HARLAN

FC021
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

# FINAL
# FLIGHT MISSION RULES

## APOLLO 9

## ( AS-504 /104 /LM-3 )

REV A
DATED 2/15/69

**DECEMBER 15, 1968**

**PREPARED BY**

## FLIGHT CONTROL DIVISION

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

FOR NASA/DOD INTERNAL USE ONLY
INCLUDING APPROPRIATE CONTRACTORS

APOLLO

FINAL FLIGHT MISSION RULES

AS-504/104/LM-3

APOLLO 9

## PREFACE

THIS DOCUMENT CONTAINS THE FLIGHT MISSION RULES FOR APOLLO 9 AND CONSTITUTES THE FINAL DOCUMENTATION. THESE RULES WILL RECEIVE AN EXTENSIVE EVALUATION DURING THE SIMULATIONS PRIOR TO THE APOLLO 9 MISSION. SUBSEQUENT REVISIONS TO THIS DOCUMENT WILL BE PRINTED ON DIFFERENT COLORED PAGES FOR EASY RECOGNITION. INFORMATION CONTAINED WITHIN THIS DOCUMENT REPRESENTS THE FINAL FLIGHT MISSION RULES FOR THE APOLLO 9 MISSION AS OF DECEMBER 15, 1968.

IT IS REQUESTED THAT ANY ORGANIZATION HAVING COMMENTS, QUESTIONS, OR SUGGESTIONS CONCERNING THESE MISSION RULES CONTACT MR. CHARLES R. LEWIS, FLIGHT CONTROL OPERATIONS BRANCH, BUILDING 45, ROOM 633, PHONE 483-3918.

ANY REQUESTS FOR ADDITIONAL COPIES OR CHANGES TO THE DISTRIBUTION LIST IN APPENDIX B OF THIS DOCUMENT MUST BE MADE IN WRITING TO MR. CHRISTOPHER C. KRAFT, JR., DIRECTOR OF FLIGHT OPERATIONS, MANNED SPACECRAFT CENTER, HOUSTON, TEXAS.

THIS IS A CONTROL DOCUMENT AND ANY CHANGES ARE SUBJECT TO THE CHANGE CONTROL PROCEDURES DELINEATED IN APPENDIX C. THIS DOCUMENT IS NOT TO BE REPRODUCED WITHOUT THE WRITTEN APPROVAL OF THE CHIEF, FLIGHT CONTROL DIVISION, MANNED SPACECRAFT CENTER, HOUSTON, TEXAS.

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FC021
2/15/69

APOLLO 9

FINAL FLIGHT MISSION RULES

REVISION A

PREFACE

THIS DOCUMENT CONTAINS REVISION A TO THE FLIGHT MISSION RULES FOR APOLLO 9 AS OF FEBRUARY 15, 1969. REVISION A IS A PAGE CHANGE REVISION AND THE PAGES SHOULD BE INSERTED IN ACCORDANCE WITH THE REVISION INSTRUCTION SHEET WHICH FOLLOWS THIS PAGE. THIS AND ALL SUBSEQUENT REVISIONS TO THIS DOCUMENT WILL BE PRINTED ON DIFFERENT COLORED PAGES FOR EASY RECOGNITION.

IT IS REQUESTED THAT ANY ORGANIZATION HAVING COMMENTS, QUESTIONS, OR SUGGESTIONS CONCERNING THESE MISSION RULES CONTACT MR. CHARLES R. LEWIS, FLIGHT CONTROL OPERATIONS BRANCH, BUILDING 45, ROOM 643A, PHONE 483-3918.

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THIS IS A CONTROL DOCUMENT AND ANY CHANGES ARE SUBJECT TO THE CHANGE CONTROL PROCEDURES DELINEATED IN APPENDIX C. THIS DOCUMENT IS NOT TO BE REPRODUCED WITHOUT THE WRITTEN APPROVAL OF THE CHIEF, FLIGHT CONTROL DIVISION, MANNED SPACECRAFT CENTER, HOUSTON, TEXAS.

APPROVED BY:

Christopher C. Kraft, Jr.

CHRISTOPHER C. KRAFT, JR.
DIRECTOR OF FLIGHT OPERATIONS

APOLLO 9

FINAL FLIGHT MISSION RULES

REVISION A

REVISION INSTRUCTION SHEET

UPDATE THIS DOCUMENT IN ACCORDANCE WITH THE FOLLOWING INSTRUCTIONS

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PART I
INTRODUCTION AND GEN GUIDELINES

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|---|---|

## INTRODUCTION & PURPOSE

MISSION RULES ARE PROCEDURAL STATEMENTS WHICH PROVIDE FLIGHT CONTROL PERSONNEL WITH GUIDELINES TO EXPEDITE THE DECISION-MAKING PROCESS. THE RULES ARE BASED ON AN ANALYSIS OF MISSION EQUIPMENT CONFIGURATION, SYSTEMS OPERATIONS AND CONSTRAINTS, FLIGHT CREW PROCEDURES, AND MISSSON OBJECTIVES. THE DIRECTOR OF FLIGHT OPERATIONS, MANNED SPACECRAFT CENTER, HOUSTON, TEXAS, HAS THE OVERALL RESPONSIBILITY FOR THE PREPARATION, CONTENTS, AND CONTROL OF THE FLIGHT MISSION RULES.

MISSION RULES CAN BE CATEGORIZED AS GENERAL AND SPECIFIC. GENERAL MISSION RULES CONTAIN THE BASIC PHILOSOPHIES USED IN THE DEVELOPMENT OF THE FLIGHT MISSION RULES. SPECIFIC MISSION RULES PROVIDE THE BASIC CRITERIA FROM WHICH REAL-TIME DECISIONS ARE MADE AND WILL BE FORMATTED AS FOLLOWS:

A. THE CONDITION/MALFUNCTION COLUMN DEFINES THE FAILURE.

B. THE PHASE COLUMN IDENTIFIES THE TIME INTERVAL IN WHICH THE CONDITION/MALFUNCTION OCCURS.

C. THE RULING COLUMN DEFINES FLIGHT CONTROLLER ACTION AND/OR PROCEDURES THAT MUST BE ACCOMPLISHED AS A RESULT OF THE CONDITION.

D. THE CUES/NOTES/COMMENTS COLUMN PROVIDES THE FLIGHT CONTROLLER WITH ADDITIONAL INFORMATION CONCERNING THE CONDITION/MALFUNCTION AND/OR RULING.

| REV | ITEM | OMSF GENERAL RULES |
|---|---|---|
| | I-1 | MISSION RULES ARE EFFECTIVE DURING THE LAUNCH COUNTDOWN, FLIGHT AND RECOVERY OPERATIONS, AND DURING PRELAUNCH TESTS WHEN APPLICABLE. THEY ARE BASED ON PRIMARY OBJECTIVES AS STATED IN THE APOLLO FLIGHT MISSION ASSIGNMENTS DOCUMENT M-D MA 500-11. PROPOSED CHANGES TO THE PRIMARY OBJECTIVES STATED IN THE MISSION ASSIGNMENTS DOCUMENT SHALL REQUIRE AA/MSF APPROVAL. |
| | I-2 | THE DIRECTOR OF FLIGHT OPERATIONS AND THE DIRECTOR OF LAUNCH OPERATIONS OR THEIR DESIGNATED REPRESENTATIVE WILL INSURE COORDINATION OF THEIR RESPECTIVE MISSION RULE CHANGES WITH THE MISSION DIRECTOR AND OTHER APPROPRIATE ORGANIZATIONS. |
| | I-3 | FOLLOWING THE CDDT OR FRT, WHICHEVER OCCURS FIRST, MISSION DIRECTOR APPROVAL AND CONCURRENCE WILL BE REQUIRED ON ALL RULES CHANGES AFFECTING SAFETY, ACCOMPLISHMENT OF TEST OBJECTIVES, DEVIATIONS FROM THE NOMINAL MISSION AND PRELAUNCH CONSTRAINTS. CONCURRENCE MAY BE OBTAINED VERBALLY IF TIME CONSIDERATIONS SO DICTATE. |
| | I-4 | DURING THE CONDUCT OF THE MISSION, THE MISSION DIRECTOR WILL BE ADVISED OF ALL RECOMMENDATIONS THAT INVOLVE CHANGES TO: MISSION OBJECTIVES, MISSION RULES, FLIGHT PLAN CONTENT, OR LAUNCH/FLIGHT SAFETY. |
| | I-5 | WITHIN THEIR RESPECTIVE AREAS OF RESPONSIBILITY, THE COMMAND PILOT, THE LAUNCH DIRECTOR, FLIGHT DIRECTOR, DOD MANAGER FOR MSF SUPPORT OPERATIONS, AND THE MISSION DIRECTOR MAY TAKE OR RECOMMEND ANY ACTION REQUIRED FOR OPTIMUM CONDUCT OF THE MISSION. |
| | I-6 | THE COMMAND PILOT, SPACECRAFT TEST CONDUCTOR, LAUNCH VEHICLE TEST CONDUCTOR, SPACE VEHICLE TEST SUPERVISOR, LAUNCH OPERATIONS MANAGER, LAUNCH DIRECTOR, FLIGHT DIRECTOR, DOD MANAGER FOR MANNED SPACE FLIGHT SUPPORT OPERATIONS, OR THE MISSION DIRECTOR MAY REQUEST A HOLD FOR CONDITIONS WITHIN THEIR RESPECTIVE AREAS OF RESPONSIBILITY. |
| | I-7 | DURING THE COUNTDOWN, THE LAUNCH VEHICLE AND SPACECRAFT PROGRAM MANAGERS AND RESPECTIVE CENTER OPERATIONS MANAGERS SHALL PROVIDE TECHNICAL ADVICE AND SUPPORT DIRECTLY TO THE LAUNCH OPERATIONS MANAGER AND LAUNCH DIRECTOR. THE LATTER TWO WILL KEEP THE MISSION DIRECTOR FULLY INFORMED OF PROBLEMS AND PROPOSED SOLUTIONS. DURING THE FLIGHT PHASE OF OPERATIONS, SIMILAR SUPPORT AS REQUIRED WILL BE PROVIDED TO THE FLIGHT DIRECTOR AND THE MSC DIRECTOR OF FLIGHT OPERATIONS. THE MISSION DIRECTOR WILL BE KEPT FULLY INFORMED BY THESE INDIVIDUALS OF PROBLEMS AND PROPOSED SOLUTIONS DURING THE APPLICABLE PHASES OF THE MISSION. |
| | I-8 | WHEN TIME PERMITS, THE FAILURE OF A MANDATORY OR HIGHLY DESIRABLE ITEM WILL BE REPORTED TO THE MISSION DIRECTOR BY THE LAUNCH DIRECTOR OR THE FLIGHT DIRECTOR. THE INITIAL REPORT WILL INCLUDE THE POSITION OR FACILITY THAT DETECTED THE MALFUNCTION. SUBSEQUENTLY, THE MISSION DIRECTOR WILL BE INFORMED OF ESTIMATED TIME TO REPAIR AND RECOMMENDED PROCEED, HOLD, RECYCLE, OR SCRUB ACTION AS IT DEVELOPS. |

| REV | ITEM | |
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| | I-9 | IF A MANDATORY ITEM FAILS DURING THE COUNTDOWN, IT WILL BE CORRECTED PRIOR TO LAUNCH, HOLDING OR RECYCLING THE COUNTDOWN AS NECESSARY. IF A MANDATORY ITEM CANNOT BE CORRECTED TO PERMIT LIFTOFF WITHIN THE LAUNCH WINDOW, THE MISSION DIRECTOR MAY PROCEED WITH THE LAUNCH AFTER APPROPRIATE COORDINATION WITH THE APPROPRIATE OPERATIONS AND PROGRAM MANAGERS. GENERALLY THE LOSS OF A MANDATORY ITEM WILL RESULT IN A SCRUB. |
| | I-10 | AS THE DESIGNATED REPRESENTATIVE OF THE PROGRAM DIRECTOR, ONLY THE MISSION DIRECTOR MAY SCRUB THE MISSION. FURTHER, THE MISSION DIRECTOR RETAINS THE PRIMARY AUTHORITY TO DOWNGRADE A MANDATORY ITEM. THIS AUTHORITY SHALL BE EXERCISED AS CIRCUMSTANCES DICTATE AND AFTER APPROPRIATE RECOMMENDATIONS FROM THE PROGRAM MANAGERS, LAUNCH DIRECTOR, AND FLIGHT DIRECTOR. |
| | I-11 | CONSIDERATION WILL BE GIVEN TO THE REPAIR OF ANY HIGHLY DESIRABLE ITEM, BUT IN NO CASE WILL THE LAUNCH BE SCRUBBED FOR ANY SINGLE HIGHLY DESIRABLE ITEM. IF TWO OR MORE HIGHLY DESIRABLE ITEMS FAIL AND/OR OTHER AGGRAVATING CIRCUMSTANCES OCCUR, THE MISSION DIRECTOR MAY SCRUB THE MISSION AFTER COORDINATION WITH THE APPROPRIATE OPERATIONS AND PROGRAM MANAGERS. |
| | I-12 | THE COUNTDOWN WILL NOT BE HELD NOR THE LAUNCH SCRUBBED FOR FAILURE OF DESIRABLE ITEMS. |
| | I-13 | WHENEVER POSSIBLE, THE LAUNCH SITE AND MCC WILL VERIFY TELEMETRY READOUT DISCREPANCIES OCCURRING PRIOR TO LIFTOFF. IF THE MCC LOSES A PARAMETER BUT THE LAUNCH SITE HAS A VALID READOUT, THE MCC WILL CONTINUE ON THE LAUNCH SITE READOUT. THIS IS TRUE EXCEPT FOR THOSE MANDATORY PARAMETERS (LISTED IN THE FLIGHT MISSION RULES) UPON WHICH MISSION RULES ACTION IS TAKEN. IN THIS CASE, A HOLD MAY BE CALLED TO EVALUATE THE PROBLEM. |
| | I-14 | THE COUNTDOWN WILL CONTINUE WHERE POSSIBLE CONCURRENTLY WITH CORRECTION OF AN EXISTING PROBLEM. |
| | I-15 | WHERE POSSIBLE, ALL MANUAL ABORT REQUESTS FROM THE GROUND DURING FLIGHT WILL BE BASED ON TWO INDEPENDENT INDICATIONS OF THE FAILURE. CREW ABORT ACTION WILL NORMALLY BE BASED UPON TWO CUES. |
| | I-16 | PRIOR TO LIFTOFF, THE DIRECTOR OF LAUNCH OPERATIONS WILL BE RESPONSIBLE FOR ALL ACTIONS IN THE EVENT OF LAUNCH SITE EMERGENCIES, EXCEPT FOR RECOVERY OPERATIONS OF SPACECRAFT AND CREW RESULTING FROM A PAD ABORT. |
| | I-17 | THE LAUNCH OPERATIONS MANAGER MAY SEND AN ABORT REQUEST FROM THE TIME THE LAUNCH ESCAPE SYSTEM IS ARMED UNTIL THE SPACE VEHICLE REACHES SUFFICIENT ALTITUDE TO CLEAR THE TOP OF THE UMBILICAL TOWER. THE CRITERIA FOR SENDING AN ABORT REQUEST WILL BE ESTABLISHED IN THE LAUNCH RULES. |

| REV | ITEM | |
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| | I-18 | FROM LIFTOFF TO TOWER CLEAR, THE LAUNCH DIRECTOR AND FLIGHT DIRECTOR WILL HAVE CONCURRENT RESPONSIBILITY FOR SENDING AN ABORT REQUEST. THE CRITERIA FOR SENDING AN ABORT REQUEST DURING THIS PERIOD WILL BE ESTABLISHED IN THE LAUNCH AND FLIGHT RULES RESPECTIVELY. |
| | I-19 | THE LAUNCH OPERATIONS MANAGER WILL INFORM MCC WHEN THE SPACE VEHICLE CLEARS THE UMBILICAL TOWER BY SAYING "CLEAR TOWER" OVER ONE OF THE LOOPS FROM KSC TO MCC. |
| | I-20 | IN THE EVENT OF NON-CATASTROPHIC SPACE VEHICLE COLLISION WITH THE UMBILICAL TOWER OR OTHER CONTINGENCIES WHICH DO NOT REQUIRE IMMEDIATE ACTION, THE LAUNCH OPERATIONS MANAGER WILL CONTINUE TO EVALUATE THE EXTENT OF THE DAMAGE AND PROVIDE INFORMATION TO THE FLIGHT DIRECTOR FOR ANY ACTION NECESSARY AFTER UMBILICAL TOWER CLEARANCE. |
| | I-21 | COMPLETE GROUND CONTROL OF THE SPACE VEHICLE PASSES TO THE FLIGHT DIRECTOR WHEN THE SPACE VEHICLE REACHES SUFFICIENT ALTITUDE TO CLEAR THE TOP OF THE UMBILICAL TOWER. |
| | I-22 | IN THE MCC, THE FLIGHT DIRECTOR, FLIGHT DYNAMICS OFFICER AND BOOSTER SYSTEMS ENGINEER WILL HAVE THE CAPABILITY TO SEND AN ABORT REQUEST SIGNAL. THE CRITERIA FOR SENDING AN ABORT REQUEST WILL BE ESTABLISHED IN THE FLIGHT RULES. |
| | I-23 | THE COMMAND PILOT MAY INITIATE SUCH INFLIGHT ACTION AS HE DEEMS ESSENTIAL FOR CREW SAFETY. |
| | I-24 | FLIGHT CREW SAFETY SHALL TAKE PRECEDENCE OVER THE ACCOMPLISHMENT OF MISSION OBJECTIVES. |
| | I-25 | IN THE EVENT OF COMMUNICATIONS LOSS BETWEEN THE MANNED SPACE FLIGHT NETWORK AND THE SPACECRAFT, THE COMMAND PILOT WILL ASSUME RESPONSIBILITY FOR MISSION CONDUCT AS DESCRIBED WITHIN THE FLIGHT RULES. |
| | I-26 | THE FLIGHT DIRECTOR, THROUGH THE RECOVERY COORDINATOR, WILL PROVIDE THE DOD MANAGER FOR MANNED SPACE FLIGHT SUPPORT OPERATIONS THE PREDICTED LOCATION AND TIME OF SPLASHDOWN. |
| | I-27 | THE DOD MANAGER FOR MANNED SPACEFLIGHT SUPPORT OPERATIONS IS RESPONSIBLE FOR RECOVERY AND COMMAND AND CONTROL OF DOD RECOVERY FORCES. RECOMMENDATIONS, GUIDELINES AND REQUIREMENTS, AS SET FORTH BY NASA, WILL BE CONSIDERED TO EFFECT SAFE AND EXPEDITIOUS RECOVERY OF THE FLIGHT CREW AND SPACECRAFT. |
| | | RULE NUMBERS 1-28 THROUGH 1-35 ARE RESERVED |

| REV | ITEM | DEFINITIONS |
|---|---|---|
| | I-36 | REDLINE: A REDLINE VALUE IS A MAXIMUM AND/OR MINIMUM LIMIT OF A CRITICAL PARAMETER NECESSARY TO IDENTIFY VEHICLE, SYSTEM, AND COMPONENT PERFORMANCE AND OPERATION. REDLINE VALUES WILL BE ESTABLISHED SUCH THAT FURTHER DEGRADATIONS OF THE SYSTEM OR COMPONENT COULD LEAD TO A FAILURE TO ACCOMPLISH THE PRIMARY MISSION. |
| | I-37 | REDLINE FUNCTION: A REDLINE FUNCTION IS A PARAMETER THAT HAS BEEN IDENTIFIED TO MONITOR THE FUNCTIONING OF A UNIT TO INSURE THE OPERATIONAL PERFORMANCE OF THAT UNIT IS ACCEPTABLE TO MEET THE PRIMARY MISSION. REDLINE FUNCTIONS ARE MANDATORY. |
| | I-38 | PRIMARY OBJECTIVE: A STATEMENT OF THE PRIMARY PURPOSE OF FLIGHT. WHEN USED IN CENTER CONTROL DOCUMENTATION THE PRIMARY OBJECTIVE MAY BE AMPLIFIED BUT NOT MODIFIED. DETAILED TEST OBJECTIVES WILL BE GENERATED AND AMPLIFIED TO FULFILL EACH MISSION OBJECTIVE. |
| | I-39 | PRINCIPAL DETAILED TEST OBJECTIVE: A DETAILED TEST OBJECTIVE WHICH MUST BE ACCOMPLISHED PRIOR TO THE LUNAR LANDING MISSION. ANY PRINCIPAL DETAILED TEST OBJECTIVE NOT SATISFACTORILY COMPLETED ON THE ASSIGNED MISSION CAN BE ATTEMPTED ON A SUBSEQUENT MISSION WITHOUT MAJOR IMPACT. |
| | I-40 | MANDATORY DETAILED TEST OBJECTIVE: A PRINCIPAL DETAILED TEST OBJECTIVE WHICH MUST BE SATISFACTORILY COMPLETED ON THE ASSIGNED MISSION. FAILURE TO DO SO WOULD UNDULY COMPROMISE SUBSEQUENT FLIGHT SCHEDULES AND/OR REQUIRE SUBSEQUENT SPACE VEHICLE RECONFIGURATION. |
| | I-41 | SECONDARY DETAILED TEST OBJECTIVE: A DETAILED TEST OBJECTIVE WHICH WOULD PROVIDE SIGNIFICANT DATA OR EXPERIENCE BUT WHICH IS NOT A PREREQUISITE TO THE LUNAR LANDING MISSION. |
| | I-42 | MANDATORY (M): A MANDATORY ITEM IS A SPACE VEHICLE OR OPERATIONAL SUPPORT ELEMENT THAT IS ESSENTIAL FOR ACCOMPLISHMENT OF THE PRIMARY MISSION, WHICH INCLUDES PRELAUNCH, FLIGHT, AND RECOVERY OPERATIONS THAT INSURE CREW SAFETY AND EFFECTIVE OPERATIONAL CONTROL AS WELL AS THE ATTAINMENT OF THE MANDATORY DETAILED TEST OBJECTIVES. |
| A | I-43 | HIGHLY DESIRABLE (HD): A HIGHLY DESIRABLE ITEM IS A SPACE VEHICLE OR OPERATIONAL SUPPORT ELEMENT THAT SUPPORTS AND ENHANCES THE ACCOMPLISHMENT OF THE PRIMARY MISSION AND IS ESSENTIAL FOR THE ACCOMPLISHMENT OF THE PRINCIPAL DETAILED TEST OBJECTIVES. |
| | I-44 | DESIRABLE (D): A DESIRABLE ITEM IS A SPACE VEHICLE ELEMENT OR OPERATIONAL SUPPORT ELEMENT THAT IS NOT ESSENTIAL FOR THE ACCOMPLISHMENT OF THE PRIMARY MISSION. |
| | I-45 | PROCEED: CONTINUE IN ACCORDANCE WITH PRESCRIBED COUNTDOWN PROCEDURES. |
| | I-46 | HOLD: INTERRUPTION OF THE COUNTDOWN FOR UNFAVORABLE WEATHER, REPAIR OF HARDWARE, OR CORRECTION OF CONDITIONS UNSATISFACTORY FOR LAUNCH OR FLIGHT. |

| REV | ITEM | |
|---|---|---|
| | I-47 | COUNTDOWN: THE PERIOD OF TIME STARTING WITH LAUNCH VEHICLE POWER UP FOR THE LAUNCH (OR SIMULATED LAUNCH) WHICH INCLUDES SERVICE STRUCTURE REMOVAL, LAUNCH VEHICLE CRYOGENIC TANKING, SPACECRAFT CLOSEOUT, AND THE TERMINAL COUNT. |
| | I-48 | HOLD-POINT: A PREDETERMINED POINT WHERE THE COUNTDOWN MAY BE CONVENIENTLY INTERRUPTED. |
| | I-49 | RECYCLE: THE COUNTDOWN IS STOPPED AND RETURNED TO A DESIGNATED POINT OR AS SPECIFIED IN THE LAUNCH MISSION RULES. |
| | I-50 | SCRUB: THE LAUNCH IS POSTPONED. |
| | I-51 | CUTOFF: THE AUTOMATIC OR MANUAL COMMAND TO STOP THE LAUNCH SEQUENCE AFTER INITIATION OF THE "AUTOMATIC LAUNCH SEQUENCE START." |
| | I-52 | LIFTOFF: THE EVENT DETERMINED BY THE INSTRUMENTATION UNIT UMBILICAL DISCONNECT SIGNAL AND IS THE POINT IN TIME WHEN PLUS TIME COMMENCES. |
| | I-53 | ABORT: MISSION TERMINATION BY UNSCHEDULED INTENTIONAL SEPARATION OF THE SPACECRAFT FROM THE LAUNCH VEHICLE PRIOR TO ORBITAL INSERTION. |
| | I-54 | EARLY MISSION TERMINATION: UNSCHEDULED INTENTIONAL MISSION TERMINATION AT OR AFTER ORBITAL INSERTION. |
| | I-55 | MEASUREMENT: A MEASUREMENT IS A SPECIFIC DATA CHANNEL OF INSTRUMENTATION MONITORING A SINGLE FUNCTION. |
| | I-56 | INSTRUMENTATION: INSTRUMENTATION IS THE EQUIPMENT THAT ACQUIRES, TRANSMITS AND MONITORS DATA FOR PERFORMANCE EVALUATION OF SPACE VEHICLE AND OPERATIONAL SUPPORT ITEMS. |

PART II
1 GENERAL RULES
AND SOP'S

**NASA — Manned Spacecraft Center**

**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | | GENERAL |
| | 1-1 | THE FLIGHT MISSION RULES OUTLINE PREPLANNED DECISIONS DESIGNED TO MINIMIZE THE AMOUNT OF REAL-TIME RATIONALIZATION REQUIRED WHEN NON-NOMINAL SITUATIONS OCCUR DURING THE TERMINAL COUNTDOWN, THE FLIGHT PHASE, AND RECOVERY OPERATIONS. |
| | 1-2 | WHENEVER POSSIBLE, THE CREW AND GROUND WILL VERIFY ALL MALFUNCTIONS. WHENEVER THERE IS A CONFLICT BETWEEN SPACECRAFT AND GROUND TELEMETRY READOUTS, THE SPACECRAFT READOUTS ARE PRIME (ASSUMING THE SPACECRAFT HAS ADEQUATE INSTRUMENTATION AND THAT APPLICABLE SPACECRAFT COCKPIT READOUTS ARE OPERATIONAL). |
| | 1-3 | IF AN ALTERNATE MISSION IS REQUIRED, MISSION OBJECTIVES WILL BE DELETED IN ACCORDANCE WITH THE PRIORITY OF OBJECTIVES STATED IN THE FLIGHT OPERATIONS RULES. LOWER ORDER OBJECTIVES WILL NOT BE ATTEMPTED IF DOING SO MAY COMPROMISE THE ACCOMPLISHMENT OF OBJECTIVES OF A HIGHER PRIORITY. |
| A | 1-4 | SPACECRAFT LAUNCH WILL NOT BE ATTEMPTED IF KNOWN SPACECRAFT SYSTEMS MALFUNCTIONS WILL LIMIT THE MISSION DURATION SUCH THAT ACCOMPLISHMENT OF THE MANDATORY PRINCIPAL DETAILED TEST OBJECTIVES WILL BE COMPROMISED. |
| | 1-5 | WHEN A CONFLICT OF FLIGHT PLAN ACTIVITIES OCCURS, THE FLIGHT DIRECTOR WILL DETERMINE THE PRIORITY OF ACTIVITIES. |
| | 1-6 | IN SOME INSTANCES, THE SPECIFIC MISSION RULES MAY DEVIATE FROM THE GENERAL GUIDELINES CONTAINED IN PART I OR FROM THESE GENERAL RULES. THE SPECIFIC MISSION RULE WILL APPLY IN ALL CASES, AND THE DEVIATIONS FROM THE GENERAL GUIDELINES WILL BE NOTED. |
| | 1-7 | THE AUTOMATIC EDS (TWO ENGINE OUT AND OVERRATE CAPABILITY) WILL BE FLOWN CLOSED LOOP. |
| | 1-8 | THE FLIGHT DIRECTOR MAY, AFTER ANALYSIS OF THE FLIGHT, CHOOSE TO TAKE ANY NECESSARY ACTION REQUIRED FOR THE SUCCESSFUL COMPLETION OF THE MISSION. |
| | 1-9 | MISSION RULE LIMITS THAT ARE CONSIDERED TO BE INTERIM OR UNCONFIRMED NUMBERS WILL BE UNDERLINED IN THIS PUBLICATION AND ALL SUBSEQUENT REVISIONS UNTIL THE NUMBERS ARE CONFIRMED BY THE RESPONSIBLE NASA AGENCY. |

| REV | ITEM | |
|---|---|---|
| | 1-10 | THE SYSTEMS LIMITS LISTED IN THESE RULES ARE THE ACTUAL VEHICLE LIMITS AS WELL AS THEY ARE KNOWN AND UNDERSTOOD AND ARE NOT BIASED TO COMPENSATE FOR TIME DELAYS OR KNOWN INSTRUMENTATION ERRORS IN THE OVERALL DATA SYSTEM. |
| | 1-11 | UNLESS STATED OTHERWISE, MANDATORY AND HIGHLY DESIRABLE INSTRUMENTATION REQUIREMENTS ARE SATISFIED BY EITHER ONBOARD OR PCM CAPABILITY. |
| | 1-12 | MANDATORY SPACE VEHICLE INSTRUMENTATION FOR THE PURPOSES OF FLIGHT MISSION RULES MUST BE IN CONSONANCE WITH THE FOLLOWING CRITERIA: (REFERENCE OMSF GENERAL RULE I-42).<br>A. REQUIRED TO INSURE FLIGHT CREW SAFETY.<br>B. REQUIRED TO IMPLEMENT RULES RESULTING IN LAUNCH ABORTS.<br>C. REQUIRED TO IMPLEMENT RULES RESULTING IN EARLY MISSION TERMINATION.<br>D. REQUIRED TO MAKE DECISION TO CONTINUE TO THE NEXT MISSION PHASE.<br>THE MANDATORY INSTRUMENTATION LISTINGS IN THIS DOCUMENT WILL BE CROSS-REFERENCED TO THE APPROPRIATE MISSION RULE MEETING THE ABOVE CRITERIA. |
| | 1-13 | THE CRITERION FOR CATEGORIZING INSTRUMENTATION AS HIGHLY DESIRABLE IN THE FLIGHT MISSION RULES IS ANY INSTRUMENTATION REQUIRED FOR NORMAL SYSTEMS MANAGEMENT OR REQUIRED FOR FLIGHT CONTROL DECISIONS NOT IN THE MANDATORY CATEGORY. |
| | 1-14 | RF COMMANDS WILL NOT BE TRANSMITTED TO THE SPACECRAFT OR LAUNCH VEHICLE DURING THE LAUNCH PHASE UNLESS SPECIFIC MISSION RULES ARE INVOKED WHICH REQUIRE COMMAND ACTIVITY. |
| | 1-15 | THE LAUNCH OPERATIONS MANAGER WILL INFORM THE FLIGHT DIRECTOR WHEN THE SPACE VEHICLE HAS CLEARED THE UMBILICAL TOWER BY STATING "CLEAR TOWER" OVER CHANNEL 111. |
| | | RULE NUMBERS 1-16 THROUGH 1-25 ARE RESERVED. |

| REV | ITEM | |
|---|---|---|
| | | **DEFINITIONS** |
| | 1-26 | ASAP: AS SOON AS PRACTICABLE (I.E., AS SOON AS POSSIBLE AND REASONABLE). |
| | 1-27 | PTP: A PREFERRED TARGET POINT IS A STRATEGICALLY LOCATED SET OF COORDINATES FOR WHICH THE SPACECRAFT SHOULD BE TARGETED IF IT BECOMES NECESSARY TO LAND ON THAT REVOLUTION. |
| | 1-28 | ATP: AN "ALTERNATE TARGET POINT" IS A STRATEGICALLY LOCATED SET OF COORDINATES CHOSEN TO PROVIDE A SPACECRAFT TARGET POINT MIDWAY BETWEEN PTP'S. |
| | 1-29 | NEXT BEST PTP: A PREFERRED TARGET POINT WHICH CAN BE REACHED BY THE SPACECRAFT WITHIN THE CONSTRAINTS IMPOSED BY THE SPACECRAFT PROBLEM CAUSING AN EARLY MISSION TERMINATION AND ALLOWING THE BEST POSSIBLE REENTRY AND LANDING AREA CONDITIONS. |
| | 1-30 | CRITICAL BURN: A BURN WHICH MUST BE ACCOMPLISHED TO MAINTAIN AN ACCEPTABLE LEVEL OF CREW SAFETY. FOR THE PURPOSE OF MISSION RULES, THE FOLLOWING ARE THE PLANNED CRITICAL BURNS:<br>A. MODE III ABORT BURNS<br>B. MODE IV CONTINGENCY ORBIT INSERTION BURNS<br>C. APOGEE KICK BURNS<br>D. DEORBIT BURNS<br>E. RESCUE BURNS<br>F. CSI, CDH AND TPI (LM VEHICLE) |
| | 1-31 | NON-CRITICAL BURN: A BURN WHICH NEED NOT BE ACCOMPLISHED TO MAINTAIN AN ACCEPTABLE LEVEL OF CREW. SAFETY. |
| | 1-32 | EARLY STAGING: UNSCHEDULED INTENTIONAL SEPARATION OF THE S-IVB STAGE FROM THE S-II STAGE. |
| | 1-33 | CONTINGENCY ORBIT INSERTION (COI): A SPS PROPULSIVE MANEUVER WHICH WILL PROVIDE CSM INSERTION INTO A SAFE ORBIT ($H_p \geq 75$ NM) IN THE EVENT OF AN SLV FAILURE OCCURRING IMMEDICATELY PRIOR TO INSERTION, OR IN THE EVENT OF DEGRADED SLV PERFORMANCE. |

