THESE CHEMICAL CHANGES ARE EVIDENCE OF OVERCHARGING. A REVIEW OF THE PRE-FLIGHT DATA REVEALED THAT THE BATTERIES HAD BEEN OVERCHARGED. THE CONCLUSION REACHED FROM THE INVESTIGATION IS THAT THE BATTERY FAILURES WERE CAUSED BY SHORTED CELLS AS A RESULT OF OVERCHARGING BEFORE THE FLIGHT. THE BATTERY CHARGING PROCEDURE USED AT KSC ON NEW FLIGHT BATTERIES HAS BEEN REVISED TO LIMIT CHARGING TO SAFE LEVELS, EFFECTIVE ON CM 101 (APOLLO 7) AND SUBSEQUENT. THIS ANOMALY HAS BEEN CLOSED BY MSC.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSC 60-DAY REPORT, PP. 12-9, 12-11;
MSC-TIE MEMO NO. 5-2713-HOU-01-011, JULY 9, 1968.
MSC ANOMALY STATUS REPORT, AUGUST 6, 1968, P. 6.

REV: C

ANOMALY REPORT

NO. 2.1.20 TITLE: DAMAGED WIRES IN CM/SM UMBILICAL

SYSTEM: CM MISSION: APOLLO 6

SUBSYSTEM: ELECTRICAL EVENT TIME: POST-FLIGHT

DESCRIPTION: DURING POST-FLIGHT INSPECTION, 39 OF THE APPROXIMATELY 1000 WIRES IN THE CM/SM UMBILICAL WERE FOUND TO BE DAMAGED NEAR THE POTTING INTERFACE ON THE UMBILICAL HOUSING (SEE FIGURE 2.1.20-1). THE DAMAGE TO THE WIRES (30 SPARES AND 9 FUNCTIONAL) RANGED FROM PINCHED INSULATION AND EXPOSED CONDUCTORS TO ONE SPARE WIRE BEING BROKEN ENTIRELY. NONE OF THE DAMAGED WIRES WERE ASSOCIATED WITH ANY FLIGHT ANOMALIES.

STATUS: BECAUSE THE DAMAGE WAS EXTENSIVE, IT WOULD HAVE BEEN DISCOVERED IF IT HAD OCCURRED DURING UMBILICAL ASSEMBLY. AFTER THE UMBILICAL WAS INSTALLED ON THE CM, IT WAS DELIVERED TO KSC, AND THE UMBILICAL WAS NOT WORKED ON DURING PRE-LAUNCH OPERATIONS. NOTHING IN THE PROXIMITY OF THE UMBILICAL COULD HAVE CAUSED THE DAMAGE DURING THE MISSION. BECAUSE OF THE CARE EXERCISED, IT IS NOT LIKELY THAT THE WIRES WERE DAMAGED DURING UMBILICAL REMOVAL AFTER THE FLIGHT. THEREFORE, THE WIRES WERE MOST PROBABLY DAMAGED DURING INSTALLATION OF THE UMBILICAL ON THE CM AT THE FACTORY. THE UMBILICAL INSTALLATION WAS DIFFICULT, AND SEVERAL WIRES WERE APPARENTLY DAMAGED NEAR THE POTTING INTERFACE BEFORE THE INSTALLATION WAS COMPLETED. A PORTION OF THE UMBILICAL HARNESS HAD TO BE INTEGRATED WITH OTHER WIRING IN THE AFT COMPARTMENT. THE WORKING SPACE IN THE AREA WAS QUITE LIMITED AND 30 OF THE DAMAGED WIRES WERE IN THIS AREA. AFTER INSTALLATION, A DETAILED INSPECTION WAS NOT POSSIBLE BECAUSE OF LACK OF VISIBILITY. A RE-DESIGN FOR BLOCK II SPACECRAFT ALLOWS COMPLETE INSPECTION AFTER THE UMBILICAL IS INSTALLED AND THE UMBILICAL HARNESS NO LONGER HAS TO INTEGRATE WITH AFT COMPARTMENT WIRE BUNDLES. THIS ANOMALY HAS BEEN CLOSED BY MSC.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSC ANOMALY STATUS REPORT, AUGUST 16, 1968, P. 6;
MSC ANOMALY STATUS REPORT, AUGUST 20, 1968, P. 6;
MSC ANOMALY REPORT NO. 13.

REV: C

DETAIL SHEET

ANOMALY 2.1.20

TITLE: DAMAGED WIRES IN CM/SM UMBILICAL

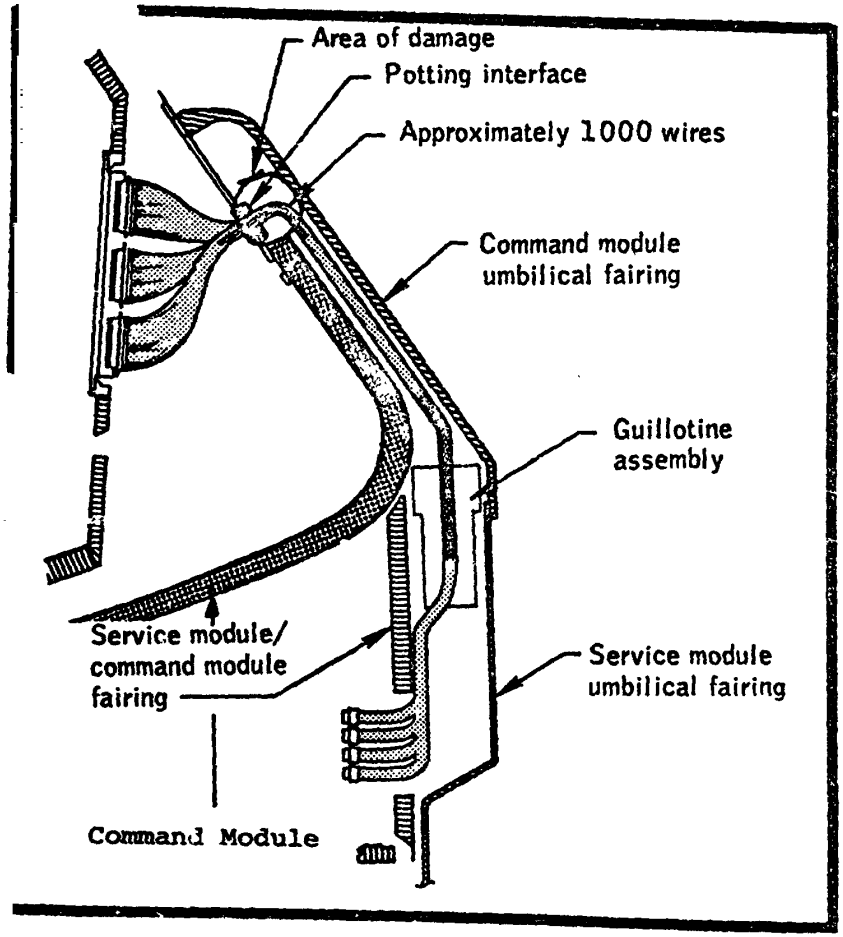


Figure 2.1.20-1. CM/SM Umbilical

ANOMALY REPORT

NO. 2.2.1 TITLE: STRUCTURAL/PROPULSION OSCILLATORY COUPLING (POGO)

SYSTEM: PROPULSION AND STRUCTURES MISSION: APOLLO 6

SUBSYSTEM: PROPULSION AND STRUCTURES. EVENT TIME: T+110 TO 140 SEC.

DESCRIPTION: WHEN THE FIRST LONGITUDINAL STRUCTURAL MODE FREQUENCY BECAME TUNED TO THE LOX FEED DUCT FIRST MODE AND F-1 ENGINE 5.3 H_z THRUST OSCILLATIONS, ACCELERATIONS WERE INCREASED OVER SA-501 LEVELS DUE TO ENGINES 1 THROUGH 5 OSCILLATING IN PHASE. A PEAK OCCURRED AT 125-128 SECONDS, THEN OSCILLATIONS DECREASED BETWEEN 128 AND 140 SECONDS.

STATUS: THE 5 CPS OSCILLATIONS ARE NOT ASSOCIATED WITH THE J-2 ENGINE ANOMALIES. ACCUMULATORS HAVE BEEN INSTALLED ON THE FIVE LOX SUCTION DUCTS BUT ONLY THE FOUR OUTBOARD LOX LINES WILL BE USED. S-II AND S-IVB PHASE OF FLIGHT HAVE BEEN EXAMINED FOR POGO AND HAVE ADEQUATE STABILITY MARGINS.

ORGANIZATION: 5-2464

REFERENCES: LISTED ON SUBSEQUENT PAGE.

RESOLUTION: MSFC: CLOSED DATE:

REV: C

ANOMALY 2.2.1

TITLE: STRUCTURAL/PROPULSION OSCILLATORY COUPLING (POGO)

A. POGO WORKING GROUP

A JOINT APO/MSFC/MSC WORKING GROUP HAD BEEN ESTABLISHED TO BE RESPONSIBLE FOR ALL POGO ACTIVITIES. CHAIRMAN IS MR. E. E. COERNER, MSFC (R-P&VE-DIR). MEMBERS ARE FROM THE FOLLOWING ORGANIZATIONS: MSFC LABS, MSFC SATURN V, ROCKETDYNE, BOEING-MICHOUD, BOEING-TIE, MSC AND LRC.

B. BACKGROUND

AROUND JULY OF THIS YEAR ANALYTICAL RESULTS WERE PRESENTED FOR A FOUR OUTBOARD LOX LINE ACCUMULATOR CONFIGURATION AND SHOWED ACCEPTABLE STABILITY MARGINS FOR THE NOMINAL CASE AND SENSITIVITY (TOLERANCE) INVESTIGATIONS. TEST RESULTS PRESENTED CONFIRMED THAT THE LOX LINE FUNDAMENTAL FREQUENCY WAS LOWERED TO 2Hz AND THAT THE PREVALVE ACCUMULATOR FIX IS COMPATIBLE WITH THE PROPULSION SYSTEM. RESULTS OF LIMITED ANALYSIS USING FIVE LINE ACCUMULATORS INDICATED STABILITY WAS MAINTAINED OR SLIGHTLY INCREASED AS COMPARED TO FOUR. RECOMMENDATIONS WERE THEREFORE MADE TO USE FIVE LOX LINE HELIUM FILLED PREVALVE ACCUMULATORS AS THE POGO SOLUTION FOR AS-503 AND TO CONTINUE VERIFICATION TESTING AND ANALYSIS ACTIVITIES.

IN SEPTEMBER OF THIS YEAR PROPULSION SYSTEMS TEST RESULTS,INCLUDING STATIC FIRING OF S-IC-6 WERE PRESENTED INDICATING THAT THE PRE-LAUNCH AND FLIGHT OPERATION OF THE POGO SOLUTION IS COMPATIBLE WITH THE F-1 ENGINE. TEST RESULTS ALSO VERIFIED THE LOX SYSTEM FREQUENCIES AND ENGINE TRANSFER FUNCTIONS THAT HAD BEEN PREVIOUSLY ESTABLISHED. THE FUEL SYSTEM FREQUENCY CHANGED FROM 7 TO 12 Hz BASED ON TEST DATA. ENGINE FUEL TRANSFER FUNCTIONS VERIFICATION WAS COMPLICATED BECAUSE OF INSTRUMENTATION SENSITIVITY LIMITATIONS. PRELIMINARY STABILITY ANALYSIS RESULTS FOR THE C' MISSION USING THE 12 Hz FUEL SYSTEM FREQUENCY INDICATED A SLIGHT INCREASE IN STABILITY MARGIN DURING S-IC BURN. RESULTS OF STABILITY ANALYSES FOR THE S-II AND S-IVB STAGE BURNS WERE NOT AVAILABLE BECAUSE OF THE CHANGE TO THE C' MISSION. FURTHER TESTING WAS RECOMMENDED TO OBTAIN ADDITIONAL DATA ON THE FUEL SIDE OF THE PROPULSION SYSTEM. STABILITY ANALYSIS EFFORTS WOULD CONTINUE WITH ALL ORGANIZATIONS INVOLVED USING C' MISSION WITH MODELS.

SINCE SEPTEMBER IT WAS CONFIRMED THAT INBOARD FUEL SYSTEM FREQUENCY IS 12 Hz AND OUTBOARD FUEL SYSTEM FREQUENCY IS 10 Hz. THE C' MISSION STRUCTURAL MATH MODEL WAS UPDATED. MODE SHAPES AND FREQUENCIES HAVE BEEN VERIFIED BY COMPARISON WITH DYNAMIC TEST DATA.

C. LATEST FINDINGS AND 503 POGO ASSESSMENTS

ORIGINAL STABILITY ANALYSIS INDICATED ADEQUATE MARGINS WITH PREVALVE ACCUMULATORS INSTALLED IN ALL S-IC ENGINES. FURTHER INVESTIGATION INTO THE CENTER ENGINE STABILITY REVEALED A COUPLING OF THE LOX LINE SECOND MODE WITH THE CENTER ENGINE STRUCTURAL MODE AND PRODUCED INSTABILITY FROM APPROXIMATELY T+40 TO T+87 SECONDS. ANALYSIS USING PREVALVE ACCUMULATORS, IN THE FOUR OUTBOARD ENGINE LINES ONLY, INDICATED STABLE CONDITIONS IN ALL MODES THROUGHOUT S-IC BOOST. S-IC-7 WAS STATIC FIRED SATISFACTORILY USING FOUR OUTBOARD ENGINE LOX LINE ACCUMULATORS. THE FOUR ENGINE ACCUMULATOR SYSTEM DOES NOT ADVERSELY AFFECT THE GUIDANCE SYSTEM STABILITY OR PRODUCE SIGNIFICANT LONGITUDINAL/LATERAL LOADS IN THE SPACECRAFT. THE USE OF THE FOUR ENGINE LINE ACCUMULATOR CONFIGURATION WAS RECOMMENDED FOR USE FOR APOLLO 8. THE S-II ANALYSIS INDICATED ADEQUATE POGO STABILITY MARGINS AT IGNITION AND CUTOFF. THE RESULTS OF THE REMAINING S-II POWERED FLIGHT ANALYSIS WILL BE AVAILABLE NOVEMBER 11, 1968. THE S-IVB ANALYSIS INDICATED ADEQUATE POGO STABILITY MARGINS THROUGHOUT FLIGHT.