| REV | ITEM | |
|---|---|---|
| | 1-34 | S-IVB DESTRUCT PACKAGE SAFING: THE EMERGENCY DESTRUCT PACKAGE IS SAFED BY THE RSO TRANSMITTING A COMMAND WHICH PERMANENTLY REMOVES POWER FROM THE RANGE SAFETY RECEIVERS. |
| | 1-35 | S-IVB ORBITAL SAFING: A PASSIVATION SEQUENCE IN WHICH S-IVB LOX, $LH_2$, AND HIGH PRESSURE SPHERES ARE DEPLETED. |
| | 1-36 | PRELAUNCH PHASE (PRELN): THE TIME INTERVAL FROM THE COMPLETION OF THE FLIGHT READINESS REVIEW TO LIFTOFF. |
| | 1-37 | FLIGHT PHASE: THE TIME INTERVAL FROM LIFTOFF TO SPLASHDOWN. LISTED BELOW ARE THE MISSION PHASES WHICH COMPRISE THE FLIGHT PHASE. THE PHASES ARE LISTED BY VEHICLE AND WILL BE USED IN THE PHASE COLUMN OF FEC/TSG FORM 291 TO IDENTIFY THE MISSION PERIOD OF ACTIVITY FOR WHICH A SPECIFIC RULING IS APPLICABLE.<br><br>A. S-IVB<br>1. LAUNCH PHASE : FROM LIFTOFF THROUGH INSERTION. (TB1 THROUGH TB4)<br>2. ORBIT PHASE: FROM INSERTION TO CSM/S-IVB SEPARATION FOR TD&E. (TB5)<br>3. TD&E PHASE: FROM CSM/S-IVB SEPARATION THROUGH LM EJECTION FROM SLA. (TB5)<br>4. TRANSLUNAR INJECTION (TLI) PHASE: FROM LM EJECTION TO COMPLETION OF S-IVB SUPPORT. THIS PHASE INCLUDES S-IVB RESTARTS AND ORBITAL SAFING. (TB5 THROUGH TB9)<br><br>B. LM<br>1. DOCKED PHASE: THE TIME INTERVALS DURING WHICH THE LM AND CSM ARE DOCKED.<br>2. UNDOCKED PHASE: THE TIME INTERVAL DURING WHICH A MANNED LM IS SEPARATED FROM CSM FOR STATION KEEPING (MAXIMUM SEPARATION DISTANCE OF ≈ 500 FT).<br>3. EVA PHASE: THE TIME INTERVAL DURING WHICH THE EVA CREWMAN IS INDEPENDENT OF THE LM ECS AND REQUIRES EMU FOR LIFE SUPPORT.<br>4. RENDEZVOUS PHASE: THE TIME INTERVAL FROM THE CSM SEPARATION MANEUVER FOR MINI-FOOTBALL TO LM/CSM DOCKING AT END OF RENDEZVOUS.<br>5. UNMANNED PHASE: FROM FINAL LM SEPARATION OR JETTISON TO COMPLETION OF LM ACTIVITIES.<br><br>C. CSM<br>1. LAUNCH PHASE: FROM LIFTOFF THROUGH INSERTION.<br>2. ORBIT (S-IVB) PHASE: FROM INSERTION TO CSM/S-IVB SEPARATION FOR TD&E.<br>3. TD&E PHASE: FROM CSM/S-IVB SEPARATION THROUGH LM EJECTION FROM SLA.<br>4. DOCKED PHASE: THE TIME INTERVALS DURING WHICH THE LM AND CSM ARE DOCKED.<br>5. EVA PHASE: THE TIME INTERVAL DURING WHICH THE EVA CREWMAN IS INDEPENDENT OF THE LM ECS AND REQUIRES THE EMU FOR LIFE SUPPORT.<br>6. UNDOCKED PHASE: THE TIME INTERVAL DURING WHICH A MANNED LM IS SEPARATED FROM CSM FOR STATION KEEPING (MAXIMUM SEPARATION DISTANCE OF ≈ 500 FT).<br>7. RENDEZVOUS PHASE: THE TIME INTERVAL FROM THE CSM SEPARATION MANEUVER FOR MINI-FOOTBALL TO LM/CSM DOCKING AT END OF RENDEZVOUS.<br>8. ORBIT (SOLO) PHASE: CSM ACTIVITIES FROM LM SEPARATION TO DEORBIT BURN CUTOFF.<br>9. ENTRY PHASE: FROM DEORBIT BURN CUTOFF TO SPLASHDOWN. |
| | 1-38 | RECOVERY PHASE: THE TIME INTERVAL FROM SPLASHDOWN TO DELIVERY OF THE FLIGHT CREW AND SPACECRAFT TO DESIGNATED LANDBASED INSTALLATIONS. |

| REV | ITEM | |
|---|---|---|
| | 1-39 | <u>REENTRY DEFINITIONS</u>:<br>A. AUTOMATIC - REENTRY CONTROLLED BY CMC WHICH OUTPUTS BANK ANGLE COMMANDS TO THE RCS.<br>B. CLOSED LOOP - REENTRY CONTROLLED BY THE CREW MANUALLY FLYING BANK ANGLE MODULATION USING CMC ENTRY PROGRAM OUTPUTS.<br>C. OPEN LOOP REENTRY - REENTRY CONTROLLED BY THE CREW USING SPACECRAFT DISPLAYS AND FLYING:<br>1. BANK ANGLE (RL 0-90) AND RETRB (RR 0-90).<br>2. CONSTANT BANK ANGLE - CONSTANT BANK ANGLES >90 DEGREES WILL NOT BE FLOWN EXCEPT WHEN SKIPOUT RULE IS VIOLATED.<br>3. ROLLING ENTRY - MAINTAIN CONSTANT 18 DEGREES PER SECOND ROLL RATE.<br>4. EMS RANGING - CONSTANT BANK ANGLE IS HELD TO <u>.2G</u> THEN THE RANGE TO GO DISPLAY AND THE RANGE POTENTIAL LINES ARE COMPARED TO MODULATE THE BANK ANGLE. AT RETRB THE PRESENT BANK ANGLE IS REVERSED. |
| | 1-40 | <u>ALTERNATE MISSION</u>: ANY DEVIATION FROM THE NOMINAL MISSION TIMELINE WHERE FURTHER MISSION OBJECTIVES ARE CONSIDERED BEFORE THE END OF THE MISSION. |
| | 1-41 | <u>CONTINUE MISSION</u>: THE CONTINUE MISSION RULING FOR MALFUNCTIONS INDICATES THAT THE MISSION WILL BE CONTINUED IN ACCORDANCE WITH PRESENT PLANS UNLESS OVERRIDING FACTORS ARE PRESENT WHICH WOULD CAUSE SELECTION OF AN ALTERNATE MISSION CHOICE. |
| | | RULE NUMBERS 1-42 THROUGH 1-45 ARE RESERVED. |

| REV | ITEM | |
|---|---|---|
| | | **CRITERIA FOR TARGET POINT SELECTION** |
| | 1-46 | THE CRITERIA LISTED BELOW WILL BE USED WHEN CHOOSING BETWEEN TWO OR MORE TARGET POINTS. THE CRITICALITY OF THE MISSION SITUATION WILL AFFECT THE APPLICATION OF THESE CRITERIA. |

| CRITERIA | PRIORITY |
|---|---|
| ACCEPTABLE WEATHER CONDITIONS FOR RECOVERY OPERATIONS | 1 |
| CAPABILITY OF RECOVERY FORCES | 2 |
| COMMUNICATION WITH THE SPACECRAFT FROM A GROUND STATION AT LEAST 40 MINUTES PRIOR TO DEORBIT BURN | 3 |
| SUFFICIENT DAYLIGHT FOR RECOVERY OPERATIONS | 4 |
| A GROUND STATION FOR POST-DEORBIT BURN TRACKING | 5 |
| VOICE CONTACT PRIOR TO AND DURING DEORBIT BURN | 6 |
| POST-BLACKOUT TRACKING DATA AVAILABLE FOR REENTY (ASSUMES PRE-BLACKOUT ACQUISITION) | 7 |
| GROUND STATIONS AVAILABLE TO OBTAIN DELTA $V_C$ READOUTS AND TO PASS CREW BACKUP GUIDANCE QUANTITIES. | 8 |

| REV | ITEM | |
|---|---|---|
| | | **PRELAUNCH RULES** |
| | 1-47 | MANDATORY - THE COGNIZANT FLIGHT CONTROLLER WILL REQUEST A HOLD OR A CUTOFF FROM THE FLIGHT DIRECTOR IN CASE OF A LOSS OR FAILURE OF A MANDATORY ITEM. PRIOR TO T-1 MIN., FAILURES OF MANDATORY ITEMS WILL BE CONFIRMED PRIOR TO REQUESTING A HOLD OR A CUTOFF. AFTER T-1 MIN., CUTOFF WILL BE REQUESTED FOR MANDATORY ITEMS WITHOUT VERIFICATION DUE TO THE LIMITED TIME REMAINING. AT T-20 SEC., ALL MANDATORY ITEMS WILL REVERT TO HIGHLY DESIRABLE UNLESS SPECIFICALLY DESIGNATED AS MANDATORY TO L/O. REFERENCE LAUNCH MISSION RULES DOCUMENT, ITEM TBD FOR SPECIFIC PROCEDURES. |
| | 1-48 | HIGHLY DESIRABLE - THE COGNIZANT FLIGHT CONTROLLER WILL NOTIFY THE FLIGHT DIRECTOR IN CASE OF A LOSS OR A FAILURE OF A HIGHLY DESIRABLE ITEM(S). A HOLD MAY BE CALLED BY THE FLIGHT DIRECTOR TO REPAIR THIS ITEM(S) WHEN IT IS CONVENIENT AND IF THE ESTIMATED TIME TO REPAIR OR REPLACE THE ITEM(S) IS ACCEPTABLE. ALL HIGHLY DESIRABLE ITEMS REVERT TO DESIRABLE AFTER AUTO SEQUENCE START. |
| | 1-49 | DESIRABLE - FLIGHT CONTROLLERS WILL NOT CALL HOLDS FOR THE LOSS OF DESIRABLE ITEMS AS THEY ARE PLACED IN THIS CATEGORY BECAUSE THEY ARE ITEMS OF SUPPORT WHICH ARE OF MINOR IMPORTANCE TO FLIGHT OPERATIONS. |
| | 1-50 | MANUAL CUTOFF WILL NOT BE ATTEMPTED FROM T-11 SECONDS (ENGINE IGNITION) TO T-0. |
| | | RULE NUMBERS 1-51 THROUGH 1-60 ARE RESERVED. |

| REV | ITEM | |
|---|---|---|
| | | **LAUNCH ABORTS** |
| | 1-61 | ABORT REQUEST COMMANDS ARE COMMANDS TRANSMITTED FROM THE MCC OR LCC WHICH ILLUMINATE THE ABORT REQUEST LIGHT ON THE COMMAND PILOT'S PANEL. THE "ABORT LIGHT" AND A VOICE REPORT "ABORT" OVER A/G ARE CONSIDERED TWO CUES FOR THE CREW TO TAKE THE NECESSARY ACTION TO ABORT THE MISSION. THE GROUND WILL USE TWO INDEPENDENT CUES PRIOR TO TRANSMITTING "ABORT REQUEST." ADDITIONAL CUES FOR THE CREW WILL COME FROM ONBOARD INDICATIONS. |
| | 1-62 | WHENEVER POSSIBLE, ALL ABORTS AND EARLY MISSION TERMINATIONS WILL BE TIMED FOR A WATER LANDING. |
| | 1-63 | THE FLIGHT DIRECTOR WILL INITIATE THE ABORT REQUEST COMMAND FOR SPACECRAFT SYSTEMS MALFUNCTIONS, TRAJECTORY DEVIATIONS, AND LAUNCH VEHICLE MALFUNCTIONS IF TIME PERMITS. |
| | 1-64 | THE FLIGHT DYNAMICS OFFICER WILL INITIATE THE ABORT REQUEST COMMAND DURING THE FLIGHT PHASE IF THE SPACE VEHICLE EXCEEDS THE FLIGHT DYNAMICS ENVELOPE. |
| | 1-65 | THE BOOSTER SYSTEMS ENGINEER WILL INITIATE THE ABORT REQUEST COMMAND BASED UPON LAUNCH VEHICLE TIME-CRITICAL SYSTEMS MALFUNCTIONS THAT WOULD NOT ALLOW A SAFE INSERTION FOR FAILURES OCCURRING FROM LIFTOFF TO S-IVB CUTOFF. |
| | 1-66 | THE ONLY KSC POSITION THAT WILL HAVE ABORT REQUEST CAPABILITY IS THE LAUNCH OPERATIONS MANAGER. THE LAUNCH OPERATIONS MANAGER MAY SEND AN ABORT REQUEST FROM THE TIME THE LAUNCH ESCAPE SYSTEM IS ARMED UNTIL THE SPACE VEHICLE REACHES SUFFICIENT ALTITUDE TO CLEAR THE TOP OF THE UMBILICAL TOWER. PRIOR TO TRANSFER OF CONTROL TO THE FLIGHT DIRECTOR, THE LAUNCH OPERATIONS MANAGER WILL INITIATE THE ABORT REQUEST COMMAND FROM KSC BASED ON THE FOLLOWING CRITERIA:<br>A. MAJOR STRUCTURAL FAILURE OR EXPLOSION.<br>B. LOSS OF POSITIVE VERTICAL MOTION.<br>C. UNCONTROLLABLE VEHICLE TILTING.<br>D. TOWER COLLISION RESULTING IN DAMAGE NECESSITATING IMMEDIATE ABORT ACTION. |
| | 1-67 | THE RSO CAN SHUTDOWN THE SLV BY TRANSMITTING THE MFCO COMMAND WHICH ALSO LIGHTS THE ABORT REQUEST LIGHT IN THE SPACECRAFT. THE MFCO WILL INITIATE AN AUTO-ABORT IF TRANSMITTED PRIOR TO EDS DISABLE. THE MFCO COMMAND INITIATES A 4.0 SEC TIMER ON THE GROUND WHICH IN TURN ENABLES DESTRUCT CAPABILITY IF TRANSMITTED. THE RSO DESTRUCT COMMAND CAN THEN DESTROY THE SLV. THE RSO WILL ALWAYS SAFE THE S-IVB AFTER TRANSMITTING MFCO UPON VERIFICATION OF CUTOFF IF THE DESTRUCT COMMAND IS NOT TO BE TRANSMITTED. |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 1-68 | FIXED TIME ABORTS ARE IMPLEMENTED FOR NON-TIME-CRITICAL FAILURES WHICH PRECLUDE CONTINUING LAUNCH TO INSERTION. FIXED TIME ABORTS ARE SCHEDULED AT THE FOLLOWING GET:<br>1 + 45 MODE IB<br>3 + 00 MODE IC<br>4 + 30 MODE II<br>9 + 10 MODE II |
| | 1-69 | THE FIXED TIME ABORT PROCEDURE IS AS FOLLOWS:<br>A. APPROPRIATE FLIGHT CONTROLLER GIVES RED STATUS AND VOICE REPORT OF FAILURE TO FLIGHT DIRECTOR.<br>B. CREW CONFIRM FAILURE.<br>C. FLIGHT DETERMINE ABORT TIME TO BE USED.<br>D. RETRO BEGIN COUNTDOWN AT ABORT TIME MINUS 10 SECONDS.<br>E. CAPCOM RELAY COUNTDOWN TO CREW.<br>F. CREW INITIATE ABORT ON "MARK".<br>G. FLIGHT DIRECTOR WILL REQUEST "RSO SEND MFCO" IF THE CREW IS UNABLE TO SHUT DOWN WITHIN 5 SECONDS AFTER "MARK". |
| | 1-70 | THE RSO WILL SAFE THE S-IVB DESTRUCT SYSTEM AFTER CONFIRMATION OF S-IVB C/O FROM THE FLIGHT DYNAMICS OFFICER. IF COMMUNICATIONS ARE LOST WITH THE FIDO, THE S-IVB DESTRUCT SYSTEM WILL BE SAFED BASED ON THE RSO'S VERIFICATION OF S-IVB CUTOFF. ONCE SAFED, THE S-IVB DESTRUCT SYSTEM CANNOT BE REINITIATED. IF THE RSO INITIATES MFCO, THE RSO WILL INITIATE SAFING AFTER VERIFICATION OF S-IVB CUTOFF. |
| | 1-71 | ABORTS ARE INITIATED BY:<br>A. CREW<br>B. EMERGENCY DETECTION SYSTEM (EDS)<br>ABORTS MAY BE REQUESTED BY:<br>A. LAUNCH OPERATIONS MANAGER<br>B. FLIGHT DIRECTOR<br>C. FLIGHT DYNAMICS OFFICER (FDO)<br>D. BOOSTER SYSTEMS ENGINEER (BSE)<br>ABORT AFTER TOWER CLEARANCE IS REQUESTED BY THE FLIGHT DIRECTOR IF TIME PERMITS. THE RESPONSIBLE FLIGHT CONTROLLER (FDO OR BSE) WILL REQUEST ABORT IN TIME-CRITICAL SITUATIONS. |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | 1-72 | EMERGENCY ENGINE SHUTDOWN METHODS. |

| INITIATOR | METHOD | STAGE | TIME FRAME |
|---|---|---|---|
| ASTRONAUT | CCW ON THC | S-IC, S-II, S-IVB | T + 30 SEC TO SECO |
| ASTRONAUT | S-II/S-IVB L/V STAGE SWITCH | S-II, S-IVB | T + 2:33 TO SECO |
| RSO | RF CMD (MFCO) | S-IC, S-II, S-IVB | T-0 TO INSERTION |
| EDS | 2 OF 3 VOTING LOGIC | S-IC | T + 30 SEC TO EDS AUTO OFF AT T + 2:00 MIN<br>NOTE: EDS WILL INITIATE ABORT FROM T-0 TO T + 30 SEC; HOWEVER, S-IC ENGINES WILL NOT BE SHUTDOWN |

A 1-73 THE EDS AUTO ABORT LOGIC WILL BE DISABLED EARLY FOR LOSS OF ANY ENTRY BATTERY.

A 1-74 ABORT MODES:

| MODE I | BOUNDARY OF APPLICATION | PROCEDURES |
|---|---|---|
| 1A | LES ABORT ENABLE (≈T-30 MIN) TO GET 42 SEC. (10 K FEET) | REFERENCE AOH 5.1.1.1 |
| 1B | GET 42 SEC TO 100K FEET ALTITIDE (GET ≈1 + 50) | REFERENCE AOH 5.1.1.2 |
| 1C | 100K FEET ALTITIDE TO TOWER JETTISON (GET ≈ 3 + 07) | REFERENCE AOH 5.1.1.3 |

A 1-75 MODE II

BOUNDARY OF APPLICATION

TOWER JETTISON (GET ≈ 3 + 07) UNTIL FULL LIFT SPLASHPOINT IS 3350 N.M. DOWNRANGE

PROCEDURES

A. REFERENCE AOH 5.1.2.1

B. MCC PROVIDES

1. GET 400K AND PITCH AT .05 G'S.
2. GET DROGUE

C. ENTRY IS FULL LIFT

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**MISSION RULES**

| REV | ITEM | | | |
|---|---|---|---|---|
| A | 1-76 | MODE III | BOUNDARY OF APPLICATION<br>FULL LIFT SPLASHPOINT BETWEEN 3350 N.M. AND INSERTION. | PROCEDURES<br>A. REFERENCE AOH 5.1.2.2<br>B. MCC PROVIDES:<br>1. GETI AT S-IVB CUTOFF PLUS 2:05<br>2. DELTA V FOR 3350 N.M. SPLASH-POINT<br>3. BURN DURATION<br>4. GET AND PITCH ATT AT 400K FT.<br>5. GET DROGUE<br>6. GET MAIN<br>C. MANEUVER IS SCS AUTO.<br>D. ENTRY IS ROLL LEFT 55 DEGREES. |
| A | 1-77 | MODE IV | BOUNDARY OF APPLICATION<br>CONTINGENCY ORBIT INSERTION CAPABILITY TO INSERTION (BASED ON COI LINE ON $\gamma$ VS V PLOT FOR NEAR NOMINAL ALTITUDE) | PROCEDURES<br>A. REFERENCE AOH 5.1.2.3<br>B. MCC PROVIDES:<br>1. GETI AT S-IVB CUTOFF PLUS 2:05<br>2. DELTA V REQUIRED TO ACHIEVE PERIGEE ≥75 N.M.<br>3. BURN DURATION<br>4. PITCH AT GETI<br>C. MANEUVER IS SCS AUTO |
| A | 1-78 | MODE<br>APOGEE KICK | BOUNDARY OF APPLICATION<br>PRE-APOGEE CUTOFFS, OUTSIDE THE COI BOUNDARY, CORRECTABLE TO SAFE ORBITAL CONDITIONS BY A MANEUVER AT APOGEE. | PROCEDURES<br>A.<br>B. MCC PROVIDES:<br>1. GETI FOR BURN AT APOGEE<br>2. DELTA V REQUIRED TO ACHIEVE ≥75 N.M.<br>3. BURN DURATION<br>4. PITCH ATTITUDE<br>C. MANEUVER IS SCS AUTO |
| A | 1-79 | CREW ABORT LIMITS<br>MAX Q REGION<br>(00:50 TO 01:40)<br>A. AOA ≥100 PCT AND PITCH, YAW AND ROLL ERROR >5 DEGREES (DISREGARD FOR S-IC CONTROL ENGINE OUT PRIOR TO 50 SECONDS)<br>B. CUES<br>1. LV GUID LT-ON<br>2. LV RATE LT-ON | | PROCEDURES<br>ABORT MODE I (ACTION ONLY AFTER BOTH HAVE REACHED THRESHOLD)<br>ABORT MODE I |

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**MISSION RULES**

| REV | ITEM | | |
|---|---|---|---|
| | 1-80 | RATES AND ATTITUDE | PROCEDURES |
| | | A. PITCH AND YAW | |
| | | 1. L/O TO S-IC/S-II STAGING - 4 DEG/SEC | ABORT MODE I |
| | | 2. S-IC/S-II STAGING TO SECO- 9 DEG/SEC | ABORT MODE I, MODE II, MODE III, OR MODE IV |
| | | B. ROLL | |
| | | 1. L/O TO SECO - 20 DEG/SEC | ABORT MODE I, MODE II, MODE III, OR MODE IV |
| | 1-81 | EDS AUTOMATIC ABORT LIMITS (UNTIL MANUAL DEACTIVATION OF TWO ENGINES OUT AUTO AND LV RATES AT 2:00 MIN) | |
| | | BOUNDARY OF APPLICATION | |
| | | A. RATES<br>PITCH AND YAW 4.0 ± .5 DEG/SEC<br>ROLL 20.0 ± .5 DEG/SEC | |
| | | B. ANY TWO ENGINES OUT | |
| | | C. CM TO IU BREAKUP | |
| | 1-82 | S-IVB TANK PRESSURE LIMITS (L/O TO CSM/LV SEP) | |
| | | A. BULKHEAD $\Delta$P<br>FUEL > OXID = 26 PSID<br>OXID > FUEL = 36 PSID | |
| A | 1-83 | ENGINE FAILURES | PROCEDURES |
| | | A. SIMULTANEOUS LOSS OF TWO OR MORE ENGINES (S-IC) | ABORT MODE I |
| | | B. SIMULTANEOUS LOSS OF TWO OR MORE ENGINES (S-II) | ABORT OR EARLY STAGE<br>REF MR 6-17 |
| | | C. S-II INBOARD ENGINE HARDOVER | ABORT PRIOR TO S-IVB TO ORBIT CAPABILITY, AFTER S-IVB TO ORBIT CAPABILITY, EARLY STAGE |

2 FLIGHT OPERATIONS RULES

| REV | ITEM | | |
|---|---|---|---|
| A | 2-1 | MISSION GO/NO-GO SUMMARY | A. COMBINED FLIGHT CONTROL/FLIGHT CREW GO/NO-GO'S WILL BE MADE FOR EACH OF THE FOLLOWING:<br>1. LAUNCH GO/NO-GO FOR ORBIT INSERTION (9 + 00)<br>2. S-IVB ORBIT COAST (POST CUTOFF)<br>3. CONTINUE PAST 2-1 TO 6-4 PTP (CRO)<br>4. TD&E<br>5. S-IVB ORBITAL MANEUVERS<br>6. SPS MANEUVERS<br>7. CONTINUE THE MISSION PAST PTP 6-4 AND DAILY PTP GO/NO-GO<br>8. IVT<br>9. DOCKED DPS BURN<br>10. EVA<br>11. CSM/LM UNDOCKING<br>12. SEPARATION MANEUVER<br>13. PHASING MANEUVER<br>14. INSERTION MANEUVER<br>15. LM STAGING<br>16. LM UNMANNED APS BURN GO/NO-GO<br>REFERENCE RULES 3-1 THROUGH 3-17 AND 3-20 THROUGH 3-41 FOR GO/NO-GO CRITERIA.<br>B. FAILURE TO SATISFY THE GO/NO-GO CRITERIA IS SUFFICIENT CAUSE TO ALTER THE NOMINAL MISSION ACTIVITIES. THE COURSE OF ACTION REQUIRED WILL BE BASED UPON THE SPECIFIC CRITERIA NOT SATISFIED AND ASSOCIATED SPECIFIC MISSION RULES.<br>C. THE LIFETIME REQUIREMENTS AND CONSUMABLES ESTABLISHED FOR THE GO/NO-GO CRITERIA MUST ACCOUNT FOR THE NOMINAL ACTIVITIES PLANNED FOR COMPLETION, OPERATIONAL RESERVES, SUFFICIENT TIME AND CONSUMABLES TO PREPARE AND CONDUCT A CSM REENTRY FROM ANY POINT IN THE NOMINAL ACTIVITIES, AND A CSM PAD OF THREE HOURS IF ENTRY IS DELAYED.<br>D. THE SYSTEMS GO/NO-GO PHILOSOPHY UTILIZED IN THE FORMULATION OF THE MISSION RULES IS AS FOLLOWS:<br>1. REDUNDANT SYSTEMS: MISSION OR MISSION PHASE TERMINATION WILL BE PLANNED ASAP FOR FAILURE OF A REDUNDANT SYSTEM IF THE FAILURE OF THE REMAINING SYSTEM WOULD CAUSE LOSS OF THE CREW.<br>2. TRIPLE REDUNDANT SYSTEMS: CONSIDERATION WILL BE GIVEN FOR MISSION CONTINUATION FOR LOSS OF ONE OF THREE SYSTEMS PROVIDING THAT THE FOLLOWING CONDITIONS ARE MET.<br>(A) EACH OF THE REMAINING SYSTEMS HAS SUFFICIENT CAPABILITY OR CAPACITY TO SUPPORT THE PLANNED MISSION PROFILE.<br>(B) SUFFICIENT TIME PRIOR TO THE GO/NO-GO EXISTS FOR DETAILED MONITORING OF THE OPERATION OF THE REMAINING SYSTEMS IN ORDER TO DETERMINE IF CONDITION 2(A) ABOVE IS SATISFIED.<br>(C) THE FAILURE MODE IS UNDERSTOOD, AND AS FAR AS CAN BE DETERMINED, THE FAILURE WILL NOT AFFECT THE REMAINING SYSTEMS.<br>(D) IF CRITERIA A, B, AND C ARE NOT SATISFIED, THE MISSION WILL NORMALLY BE TERMINATED.<br>3. SYSTEMS WITH INTEGRAL BACKUP MODES: THERE ARE SEVERAL SPACECRAFT SYSTEMS THAT HAVE MORE THAN ONE WAY (MODE) TO ACCOMPLISH THEIR DESIGN FUNCTION. FOR THESE SYSTEMS, THE FOLLOWING GUIDELINES WILL APPLY:<br>(A) SINGLE SYSTEM WITH BACKUP MODES: IF THE REDUNDANT MODES HAVE EQUAL CAPABILITY, GUIDELINE 1 WILL APPLY.<br>(B) DUAL SYSTEMS, EACH WITH BACKUP MODES: FOR THIS CASE, THE S/C HAS FOUR MODES IN WHICH TO ACCOMPLISH ITS DESIGN FUNCTION. THE MISSION WILL NORMALLY CONTINUE WITH LOSS OF ONE OF THE ABOVE MODES. FOR THE CASE WHERE TWO OF THE FOUR MODES ARE LOST, EACH OF THE REMAINING SYSTEMS HAS SUFFICIENT CAPABILITY TO SUPPORT THE MISSION PROFILE; HOWEVER, MISSION TERMINATION WILL BE PLANNED BECAUSE MULTIPLE SIMILAR FAILURES HAVE OCCURRED AND CONFIDENCE HAS BEEN LOST IN THE SYSTEM.<br>4. THE ABOVE GUIDELINES MAY BE INVOKED DURING THE CONDUCT OF THE MISSION BY EITHER THE FLIGHT DIRECTOR OR FLIGHT CREW IN ORDER TO MAXIMIZE THE CHANCE OF MISSION SUCCESS AND STILL MAINTAIN AN ADEQUATE MARGIN OF CREW SAFETY. |

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**MISSION RULES**

| REV | ITEM | | |
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| | 2-2 | PRELAUNCH | A. LAUNCH WINDOW OPENS AT 1600 GMT, BASED ON ACHIEVING PROPER RENDEZVOUS LIGHTING AND MSFN COVERAGE, AND CLOSES AT 1900 GMT, BASED ON IRRETRIEVABLE LOSS OF RENDEZVOUS LIGHTING CONDITIONS.<br><br>B. THE LAUNCH WINDOW WAS EXTENDED BY UTILIZING THE $\Delta V$ BUDGETS OF SPS BURNS 2, 3, 4, AND 5 AND THE DOCKED DPS BURN TO MAINTAIN REQUIRED RENDEZVOUS LIGHTING AND MSFN COVERAGE CONSTRAINTS. FAILURE TO COMPLETE THESE BURNS MAY RESULT IN AN ALTERNATE RENDEZVOUS MISSION.<br><br>C. WIND CONSTRAINTS - THE FLIGHT DIRECTOR WILL EVALUATE THE MODE I (TOWER) ABORT IP TRACK WIND SIMULATIONS PRIOR TO THE START OF CRITICAL COUNTDOWN ACTIVITIES AND WILL ADVISE THE LAUNCH DIRECTOR OF ANY PREDICTED PERIODS OF LAND LANDING. IF THE FLIGHT DIRECTOR IS UNABLE TO PROVIDE THIS EVALUATION, A LAND LANDING WILL BE ASSUMED AND THE SPACECRAFT WIND CONSTRAINTS FOR LAND IP'S WILL BE APPLIED. THESE CONSTRAINTS (REF LMRD) REQUIRE THAT THE SPACECRAFT NOT BE LAUNCHED OR REMAIN IN A TOWER ABORT MODE IF A TOWER ABORT WOULD RESULT IN A LAND LANDING WITH A HORIZONTAL VELOCITY COMPONENT OF GREATER THAN 54 FEET PER SECOND AT IMPACT. IN ALL CASES, THE LAUNCH DIRECTOR WILL BE PRIME FOR CALLING HOLDS FOR LAND LANDING LAUNCH WIND VIOLATIONS. |
| | 2-3 | LAUNCH | IT IS PREFERABLE TO GO INTO ORBIT AND REENTER INTO THE WEST ATLANTIC RATHER THAN PERFORM A LAUNCH ABORT. THEREFORE, THE LAUNCH WILL BE CONTINUED AS LONG AS THE CREW CONDITION IS SATISFACTORY, NO S/C OR SLV PROBLEMS EXIST WHICH JEOPARDIZE CREW SAFETY, AND SUFFICIENT CONSUMABLES, COOLANT, AND ELECTRICAL ENERGY REMAIN FOR AT LEAST ONE REVOLUTION PLUS ENTRY. FOR CASES WHERE THE ABOVE ANOMOLIES EXIST AND ALSO LAUNCH TRAJECTORY DEVIATIONS ARE EVIDENT, THE MISSION MAY BE ABORTED DURING LAUNCH PHASE. |
| | 2-4 | EARLY STAGING | IF REQUIRED, EARLY S-IVB STAGING MAY BE INITIATED BY THE FLIGHT CREW ONLY AFTER S-IVB-TO-ORBIT CAPABILITY IS OBTAINED. |
| | 2-5 | ORBIT GO/NO-GO | A GO/NO-GO DECISION WILL BE MADE AT CRO ON REV 1 TO CONTINUE FROM THE 2-1 TO THE 6-4 PTP. PRIOR TO REACHING THE 6-4 PTP, A GO/NO-GO DECISION WILL BE MADE TO CONTINUE TO THE 18-1 PTP. AFTER THE 18-1 PTP, A GO/NO-GO DECISION WILL BE MADE ON A DAY-BY-DAY BASIS FOR CONTINUATION TO THE NEXT GO/NO-GO PTP. |
| A | 2-6 | EARLY CSM/S-IVB SEPARATION (NO LM EXTRACTION)<br><br>(CONTINUED) | A. A S-IVB FAILURE OR SYSTEMS TREND THAT WILL RESULT IN A HAZARDOUS SITUATION FOR THE FLIGHT CREW IS CAUSE FOR AN IMMEDIATE CSM/S-IVB SEPARATION. THE FLIGHT CREW WILL PERFORM A SEPARATION MANEUVER ASAP.<br><br>B. IF THE RANGE SAFETY SYSTEM IS NOT SAFED AND EBW IS ARMED, THE CSM WILL PERFORM A SEPARATION MANEUVER ASAP. |

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| REV | ITEM | | |
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| A | 2-6 CONT'D | EARLY CSM/S-IVB SEPARATION (NO LM EXTRATION) | C. IF THE CSM SEPARATES EARLY AND MANEUVERS TO ACHIEVE SAFE SEPARATION DISTANCE (7000 FT), THE CSM WILL BE PREPARED TO IMPLEMENT A S-IVB/LM RENDEZVOUS AND POSSIBLE DOCKING IN THE EVENT THE REASON FOR EARLY SEPARATION HAS BEEN CORRECTED. IN THIS CASE, THE NOMINAL S-IVB ACTIVITIES WILL BE DELETED. |
| | 2-7 | TRANSPOSITION, DOCKING, AND EXTRATION (TD&E) | A. EARLY TD&E WILL BE ATTEMPTED ONLY FOR S-IVB LIFETIME PROBLEMS WHICH WOULD RESULT IN PREDICTED STAGE FAILURES PRIOR TO THE END OF THE NOMINAL LM EXTRATION TIME. TD&E SHALL NOT BE ATTEMPTED EARLIER THAN SUNRISE ON REV 1.<br>B. TD&E MAY BE DELAYED IF S-IVB AND/OR CSM SYSTEMS PROBLEMS EXIST WHICH DO NOT IMPACT CREW SAFETY BUT REQUIRE EXTENSIVE PARTICIPATION BY THE FLIGHT CREW AND/OR FLIGHT CONTROL FOR MONITORING AND CORRECTIVE ACTION.<br>C. IF TD&E IS DELAYED BUT THERE IS A REASONABLE CHANCE OF COMPLETION, THE LM EXTRACTION WILL BE THE PRIORITY OBJECTIVE AND THE S-IVB RESTARTS WILL REMAIN INHIBITED UNTIL SEPARATION.<br>D. A CSM MALFUNCTION REQUIRING ENTRY INTO 6-4 PTP SHALL NOT PRECLUDE ATTEMPTING THE TD&E ACTIVITY IF THE TD&E ACTIVITIES WOULD NOT FURTHER AGGRAVATE THE MALFUNCTION CONDITION.<br>E. IF NORMAL LM EXTRACTION (CSM/LM UMBILICAL) IS NOT SUCCESSFUL, NO ATTEMPT WILL BE MADE TO MAN THE LM AND "STAGE" TO RECOVER THE ASCENT STAGE.<br>F. IN THE EVENT OF ADVERSE LIGHTING, ATTITUDES OR RATES, THE FLIGHT CREW WILL MAKE THE FINAL DECISION TO ATTEMPT DOCKING AND EXTRACTION.<br>G. IF ADVERSE ATTITUDE RATES OCCUR AFTER CSM DOCKING TO THE S-IVB/LM, THE CSM WILL PERFORM SEPARATION. SEPARATION SHOULD BE ATTEMPTED BY THE PROBE EXTEND RELEASE. IF THIS FAILS, A FINAL SEPARATION (PYROTECHNIC) WILL BE PERFORMED.<br>H. THE SM-RCS MANEUVER PERFORMED IMMEDIATELY AFTER LM EXTRACTION WILL PROVIDE A SAFE DISTANCE (500 FT) BETWEEN THE CSM/LM AND S-IVB AT THE TIME OF S-IVB RESTART.<br>I. THE NORMAL MINIMUM CABIN PRESSURE REDLINE OF 4.0 PSIA FOR TUNNEL/LM PRESSURIZATION SEQUENCES WILL BE WAIVED DURING TD&E. FOR TUNNEL OR LM LEAKS WHICH PREVENT NORMAL PRESSURIZATION, THE CM WILL BE DEPRESSURIZED AS REQUIRED FOR HATCH REMOVAL AND UMBILICAL HOOKUP.<br>J. FOR SLA JETTISON ANOMALIES, THE FLIGHT CREW WILL MAKE THE FINAL DECISION TO ATTEMPT LM EXTRACTION. |

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**MISSION RULES**

| REV | ITEM | | |
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| A | 2-8 | S-IVB RESTARTS | A. THE S-IVB RESTARTS WILL REMAIN INHIBITED UNTIL THE CSM OR CSM/LM SEPARATES FROM THE S-IVB AND THE PROJECTED SEPARATION DISTANCE AT S-IVB RESTART TIME IS GREATER THAN 500 FEET WITH NO RECONTACT PROBLEM.<br>B. THE FIRST S-IVB RESTART MAY BE INHIBITED IF DATA INDICATES A RESTART WOULD RESULT IN A CATASTROPHIC VEHICLE SPINUP. SPINUP COULD RESULT FROM:<br>1. A LOSS OF THE S-IVB HYDRAULIC SYSTEM.<br>2. AN S-IVB ACTUATOR HARDOVER WITH NOMINAL HYDRAULIC SYSTEM OPERATION.<br>C. THE FIRST S-IVB RESTART MAY BE INHIBITED IF IT IS DETERMINED THAT A RETROGRADE COMPONENT OF VELOCITY WILL BE ACHIEVED DURING THE BURN. |
| | 2-9 | INTRAVEHICULAR TRANSFER | ONE HARDSUIT IVT FROM THE CSM TO THE LM WILL BE ACCOMPLISHED IF A REASONABLE CHANCE EXISTS THAT CORRECTIVE ACTION CAN BE TAKEN FOR A LM/TUNNEL PRESSURIZATION PROBLEM. |
| A | 2-10 | DOCKED LM OPERATION | A. LIMITED EVALUATION OF LM SYSTEMS PERFORMANCE WILL CONTINUE AS LONG AS LIFE SUPPORT CAN BE PROVIDED (EXCLUDING HARDSUIT OPERATION) TO AT LEAST ONE CREWMAN (VIA CM OR LM) AND AS LONG AS LM/CSM VOICE COMMUNICATIONS ARE AVAILABLE AND NO HAZARDOUS CREW SAFETY SITUATIONS EXIST.<br>B. FOR AN IMPENDING HAZARDOUS SITUATION RESULTING FROM A DESCENT STAGE PROBLEM, THE LM WILL BE "STAGED" AND ASC STAGE OPERATIONS WILL CONTINUE.<br>C. FOR MANNED LM OPERATIONS,A MINIMUM OF TWO EVA SUPPORT UNITS (PLSS + OPS OR 2 OPS) MUST BE VERIFIED OPERATIONAL PRIOR TO INSTALLATION OF TUNNEL HARDWARE.<br>D. THE LOSS OF CM GNCS ABILITY TO MONITOR THE DOCKED DPS BURN SHALL NOT PRECLUDE EXECUTION OF THIS MANEUVER. |
| A | 2-11 | EXTRAVEHICULAR ACTIVITY<br><br>(CONTINUED) | A. IF EVT IS ATTEMPTED AND NOT COMPLETED SATISFACTORILY WITHIN THE OPS LIFETIME, NO MANNED UNDOCKED ACTIVITIES SHALL BE PERFORMED.<br>B. FOR MISSION LIFETIME PROBLEMS WHICH REDUCE LM SYSTEMS EVALUATION TIME, THE UNDOCKED ACTIVITIES SHALL TAKE PRIORITY OVER EVA. IN THIS CASE, CSM/LM UNDOCKING WILL BE PERFORMED WITHOUT AN EVT DEMONSTRATION IF TWO OF THREE EVA LIFE SUPPORT UNITS (PLSS AND OPS OR 2 OPS) ARE OPERATIONAL.<br>C. EVA WILL BE RESTRICTED TO THE LM FORWARD LEG OR THE NOMINAL EVT TR PATH BETWEEN THE LM FORWARD HATCH AND CM SIDE HATCH EXCEPT FOR RETRIEVAL OF LM AND SM THERMAL SAMPLES. |

| REV | ITEM | | |
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| A | 2-11 (CONT'D) | EXTRAVEHICULAR ACTIVITY | D. INABILITY TO ISOLATE CSM AND/OR LM-RCS THRUSTERS WHICH IMPINGE ON THE EVT TRANSFER PATH IS SUFFICIENT CAUSE NOT TO ATTEMPT EVT. HOWEVER AN ALTERNATE OR ABBREVIATED EVA MAY BE CONDUCTED. IN EITHER CASE, THE EVT OR AN ALTERNATE EVA IS NOT A PREREQUISITE FOR MANNED UNDOCKED ACTIVITIES.<br>E. VOICE COMMUNICATIONS BETWEEN THE EVA CREWMAN AND THE LM AND CM CREWMEN ARE REQUIRED TO INITIATE EVA.<br>F. CM OR LM RECORDING OF EVA VOICE COMMUNICATIONS SHALL NOT CONSTRAIN SELECTION OF THE OPTIMUM EVA/LM/CM/MSFN VOICE COMMUNICATIONS CONFIGURATION.<br>G. MSFN VOICE AND/OR DATA ARE NOT REQUIRED FROM THE EVA CREWMAN IN ORDER TO GIVE A GO FOR EVA. |
| | 2-12 | CSM/LM UNDOCKING | A. A MANNED LM WILL NOT BE SEPARATED FROM THE CSM WITHOUT INDEPENDENT MANEUVER CAPABILITY OF BOTH VEHICLES TO TERMINATE SEPARATED ACTIVITIES AND TO ACCOMPLISH DOCKING.<br>B. VHF VOICE COMMUNICATIONS BETWEEN THE LM AND CSM ARE MANDATORY FOR UN-DOCKING.<br>C. CM AND LM SUIT LOOP INTEGRITY IS REQUIRED FOR MANNED UNDOCKING.<br>D. A LM-RCS REDLINE WILL BE ESTABLISHED BASED ON LM AS THE ACTIVE DOCKING VEHICLE.<br>E. PRIOR TO UNDOCKING THE GO/NO-GO WILL BE INCLUSIVE OF THE CHOICE TO CON-TINUE WITH THE NOMINAL RENDEZVOUS PLAN OR AN APPROPRIATE ALTERNATE MISSION. ALTERATION OF ACTIVITIES AFTER UNDOCKING WILL BE BASED ON:<br>1. CHANGE IN CSM OR LM SYSTEMS STATUS AFTER UNDOCKING.<br>2. VIOLATION OR PREDICTED VIOLATION OF CONSUMABLE REDLINES.<br>F. SELECTION OF THE ACTIVE VEHICLE FOR DOCKING WILL BE DETERMINED BY FLIGHT CONTROL AND THE FLIGHT CREW BASED UPON CONSUMABLES AND SYSTEMS PERFORMANCE.<br>G. A MINIMUM OF TWO EVA SUPPORT UNITS MUST BE VERIFIED OPERATIONAL PRIOR TO UNDOCKING; HOWEVER, A SINGLE MANNED LM OPERATION AND UNDOCKING WILL BE PLANNED IF ONLY ONE EVA SUPPORT UNIT IS AVAILABLE. |

| REV | ITEM | | |
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| A | 2-13 | RENDEZVOUS | A. FOR SYSTEM FAILURES IN EITHER SPACECRAFT THAT WOULD RESULT IN EARLY TERMINATION, THE TOTAL LM CAPABILITY (WITHIN ESTABLISHED REDLINES AND NO VIOLATION OF DETAILED SYSTEMS RULES) WILL BE DEDICATED TO COMPLETION OF THE RENDEZVOUS IN PROGRESS.<br><br>B. CSM GO/NO-GO CRITERIA WILL INCLUDE THE CAPABILITY (SINGLE CREWMAN) TO EXECUTE A LM RESCUE FROM ANY POINT IN THE RENDEZVOUS SEQUENCE AND PERFORM DOCKING TO THE LM.<br><br>C. SATISFACTORY PERFORMANCE OF THE CSM SPS MUST BE DEMONSTRATED PRIOR TO RENDEZVOUS. CRITICAL BURN CAPABILITY MUST EXIST FOR RENDEZVOUS.<br><br>D. LM STAGING MAY BE DELAYED, POSSIBLY UNTIL AFTER DOCKING, IF NECESSARY TO MAINTAIN SUFFICIENT ELECTRICAL POWER, LIFE SUPPORT AND/OR PROPULSION CAPABILITY FOR COMPLETION OF THE RENDEZVOUS IN PROGRESS AND DOCKING.<br><br>E. FITH STAGING FROM EITHER AN INACTIVE DPS OR AN ACTIVE DPS WILL NOT BE PERFORMED.<br><br>F. A LM CONSUMABLES RESERVE OF THREE HOURS IS REQUIRED TO COMMIT TO THE NOMINAL RENDEZVOUS.<br><br>G. TWO-WAY A/G MSFN VOICE COMMUNICATIONS ARE REQUIRED TO BOTH VEHICLES IN ORDER TO CONTINUE THE RENDEZVOUS. |

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| REV | ITEM | | |
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| | 2-14 | UNMANNED APS BURN | A. THE APS BURN WILL NOT BE INITIATED IF ATTITUDE CONTROL IS NOT AVAILABLE OR IF IGNITION COULD RESULT IN STAGE DESTRUCTION BASED ON NON-NOMINAL SYSTEM STATUS.<br>B. THE APS BURN WILL BE TERMINATED VIA RF COMMAND IF INDICATIONS ARE THAT ATTITUDE CONTROL HAS BEEN LOST PRIOR TO THE PLANNED DURATION. MSFN WILL CONTINUE MONITORING LM SYSTEMS PERFORMANCE FOR THE REMAINING LM LIFETIME.<br>C. MSFN COVERAGE MUST BE PROVIDED TO ALLOW FOR A NOMINAL COMMAND PREPARATION TIME OF 4 MINUTES FOR INITIATION OF THE BURN AND APPROXIMATELY 6 MINUTES OF BURN DURATION. THIS BURN IS TIME CRITICAL, AND DUE TO THE MSFN COVERAGE ANTICIPATED, THIS OBJECTIVE MAY NOT BE SATISFIED. |
| A | 2-15 | CSM DEORBIT | A. TWO METHODS OF DEORBIT ARE REQUIRED TO CONTINUE PAST THE NEXT BEST PTP.<br>B. IF A SUBSEQUENT SINGLE FAILURE WOULD PRECLUDE DEORBIT BY BOTH METHODS REMAINING, THE CSM WILL DEORBIT THE NEXT BEST PTP.<br>C. SPS DEORBIT IS PRIME. SUFFICIENT $\Delta V$ WILL BE RESERVED FOR SPS DEORBIT FROM ANY POINT IN THE MISSION.<br>D. SM-RCS (4 QUAD) AND SM-CM/RCS HYBRID WILL BE CONSIDERED AS INDEPENDENT DEORBIT METHODS AS LONG AS INDIVIDUAL SM-RCS QUAD AND GNCS OR SCS INTEGRITY IS MAINTAINED AND SUFFICIENT RCS PROPELLANT IS AVAILABLE.<br>E. THE LM PROPULSION SYSTEMS (DPS OR RCS) MAY BE USED TO PLACE THE CSM IN AN ORBIT ($H_P \geq$ 80 NM) FROM WHICH A SM-RCS OR SM-CM/RCS HYBRID DEORBIT CAN BE CONDUCTED.<br>F. UTILIZATION OF BACKUP DEORBIT METHODS WILL BE BASED ON THE FOLLOWING PRIORITIES:<br>1. SM-RCS<br>2. LM PROPULSION PLUS SM-RCS (LM PROPULSION FOR ORBIT SHAPING)<br>3. SM-CM/RCS HYBRID<br>4. LM PROPULSION PLUS SM-CM/RCS HYBRID<br>G. DEORBIT BURN AND ENTRY MODE PRIORITIES ARE:<br>DEORBIT BURN MODES.<br>1. G&N<br>2. SCS AUTO<br>3. HORIZON MONITOR MANUAL TVC.<br>ENTRY MODES.<br>1. G&N<br>2. EMS<br>3. B&B<br>4. ROLLING |

| REV | ITEM | | |
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| | 2-16 | MANEUVER PREPARATION TIME | A. SCS MANEUVER PREPARATION TIME IS:<br>1. VALID IMU TO INITIALIZE GDC - PAD DATA PLUS 15 MINUTES.<br>2. VERIFICATION OF GDC REQUIRED - PAD DATA PLUS ONE FULL NIGHT PASS FOR OPTICS CHECK, OR HORIZON CHECK, FOR RETROFIRE.<br>3. GDC INITIALIZATION WITH OPTICS - PAD DATA PLUS ONE FULL NIGHT PASS.<br>4. GDC INITIALIZATION WITH HORIZON - PAD DATA PLUS 30 MINUTES.<br>B. AGS MANEUVER PREPARATION TIME IS:<br>1. VALID IMU TO INITIALIZE AGS - PAD DATA +7 MINUTES.<br>2. VERIFICATION OF AGS - REQUIRES 20 MIN AND THE FOLLOWING:<br>(A) PAD DATA<br>(B) INITIALIZED ORDEAL<br>(C) LIT HORIZON CHECK AT TIG -5 MIN.<br>3. AGS INITIALIZATION WITH OPTICS<br>(A) ONE NIGHT PASS AND CREW READOUT OF STARS UTILIZED, AOT ANGLES $A_1$ AND $A_2$ AND AOT DETENT FOR BODY AXIS ALIGN.<br>(B) GROUND COMPUTATION OF REQUIRED PAD DATA.<br>(C) PAD DATA +25 MIN.<br>C. CMC AND LGC MANEUVER PREPARATION TIME IS:<br>1. IMU OFF OR UNKNOWN - ONE FULL NIGHT PASS AFTER IMU WARMUP.<br>2. IMU KNOWN AND UNACCEPTABLE - COARSE ALIGNMENT TO PREFERRED ALIGNMENT PLUS ONE FULL NIGHT PASS.<br>3. IMU KNOWN AND ACCEPTABLE - PAD DATA PLUS:<br>(A) 10 MINUTES FOR RENDEZVOUS MANEUVERS.<br>(B) 30 MINUTES FOR ALL OTHER MANEUVERS. |
| A | 2-17 | DATA PRIORITY GUIDELINES<br><br>(CONTINUED) | A. LAUNCH<br>1. "EARLY STAGING TO ORBIT" SHOULD ONLY INVOLVE THE S-IVB.<br>2. MANUAL ABORTS WILL BE INITIATED UPON THE RECEIPT OF TWO RELATED ABORT CUES.<br>3. DATA PASSED TO THE CREW IN THE EVENT OF AN ABORT ARE AS FOLLOWS:<br>(A) MODE II<br>(1) "FULL LIFT"<br>(2) GET 400,000 FT<br>(3) PITCH AT ENTRY<br>(4) BLACKOUT TIMES<br>(B) MODE III<br>(1) LIFT<br>(2) GET OF IGNITION*<br>(3) ΔV OF BURN*<br>(4) ΔT OF BURN*<br>(5) PITCH AT IGNITION*<br>(6) GET 400,000 FT<br>(7) PITCH AT .05G<br>(8) GET OF DROGUE |

*OMITTED IF A BURN IS NOT REQUIRED.

| REV | ITEM | | |
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| A | 2-17 (CONTD) | DATA PRIORITY GUIDELINES | (C) MODE IV<br>(1) GET OF IGNITION<br>(2) $\Delta V$ OF BURN<br>(3) $\Delta T$ OF BURN<br>(4) PITCH ANGLE AT IGNITION<br>(D) APOGEE KICK<br>(1) GET OF IGNITION<br>(2) $\Delta V$ OF BURN<br>(3) $\Delta T$ OF BURN<br>(4) PITCH ANGLE AT IGNITION<br>B. ORBIT/DEORBIT<br>1. CSM OR LM BURNS INDEPENDENT OF RENDEZVOUS WILL NOT TRIM RESIDUALS. THE DEORBIT BURN IS AN EXCEPTION AND SHOULD BE TRIMMED TO 0.2 FPS IN ALL AXES.<br>2. A DESIRED REFSMMAT WILL BE UPDATED PRIOR TO THE DEORBIT BURN.<br>3. A STATE VECTOR WILL NOMINALLY BE UPLINKED AT ONE HOUR PRIOR TO DEORBIT.<br>C. RENDEZVOUS<br>1. THE BODY AXIS RESIDUALS, RESULTING FROM LM MANEUVERS, WILL BE TRIMMED AS FOLLOWS:<br>(A) PHASING<br>$\Delta V_X = \pm 2.0$ FPS<br>$\Delta V_Y = \pm 0$ FPS<br>$\Delta V_Z = \pm 0$ FPS<br>(B) ALL OTHER MANEUVERS, EXCEPT TPI, WILL BE TRIMMED TO 0 FPS IN ALL AXES<br>2. THE BODY AXES RESIDUALS, RESULTING FROM ANY CSM MANEUVERS REQUIRED DURING THE RENDEZVOUS, WILL BE TRIMMED TO 0.2 FPS IN ALL AXES.<br>3. A "NOMINAL" DESIRED REFSMMAT WILL BE UPLINKED TO THE CSM AND LM PRIOR TO THE RENDEZVOUS.<br>4. PRIOR TO RENDEZVOUS, THE CMC AND LGC CLOCKS WILL BE "SYNCHRONIZED" AS CLOSE AS POSSIBLE TO GROUND GET.<br>5. ONLY ONE STATE VECTOR UPDATE IS PLANNED. THIS WILL BE TO BOTH VEHICLES AND WILL OCCUR PRIOR TO THE RCS SEPA TION BURN.<br>6. FAILURE OF THE LM TO PERFORM CSI OR CDH WILL RESULT IN THE CSM PERFORMING AN EQUAL AND OPPOSITE BURN, BIASED FOR EXECUTION 60 SECONDS LATER (MIRROR IMAGE). IF, HOWEVER, IT IS KNOWN 20 MINUTES PRIOR TO A LM BURN, THAT THE LM CANNOT PERFORM THE REQUIRED MANEUVER, THE CSM WILL BE TARGETED TO EXECUTE THE PROPER ONTIME CSM MANEUVER.<br>7. IN THE EVENT THE $TPI_0$ MANEUVER MUST BE PERFORMED IT IS DESIRABLE TO DO SO ON THE FIRST $TPI_0$ OPPORTUNITY.<br>8. AGS ALIGNMENTS AND STATE VECTOR UPDATES (FROM THE PNGCS) ARE TO BE PERFORMED EACH TIME THE PNGS IS DETERMINED TO BE OPERATING PROPERLY.<br>9. TPI SHOULD ALWAYS BE TARGETED WITH RESPECT TO DARKNESS SUCH THAT BRAKING MAY BE INITIATED AND COMPLETED IN DAYLIGHT.<br>10. PARTIAL INSERTION BURNS ARE UNACCEPTABLE. INSERTION MUST EITHER BE COMPLETED, OR THE EQUIPERIOD FOOTBALL GEOMETRY MUST BE MAINTAINED. IF $\Delta V_{INS} \leq 20$ FPS THE $\Delta V$ CAN BE "BACKED OUT". IF THE $\Delta V$ REMAINING IS $\leq 8$ FPS THEN RCS MAY BE USED TO COMPLETE THE MANEUVER. $\Delta$VELOCITY ERRORS FALLING BETWEEN THESE LIMITS MAY BE ADDED BY "STAGING" THE DESCENT STAGE AND UTILIZING THE RCS. |
| | | RULES 2-18 THROUGH 2-29 ARE RESERVED. | |

| REV | ITEM | |
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| A | 2-30 | ALTERNATE MISSION GUIDELINES |

A. MAJOR ACTIVITIES WILL BE SCHEDULED FOR ALTERNATE MISSIONS IN ACCORDANCE WITH THE FOLLOWING PRIORITY:

1. SUFFICIENT LM EVALUATION TO PERMIT RENDEZVOUS ACTIVITY
2. RENDEZVOUS
   - NOMINAL (6 HRS)
   - FOOTBALL (4 1/2 HRS - 2 REVS)
   - FOOTBALL (3 HRS - 1 REV)
3. DOCKED DPS BURN
4. STATION KEEPING
5. UNMANNED APS BURN
6. EVA
7. DOCKED SPS BURNS

B. IF THE SPS FAILS, THE MISSION WILL BE CONTINUED AND ALL DOCKED LM ACTIVITIES, STATION KEEPING AND THE UNMANNED APS BURN WILL BE CONDUCTED.

C. IF THE CSM GNCS FAILS, THE SPS BURNS, DOCKED LM ACTIVITIES, STATION KEEPING AND THE UNMANNED APS BURN WILL BE CONDUCTED.

D. IF THE CSM PRIMARY COOLANT LOOP FAILS, THE LM RENDEZVOUS WILL BE TERMINATED; ALL OTHER ACTIVITIES WILL CONTINUE.

E. IF THE LM DPS FAILS PRIOR TO RENDEZVOUS AN ALTERNATE RENDEZVOUS PLAN WILL BE EXECUTED. ALL OTHER LM AND CSM ACTIVITIES OF THE NOMINAL MISSION WILL BE CONDUCTED WITHIN SYSTEMS CAPABILITIES.

F. IF A LM APS PRESSURIZATION FAILURE IS DETECTED PRIOR TO RENDEZVOUS, THE NOMINAL RENDEZVOUS WILL BE DELETED; HOWEVER, AN ALTERNATE RENDEZVOUS (FOOTBALL) MAY BE CONDUCTED.

G. IF THE LM PGNCS FAILS PRIOR TO RENDEZVOUS ALL DPS AND APS MANEUVERS AND THE RENDEZVOUS WILL BE DELETED. LM-ACTIVE STATION KEEPING MINI-BALL WILL BE CONDUCTED.

H. IN THE EVENT AN ALTERNATE MISSION IS EXECUTED, AS MANY DTO'S WILL BE ACCOMPLISHED AS POSSIBLE. REF TABLE 2-I, PAGE 2-11, FOR MISSION ACTIVITIES DTO POSSIBILITIES.

A

TABLE 2-I.- MISSION ACTIVITY/DTO ACCOMPLISHMENTS

| PRIORITY | | | | LAUNCH | CSM/S-IVB LM INACTIVE | UNMANNED LM DOCKED | MANNED LM DOCKED | DOCKED DPS BURN | STATION KEEPING | RENDEZVOUS | APS BURN UNMANNED UNDOCKED | CSM SOLO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | M13.12 | GROUP 1 HIGHEST PRIORITY | DPS BURN DURATION EFFECTS AND PRIMARY PROPULSION/ VEHICLE INTERACTIONS | | | | | P | | C | | |
| 2 | M17.17 | | LM ENVIRONMENTAL AND PROPULSION THERMAL EFFECTS | | | | P | P | | P | C | |
| 3 | M17.18 | | LM STRUCTURAL INTEGRITY | P | P[1] | | | P | P[1] | P[1] | C | |
| 4 | M11.6 | | LM PGNCS/DAP PERFORMANCE AND DPS THRUST PERFORMANCE | | | | | P | | C | | |
| 5 | M13.11 | | LONG DURATION APS BURN | | | | | | | | C | |
| 6 | M14 | | LM ECS PERFORMANCE | | | | C | | | | | |
| 7 | M17.9 | | LANDING GEAR DEPLOYMENT/THERMAL | | | | P | P | P[1] | C | | |
| 8 | M15.3 | | LM EPS PERFORMANCE DETERMINATION | | | P | P | | | C | | |
| 9 | M16.7 | | LANDING RADAR/STRUCTURE/PLUME | | | | | P | P | C | | |
| 10 | P12.4 | GROUP 2 HIGH PRIORITY | AGS ΔV CAPABILITY USING DPS | | | | | | | C | | |
| 11 | P11.14 | | PGNCS CONTROLLED APS BURN | | | | | | | | C | |
| 12 | P11.7 | | PGNCS ATTITUDE/TRANSLATION CONTROL | | | | | | | C | | |
| 13 | P20.22 | | LM/CSM/MSFN/EVA S-BAND/VHF COMPATIBILITY | | | | P | | | C | | |
| 14 | P12.3 | | AGS/CES ATTITUDE/TRANSLATION CONTROL | | | | | | P | C | | |
| 15 | P1.23 | | CSM AUTOPILOT STABILITY MARGIN | | | C | | | | | | |
| 16 | P20.28 | | LM ACTIVE DOCKING | | | | | | | C | | |
| 17 | P20.25 | | LM EJECTION FROM SLA | | | P | P[1] | | P[1] | C | | |
| 18 | P20.24 | | CSM ACTIVE DOCKING | | C | | | | | | | |
| 19 | P20.26 | | LM/CSM UNDOCKING | | | | | | C | | | |
| 20 | P11.10 | | PGNCS AND GNCS IMU PERFORMANCE | P | | P | P | P | | P | P | C |
| 21 | P2.9 | | GNCS/MTVC TAKEOVER | | | | | | | | | |
| 22 | P16.4 | | RENDEZVOUS RADAR TRACKING PERFORMANCE | | | | | | | C | | |
| 23 | P20.21 | | LM/MSFN S-BAND COMMUNICATION PERFORMANCE | | | | C | | | | | |
| 24 | P20.34 | GROUP 3 LOW PRIORITY | INTRAVEHICULAR CREW TRANSFER | | | P | C | | | | | |
| 25 | P12.2 | | AGS INFLIGHT CALIBRATION AND PERFORMANCE | | | | P | P | | C | | |
| 26 | P11.5 | | LM IMU INFLIGHT ALIGNMENT | | | | P | | P | C | | |
| 27 | P20.29 | | LM JETTISON | | | | | | | | C | |
| 28 | P16.19 | | RENDEZVOUS RADAR/RCS PLUME IMPINGEMENT/CORONA EFFECT | | | | | | | P | | |
| 29 | P20.31 | | SUPPORT FACILITIES PERFORMANCE | P | P | P | P | P | P | P | P | C |
| 30 | P1.25 | | IMU ORIENTATION DETERMINATION/VISIBILITY | | | P | | | | | | C |
| 31 | P1.24 | | CSM IMU ALIGNMENT ACCURACY | | | P | C | | | | | |
| 32 | P20.33 | | CSM SINGLE CREWMAN RENDEZVOUS CAPABILITY | | | | | | | C | | |
| 33 | P16.6 | | LANDING RADAR SELF TEST | | | | P | | P | C | | |
| 34 | S7.29 | GROUP 4 LOWEST PRIORITY | EXHAUST EFFECTS/CSM | | P | P | P | | | C[1] | | |
| 35 | S20.32 | | CREW ACTIVITIES EVALUATION (CSM/LM) | P | P | P | P | P | P | P | P | C |
| 36 | S1.26 | | ORBITAL NAVIGATION/LANDMARK TRACKING | | | P | | | | | | C |
| 37 | S13.10 | | APS BURN TO DEPLETION | | | | | | | | C | |
| 38 | S20.37 | | DPS PLUME EFFECT | | | | | P | | C | | |
| 39 | S20.120 | | CSM/LM ELECTROMAGNETIC COMPATIBILITY | | | | P | | | | C | |

P = PARTIALLY COMPLETE
C = COMPLETED

[1] CSM ECS/EPS RADIATOR HEAT REJECTION

[2] DOCKED SPS

[3] BEFORE AND AFTER DPS BURN

[4] IF STAGED

| REV | ITEM | |
|---|---|---|
| A | 2-31 | ALTERNATE MISSION DESCRIPTIONS |

ALL OR PARTS OF THE FOLLOWING ALTERNATE MISSIONS MAY BE COMPLETED DEPENDING UPON THE ANOMALY, WHEN THE ANOMALY OCCURS AND/OR THE LIFETIME REMAINING. EXCEPTIONS TO AN ALTERNATE MISSION WILL BE INCLUDED IN THE RULING COLUMN OF THE SPECIFIC MISSION RULE. IN APPLICABLE CASES, THE NOMINAL S-IVB ACTIVITIES WILL BE CONTINUED IF NOT IN VIOLATION OF SPECIFIC MISSION RULES.

DETAILED TIMELINES OF THE FOLLOWING ALTERNATE MISSIONS LISTED BELOW CAN BE LOCATED IN THE APOLLO 9 SPACECRAFT OPERATIONAL ALTERNATE MISSION PLAN MSC INTERNAL NOTE NO. 69-FM-3.

| NOMINAL MISSION PERIOD OF ENTRY | | TYPICAL FUNCTIONAL FAILURE PRECIPITATING ALTERNATE MISSION |
|---|---|---|
| | ALTERNATE MISSION A | |
| 1 | COI<br>SPS 1 | NO LM |
| 1 OR 2 | SPS 2<br>SPS 3<br>SPS 4 | |
| 3 | SPS 5 | |
| 6 | SPS 6<br>SPS 7<br>SPS 8 | |
| | ALTERNATE MISSION B | |
| 1 | TD&E | CSM LIFETIME, NO SPS<br>LM LIFETIME |
| 2 OR 3 | LM SYSTEMS EVALUATION<br>EXECUTE DOCKED DPS BURN | |
| 3 OR 4 | PERFORM EVA | |
| 4 OR 5 | STATION KEEPING (STAGE LM PRIOR TO DOCKING) | |
| 4 OR 5 | LONG APS BURN | |
| 5 OR 6 | DEORBIT | |
| | ALTERNATE MISSION C | |
| 3 OR 4 | PERFORM EVA<br><br>LONG APS BURN<br>CONTINUE MISSION | UNSAFE DESCENT STAGE (DESCENT STAGE SEPARATED PRIOR TO ALTERNATE MISSION). EVT GREATER THAN 15 MINUTES. |
| | ALTERNATE MISSION D | |
| 1 | TD&E | CSM LIFETIME, LM LIFETIME, EITHER CSM COOLANT LOOP FAILURE |
| 2 OR 3 | LM SYSTEMS EVALUATION<br><br>EXECUTE DOCKED DPS BURN | |
| 3 - 5 | STAGE DESCENT STAGE LONG APS BURN | |
| 3 - 6 | DEORBIT | |

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**MISSION RULES**

| REV | ITEM | NOMINAL MISSION PERIOD OF ENTRY | | TYPICAL FUNCTIONAL FAILURE PRECIPITATING ALTERNATE MISSION |
|---|---|---|---|---|
| A | 2-31 (CONT'D) | | | |
| | | | ALTERNATE MISSION E | |
| | | 5 | E-5A STATION KEEPING. CONTINUE NOMINAL MISSION TIMELINE<br>E-5B MINI-FOOTBALL RENDEZVOUS. CONTINUE NOMINAL MISSION TIMELINE<br>E-5C FOOTBALL RENDEZVOUS. CONTINUE NOMINAL MISSION TIMELINE<br>E-5D CSM ACTIVE RENDEZVOUS. CONTINUE NOMINAL MISSION TIMELINE | UNSAFE DESCENT STAGE DPS FAILURE, LM PRIMARY COOLANT LOOP FAILURE, DESCENT OR ASCENT STAGE ELECTRICAL POWER PROBLEMS. PGNCS FAILURE, RENDEZVOUS RADAR FAILURE. AGS LOST. |
| | | | ALTERNATE MISSION F | |
| | | 3 | DELETE DOCKED DPS BURN<br>PERFORM SPS 5 | PGNCS FAILURE |
| | | 4 | PERFORM EVA | |
| | | 5 | STATION KEEP, STAGE LM AND DOCK.<br>EXECUTE CSM ACTIVE RENDEZVOUS (E-5D)<br>DELETE LONG DURATION APS BURN<br>CONTINUE MISSION | |
| | | | ALTERNATE MISSION G | |
| | | 3 | DELETE DOCKED DPS BURN | LM PRIMARY COOLANT LOOP FAILURE OR DPS NON-OPERABLE |
| | | 4 | PERFORM EVA | |
| | | 5 | STATION KEEPING (E-5A)<br>LONG APS BURN<br>CONTINUE MISSION | |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 2-32 | LIFETIME CASES |

| CASE | SUMMARY PLAN |
|---|---|
| 1. MISSION MUST BE TERMINATED IN 6 - 4. | 1. COMPLETE TD&E IF POSSIBLE. CONTINUE S-IVB ACTIVITIES. |
| 2. MISSION MUST BE TERMINATED IN 18 - 1. | 2. COMPLETE TD&E IF POSSIBLE. CONTINUE S-IVB ACTIVITIES PLUS FIRST DOCKED SPS BURN, LM POWER UP AND FINAL SEPARATION. |
| 3. SPACECRAFT PROBLEM DETECTED WHICH WILL CAUSE MISSION TO BE TERMINATED AT END OF SECOND DAY. | 3. PERFORM LM CHECKOUT, DOCKED DPS BURN AND UNMANNED APS BURN. DELETE DOCKED SPS BURNS. |
| 4. MISSION MUST BE TERMINATED AT END OF THIRD DAY. | 4. PERFORM LM CHECKOUT, DOCKED DPS BURN, LM SEPARATION AND ALTERNATE RENDEZVOUS, STAGING AND UNMANNED APS BURN. DELETE DOCKED SPS BURNS UNLESS ALREADY PERFORMED. |
| 5. MISSION MUST BE TERMINATED AT END OF FOURTH DAY. | 5. PERFORM SPS BURNS TO SET UP ALTERNATE RENDEZVOUS, LM CHECKOUT AND DOCKED SPS BURN, LM RENDEZVOUS AND UNMANNED APS BURN. |
| 6. MISSION MUST BE TERMINATED AT END OF FIFTH DAY. | 6. PERFORM NOMINAL LM ACTIVITIES. |
| 7. REDUCED LM ASCENT OR DESCENT STAGE LIFETIME. | 7. PERFORM AS MUCH AS POSSIBLE, IN THE FOLLOWING ORDER OF PRIORITY:<br>(1) LM CHECKOUT<br>(2) RENDEZVOUS<br>(3) DOCKED DPS BURN<br>(4) STATION KEEPING<br>(5) UNMANNED APS BURN<br>(6) EVA. |

RULE NUMBERS 2-33 THROUGH 2-39 ARE RESERVED.

## 3 MISSION RULE SUMMARY

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | | **GO/NO-GO SUMMARY** |
| A | 3-1 | A FORMAL GO/NO- O WILL BE GIVEN FOR THE CSM AT EACH DAILY PTP. REFERENCE MISSION RULES 3-20 THROUGH 3-41 FOR CONSUMABLE RULES AND TABLE 3-I, PAGE 3-21A, FOR GO/NO-GO SUMMARY. |
| | 3-2 | THE LAUNCH PHASE WILL BE ABORTED FOR:<br>A. S-IC LOSS OF THRUST<br>B. LAUNCH VEHICLE INERTIAL PLATFORM FAILURE<br>C. S-II GIMBAL SYSTEM FAILURE - ACTUATOR HARDOVER INBOARD (PRIOR TO S-IVB TO ORBIT CAPABILITY)<br>D. S-II TOTAL LOSS OF THRUST ( RIOR TO S-IVB TO ORBIT CAPABILITY)<br>E. S-II SECOND PLANE SEPARATION FAILS TO OCCUR<br>F. S-IVB LOSS OF HYDRAULIC FLUID (PRIOR TO S-IVB IGNITION)<br>G. S-IVB FAILURE TO ATTAIN THRUST<br>H. VIOLATION OF EDS LIMITS (AUTO/MANUAL)<br>I. VIOLATION OF TRAJECTORY LIMIT LINES<br>J. FIRE/SMOKE IN CM<br>K. MALFUNCTION OF:<br>1. LOSS OF BOTH CM-RCS SYSTEMS DURING MODE I<br>2. CABIN AND SUIT PRESSURE<br>3. CABIN PRESSURE AND $O_2$ MANIFOLD LEAKS<br>4. THREE FUEL CELLS AND 1 BATTERY<br>5. UNCONTROLLABLE SHORTED MAIN BUS<br>6. BOTH AC BUSES DURING MODE I OR MODE III<br>L. TEAM DISCRETION WILL BE USED FOR:<br>1. SUIT/CABIN CONTAMINATION<br>2. MEDICAL PROBLEMS |
| A | 3-3 | <u>POST INSERTION GO/NO-GO</u><br>A. THE S-IVB WILL BE <u>NO-GO</u> AFTER INSERTION OR DURING ORBIT IF ANY OF THE FOLLOWING CONDITIONS EXIST:<br>1. IMPENDING S-IVB BULKHEAD ΔP PROBLEM<br>2. S-IVB COLD HE SHUTOFF VALVES FAIL TO CLOSE<br>3. S-IVB RANGE SAFETY DESTRUCT SYSTEM ARMED<br>4. S-IVB IN WRONG TIME BASE<br>5. LOSS OF ATTITUDE CONTROL<br>B. THE CSM WILL BE <u>NO-GO</u> IF ANY OF THE FOLLOWING CONDITIONS EXIST:<br>1. ECS<br>(A) LOSS OF CABIN AND SUIT INTEGRITY. |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 3-4 | CONTINUE PAST 2-1 GO/NO-GO'S |

A. THE CSM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. ECS

   (A) LOSS OF CABIN INTEGRITY AND LOSS OF SUIT INTEGRITY, LOSS OF SUIT LOOP INTEGRITY, LOSS OF $O_2$ MANIFOLD, OR LOSS OF ENTRY $O_2$ SUPPLIES.