LOX FEED LINE SYSTEM

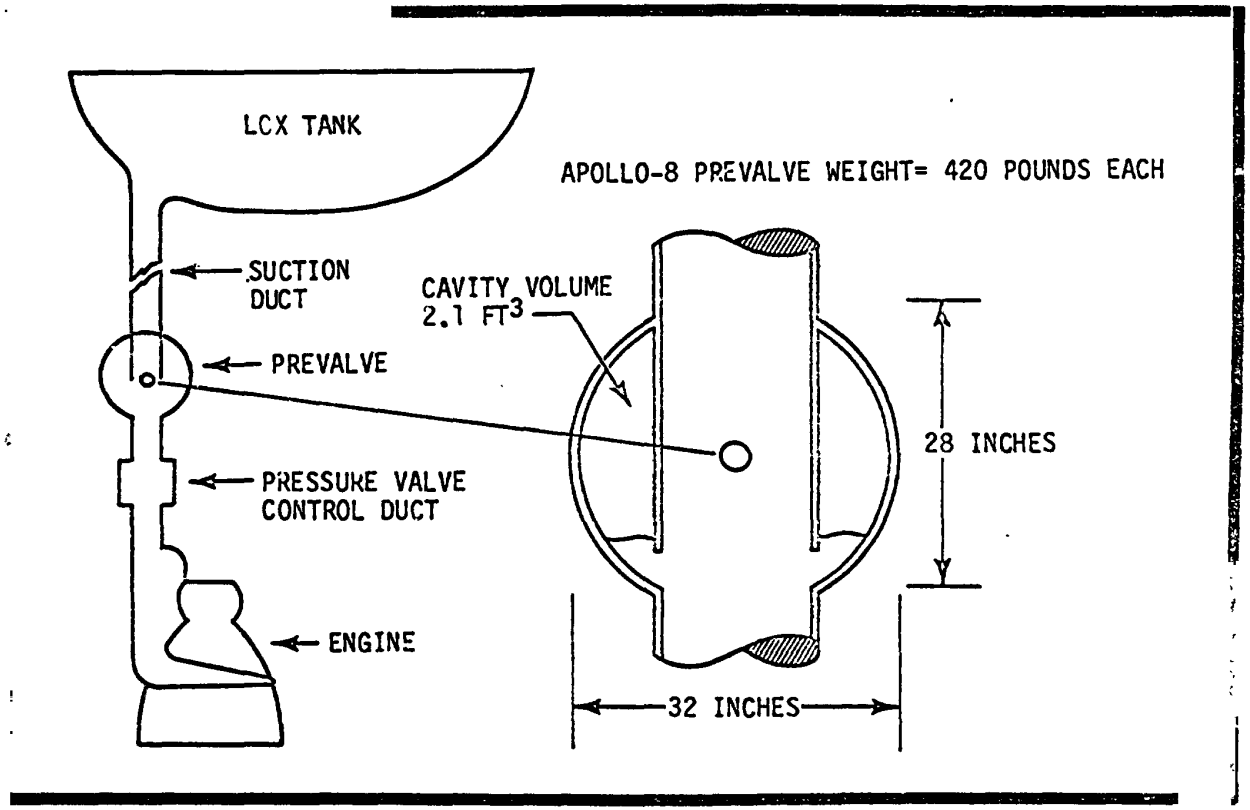


Figure 2.2.1-1

TITLE: STRUCTURAL/PROPULSION OSCILLATORY COUPLING (POGO) -- CONTINUED

REFERENCES

MSFC AS-502 FLIGHT RESULTS MEETING, APRIL 10, 1968;
AS-503 SEMI-DCR/AS-502 EVALUATION MEETING, APRIL 21, 1968;
AS-503 PROGRAM ACTION REVIEW, MAY 2, 1968;
APO-TIE LETTER NO. 5-2131-WDC-1-021, MAY 22, 1968;
MSFC 30-DAY REPORT, ITEM 2;
MSFC 30-DAY REPORT, REVISION A, ITEM 2;
MSFC 30-DAY REPORT REVISION B, ITEM 2;
NASA-APO MONTHLY PROGRAM REVIEW, JUNE 11, 1968.
AS-503 PROGRAM ACTIONS REVIEW, JUNE 18, 1968.
AS-503 PROGRAM ACTIONS REVIEW, JULY 15, 1968.
MSFC 30-DAY REPORT, REVISION D, ITEM 2;
MSFC 60-DAY REPORT, SECTION 5.
APOLLO 8 MISSION SELECTION DECISION TELECON, NOVEMBER 9, 1968
APOLLO 8 DCR, NOVEMBER 7, 1968

ANOMALY REPORT

NO. 2.2.2 TITLE: FAILURE OF S-II ENGINE NO. 2

SYSTEM: S-II MISSION: APOLLO 6

SUBSYSTEM: PROPULSION EVENT TIME: T + 413 SECONDS

DESCRIPTION: AT 319 SECONDS, A SUDDEN PERFORMANCE SHIFT OF 7600 LBF OCCURRED. AT 412.92 SECONDS, DROPOUT OF THE THRUST OK SWITCHES INDICATED ENGINE NO. 2 CUTOFF.

STATUS: POST-FLIGHT EVALUATION OF TELEMETERED DATA LED TO THE CONCLUSION THAT THE ENGINE NO. 2 AUGMENTED SPARK IGNITER (ASI) FUEL LINE FAILED AND ULTIMATELY CAUSED FAILURE OF THE ENGINE. SINCE THE FLIGHT, TESTING AT MARSHALL SPACE FLIGHT CENTER AND THE MANUFACTURER'S FACILITY HAS SUBSTANITIATED THIS CONCLUSION. THE TESTING REVEALS THAT AN OXIDIZER-RICH MIXTURE, CAUSED BY A FUEL LEAK, CREATES VERY HIGH TEMPERATURES AND RAPIDLY ERODES THE INJECTOR. BECAUSE OF THIS EROSION THE LOX DOME OF ENGINE NO. 2 EVENTUALLY FAILED, OPENING THE LOX HIGH PRESSURE SYSTEM AND CAUSING ENGINE CUTOFF (ECO). A MODIFICATION OF THE ASI PROPELLANT FEED-LINES (BOTH FUEL AND LOX) WILL BE ACCOMPLISHED ON AS-205, AS-503, AND SUBSEQUENT. THIS ANOMALY HAS BEEN CLOSED BY MSFC.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: SEE SUBSEQUENT PAGE. REV: C

ANOMALY 2.2.2

TITLE: FAILURE OF S-II ENGINE NO. 2

RELATED EVENTS

A. ENVIRONMENTAL CHANGES

THERE WAS A DECREASE IN MAIN OXIDIZER VALVE CONTROL LINE AND BODY TEMPERATURES ON ENGINE NUMBER 5 AT 225 SECONDS. THESE AND OTHER AREA TEMPERATURES INDICATED A CRYOGENIC COOLING CAUSED BY SPRAY FROM THE LEAKING ASI LINE.

AT SHUTDOWN OF ENGINES 2 AND 3, HEAT SHIELD CURTAIN GAS TEMPERATURES EXHIBITED A SUDDEN RISE. ENGINE NO. 2 SHUTDOWN WAS INITIATED BY A LOX DOME BURNTHROUGH PRECIPITATED BY HOT GAS BACKFLOW THROUGH ASI CHAMBER AND RUPTURED ASI FUEL LINE. HIGH CURTAIN GAS TEMPERATURES RESULTED FROM THE BURNTHROUGH.

B. PITCH AND YAW ACTUATOR DIFFERENTIAL PRESSURE INCREASE

PRESSURE INCREASES ON ENGINE NUMBER 2 PITCH AND YAW ACTUATORS WERE DUE TO INSTRUMENTATION ERROR RESULTING FROM CYROGENIC FLUID SPRAYED ON THE TRANSDUCER FROM RUPTURED ASI FUEL LINE, AND SIDE LOADS DUE TO THRUST CHAMBER DAMAGE FROM INJECTOR DEBRIS PRODUCED BY HIGH ASI MIXTURE RATIO.

TESTS

TESTING AT THE MARSHALL SPACE FLIGHT CENTER AND ENGINE MANUFACTURER'S FACILITY SUBSTANTIATED THE THEORY THAT ENGINE NUMBER 2 FAILURE WAS CAUSED BY EROSION OF THE LOX DOME. AN ASI FUEL LINE FAILURE WAS SIMULATED BY REDUCING THE FUEL SUPPLY, CREATING AN ASI 9.5 LOX/LH_2 MIXTURE RATIO. THE HIGH MIXTURE RATIO PRODUCED ABNORMALLY HIGH TEMPERATURES IN THE MAIN INJECTOR, WHICH CAUSED SEVERE EROSION TO OCCUR.

DETAIL SHEET

ANOMALY 2.2.2

TITLE: FAILURE OF S-II ENGINE NO. 2

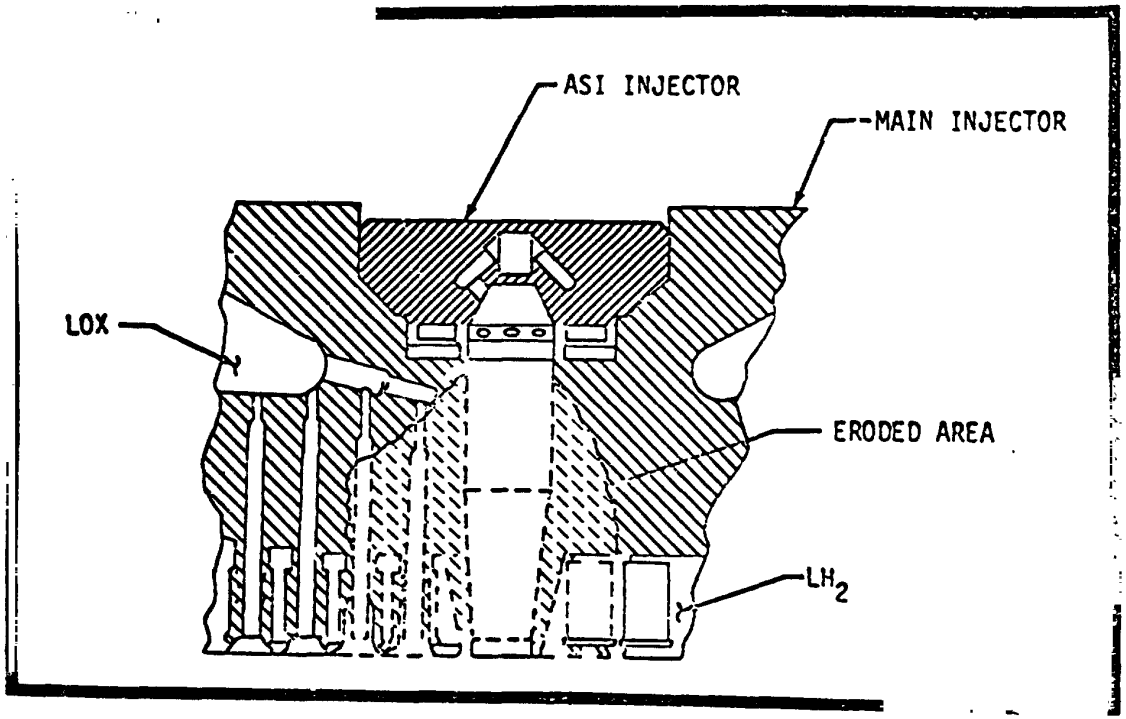


Figure 2.2.2-1

S-II Injector After 28 Second Test at High ASI Mixture Ratio

ANOMALY 2.2.2

TITLE: FAILURE OF S-II ENGINE NO. 2

REFERENCES

KSC 3-DAY REPORT, PP. 4, 5, AND 6;
MSFC AS-502 FLIGHT RESULTS MEETING, APRIL 10, 1968;
AS-503 SEMI-DCR/AS-502 EVALUATION MEETING, APRIL 21, 1968;
AS-503 PROGRAM ACTION REVIEW, MAY 2, 1968;
MSFC 30-DAY REPORT, ITEM 6;
AS-503 PROGRAM ACTIONS REVIEW, JUNE 18, 1968;
MSFC 30-DAY REPORT, REVISION D, ITEM 6;
MSFC 60-DAY REPORT, PP. 6-14 THROUGH 6-19.

ANOMALY REPORT

NO. 2.2.3 TITLE: INCREASE IN PITCH AND YAW ACTUATOR DIFFERENTIAL PRESSURE

SYSTEM: S-II MISSION: APOLLO 6

SUBSYSTEM: HYDRAULIC EVENT TIME: 00:04:38

DESCRIPTION: THERE WAS A STEADY INCREASE IN ENGINE NUMBER 2 YAW ACTUATOR DIFFERENTIAL PRESSURE BEGINNING AT 280 SECONDS. A SUDDEN INCREASE IN BOTH PITCH AND YAW ACTUATOR DIFFERENTIAL PRESSURES ASSOCIATED WITH A SUDDEN DECREASE IN THRUST OCCURRED AT 319 SECONDS. AT 334 SECONDS, THE YAW ACTUATOR DIFFERENTIAL PRESSURE PEAKED, BUT THE PITCH ACTUATOR PRESSURE REMAINED CONSTANT UNTIL ENGINE NUMBER 2 CUTOFF.

STATUS: THE RAMP INCREASE STARTING AT 280 SECONDS WAS THE RESULT OF CRYOGENIC FLUID SPRAYED ON THE TRANSDUCER. THE SUDDEN INCREASE IN PITCH AND YAW ACTUATOR DIFFERENTIAL PRESSURE AT 319 SECONDS WAS THE RESULT OF A SUDDEN LOAD ON THE ACTUATORS. ALL OF THE ANOMALOUS ACTUATOR CONDITIONS RESULTED FROM EVENTS ASSOCIATED WITH FAILURE OF THE NUMBER 2 ENGINE (SEE BACKUP SHEETS). NO MODIFICATION WILL BE MADE TO THE HYDRAULIC SYSTEM. THIS ANOMALY HAS BEEN CLOSED BY MSFC.

ORGANIZATION: 5-2464

RESOLUTION: CLOSED DATE:

REFERENCES: KSC 3-DAY REPORT, P. 6;
AS-503 SEMI-DCR/AS-502 EVALUATION MEETING, APRIL 21, 1968. REV: C
MSFC 30-DAY REPORT. ITEM 5;
MSFC 30-DAY REPORT, REVISION D, ITEM 5
MSFC 60-DAY REPORT, PP 8-1 TO 8-9, 11-30 TO 11-33, 23-3

DETAIL SHEET

ANOMALY 2.2.3

TITLE: INCREASE IN PITCH AND YAW ACTUATOR DIFFERENTIAL PRESSURE (CONTINUED)

AT 280 SECONDS, THE ENGINE NUMBER 2 YAW ACTUATOR DIFFERENTIAL PRESSURE MEASUREMENT STARTED A POSITIVE RAMP INCREASE AS SHOWN IN FIGURE 2.2.3-1. THIS INDICATION WAS APPARENTLY NOT A MEASURE OF INCREASING PRESSURE, BUT WAS THE RESULT OF CRYOGENIC FLUID COMING IN CONTACT WITH THE TRANSDUCER. THIS EFFECT HAS BEEN REPRODUCED IN TESTS PERFORMED AT MSFC AND AT THE S-II STAGE CONTRACTORS' TEST FACILITY. THE TRANSDUCER UTILIZES TWO BOURDON TUBES TO SENSE PRESSURE DIFFERENCE. IN THE TESTS LIQUID NITROGEN SPRAYED ON THE ACTUATOR CAUSED THE INSTRUMENT TO SHOW A PRESSURE DIFFERENCE SIMILAR TO THAT SHOWN IN FIGURE 2.2.3-1, ALTHOUGH NO PRESSURE WAS APPLIED TO THE ACTUATOR. THE INDICATION ROSE, PEAKED, AND THEN DECAYED APPARENTLY BECAUSE ONE OF THE BOURDON TUBES WAS COOLED FIRST AND THEN THE OTHER. WHEN BOTH TUBES HAD BEEN COOLED TO THE SAME TEMPERATURE, INDICATIONS ARE THAT THE TRANSDUCER WAS AGAIN ABLE TO MEASURE DIFFERENTIAL PRESSURE.

THE RAMP INCREASE CONTINUED UNTIL 319 SECONDS WHEN THE APPARENT FORCE ON THE YAW ACTUATOR HAD REACHED 18,000 lb. AT 319 SECONDS, THE ENGINE NO. 2 PITCH AND YAW ACTUATORS SHOWED A STEP INCREASE IN PRESSURE WHICH WAS APPARENTLY CAUSED BY A SIDE LOAD ON THE ENGINE. THE APPARENT FORCE ON THE YAW ACTUATOR ROSE RAPIDLY AS A CONSTANT FORCE WAS ADDED TO THE TEMPERATURE-INDUCED INDICATION. AT THE SAME TIME, THE FORCE ON THE PITCH ACTUATOR INCREASED. THESE CONSTANT FORCES REMAINED UNTIL ENGINE NO. 2 CUTOFF. IN ENGINE STATIC FIRING TESTS CONDUCTED AT MSFC, THESE ACTUATOR HYDRAULIC PRESSURE CHANGES AND ENGINE MOVEMENTS HAVE BEEN REPRODUCED. IN THE TESTS, A LOX-RICH AUGMENTED SPARK IGNITER (ASI) MIXTURE RATIO WAS USED. THIS CAUSED THE MAIN INJECTOR TO BE ERODED, WHICH, IN TURN, MADE A HOLE IN THE AFT PORTION OF THE THRUST CHAMBER. EXPANDING GASES FROM THIS HOLE CREATED A SIDE THRUST WHICH CAUSED EFFECTS VERY SIMILAR TO THOSE OBSERVED IN FLIGHT.

TITLE: INCREASE IN PITCH AND YAW ACTUATOR DIFFERENTIAI PRESSURE (CONTINUED)

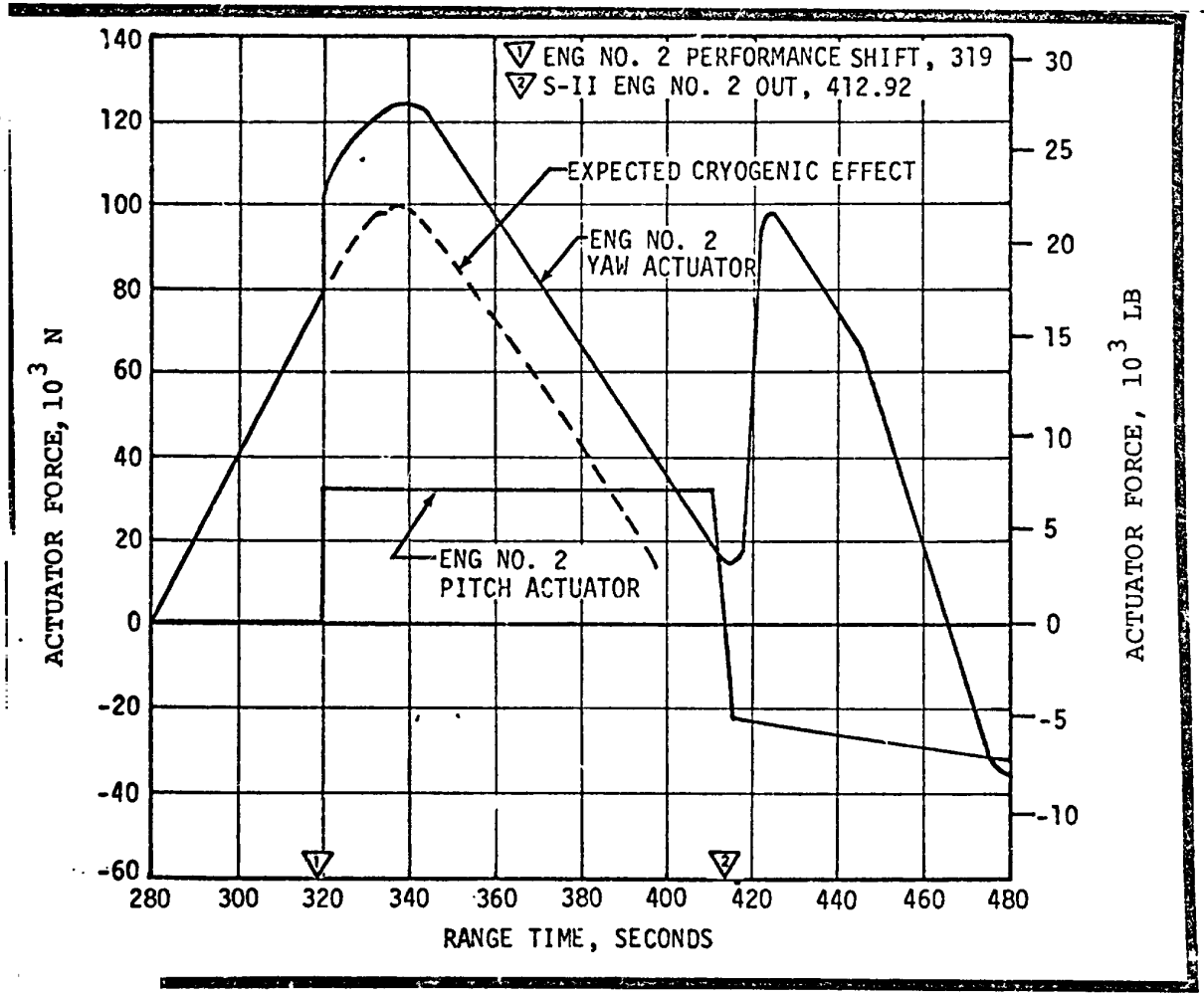


FIGURE 2.2.3-1 NUMBER 2 ENGINE ACTUATOR FORCES

DETAIL SHEET

ANOMALY 2.2.3

TITLE: INCREASE IN PITCH AND YAW ACTUATOR DIFFERENTIAL PRESSURE (CONTINUED)

AFTER ENGINE NO. 2 CUTOFF, BOTH THE PITCH AND YAW ACTUATOR PRESSURE MEASUREMENTS INDICATED A FORCE WHICH TENDED TO MOVE THE ENGINE INBOARD. THIS INDICATED FORCE IS STILL UNDER INVESTIGATION. THE PITCH ACTUATOR CONTINUED TO RESPOND TO GUIDANCE COMMANDS UNTIL 480 SECONDS WHEN THE ACCUMULATOR BECAME EMPTY OF FLUID. SHORTLY AFTER ENGINE NO. 2 CUTOFF, THE YAW ACTUATOR FAILED TO RESPOND TO GUIDANCE COMMANDS, AND ITS PERFORMANCE INDICATES THAT IT LOCKED UP AT THIS TIME. THE PROBABLE CAUSE OF THIS WAS CLOSURE OF THE HYDRAULIC LOCK VALVE WITHIN THE ACTUATOR OR SEIZURE OF THE PISTON. THE LOCK NORMALLY CLOSES WHEN THE DIFFERENCE BETWEEN THE ACTUATOR SUPPLY AND RETURN PRESSURES DECAYS BELOW 900 TO 1200 N/cm^2 (1300 to 1700 PSID). A LOW DIFFERENTIAL PRESSURE COULD HAVE BEEN CAUSED BY HIGHLY VISCOUS FLUID WITHIN THE ACTUATOR OR THE SUPPLY AND RETURN LINES TO THE ACTUATOR, RESULTING FROM A LOW TEMPERATURE CONDITION. PISTON SEIZURE COULD HAVE RESULTED FROM CRYOGENIC FLUID SPRAYING ON THE ACTUATOR CYLINDER. THE NO. 2 HYDRAULIC RESERVOIR LEVEL ALSO APPEARED TO HAVE DROPPED SHARPLY FROM 9 PERCENT TO ZERO AT ECO, PROBABLY DUE TO A COMPLETE LOSS OF RESERVOIR FLUID CAUSED BY A RUPTURE SOMEWHERE IN THE LOW PRESSURE SIDE OF THE SYSTEM. THE CAUSE OF THE RUPTURE HAS NOT BEEN DEFINED, HOWEVER, AN ABNORMALLY LOW ENVIRONMENTAL TEMPERATURE COULD HAVE SUBJECTED A PORTION OF THE SYSTEM TO EXTREME STRAINS AND EVENTUAL RUPTURE.

ANOMALY REPORT

NO. 2.2.4 TITLE: PREMATURE SHUTDOWN OF S-II ENGINE NO. 3

SYSTEM: S-II STAGE MISSION: APOLLO 6

SUBSYSTEM: PROPULSION EVENT TIME: 00:06:54.2

DESCRIPTION: ENGINE NUMBER 3 WAS PREMATURELY CUT OFF AT 414.18 SECONDS.

STATUS: NUMBER 3 ENGINE LOX PREVALVE WAS CLOSED BY THE ENGINE NUMBER 2 CUTOFF SIGNAL. THE ANOMALY WAS CAUSED BY ABSENCE OF ELECTRICAL REFERENCE DESIGNATOR MARKINGS ON THE STRUCTURE, WHICH RESULTED IN CROSS-WIRING OF THE #2 AND #3 ENGINE PREVALVE CONTROL LINES. THE SIMULTANEOUS CHECKOUT OF ALL PREVALVES PREVENTS DETECTION OF AN ERROR OF THIS TYPE. THE WIRING HARNESSES ON SUBSEQUENT STAGES WILL BE RE-INSPECTED OR RE-DESIGNED. THE ENGINE CHECKOUT PROGRAM WILL BE REVISED TO PROVIDE INDIVIDUAL ENGINE PRE-VALVE TIMING TESTS ON S-II-3 AND SUBSEQUENT. THIS ANOMALY HAS BEEN CLOSED BY MSFC.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: KSC 3-DAY REPORT, PP. 4,5, AND 6;
MSFC AS-502 FLIGHT RESULTS MEETING, APRIL 10, 1968; REV: C
AS-503 SEMI-DCR/AS-502 EVALUATION MEETING, APRIL 21, 1968
MSFC 30-DAY REPORT, REVISION B, ITEM 7
MSFC 60-DAY REPORT, PP. 6-1, 6-19, 23-3.

ANOMALY REPORT

NO. 2.2.5 TITLE: FAILURE OF S-IVB HYDRAULID PUMPS TO PRESSURIZE SYSTEM FOR RESTART

SYSTEM: S-IVB MISSION: APOLLO 6

SUBSYSTEM: PROPULSION EVENT TIME: 03:13:34

DESCRIPTION: ALL ENGINE AND STAGE PRESTART CONDITIONS APPEARED NORMAL FOR S-IVB RESTART UNTIL THE END OF THE START BOTTLE BLOWDOWN 8.5 SECONDS AFTER THE ENGINE START COMMAND. AT THIS TIME, THE MAIN OXIDIZER VALVE OPENED BUT THE ENGINE DID NOT IGNITE. ENGINE OPERATION WAS TERMINATED BY THE IU MONITOR AT 03:13:50.3 FOR LACK OF SUFFICIENT THRUST.

STATUS: FAILURE OF THE ENGINE TO IGNITE WAS CAUSED BY FAILURE OF AN AUGMENTED SPARK IGNITER (ASI) PROPELLANT LINE, WHICH OCCURRED DURING THE FIRST S-IVB BURN. THIS FAILURE IS SIMILAR TO THE ONE WHICH CAUSED PREMATURE SHUTDOWN OF THE NO. 2 ENGINE ON THE S-II STAGE. SEE BACKUP SHEETS AND ANOMALY 2.2.2 FOR DETAILS. A MODIFICATION OF THE ASI PROPELLANT FEED LINES WILL BE ACCOMPLISHED ON AS-205, AS-503 AND SUBSEQUENT. THIS ANOMALY HAS BEEN CLOSED BY MSFC.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: KSC 3-DAY REPORT, P. 11;
MSFC AS-502 FLIGHT RESULTS MEETING, APRIL 10, 1968;
AS-503 SEMI-DCR/AS-502 EVALUATION MEETING, APRIL 21, 1968;
AS-503 PROGRAM ACTIONS REVIEW, MAY 2, 1968;
MSFC 30-DAY REPORT, REVISION D, ITEMS 9 AND 11
MSFC 60-DAY REPORT, PP. 7-2, 7-15 TO 7-28, 23-3.

REV: C

ANOMALY 2.2.5

TITLE: FAILURE OF S-IVB HYDRAULIC PUMPS TO PRESSURIZE SYSTEM FOR RESTART

A. PERFORMANCE SHIFT DURING FIRST BURN

DURING THE FIRST S-IVB BURN, CHILLING OF THE ENGINE AREA OCCURRED BEGINNING AT T+645 SECONDS. A J-2 ENGINE PERFORMANCE SHIFT OCCURRED BETWEEN 684 AND 702 SECONDS. INVESTIGATION SHOWS TEMPERATURE CHANGES IN ENGINE REGION AT TIME OF SHIFT APPARENTLY CAUSED BY FLASH FIRE IN ENGINE AREA AT 696 SECONDS. FUEL PUMP DISCHARGE PRESSURE, CHAMBER PRESSURE, AND CHAMBER FLOW RATE DECREASED AND FUEL INJECTION TEMPERATURE INCREASED. SYMPTOMS INDICATE A LEAK IN THE ASI FUEL LINE.

B. FAILURE OF S-IVB HYDRAULIC PUMPS TO PRESSURIZE SYSTEM

A PROGRAMMED COMMAND WAS GIVEN TO INITIATE THE AUXILIARY HYDRAULIC PUMP AT 2:47:55, BUT PROPER HYDRAULIC PRESSURE WAS NOT OBTAINED. ADDITIONAL ATTEMPTS AFTER SPACECRAFT SEPARATION ALSO FAILED TO OBTAIN PRESSURE. IT IS SUSPECTED THAT THE LEAKING ASI FUEL LINE SPRAYED ON THE COMMON HYDRAULIC RETURN LINE, FREEZING HYDRAULIC FLUID AND PREVENTING HYDRAULIC FLOW AT RESTART. INDICATION IS THAT BOTH ENGINE AND AUXILIARY HYDRAULIC PUMPS WERE RUNNING, BUT CAVITATING. HAD A SECOND BURN BEEN ACHIEVED, IT IS DOUBTFUL IF HYDRAULIC PRESSURE WOULD HAVE BEEN AVAILABLE FROM EITHER THE AUXILIARY PUMP OR THE ENGINE DRIVEN PUMP. LOSS OF THRUST VECTOR CONTROL FROM SUCH A CIRCUMSTANCE COULD CAUSE A MISSION ABORT.

ANOMALY REPORT

NO. 2.2.6 TITLE: UNEXPECTED LAUNCH VEHICLE TRANSIENT

SYSTEM: S-II, S-IVB, IU MISSION: APOLLO 6

SUBSYSTEM: DATA EVENT TIME: T+133 SECONDS

DESCRIPTION: AT APPROXIMATELY 133 SECONDS ABRUPT CHANGES OF STRAIN, VIBRATION, AND ACCELERATION MEASUREMENTS WERE INDICATED IN THE S-IVB, INSTRUMENT UNIT (IU), SPACECRAFT/LUNAR MODULE ADAPTER (SLA), LUNAR MODULE TEST ARTICLE (LTA), AND COMMAND AND SERVICE MODULE (CSM). PHOTOGRAPHIC COVERAGE, AIRBORNE LIGHT OPTICAL TRACKING SYSTEM (ALOTS), AND GROUND CAMERA FILM SHOWED PIECES SEPARATING FROM THE AREA OF THE ADAPTER. THERE WERE NO STRUCTURAL FAILURES ON THE LAUNCH VEHICLE.