   (B) LOSS OF ALL COOLING

2. CRYO

   (A) LOSS OF BOTH $H_2$ OR BOTH $O_2$ CRYOGENIC STORAGE TANKS

3. EPS

   (A) LOSS OF THREE FUEL CELLS

   (B) LOSS OF TWO ENTRY BATTERIES

   (C) LOSS OF BOTH AC BUSES

4. SPS

   (A) SUSTAINED PRESSURE DECAY IN FUEL OR OXIDIZER TANKS

5. CM-RCS

   (A) LOSS OF BOTH CM-RCS RINGS

6. UNSATISFACTORY CREW CONDITION

7. PERIGEE <75 NM

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 3-5 | TD&E GO/NO-GO |

A. THE CSM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. ECS
   - (A) LOSS OF CABIN INTEGRITY
   - (B) LOSS OF SUIT CIRCUIT
   - (C) LOSS OF O2 MANIFOLD
   - (D)
   - (E) LOSS OF SUIT INTEGRITY
   - (F) LOSS OF ALL COOLING
   - (G) CONFIRMED LEAK OF GLYCOL IN EITHER COMMAND MODULE OR SUIT CIRCUIT
2. CRYO
   - (A) INSUFFICIENT $O_2$ AND $H_2$ TO SUPPLY CELL AND ECS DEMANDS TO THE NEXT GO/NO-GO PTP PLUS THREE HOURS (DRIFTING FLIGHT PLUS GUIDED ENTRY MANEUVER)
3. EPS
   - (A) LOSS OF TWO FUEL CELLS
   - (B) LOSS OF TWO ENTRY BATTERIES
   - (C) LOSS OF ONE MAIN BUS, ONE BATTERY BUS, ONE AC BUS, OR THE BATTERY RELAY BUS
   - (D) LOSS OF TWO INVERTERS
4. COMM/INSTRUMENTATION
   - (A) LOSS OF INSTRUMENTATION (TM OR ONBOARD) SUCH THAT IT IS NOT POSSIBLE TO VERIFY GO/NO-GO CRITERIA EITHER IN S/C OR ON GROUND.
5. SEQUENTIAL
   - (A) LOSS OF SEQUENTIAL LOGIC BUS A OR B
   - (B) LOSS OF PYRO BUS A OR B
6. G&C
   - (A) LOSS OF TRANSLATION CAPABILITY (X-AXIS)
   - (B) LOSS OF DIRECT RCS (ANY AXIS)
   - (C) LOSS OF TWO DEORBIT METHODS
7. SPS
   - (A) PRESSURE DECAY IN EITHER FUEL OR OXIDIZER TANK
   - (B) IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE AND:
     - (1) LOSS OF CAPABILITY TO PERFORM CRITICAL MANEUVERS
     - (2) $\Delta V$ REMAINING LESS THAN SPS DEORBIT REQUIREMENT
8. SM-RCS
   - (A) LOSS OF TWO QUADS
   - (B) LOSS OF ATTITUDE CONTROL IN ONE OR MORE AXES
   - (C) PROPELLANT REMAINING LESS THAN HYBRID DEORBIT REQUIREMENT, IF HYBRID AND SPS DEORBIT AVAILABLE. OTHERWISE PROPELLANT REMAINING LESS THAN SM DEORBIT REQUIREMENT.
9. CM-RCS
   - (A) LOSS OF SOURCE PRESSURE - ONE RING
   - (B) LOSS OF MANIFOLD PRESSURE - ONE RING
   - (C) CM-RCS ARMED

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 3-6 | CONTINUE MISSION PAST 6-4 AND DAILY PTP GO/NO-GO |

A. THE CSM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. ECS
   - (A) LOSS OF CABIN INTEGRITY
   - (B) LOSS OF SUIT CIRCUIT
   - (C) LOSS OF $O_2$ MANIFOLD
   - (D)
   - (E) LOSS OF CYCLIC ACCUMULATOR OPERATION
   - (F) POTABLE WATER TANK QUANTITY PLUS FUEL CELL PRODUCTION TO THE NEXT PTP WILL TOTAL <20 LBS
   - (G)
   - (H) LOSS OF URINE DUMP CAPABILITY FOR PTP'S SUBSEQUENT TO LM JETTISON
   - (I) LOSS OF ALL COOLING
   - (J) CONFIRMED LEAK OF GLYCOL IN EITHER COMMAND MODULE OR SUIT CIRCUIT
2. CRYO
   - (A) INSUFFICIENT $O_2$ AND $H_2$ TO SUPPLY FUEL CELL AND ECS DEMANDS TO THE NEXT GO/NO-GO PTP PLUS THREE HOURS (DRIFTING FLIGHT PLUS GUIDED ENTRY MANEUVER)
3. EPS
   - (A) LOSS OF TWO FUEL CELLS
   - (B) LOSS OF TWO ENTRY BATTERIES
   - (C) LOSS OF ONE MAIN BUS, ONE BATTERY BUS, ONE AC BUS, OR THE BATTERY RELAY BUS
   - (D) LOSS OF TWO INVERTERS
4. COMM/INSTRUMENTATION
   - (A) LOSS OF INSTRUMENTATION (TM OR ONBOARD) SUCH THAT IT IS NOT POSSIBLE TO VERIFY GO/NO-GO CRITERIA EITHER IN S/C OR ON GROUND.
   - (B) LOSS OF TWO-WAY VOICE COMMUNICATION AFTER LM JETTISON (CSM/MSFN)
5. SEQUENTIAL
   - (A) LOSS OF SEQUENTIAL LOGIC BUS A OR B
   - (B) LOSS OF PYRO BUS A OR B
6. G&C
   - (A) LOSS OF DIRECT RCS (ANY AXIS)
   - (B) LOSS OF RATE DAMPING (ANY AXIS)
   - (C) LOSS OF TWO DEORBIT METHODS
7. SPS
   - (A) PRESSURE DECAY IN EITHER FUEL OR OXIDIZER TANK
   - (B) IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE AND:
     - (1) LOSS OF CAPABILITY TO PERFORM CRITICAL MANEUVERS
     - (2) $\Delta V$ REMAINING LESS THAN SPS DEORBIT REQUIREMENT
8. SM-RCS
   - (A) LOSS OF TWO QUADS
   - (B) LOSS OF ATTITUDE CONTROL IN ONE OR MORE AXES
   - (C) PROPELLANT REMAINING LESS THAN HYBRID DEORBIT REQUIREMENT, IF HYBRID AND SPS DEORBIT AVAILABLE. OTHERWISE PROPELLANT REMAINING LESS THAN SM DEORBIT REQUIREMENT.
9. CM-RCS
   - (A) LOSS OF SOURCE PRESSURE - ONE RING
   - (B) LOSS OF MANIFOLD PRESSURE - ONE RING
   - (C) CM-RCS ARMED
10. UNSATISFACTORY CREW CONDITION
11. TWO METHODS OF DEORBIT ARE AVAILABLE
12. A SUBSEQUENT SINGLE FAILURE WOULD NOT REQUIRE ENTRY IN ONE REV OR LESS.

| REV | ITEM | |
|---|---|---|
| A | 3-7 | NON-CRITICAL SPS MANEUVER GO/NO-GO |

A. THE CSM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. ECS
   (A) LOSS OF CABIN INTEGRITY
   (B) LOSS OF SUIT CIRCUIT
   (C) LOSS OF $O_2$ MANIFOLD
   (D)
   (E) LOSS OF CYCLIC ACCUMULATOR OPERATION
   (F) LOSS OF SUIT INTEGRITY (FOR DOCKED SPS BURNS)
   (G) LOSS OF ALL COOLING
   (H) CONFIRMED LEAK OF GLYCOL IN EITHER COMMAND MODULE OR SUIT CIRCUIT

2. CRYO
   (A) INSUFFICIENT $O_2$ AND $H_2$ TO SUPPLY FUEL CELL AND ECS DEMANDS TO THE NEXT GO/NO-GO PTP PLUS THREE HOURS (DRIFTING FLIGHT PLUS GUIDED ENTRY MANEUVER)

3. EPS
   (A) LOSS OF TWO FUEL CELLS
   (B) LOSS OF TWO ENTRY BATTERIES
   (C) LOSS OF ONE MAIN BUS, ONE BATTERY BUS, ONE AC BUS, OR THE BATTERY RELAY BUS
   (D) LOSS OF TWO INVERTERS

4. COMM/INSTRUMENTATION
   (A) LOSS OF INSTRUMENTATION (TM OR ONBOARD) SUCH THAT IT IS NOT POSSIBLE TO VERIFY GO/NO-GO CRITERIA EITHER IN S/C OR ON GROUND.
   (B) LOSS OF TWO-WAY VOICE COMMUNICATION (CSM/MSFN)

5. SEQUENTIAL
   (A) LOSS OF SEQUENTIAL LOGIC BUS A OR B
   (B) LOSS OF PYRO BUS A OR B

6. G&C
   (A) LOSS OF TWO TVC SERVO LOOPS
   (B) LOSS OF THREE TVC CONTROL MODES (G&N, SCS AUTO, AND MTVC RATE CMD)

7. SPS
   (A) LOSS OF BOTH $GN_2$ BOTTLES (<400 PSI)
   (B) FUEL OR OXIDIZER FEEDLINE TEMP <27°F
   (C) FLANGE TEMP >480°F ON PREVIOUS BURN
   (D) CHAMBER PRESSURE <70 PSI ON PREVIOUS BURN
   (E) FUEL/OXIDIZER $\Delta P$ >20 PSI
   (F) LOSS OF ULLAGE CAPABILITY FOR FIRST BURN SUBSEQUENT TO DOCKED DPS BURN, OR AFTER STORAGE TANKS EMPTY
   (G) FIRST BURN SUBSEQUENT TO DOCKED DPS WAS <40 SEC, CONTINUOUS
   (H) PRESSURE IN EITHER FUEL OR OXIDIZER TANK <140 PSI
   (I) $\Delta V$ REMAINING LESS THAN MANEUVER PLUS DEORBIT REQUIREMENT

B. THE NON-CRITICAL DOCKED SPS BURNS WILL BE NO-GO IF THE FOLLOWING INTERFACE CONDITION EXISTS:

1. DOCKING SYSTEM
   (A) LESS THAN NINE GOOD DOCKING RING LATCHES

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 3-8 | CRITICAL SPS MANEUVER GO/NO-GO |

A. THE CSM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. G&C
   - (A) LOSS OF TWO TVC SERVO LOOPS
   - (B) LOSS OF THREE TVC CONTROL MODES (G&N, SCS AUTO, AND MTVC - RATE CMD)
2. SPS
   - (A) PRESSURE IN EITHER FUEL OR OXIDIZER TANK <115 PSI
   - (B) LOSS OF BOTH $GN_2$ BOTTLES (<400 PSI)
   - (C) FUEL OR OXIDIZER FEEDLINE TEMP <27°F
   - (D) FLANGE TEMP >480°F ON PREVIOUS BURN
   - (E) CHAMBER PRESSURE <70 PSI ON PREVIOUS BURN
   - (F) FUEL/OXIDIZER $\Delta P$ >20 PSI
   - (G) FIRST BURN SUBSEQUENT TO DOCKED DPS WAS <40 SEC

| REV | ITEM | |
|---|---|---|
| A | 3-9 | IVT (CSM TO LM) GO/NO-GO |

A. THE CSM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. ECS
   (A) LOSS OF CABIN INTEGRITY
   (B) LOSS OF SUIT CIRCUIT
   (C) LOSS OF $O_2$ MANIFOLD
   (D)
   (E) LOSS OF CYCLIC ACCUMULATOR OPERATION
   (F) LOSS OF SUIT INTEGRITY
   (G) LOSS OF ALL COOLING
   (H) CONFIRMED LEAK OF GLYCOL IN EITHER COMMAND MODULE OR SUIT CIRCUIT
2. CRYO
   (A) INSUFFICIENT $O_2$ AND $H_2$ TO SUPPLY FUEL CELL AND ECS DEMANDS TO THE NEXT GO/NO-GO PTP PLUS THREE HOURS (DRIFTING FLIGHT PLUS GUIDED ENTRY MANEUVER)
3. EPS
   (A) LOSS OF TWO FUEL CELLS
   (B) LOSS OF TWO ENTRY BATTERIES
   (C) LOSS OF ONE MAIN BUS, ONE BATTERY BUS, ONE AC BUS, OR THE BATTERY RELAY BUS
   (D) LOSS OF TWO INVERTERS
4. COMM/INSTRUMENTATION
   (A) LOSS OF INSTRUMENTATION (TM OR ONBOARD) SUCH THAT IT IS NOT POSSIBLE TO VERIFY GO/NO-GO FOR CRITERIA EITHER IN S/C OR ON GROUND.
5. SEQUENTIAL
   (A) LOSS OF SEQUENTIAL LOGIC BUS A OR B
   (B) LOSS OF PYRO BUS A OR B
6. G&C
   (A) LOSS OF DIRECT RCS (ANY AXIS)
   (B) LOSS OF RATE DAMPING (ANY AXIS)
   (C) LOSS OF TWO DEORBIT METHODS
7. SPS
   (A) PRESSURE DECAY IN EITHER FUEL OR OXIDIZER TANK
   (B) IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE AND:
      (1) LOSS OF CAPABILITY TO PERFORM CRITICAL MANEUVERS
      (2) $\Delta V$ REMAINING LESS THAN SPS DEORBIT REQUIREMENT
8. SM-RCS
   (A) LOSS OF TWO QUADS
   (B) LOSS OF ATTITUDE CONTROL IN ONE OR MORE AXES
   (C) PROPELLANT REMAINING LESS THAN HYBRID DEORBIT REQUIREMENT, IF HYBRID AND SPS DEORBIT AVAILABLE. OTHERWISE PROPELLANT REMAINING LESS THAN SM DEORBIT REQUIREMENT.
9. CM-RCS
   (A) LOSS OF SOURCE PRESSURE - ONE RING
   (B) LOSS OF MANIFOLD PRESSURE - ONE RING
   (C) CM-RCS ARMED

B. THE IVT FROM THE CSM TO THE LM WILL BE NO-GO IF ANY OF THE FOLLOWING INTERFACE CONDITIONS EXIST:

1. DOCKING SYSTEM
   (A) LESS THAN THREE GOOD DOCKING RING LATCHES 120 DEGREES APART
   (B) FAILURE OF CSM FORWARD HATCH PRIMARY LOCK/UNLOCK MECHANISM

| REV | ITEM | |
|---|---|---|
| A | 3-10 | DOCKED DPS BURN GO/NO-GO |

A. THE CSM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. ECS
   - (A) LOSS OF CABIN INTEGRITY
   - (B) LOSS OF SUIT CIRCUIT
   - (C) LOSS OF $O_2$ MANIFOLD
   - (D)
   - (E) LOSS OF CYCLIC ACCUMULATOR OPERATION
   - (F) LOSS OF SUIT INTEGRITY
   - (G) LOSS OF ALL COOLING
   - (H) CONFIRMED LEAK OF GLYCOL IN EITHER COMMAND MODULE OR SUIT CIRCUIT
2. CRYO
   - (A) INSUFFICIENT $O_2$ AND $H_2$ TO SUPPLY FUEL CELL AND ECS DEMANDS TO THE NEXT GO/NO-GO PTP PLUS THREE HOURS (DRIFTING FLIGHT PLUS GUIDED ENTRY MANEUVER)
3. EPS
   - (A) LOSS OF TWO FUEL CELLS
   - (B) LOSS OF TWO ENTRY BATTERIES
   - (C) LOSS OF ONE MAIN BUS, ONE BATTERY BUS, ONE AC BUS, OR THE BATTERY RELAY BUS
   - (D) LOSS OF TWO INVERTERS
4. COMM/INSTRUMENTATION
   - (A) LOSS OF INSTRUMENTATION (TM OR ONBOARD) SUCH THAT IT IS NOT POSSIBLE TO VERIFY GO/NO-GO CRITERIA EITHER IN S/C OR ON GROUND.
   - (B) LOSS OF TWO-WAY VOICE COMMUNICATION (CSM/MSFN)
5. SEQUENTIAL
   - (A) LOSS OF SEQUENTIAL LOGIC BUS A OR B
   - (B) LOSS OF PYRO BUS A OR B
6. G&C
   - (A) LOSS OF DIRECT RCS (ANY AXIS)
   - (B) LOSS OF RATE DAMPING (ANY AXIS)
   - (C) LOSS OF TWO DEORBIT METHODS
7. SPS
   - (A) PRESSURE DECAY IN EITHER FUEL OR OXIDIZER TANK
   - (B) IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE AND:
     - (1) LOSS OF CAPABILITY TO PERFORM CRITICAL MANEUVERS
     - (2) $\Delta V$ REMAINING LESS THAN SPS DEORBIT REQUIREMENT
8. SM-RCS
   - (A) LOSS OF TWO QUADS
   - (B) LOSS OF ATTITUDE CONTROL IN ONE OR MORE AXES
   - (C) PROPELLANT REMAINING LESS THAN HYBRID DEORBIT REQUIREMENT, IF HYBRID AND SPS DEORBIT AVAILABLE. OTHERWISE PROPELLANT REMAINING LESS THAN SM DEORBIT REQUIREMENT
9. CM-RCS
   - (A) LOSS OF SOURCE PRESSURE - ONE RING
   - (B) LOSS OF MANIFOLD PRESSURE - ONE RING
   - (C) CM-RCS ARMED

B. THE LM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. SEQUENTIAL AND PYRO
   - (A) LOSS OF BOTH PYRO SYSTEMS A AND B

| REV | ITEM | |
|---|---|---|
| A | 3-10 (CONT'D) | 2. EPS<br>(A) LOSS OF EITHER CDR OR LM BUS<br>(B) LOSS OF THREE OR MORE DESCENT BATTERIES<br>(C) LOSS OF TWO OR MORE DESCENT BATTERIES IF EITHER ASCENT BATTERY IS LOST<br>(D) LOSS OF BOTH ASCENT BATTERIES<br>(E) LOSS OF BOTH INVERTERS 1 AND 2<br>(F) LOSS OF AC BUS A<br>(G) LOSS OF INTEGRAL AND FLOOD LIGHTS |
| | | 3. ECS<br>(A) LOSS OF CABIN INTEGRITY<br>(B) LOSS OF SUIT LOOP INTEGRITY<br>(C) LOSS OF BOTH SUIT FANS<br>(D) LOSS OF BOTH DEMAND REGULATORS<br>(E) LOSS OF BOTH PRIMARY AND SECONDARY COOLANT LOOPS<br>(F) LOSS OF ALL $O_2$ TANKS<br>(G) LOSS OF ALL $H_2O$ TANKS |
| | | 4. COMMUNICATIONS/INSTRUMENTATION<br>(A) LOSS OF CRITICAL ONBOARD DISPLAYS<br>(B) LOSS OF ALL VHF COMMUNICATIONS |
| | | 5. GUIDANCE AND CONTROL<br>(A) LOSS OF PGNS AND MANUAL AGS TTCA ATTITUDE CONTROL CAPABILITY<br>(B) LOSS OF DPS GIMBAL TRIM CONTROL<br>(C)<br>(D) LOSS OF +X ULLAGE CAPABILITY<br>(E) LOSS OF DPS ENG ON/OFF CAPABILITY<br>(F) LOSS OF OPERATIONAL THROTTLE CONTROL |
| | | 6. DPS<br>(A) PROPELLANT LEAK<br>(B) LOSS OF OPERATIONAL DPS |
| | | 7. APS<br>(A) PROPELLANT LEAK |
| | | 8. RCS<br>(A) RCS +X ULLAGE CAPABILITY<br>(B) THREE AXIS ATTITUDE CONTROL<br>(C) PROPELLANT LEAKS |
| | | C. THE DOCKED DPS BURN WILL BE <u>NO-GO</u> IF ANY OF THE FOLLOWING INTERFACE CONDITIONS EXIST: |
| | | 1. DOCKING SYSTEM<br>(A) LESS THAN NINE GOOD DOCKING RING LATCHES<br>(B) FAILURE OF CSM FORWARD HATCH PRIMARY LOCK/UNLOCK MECHANISM.<br>(C) FAILURE OF LM DEMAND REGULATORS TO MAINTAIN CABIN PRESSURE $\geq$ (TBD) PSIA |
| | | 2. COMMUNICATIONS<br>(A) LOSS OF TWO-WAY VHF VOICE COMMUNICATIONS BETWEEN CSM AND LM<br>(B) LOSS OF TWO-WAY VOICE COMMUNICATIONS BETWEEN MSFN AND BOTH CSM AND LM<br>(C) LOSS OF CRITICAL ONBOARD DISPLAYS |
| | | D. THE DOCKED DPS BURN WILL BE <u>NO-GO</u> IF ANY OF THE FOLLOWING EMU CONDITIONS EXIST: |
| | | 1. OPS CHECKOUT<br>(A) OPS SOURCE PRESSURE < <u>5380</u> PSIA<br>(B) OPS REG PRESSURE >4.0 PSID OR <3.4 PSID AT <u>0.3</u> LBS/HR<br>(C) LOSS OF ILLUMINATION OF BOTH GREEN HEATER STATUS LIGHTS |
| | | 2. PLSS POS PRESSURE <850 PSIA |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 3-11 | EVA GO/NO-GO |

A. THE CS WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. ECS
   - (A) LOSS OF CABIN INTEGRITY
   - (B) LOSS OF SUIT CIRCUIT
   - (C) LOSS OF $O_2$ MANIFOLD
   - (D) LOSS OF SURGE TANK OR REPRESS PACK
   - (E) LOSS OF CYCLIC ACCUMULATOR OPERATION
   - (F) LOSS OF SUIT INTEGRITY
   - (G) LOSS OF ALL COOLING
   - (H) CONFIRMED LEAK OF GLYCOL IN EITHER COMMAND MODULE OR SUIT CIRCUIT
2. CRYO
   - (A) INSUFFICIENT $O_2$ AND $H_2$ TO SUPPLY FUEL CELL AND ECS DEMANDS TO THE NEXT GO/NO-GO PTP PLUS THREE HOURS (DRIFTING FLIGHT PLUS GUIDED ENTRY MANEUVER)
3. EPS
   - (A) LOSS OF TWO FUEL CELLS
   - (B) LOSS OF TWO ENTRY BATTERIES
   - (C) LOSS OF ONE MAIN BUS, ONE BATTERY BUS, ONE AC BUS, OR THE BATTERY RELAY BUS
   - (D) LOSS OF TWO INVERTERS
4. COMM/INSTRUMENTATION
   - (A) LOSS OF INSTRUMENTATION (TM OR ONBOARD) SUCH THAT IT IS NOT POSSIBLE TO VERIFY GO/NO-GO CRITERIA EITHER IN S/C OR ON GROUND.
   - (B) LOSS OF TWO-WAY VOICE COMMUNICATION (CSM/ SFN)
   - (C) LOSS OF TWO-WAY VOICE COMMUNICATIONS (CSM/LM)
5. SEQUENTIAL
   - (A) LOSS OF SEQUENTIAL LOGIC BUS A OR B
   - (B) LOSS OF PYRO BUS A OR B
6. G&C
   - (A) LOSS OF DIRECT RCS (ANY AXIS)
   - (B) LOSS OF RATE DAMPING (ANY AXIS)
   - (C) LOSS OF TWO DEORBIT METHODS
7. SPS
   - (A) PRESSURE DECAY IN EITHER FUEL OR OXIDIZER TANK
   - (B) IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE AND:
     - (1) LOSS OF CAPABILITY TO PERFORM CRITICAL MANEUVERS
     - (2) $\Delta V$ REMAINING LESS THAN SPS DEORBIT REQUIREMENT
8. SM-RCS
   - (A) LOSS OF TWO QUADS
   - (B) LOSS OF ATTITUDE CONTROL IN ONE OR MORE AXES
   - (C) PROPELLANT REMAINING LESS THAN HYBRID DEORBIT REQUIREMENT, IF HYBRID AND SPS DEORBIT AVAILABLE. OTHERWISE PROPELLANT REMAINING LESS THAN SM DEORBIT REQUIREMENT
   - (D) LEAK IN ANY FUEL OR OXIDIZER TANK
9. CM-RCS
   - (A) LOSS OF SOURCE PRESSURE - ONE RING
   - (B) LOSS OF MANIFOLD PRESSURE - ONE RING
   - (C) CM-RCS ARMED

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 3-11 (CONT'D) | B. THE LM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST: |

B. THE LM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. EPS
   - (A) LOSS OF EITHER CDR OR LMP BUS
   - (B) LOSS OF THREE OR MORE DESCENT BATTERIES
   - (C) LOSS OF TWO OR MORE DESCENT BATTERIES IF EITHER ASCENT BATTERY IS LOST
   - (D) LOSS OF BOTH ASCENT BATTERIES
   - (E) LOSS OF INTEGRAL AND FLOOD LIGHTS
2. ECS
   - (A) LOSS OF CABIN INTEGRITY
   - (B) LOSS OF SUIT LOOP INTEGRITY
   - (C) LOSS OF BOTH SUIT FANS
   - (D) LOSS OF BOTH DEMAND REGULATORS
   - (E) LOSS OF PRIMARY AND SECONDARY COOLANT LOOPS
   - (F) LOSS OF DESCENT $O_2$ TANK
   - (G) LOSS OF BOTH ASCENT TANKS
   - (H) LOSS OF ALL $H_2O$ TANKS
3. COMMUNICATIONS/INSTRUMENTATION
   - (A) LOSS OF CRITICAL ONBOARD DISPLAYS
   - (B) LOSS OF VHF DUPLEX CAPABILITY
4. PROPULSION (APS/DPS)
   - (A) PROPELLANT LEAKS
   - (B) IMPENDING DPS PROPELLANT VENTING
5. RCS
   - (A) PROPELLANT LEAK

C. THE EVA WILL BE NO-GO IF ANY OF THE FOLLOWING INTERFACE CONDITIONS EXIST:

1. ECS
   - (A) FAILURE OF CM OR LM TO MAINTAIN SEPARATE PRESSURE INTEGIRTY
   - (B) FAILURE OF LM DEMAND REGULATORS TO MAINTAIN CABIN PRESSURE $\geq$ (TBD) PSIA
2. COMMUNICATIONS
   - (A) LOSS OF TWO-WAY VHF VOICE COMMUNICATIONS BETWEEN THREE CREWMAN (CONFERENCE)
   - (B) LOSS OF TWO-WAY VOICE BETWEEN MCC AND BOTH CMP AND CDR
   - (C)

D. THE EVA WILL BE NO-GO IF ANY OF THE FOLLOWING EMU CONDITIONS EXIST:

1. OPS CHECKOUT
   - (A) OPS SOURCE PRESSURE <5380 PSIA
   - (B) OPS REG PRESSURE >4.0 PSID OR <3.4 PSID AT 0.3 LBS/HR
   - (C) LOSS OF ILLUMINATION OF BOTH GREEN HEATER STATUS LIGHTS
2. PGA/PLSS CHECKOUT
   - (A) POS <850 PSIA
   - (B) PGA PRESSURE >4.0 PSID OR <3.7 PSID, OR EMU PRESSURE DECAY >0.40 PSID/MIN
   - (C) BAT VOLTAGE <16 VDC
   - (D) FAILURE TO ACTIVATE PUMP OR FAN
   - (E) PGA PRESSURE <4.3 PSID DURING LM CABIN DEPRESS
   - (F) LOSS OF CRITICAL INSTRUMENTATION
3. SUBLIMATOR CHECKOUT

   INADEQUATE LCG/LTV COOLING

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 3-12 | CSM/LM UNDOCKING GO/NO-GO |

A. THE CSM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. ECS
   - (A) LOSS OF CABIN INTEGRITY
   - (B) LOSS OF SUIT CIRCUIT
   - (C) LOSS OF $O_2$ MANIFOLD
   - (D)
   - (E) LOSS OF CYCLIC ACCUMULATOR OPERATION
   - (F) LOSS OF SUIT INTEGRITY
   - (G) LOSS OF ALL COOLING
   - (H) POTABLE WATER TANK QUANTITY PLUS FUEL CELL PRODUCTION TO THE COMPLETION OF RENDEZVOUS WILL TOTAL <10 LBS
   - (I)
   - (J) CONFIRMED LEAK OF GLYCOL IN EITHER COMMAND MODULE OR SUIT CIRCUIT.
2. CRYO
   - (A) INSUFFICIENT $O_2$ AND $H_2$ TO SUPPLY FUEL CELL AND ECS DEMANDS TO THE NEXT GO/NO-GO PTP PLUS THREE HOURS (DRIFTING FLIGHT PLUS GUIDED ENTRY MANEUVER)
3. EPS
   - (A) LOSS OF TWO FUEL CELLS
   - (B) LOSS OF TWO ENTRY BATTERIES
   - (C) LOSS OF ONE MAIN BUS, ONE BATTERY BUS, ONE AC BUS, OR THE BATTERY RELAY BUS
   - (D) LOSS OF TWO INVERTERS
4. COMM/INSTRUMENTATION
   - (A) LOSS OF INSTRUMENTATION (TM OR ONBOARD) SUCH THAT IT IS NOT POSSIBLE TO VERIFY GO/NO-GO CRITERIA EITHER IN S/C OR ON GROUND.
   - (B) LOSS OF TWO-WAY VOICE COMMUNICATION (CSM/MSFN)
   - (C) LOSS OF TWO-WAY VOICE COMMUNICATIONS (CSM/LM)
5. SEQUENTIAL
   - (A) LOSS OF SEQUENTIAL LOGIC BUS A OR B
   - (B) LOSS OF PYRO BUS A OR B
6. G&C
   - (A) LOSS OF TRANSLATION CAPABILITY (X-AXIS)
   - (B) LOSS OF DIRECT RCS (ANY AXIS)
   - (C) LOSS OF RATE DAMPING (ANY AXIS)
   - (D) LOSS OF TWO DEORBIT METHODS
7. SPS
   - (A) PRESSURE DECAY IN EITHER FUEL OR OXIDIZER TANK
   - (B) IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE AND:
     - (1) LOSS OF CAPABILITY TO PERFORM CRITICAL MANEUVERS
     - (2) $\Delta V$ REMAINING LESS THAN SPS DEORBIT REQUIREMENT
8. SM-RCS
   - (A) LOSS OF TWO QUADS
   - (B) LOSS OF ATTITUDE CONTROL IN ONE OR MORE AXES
   - (C) PROPELLANT REMAINING LESS THAN HYBRID DEORBIT REQUIREMENT, IF HYBRID AND SPS DEORBIT AVAILABLE. OTHERWISE PROPELLANT REMAINING LESS THAN SM DEORBIT REQUIREMENT
9. CM-RCS
   - (A) LOSS OF SOURCE PRESSURE - ONE RING
   - (B) LOSS OF MANIFOLD PRESSURE - ONE RING
   - (C) CM-RCS ARMED

| REV | ITEM | |
|---|---|---|
| A | 3-12 (CONT'D) | B. THE LM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST: |

B. THE LM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. EPS

   (A) LOSS OF EITHER CDR OR LM BUS
   (B) LOSS OF THREE OR MORE DESCENT BATTERIES
   (C) LOSS OF TWO OR MORE DESCENT BATTERIES IF EITHER ASCENT BATTERY IS LOST
   (D) LOSS OF BOTH ASCENT BATTERIES

2. ECS

   (A) LOSS OF CABIN PRESSURE INTEGRITY
   (B) LOSS OF SUIT CIRCUIT INTEGRITY
   (C) LOSS OF BOTH SUIT FANS
   (D) LOSS OF BOTH DEMAND REGULATORS
   (E) LOSS OF PRIMARY AND SECONDARY COOLANT LOOPS
   (F) LOSS OF TWO OR MORE $O_2$ TANKS
   (G) LOSS OF ALL $H_2O$ TANKS

3. COMMUNICATIONS/INSTRUMENTATION

   (A) LOSS OF CRITICAL ONBOARD DISPLAYS

4. GUIDANCE AND CONTROL

   (A) LOSS OF REDUNDANT 3-AXIS ATTITUDE CONTROL
   (B) LOSS OF 3-AXIS TRANSLATION CAPABILITY

5. DPS

   (A) PROPELLANT LEAKS

6. APS

   (A) PROPELLANT LEAKS

7. RCS

   (A) REDUNDANT 3-AXIS ATTITUDE CONTROL
   (B) 3-AXIS TRANSLATION CONTROL
   (C) PROPELLANT LEAK

C. THE CSM/LM UNDOCKING WILL BE NO-GO IF ANY OF THE FOLLOWING INTERFACE CONDITIONS EXIST:

1. DOCKING SYSTEM

   (A) THREE DOCKING RETRACT SQUIBS HAVE FIRED OR MISFIRED.
   (B) FAILURE TO REINSTALL OR CLOSE DOCKING PROBE, DROGUE, LM UPPER HATCH

2. COMMUNICATION

   (A) LOSS OF TWO-WAY VOICE COMMUNICATION BETWEEN CSM AND LM
   (B) LOSS OF MSFN VOICE COMMUNICATION WITH EITHER CSM OR LM

D. THE CSM/LM UNDOCKING WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. LOSS OF TWO OR MORE EVA LIFE SUPPORT UNITS

   (A) OPS $O_2$ SOURCE PRESSURE <5380 PSIA
   (B) OPS REG PRESSURE >4.0 PSID OR <3.4 PSID AT 0.3 LBS/HR
   (C) LOSS OF ILLUMINATION OF BOTH GREEN HEATER STATUS LIGHTS
   (D) PLSS POS PRESSURE <850 PSIA
   (E) PLSS POS PRESSURE <400 PSIA POST EVA (INITIAL CHECKOUT LEAK RATE <0.4 PSIA PER MIN)