STATUS: ALL DATA FROM BOTH THE LAUNCH VEHICLE AND SPACECRAFT RELEVANT TO THIS 133 SECOND ANOMALY HAVE BEEN INVESTIGATED BY A JOINT TASK GROUP AT THE MANNED SPACECRAFT CENTER (MSC). THE RESULTS OF THIS INVESTIGATION ARE BEING PUBLISHED IN A SEPARATE ANOMALY REPORT BY MSC. ALSO INCORPORATED INTO ANOMALY 2.1.1.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSFC 7-DAY FEWG MEETING;
MSC 3-DAY REPORT, P. 14;
KSC 3-DAY REPORT, P. 16;
MSFC 14-DAY FEWG MEETING;
MSFC 30-DAY REPORT, ITEM 12;
MSFC 30-DAY REPORT, REVISION C, ITEM 12;
MSFC 60-DAY REPORT, P. 23-4

REV: C

ANOMALY REPORT

NO. 2.2.7 TITLE: S-IVB HELIUM LEAK

SYSTEM: S-IVB MISSION: APOLLO 6

SUBSYSTEM: LOX PRESSURIZATION EVENT TIME: ORBITAL COAST

DESCRIPTION: SHORTLY AFTER ORBIT INSERTION, A LEAK DEVELOPED IN THE COLD HELIUM SYSTEM WHICH BLED THE SUPPLY PRESSURE FROM 1370 TO 850 PSI. HELIUM PLUMBING LEAKAGE ON S-IVB IS A CHRONIC PROBLEM. CONOSEALS, "MC" FITTINGS, AND VALVES HAVE BEEN SUSPECT.

STATUS: CONOSEAL GASKETS WILL BE CHANGED TO TEFLON COATED 2075 ALUMINUM THROUGHOUT COLD HELIUM SYSTEM (ECP 2886). M.C. FLARED FITTING TORQUE CHECK NOW INCLUDED IN PREFLIGHT PROCEDURES. MSFC CLOSED OUT AS AN ACCEPTABLE FIX ON AS-503.

ORGANIZATION: 5-2464

REFERENCES: KSC 3-DAY REPORT. P.9;
AS-503 SEMI-DCR/AS-502 EVALUATION MEETING, APRIL 21, 1968;
MSFC 30-DAY REPORT, ITEM 8;
MSFC 30-DAY REPORT, REVISION D, ITEM 8
AS-503 DELTA DCR TELECONFERENCE, SEPTEMBER 19, 1968
MSFC 60-DAY REPORT, P. 7-45
SA-205 LAUNCH VEHICLE FRR ASSESSMENT, OCTOBER 3, 1968

RESOLUTION: CLOSED DATE:

REV: C

ANOMALY 2.2.7

TITLE: S-IVB HELIUM LEAK

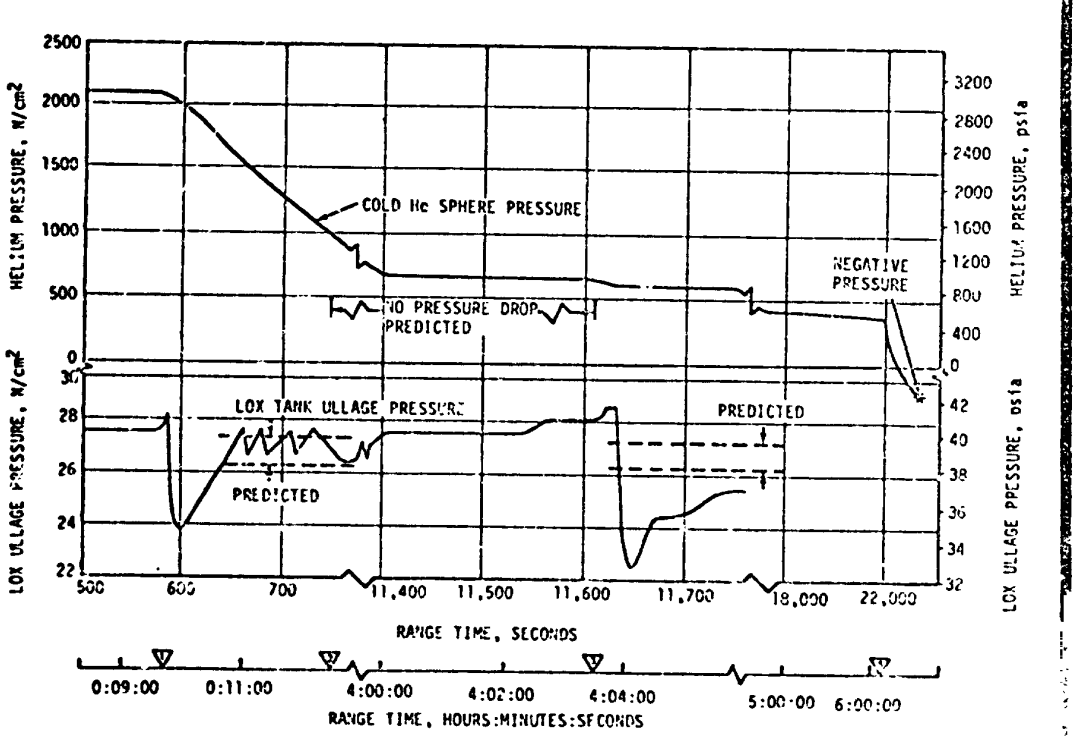
BACKGROUND: UNEXPLAINED He CONSUMPTION HAS TAKEN PLACE ON S-IVB 201, 202, 203, 501 AND ABOUT FIVE TIMES MORE He THAN DICTATED BY ACTUAL EQUIPMENT REQUIREMENTS IS CARRIED ON EACH FLIGHT TO PROVIDE FOR PNEUMATIC SYSTEM LEAKAGE. THIS PROBLEM BECOMES MORE CRITICAL AS THE S-IVB MISSION TIME IS EXTENDED.

FOR APOLLO 6 THE COLD HELIUM SUPPLY WAS ADEQUATE TO MEET ALL FLIGHT REQUIREMENTS. AT FIRST BURN ESC THE COLD HELIUM SPHERES CONTAINED 151 KILOGRAMS (332 lbm) OF HELIUM AT A PRESSURE 2027 N/cm^2 (2940 psia). AT THE END OF THE 166.52-SECOND ENGINE BURN, THE HELIUM MASS HAD DECREASED TO 124 KILOGRAMS (273 lbm) AT A PRESSURE OF 951 N/cm^2 (1380 psia). FOLLOWING FIRST BURN ECO N/cm^2/min (2.9 psi/min) AS SHOWN IN FIGURE 2.2.7-1, RESULTING IN AN APPARENT PRESSURE AT SECOND BURN ESC OF 593 N/cm^2 (860 psia).

DETAIL SHEET

ANOMALY 2.2.7

TITLE: S-IVB HELIUM LEAK



APOLLO 6 S-IVB COLD HELIUM SUPPLY DECAY
FIGURE 2.2.7-1

ANOMALY REPORT

NO. 2.2.8 TITLE: FAILURE OF S-IC CAMERAS TO EJECT

SYSTEM: S-IC MISSION: APOLLO 6

SUBSYSTEM: CAMERA DATA EVENT TIME: T+174.25 SECONDS

DESCRIPTION: THREE OF THE FOUR S-IC CAMERAS FAILED TO EJECT AFTER FIRST STAGE SEPARATION. ONE OF THE THREE CAMERAS WHICH FAILED TO EJECT PROVIDES VISUAL DATA OF S-IC/S-II SEPARATION. THE OTHER TWO CAMERAS PROVIDE VISUAL DATA ON THE LOX SURFACE BEHAVIOR DURING PROPELLANT USAGE AND RUNOUT. INVESTIGATIONS TO DATE INDICATE MOST LIKELY CAUSE IS LOSS OF EJECT BOTTLE PRESSURE THROUGH LINE RUPTURE. OTHER INSTRUMENTATION IN THE S-IC FORWARD SKIRT AREA INDICATES A MORE SEVERE THAN PREDICTED THERMAL AND GAS VELOCITY ENVIRONMENT CAUSED BY S-II ENGINE IGNITION. CAMERA SYSTEM IS INSTALLED ON AS-502 AND AS-503 ONLY.

STATUS: THERMAL PROTECTION WILL BE ADDED TO LOX TANK ULLAGE PRESSURE MEASUREMENTS, CAMERA PORT SQUIB CABLE ASSEMBLY, CAMERA PURGE AND EJECTION TUBING, AND CONTROL PRESSURE LINES ASSOCIATED WITH THE LOX VENT VALVES (SEE ANOMALY 2.2.12). THIS ACTION (ECP 441C, CCBD 302-8-182 AND CCBD 302-8-183) WAS APPROVED BY THE LEVEL II CHANGE BOARD ON 5/15/68, EFFECTIVE ON S-IC-3 AND SUBSEQUENT. THIS ANOMALY HAS BEEN CLOSED BY MSFC.

ORGANIZATION: 5-2404 RESOLUTION: CLOSED DATE:

REFERENCES: KSC 3-DAY REPORT, P. 3;
MSFC 30-DAY REPORT, ITEM 4.
MSFC 30-DAY REPORT, REVISION C, ITEM 4.
MSFC 60-DAY REPORT

REV: C

ANOMALY REPORT

NO. 2.2.9 TITLE: EXHAUST GAS FLOW REVERSAL FORWARD ON S-IC SURFACE

SYSTEM: S-IC MISSION: APOLLO 6

SUBSYSTEM: PROPULSION EVENT TIME: S-IC FLIGHT

DESCRIPTION: DURING THE LATTER PORTION OF S-IC FLIGHT, FLAMES WERE OBSERVED GOING FORWARD ON THE SIDE OF THE S-IC STAGE. A DARKENING OF THE STAGE WAS OBSERVED. THIS WAS ALSO OBSERVED ON AS-501 FLIGHT FILMS.

STATUS: FORWARD FLAME PROPAGATION WAS CAUSED BY FLOW SEPARATION AHEAD OF EXPANDED ENGINE PLUME. FUEL RICH ENGINE GASES FLOWED FORWARD ALONG THE SIDE OF THE VEHICLE IN THE SEPARATION FLOW REGION AND WERE IGNITED ALONG THE FREE STREAM BOUNDARY LAYER. SKIN TEMPERATURE MEASUREMENTS SHOWED TEMPERATURE TO BE WELL WITHIN DESIGN LIMITS. PRESSURES WERE NOT SIGNIFICANTLY AFFECTED.

MSFC DOES NOT CONSIDER THIS TO BE AN ANOMALY.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: AS-501 AND AS-502 FLIGHT FILMS
MSFC 60-DAY REPORT REV: C

ANOMALY REPORT

NO. 2.2.10 TITLE: S-IC ACCESS DOOR OPEN

SYSTEM: S-IC MISSION: APOLLO 6

SUBSYSTEM: UMBILICAL EVENT TIME: LAUNCH

DESCRIPTION: AN S-IC UMBILICAL DOOR WAS OBSERVED TO BE OPEN AND FLAPPING DURING THE APOLLO 6 LAUNCH.

STATUS: FORWARD ACCESS DOOR DISCONNECT CABLE INTERFERES WITH DOOR ON SEPARATION. AN ECP WAS INITIATED TO FIX THIS DOOR FOR AS-502 BUT WAS DISALLOWED. IT WILL BE FIXED FOR 504. MSFC DOES NOT CONSIDER THIS TO BE AN ANOMALY.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: AS-502 SEPARATION FILM REV: C

ANOMALY REPORT

NO. 2.2.11 TITLE: CHATTERING THRUST-OK SWITCHES

SYSTEM: S-IC MISSION: APOLLO 6

SUBSYSTEM: PROPULSION EVENT TIME: S-IC FLIGHT

DESCRIPTION: THE S-IC THRUST-OK SWITCHES WERE CHATTERING DURING FLIGHT.

STATUS: THESE SWITCHES HAVE BEEN QUALIFIED WITH 200 μ SEC CHATTER.
MSFC DOES NOT CONSIDER THIS TO BE AN ANOMALY.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSFC 14-DAY FEWG MEETING REV:

ANOMALY REPORT

NO. 2.2.12 TITLE: SEVERE S-IC SEPARATION ENVIRONMENT

SYSTEM: S-IC MISSION: APOLLO 6

SUBSYSTEM: FORWARD SKIRT EVENT TIME: S-IC/S-II SEPARATION

DESCRIPTION: AT S-IC/S-II SEPARATION, THE ENVIRONMENT IN THE S-IC FORWARD SKIRT WAS MORE SEVERE THAN THE DESIGN CRITERIA BECAUSE OF IMPINGEMENT OF S-II EXHAUST PLUME. PRESSURE TUBES RUPTURED IN THE LOX TANK FORWARD DOME AREA WITH THE FOLLOWING RESULTS: LOX TANK ULLAGE MEASUREMENTS FAILED; CONTROL PRESSURE FOR LOX TANK VENT VALVE WAS LOST; CAMERA EJECT SYSTEM MAY HAVE LOST PNEUMATIC PRESSURE.

STATUS: THERMAL PROTECTION WILL BE ADDED TO LOX TANK ULLAGE PRESSURE MEASUREMENT, CAMERA PORT SQUIB CABLE ASSEMBLY, CAMERA PURGE AND EJECTION TUBING, AND CONTROL PRESSURE LINES ASSOCIATED WITH THE LOX VENT VALVES (SEE ANOMALY 2.2.8). ECP 441 HAS BEEN APPROVED AND THE 6061-T6 ALUMINUM LINES TO THE SOLENOID VALVES THAT CONTROL THE LOX TANK VENT AND RELIEF VALVES WILL BE REPLACED WITH STAINLESS STEEL LINES FOR AS-503 AND SUBSEQUENT. THIS ANOMALY HAS BEEN CLOSED BY MSFC.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSFC 14-DAY FEWG MEETING;
MSFC 30-DAY REPORT, ITEM 3.
MSFC 30-DAY REPORT, REVISION B, ITEM 3.
MSFC 60-DAY REPORT.

REV: C

ANOMALY REPORT

NO. 2.2.13 TITLE: HIGH RETROROCKET PERFORMANCE

SYSTEM: S-IC MISSION: APOLLO 6

SUBSYSTEM: PROPULSION EVENT TIME: S-IC/S-II SEPARATION

DESCRIPTION: THERE ARE INDICATIONS THAT THE S-IC RETROROCKETS HAD HIGH PERFORMANCE ON S-IC/S-II SEPARATION.

STATUS: THE LONGITUDINAL ACCELERATION INDICATED THAT PHYSICAL SEPARATION OCCURRED APPROXIMATELY 0.1 SECOND EARLIER THAN AS-501. THIS WAS DUE TO THE RETRO MOTOR THRUST RISING TO FULL THRUST 0.1 SECONDS EARLIER. (SEE FIGURE 2.2.13-1.) GOOD AGREEMENT BETWEEN CALCULATED RESULTS AND FLIGHT DATA EXISTED FOR THIS FLIGHT. MSFC DOES NOT CONSIDER THIS TO BE AN ANOMALY.

ORGANIZATION: S-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSFC 14-DAY FEWG MEETING
MSFC 60-DAY REPORT REV: C

DETAIL SHEET

ANOMALY 2.2.13

TITLE: HIGH RETROROCKET PERFORMANCE

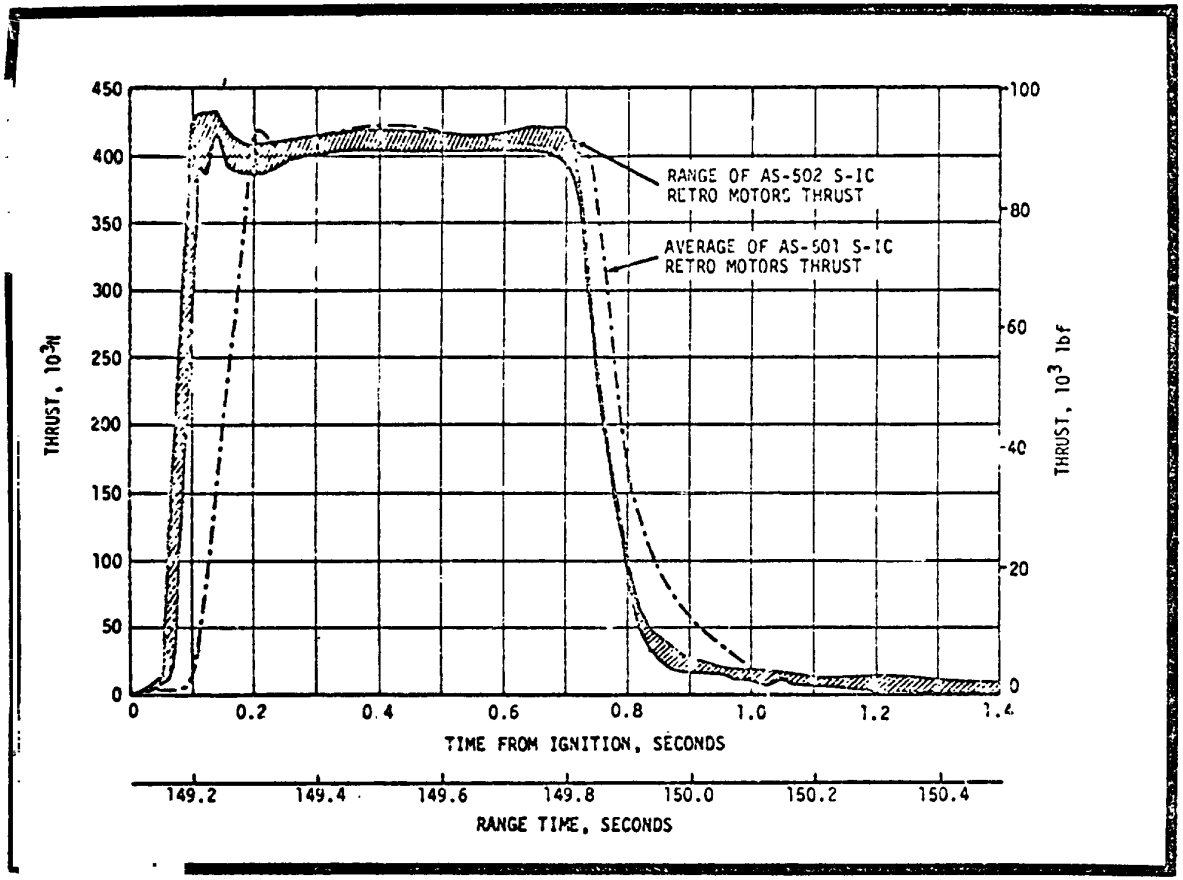


Figure 2.2.13-1. S-IC Retro Motor Thrust

ANOMALY REPORT

NO. 2.2.14 TITLE: VIBRATION MEASUREMENT FAILURE

SYSTEM: LAUNCH VEHICLE MISSION: APOLLO 6

SUBSYSTEM: INSTRUMENTATION EVENT TIME: S-II BURN

DESCRIPTION: THE AS-502 MEASUREMENT SYSTEMS OPERATED SATISFACTORILY. LOST MEASUREMENTS DID NOT ADVERSELY AFFECT VEHICLE POST-FLIGHT EVALUATION, EXCEPT IN ISOLATED CASES SUCH AS J-2 ENGINE VIBRATIONS.

STATUS: ECP #5513E HAS BEEN SUBMITTED BY CONTRACTOR AND APPROVED, BUT WILL NOT BE EFFECTIVE UNTIL 504.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSFC - 7-DAY FEWG MEETING
MSFC - 14-DAY FEWG MEETING
MSFC - 60-DAY REPORT

REV:

SA-502 HIGH FREQUENCY* VIBRATION MEASUREMENTS SUMMARY

STAGE	INVALID	QUESTIONABLE OR PARTIAL VALID	VALID	TOTAL
S-IC	13(25%)	1(2%)	37(73%)	51(100%)
S-IC ENGINE	10(52%)	0%	9(48%)	19(100%)
S-II	19(32%)	15(25%)	26(43%)	60(100%)
S-II ENGINE	15(100%)	0%	0%	15(100%)
S-IVB	1(3%)	8(23%)	26(74%)	35(100%)
S-IU	0%	7(25%)	21(75%)	28(100%)
TOTAL LAUNCH VEHICLE	33(19%)	31(18%)	110(63%)	174(100%)

*100-3000 HERTZ. TRANSMITTED OVER THE SINGLE SIDEBAND/FM TELEMETRY LINKS.

TITLE: VIBRATION MEASUREMENT FAILURE

VIBRATION EVALUATION

I. S-IC STAGE AND ENGINE EVALUATION

THE INTERTANK STRUCTURE AND FORWARD SKIRT STRUCTURE SHOW VIBRATION LEVELS SIMILAR TO AS-501 FLIGHT DATA, THE LEVELS FOR LAUNCH AND THROUGHOUT AS-502 FLIGHT WERE LOWER THAN STATIC FIRING LEVELS.

FOUR OF THE FIVE F-1 ENGINE COMBUSTION CHAMBER VIBRATION MEASUREMENTS YIELDED VALID DATA. ALL VIBRATION MEASUREMENTS ON THE COMBUSTION CHAMBER OF AS-501 WERE INVALID.

ONLY 48% OF THE S-IC-2 ENGINE VIBRATION REQUIREMENTS WERE VALID; PROPOSED CHANGES FOR S-IC-3 THROUGH S-IC-5 ARE: 1) WILL ADD HIGH PASS FILTERS (DOWN 2 DB AT 50 HZ) BETWEEN EMITTER - FOLLOWERS AND AMPLIFIERS. 2) WILL REPLACE 2 OF THE 75G TRANSDUCERS WITH 110G TRANSDUCERS. 3) WILL INCREASE RANGE OF 3 TRANSDUCERS BY ADDING ATTENUATORS (RESISTORS) BETWEEN EMITTER-FOLLOWERS AND AMPLIFIERS.

II. S-II STAGE AND ENGINE EVALUATION

THE 15 S-II ENGINE VIBRATION MEASUREMENTS (COMBUSTION DOMES, LOX PUMP, AND LH_2 PUMPS) FOR AS-501 AND AS-502 WERE CONSIDERED INVALID BECAUSE OF AMPLIFIER SATURATION AT FREQUENCIES ABOVE 3000 HERTZ.

RESULTS WERE WITHIN DESIGN LEVELS EXCEPT FOR THE FORWARD SKIRT CONTAINERS WHICH, LIKE THE FORWARD SKIRT STRUCTURE, EXCEEDED THE DESIGN CRITERIA FOR ABOUT 1 SEC. DURING THE LIFT-OFF PERIOD. NO FAILURES OCCURRED IN THE AFFECTED EQUIPMENT: ECP 5513 WILL INCREASE TRANSDUCER RANGES FROM 50G PEAK TO 150 AND 250G PEAK ON S-II-3.

III. S-IVB STAGE AND ENGINE EVALUATION

NINE VIBRATION MEASUREMENTS WERE MADE ON THE STRUCTURE, TWENTY-TWO AT COMPONENTS AND SIX ON THE ENGINE. THE MAXIMUM VIBRATION LEVELS MEASURED ON THE S-IVB STRUCTURE WERE SLIGHTLY LOWER ON AS-502 THAN ON AS-501. FORWARD COMPONENT MAXIMUM VIBRATION LEVELS WERE GREATER ON AS-502 THAN MEASURED AT SIMILAR LOCATIONS DURING THE AS-501 FLIGHT. THE MAXIMUM VIBRATION LEVELS MEASURED AT THE AFT COMPONENTS WERE 70% OF THOSE MEASURED AT SIMILAR LOCATIONS DURING THE AS-501 FLIGHT. THE MAXIMUM VIBRATION LEVELS MEASURED ON THE ENGINE WERE ALMOST IDENTICAL TO THOSE

ANOMALY 2.2.14

TITLE: VIBRATION MEASURE FAILURE

VIBRATION EVALUATION

MEASURED DURING THE FIRST S-IVB BURN OF THE AS-501 FLIGHT.

IV. INSTRUMENT UNIT EVALUATION

EIGHT MEASUREMENTS WERE USED ON THE IU FOR MONITORING STRUCTURAL VIBRATION OF THE UPPER AND LOWER INTERFACE RINGS. TWENTY MEASUREMENTS WERE USED TO MONITOR IU COMPONENT VIBRATION LEVELS.

	S-IC STAGE	S-II STAGE	S-IVB STAGE		INSTRUMENT UNIT	TOTAL VEHICLE
			PHASE I	PHASE II		
No. Scheduled	888	958	604***	604***	338	2788***
No. Waived/ Scrubbed	8	7	9	9	2	26**
No. Failures	15	24	10	19*	0	58
No. Partial Successes	21	33*	0	0	0	54
No. Improper Range	19	24	8	8	6	57
No. Questionable	0	0	2	1	0	2
Measurement Reliability	98.3%	97.5%	98.3%	96.8%	100%	97.9%

ANOMALY REPORT

NO. 2.2.15 TITLE: SPACE VEHICLE OVERSPEED AT INSERTION

SYSTEM: IU MISSION: APOLLO 6

SUBSYSTEM: GUIDANCE, NAVIGATION AND CONTROL EVENT TIME: ORBITAL INSERTION

DESCRIPTION: ALTHOUGH IU GUIDANCE, NAVIGATION AND CONTROL SYSTEM PERFORMED PER SPECIFICATION, IT WAS NOT DESIGNED TO SENSE OR ACCOMMODATE A TWO-ENGINE-OUT CONDITION. THIS CONSTRAINT PREVENTED THE FLIGHT PROGRAM FROM CONVERGING SIMULTANEOUSLY ON BOTH ALTITUDE AND VELOCITY END CONDITIONS AT INSERTION, RESULTING IN AN OVERSPEED OF 48.9 M/S (160 FT/S).

STATUS: IBM IS CONDUCTING A STUDY TO DETERMINE IF THE APOLLO PROGRAM SPEC SHOULD BE CHANGED REQUIRE LAUNCH VEHICLE G&N TO ACCOMMODATE MULTIPLE S-II ENGINE S-II FAILURES. THE COST AND SCHEDULE IMPACT OF SUCH A CHANGE WILL ALSO BE DETERMINED. THIS ANOMALY HAS BEEN CLOSED BY MSFC ALONG WITH THE S-II ENGINE FAILURE ANOMALIES.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSC 3-DAY REPORT, PP. 1 AND 6;
MSFC AS-502 FLIGHT RESULTS MEETING, APRIL 10, 1968; REV: C
MSFC 14-DAY FEWG MEETING;
MSFC 60-DAY REPORT.
MSFC 30-DAY REPORT, REVISION D, ITEM 7

TITLE: SPACE VEHICLE OVERSPEED AT INSERTION

THE OFF-NOMINAL FLIGHT CONDITIONS RESULTED FROM A DOUBLE S-II ENGINE FAILURE IN THE APOLLO 6 FLIGHT. THIS CREATED A SITUATION WHEREBY THE IGM GUIDANCE SYSTEM COULD NOT PROPERLY ACHIEVE NOMINAL ORBIT INSERTION CONDITIONS. THIS SITUATION ARISES FROM THE BASIC INABILITY OF THE DESIGNED GUIDANCE SYSTEM TO RECOGNIZE AND MAKE CORRECTION FOR A DOUBLE ENGINE FAILURE.

NOMINALLY, IGM PROVIDES FOR S-IVB CUTOFF IN ORBIT TO MEET SPECIFIED VALUES FOR RADIOUS (R), VELOCITY (V), FLIGHT PATH ANGLE (γ), AND AZIMUTH (A_z). THE GUIDANCE EQUATIONS HAVE CAPABILITY TO ADJUST FOR A SINGLE ENGINE FAILURE IN THE S-II. UPON ENGINE-OUT SIGNAL, THE MASS FLOWRATES ARE ASSUMED TO CHANGE BY A 4/5 FACTOR, AND THE GUIDANCE TIMES (T) ARE UPDATED BY A 5/4 FACTOR. THIS UPDATING COMPENSATES FOR THE LONGER BURN PERIOD REQUIRED AT REDUCED THRUST.

IN THE S-II PORTION OF AS-502 FLIGHT, AS IGM WAS STARTING TO LOOK FOR THE MIXTURE RATIO SHIFT (MRS), THE TWO ENGINES WENT OUT. THEREFORE, THE GUIDANCE PARAMETERS (PRIMARILY TIME AND F/M) WERE UPDATED FOR A SINGLE ENGINE OUT. WHEN THE PREDICTED TIME PARAMETER (T_2) REACHED 5 SECONDS, THE ACTUAL CUTOFF TIME, ($T_{c.o.}$), WAS APPROXIMATELY 54 SECONDS AWAY. THUS. PITCH ATTITUDE ANGLE (χ_c) WAS FROZEN FOR SOME 54 SECONDS PRIOR TO S-II BURN-OUT, AND CONSEQUENTLY, A LARGE ERROR IN VEHICLE ATTITUDE WAS GENERATED, RESULTING IN AN EXTREMELY HIGH S-II TRAJECTORY, WITH HIGH RADIUS (R) AND FLIGHT PATH ANGLE (γ), AND LOW VELOCITY.

AFTER S-IVB IGNITION AND CORRESPONDING IGM UPDATE, THE χ_c WENT ON THE RATE-LIMITER TO TRY TO PITCH THE VEHICLE DOWN. IT RODE THE LIMITER FOR SOME 40-50 SECONDS, THEN SEEMED TO HAVE CORRECTED THE $\chi_c - \chi$ ERROR. IT THEN CONTINUED TO PITCH THE VEHICLE DOWN TOWARD THE DESIRED CONDITION WHILE BUILDING UP VELOCITY.

AT SOME PRESET TIME PRIOR TO CUTOFF (SET AT 35 SECONDS), IGM ENTERS THE CHI-TILDE MODE, WHICH RELEASES THE CONSTRAINT ON R, AND TRIES TO NULL OUT THE V_R AND V_T COMPONENT ERRORS, TO ACHIEVE DESIRED TERMINAL VELOCITY (V) AND A CORRESPONDING FLIGHT PATH ANGLE (γ) =0. WHEN V WAS SUCH THAT TIME-TO-GO (T_T) REACHED 8 SECONDS, IGM ENTERED THE HIGH SPEED VELOCITY CUTOFF LOOP. IT TESTED V - VREQ'D, AND WHEN THIS TERM BECAME NEGATIVE, GUIDANCE CUTOFF OCCURRED WITH THE RADIAL VELOCITY COMPONENT LARGER THAN DESIRED.

DETAIL SHEET

ANOMALY 2.2.15

TITLE: SPACE VEHICLE OVERSPEED AT INSERTION

ON ENTERING THE CUTOFF LOOP, THE AS-502 TOTAL VELOCITY WAS IN EXCESS OF THE DESIRED VALUE OF 7790.9 M/S (25,560.7 FT/S), AND CUTOFF SIGNAL WAS IMMEDIATELY GIVEN AT 747.04 SECONDS WITH AN OVERSPEED OF 48.9 M/S (160 FT/S).