2. EVT HAS BEEN ATTEMPTED AND NOT COMPLETED SATISFACTORILY WITHIN THE OPS LIFETIME.

| ITEM | |
|---|---|
| 3-13 | SEPARATION MANEUVER GO/NO-GO |

A. THE CSM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. ECS
   - (A) LOSS OF CABIN INTEGRITY
   - (B) LOSS OF SUIT CIRCUIT
   - (C) LOSS OF $O_2$ MANIFOLD
   - (D)
   - (E) LOSS OF CYCLIC ACCUMULATOR OPERATION
   - (F) LOSS OF PRIMARY GLYCOL LOOP COOLING
   - (G) POTABLE WATER TANK QUANTITY PLUS FUEL CELL PRODUCTION TO THE COMPLETION OF RENDEZVOUS WILL TOTAL <10 LBS
   - (H)
   - (I) CONFIRMED LEAK OF GLYCOL IN EITHER COMMAND MODULE OR SUIT CIRCUIT
2. CRYO
   - (A) INSUFFICIENT $O_2$ AND $H_2$ TO SUPPLY FUEL CELL AND ECS DEMANDS TO THE NEXT GO/NO-GO PTP PLUS 2 REVS (DRIFTING FLIGHT PLUS GUIDED ENTRY MANEUVER)
3. EPS
   - (A) LOSS OF TWO FUEL CELLS
   - (B) LOSS OF TWO ENTRY BATTERIES, OR LOSS OF ONE ENTRY BATTERY AND THE BATTERY CHARGER
   - (C) LOSS OF ONE MAIN BUS, ONE BATTERY BUS, ONE AC BUS, OR THE BATTERY RELAY BUS
   - (D) LOSS OF TWO INVERTERS
4. COMM/INSTRUMENTATION
   - (A) LOSS OF TELEMETRY SUCH THAT IS IS NOT POSSIBLE TO VERIFY GO/NO-GO CRITERIA EITHER IN S/C OR ON GROUND.
   - (B) LOSS OF TWO-WAY VOICE COMMUNICATION (CSM/MSFN)
   - (C) LOSS OF TWO-WAY VOICE COMMUNICATION (CSM/LM)
5. SEQUENTIAL
   - (A) LOSS OF SEQUENTIAL LOGIC BUS A OR B
   - (B) LOSS OF PYRO BUS A OR B
6. G&C
   - (A) LOSS OF DIRECT RCS (ANY AXIS)
   - (B) LOSS OF RATE DAMPING (ANY AXIS)
   - (C) LOSS OF TWO DEORBIT METHODS
   - (D) LOSS OF CAPABILITY TO PERFORM CRITICAL SPS MANEUVER
   - (E) LOSS OF IMU, CMC, BOTH DSKY'S, OPTICS, OR BOTH FDAI'S
   - (F) LOSS OF TRANSLATION CAPABILITY (ANY AXIS)
7. SPS
   - (A) PRESSURE DECAY IN EITHER FUEL OR OXIDIZER TANK
   - (B) IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE AND:
     - (1) LOSS OF CAPABILITY TO PERFORM CRITICAL MANEUVERS
     - (2) $\Delta V$ REMAINING LESS THAN SPS DEORBIT REQUIREMENT
8. SM-RCS
   - (A) LOSS OF ONE QUAD
   - (B) LOSS OF ATTITUDE CONTROL IN ONE OR MORE AXES
   - (C) PROPELLANT REMAINING LESS THAN HYBRID DEORBIT REQUIREMENT, IF HYBRID AND SPS DEORBIT AVAILABLE. OTHERWISE PROPELLANT REMAINING LESS THAN SM DEORBIT REQUIREMENT.
9. CM-RCS
   - (A) LOSS OF SOURCE PRESSURE - ONE RING
   - (B) LOSS OF MANIFOLD PRESSURE - ONE RING
   - (C) CM-RCS ARMED

| REV | ITEM | |
|---|---|---|
| | 3-13 (CONT'D) | B. THE LM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST: |

1. EPS
   - (A) LOSS OF EITHER CDR OR LMP BUS
   - (B) LOSS OF THREE OR MORE DESCENT BATTERIES
   - (C) LOSS OF TWO OR MORE DESCENT BATTERIES IF EITHER ASCENT BATTERY LOST
   - (D) LOSS OF BOTH ASCENT BATTERIES
   - (E) LOSS OF BOTH INVERTERS
   - (F) LOSS OF AC BUS A
2. ECS
   - (A) LOSS OF CABIN PRESSURE INTEGRITY
   - (B) LOSS OF SUIT LOOP INTEGRITY
   - (C) LOSS OF BOTH SUIT FANS
   - (D) LOSS OF BOTH DEMAND REGULATORS
   - (E) LOSS OF EITHER PRIMARY OR SECONDARY COOLANT LOOP
   - (F) LOSS OF PRIMARY $H_2O$ FEEDPATH CAPABILITY
   - (G) LOSS OF ALL $H_2O$ TANKS
   - (H) LOSS OF TWO OR MORE $O_2$ TANKS
3. COMMUNICATIONS/INSTRUMENTATION
   - (A) LOSS OF ONBOARD CRITICAL DISPLAYS
4. GUIDANCE AND CONTROL
   - (A) LOSS OF REDUNDANT 3-AXIS ATTITUDE CONTROL
   - (B) LOSS OF PGNS
   - (C) LOSS OF 3-AXIS TRANSLATION CAPABILITY
   - (D) LOSS OF BOTH FDAI'S
   - (E) LOSS OF DSKY
5. DPS
   - (A) NO PROPELLANT LEAKS
6. APS
   - (A) NO PROPELLANT LEAKS
7. RCS
   - (A) 3-AXIS TRANSLATION CONTROL
   - (B) REDUNDANT 3-AXIS ATTITUDE CONTROL

C. THE SEPARATION MANEUVER WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. COMMUNICATIONS
   - (A) LOSS OF TWO-WAY VOICE COMMUNICATION BETWEEN VEHICLES WITH BACKUP
   - (B) LOSS OF TWO-WAY VOICE COMMUNICATIONS BETWEEN MSFN AND EITHER CSM OR LM
   - (C) LOSS OF LM TELEMETRY OR CSM TELEMETRY

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 3-14 | PHASING MANEUVER GO/NO-GO |

A. THE CSM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. ECS
   (A) LOSS OF CABIN INTEGRITY
   (B) LOSS OF SUIT CIRCUIT
   (C) LOSS OF $O_2$ MANIFOLD
   (D)
   (E) LOSS OF CYCLIC ACCUMULATOR OPERATION
   (F) LOSS OF PRIMARY GLYCOL LOOP COOLING
   (G) POTABLE WATER TANK QUANTITY PLUS FUEL CELL PRODUCTION TO THE COMPLETION OF RENDEZVOUS WILL TOTAL <10 LBS
   (H)
   (I) CONFIRMED LEAK OF GLYCOL IN EITHER COMMAND MODULE OR SUIT CIRCUIT

2. CRYO
   (A) INSUFFICIENT $O_2$ AND $H_2$ TO SUPPLY FUEL CELL AND ECS DEMANDS TO THE NEXT GO/NO-GO PTP PLUS 2 REVS (DRIFITING FLIGHT PLUS GUIDED ENTRY MANEUVER)

3. EPS
   (A) LOSS OF TWO FUEL CELLS
   (B) LOSS OF TWO ENTRY BATTERIES, OR LOSS OF ONE ENTRY BATTERY AND THE BATTERY CHARGER
   (C) LOSS OF ONE MAIN BUS, ONE BATTERY BUS, ONE AC BUS, OR THE BATTERY RELAY BUS
   (D) LOSS OF TWO INVERTERS

4. COMM/INSTRUMENTATION
   (A) LOSS OF TELEMETRY SUCH THAT IT IS NOT POSSIBLE TO VERIFY GO/NO-GO CRITERIA EITHER IN S/C OR ON GROUND.
   (B) LOSS OF TWO-WAY VOICE COMMUNICATION (CSM/MSFN)
   (C) LOSS OF TWO-WAY VOICE COMMUNICATIONS (CSM/LM)
   (D) LOSS OF RR TRANSPONDER

5. SEQUENTIAL
   (A) LOSS OF SEQUENTIAL LOGIC BUS A OR B
   (B) LOSS OF PYRO BUS A OR B

6. G&C
   (A) LOSS OF DIRECT RCS (ANY AXIS)
   (B) LOSS OF RATE DAMPING (ANY AXIS)
   (C) LOSS OF TWO DEORBIT METHODS
   (D) LOSS OF CAPABILITY TO PERFORM CRITICAL SPS MANEUVER
   (E) LOSS OF IMU, CMC, BOTH DSKY'S, OPTICS OR BOTH FDAI'S
   (F) LOSS OF TRANSLATION CAPABILITY (ANY AXIS)

7. SPS
   (A) PRESSURE DECAY IN EITHER FUEL OR OXIDIZER TANK
   (B) LOSS OF CAPABILITY TO PERFORM NON-CRITICAL MANEUVER

8. SM-RCS
   (A) LOSS OF ONE QUAD
   (B) LOSS OF ATTITUDE CONTROL IN ONE OR MORE AXES
   (C) PROPELLANT REMAINING LESS THAN HYBRID DEORBIT REQUIREMENT, IF HYBRID AND SPS DEORBIT AVAILABLE. OTHERWISE PROPELLANT REMAINING LESS THAN SM DEORBIT REQUIREMENT.

9. CM-RCS
   (A) LOSS OF SOURCE PRESSURE - ONE RING
   (B) LOSS OF MANIFOLD PRESSURE - ONE RING
   (C) CM-RCS ARMED

| REV | ITEM | |
|---|---|---|
| A | 3-14 (CONT'D) | B. THE LM WILL BE <u>NO-GO</u> IF ANY OF THE FOLLOWING CONDITIONS EXIST: |

1. SEQUENTIAL AND PYROTECHNICS
   - (A) LOSS OF EITHER PYRO SYSTEM A OR B
2. EPS
   - (A) LOSS OF EITHER CDR OR LMP BUS
   - (B) LOSS OF THREE OR MORE DESCENT BATTERIES
   - (C) LOSS OF TWO OR MORE DESCENT BATTERIES IF EITHER ASCENT BATTERY LOST
   - (D) LOSS OF BOTH ASCENT BATTERIES
   - (E) LOSS OF BOTH INVERTERS
   - (F) LOSS OF AC BUS A
3. ECS
   - (A) LOSS OF CABIN PRESSURE INTEGRITY
   - (B) LOSS OF SUIT LOOP INTEGRITY
   - (C) LOSS OF BOTH SUIT FANS
   - (D) LOSS OF BOTH $H_2O$ SEPARATORS
   - (E) LOSS OF BOTH DEMAND REGULATORS
   - (F) LOSS OF EITHER PRIMARY OR SECONDARY COOLANT LOOPS
   - (G) LOSS OF PRIMARY $H_2O$ FEEDPATH CAPABILITY
   - (H) LOSS OF TWO OR MORE $O_2$ TANKS
   - (I) LOSS OF ALL $H_2O$ TANKS
4. COMMUNICATIONS/INSTRUMENTATION
   - (A) LOSS OF CRITICAL ONBOARD DISPLAYS
5. GUIDANCE AND CONTROL
   - (A) LOSS OF REDUNDANT 3-AXIS ATTITUDE CONTROL
   - (B) LOSS OF PGNS
   - (C) LOSS OF 3-AXIS TRANSLATION CAPABILITY
   - (D) LOSS OF RR/TRANSPONDER
   - (E) LOSS OF BOTH FDAI'S
   - (F) LOSS OF DSKY
   - (G) LOSS OF ENG ON/OFF CAPABILITY
   - (H) LOSS OF OPERATIONAL THROTTLE CONTROL CAPABILITY
   - (I) LOSS OF BOTH AOT AND COAS
6. DPS
   - (A) PROPELLANT LEAKS
   - (B) LOSS OF OPERATIONAL DPS
   - (C) LESS THAN 245 FPS $\Delta V$
7. APS
   - (A) APS PROPELLANT LEAK
   - (B)
   - (C) PROPELLANT LEAK
8. RCS
   - (A) REDUNDANT 3-AXIS ATTITUDE CONTROL
   - (B) 3-AXIS TRANSLATION CONTROL

C. THE PHASING MANEUVER WILL BE <u>NO-GO</u> IF ANY OF THE FOLLOWING INTERFACE CONDITIONS EXIST:

1. COMMUNICATIONS
   - (A) LOSS OF TWO-WAY VOICE COMMUNICATION BETWEEN VEHICLES WITH BACKUP
   - (B) LOSS OF TWO-WAY VOICE COMMUNICATIONS BETWEEN MSFN AND EITHER CSM OR LM
   - (C) LOSS OF LM TELEMETRY OR CSM TELEMETRY

| REV | ITEM | |
|---|---|---|
| A | 3-15 | INSERTION MANEUVER GO/NO-GO |

A. THE CSM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. ECS
   - (A) LOSS OF CABIN INTEGRITY
   - (B) LOSS OF SUIT CIRCUIT
   - (C) LOSS OF $O_2$ MANIFOLD
   - (D)
   - (E) LOSS OF CYCLIC ACCUMULATOR OPERATION
   - (F) LOSS OF PRIMARY GLYCOL LOOP COOLING
   - (G) POTABLE WATER TANK QUANTITY PLUS FUEL CELL PRODUCTION TO THE COMPLETION OF RENDEZVOUS WILL TOTAL <10 LBS
   - (H)
   - (I) CONFIRMED LEAK OF GLYCOL IN EITHER COMMAND MODULE OR SUIT CIRCUIT
2. CRYO
   - (A) INSUFFICIENT $O_2$ AND $H_2$ TO SUPPLY FUEL CELL AND ECS DEMANDS TO THE NEXT GO/NO-GO PTP PLUS 2 REVS (DRIFTING FLIGHT PLUS GUIDED ENTRY MANEUVER)
3. EPS
   - (A) LOSS OF TWO FUEL CELLS
   - (B) LOSS OF TWO ENTRY BATTERIES, OR LOSS OF ONE ENTRY BATTERY AND THE BATTERY CHARGER
   - (C) LOSS OF ONE MAIN BUS, ONE BATTERY BUS, ONE AC BUS, OR THE BATTERY RELAY BUS
   - (D) LOSS OF TWO INVERTERS
4. COMM/INSTRUMENTATION
   - (A) LOSS OF TELEMETRY SUCH THAT IT IS NOT POSSIBLE TO VERIFY GO/NO-GO CRITERIA EITHER IN S/C OR ON GROUND.
   - (B) LOSS OF TWO-WAY VOICE COMMUNICATION (CSM/MSFN)
   - (C) LOSS OF TWO-WAY VOICE COMMUNICATIONS (CSM/LM)
   - (D)
5. SEQUENTIAL
   - (A) LOSS OF SEQUENTIAL LOGIC BUS A OR B
   - (B) LOSS OF PYRO BUS A OR B
6. G&C
   - (A) LOSS OF DIRECT RCS (ANY AXIS)
   - (B) LOSS OF RATE DAMPING (ANY AXIS)
   - (C) LOSS OF TWO DEORBIT METHODS
   - (D) LOSS OF CAPABILITY TO PERFORM CRITICAL SPS MANEUVERS
   - (E) LOSS OF IMU, CMC, BOTH DSKY'S, OPTICS OR BOTH FDAI'S
   - (F) LOSS OF TRANSLATION CAPABILITY (ANY AXIS)
7. SPS
   - (A) PRESSURE DECAY IN EITHER FUEL OR OXIDIZER TANK
   - (B) LOSS OF CAPABILITY TO PERFORM NON-CRITICAL MANEUVER
8. SM-RCS
   - (A) LOSS OF ONE QUAD
   - (B) LOSS OF ATTITUDE CONTROL IN ONE OR MORE AXES
   - (C) PROPELLANT REMAINING LESS THAN HYBRID DEORBIT REQUIREMENT, IF HYBRID AND SPS DEORBIT AVAILABLE. OTHERWISE PROPELLANT REMAINING LESS THAN SM DEORBIT REQUIREMENT.
9. CM-RCS
   - (A) LOSS OF SOURCE PRESSURE - ONE RING
   - (B) LOSS OF MANIFOLD PRESSURE - ONE RING
   - (C) CM-RCS ARMED

| REV | ITEM | |
|---|---|---|
| A | 3-15 (CONT'D) | B. THE LM WILL NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST: |

1. SEQUENTIAL AND PYROTECHNICS
   (A) LOSS OF EITHER PYRO SYSTEM A OR B
2. EPS
   (A) LOSS OF EITHER CDR OR LMP BUS
   (B) LOSS OF TWO OR MORE DESCENT BATTERIES
   (C) LOSS OF EITHER ASCENT BATTERY
   (D) LOSS OF EITHER INVERTER 1 OR 2
   (E) LOSS OF EITHER AC BUS A OR B
3. ECS
   (A) LOSS OF CABIN PRESSURE INTEGRITY
   (B) LOSS OF SUIT LOOP INTEGRITY
   (C) LOSS OF BOTH SUIT FANS
   (D) LOSS OF BOTH $H_2O$ SEPARATORS
   (E) LOSS OF BOTH DEMAND REGULATORS
   (F) LOSS OF EITHER PRIMARY OR SECONDARY COOLANT LOOPS
   (G) LOSS OF PRIMARY $H_2O$ FEED PATH CAPABILITY
   (H) LOSS OF DESCENT $O_2$ TANK
   (I) LOSS OF BOTH ASCENT $O_2$ TANKS
   (J) LOSS OF TWO OR MORE $H_2O$ TANKS
4. COMMUNICATIONS/INSTRUMENTATION
   (A) LOSS OF CRITICAL ONBOARD DISPLAYS
5. GUIDANCE AND CONTROL
   (A) LOSS OF REDUNDANT 3-AXIS ATTITUDE CONTROL CAPABILITY
   (B) LOSS OF PGNS
   (C) LOSS OF +X-AXIS TRANSLATION CAPABILITY
   (D)
   (E) LOSS OF BOTH FDAI'S
   (F) LOSS OF DSKY
   (G) LOSS OF ENG ON/OFF CAPABILITY
   (H) LOSS OF OPERATIONAL THROTTLE CONTROL
   (I) LOSS OF AOT AND COAS
6. DPS/APS
   (A) LOSS OF OPERATIONAL DPS AND APS
   (B) APS PROPELLANT LEAK
   (C) LESS THAN 160 FPS DPS $\Delta V$ CAPABILITY IF APS IS NOT OPERATIONAL
7. RCS
   (A) LOSS OF REDUNDANT 3-AXIS ATTITUDE CONTROL
   (B) LOSS OF +X AXIS TRANSLATION CAPABILITY
   (C) RCS PROPELLANT LEAK

C. THE INSERTION WILL BE NO-GO IF ANY OF THE FOLLOWING INTERFACE CONDITIONS EXIST:

1. COMMUNICATIONS
   (A) LOSS OF TWO-WAY VOICE COMMUNICATION BETWEEN VEHICLES WITH BACKUP
   (B) LOSS OF TWO-WAY VOICE COMMUNICATIONS BETWEEN MSFN AND EITHER CSM OR LM
   (C) LOSS OF LM TELEMETRY OR CSM TELEMETRY

| REV | ITEM | |
|---|---|---|
| A | 3-16 | <u>LM STAGING GO/NO-GO</u> |

A. THE LM WILL BE <u>NO-GO</u> IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. SEQUENTIAL AND PYROTECHNICS
   (A) LOSS OF EITHER SYSTEM A OR B

2. EPS
   (A) LOSS OF EITHER CDR OR LMP BUS
   (B) LOSS OF EITHER ASCENT BATTERY

3. ECS
   (A) LOSS OF CABIN PRESSURE INTEGRITY
   (B) LOSS OF SUIT LOOP INTEGRITY
   (C) LOSS OF BOTH SUIT FANS
   (D) LOSS OF BOTH $H_2O$ SEPARATORS
   (E) LOSS OF BOTH DEMAND REGULATORS
   (F) LOSS OF EITHER ASCENT $O_2$ TANK
   (G) LOSS OF BOTH ASCENT $H_2O$ TANKS

4. COMMUNICATIONS/INSTRUMENTATION
   (A) INSUFFICIENT INFORMATION TO ASSESS THE STATUS OF THE ASCENT STAGE SYSTEMS
   (B) INSUFFICIENT INFORMATION TO ASSESS THE STATUS OF THE ASCENT STAGE SYSTEMS

5. GUIDANCE AND CONTROL
   (A) LOSS OF PGNS
   (B) LOSS OF +X TRANSLATION CAPABILITY

6. APS
   (A) PROPELLANT LEAK
   (B)

7. RCS
   (A) LOSS OF +X TRANSLATION CAPABILITY
   (B) LOSS OF 3-AXIS ATTITUDE CONTROL CAPABILITY

| REV | ITEM | |
|---|---|---|
| A | 3-17 | LM UNMANNED APS BURN GO/NO-GO |

A. THE LM WILL BE NO-GO IF ANY OF THE FOLLOWING CONDITIONS EXIST:

1. EPS

   (A) LOSS OF CDR BUS
   (B) LOSS OF BOTH ASCENT BATTERIES

2. GUIDANCE AND CONTROL

   (A) LOSS OF PGNS
   (B) LOSS OF APS ARM-DEARM/ON-OFF CONTROL

3. APS

   NON-OPERATIONAL APS (REF MR 27-3)

4. RCS

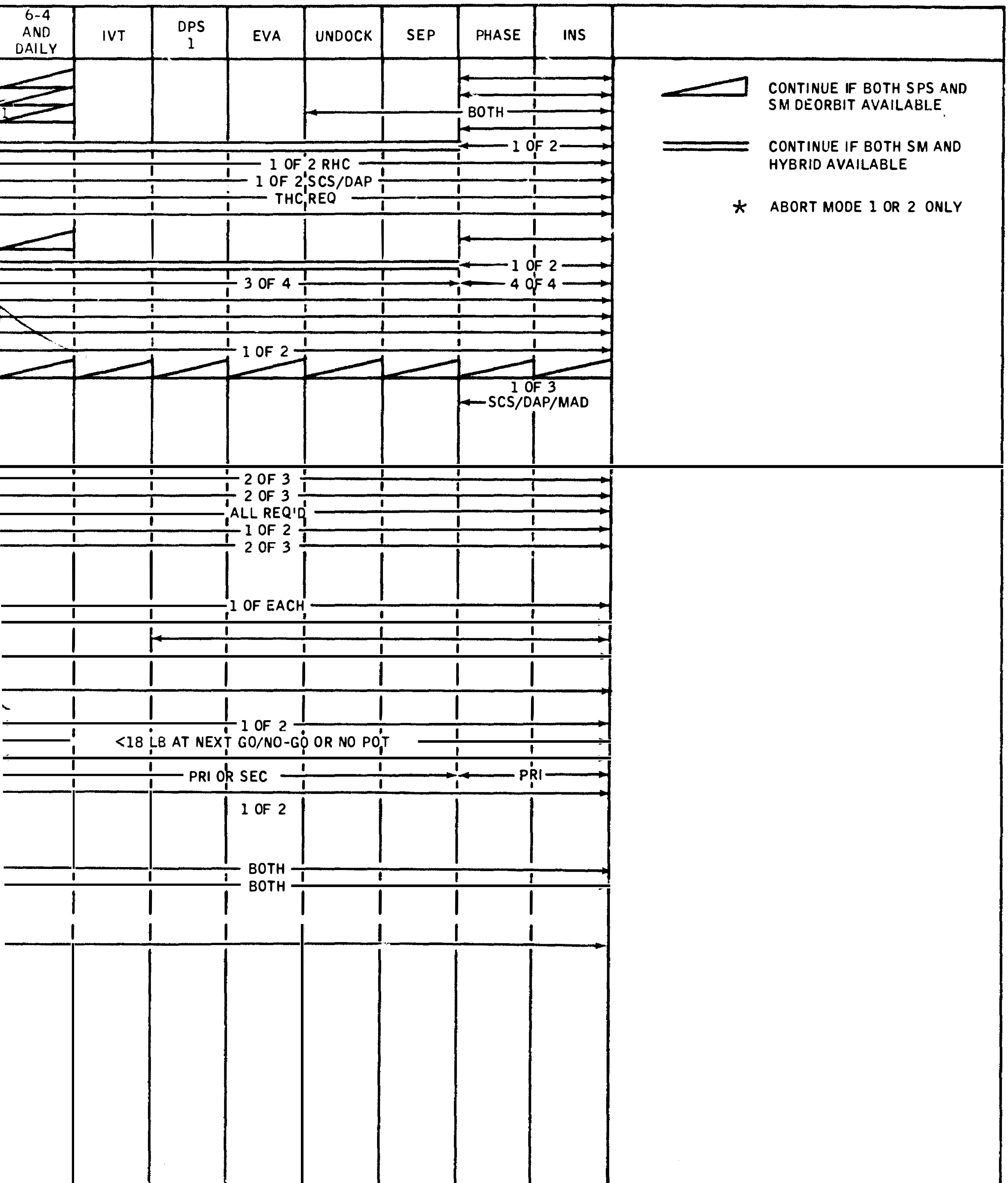
   (A) LOSS OF 3-AXIS ATTITUDE CONTROL

RULE NUMBERS 3-18 THROUGH
3-19 ARE RESERVED.

| LM GUIDANCE AND CONTROL | DPS 1 | EVA | UNDOCK | ROM | SEP | ROM | PHASE | ROM | INS | ROM | STAGE | APS DEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PGNS OR DSKY | USE ←→ TTCA | | | ←→ | MINI | ←→ | | | | | | ←→ |
| DPS GIMBAL TRIM | ←→ | | | | | | | | | | | |
| ULLAGE CAPABILITY | ←→ | | | ←→ | | | | | | | | |
| NON OPN'L DPS- {PRESS ON/OFF | ←→ | | | | | | FOOTBALL | | STAGE | | | |
| THROTTLE | ←→ | | | | | | 10% >OK < 60% STAGE | | | | | |
| REDUNDANT 3 AXIS ATT | | | | | PGNS AND AGS OR AGS AND SEC COILS | | | | | | | |
| 3 AXIS X1A +C +1 | | | ←→ | | | | | | +X REQ'D | | | |
| RR/XPONDER | | | | ←→ | | | | | | | | |
| FDAI'S (2) | | | | | | | 1 OF 2 | | | | | |
| AGS GUIDANCE | | | | | N/R | | N/R | | N/R | | | |
| NO APS ENG {PRESS ON/OFF | | | | | | | | | | | | ←→ |
| AOT OR COAS | | | | | | | | 1 OF 2 | | | | |
| NO PGNS OR AGS | | | | | | | | | | RESCUE | | |
| PROPELLANT LEAK | | | | | | | | | | | | |
| IMPENDING PROP VENT | | MAN / VENT | | | | | | | | | | |
| **ELECTRICAL** | | | | | | | | | | | | |
| NO CDR OR LMP BUS | | | | | | | BOTH | | | | | CDR |
| DESCENT BAT 1-4 | 2 OF 6 | 2 DES + 2 ASC | OR 3 DES + 1 ASC | 3 | 2D/2A OR 3D/1A | 3 | 2D/2A OR 3D/1A | | 3 OF 4 | | | |
| ASC BATTERY 5-6 | | | | 2 | | 2 | | | BOTH | | | 1 |
| INVERTERS (2) | 1 | | | 2 | 1 | 2 | 1 | | BOTH | | | |
| AC BUS A/B | A | | | BOTH | A | BOTH | A | | BOTH | | | |
| TRACKING LT | | | | ←→ | | ←→ | | | | | | |
| **PYRO** | | | | | | | | | | | | |
| PYRO A/B | 1 | | | BOTH | | | | BOTH | | | | |
| **ECS** | | | | | | | | | | | | |
| CABIN INTEGRITY | ←→ | | | | | | | | | | | |
| SUIT LOOP INTEGRITY | ←→ | | | | | | | | | | | |
| SUIT FANS (2) | | | | | | 1 OF 2 | | | | | | |
| $H_2O$ SEP (2) | | | | 1 OF 2 | CREW OPT | | | 1 OF 2 | | | | |
| DEMAND REGS (2) | | | | | | | 1 OF 2 | | | | | |
| PRI-SEC COOLANT LOOP | | 1 OF 2 | | BOTH | PRI | | | BOTH | | | 1 OF 2 | 1 OF 2 |
| DESCENT $O_2$ | 1 OF 3 | ←→ | 2 OF 3 | ←→ | 2 OF 3 | ←→ | 2 OF 3 | ←→ | | | | |
| ASCENT $O_2$ 1 / ASCENT $O_2$ 2 | | 1 OF 2 | | BOTH | | BOTH | | BOTH | 1 OF 2 | BOTH | BOTH | |
| DES $H_2O$ / ASC $H_2O$ 1 | | 1 OF 3 | | 2 OF 3 | 1 OF 3 | 2 OF 3 | 1 OF 3 | | 2 OF 3 | | | |
| ASC $H_2O$ 2 | | | | | | | | | | | 1 OF 2 | |
| **COMM/INSTR** | | | | | | | | | | | | |
| CRITICAL ONB'D DISP | ←→ | | | | | | | | | | | |
| OPS TM | | | | ←→ | | | | | | | | |
| VOICE COMM - S BAND | | | | | N/R | SEE BELOW | | | | | | |
| VHF DUP (A OR B) SIM (A OR B) | 1 OF 2 | ←→ | | | | | | | | | | |
| VHF DUP A AND B / VHF SIM A AND B / S-BAND +VHF DOP A OR B / S-BAND +VHF SIM A OR B | | | | | | | 1 OF 4 | | | | | |

TABLE 3-I. - GO/NO-GO SUMMARY

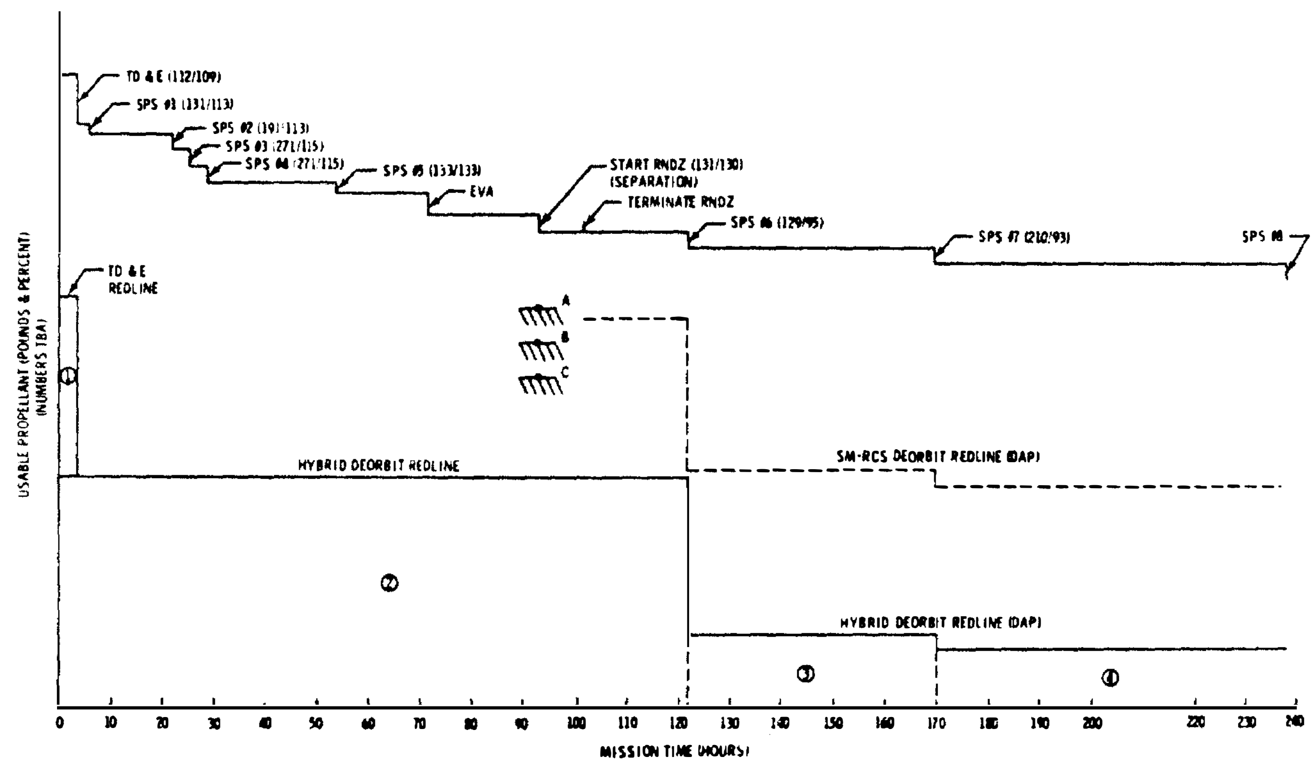
| STAGE | APS DEP | | CSM GUIDANCE / PROP | LAUNCH | TD AND E | 6-4 AND DAILY | IVT | DPS 1 | EVA | UNDOCK | SEP | PHASE | INS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NO IMU | | | | | | | | | | |
| | | | NO CMC OR DSKY (2) | | | | | | | | | | |
| | | | FDAI'S | | | 1 | | | | | | BOTH | |
| | | | NO OPTICS | | | | | | | | | | |
| | | | TVC LOOP (2 P-Y) | | | | | | | | | 1 OF 2 | |
| | | | DIRECT RCS (ANY AXIS) | | | | | | 1 OF 2 RHC | | | | |
| | | | RATE DAMP (ANY AXIS) | | | | | | 1 OF 2 SCS/DAP | | | | |
| | | | TRANS CONTROL (ANY AXIS) | | | | | | THC REQ | | | | |
| | | | SPS - FUEL/OX DECAY | | | | | | | | | | |
| | | | SPS - NON OPN'L { TEMPS, TC P, $\Delta P$ } | | | | | | | | | | |
| | | | BALL VALVES A/B ($GN_2$) | | | | | | | | | 1 OF 2 | |
| | | | SM-RCS QUADS (4) | | | | | | 3 OF 4 | | | 4 OF 4 | |
| | | | NO 3 AXIS ATT C+1 | | | | | | | | | | |
| | | | CM-RCS HE SOURCE/MAN A -RCS ARMED | | | | | | | | | | |
| | | | BMAG 1 AND 2 POR YAW | | | | | | 1 OF 2 | | | | |
| | | | BMAG 1 OF 2 ROLL | | | | | | | | | | |
| | | | ULLAGE CAPABILITY | | | | | | | | | 1 OF 3 SCS/DAP/MAD | |
| | | | ELECTRICAL | | | | | | | | | | |
| | CDR | | FUEL CELLS (3) | 0 | | | | | 2 OF 3 | | | | |
| | | | ENTRY BAT (3) | 1 OF 3 | | | | | 2 OF 3 | | | | |
| | | | BUS MAIN (2), BAT (2), BRB | | | | | | ALL REQ'D | | | | |
| | 1 | | BUS AC (2) | * | | | | | 1 OF 2 | | | | |
| | | | INVERTERS (3) | 1 OF 3 | | | | | 2 OF 3 | | | | |
| | | | ECS | | | | | | | | | | |
| | | | CRYO $O_2/H_2$ | | | | | | 1 OF EACH | | | | |
| | | | CABIN INTEGRITY | E/O WITH CABIN LOSS | | | | | | | | | |
| | | | SUIT INTEGRITY | | | | | | | | | | |
| | | | SUIT LOOP/1 OF 2 FANS | | | | | | | | | | |
| | | | $O_2$ MANIFOLD | | | | | | | | | | |
| | | | CYCLIC ACCUM (2) | | | | | | 1 OF 2 | | | | |
| | | | POTABLE/WASTE $H_2O$ | | | | | <18 LB AT NEXT GO/NO-GO OR NO POT | | | | | |
| | | | LOSS OF $H_2O$/URINE DUMP | | | | | | | | | | |
| | | | PRI OR SEC GLY LOOP | | | | | | PRI OR SEC | | | PRI | |
| 1 OF 2 | 1 OF 2 | | GLYCOL LEAK/SUIT CABIN | | | | | | | | | | |
| | | | SURGE TANK/REPRESS PK | | | | | | 1 OF 2 | | | | |
| BOTH | | | SEQUENTIAL | | | | | | | | | | |
| | | | SEQ LOGIC BUS A/B | | | | | | BOTH | | | | |
| | | | PYRO BUS A/B | | | | | | BOTH | | | | |
| | | | COMM/INSTR | | | | | | | | | | |
| 1 OF 2 | | | CRITICAL ONB'D DISP | | | | | | | | | | |
| | | | VOICE COMM - S-BAND (SEE LM REQ) | | | | | | | | | | |


6-4 AND DAILY
IVT
DPS 1
EVA
UNDOCK
SEP
PHASE
INS
BOTH
1 OF 2
1 OF 2 RHC
1 OF 2 SCS/DAP
THC REQ
1 OF 2
3 OF 4
4 OF 4
1 OF 2
1 OF 3 SCS/DAP/MAD
2 OF 3
2 OF 3
ALL REQ'D
1 OF 2
2 OF 3
1 OF EACH
1 OF 2
<18 LB AT NEXT GO/NO-GO OR NO POT
PRI OR SEC
PRI
1 OF 2
BOTH
BOTH
CONTINUE IF BOTH SPS AND SM DEORBIT AVAILABLE
CONTINUE IF BOTH SM AND HYBRID AVAILABLE
* ABORT MODE 1 OR 2 ONLY

**NASA — Manned Spacecraft Center**

**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | 3-20 | **SM-RCS** |




ASSUMPTIONS

A. TRAPPED PROPELLANT - 28 LBS

GAGING UNCERTAINTY - 80 LBS

108 LBS - (UNUSABLE AND NOT SHOWN ON GRAPH)

B. NO OPS RESERVE

GO/NO-GO (TRW)

1. RENDEZVOUS:

   A. PROPELLANT REQUIRED FOR SEPARATION MANEUVER PLUS CSM RESCUE OF LM AFTER LM INSERTION. INCLUDES ULLAGE FOR CSI AND CDH MANEUVERS, TPI, MIDCOURSES, BRAKING, DOCKING AND THE HYBRID DEORBIT REDLINE.

   B. PROPELLANT REQUIRED FOR SEPARATION MANEUVER PLUS SEPARATION MANEUVER PLUS CSM RESCUE OF LM AFTER PHASING BUT PRIOR TO INSERTION. INCLUDES TPI, MIDCOURSES, BRAKING, DOCKING, AND THE HYBRID DEORBIT REDLINE.

   C. PROPELLANT REQUIRED FOR SEPARATION MANEUVER PLUS CSM RESCUE OF LM AFTER SEPARATION BUT PRIOR TO PHASING. INCLUDES LOS CONTROL, BRAKING, DOCKING, AND THE HYBRID DEORBIT REDLINE.

2. THE EVA WILL BE CONSIDERED FOR DELETION IN ORDER TO MEET THE GO/NO-GO POINT (B) FOR THE FOOTBALL RENDEZVOUS.

REDLINES

1. ORBIT INSERTION TO LM EXTRACTION

   (1) THE TD&E WILL BE TERMINATED AT THE TD&E REDLINE. THE PROPELLANT IN 1 WILL ALLOW A CSM ACTIVE RENDEZVOUS WITH THE S-IVB/LM AND ALLOWS ____ LBS FOR DTO ACCOMPLISHMENT. REF ALTERNATE MISSION ______.

   (2) THE HYBRID DEORBIT REDLINE THROUGHOUT THIS PERIOD IS THE PROPELLANT REQUIRED FOR A HYBRID DEORBIT FROM THE RENDEZVOUS ORBIT ≈ (130/134) AT THE END OF RENDEZVOUS CSM WEIGHT. IF THE CSM MUST SEPARATE EARLY FROM THE S-IVB/LM FOR SAFETY REASONS AND IT IS SUBSEQUENTLY DECIDED TO RENDEZVOUS AND ATTEMPT EXTRACTION, THE ONLY APPLICABLE REDLINE IS THE HYBRID DEORBIT REDLINE.

2. LM EXTRACTION TO SPS #6:

   (2) SAME AS (2) ABOVE

3. SPS #6 TO SPS #7:

   (3) PROPELLANT REQUIRED FOR A HYBRID DEORBIT FROM A ≈ 129/93 NM ORBIT.

4. SPS #7 TO SPS #8:

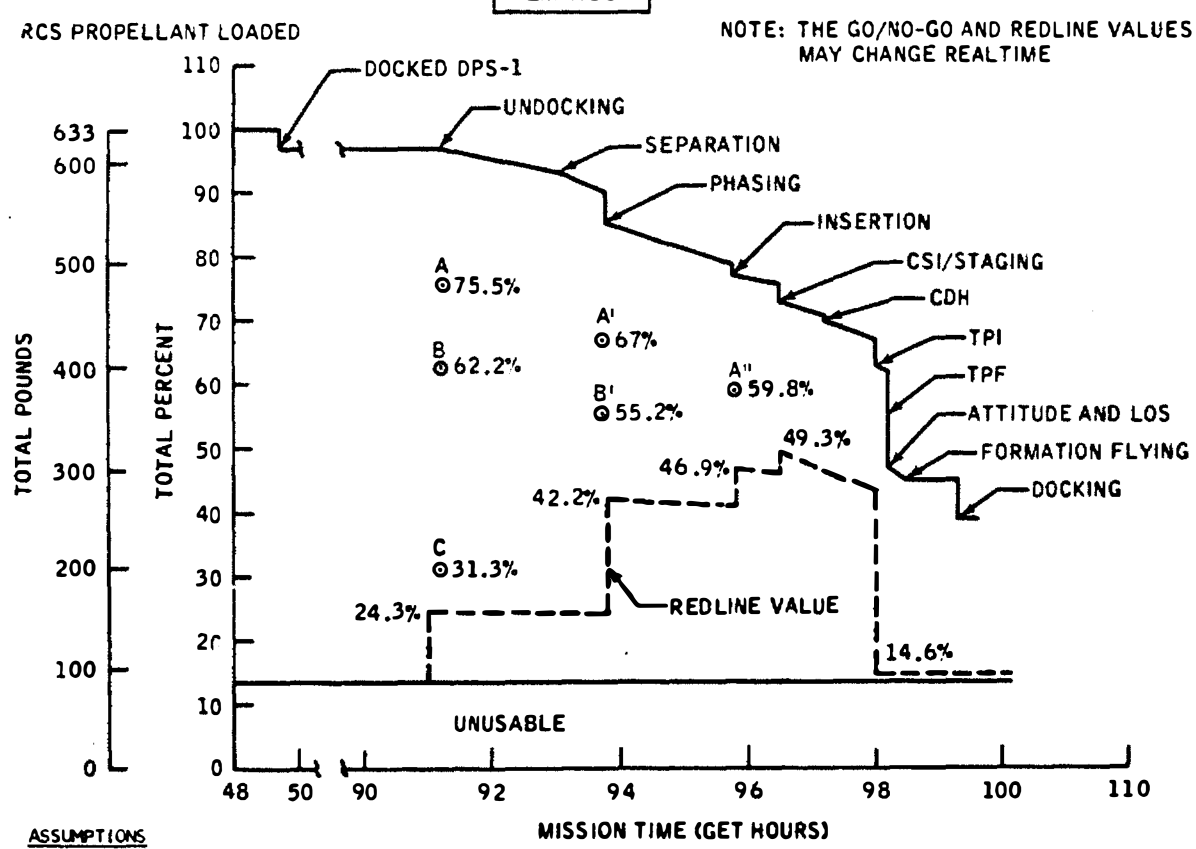
   (4) PROPELLANT REQUIRED FOR A HYBRID DEORBIT FROM A ≈ 210/93 NM ORBIT.

IN THE EVENT OF THE LOSS OF ONE SPS TVC SERVO LOOP, THE DEORBIT REDLINES WILL BE INCREASED BY 40 LBS IN THE AFFECTED AXIS TO ALLOW FOR RCS RECOVERY OF A SUBSEQUENT SPS HARDOVER.

AFTER RENDEZVOUS EVERY ATTEMPT WILL BE MADE TO STAY ABOVE THE SM RCS REDLINE (DAP). SPS #6 WILL BE CONSIDERED FOR EARLY EXECUTION TO MEET THIS OBJECTIVE.

| REV | ITEM | |
|---|---|---|
| | | **CSM SPS** |
| | 3-21 | THE NOMINAL END OF MISSION SPS PROPELLANT MARGIN IS APPROXIMATELY 2100 LBS. |
| | 3-22 | THE SPS PROPELLANT REDLINE TO PROVIDE A MINIMUM 40-SECOND POST-DOCKED DPS BURN, LM RESCUE, AND DEORBIT CAPABILITY FROM ANY POINT IN THE MOST STRINGENT NOMINAL ORBIT IS 14.1 PERCENT INDICATED PROPELLANT REMAINING. |
| | 3-23 | THE SPS PROPELLANT REDLINE TO PROVIDE 21 SECONDS OF BURN FOR LM RESCUE PLUS DEORBIT CAPABILITY FROM ANY POINT IN THE MOST STRINGENT NOMINAL ORBIT IS 7.3 PERCENT INDICATED PROPELLANT REMAINING. |
| | 3-24 | THE SPS PROPELLANT REDLINE TO PROVIDE A DEORBIT CAPABILITY OF 620 FPS IS 3.6 PERCENT INDICATED PROPELLANT REMAINING AND IS SUFFICIENT TO ACCOMPLISH DEORBIT FROM ANY POINT IN THE MOST STRINGENT NOMINAL ORBIT. |
| | | **CSM CRYOGENICS AND WATER** |
| A | 3-25 | THE NOMINAL END OF MISSION MARGINS FOR CSM CRYOGENICS ARE: $H_2$ - 10.15 LBS, AND $O_2$ - 150.3 LBS |
| | 3-26 | THE MINIMUM REQUIREMENT TO CONTINUE PAST A DAILY GO/NO-GO PTP IS SUFFICIENT CRYOGENICS AND WATER TO SUPPLY FUEL CELL AND ECS DEMANDS TO THE NEXT DAILY GO/NO-GO PTP PLUS TWO REVOLUTIONS. |
| | 3-27 | THE MINIMUM REQUIREMENT TO INITIATE A MISSION PHASE IS (1) SUFFICIENT CRYOGENICS AND WATER TO SUPPLY FUEL CELL AND ECS DEMANDS FOR THAT PHASE, (2) THE SUBSEQUENT DEMANDS TO THE NEXT BEST PTP AFTER COMPLETION OF THE PHASE, AND (3) TWO EXTRA REVOLUTIONS. |
| | 3-28 | IF THE CRYOGENICS OR WATER ARE PREDICTED TO BE INSUFFICIENT FOR THE TOTAL MISSION, AN ALTERNATE MISSION MAY BE SELECTED IMMEDIATELY EVEN THOUGH THE DAILY GO/NO-GO PTP REQUIREMENTS ARE SATISFIED. |
| | | RULE NUMBERS 3-29 THROUGH 3-30 ARE RESERVED. |

| REV | ITEM | |
|---|---|---|
| A | 3-31 | LM RCS |




ASSUMPTIONS

A. TRAPPED PROPELLANT - 42.1 LBS
GAGING UNCERTAINTY - 44.3 LBS

86.4 LBS (UNUSABLE AND NOT SHOWN ON GRAPH)

B. OPS RESERVE = 1 REV OF LM ACTIVE STATION KEEPING (27 LBS). AFTER TPI, OPS RESERVE = 6 LBS

GO/NO-GO'S ( )

UNDOCKING/SEPARATION:

A. PROPELLANT REQUIRED FOR UNDOCKING AND NOMINAL RENDEZVOUS PLUS OPS RESERVE

B. PROPELLANT REQUIRED FOR UNDOCKING AND FOOTBALL RENDEZVOUS PLUS OPS RESERVE

C. PROPELLANT REQUIRED FOR UNDOCKING AND MINI-FOOTBALL RENDEZVOUS PLUS OPS RESERVE

PHASING:

A'. PROPELLANT REQUIRED FOR PHASING AND NOMINAL RENDEZVOUS PLUS OPS RESERVE

B'. PROPELLANT REQUIRED FOR PHASING AND FOOTBALL RENDEZVOUS PLUS OPS RESERVE

INSERTION:

A". PROPELLANT REQUIRED FOR INSERTION AND NOMINAL RENDEZVOUS PLUS OPS RESERVE

REDLINES

UNDOCKING-TO-PHASING:

1. PROPELLANT REQUIRED FOR DOCKING PLUS OPS RESERVE.

PHASING-TO-INSERTION:

2. PROPELLANT REQUIRED IN THE FOOTBALL RENDEZVOUS FOR NARROW DEADBAND ATTITUDE HOLD TO BRAKING, TPI, BRAKING, DOCKING, PLUS OPS RESERVE

INSERTION-TO-TPI:

3. PROPELLANT REQUIRED IN THE NOMINAL RENDEZVOUS FOR NARROW DEADBAND ATTITUDE HOLD TO BRAKING, TPI, BRAKING, DOCKING, PLUS OPS RESERVE

TPI-TO-DOCKING:

4. PROPELLANT REQUIRED FOR OPS RESERVE.

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | | **LM DPS** |
| | 3-32 | THE NOMINAL DPS PROPELLANT MARGIN IS APPROXIMATELY 7000 LBS. THERE ARE NO REDLINES OR GO/NO-GO'S PLANNED. |
| | | **LM APS** |
| | 3-33 | THE NOMINAL APS PROPELLANT MARGIN AT THE BEGINNING OF THE APS DEPLETION BURN IS APPROXIMATELY 4200 LBS. THERE ARE NO REDLINES OR GO/NO-GO'S PLANNED. |
| | | **LM EPS** |
| | 3-34 | LM DESCENT STAGE BATTERIES:<br>A. ALL DESCENT STAGE BATTERY LIFETIME WILL BE AVAILABLE TO ASSURE SUCCESSFUL ACCOMPLISHMENT OF THE DOCKED LM EVALUATION.<br>B. EVA WILL BE DELETED OR TERMINATED EARLY IN ORDER TO MAINTAIN SUFFICIENT LIFETIME TO PERFORM THE RENDEZVOUS.<br>C. FOLLOWING MANNED LM UNDOCKING, ALL REMAINING DESCENT POWER WILL BE COMMITTED TO SUCCESSFUL COMPLETION OF UNDOCKED ACTIVITIES.<br>D. IF THE AMP HOUR USAGE EXTRAPOLATION INDICATES THE DESCENT BATTERIES WILL BE DEPLETED PRIOR TO THE NOMINAL TIME OF STAGING, THE RENDEZVOUS INSERTION BURN WILL NOT BE PERFORMED.<br>E. ONLY THAT PORTION OF THE RENDEZVOUS WILL BE ATTEMPTED WHICH WILL GUARANTEE SUFFICIENT AMP HOURS REMAINING TO PERFORM THE APS DEPLETION BURN.<br>F. REFERENCE FIGURE 3-1 |
| | 3-35 | LM ASCENT STAGE BATTERIES:<br>A. LM ASCENT BATTERIES MAY BE USED IF NECESSARY TO SUCCESSFULLY ACCOMPLISH DOCKED LM EVALUATION. LM ASCENT AMP HOURS WILL NOT BE AVAILABLE FOR EVA, BUT WILL BE RESERVED FOR UNDOCKED ACTIVITIES.<br>B. BEFORE COMMITTING TO A RENDEZVOUS, SUFFICIENT COMBINED ASCENT AND DESCENT BATTERY POWER MUST BE AVAILABLE TO ACCOMPLISH THE RENDEZVOUS with 150 AH Reserves AND THE APS DEPLETION BURN.<br>C. THE INSERTION BURN WILL NOT BE PERFORMED IF EXTRAPOLATION OF ASCENT BATTERY PROFILE INDICATES THAT A DELAYED STAGING WILL BE NECESSARY IN ORDER TO MEET THE LIFETIME REQUIRED FOR RENDEZVOUS AND DOCKING PLUS TWO REVOLUTIONS.<br>D. REF FIGURE 3-1 |
| | 3-36 | AFTER COMMITTING TO RENDEZVOUS, THE LM WILL PERFORM THE RENDEZVOUS MANEUVERS AS LONG AS THERE IS POWER ENOUGH TO COMPLETE THAT MANEUVER AND POWERED DOWN FLIGHT THROUGH CSM RESCUE. |
| | | **LM $O_2$/WATER** |
| | 3-37 | THE LM $O_2$ AND $H_2O$ MINIMUM REQUIREMENTS TO INITIATE AN ACTIVE LM MISSION PHASE IS SUFFICIENT $O_2$/WATER TO MEET ECS DEMANDS FOR THAT PHASE PLUS TWO REVOLUTIONS. |
| | 3-38 | THE INSERTION BURN WILL NOT BE PERFORMED IF EXTRAPOLATION OF TRENDS INDICATE THAT A DELAYED STAGING WILL BE NECESSARY IN ORDER TO MEET THE REQUIRED ECS DEMANDS FOR RENDEZVOUS AND DOCKING PLUS TWO REVOLUTIONS. |

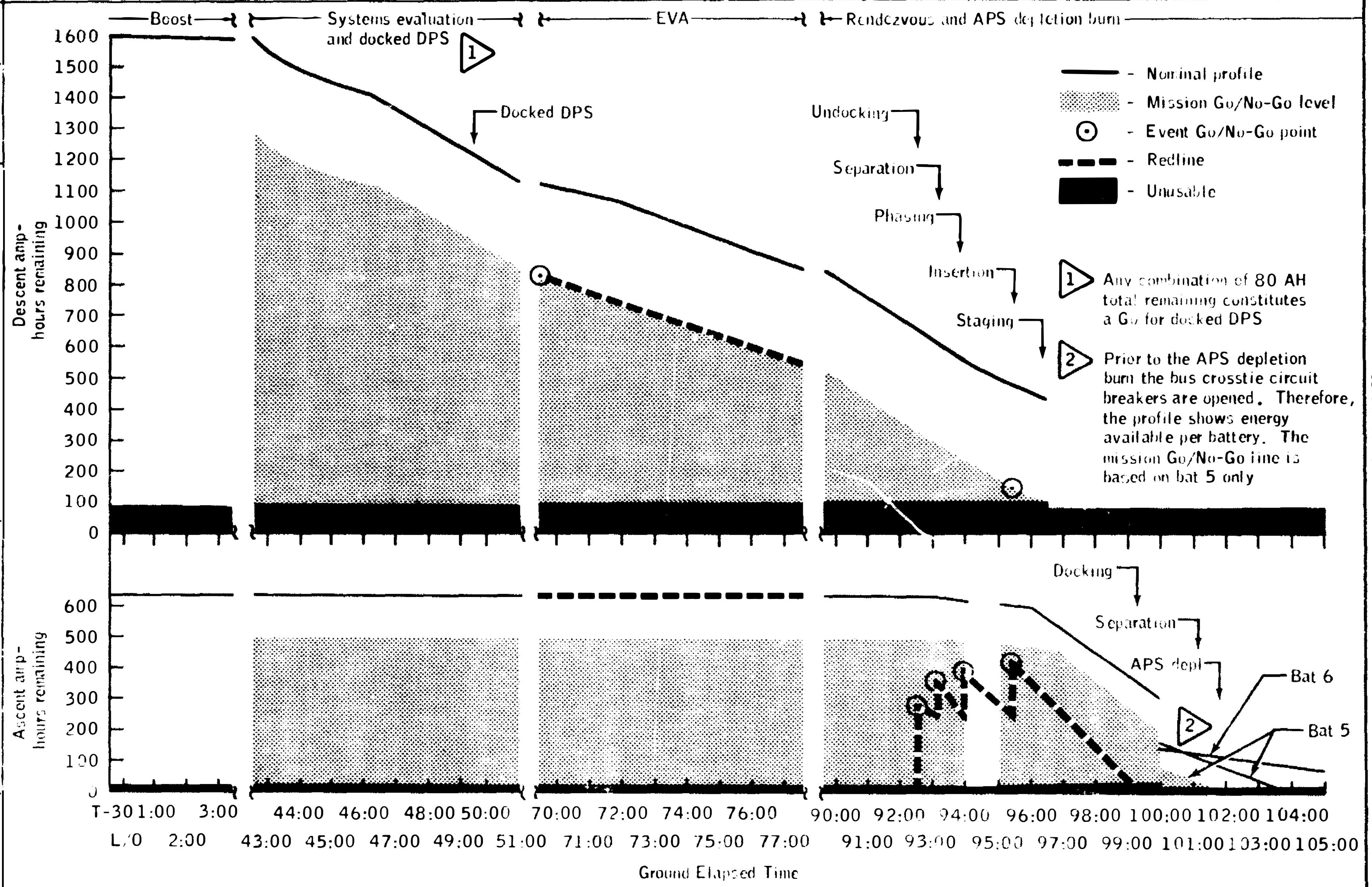


Figure 3-1.- LM EPS consumables plot.

| REV | ITEM | PLSS |
|---|---|---|
| | 3-39 | THE PLSS PRIMARY OXYGEN SUBSYSTEM (POS) IS CONSIDERED TO HAVE NOMINAL SOURCE PRESSURE OF 850 PSIA. THE CONSUMABLE PROFILE TO SUPPORT THE EVA PHASE IS DEFINED AS FOLLOWS: |

| ALLOWANCES | PRESSURE PSIA | QUANTITY (LBS MASS) |
|---|---|---|
| A. USABLE | | |
| (1) PLANNING ALLOWANCE** | 660 | .811 |
| (2) OPERATIONAL RESERVE | 60 | 0.076 |
| B. UNUSABLE | | |
| (1) MEASUREMENT INACCURACIES | 45 | 0.056 |
| (2) RESIDUAL | 85 | 0.105 |
| C. TOTAL | 850 | 1.048 |

**BASED ON WORSE CASE LEAK RATE .4 PSID/MIN AT 8.35 PSIA.
*ALL PRESSURES ARE TAKEN AT THE NOMINAL OF 70°F.

3-40 THE PRIMARY OXYGEN SUBSYSTEM (POS) CONSUMABLE PROFILE TO SUPPORT A CONTINGENCY TRANSFER IS DEFINED AS FOLLOWS:

| ALLOWANCES | PRESSURE PSIA | QUANTITY LBS. MASS |
|---|---|---|
| A. USABLE | | |
| PLANNING ALLOWANCE* | 270 | 0.325 |
| B. UNUSABLE | | |
| (1) MEASUREMENT INACCURACIES | 45 | 0.056 |
| (2) RESIDUAL | 85 | 0.105 |
| C. TOTAL | 400 | .486 |

*THE PLANNING ALLOWANCE INCLUDES DEPRESS AND REPRESS ALLOWANCES, C/O, METABOLIC EXPENDITURE AND WORSE CASE LEAK RATE OF 0.4 PSID/MIN AT 8.85 PSIA.

3-41 THE PLSS BATTERY IS CONSIDERED TO HAVE A MINIMUM OF 14.3 AMP-HR CAPABILITY. THE CONSUMABLE PROFILE TO SUPPORT THE EVA PHASE IS DEFINED AS FOLLOWS:

| | POWER (AMP-HRS) |
|---|---|
| 1. USABLE | |
| (A) PLANNING ALLOWANCE | 10.00 |
| (B) OPERATIONAL RESERVE | 2.90** |
| 2. UNUSABLE | |
| MEASUREMENT INACCURACY | 1.40* |
| 3. TOTAL CHARGE | 14.30 |

**THE 2.90 + 1.40 (4.3) AMP-HRS OPERATIONAL RESERVE IS REQUIRED FOR CONTINGENCY TRANSFER.
*10 PERCENT MEASUREMENT INACCURACY IS DUE TO INSTRUMENTATION ERROR AND THE UNCERTAINTIES OF THE POWER PROFILE DURING ABSENCE OF STATION COVERAGE.

4 GROUND INSTRUMENTATION REQUIREMENTS

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 4-1 | GENERAL |

A. THE FOLLOWING PRELAUNCH REQUIREMENTS DEFINE THE MCC/MSFN REQUIREMENTS WHICH MUST BE MET BEFORE A "GO" IS GIVEN FOR LAUNCH.

B. WHEN A SPECIFIC HARDWARE ITEM OR OPERATIONAL CAPABILITY IS DEFINED AS A MANDATORY ITEM, THE HARDWARE AND/OR SOFTWARE INTERFACE REQUIRED TO PROVIDE THE MANDATORY FUNCTIONS OF THAT HARDWARE ITEM OR OPERATIONAL CAPABILITY ARE TO ASSUME A MANDATORY STATUS ALSO.

C. WHERE REDUNDANCY EXISTS FOR MANDATORY ITEMS, A BACKUP CAPABILITY IS CONSIDERED HIGHLY DESIRABLE.

NOTE 1

THE VARIOUS EQUIPMENT LISTINGS IN THIS SECTION ARE TO BE UTILIZED AS A GUIDE ONLY. IT IS MANDATORY, PRIOR TO COMMITTING THE MISSION TO LAUNCH, TO BE ABLE TO:

A. RECEIVE AND DISPLAY TELEMETRY AND TRACKING DATA.
B. MAINTAIN VOICE COMMUNICATIONS WITH THE CREW.

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 4-2 | COMPUTER | | | |
| | | A. MOC (IBM 360/75) | PRE LN | MANDATORY | TO PROCESS MANDATORY S/V PARAMETERS AND TRAJECTORY DATA. |
| | | B. DSC (IBM 360/75) | PRE LN | HIGHLY DESIRABLE | AN SSC (IBM 360/75) IS AVAILABLE AS BACKUP TO THE MOC OR DSC. |
| | | C. CCATS (UNIVAC 494) - ONLINE<br>D. CCATS (UNIVAC 494) - STANDBY | PRE LN | 1 MANDATORY AND 1 HIGHLY DESIRABLE | ALL DATA ENTERING OR LEAVING MCC MUST BE ROUTED BY CCATS. |
| | | E. RTACF - 2 | PRE LN | 1 HIGHLY DESIRABLE | |
| A | 4-3 | COMMAND | | | |
| | | A. MOCR TOGGLE SWITCHES (BOTH A AND B) | | | |
| | | 1. BSE ABORT REQUEST | PRE LN | HIGHLY DESIRABLE | FOR LAUNCH PHASE ABORT REQUEST |
| | | 2. FIDO ABORT REQUEST | PRE LN | HIGHLY DESIRABLE | |
| | | 3. FD ABORT REQUEST | PRE LN | HIGHLY DESIRABLE | |
| | | B. MOCR COMMAND PANELS: EECOM, GUIDO, BSE, TELCOM, CONTROL | PRE LN | 1 OF 5 MANDATORY | REQUIRED TO SATISFY RULE 4-21 |
| | | C. MOCR CONSOLE/SITE SELECT CAPABILITY | | | |
| | | 1. RTC CONSOLE (CCATS)<br>2. CCATS CMD CONSOLE MED | PRE LN | 1 OF 2 MANDATORY | REQUIRED TO SITE SELECT A CONSOLE SO THAT COMMANDING CAN BE ACCOMPLISHED |
| | | D. FC/MSO SWITCHING CAPABILITY | | HIGHLY DESIRABLE | |
| | | 1. FLIGHT DIRECTOR<br>2. CCATS CMD MED | PRE LN | 1 OF 2 MANDATORY | REQUIRED TO ENABLE MCC OUTPUT COMMANDING |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 4-4 | TELEMETRY | | | |
| | | A. CONSOLE DISPLAY (D/TV, EVENTS, ANALOGS) | PRE LN | MANDATORY | FOR DISPLAY OF MANDATORY S/V PARAMETERS. |
| | | B. PCM GROUND STATIONS (4) | PRE LN | 1 OF 4 MANDATORY, 1 HIGHLY DESIRABLE | FOR DISPLAY OF MANDATORY S/V EVENTS AND ANALOGS. |
| | | C. RECORDING AND PLAYBACK | | | |
| | | ALDS } MSFN } | PRE LN | BOTH DESIRABLE | |
| | | D. FM - GROUND STATION | PRE LN | 1 OF 2 MANDATORY | TO PROVIDE MANDATORY DISPLAY DATA FOR THE MCC SURGEON. |
| A | 4-5 | TRAJECTORY | | | |
| | | A. TRAJECTORY DATA PROCESSING | | | THE TRAJECTORY DATA SOURCES ARE UTILIZED AS FOLLOWS: |
| | | 1. AVAILABILITY OF ONE INDEPENDENT TRACKING SOURCE ($IP_R$, USB) FROM LIFTOFF TO T+10 MINUTES. | PRE LN | 1 MANDATORY | 1. INDEPENDENT VERIFICATION OF L/V NAVIGATION. 2. PROTECT AGAINST VIOLATION OF LAUNCH ENVELOPE. |
| \| | | 2. IU AND CMC TLM VECTORS FROM LIFTOFF TO INSERTION PLUS 60 SECONDS. | PRE LN | BOTH MANDATORY | REQUIRED FOR MAKING ORBIT GO/NO-GO DECISION |
| \| | | B. RTCC - DATA SELECT CAPABILITY | PRE LN | MANDATORY | REQUIRED TO SELECT BEST AVAILABLE TRACKING SOURCE FOR INPUT TO RTCC FOR ORBITAL DETERMINATION. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 4-6 | MCC POWER | | | |
| | | A. BUS $A_1$ | PRE LN | MANDATORY | UNINTERRUPTABLE POWER FOR:<br>WIDE BAND CROSSBAR SWITCH |
| | | B. BUS $A_2$ | PRE LN | MANDATORY | UNINTERRUPTABLE POWER FOR:<br>D/TV DATA DISTRIBUTORS |
| | | C. BUS $B_1$ | PRE LN | MANDATORY | 20 SECONDS INTERRUPTABLE POWER FOR:<br>PLOTBOARDS |
| | | D. BUS $B_2$ | PRE LN | MANDATORY | 20 SECONDS INTERRUPTABLE POWER FOR:<br>VIDEO SWITCHING MATRIX (VSM) |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 4-7 | DISPLAY | | | |
| | | A. MOCR D/TV CHANNELS | PRE LN/LN | 22 OF 36 MANDATORY TO T-10 MIN. 20 OF 36 MANDATORY AFTER T-10 MIN TO T-20 SEC | GNC - 3, EECOM - 3, RTCC - 1, FIDO/GUIDO/RETRO - 4, BSE - 8, SURGEON - 2, TELCOM - 1, CONTROL - 1. |
| | | MSK NUMBER | | | |
| | | GNC (3 CHANNELS) | | | |
| | | 1. 0683 | | GNC PRIMARY | |
| | | 2. 0966 | | CMC COMMON | |
| | | 3. EXTRA | | ONE EXTRA CHANNEL IS REQUIRED TO OBSERVE VARIOUS OTHER DISPLAYS WHICH WHILE THEY MAY HAVE NO MANDATORY MEASUREMENTS, HAVE GROUPS OF PARAMETERS THAT ARE MANDATORY IN TOTAL. | |
| | | EECOM (3 CHANNELS) | | | |
| | | 4. 0443 | | EPS COMMUNICATIONS | |
| | | 5. 0613 | | ECS CRYO | |
| | | 6. 0518 | | EPS HIGH DENSITY | |
| | | RTCC (1 CHANNEL) | | | |
| | | 7. ONE CHANNEL TO BE SHARED BY THE FOLLOWING DISPLAYS: | | GAMMA VS VELOCITY (BEST SOURCE)<br>GAMMA VS VELOCITY (RAW) | DATA SELECT IS DISPLAYING 4 TRACKING DATA SOURCES (2 PER CHANNEL) FOR RTCC TRAJECTORY PROCESSING. |
| | | 1613<br>1614<br>2001 | | (IBM) TM STATUS NO. 1 - DISPLAYS COMPUTER EVENTS, TIMING, INPUT/OUTPUT COMPUTER STATUS. | |
| | | FIDO, GUIDO, RETRO (4 CHANNELS) | | | |
| | | 8. 0043 | | FIDO LAUNCH DIGITALS | ONLY DISPLAY SOURCE FOR MODE 4 ABORTS. |
| | | 9. 0330 | | RFO LAUNCH DIGITAL | ONLY DISPLAY SOURCE FOR MODE 3 ABORTS. |
| | | 10. ONE CHANNEL | | GUIDANCE INSERTION/INJECTION DIGITALS | REQUIRED FOR G&N GO/NO-GO DECISIONS. |
| | | BOOSTER (8 CHANNELS) | | | |
| | | 12. 1402 | | BSE NO. 1 | ALL IC/S-II |
| | | 13. 1403 | | BSE NO. 2 S-IVB/IU | MOST ALL S-IVB PROPELLANT DATA. |
| | | 14. 1404 | | BSE NO. 3 | GUIDANCE/NAVIGATION DATA. |
| | | 15. 1400 } 1 OF 3 | | GND NO. 1 | GUIDANCE/NAVIGATION DATA. |
| | | 1401 } | | GND NO. 2 | DIGITAL SYSTEMS DATA. |
| | | 1411 } | | GND NO. 3 | DIGITAL SYSTEMS DATA. |
| | | 16. 1416 | | ACS NO. 1 | ATTITUDE CONTROL DATA. |
| | | 17. 1405 | | PSS NO. 1/LAUNCH | PROPULSION DATA. |
| | | 18. 1407 | | ENS NO. 1 | ELECTRICAL ALL STAGES AND IU/ECS. |
| | | 19. 0231 | | SWITCH SELECTOR COMMAND TABLES | |
| | | SURGEON (2 CHANNELS) | | | |
| | | 20. 1700 } 1 OF 3 | | CSM/CDR BIO ENVMTL | |
| | | 1703 } | | CSM/CMP BIO ENVMTL | |
| | | 1706 } | | CSM/LMP BIO ENVMTL | |
| | | 21. 1709 | | ALL ASTROS ENVMTL | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 4-7 (CONT) | TELCOM (1 CHANNEL)<br>22. 1091, 1051 } 1 OF 2 | | ELEC/COM · R/T<br>LM ECS · R/T | LM DISPLAYS WILL BE RELEASED AT T-10 MINUTES. |
| | | CONTROL (1 CHANNEL)<br>23. 1123, 1125, 1127, 1137 } 1 OF 4 | | GNC/PROP · CONTROL R/T<br>PROP · R/T<br>AGS · R/T<br>GNC · R/T | |
| | | B. TRAJECTORY DISPLAY | | | |
| | | 1. FDO LAUNCH DIGITALS | PRE LN | MANDATORY ON D/TV | FOR CONTINGENCY ORBIT INSERTION MANEUVER DATA AND $T_{FF}$ LIMITS. |
| | | 2. $\gamma$ VS V | PRE LN | MANDATORY 1 OF 4:<br>A. 10 X 20 SCRIBER PLOTTER<br>B. D/TV<br>C. RTCC PLOTBOARD<br>D. SSR PLOTBOARD | FROM SELECTED TRACKING DATA SOURCE. THE PLOT PROVIDES A MONITOR OF L/V PERFORMANCE. |
| | | 3. RFO LAUNCH DIGITALS | PRE LN | MANDATORY ON D/TV | MONITOR FOR MODES III AND IB MANEUVER DATA. |
| | | 4. $\gamma_{EI}$ VS $V_{EI}$ | PRE LN | MANDATORY OF 1 OF 2<br>A. D/TV<br>B. SSR PLOTBOARD | MONITOR FOR G-LIMIT VIOLATION |
| | | 5. $\phi$ VS $\lambda$ | PRE LN | MANDATORY ON 1 OF 2:<br>A. RTCC PLOTBOARD<br>B. SSR PLOTBOARD | MONITOR FOR CROSS-RANGE LIMITS |
| | | 6. $T_{FF}$ VS $R_{IP}$ | PRE LN | HIGHLY DESIRABLE ON 1 OF 2:<br>A. D/TV<br>B. SSR PLOTBOARD | MONITOR FOR ABORT MODES II, III, AND IB. |
| | | 7. h VS d | PRE LN | MANDATORY ON 10 X 20 SCRIBER PLOTTER | MONITOR FOR VEHICLE BREAKUP LIMIT |
| | | 8. $\gamma_i$ VS $V_i$ (CMC DYNAMIC STATUS) | PRE LN | HIGHLY DESIRABLE ON 10 X 10 SCRIBER PLOTTER | MONITOR FOR L/V AND S/C NAVIGATION PERFORMANCE (GUIDANCE SYSTEM ANALYSIS - COMPARES CMC WITH TRACKING) |
| | | 9. WEDGE ANGLE MONITOR | PRE LN | HIGHLY DESIRABLE ON D/TV | MONITOR FOR L/V AND S/C NAVIGATION PERFORMANCE |
| \| | | 10. GUIDO ANALOG CHART RECORDERS ONE AND TWO | PRE LN | HIGHLY DESIRABLE VIA SSR OPAQUE TV | |
| \| | | 11. GUIDANCE INSERTION/INJECTION DIGITALS | PRE LN | MANDATORY ON D/TV | REQUIRED TO MAKE G&N GO/NO-GO DECISIONS. |
| | | C. ADEG CHANNELS 90-93 | PRE LN | HIGHLY DESIRABLE | FOR DSC DISPLAYS |
| | | D. VIDEO SWITCHING MATRIX | PRE LN | MANDATORY | REQUIRED FOR DISPLAYING MANDATORY DISPLAYS |
| | | E. AUX VSM | PRE LN | HIGHLY DESIRABLE | |
| | | F. EIDOPHORS (3) | PRE LN | 2 HIGHLY DESIRABLE | |

NOTE: INDIVIDUAL FLIGHT CONTROLLERS WILL BE RESPONSIBLE FOR REPORTING LOSS OF DISPLAY CAPABILITY OF MANDATORY PARAMETERS TO THE FLIGHT DIRECTOR.