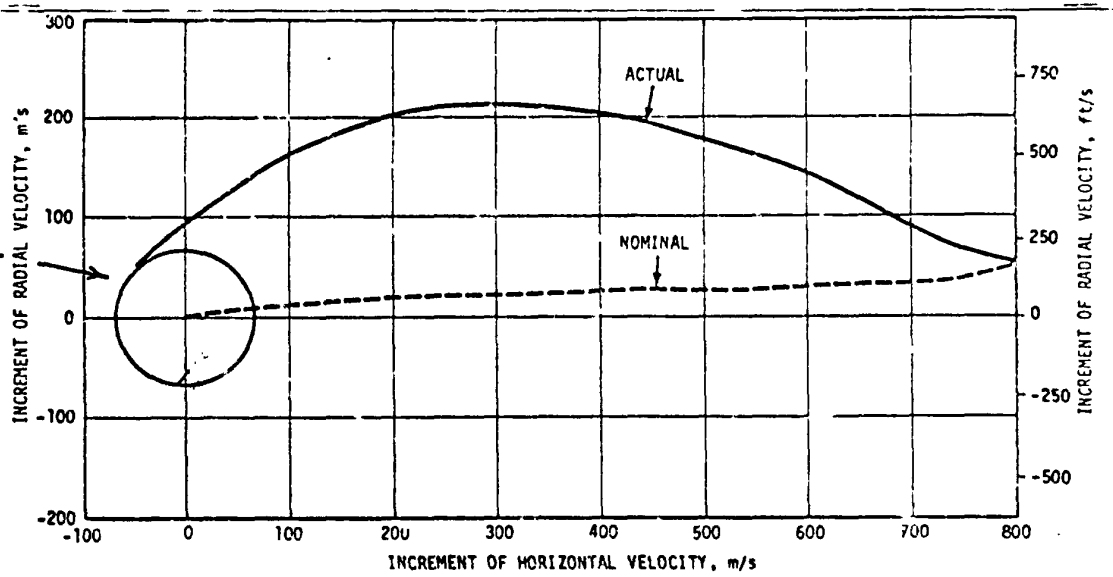


FIGURE 2.2.15-1

FIGURE I IS A PLOT OF THE RADIAL VELOCITY (X_V) TO-BE-GAINED VERSUS THE HORIZONTAL VELOCITY (Z_V) TO-BE-GAINED. THE CIRCLE ABOUT THE ORIGIN REPRESENTS THE CUTOFF LOOP WHICH IS ENTERED WHEN TOTAL VELOCITY-TO-BE-GAINED FALLS BELOW APPROXIMATELY 65 M/S (213 FT/S). THE DIFFERENCE IN THE ACTUAL AND NOMINAL VELOCITIES-TO-BE-GAINED IS A RESULT OF PITCH DOWN ATTITUDE COMMANDS TO CORRECT ALTITUDE DURING THE INITIAL PORTION OF S-IVB GUIDANCE. THE PITCH DOWN ATTITUDE TENDED TO INCREASE THE RADIAL VELOCITY-TO-BE-GAINED RATHER THAN DECREASE IT.

ANOMALY REPORT

NO. 2.2.16 TITLE: FAILURE OF RANGE SAFETY SYSTEM TO BE SAFED AFTER INSERTION

SYSTEM: IU/S-IVB MISSION: APOLLO 6

SUBSYSTEM: SECURE RANGE SAFETY COMMAND SYSTEM EVENT TIME: 00:12:37

DESCRIPTION: THE LAUNCH VEHICLE-LUNAR MODULE TEST ARTICLE/COMMAND SERVICE MODULE (LV-LTA/CSM) WAS INSERTED IN EARTH ORBIT WITH THE RANGE SAFETY SYSTEM ARMED, WHICH IS NORMAL. THE SAFING COMMAND WHICH NORMALLY FOLLOWS SHORTLY AFTER INSERTION WAS NOT SENT, HOWEVER, SINCE THE S-II AND S-IVB EXTENDED BURN PERIODS RESULTED IN INSERTION OCCURRING FURTHER DOWNRANGE, LEAVING INSUFFICIENT TIME BEFORE LOSS OF SIGNAL (LOS) TO SAFE THE VEHICLE AT THE NORMAL POST INSERTION TIME. THE SYSTEM WAS SAFED DURING THE FIRST ORBITAL PASS OVER KSC.

STATUS: APPROXIMATELY 12 SECONDS REMAINED TO SAFE SYSTEM AFTER INSERTION. OTHER PROBLEMS PREVENTED EXECUTION OF SAFING PROCEDURE BEFORE LOSS OF SIGNAL. MSFC CONSIDERS THIS TO BE A MINOR FLIGHT DEVIATION AND NOT AN ANOMALY.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: KSC 3-DAY REPORT, P. 22
MSFC - 60-DAY REPORT, PP. 14-1, 23-5

REV: C

ANOMALY REPORT

NO. 2.2.17 TITLE: S-IVB LOX PROPELLENT UTILIZATION (PU) MALFUNCTION

SYSTEM: S-IVB MISSION: APOLLO 6

SUBSYSTEM: PROPULSION EVENT TIME: 03:13:00

DESCRIPTION: AN ANOMALY OF 100 PERCENT INDICATED LOX MASS WAS EXPERIENCED DURING THE SECOND ORBITAL REVOLUTION. THE LOX MASS BRIDGE EXPERIENCED DISTURBANCES ON NONE DIFFERENT OCCASIONS WHICH CAUSED THE LOX BRIDGE TO SLEW TOWARD THE FULL STOP.

STATUS: TWO POSSIBLE CAUSES OF THE PU SYSTEM ANOMALY ARE:

a) AN INTERMITTENT CABLE SHIELD BETWEEN THE MASS PROBE AND THE PU ELECTRONICS ASSEMBLY (SEE FIGURE 2.2.17-1).

b) METALLIC DEBRIS OF SOME TYPE IN THE LOX TANK WHICH CAUSED A SHORT BETWEEN THE INNER AND OUTER ELEMENTS OF THE LOX PU PROBE. FIGURE 2.2.17-2 SHOWS A CUTAWAY OF THE PU PROBE AND THE POSSIBLE FAILURE MODES. THE AS-205 AND AS-503 WILL FLY WITH THE PROPELLANT MIXTURE RATIO COMMANDED BY THE IU SOFTWARE. MSFC CLOSED THIS ANOMALY FOR AS-503 ONLY. FINAL DISPOSITION OF THIS ITEM WITH RESPECT TO AS-504 AND SUBS MUST BE BASED UPON FINDINGS OF QUALITY AUDIT AND STUDIES TO DETERMINE LAUNCH VEHICLE "OPEN-LOOP" PU PERFORMANCE.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: KSC 3-DAY REPORT, P. 11;
AS-503 SEMI-DCR/AS-502 EVALUATION MEETING, APRIL 21, 1968; REV: C
MSFC 30-DAY REPORT, ITEM 10;
MSFC 30-DAY REPORT, REVISION D, ITEM 10;
MSFC 60-DAY REPORT;
AS-503 DELTA DCR TELECONFERENCE, SEPTEMBER 19, 1968

ANOMALY 2.2.17

TITLE: S-IVB LOX PROPELLENT UTILIZATION (PU) MALFUNCTION

DEBRIS IN THE TANK DURING ORBITAL CONDITIONS COULD BE DISTRIBUTED ANYWHERE IN THE TANK AND POSSIBLY LODGE BETWEEN THE PROBE ELEMENTS. SINCE THE PU SYSTEM OPERATION WAS NORMAL DURING POWERED FLIGHT WHILE THE LOX MASS PROBE, ITS ASSOCIATED CABLE AND PU ELECTRONICS ASSEMBLY, WERE UNDER THE HIGHEST VIBRATION LEVELS EXPERIENCED DURING FLIGHT, THE POSSIBILITY OF AN INTERMITTENT CABLE SHIELD APPEARS REMOTE. THEREFORE, THE MOST PROBABLE CAUSE OF THE PU SYSTEM ANOMALY WAS METALLIC DEBRIS IN THE LOX TANK SHORTING THE INNER AND OUTER ELEMENT OF THE LOX PROBE, THUS CAUSING THE LOX BRIDGE TO SLEW AT A MAXIMUM RATE TO THE "OVER-FILL" CONDITION.

ADDITIONAL TESTS WILL BE CONDUCTED TO CHECK THE CRIMPING OF THE CABLE CONNECTOR. THE DESIRABILITY OF INSULATING ONE OR BOTH OF THE PROBE ELEMENTS TO PREVENT SHORTING BY DEBRIS IS ALSO BEING CONSIDERED.

TITLE: S-IVB LOX PROPELLENT UTILIZATION (PU) MALFUNCTION

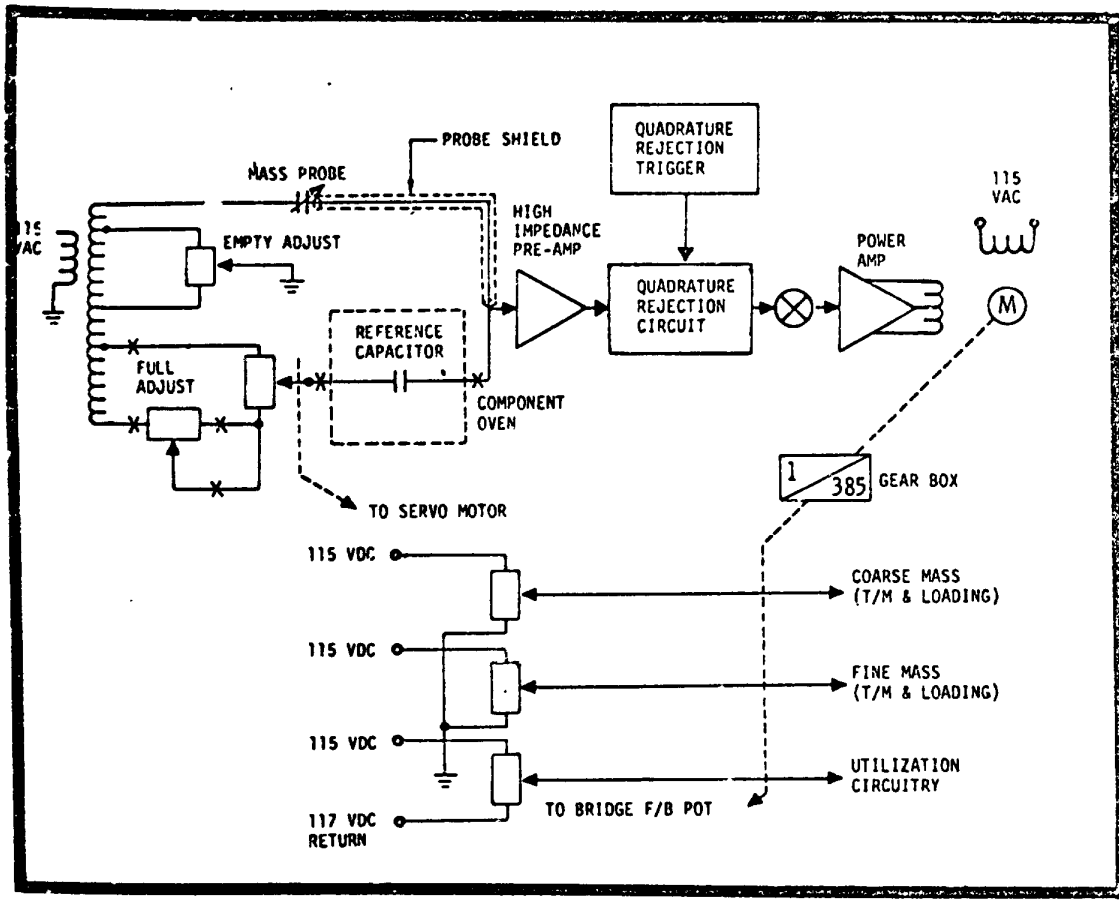
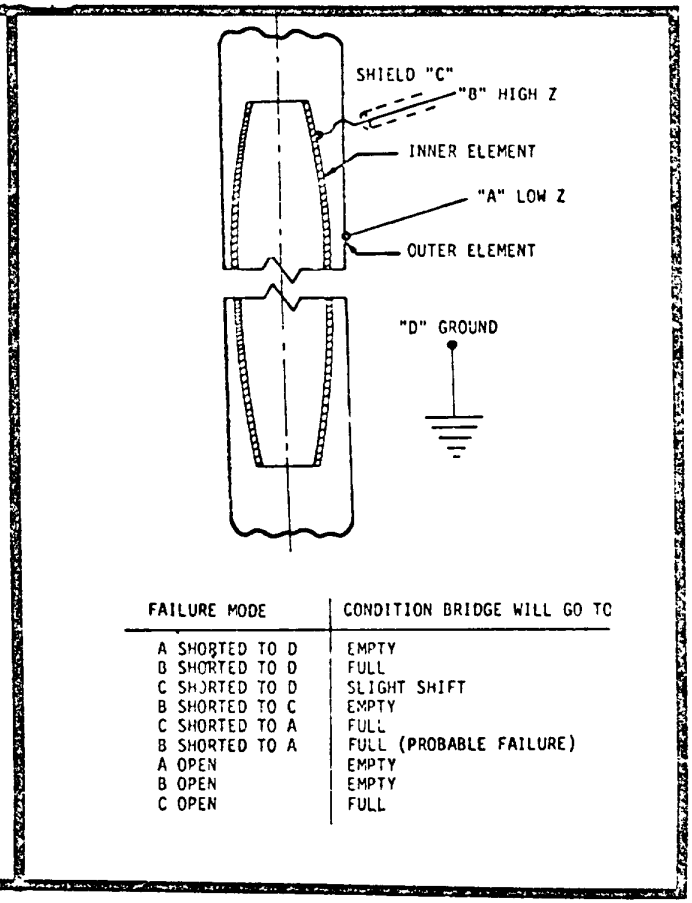


Figure 2.2.17-1 S-IVB Servo Bridge



FAILURE MODE	CONDITION BRIDGE WILL GO TO
A SHORTED TO D	EMPTY
B SHORTED TO D	FULL
C SHORTED TO D	SLIGHT SHIFT
B SHORTED TO C	EMPTY
C SHORTED TO A	FULL
B SHORTED TO A	FULL (PROBABLE FAILURE)
A OPEN	EMPTY
B OPEN	EMPTY
C OPEN	FULL

Figure 2.2.17-2 Failure Modes of S-IVB PU Probe

ANOMALY REPORT

NO. 2.2.18 TITLE: LOSS OF S-IC BASE HEAT SHIELD INSULATION

SYSTEM: S-IC MISSION: APOLLO 6

SUBSYSTEM: STRUCTURE EVENT TIME: 00:01:35

DESCRIPTION: ON SOME SECTIONS OF THE BASE HEAT SHIELD, LOSS OF M-31 INSULATION TO THE LEVEL OF THE CRUSHED CORE WAS OBSERVED VIA THE TV CAMERAS. BASE HEAT SHIELD TEMPERATURE MEASUREMENTS CONFIRM THE INSULATION LOSS; THE DATA IS WELL WITHIN DESIGN LIMITS EXCEPT FOR TWO MEASUREMENTS. DATA SHOW A SIMILAR LOSS OF M-31 INSULATION ON APOLLO 4 (AS-501) AT 00:01:50.

STATUS: M-31 INSULATION LOSS WHICH OCCURRED AT 110 SECONDS ON AS-501 AND 95 SECONDS ON AS-502 APPEARS TO BE A RANDOM PROCESS, AND IT MAY OCCUR AT ALMOST ANY TIME DURING FLIGHT. THE EFFECT OF THIS LOSS AT VARIOUS TIMES WAS COMPUTED AND THE RESULTS ARE PRESENTED IN FIGURE 2.2.18-1. NOTE THAT THE LOSS OF M-31 AT 20 SECONDS WOULD RESULT IN OUTBOARD ENGINE CUTOFF TEMPERATURES OF 1094°F AT THE AFT HONEYCOMB FACE SHEET AND 504°F AT THE FORWARD HONEYCOMB FACE SHEET. THE MAXIMUM ALLOWABLE TEMPERATURE FOR THE FORWARD FACE SHEET IS 300°F. HOWEVER, THIS IS INTERPRETED AS A DESIGN GOAL AND TESTING SHOWED THE HEAT SHIELD IS CAPABLE OF WITHSTANDING TEMPERATURES ABOVE THIS LEVEL. ACTUAL LIMITS FOR EITHER FACE SHEET ARE NOT DEFINED AT THIS TIME BUT ARE BEING EXAMINED TO DETERMINE WHETHER A POTENTIAL PROBLEM EXISTS. THIS ANOMALY HAS BEEN CLOSED BY MSFC.