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 4-8 | TIMING | | | |
| | | A. MITE (2) | PRE LN | 1 MANDATORY | MCC TIMING STANDARD TO SUPPORT MANDATORY RTCC/CCATS COMPUTERS |
| | 4-9 | COMMUNICATIONS | | | |
| | | A. MOCR<br>FD LOOP<br>AFD CONF LOOP | PRE LN | 1 OF 2 MANDATORY | FOR MISSION CONTROL |
| | | MOCR SYS 1 & 2<br>MOCR DYN<br>A/G 1 LOOP<br>A/G 2 LOOP | PRE LN | ALL HIGHLY DESIRABLE | |
| | | B. MCC/LAUNCH COMPLEX<br>121 CLTC<br>111 CVTS<br>212 MSTC | PRE LN | 1 OF 3 MANDATORY | FOR TERMINAL COUNT COORDINATION OF MCC - PAD ACTIVITIES |
| | | C. MCC/RSO<br>FD LINE TO RSO<br>RSO PRIVATE LINE<br>CAPE 111 RSO LOOP | PRE LN | 2 OF 3 MANDATORY | FOR TRAJECTORY VERIFICATION AND BOOSTER SAFING |
| | | D. MISCELLANEOUS<br>BSE TM MONITOR LOOP<br>CIF/USB LOOP | PRE LN | BOTH HIGHLY DESIRABLE | USED FOR MONITORING SPACE VEHICLES SUBSYSTEM CHECKOUT |
| | | E. MCC/REMOTED SITES<br>SEE A/G COMMUNICATIONS RULES 4-18 AND 4-19 | PRE LN | | |
| | | RULE NUMBERS 4-10 THROUGH 4-15 ARE RESERVED. | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 4-16 | GSFC | | | |
| | | A. GSFC UNIVAC - 494 (2) COMMUNICATIONS PROCESSOR | PRE LN | 1 MANDATORY | A. ONE UNIVAC - 494 CAN PERFROM ALL NECESSARY FUNCTIONS, THE SECOND ONE IS BACKUP. |
| | | B. WBD (50.0 KBPS) LINES (2) BETWEEN MCC AND GSFC | PRE LN | 1 MANDATORY | B. EITHER LINE CAN BE SWITCHED TO EITHER UNIVAC - 494. |
| | | C. TTY CIRCUITS BETWEEN MCC AND GSFC | | | |
| | | 1. TEXT CIRCUITS (TRANSMIT ONLY) | PRE LN | 1 OF 6 HIGHLY DESIRABLE | C.1. FOR ACQ MSG, LS CMD |
| | | 2. SIX LOW-SPEED (JJ) CIRCUITS | PRE LN | 1 OF 6 MANDATORY | 2. FOR RECEPTION OF LOW-SPEED RADAR DATA. |
| | 4-17 | KSC | | | |
| | | TELEMETRY: | | | |
| | | A. DATA CORE (2) | PRE LN | HIGHLY DESIRABLE | A. EITHER DATA CORE CAN BE SWITCHED TO EITHER ALDS COMPUTER. ONLY SIC SOURCE TO MCC. |
| | | B. SDS - 930 (2) ALDS COMPUTER | PRE LN | HIGHLY DESIRABLE | B. EITHER SDS - 930 CAN RECEIVE INPUTS FROM EITHER DATA CORE AND CAN OUTPUT ON EITHER WBD (50.0 KBPS) LINE. |
| | | C. WBD (40.8 KBPS) LINES BETWEEN MCC AND KSC (2) | PRE LN | HIGHLY DESIRABLE | C. EITHER CAN BE SWITCHED TO EITHER ALDS COMPUTER. |
| | | D. VHF TM FROM THE FOLLOWING: 1. TEL IV - 30-FT DISH, 2. CIF ANTENNA, OR 3. MILA VHF ANTENNA | PRE LN | 1 MANDATORY | D. ALTHOUGH THE MILA VHF ANTENNA IS PRIME, THE OTHER ANTENNAS CAN ALSO BE SWITCHED TO EITHER DATA CORE. DATA FROM THESE ANTENNAS CAN BE SENT TO THE MILA USB SITE PCM GROUND STATIONS VIA HARD-LINE TO BACKUP THE MILA VHF ANTENNA. VHF IS THE S-II'S ONLY SOURCE OF DATA |
| | | E. USB TM FROM THE FOLLOWING: 1. MILA USB, OR 2. MANDY USB | | 1 MANDATORY | E. USB IS THE CSM'S ONLY SOURCE OF DATA. |
| | | COMMAND: | | | |
| | | THIS CAPABILITY IS DEFINED UNDER GSFC/KSC/MSFN COMMAND RULE 4-18A FOR LAUNCH COVERAGE. | | | |
| | | TRACKING: | | | |
| | | THAT CAPABILITY REQUIRED TO SATISFY RULE 4-5 (TRAJECTORY) IS MANDATORY. | | | |
| | | VOICE COMMUNICATIONS: | | | |
| | | THAT CAPABILITY REQUIRED TO SATISFY MCC RULE 4-9 (COMMUNICATIONS) IS MANDATORY. | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 4-18 | LAUNCH COVERAGE | | | |
| | | KSC/MSFN SITES MUST PROVIDE THE FOLLOWING CAPABILITIES: | | | |
| | | A. CMD | | | |
| | | CCS | PRE LN | HIGHLY DESIRABLE AT BDA OR VAN | TO BACKUP CRITICAL SLV FUNCTIONS. |
| | | B. TELEMETRY S-IC (VHF) | PRE LN | HIGHLY DESIRABLE | S-IC DATA IS ONLY HIGHLY DESIRABLE SINCE THE MCC IS NOT PRIME FOR REQUESTING AN ABORT FOR S-IC MALFUNCTIONS. |
| | | S-II(VHF) | PRE LN | MANDATORY FROM LIFTOFF TO S-II CUTOFF (APPROX: 8 + 36 SEC) | MCC IS PRIME FOR REQUESTING AN ABORT FOR S-II MALFUNCTIONS. |
| | | S-IVB VHF (CP-1)<br>IU CCS (DP-1B) | PRE LN<br>PRE LN | } 1 OF 2 MANDATORY FROM LIFTOFF TO S-IVB CUTOFF PLUS 60 SEC. | MCC IS PRIME FOR REQUESTING AN ABORT FOR S-IVB MALFUNCTIONS. |
| | | IU VHF (DP-1)<br>IU S-BAND (DP-1A) | PRE LN<br>PRE LN | } 1 OF 2 MANDATORY FROM LIFTOFF TO S-IVB CUTOFF PLUS 60 SEC. | |
| | | CSM (USB) | PRE LN | MANDATORY FROM LIFTOFF THROUGH S-IVB CUTOFF PLUS 60 SEC. | FOR ABORT CUES FROM MCC |
| | | C. TRACKING | | | |
| | | THAT CAPABILITY REQUIRED TO SATISFY RULE 4-5 (TRAJECTORY) IS MANDATORY | | | |
| | | D. A/G COMMUNICATIONS | | | |
| | | 1. LIFTOFF THROUGH MILA LOS. | PRE LN | ONE A/G PATH (VIA GSFC OR A/G LONGLINE BETWEEN MCC/KSC) 1 OF 2 MANDATORY | TO PROVIDE ABORT RECOMMENDATIONS TO THE CREW. |
| | | 2. POST MILA LOS | PRE LN | ONE A/G PATH VIA GSFC IS MANDATORY | TO RELAY APOGEE KICK DATA TO THE CREW. |
| | | 3. VAN OR CYI | | | |
| A | 4-19 | GENERAL ORBITAL COVERAGE | | | |
| | | IT IS REQUIRED THE MSFN HAVE THE CAPABILITY OF PROVIDING THE MCC THE MINIMUM MISSION CONTROL SUPPORT LISTED BELOW OF 2 MSFN USB SITES PER REVOLUTION THROUGH REVOLUTION 5 FOR THE 6-4 GO/NO-GO DECISION, AND ONE MSFN USB SITE PER REVOLUTION THEREAFTER. | | | |
| | | A. CMD CCS | PRE LN | HIGHLY DESIRABLE | |
| | | CSM USB | PRE LN | HIGHLY DESIRABLE | |
| | | B. TELEMETRY | | | |
| | | S-IVB VHF (CP-1)<br>IU CCS (DP-1B) | PRE LN | } 1 OF 2 MANDATORY | ONE OF EACH PAIR OF DOWNLINKS IS REQUIRED TO RECOVER ALL S-IVB DATA. |
| | | IU VHF (DP-1)<br>IU S-BAND (DP-1A) | PRE LN | } 1 OF 2 MANDATORY | |
| | | CSM USB | PRE LN | MANDATORY | |
| | | C. TRACK C-BAND<br>USB | PRE LN<br>PRE LN | BOTH HIGHLY DESIRABLE | |
| | | D. A/G COMMUNICATIONS | PRE LN | ONE A/G PATH IS MANDATORY. | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 4-20 | REV 1 - CRO (OR HSK FOR USB ITEMS) | | | DATA MUST BE PROVIDED TO MCC SO THAT A GO/NO-GO DECISION CAN BE MADE FOR PTP 2-1. S-IVB SYSTEMS PERFORMANCE MUST BE EVALUATED TO INSURE CREW SAFETY WHILE ATTACHED TO S-IVB. |
| | | A. CMD CCS | PRE LN | HIGHLY DESIRABLE | |
| | | CSM USB | PRE LN | HIGHLY DESIRABLE | |
| | | B. TELEMETRY | | | |
| | | S-IVB VHF (CP-1) IU CCS (DP-1B) | PRE LN | 1 OF 2 MANDATORY | |
| | | IU VHF (DP-1) IU S-BAND (DP-1A) | PRE LN | 1 OF 2 MANDATORY | |
| | | CSM (USB) | PRE LN | MANDATORY | |
| | | C. TRACK C-BAND USB | PRE LN | BOTH HIGHLY DESIRABLE | |
| | | D. A/G COMMUNICATIONS | PRE LN | ONE A/G PATH IS MANDATORY | |
| A | 4-21 | REV 3/4 (AT APPROXIMATELY 4.5 HOURS) - HAW, RED, GYM<br>CMD CCS | | 1 OF 3 MSFN SITES MANDATORY | COMMAND CAPABILITY IS REQUIRED TO REMOVE AN INHIBIT WHICH ALLOWS THE S-IVB RESTART TO BE ACCOMPLISHED. |
| A | | RULE NUMBERS 4-22 THROUGH 4-25 ARE RESERVED | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 4-26 | RIOMETER NETWORK SITES | PRE LN | | |
| | | A. LIMA | | HIGHLY DESIRABLE | |
| | | B. CRO }<br>CYI } | | 1 OF 2 HIGHLY DESIRABLE | |

5 TRAJECTORY AND GUIDANCE

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 5-1 | THE LAUNCH PHASE WILL BE TERMINATED FOR THE FOLLOWING CONDITIONS:<br>A. VIOLATION OF VEHICLE BREAKUP LINE.<br>B. $T_{FF} \leq \underline{1+40}$ AND DECREASING AFTER TOWER JETTISON.<br>C. VIOLATION OF ENTRY "G" LIMIT.<br>D. V SAFE INCREASING.<br>E. OVERSPEED CONDITIONS AT INSERTION.<br>F. VIOLATION OF EXIT HEATING LIMITS. |
| | 5-2 | THE LES WILL NOT BE JETTISONED UNTIL MODE II CAPABILITY IS ESTABLISHED BY $T_{FF} \geq \underline{1+20}$ AND INCREASING. |
| A | 5-3 | DELETED |
| A | 5-4 | MODE II, III, IV AND APOGEE KICK.<br>A. THE GROUND IS PRIME FOR ABORT MODE DETERMINATION AND THE S/C IS PRIME FOR MANEUVER EXECUTION.<br>B. MANEUVERS WILL BE INTERRUPTED WHEN $T_{FF}$ = 1+40 AND DECREASING.<br>C. MODE IV MANEUVERS WILL BE INTERRUPTED IF THE CURRENT ALTITUDE IS 75 NM AND DECREASING AND Hp <400K FT<br>D. IF ENTERING, UTILIZE LIFT TO AVOID LAND.<br>E. IF NO SLA SEP OR IF SPS FAILS:<br>1. Hp <40 - DO NOT BURN, CM/SM SEP BY $T_{FF}$ = 1+40.<br>2. 40 <Hp <75 - GROUND WILL DECIDE TO USE SM RCS OR CM RCS ASAP OR AT APOGEE TO REDUCE Hp TO 40 NM (THE CM RCS WILL BE USED ONLY FOR THE NO SLA SEP CASES) |
| A | 5-5 | MODE III ABORTS.<br>A. PREDICTED $T_{FF}$ AFTER CUTOFF <1+40.<br>1. FULL LIFT IP ON WATER - DO NOT BURN.<br>2. G&N GO AND FULL LIFT IP ON LAND - BURN TO $T_{FF}$ = 1+40, RL 90°.<br>3. G&N NO-GO AND FULL LIFT IP ON LAND - BURN A REDUCED ΔV TO MAINTAIN $T_{FF} \underline{\geq}$1+40 AFTER C/O AND RL 90°.<br>B. IF $\Delta T_B \underline{\leq 2}$ SECONDS, DO NOT BURN.<br>C. IF NO IGNITION BY GETI +10 SECONDS, BURN UNTIL G&N ΔR = 0, RL 55°. (IF UNABLE TO BURN ΔR TO ZERO FLY RL90°.) ALL THRUSTING WILL BE TERMINATED AT $T_{FF}$ = 1+40. |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 5-6 | THE SPACECRAFT G&N WILL BE NO-GO FOR ABORT MANEUVER DETERMINATION AND MONITORING FOR THE FOLLOWING:<br>A. CMC PROGRAM FAILURE<br>B. RTCC AND CMC $T_{FF}$ DIFFERENCE $>\underline{40}$ SECONDS.<br>C. CONFIRMED ERROR IN S/C PLATFORM VELOCITY COMPONENTS OF $>\underline{50}$ FPS IN X OR $\underline{100}$ FPS IN Z.<br>D. |
| | 5-7 | THE ORBIT IS "GO" IF $h_p \geq 75$ NM.<br><br>RULE NUMBERS 5-8 THROUGH 5-19 ARE RESERVED FOR FURTHER LAUNCH RULES. |

| REV | ITEM | |
|---|---|---|
| | 5-20 | MANNED VEHICLE ORBITAL ALTITUDE CONSTRAINTS.<br>A. REAL-TIME MISSION PLANNING<br>PERIGEE - <u>80</u> NM MINIMUM. MAXIMUM IS DEFINED BY RCS REDLINES.<br>APOGEE - <u>TBD</u>. MAXIMUM<br>B. CONTINGENCY (VIOLATIONS MUST BE CORRECTED ASAP)<br>PERIGEE - 75 NM MINIMUM.<br>APOGEE - <u>TBD</u>. |
| | 5-21 | CONTINGENCY CSM SEPARATION MANEUVERS.<br>A. IMPENDING S-IVB OR UNMANNED LM EXPLOSION: 55 FPS SPS ASAP.<br>B. S-IVB OR UNMANNED LM ATTITUDE RATES $\geq$5°/SEC: 5 FPS RCS ASAP.<br>C. S-IVB OR UNMANNED LM YAW ATTITUDE >45°: 5 FPS RCS ASAP.<br>D. CSM DEORBIT REQUIRED WHILE ATTACHED TO S-IVB: MANEUVER CSM/S-IVB TO RETROGRADE, HEADS-UP, HORIZON MONITOR ATTITUDE; SEPARATE 20 MINUTES PRIOR TO PLANNED RETROFIRE (OR GROUND/CREW AGREED UPON TIME) WITH 5 FPS +X TRANSLATION.<br>E. CSM DEORBIT REQUIRED WHILE ATTACHED TO LM OR DOCKING RING: MANEUVER CSM/LM TO POSIGRADE, HEADS-DOWN, HORIZON MONITOR ATTITUDE; SEPARATE 20 MINUTES PRIOR TO PLANNED RETROFIRE (OR GROUND/CREW AGREED UPON TIME) WITH 5 FPS -X TRANSLATION. |
| | 5-22 | SPACECRAFT COMPUTER TIMING UPDATES ARE REQUIRED FOR SET ERRORS GREATER THAN:<br>A. LGC AND CMC ><u>0.5</u> SECONDS.<br>B. AGS ><u>.5</u> SECONDS.<br>C. SPACECRAFT L.O. TIME WILL BE REPLACED BY SRO L.O., ON THE GRD, IF THE DIFFERENCE BETWEEN CMC L.O. TIME AND SRO L.O. TIME IS >10 SEC. THE S/C WILL BE UPDATED TO THE SRO L.O. TIME.<br><br>RULE NUMBERS 5-23 THROUGH 5-29 ARE RESERVED FOR FURTHER ORBIT RULES. |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | 5-30 | MANEUVER RETARGETING AND STATE VECTOR UPDATES MAY BE REQUIRED WHEN RTCC TRAJECTORY UPDATES CAUSE PLANNED ORBITAL MANEUVERS TO RESULT IN UNACCEPTABLE TRAJECTORY CHARACTERISTICS. |
| | 5-31 | THE CMC (CSM) OR LGC (LM) WILL BE NO-GO FOR MANEUVERS FOR ANY OF THE FOLLOWING:<br>A. COMPUTER FAILURE.<br>B. CMC/IMU ALIGNMENT DISCREPANCY FOR MANEUVER, MONITORING AND ORBIT DETERMINATION.<br>1. SEXTANT STAR CHECK: AUTO OPTICS POSITIONING DOES NOT PLACE SELECTED STAR WITHIN 5 DEG OF THE CENTER OF THE TELESCOPE.<br>2. HORIZON CHECK ERROR >4 DEG FOR RETROFIRE.<br>C. LGC/IMU ALIGNMENT DISCREPANCY.<br>1. AOT ANGLE $A_1$ ERROR > _____ DEG<br>2. AOT ANGLE $A_2$ ERROR > _____ DEG<br>3. HORIZON CHECK ERROR > _____ DEG<br>D. DIFFERENCES BETWEEN CMC/LGC/GND NAV CHECK AFTER A NAV UPDATE FROM GROUND IS:<br>1. $\phi$ >0.02 DEG<br>2. $\lambda$ >0.02 DEG<br>3. H >0.2 NM |
| A | 5-32 | NON-CRITICAL MANEUVERS WILL BE NO-GO OR TERMINATED FOR:<br>A. $h_p$ <80 NM AND DECREASING<br>B. ATTITUDE EXCURSIONS >10 DEG<br>C.<br>D. ATTITUDE RATES >5 DEG/SEC<br>E. 1 SEC OVERBURN WHEN UNDOCKED<br>F. 3 SEC OVERBURN WHEN DOCKED |
| A | 5-33 | CRITICAL MANEUVERS WILL BE COMPLETED BY SCS (MTVC OR AUTO) OR AGS TAKEOVER FOR ANY OF THE FOLLOWING:<br>A. ATTITUDE EXCURSIONS ≥ 10 DEG<br>B.<br>C. ATTITUDE RATES ≥ 5 DEG/SEC |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | 5-34 | IF $h_p$ <75 NM AND MANEUVER TO RAISE $h_p$ IS NOT POSSIBLE (REF 5-20B): |
| | | A. 40 <$h_p$ <75 - EXECUTE SPS RETROGRADE ASAP UNTIL $h_p$ <40. IF NO SPS, USE SM-RCS. |
| | | B. $h_p$ <40 - CM/SM SEP, RETRO WILL RECOMMEND ENTRY PROFILE. |
| | | RULE NUMBERS 5-35 THROUGH 5-39 ARE RESERVED FOR FURTHER MANEUVER RULES. |

| REV | ITEM | |
|---|---|---|
| | 5-40 | MINIMUM ACCEPTABLE TARGET ORBIT FOR THE TARGET VEHICLE IS 110 NM CIRCULAR. |
| A | 5-41 | RENDEZVOUS PLANS SHALL, WHERE POSSIBLE, SATISFY THE FOLLOWING CONSTRAINTS:<br>A. RENDEZVOUS MANEUVERS THROUGH TPI MUST BE AT LEAST 30 MINUTES APART.<br>B. TPI ELEVATION ANGLE (27.5 DEG) WILL EXIST WHEN THE CSM IS 25 MIN FROM SUNRISE.<br>C. THE ALLOWABLE SLIP IN TPI TIME IS 4 MIN EARLY OR 20 MIN LATE.<br>D. THE $\Delta$H (ABOVE AND BELOW) RESULTING FROM THE PHASING MANEUVER WILL BE 12 $\pm$1 NM<br>E. $\Delta$H AFTER CDH IS CONSTRAINED TO BE $\pm$10 NM.<br>F.<br>G. AT LEAST 12 MINUTES OF TRACKING, ENDING AT LEAST 17 MINUTES PRIOR TO EACH MANEUVER.<br>H. A VOICE UPDATE SITE AT LEAST 10 MINUTES PRIOR TO EACH MANEUVER BUT AT LEAST 7 MINUTES AFTER TRACKING ENDS. |
| A | 5-42 | THE PGNS IS PRIME FOR CSI AND CDH SOLUTIONS WITH THE AGS AS BACKUP UTILIZING THE ACCEPTED SOLUTION.<br>A. THE ONBOARD SOLUTION OF CSI WILL NOT BE USED IF DIFFERENT FROM THE GROUND BY:<br>1. $\delta\Delta V_X = \pm 2$ FPS<br>2. $\delta\Delta V_Y = \pm 5$ FPS<br>B. THE ONBOARD SOLUTION OF CDH WILL NOT BE USED IF DIFFERENT FROM THE GROUND BY:<br>1. TPI GETI -6-1/2 MIN (EARLY) OR +22-1/2 MIN (LATER).<br>2. $\delta\Delta V_X = \pm 2$ FPS<br>3. $\delta\Delta V_Y = \pm 5$ FPS<br>4. $\delta\Delta V_Z = \pm 6$ FPS<br>C. CSI AND CDH OUT-OF-PLANE COMPONENTS ($\dot{Y}$) WILL NOT BE EXECUTED IF $\leq$1 FPS. IF A PLANE CHANGE MANEUVER OF $\geq$10 FPS IS REQUIRED (DURING THE RENDEZVOUS), IT MAY BE SCHEDULED FOR THE LM FOLLOWING CDH, OR CSI/CDH MAY BE REPLACED WITH $N_{CC}/N_{SR}$ MANEUVER COMBINATION. |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 5-43 | THE ORDER OF PRIORITY FOR $TPI_{O_1}$ SOLUTIONS IS LGC, BACKUP CHARTS, CMC. THE LGC SOLUTION WILL NOT BE USED IF DIFFERENT FROM THE CMC BY:<br>A. $\delta\Delta V_x = \pm 2$ FPS<br>B. $\delta\Delta V_y = \pm 5$ FPS<br>C. $\delta\Delta V_z = \pm 6$ FPS |
| A | 5-44 | THE ORDER OF PRIORITY FOR $TPI_{O_2}$ SOLUTIONS IS LGC, BACKUP CHARTS, CMC, AND GROUND. THE ONBOARD LGC OR CMC $TPI_{O_2}$ SOLUTIONS WILL NOT BE USED IF DIFFERENT FROM THE GROUND BY:<br>A. $\delta\Delta V_x = \pm 2$ FPS<br>B. $\delta\Delta V_y = \pm 5$ FPS<br>C. $\delta\Delta V_z = \pm 6$ FPS |
| A | 5-45 | A. THE ORDER OF PRIORITY FOR $TPI_F$ SOLUTIONS IS G&N, BACKUP CHARTS, CMC, GROUND. THE ONBOARD SOLUTIONS WILL NOT BE USED IF DIFFERENT FROM THE GROUND BY:<br>1. LGC<br>(A) GETI ±2 MINUTES<br>(B) F/A ±2 FPS<br>(C) R/L ±5 FPS<br>(D) D/U ±6 FPS<br>2. CMC<br>(A) GETI ±2 MINUTES<br>(B) $\delta\Delta V_x = \pm 2$ FPS<br>(C) $\delta\Delta V_y = \pm 5$ FPS<br>(D) $\delta\Delta V_z = \pm 6$ FPS<br>B. THE LGC SOLUTION WILL NOT BE USED IF DIFFERENT FROM THE C C BY:<br>1. GETI ±2 MINUTES<br>2. $\delta\Delta V_x = \pm 2$ FPS<br>3. $\delta\Delta V_y = \pm 5$ FPS<br>4. $\delta\Delta V_z = \pm 6$ FPS<br><br>RULE NUMBERS 5-46 THROUGH 5-49 ARE RESERVED FOR FURTHER RENDEZVOUS RULES. |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | 5-50 | RETROFIRE MANEUVERS WILL BE PLANNED SUCH THAT TIME BETWEEN GETI AND 400K FT WILL BE $\geq$ 9 MINUTES. |
| | 5-51 | IF $\Delta T_B \leq 7$ SECONDS, USE SCS AUTO TVC. |
| | 5-52 | PLANNED G&N AND SCS RETROFIRE MANEUVERS WILL BE UPDATED IF:<br>A. THE COMPUTED RETROFIRE POSITION CHANGES BY >0.50 DEG LONGITUDE PRIOR TO GETI - 30 MINUTES.<br>B. THE COMPUTED RETROFIRE POSITION CHANGES BY >2 DEG LONGITUDE AFTER GETI - 30 MINUTES. |
| | 5-53 | IF SPS FAILS AFTER IGNITION:<br>A. Hp >75 NM - RETARGET FOR NEXT BEST PTP WITH RCS.<br>B. 40 <Hp <75 NM - PITCH UP 50 DEG FROM RETRO ATTITUDE AND BURN SM-RCS USING FOLLOWING PRIORITIES:<br>1. BURN Hp TO PAD VALUE.<br>2. BURN MAXIMUM SM $\Delta$V AVAILABLE IF SM-RCS $\Delta$V INSUFFICIENT TO OBTAIN 40 NM BURN CM-RCS TO 40 NM<br>C. Hp <40 NM - REMAIN IN RETRO ATTITUDE AND BURN SM-RCS USING FOLLOWING PRIORITY:<br>1. BURN $\Delta$V RESIDUALS.<br>2. BURN MAXIMUM SM $\Delta$V AVAILABLE.<br>NOTE: IF Hp <40 NM TERMINATE ALL THRUSTING BY $T_{ff}$ = 9 MINUTES. |
| | 5-54 | NO SLA SEP.<br>A. S-IVB LOX DUMF CAPABILITY WILL BE USED FOR:<br>1. ORBIT SHAPING FOR A RETROFIRE MANEUVER.<br>2. REDUCING THE WEIGHT OF THE S-IVB TO OBTAIN MORE $\Delta$V CAPABILITY FROM THE SM-RCS.<br>B. THE S/C WILL PERFORM A HYBRID TYPE RETROFIRE WITH THE S-IVB/CSM STACK, USING <u>500</u> SEC SM-RCS PLUS CM-RCS TO OBTAIN $h_p \leq 40$ NM |
| | 5-55 | THE G&N IS NO-GO FOR ENTRY IF:<br>A. CMC VALUE OF DOWNRANGE ERROR ($R_P$ - $R_T$) AT .2g DIFFERS >±100 NM FROM GROUND VALUE OR >±130 NM FROM BACKUP CHART VALUE. CREW FAILOVER TO EMS ENTRY AS FIRST PRIORITY OR GROUND BANK ANGLE AND RETRB AS SECOND PRIORITY.<br>B. V AND $\gamma$ AT 400K ARE OUTSIDE CORRIDOR. GROUND WILL PROVIDE ENTRY PROFILE.<br><br>RULE NUMBERS 5-56 THROUGH 5-69 ARE RESERVED. |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 5-70 | RANGE SAFETY POLICIES AND CRITERIA ARE SPECIFIED IN AFETR MANUAL (AFETRM) 127-1, DATED JANUARY 1, 1969. THE FOLLOWING MISSION RULES CONCERNING SPECIFIC ETR/NASA INTERFACE SUPPLEMENT AFETRM 127.1. |
| A | 5-71 | THE RSO WILL ACCOMPLISH THE PAD EMERGENCY RANGE CUTOFF PROCEDURE IF IGNITION OCCURS BUT THE SPACE VEHICLE WILL NOT LIFT OFF AND NASA IS UNABLE TO ACCOMPLISH CUTOFF. THE RSO WILL SEND "ARM/MFCO" ONLY IN RESPONSE TO A CODED VERBAL REQUEST FROM THE NASA LAUNCH VEHICLE TEST CONDUCTOR (CLTC). THE CLTC WILL CALL THE RSO ON THE GREENPHONE CLTC-RSO LINK TO TRANSMIT THIS REQUEST. THE RSO WILL NOT EXECUTE THIS PROCEDURE IF HE HAS A LIFTOFF INDICATION. |
| A | 5-72 | THE FLIGHT DIRECTOR (FD) WILL INITIATE ABORT REQUEST IN RESPONSE TO A CODED VERBAL REQUEST FROM THE RSO. THIS PROCEDURE WILL BE EXECUTED IF RANGE SAFETY FLIGHT TERMINATION CRITERIA HAVE BEEN VIOLATED AND RSO EFFORTS TO TERMINATE THRUST HAVE FAILED. THE REQUEST FROM RSO TO FD WILL BE TRANSMITTED ON THE FIDO-RSO PRIVATE LINE WITH THE FLIGHT DIRECTOR LOOP AS BACKUP. |
| | 5-73 | THE RSO WILL SEND "ARM/MFCO" IN RESPONSE TO A CODED VERBAL REQUEST FROM THE FLIGHT DIRECTOR (FD) OR THE FLIGHT DYNAMICS OFFICER (FIDO). THIS PROCEDURE WILL BE EXECUTED IF ABORT LIMITS HAVE SEEN EXCEEDED AND ABORT ACTION HAS BEEN UNSUCCESSFUL. THE REQUEST FROM FD/FIDO TO THE RSO WILL BE TRANSMITTED ON THE APOLLO RSO LOOP, WITH THE FIDO-RSO PRIVATE LINE AS BACKUP. |
| A | 5-74 | THE FD WILL INFORM THE RSO WHEN THE #3 ENGINE HAS SHUT DOWN BY STATING "RSO, #3 OUT" AND/OR ACTIVATE THE ENGINE OUT LIGHT ON THE RSO CONSOLE. |
| A | 5-75 | IF RANGE SAFETY DESTRUCT LINES ARE VIOLATED, THE RSO WILL SEND "ARM/MFCO" AND NOTIFY THE FD/FIDO. NO SPS THRUSTING MANEUVER WILL BE INITIATED FOLLOWING SUCH RANGE SAFETY ACTION. |
| A | 5-76 | IF THE "ARM/MFCO" COMMAND IS REQUIRED AND TRANSMITTED, AND AN ESTABLISHED IMPACT POINT (IP) IS ON THE CAPE KENNEDY LAND AREA, "DESTRUCT/PD" WILL BE SENT. "DESTRUCT/PD" WILL BE USED TO TERMINATE THRUST IF AN IP CANNOT BE ESTABLISHED. |
| A | 5-77 | WHEN THE IP HAS MOVED OFF THE CAPE, FLIGHT TERMINATION ACTION WILL BE LIMITED TO "ARM/MFCO" OR CREW INITIATED ABORT. THE "DESTRUCT/PD" FUNCTION WILL BE SENT AS NECESSARY ONLY FOR DISPERSION PURPOSES, AND ONLY AFTER FD/FIDO CONFIRMATION OF SATISFACTORY SPACECRAFT SEPARATION. |
| A | 5-78 | IF A SATISFACTORY IP IS ESTABLISHED AND "DESTRUCT/PD" IS DEEMED UNNECESSARY, THE RSO WILL NOTIFY FD/FIDO AND SEND "SAFE" UPON FD/FIDO'S REQUEST. |

| REV | ITEM | |
|---|---|---|
| A | 5-79 | FD/FIDO WILL DECLARE TO THE RSO WHEN THERE IS NO POSSIBILITY OF INSERTING THE SPACECRAFT INTO AN ORBIT, AND THE RSO WILL NOT ALLOW THE AFRICAN GATE TO BE OVERFLOWN. |
| A | 5-80 | AN ETR RANGE SAFETY OFFICER (BRSO) IS REQUIRED AT BERMUDA TO MONITOR PRESENT POSITION AND IMPACT PREDICTION CHARTS, AND TO TRANSMIT THE RANGE SAFETY FUNCTIONS WHEN COMMANDED TO DO SO BY THE RSO. THE BRSO WILL ASSUME RANGE SAFETY RESPONSIBILITY IN THE EVENT OF LOSS OF COMMUNICATIONS BETWEEN THE BRSO AND THE RSO. |
| A | 5-81 | SAFING BY THE RSO WILL BE DONE ONLY IF THE RSO HAS VERIFICATION OF S-IVB C/O OR THE FD/FIDO REQUESTS "SAFE". WHEN SAFING IS CONFIRMED, THE RSO WILL STATE TO THE FD/FIDO "SAFING CONFIRMED." |
| A | 5-82 | IF SAFING CANNOT BE CONFIRMED BY THE RSO, ANOTHER SAFING ATTEMPT WILL BE MADE BY THE RSO ON THE FIRST ORBITAL PASS OVER THE CAPE. COORDINATION WILL BE EFFECTED WITH THE SUPERINTENDENT OF RANGE OPERATIONS (SRO) AND FIDO TO ENSURE COMMAND COVERAGE, NON-INTERFERENCE WITH OTHER COMMAND FUNCTIONS, AND TELEMETRY DISPLAY AVAILABILITY. AT THE AGREED TIME, FIDO WILL STATE, "COMMAND CLEAR, RSO SEND SAFE." UPON CONFIRMATION, THE RSO WILL STATE, "SAFING CONFIRMED." |
| A | 5-83 | <u>TRACKING SOURCES</u><br><br>AT LEAST TWO (2) VEHICLE POSITION DATA SOURCES ARE <u>MANDATORY</u> BEFORE LAUNCH FOR EACH PHASE OF POWERED FLIGHT TO ENABLE THE RANGE SAFETY OFFICER TO DETERMINE IF THE SPACE VEHICLE IS NORMAL OR VIOLATES ESTABLISHED INFLIGHT SAFETY CRITERIA. |
| A | 5-84 | DATA FROM TWO (2) OF THE FOLLOWING THREE (3) RADARS ARE <u>MANDATORY</u> BEFORE LAUNCH (OTHER <u>HIGHLY DESIRABLE</u>): BERMUDA FPS-16, BERMUDA FPQ-6, AND GRAND TURK TPQ-18. |
| A | 5-85 | XY, XZ AND IP PLOTS AT BERMUDA (BDA) USING INPUTS FROM EITHER THE BDA FPS-16 OR BDA FPQ-6 RADAR ARE <u>HIGHLY DESIRABLE</u> FOR LAUNCH. |
| A | 5-86 | ODOP DATA TO THE CAPE KENNEDY REAL-TIME COMPUTER SYSTEM (RTCS) FOR IP COMPUTATION AND RSO DISPLAY DURING FIRST STAGE BURN ARE <u>HIGHLY DESIRABLE</u>. |

| REV | ITEM | |
|---|---|---|
| A | 5-87 | AIRBORNE SYSTEMS:<br><br>TWO (2) OPERATIONAL RANGE SAFETY COMMAND RECEIVERS ON EACH LAUNCH VEHICLE STAGE (S-IC, S-II, AND S-IVB) ARE MANDATORY FOR LAUNCH. THE RANGE SAFETY SUPERVISOR (CRSS) AT THE LAUNCH CONTROL CENTER WILL DETERMINE IF THE RECEIVERS ARE OPERATING PROPERLY FOR LAUNCH. |
| A | 5-88 | ONE (1) OF TWO (2) IU C-BAND BEACONS IS MANDATORY FOR LAUNCH. (OTHER HIGHLY DESIRABLE). |
| A | 5-89 | COMMAND/CONTROL<br><br>THE NASA BERMUDA DRS COMMAND/CONTROL SYSTEM IS MANDATORY FOR LAUNCH. |
| A | 5-90 | RANGE SAFETY COMMAND ("ARM/MFCO" AND "DESTRUCT/PD") WILL HAVE MANDATORY PRECEDENCE OVER ALL OTHER COMMANDS. TIMERS IN THE RCC WILL PROVIDE A 4 SECOND TIME DELAY BETWEEN "ARM/MFCO" AND "DESTRUCT/PD." |
| A | 5-91 | COMMUNICATIONS:<br><br>TWO (2) PRIVATE, INDEPENDENT, GEOGRAPHICALLY DIVERSIFIED COMMUNICATIONS LINKS BETWEEN THE RSO AND BRSO ARE REQUIRED. ONE OF TWO COMM LINKS IS MANDATORY. |
| A | 5-92 | TWO (2) OF THE FOLLOWING THREE (3) COMMUNICATIONS LINKS ARE MANDATORY BETWEEN THE RSO AND FD/FIDO:<br><br>A. RSO LOOP (CAPE 111).<br><br>B. RSO PRIVATE LINE (GREENPHONE/YELLOWPHONE).<br><br>C. FLIGHT DIRECTOR LOOP. |
| A | 5-93 | A COMMUNICATIONS LINK BETWEEN THE RSO AND THE RANGE SAFETY SUPERVISOR (CRSS) AT THE LAUNCH CONTROL CENTER IS MANDATORY. |
| A | 5-94 | A GREENPHONE COMMUNICATIONS LINK BETWEEN THE RSO AND THE LAUNCH VEHICLE TEST CONDUCTOR (CLTC) IS HIGHLY DESIRABLE. |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 5-95 | TELEMETRY:<br><br>IU TELEMETRY DATA (ONBOARD GUIDANCE PARAMETERS) TO THE RTCS ARE HIGHLY DESIRABLE FROM T+0 UNTIL S-IVB CUTOFF FOR IP COMPUTATION AND RSO DISPLAY. |
| A | 5-96 | TELEMETRY REQUIREMENTS TO BE DISPLAYED FOR THE RSO AND BRSO ARE HIGHLY DESIRABLE. FOR LAUNCH VEHICLE AND SPACECRAFT HARDWARE ENTRIES AND APPROPRIATE CATEGORIES, REFERENCE THE FOLLOWING ITEMS:<br><br>A. FOR RSO DISPLAY (SEE ATCH #1)<br><br>B. FOR BRSO DISPLAY (SEE ATCH #2) |
| A | 5-97 | WEATHER:<br><br>WIND RESTRICTIONS: AN ANNUAL PROFILE WIND RESTRICTION OF 1.25 SIGMA (11%) WILL BE IN EFFECT FOR THE LAUNCH AREA. |
| A | 5-98 | CEILING AND VISIBILITY RESTRICTIONS: MINIMUM RANGE SAFETY CEILING 2000 FEET WITH PAD VISIBLE FROM 11 NM. |