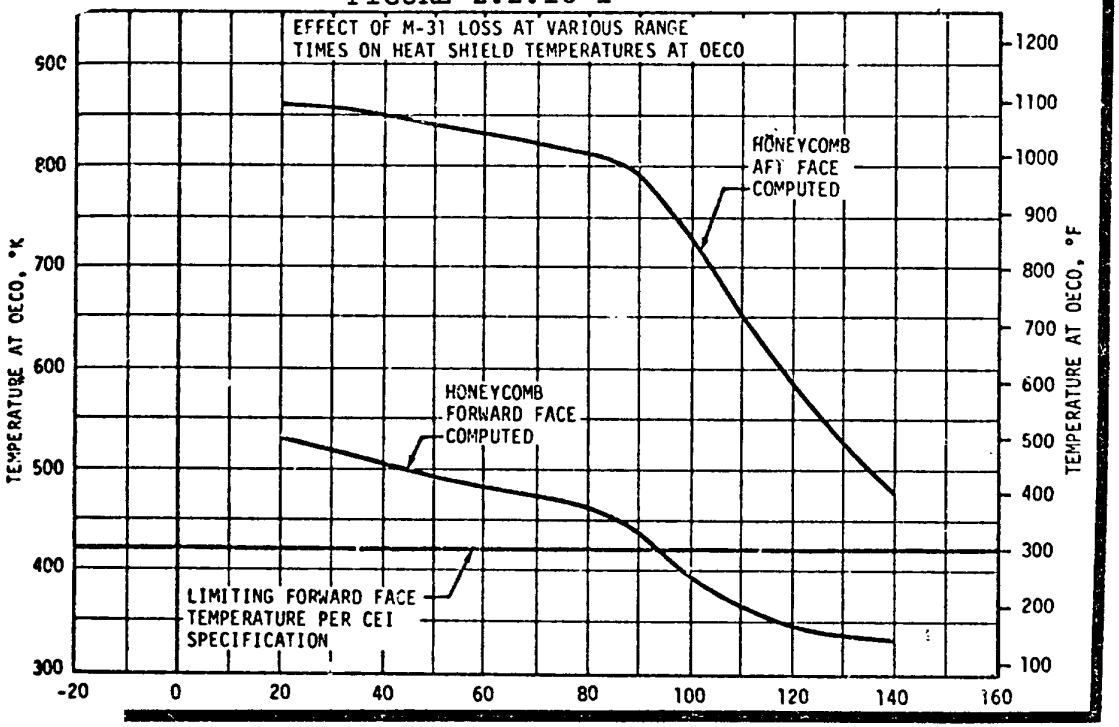
ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSFC 30-DAY REPORT, ITEM 1;
MSFC 30-DAY REPORT, REVISION A, ITEM 1;
MSFC 60-DAY REPORT, PP. 17-1, 17-4 to 17-7, 23-2

REV: C

TITLE: LOSS OF S-IC BASE HEAT SHIELD INSULATION (CONTINUED)

FIGURE 2.2.18-1



ANOMALY REPORT

NO. 2.3.1 TITLE: ACTIVATION OF DRY FIRE EXTINGUISHER

SYSTEM: KSC-GSE MISSION: APOLLO 6

SUBSYSTEM: ML FIRE PROTECTION SYSTEM EVENT TIME: LAUNCH

DESCRIPTION: THE DRY CHEMICAL SYSTEMS IN 3AB OF PAD "A," "B" LEVEL, AND IN LUT ROOM 4A WAS ACTIVATED. THE ACTIVATION IN LUT ROOM 4A WAS A RECURRENCE OF AN AS-501 PROBLEM RESULTING IN THE FILLING AT THE RP-1 DISTRIBUTOR CABINET WITH FIRE EXTINGUISHING POWDER. BLANKETING OF EQUIPMENT FOR EXTENDED PERIODS OF TIME CAN CAUSE CORROSION.

STATUS: ECP 0822*R* HAS BEEN APPROVED TO RE-DESIGN THE ACTIVATION MECHANISM TO REDUCE ITS SUSCEPTIBILITY TO VIBRATION. THIS IS CONSIDERED A LAUNCH PROBLEM BUT NOT A SIGNIFICANT ANOMALY BY KSC, AND THE PROBLEM HAS BEEN CLOSED BY KSC.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: KSC 3-DAY REPORT, SEC. 3.1, P. 13.
KSC 60-DAY REPORT, PARA. 5.1.3 REV:
KSC ANOMALY STATUS REPORT, AUGUST 19, 1968, P.13

ANOMALY REPORT

NO. 2.3.2 TITLE: DAMAGE TO POWER PEDESTAL

SYSTEM: KSC-GSE MISSION: APOLLO 6

SUBSYSTEM: ELECTRICAL SYSTEM EVENT TIME: LAUNCH

DESCRIPTION: THE DISTRIBUTION PANEL, TRANSFORMER, CONDUIT STUBS, AND WIRING FOR THE POWER PEDESTAL ON THE WEST SIDE OF THE PAD SURFACE WERE COMPLETELY DESTROYED. THIS PEDESTAL IS A DISTRIBUTION POINT FOR PAD A LIGHTING AND 110V 60-HERTZ UTILITY OUTLETS.

STATUS: A PROPOSED CHANGE (ECP RC 3906) WILL RELOCATE THE PEDESTAL AT THE BASE OF THE PAD AND PROVIDE A PROTECTIVE BLAST SHIELD. THIS ITEM WAS NOT INCLUDED IN THE KSC 30-DAY REPORT AND IS NOT CONSIDERED AN ANOMALY IN THE KSC 60-DAY REPORT.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: KSC 3-DAY REPORT, SEC. 3.2, P. 14
KSC 60-DAY REPORT, PARA 5.40.2 REV:

ANOMALY REPORT

NO. 2.3.3 TITLE: FIRE ALARM WIRING DAMAGE

SYSTEM: KSC-GSE MISSION: APOLLO 6

SUBSYSTEM: ML FIRE PROTECTION SYSTEM EVENT TIME: LAUNCH

DESCRIPTION: THE FIRE ALARM WIRING AND SENSORS BETWEEN AND ON ALL LEVELS OF MOBILE LAUNCHER-2 AND PAD A WERE COMPLETELY DESTROYED BY THE INTENSE HEAT.

STATUS: THE POST-LAUNCH REFURBISHMENT PLAN PROVIDES FOR THE FOLLOWING:

1) REPLACEMENT OF ALL DAMAGED METALLIC INSULATED CABLES AND ONE IONIZATION DETECTOR?
2) INSTALLATION OF PROTECTIVE SHIELDING TO PREVENT RECURRENCE OF LAUNCH DAMAGE.
3) REPLACEMENT OF MANUAL ALARM STATIONS AND ALL AUDIBLE ALARMS
4) COMPLETE RE-VALIDATION OF BOTH PAD A AND LUT 2.

THIS ANOMALY HAS BEEN CLOSED BY KSC.

ORGANIZATION: 5-2464

REFERENCES: KSC 3-DAY REPORT, SEC. 3.2, P.14.
KSC ANOMALY STATUS REPORT, OCTOBER 1, 1968, P.12

RESOLUTION: CLOSED

DATE:

REV: C

ANOMALY REPORT

NO. 2.3.4 TITLE: S-II CRYOGENIC SERVICING SYSTEM MALFUNCTION

SYSTEM: KSC -GSE MISSION: APOLLO 6

SUBSYSTEM: S-II CRYOGENIC SERVICING SYSTEM EVENT TIME: PRE-LAUNCH

DESCRIPTION: GSE CRYOGENIC SERVICING EQUIPMENT (A771) MALFUNCTION CAUSED INCORRECT S-II PROPELLANT TEMPERATURE AT LAUNCH.

STATUS: UNABLE TO CONFIRM THIS REPORTED MALFUNCTION, NOT INCLUDED IN KSC 3-DAY, 30-DAY, 60-DAY, OR ANOMALY STATUS REPORTS.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: MSFC 14-DAY FEWG MEETING REV:

ANOMALY REPORT

NO. 2.3.5 TITLE: CRACKED LH_2 BUBBLE CAPS

SYSTEM: KSC-GSE MISSION: APOLLO 6

SUBSYSTEM: LH_2 SERVICING SYSTEM EVENT TIME: POST-CDDT

DESCRIPTION: 32 BUBBLE CAPS IN THE LH_2 BURN POND WERE REPLACED DUE TO CRACKS ON THE TOPS OF THE BUBBLE CAPS. THESE BUBBLE CAPS WERE INCORPORATED BY ECP 0588R AFTER THE AS-501 LAUNCH. THE CRACKS EXPOSED THE VENT SYSTEM DIRECTLY TO THE ATMOSPHERE, CREATING AN EXPLOSION HAZARD BECAUSE OF AIR LEAKING THROUGH THE CRACKS INTO THE LH_2 VENT LINES.

STATUS: FAILURE RESULTED FROM INTERGRANULAR CORROSION, COMBINED WITH LOCALIZED OVERHEATING FOLLOWED BY RAPID COOLING BY THE SPLASHING WATER IN THE POND. CORRECTIVE ACTION HAS BEEN ESTABLISHED BY ECP 0829R (REV. B) EFFECTIVE FOR AS-503 AND SUBSEQUENT. (SEE BACKUP SHEETS). THIS ANOMALY HAS BEEN CLOSED BY KSC.

ORGANIZATION. 5-2464

REFERENCES: KSC 3-DAY REPORT, P. 1; RESOLUTION: CLOSED DATE:

KSC 30-DAY REPORT, P. 2-5

KSC 60-DAY REPORT, PARA. 5.3.4 REV: C

KSC 30-DAY REPORT, REVISION NO. 1, P. 2-3

KSC ANOMALY STATUS REPORT, OCTOBER 1, 1968, P. 3

ANOMALY 2.3.5

TITLE: CRACKED LH_2 BUBBLE CAPS

DESCRIPTION: THE BUBBLE CAPS ARE CONSTRUCTED OF A 9 INCH O.D. TUBE 11 INCHES LONG WITH A FLAT CIRCULAR PLATE WELDED TO THE TUBE FOR A TOP. A HOLE IS CUT IN THE TOP PLATE AND A STAINLESS STEEL NUT IS WELDED TO THE PLATE. THE WHOLE ASSEMBLY IS SCREWED TO THE BUBBLE CAP SUPPORT IN THE BURN POND.

FAILURE ANALYSIS WAS PERFORMED BY THE KSC MATERIALS ANALYSIS BRANCH LAB. CONCLUSIONS REACHED WERE: 1) THE BUBBLE CAPS AND SHEET MATERIAL WERE 304 STAINLESS STEEL; 2) THE FAILURE OF THE BUBBLE CAPS RESULTED FROM INTER-GRANULAR CORROSION, WHICH WAS ATTRIBUTED TO THE DEPLETION OF CHROMIUM FROM THE AUSTENITE GRAINS.

CORRECTIVE ACTION: THE CORRECTIVE ACTION TAKEN UNDER ECP-0829R (REV. B) IS AS FOLLOWS:

(A) REPLACED ALL BUBBLE CAPS WITH NEW CAPS MADE OF 321 STAINLESS STEEL WITH DIMENSIONS OF 9 INCH O.D. X 11 INCHES LONG AND 0.109 INCH THICK. THE HEAD IS FORMED SIMILAR TO AN ASA TYPE PIPE CAP. 50 SPARE BUBBLE CAPS PER POND ARE PROVIDED FOR PADS A & B.

(B) COATED ALL CAPS WITH AN INORGANIC ZINC COMPOUND.

(C) INSTALLED CAP SUPPORTS FOR PAD B PER ECP-0588R.

(D) REVISED HEADER SUPPORTS TO BETTER CONTAIN THE TEFLON CUSHIONS ON BOTH THE VEHICLE AND FACILITY SIDE OF PONDS.

ANOMALY REPORT

NO. 2.3.6 TITLE: WATER IN LH_2 VENT SYSTEM

SYSTEM: KSC-GSE MISSION: APOLLO 6

SUBSYSTEM: LH_2 SERVICING SYSTEM EVENT TIME: COUNTDOWN

DESCRIPTION: WATER ENTERED THE VEHICLE LH_2 VENT SYSTEM AT THE BURN POND END AFTER THE REPLENISH SEQUENCE WAS TERMINATED DURING CDDT AND LAUNCH COUNTDOWN. THIS ALSO OCCURRED DURING THE APOLLO 7 LOADING OPERATIONS AND AT THAT TIME IT WAS ATTRIBUTED TO SIPHONING ACTION THROUGH THE STANDPIPES, INITIATED BY RAPID CLOSING OF THE VENT VALVES AFTER STAGE VENTING.

STATUS: THIS ANOMALY MAY HAVE BEEN CAUSED BY INSUFFICIENT HELIUM PURGE, LEAVING COLD PIPING WHICH CAUSED THE HELIUM IN THE VENT LINES TO CONTRACT ONCE THE PURGE WAS TERMINATED. THIS LOWERED THE PRESSURE IN THE VENT SECTION AND INITIATED THE SIPHONING ACTION (SEE SYSTEM SCHEMATIC, FIGURE 2.3.6-1). PROCEDURES HAVE BEEN CHANGED BY KSC (ECP 0332-3) TO EXTEND THE DURATION OF THE HELIUM PURGE OF THE VENT TRANSFER LINES EFFECTIVE ON AS-503. THE OTHER POSSIBLE CAUSE IS THE DYNAMIC BEHAVIOR OF THE VENT GASES WHEN HIGH VENT GAS FLOW RATES ARE INTERRUPTED. A SIPHON BREAKER WHICH WILL PREVENT NEGATIVE PRESSURE IN THE VENT LINES ARISING FROM ANY CAUSE WILL BE INSTALLED FOR AS-505. THIS ANOMALY HAS BEEN CLOSED BY KSC.

ORGANIZATION: 5-2464

REFERENCES: KSC 30-DAY REPORT, P. 2-4.
KSC 60-DAY REPORT, PARA. 5.3.4.
KSC 30-DAY REPORT, REVISION NO. 1, P.2-2
KSC ANOMALY STATUS REPORT, AUGUST 19, 1968, P.2

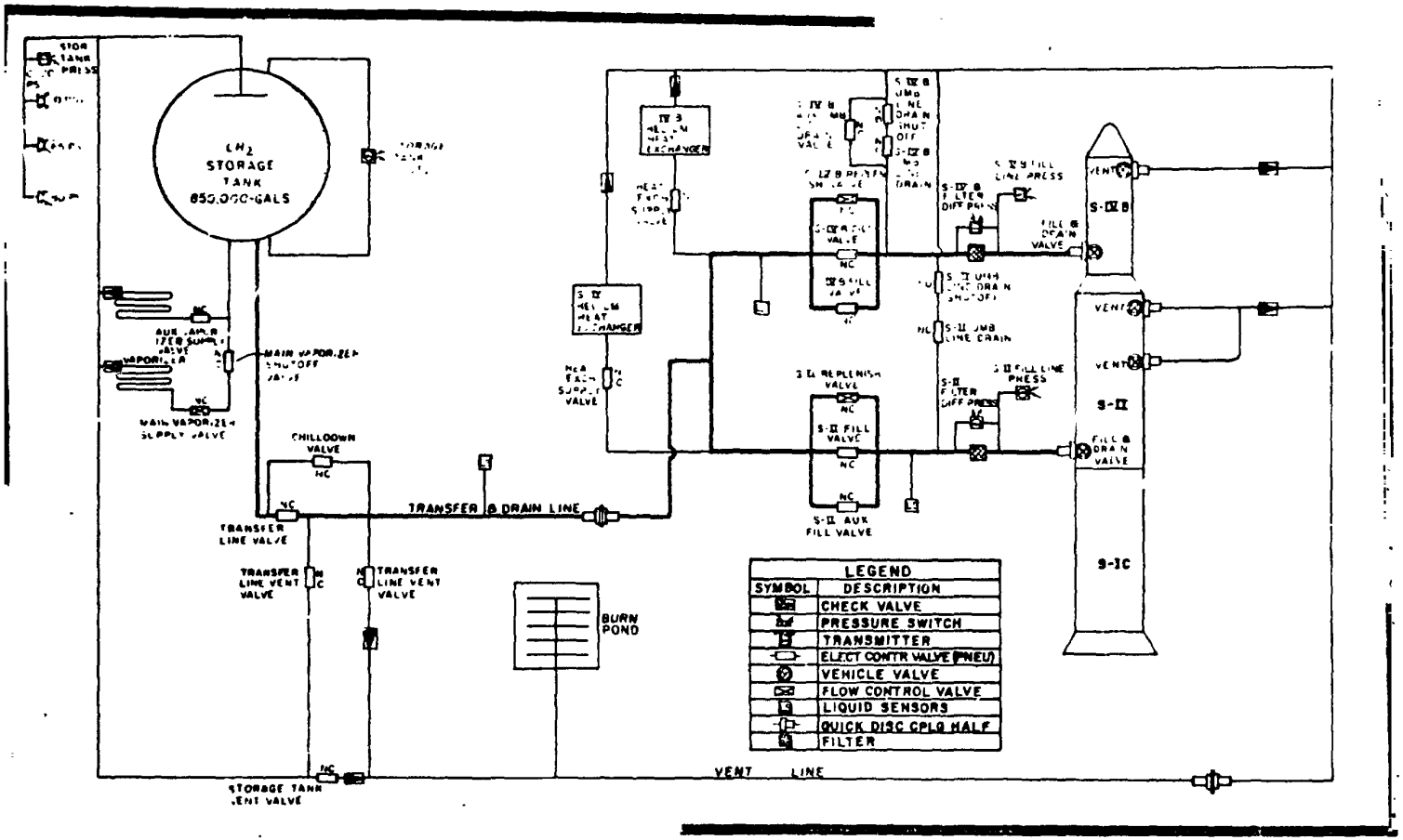
RESOLUTION: CLOSED

DATE:

REV: C

TITLE: WATER IN LH_2 VENT SYSTEM (CONTINUED)

FIGURE 2.3.6 -1. LH_2 SERVICING SYSTEM SCHEMATIC



ANOMALY REPORT

NO. 2.3.7 TITLE: LOW S-IC AFT ENGINE COMPARTMENT TEMPERATURE

SYSTEM: KSC-GSE MISSION: APOLLO 6

SUBSYSTEM: ENVIRONMENTAL CONTROL SYSTEM (ECS) EVENT TIME: COUNTDOWN

DESCRIPTION: THE S-IC AFT ENGINE COMPARTMENT TEMPERATURE INDICATION COULD NOT BE MAINTAINED WITHIN THE DESIRED 80 + 5°F AFTER THE START OF S-IC LOX LOADING, EVEN THOUGH THE ECS MET OR EXCEEDED THE INTERFACE TEMPERATURE AND FLOW REQUIREMENTS. INTERFACE TEMPERATURES WITH 100 PERCENT REHEAT WERE 235°F MAXIMUM (20°F ABOVE REQUIREMENT) BUT THE COMPARTMENT TEMPERATURE COULD NOT BE RAISED ABOVE 66°F. THIS CONDITION STARTED AT T-4 1/2 HOURS AND CONTINUED UNTIL LAUNCH. SIMILAR CONDITIONS OCCURRED DURING AS-502 CDDT AND DURING THE APOLLO 4 (AS-501) LAUNCH

STATUS: IF AN INTERFACE TEMPERATURE ABOVE 235°F IS REQUIRED, MODIFICATION OF THE ECS WILL BE NECESSARY. NO FURTHER ACTION WILL BE TAKEN UNLESS MICHOUD/MSFC CONFIRMS THAT THIS PROBLEM HAS AN IMPACT ON THE S-IC STAGE EQUIPMENT AND RECOMMENDS THAT THE PROBLEM BE SOLVED ON THE GSE SIDE OF THE INTERFACE. NO ACTION WILL BE TAKEN FOR APOLLO 8 (AS-503). THIS ANOMALY HAS BEEN CLOSED BY KSC.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: KSC 30-DAY REPORT, P. 3-3;
KSC 60-DAY REPORT, PARA. 5.4.4
KSC 30-DAY REPORT, REVISION NO. 1, P. 3-5
KSC ANOMALY STATUS REPORT, OCTOBER 1, 1968, P. 3

REV: C

ANOMALY REPORT

NO. 2.3.8 TITLE: MARGINAL GSE HEATER CAPACITY FOR IU/S-IVB FORWARD COMPARTMENT

SYSTEM: KSC-GSE MISSION: APOLLO 6

SUBSYSTEM: ENVIRONMENTAL CONTROL SYSTEM (ECS) EVENT TIME: COUNTDOWN

DESCRIPTION: THE KSC ECS MET THE INTERFACE INLET TEMPERATURE AND FLOW REQUIREMENTS TO THE IU/S-IVB FORWARD COMPARTMENT; HOWEVER, THE HEATER REDUNDANCY WAS SACRIFICED IN ORDER TO MEET THE REQUIREMENT.

STATUS: ECP 0833 HAS BEEN APPROVED TO REDESIGN THE HEATERS TO INSURE TEMPERATURE REQUIREMENTS CAN BE MET WITH ADEQUATE REDUNDANCY FOR AS-504 AND SUBSEQUENT (SEE BACK-UP SHEET FOR DETAILS). ECP EL-2715 WILL PROVIDE A WORKAROUND FOR AS-503. THIS ANOMALY HAS BEEN CLOSED BY KSC.

ORGANIZATION: 5-2464

REFERENCES: KSC 30-DAY REPORT, PP. 2-3 AND 3-2.
KSC 30-DAY REPORT, REVISION NO. 1, P. 3-4
KSC ANOMALY STATUS REPORT, AUGUST 19, 1968, P. 3.

RESOLUTION: CLOSED DATE:

REV: C

DETAIL SHEET

ANOMALY 2.3.8

TITLE: MARGINAL GSE HEATER CAPACITY FOR IU-S-IVB FORWARD COMPARTMENT

STATUS: ECP 0833 HAS BEEN APPROVED FOR AS-504 AND SUBSEQUENT TO PROVIDE A REDESIGN OF THE IU/S-IVB FORWARD HEATERS TO INSURE REQUIREMENTS AT THE ECS/VEHICLE INTERFACE ARE MET WHILE STILL MAINTAINING ADEQUATE REDUNDANCY. THESE HEATERS ARE LOCATED IN THE ECS ROOM AT EACH PAD. THE CHANGE WILL CONSIST OF, BUT NOT BE LIMITED TO, THE FOLLOWING:

1. REDESIGN HEATER CASING WIRING.

2. INCREASE KVA RATING OF A NUMBER OF HEATER ELEMENTS IN EACH REHEAT ASSEMBLY.

3. MODIFY WIRING IN ECS ROOM

4. PROVIDE SCR FORCED DRAFT COOLING AS REQUIRED.

ECP 0833 HAS BEEN ASSIGNED A "HIGHLY DESIRABLE" CAT II SINGLE POINT FAILURE (SPF) PRIORITY.

ANOMALY REPORT

2.3.9 TITLE: ERRATIC HYDRAULIC CHARGING UNIT PRESSURE READINGS

SYSTEM: KSC-GSE MISSION: APOLLO 6

SUBSYSTEM: HYDRAULIC CHARGING UNIT (HCU) EVENT TIME: CDDT

ESCRIPTION: DURING THE COUNTDOWN, WHILE THE HYDRAULIC CHARGING UNIT (HCU) WAS SUPPORTING THE TEST IT WAS NOTED THAT UNIT NO. 1 PRESSURE READINGS WERE ERRATIC AND ERRONEOUS AS COMPARED WITH THE HCU DELIVERY GAGE. THE METER INDICATIONS WERE VARYING FROM 1000 PSIG TO 3450 PSIG CONSTANTLY. AFTER APPROXIMATELY 10 MINUTES, THE TRANSDUCER STABILIZED BUT AGAIN BECAME ERRATIC APPROXIMATELY EVERY THREE MINUTES. THE REPLACEMENT TRANSDUCER ALSO BECAME SLIGHTLY ERRATIC AFTER INSTALLATION, BUT IT WAS USED FOR THE APOLLO 6 LAUNCH. THE TRANSDUCER ON HCU UNIT NO. 2 WAS ALSO REPLACED DURING CDDT BECAUSE OF A SIMILAR FAILURE.

STATUS: ANALYSIS OF PRIOR FAILURES HAVE CITED CONTAMINATION CAUSED BY DEGRADATION OF INTERNAL BONDING MATERIALS, EXTREME WIPER CONTACT WEAR, AND IMPROPERLY EXECUTED ASSEMBLY PROCESSES. THE KSC MATERIALS ANALYSIS BRANCH HAS RECOMMENDED A COMPLETE DESIGN AND QUALITY CONTROL REVIEW OF THIS COMPONENT. QUALIFICATION OF A NEW TYPE TRANSDUCER IS IN PROGRESS, HOWEVER, BECAUSE OF ITS LOW PRIORITY, HARDWARE CHANGEOUT IS NOT EXPECTED BEFORE AS-505. THE PRESSURE TRANSDUCER IS NOT LAUNCH-CRITICAL, SINCE AN INDEPENDENT INDICATION OF PRESSURE IS OBTAINED FROM THE PRESSURE SWITCH. THIS ANOMALY HAS BEEN CLOSED BY KSC.

ANIZATION: 5-2464

EFERENCES: KSC 30-DAY REPORT, P.2-2
KSC 30-DAY REPORT, REVISION NO. 1, P 3-2
KSC ANOMALY STATUS REPORT, AUGUST 19, 1968, P.5

RESOLUTION: CLOSED DATE:

REV: C

ANOMALY REPORT

NO. 2.3.10 TITLE: MARGINAL GSE HEATER CAPACITY FOR S-IC FORWARD COMPARTMENT

SYSTEM: KSC-GSE MISSION: APOLLO 6

SUBSYSTEM: ENVIRONMENTAL CONTROL SYSTEM (ECS) EVENT TIME: COUNTDOWN

DESCRIPTION: THE KSC ECS MET THE INTERFACE INLET TEMPERATURE AND FLOW REQUIREMENTS TO THE S-IC FORWARD COMPARTMENT UPPER AND LOWER SYSTEMS, ALTHOUGH HEATER REDUNDANCY WAS SACRIFICED IN ORDER TO MEET THE REQUIREMENTS.

STATUS: ON AS-503, THE REDUNDANT HEATERS WILL BE UTILIZED AS A WORK-AROUND ON AN ACCEPTED RISK BASIS (CCBD NO. PPR-5-154). EFFECTIVE ON AS-504 AND SUBSEQUENT, ECP 0911 WILL PROVIDE A 20% INCREASE IN THE ECS REHEAT CAPACITY TO THE S-IC FORWARD COMPARTMENT, ENABLING ONE HEATER TO SATISFY THE AS-504 INTERFACE REQUIREMENTS (SEE BACKUP SHEET). THIS ANOMALY HAS BEEN CLOSED BY KSC.

ORGANIZATION: 5-2464 RESOLUTION: CLOSED DATE:

REFERENCES: KSC 30-DAY REPORT, PP. 2-3 AND 3-2;
KSC 30-DAY REPORT, REVISION NO. 1, P 3-3
KSC ANOMALY STATUS REPORT, AUGUST 19, 1968, P.3

REV: C

DETAIL SHEET

ANOMALY 2.3.10

TITLE: MARGINAL GSE HEATER CAPACITY FOR S-IC FORWARD COMPARTMENT

DESCRIPTION

DURING THE AS-501 AND AS-502 LAUNCHES, THE KSC ECS FAILED TO MEET THE INTERFACE INLET TEMPERATURE AND FLOW REQUIREMENTS TO THE S-IC FORWARD UPPER AND LOWER SYSTEMS. A TEMPORARY FIX USING BOTH HEATERS SIMULTANEOUSLY WAS EMPLOYED, WHICH LEFT THE SYSTEM WITH NO BACKUP HEATER. THIS CONDITION OCCURRED DURING THE LAST 25 MINUTES OF COUNTDOWN. AN ADDITIONAL PROBLEM IS THAT THE RESPONSE TIME OF THE SYSTEM IS TOO LONG TO RESPOND QUICKLY ENOUGH TO A HOLD DURING CHILLDOWN OF THE S-II ENGINES.

LEVEL II CCB ACTION (PPR-5-1541) AUTHORIZED THE USE OF REDUNDANT HEATERS FOR AS-502 AND AS-503 AS AN ACCEPTED RISK. THE VEHICLE TEMPERATURE REQUIREMENTS AND RESPONSE CRITERIA HAVE BEEN RELAXED FOR AS-504 AND SUBSEQUENT. ECP 0911 WILL INCREASE THE S-IC FORWARD (UPPER AND LOWER) HEATER CAPACITY FROM 16 TO 20 KW. THIS INCREASED HEATER CAPACITY WILL ALLOW THE INTERFACE REQUIREMENTS TO BE MET BY A SINGLE HEATER FOR AMBIENT TEMPERATURES DOWN TO 30°F. THE INCREASE IN HEATER CAPACITY WILL BE ACCOMPLISHED BY REPLACING THE NINE HEATERS ELEMENTS IN EACH HEATER ASSEMBLY WITH HIGHER POWER ELEMENTS HAVING THE SAME PHYSICAL DIMENSIONS. THE HIGHER POWER RATING IS OBTAINED BY RAISING THE OPERATING SHEATH TEMPERATURE FROM 35°F TO 450°F. NO CHANGES TO THE HEATER CASING ARE REQUIRED.

CORRECTIVE ACTION

AS-503: USE REDUNDANT HEATERS ON AN ACCEPTED RISK BASIS PER CCB NO. PPR-5-1541.
AS-504 & SUBS: ECP 0911 WILL INCREASE HEATER CAPACITY 20%, ALLOWING ONE HEATER TO SATISFY INTERFACE REQUIREMENTS.

3.0 REFERENCES

1. APOLLO 6 (AS-502) REPORT AT MISSION COMPLETION PLUS TWO HOURS, NASA-MSFC DATAFAX, APRIL 4, 1968.

2. APOLLO 6 MISSION, MISSION DIRECTORS'S 24-HOUR REPORT, NASA-MSC TWX NO. M-C MAO, APRIL 4, 1968.

3. 24-HOUR FLIGHT EVALUATION WORKING GROUP (FEWG) MEETING, MSFC, APRIL 5, 1968.

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