6 SLV – TB1 THROUGH TB4/TB4A

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 6-1 | S-IC STAGE LOSS OF THRUST | | | |
| | | A. ANY SINGLE ENGINE PRIOR TO TB3. | LAUNCH | A. CONTINUE MISSION.<br>BSE INFORM FLIGHT AND FIDO. | A&B. CUES:<br>1. THRUST OK SWITCHES (K33-115; K34-115; K35-115; K36-115; K37-115; K38-115; K39-115; K40-115; K41-115; K42-115; K43-115; K44-115; K45-115; K46-115; K47-115 |
| | | B. ANY TWO OR MORE ENGINES | LAUNCH | | |
| | | 1. PRIOR TO DEACTIVATION OF TWO ENGINES OUT AUTOMATIC ABORT. | | B.1. ABORT.<br>BSE INFORM FLIGHT AND FIDO AND TRANSMIT ABORT REQUEST (ABORT WILL BE INITIATED AUTOMATICALLY). | |
| | | 2. AFTER DEACTIVATION OF TWO ENGINES OUT AUTOMATIC ABORT. | | 2. CONTINUE MISSION.<br>(A) BSE INFORM FLIGHT AND FIDO.<br>(B) CAPCOM ADVISE CREW OF POTENTIAL OVERRATE CONDITION. | 2. THRUST CHAMBER PRESSURE <500 PSIA (D8-101 THROUGH D8-105)<br>3. LONGITUDINAL ACCELERATION. (VA2-603)<br>4. FINAL THRUST OK CUTOFF. (K52-115, K53-115, K54-115, K55-155, K56-115)<br>A&B. NOTE:<br>1. CREW MAY DEACTIVATE AUTOMATIC ABORT AFTER TBI + 120 SEC. |
| | | C. LOSS OF THRUST-ENGINE 3 (THIS RULE APPLIES ONLY FOR THE UNIQUE CASE OF ENGINE 3 THRUST LOSS BETWEEN 0 TO 45 SEC.) | LAUNCH | C. CONTINUE MISSION<br>BSE INFORM FLIGHT AND FIDO. FLIGHT WILL INFORM RSO. | C. CUES:<br>1. THRUST CHAMBER PRESSURE, (D8-103) < 500 PSIA<br>2. THRUST OK SWITCHES OFF (K39-115; K40-115; K41-115)<br>3. FINAL THRUST OK SWITCHES OFF (K54-115) |
| | | 1. VOICE COMM WITH RSO | | 1.(A) FLIGHT CONFIRM ENGINE 3 OUT VIA RSO PRIVATE LINE<br>(B) FLIGHT CONFIRM NO OTHER KNOWN ANOMALIES BY LITE ACTIVATION AND VOICE REPORT | C. NOTES:<br>1. RSO LOOP 111 OR FD LOOP BACKUP TO PL. |
| | | 2. NO VOICE COMM WITH RSO | | 2. FLIGHT CONFIRM ENGINE 3 OUT AND NO OTHER KNOWN ANOMALIES BY LITE ACTIVATION | 2. CONFIRMATION OF NO OTHER KNOWN ANOMALIES WILL BE BASED ON:<br>(A) ENGINE CHAMBER PRESSURE ABOVE 500 PSI AND HOLDING.<br>(B) THRUST OK SWITCHES ON. |

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| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 6-2 | S-IC STAGE GIMBAL SYSTEM FAILURE<br><br>ANY SINGLE ACTUATOR HARD-OVER ANY ENGINE - PITCH OR YAW<br><br>(TB1 + 0 SEC TO TB3 + 0 SEC) | LAUNCH | CONTINUE MISSION.<br><br>BSE INFORM FLIGHT AND FIDO. | CUES:<br><br>1. ACTUATOR POSITION EXCEEDS ±5 DEG (VG1-101 THROUGH VG1-104; VG2-101 THROUGH VG2-104)<br><br>2. ROLL ANGULAR RATE EXCEEDS 5 DEG/SEC (VR6-602; VR12-602)<br><br>3. ROLL ATTITUDE ERROR EXCEEDS 5 DEG (VH69-602; VH56-603).<br><br>NOTES:<br><br>1. AUTOMATIC ABORT BY LES WHEN ATTITUDE RATE LIMIT IS EXCEEDED PRIOR TO AUTO ABORT/DEACTIVATION.<br><br>2. MANUAL ABORT BY LES WITH TWO CUES:<br><br>(A) ATTITUDE ERROR LIMIT EXCEEDED.<br><br>(B) Q-BALL ΔP (AOA) LIMIT EXCEEDED<br><br>(C) PITCH OR YAW RATE LIMIT EXCEEDED |
| A | 6-3 | LOSS OF ATTITUDE CONTROL<br><br>A. S-IC BURN | LAUNCH | CONTINUE MISSION.<br><br>A. BSE INFORM FLIGHT AND FIDO; CAPCOM ADVISE CREW OF IMPENDING LOSS OF ATTITUDE CONTROL. | CUES:<br><br>A. S-IC BURN<br><br>1. ANGULAR RATES EXCEED 2 DEG/SEC (VR4-602, VR5-602, VR6-602, VR8-602, VR12-602, VR13-602)<br><br>2. ATTITUDE ERRORS EXCEED 4 DEG (H69-602, H70-602, H71-602, H54-603, H55-603, H56-603)<br><br>3. ACTUATOR POSITION INDICATES HARDOVER (±5 DEG) OR ERRATIC ACTUATORS (G1-101 THROUGH G1-104, G2-101 THROUGH G2-104) |
| | | B. S-II BURN | | B. BSE INFORM FLIGHT AND FIDO; CAPCOM ADVISE CREW OF IMPENDING LOSS OF ATTITUDE CONTROL. | B. S-II BURN<br><br>1. ANGULAR RATES EXCEED 5 DEG/SEC) (VR4-602; VR8-602; VR5-602; VR12-602; VR13-602; VR6-602)<br><br>2. ATTITUDE ERRORS EXCEED 10 DEG (H69-602; H70-602; H71-602; H54-603; H55-603; H56-603) |

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| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 6-3 (CONT) | | | | 3. ACTUATOR POSITION INDICATES HARDOVER ±5 DEG OR ERRATIC ACTUATOR(S) (G8-201 THROUGH G8-204; G9-201 THROUGH G9-204)<br>4. S-II BURN MODE DISCRETE REMAINS OFF AT STAGING (K90-602)<br>5. S-IC BURN MODE DISCRETE REMAINS ON AT STAGING (K89-602) |
| | | C. S-IVB BURN | | C. BSE INFORM FLIGHT AND FIDO; CAPCOM ADVISE CREW OF IMPENDING LOSS OF ATTITUDE CONTROL. | C. S-IVB BURN<br>1. ANGULAR RATES EXCEED 5 DEG/SEC (VR4-602; VR8-602; VR5-602; VF12-602; VR13-602; VR6-602)<br>2. ROLL ATTITUDE ERROR ≥±3.5 DEG: PITCH OR YAW ATTITUDE ERROR >10 DEG (H69-602; H70-602; H71-602; H54-603; H55-603; H56-603)<br>3. ACTUATOR POSITION INDICATES SUSTAINED HARDOVER ±5 DEG (G1-400; G1-403) (G2-400; G2-403)<br>4. S-IVB BURN MODE DISCRETE REMAINS OFF AT STAGING (K20-602)<br><br>NOTES:<br>CREW ABORT LIMITS<br>A. S-IC BURN<br>1. PITCH AND YAW RATES ±4 DEG/SEC<br>2. ROLL ±20 DEG/SEC<br>3. ATTITUDE ERROR >±5 DEG<br>4. Q-BALL ΔP >3.2 PSID<br>B. S-II/S-IVB BURN<br>1. PITCH AND YAW RATES ±10 DEG/SEC<br>2. ROLL ±20 DEG/SEC |

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| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 6-4 | ROLL PROGRAM FAILS TO INITIATE BY TB1 + 12 SEC | LAUNCH | CONTINUE MISSION.<br><br>BSE INFORM FLIGHT AND FIDO. | CUES:<br><br>1. ROLL RATE REMAINS CONSTANT AT APPROXIMATELY ZERO DEG/SEC (VR12-602; VR6-602)<br><br>2. ROLL COMMAND ANGLE REMAINS AT APPROXIMATELY LAUNCH VALUE (H60-603)<br><br>3. ROLL ATTITUDE REMAINS CONSTANT AT APPROXIMATELY LAUNCH VALUE (H69-603)<br><br>4. ROLL ATTITUDE ERROR REMAINS CONSTANT AT APPROXIMATELY ZERO (H69-602; VH56-602)<br><br>5. GUIDANCE MODE WORD ONE (MODE CODE 25) BIT D24 (H60-603) |
| A | 6-5 | PITCH PROGRAM FAILS TO INITIATE BY TB1 + 12 SEC | LAUNCH | CONTINUE MISSION.<br><br>BSE INFORM FLIGHT AND FIDO THAT VEHICLE WILL CONTINUE VERTICAL FLIGHT AND WILL EVENTUALLY VIOLATE RSO LIMITS.<br><br>FIDO INFORM RSO. | CUES:<br><br>1. GUIDANCE MODE WORD ONE (MODE CODE 25) BIT D24 NOT SET TO "ONE" (H60-603)<br><br>2. PITCH COMMANDED ANGLE REMAINS AT APPROXIMATELY ZERO DEGREES (H60-603)<br><br>3. PITCH RATE REMAINS CONSTANT AT APPROXIMATELY ZERO DEG/SEC (VR4-602, VR13-602)<br><br>4. PITCH GIMBAL ANGLE REMAINS CONSTANT AT APPROXIMATELY ZERO OR 360° (H60-603)<br><br>5. PITCH ATTITUDE ERROR REMAINS CONSTANT AT APPROXIMATELY ZERO (VH71-602, VH54-603) |

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| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 6-6 | ROLL PROGRAM FAILS TO TERMINATE BY TB1 + 35 SEC | LAUNCH | <u>CONTINUE MISSION</u>.<br><br>BSE INFORM FLIGHT AND FIDO.<br><br>CAPCOM ADVISE CREW OF TRAJECTORY DEVIATION AND VEHICLE CONTINUOUS ROLL. | <u>CUES</u>:<br><br>1. GUIDANCE MODE WORD ONE (MODE CODE 25) BIT D23 NOT SET TO ONE (H60-603)<br><br>2. ROLL COMMAND ANGLE NOT EQUAL TO ZERO (H60-603)<br><br>3. ROLL RATE REMAINS CON- STANT AT APPROXIMATELY 1 DEG/SEC (VR12-602; VR6-602)<br><br>4. ROLL ATTITUDE ERROR RE- MAINS IN EXCESS OF 0.5 DEGREES. (VH56-603; H69-602)<br><br>5. ROLL GIMBAL ANGLE CONTINUES TO CHANGE (H60-603)<br><br><u>NOTE</u>:<br><br>CUES 1 AND 4 MUST CONCUR WITH CUE 2 AND/OR 3 BEFORE THEY CAN BE INTERPRETED AS INDICATIONS OF FAILURE. |
| A<br>I | 6-7 | PITCH PROGRAM FAILS TO TERMINATE BY TB1 + 2 MIN 37 SEC | LAUNCH | <u>CONTINUE MISSION</u>.<br><br>A. BSE INFORM FLIGHT AND FIDO.<br><br>B. CAPCOM ADVISE CREW OF CON- TINUOUS PITCH THROUGH S-IC/ S-II STAGING OF APPROXIMATELY 0.3 DEG/SEC. | <u>CUES</u>:<br><br>1. GUIDANCE MODE WORD (MODE CODE 25) BIT D21 NOT SET TO ONE (H60-603)<br><br>2. PITCH COMMAND ANGLE CON- TINUES TO DECREASE (H60-603)<br><br>3. PITCH RATE REMAINS APPROX- IMATELY 0.3 DEGREES/SECOND (VR4-602, VR13-602)<br><br>4. PITCH GIMBAL ANGLE CON- TINUES TO DECREASE (H60-603)<br><br><u>NOTE</u>:<br><br>PITCH PROGRAM COULD BE EXTEND- ED BY AS LONG AS 60 SEC WITH ONE S-IC ENGINE OUT. |

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| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 6-8 | INERTIAL PLATFORM FAILURE - ACCELEROMETER | LAUNCH | CONTINUE MISSION.<br><br>A. BSE INFORM FLIGHT, FIDO, AND GUIDO.<br><br>B. CAPCOM ADVISE CREW OF PROBABLE DEGRADED ORBIT. | CUES:<br><br>1. GUIDANCE STATUS WORD (MODE CODE 24) (H60-603) BITS D26 AND D25 FOR Z ACCEL SET TO "ONE" BITS D24 AND D23 FOR X ACCEL SET TO "ONE" BITS D22 AND D21 FOR Y ACCEL SET TO "ONE"<br><br>2. ACCELEROMETER PICKOFFS (X, Y, OR Z) INDICATE IN EXCESS OF 0.5° OR REMAIN CONSTANT AT ZERO (VH10-603, VH11-603, VH12-603)<br><br>NOTES:<br><br>1. NO EFFECT ON VEHICLE TRAJECTORY DURING S-IC BURN.<br><br>2. LVDC SWITCHES TO A BACK-UP MODE AND UTILIZES A PRECOMPUTED F/M PROFILE FOR FAILED AXIS DURING THE S-IC, S-II AND S-IVB BURNS. |
| A | 6-9 | LAUNCH VEHICLE INERTIAL PLATFORM FAILURE - ATTITUDE REFERENCE<br><br>A. PRIOR TO TB1 + 50 SEC<br><br>B. AFTER TB1 + 50 SEC BUT PRIOR TO TB1 + 100 SEC<br><br>C. AFTER TB1 + 100 SEC | LAUNCH | A. ABORT<br>BSE INFORM FLIGHT, FIDO AND GUIDO, TRANSMIT ABORT REQUEST AT 50 SEC.<br><br>B. ABORT<br>BSE INFORM FLIGHT, FIDO AND GUIDO, TRANSMIT ABORT REQUEST (REF NOTE 3).<br><br>C. CONTINUE MISSION.<br>BSE INFORM FLIGHT, FIDO AND GUIDO (REF NOTE 4). | CUES:<br><br>1. GUIDANCE STATUS WORD - (MODE CODE 24) (H60-603)<br>BITS D20 AND D19 FOR Z GIMBAL SET TO "ONE"<br>BITS D18 AND D17 FOR X GIMBAL SET TO "ONE"<br>BITS D16 AND D15 FOR Y GIMBAL SET TO "ONE"<br><br>2. LADDER OUTPUTS CONSTANT FOR FAILED AXIS (H54-603; H55-603; H56-603)<br><br>3. GUIDANCE MODE WORD #2 (MODE CODE 26) BIT D8 SET TO ONE<br><br>NOTES:<br><br>1. THE LVDC/LVDA WILL HOLD THE LADDER SIGNALS AT THE LAST PREVIOUS VALID VALUE.<br><br>2. ATTITUDE CONTROL WILL BE LOST IN THE FAILED AXIS.<br><br>3. CREW PERFORM MANUAL ABORT ON THE TWO GUIDANCE FAILURE LIGHTS.<br><br>4. MANUAL ABORT WHEN FIDO LIMITS ARE EXCEEDED. |

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| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 6-10 | S-II STAGE GIMBAL SYSTEM FAILURE ANY SINGLE ACTUATOR HARDOVER (IN BOARD)<br><br>A. PRIOR TO S-IVB TO ORBIT CAPABILITY<br><br>B. AFTER S-IVB TO ORBIT CAPABILITY | LAUNCH | A. ABORT<br><br>BSE INFORM FLIGHT AND TRANSMIT ABORT REQUEST.<br><br>B. EARLY STAGE<br><br>BSE INFORM FLIGHT AND RECOMMEND EARLY STAGING. | CUES:<br><br>1. YAW ACTUATOR POSITION EXCEEDS +6 DEGREES (VG8-201 THROUGH 204) (G30-201 THROUGH 204)<br><br>2. PITCH ACTUATOR POSITION EXCEEDS +6 DEGREES (G9-201 THROUGH 204) (G31-201 THROUGH 204)<br><br>3. ROLL ATTITUDE ERROR EXCEEDS 5 DEG (VH69-602 AND VH56-603)<br><br>4. ROLL ATTITUDE RATE EXCEEDS 3 DEG/SEC (VR12-602 AND VR6-602) |
| | | RULE NUMBERS 6-11 THROUGH 6-15 ARE RESERVED. | | | |

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| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 6-17 | S-II LOSS OF THRUST | LAUNCH | | CUES: |
| | | A. ANY SINGLE ENGINE - FAILURE TO ATTAIN THRUST OR LOSS OF THRUST PRIOR TO NOMINAL S-II CUTOFF | | A. CONTINUE MISSION.<br>BSE INFORM FLIGHT AND FIDO. | A.1. THRUST OK SWITCHES - OFF (K285-201 THROUGH 205) (K286-201 THROUGH 205)<br>2. THRUST CHAMBER PRESSURE <300 PSIA (D13-201 THROUGH 205)<br>3. LONGITUDINAL ACCELERATION (A2-603) |
| | | B. ANY TWO ENGINES - FAILURE TO OBTAIN THRUST OR LOSS OF THRUST PRIOR DEPLETION SENSORS CUTOFF ARMED (TB3 + 5 MIN 39 SEC)<br>1. ATTITUDE ERROR EXCEEDS 40 DEG | | B.1. ABORT<br>BSE INFORM FLIGHT AND FIDO TRANSMIT ABORT REQUEST. | B.1.(A) TWO ENGINES OUT (CUES A.1, A.2, A.3)<br>(B) ANGULAR RATE (R6-602, R8-602, R4-602, R13-602, R12-602, R5-602)<br>(C) ATTITUDE ERRORS (H54-603, H55-603, H56-603, H69-602, H70-602, H71-602)<br>(D) COMMAND ANGLES AND GIMBAL ANGLES (H60-603) |
| | | 2. ABORT LIMITS NOT EXCEEDED | | 2. EARLY STAGE<br>BSE INFORM FLIGHT AND FIDO RECOMMEND EARLY STAGING AT CHI FREEZE PLUS 5 SEC. | B.2.(A) TWO ENGINES OUT (CUES A.1, A.2, A.3)<br>(B) ANGULAR RATE (R6-602, R8-602, R4-602, R13-602, R12-602, R5-602)<br>(C) ATTITUDE ERRORS (H54-603, H55-603, H56-603, H69-603, H70-602, H71-602)<br>(D) COMMAND ANGLES AND GIMBAL ANGLES (H60-603) |
| | | C. THREE OR MORE ENGINES-FAIL TO ATTAIN THRUST OR LOSS OF THRUST PRIOR TO S-IVB TO ORBIT CAPABILITY | | C. ABORT<br>BSE INFORM FLIGHT AND FIDO TRANSMIT ABORT REQUEST. | C.1. THRUST OK SWITCHES - OFF (K285-201 THROUGH 205) (K286-201 THROUGH 205)<br>2. THRUST CHAMBER PRESSURE <300 PSIA (D13-201 THROUGH 205)<br>3. LONGITUDINAL ACCELERATION (A2-603) |
| | | D. THREE OR MORE ENGINES-LOSS OF THRUST AFTER S-IVB TO ORBIT CAPABILITY BUT PRIOR TO DEPLETION SENSORS CUTOFF ARMED | | D. EARLY STAGE<br>BSE INFORM FLIGHT AND FIDO RECOMMEND IMMEDIATE EARLY STAGING. | D.1. THRUST OK SWITCHES - OFF (K285-201 THROUGH 205) (K286-201 THROUGH 205)<br>2. THRUST CHAMBER PRESSURE <300 PSIA (D13-201 THROUGH 205)<br>3. LONGITUDINAL ACCELERATION (A2-603) |
| | | E. TWO OR MORE ENGINES LOSS OF THRUST AFTER DEPLETION SENSORS CUTOFF ARMED | | E. CONTINUE MISSION.<br>BSE INFORM FLIGHT AND FIDO. | E.1. THRUST OK SWITCHES - OFF (K285-201 THROUGH 205) (K286-201 THROUGH 205)<br>2. THRUST CHAMBER PRESSURE <300 PSIA (D13-201 THROUGH 205)<br>3. LONGITUDINAL ACCELERATION (A2-603)<br>NOTE:<br>CREW WILL TAKE APPROPRIATE ACTION BASED ON ENGINE OUT LIGHTS AND 10 DEG/SEC ANGULAR RATE. |

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| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 6-18 | ITERATIVE GUIDANCE MODE (IGM) FAILS TO INITIATE AT TB3 + 41 SEC | LAUNCH | CONTINUE MISSION.<br>A. BSE INFORM FLIGHT, FIDO AND GUIDANCE.<br>B. CAPCOM ADVISE CREW. | CUES:<br>1. GUIDANCE MODE WORD 1 (MODE CODE 25) BIT D14 NOT SET TO ONE (H60-603)<br>2. PITCH GIMBAL ANGLE REMAINS CONSTANT (H60-603)<br>3. PITCH COMMANDED ANGLE REMAINS CONSTANT (H60-603)<br>4. ATTITUDE ERROR REMAINS AT APPROXIMATELY ZERO (H69-602, H70-602, H71-602, H54-603, H55-603, H56-603)<br>NOTE:<br>CUTOFF WILL BE INITIATED FROM SPACECRAFT BASED ON VIOLATION OF FIDO OR RSO LIMIT LINES. |
| A | 6-19 | S-II SECOND PLANE SEPARATION FAILS TO OCCUR BY TB3 + 31 SEC<br><br>RULE NUMBERS 6-22 THROUGH 6-26 ARE RESERVED. | LAUNCH | ABORT<br>BSE INFORM FLIGHT AND TRANSMIT ABORT REQUEST PRIOR TO TB3 + 46 SEC. | CUES:<br>1. SECOND PLANE SEPARATION INDICATES NO SEPARATION (VM86-206; M87-206)<br>2. GUIDANCE MODE WORD 1 (MODE CODE 25) BIT D15 REMAINS ZERO (H60-603)<br>3. IGNITION BUS VOLTAGE REMAINS AT APPROXIMATELY 28 VDC (XM125-207)<br>4. RECIRCULATION BUS VOLTAGE REMAINS AT APPROXIMATELY 56 VDC (XM111-207)<br>NOTES:<br>1. PROBABLE SUBSEQUENT LOSS OF VEHICLE DUE TO EXCESSIVE TEMPERATURE.<br>2. MANUAL ABORT BY CREW WITH ONBOARD INDICATION. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 6-27 | S-IVB GIMBAL SYSTEM FAILURE | LAUNCH | | CUES: |
| | | A. S-IVB ENGINE ACTUATOR HARDOVER INDICATED PRIOR TO FIRST BURN | | A. CONTINUE MISSION.<br>1. BSE INFORM FLIGHT AND FIDO<br>2. CAPCOM ADVISE CREW OF POSSIBLE OVER-RATE CONDITION AFTER S-IVB IGNITION. CREW EXECUTE MANUAL ABORT ON ESTABLISHED LIMITS AFTER S-IVB IGNITION. | A.1. ACTUATOR POSITION ±5 DEG OR GREATER (G1-403, G2-403)<br>NOTE:<br>CREW ABORT LIMITS:<br>THE RATE LIMITS WHICH THE CREW WILL ABORT DURING S-IVB FLIGHT ARE:<br>A. PITCH OR YAW RATE: ±10 DEG/SEC<br>B. ROLL RATE ±20 DEG/SEC |
| | | B. S-IVB LOSS OF STAGE HYDRAULIC FLUID CONFIRMED PRIOR TO FIRST BURN | | B. ABORT<br>BSE INFORM FLIGHT AND FIDO RECOMMEND ABORT PRIOR TO S-II/S-IVB STAGING. | CUES:<br>B.1. HYDRAULIC SYSTEM PRESSURE LESS THAN 1700 PSIA (D41-403)<br>2. HYDRAULIC RESERVOIR OIL LEVEL APPROXIMATELY ZERO (L7-403)<br>3. HYDRAULIC RESERVOIR PRESSURE APPROXIMATELY ZERO (D42-403)<br>NOTE:<br>ALL THREE CUES MUST CONFIRM MALFUNCTION PRIOR TO BSE TAKING ACTION. |
| A | 6-28 | S-IVB STAGE LOSS OF THRUST | LAUNCH | | CUES: |
| | | A. FAILS TO ATTAIN THRUST BY TB4 + 10 SECONDS OR TB4A (EARLY STAGE SEQUENCE) PLUS 15 SECONDS | | A. ABORT<br>1. BSE INFORM FLIGHT AND FIDO AND RECOMMEND ABORT. | 1. THRUST CHAMBER PRESSURE - <300 PSIA (D1-401)<br>2. THRUST OK SWITCHES OFF (K14-401, K157-401, K158-401, K159-401)<br>3. LONGITUDINAL ACCELERATION - <.3g (VA2-603) |
| | | B. S-IVB PREMATURE SHUTDOWN PRIOR TO S-IVB FIRST BURN VELOCITY CUTOFF | | B. CONTINUE MISSION<br>1. BSE INFORM FLIGHT AND FIDO (REF NOTE 1). | 4. TIME BASE 5 IS INITIATED, MODE CODE 25, BIT D2 SET TO ONE. (H60-603)<br>NOTE:<br>FIDO WILL INITIATE APPROPRIATE ACTION IF UNACCEPTABLE ORBIT IS ATTAINED. |
| | | RULE NUMBERS 6-29 THROUGH 6-30 ARE RESERVED. | | | |

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| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 6-31 | TIME BASE 5 FAILS TO INITIATE AT S-IVB CUTOFF | LAUNCH | S/C SEPARATION.<br><br>BSE INFORM FLIGHT AND FIDO AND RECOMMEND IMMEDIATE SEPARATION TO A SAFE DISTANCE. | CUES:<br>1. TIME OF TB INITIATE REMAINS AT PREVIOUS VALUE (H60-603)<br>2. TIME-IN-TIME BASE CONTINUES TO COUNT (H60-603)<br>3. GUIDANCE MODE WORD ONE (MODE CODE 25) BIT D2 NOT SET TO "ONE" (H60-603)<br>4. ORBITAL SEQUENCE FAILS TO INITIATE.<br><br>NOTES:<br>1. THIS CONDITION WILL RESULT IN LOSS OF SEQUENCING AND ATTITUDE CONTROL.<br>2. LVDC WILL INITIATE TB5 AFTER RECEIVING ANY TWO OF FOUR FUNCTIONS, AFTER TB4 + 10 SEC OR TB4A + 15 SEC.<br>A. S-IVB ENGINE OUT "A".<br>B. S-IVB ENGINE OUT "B".<br>C. S-IVB VELOCITY CUTOFF.<br>D. ACCELEROMETER LOSS OF THRUST INDICATION. |
| A | 6-32 | FAILURE OF S-IVB TO CUTOFF<br>A. AT NOMINAL S-IVB FIRST BURN VELOCITY CUTOFF<br>B. AT TB6 + 10 MIN 41 SEC, TB8 + 11 MIN 41 SEC OR TB8A + 14 MIN 41 SEC | LAUNCH<br>LAUNCH | CONTINUE MISSION.<br>A.1. BSE INFORM FLIGHT AND FIDO<br>2. CAPCOM REQUEST CREW TO CUTOFF S-IVB<br>B. BSE INFORM FLIGHT AND FIDO | CUES:<br>1. THRUST CHAMBER PRESSURE GREATER THAN 300 PSIA (D1-403)<br>2. THRUST OK SWITCHES ON (K14-401, K157-401)<br>3. LVDC FAILURE EMR BITS D24, D25, AND D26 SET TO ONE (H60-603) |

7 SLV – TB5 AND TB7

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| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 7-1 | S-IVB J-2 ENGINE START BOTTLE PRESSURE GREATER THAN <u>1500</u> PSIA FOR FIRST AND SECOND RESTART (TB 6/8 AND TB8A) | ORBIT<br>TD&E | <u>CONTINUE MISSION.</u><br><br>BSE INFORM FLIGHT AND COMMAND:<br><br>A. START TANK VENT VALVE OPEN AND CLOSED<br>B. REPEAT AS NECESSARY TO MAINTAIN START BOTTLE PRESSURE BETWEEN <u>1300</u> AND <u>1500</u> PSIA | <u>CUES</u>:<br><br>1. GH2 START BOTTLE PRESSURE (D0017-401; D0241-401)<br><br><u>NOTE</u>:<br>IF START BOTTLE PRESSURE REACHES 1800 PSIA AND CANNOT BE VENTED TO AN ACCEPTABLE LEVEL, THE S/C SHOULD IMMEDIATELY SEPARATE TO A SAFE DISTANCE. |
| | | RULE NUMBER 7-2 IS RESERVED. | | | |
| A | 7-3 | S-IVB COLD HELIUM SHUTOFF VALVES FAIL TO CLOSE AT:<br><br>A. FIRST ENGINE CUTOFF (TB5 PLUS 1.4 SEC)<br><br>B. SECOND ENGINE CUTOFF (TB7 PLUS 1.4 SEC) | ORBIT | A. <u>CONTINUE MISSION</u><br>BSE INFORM FLIGHT AND COMMAND:<br>1. LOX TANK FLIGHT PRESSURIZATION SHUTOFF VALVES CLOSED<br>IF UNSUCCESSFUL, BSE SEND:<br>2. LOX TANK NON-PROPULSIVE VENT OPEN<br>3. (AT CRO FIRST REV) LOX TANK NON-PROPULSIVE VENT CLOSED<br>4. RECOMMEND SPACECRAFT SEPARATION IF LOX ULLAGE PRESSURE AT 50 PSIA<br><br>B. <u>CONTINUE MISSION</u><br>BSE INFORM FLIGHT AND COMMAND:<br>1. LOX TANK FLIGHT PRESSURIZATION SHUTOFF VALVES CLOSED<br>IF UNSUCCESSFUL, AND ULLAGE PRESSURE RISES TO 50 PSIA OR SATURATED, BSE COMMAND:<br>2. LOX TANK VENT VALVE OPEN AND CLOSE TO MAINTAIN ULLAGE PRESSURE BELOW <u>40</u> PSIA AT ASC LOS | <u>CUES</u>:<br><br>1. COLD HELIUM DISCHARGE PRESSURE GREATER THAN <u>100</u> PSIA (D105-403)<br><br>2. COLD HELIUM BOTTLE PRESSURES DECAYING (D16-425; D248-405)<br><br>3. LOX TANK ULLAGE PRESSURES AT RELIEF SETTING (D179-406; D180-406)<br><br><u>NOTES</u>:<br><br>1. FAILURE TO CLOSE THE SHUTOFF VALVES WILL RESULT IN THE DEPLETION OF THE COLD HELIUM<br><br>2. ACTION REQUIRE TO AVOID EXCEEDING LOX TANK OVER PRESSURE LIMITS |
| A | 7-4 | S-IVB AUXILIARY HYDRAULIC PUMP FAILS TO TURN OFF AS PROGRAMMED | ORBIT<br>TD&E | <u>CONTINUE MISSION</u>.<br><br>BSE INFORM FLIGHT AND TRANSMIT:<br><br>AUXILIARY HYDRAULIC PUMP FLIGHT MODE OFF AS SOON AS POSSIBLE | <u>CUES</u>:<br><br>1. SYSTEM PRESSURE ABOVE 1700 PSIA (D41-403)<br><br>2. RESERVOIR LEVEL BELOW 50 PERCENT (L7-403)<br><br>3. AFT BUS NO. 2 CURRENT ABOVE 20 AMPS (M22-404)<br><br>4. HYDRAULIC RESERVOIR OIL PRESSURE GREATER THAN 137 PSIA (D42-403)<br><br><u>NOTE</u>:<br><br>FAILURE TO TURN OFF HYDRAULIC PUMP DEPLETES AFT NO. 2 BATTERY IN APPROXIMATELY 90 MIN AND MAY OVERHEAT HYDRAULIC SYSTEM IN APPROXIMATELY 13 MIN. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 7-5 | LOSS OF ATTITUDE CONTROL<br><br>A. BEFORE CSM SEP | ORBIT | A. SPACECRAFT SEPARATION<br><br>BSE INFORM FLIGHT AND FIDO AND RECOMMEND SPACECRAFT SEPARATION | CUES:<br>1. THE DIFFERENCE BETWEEN COMMANDED ATTITUDE (CHI) AND THE ACTUAL VEHICLE ATTITUDE (THETA) IS GREATER THAN 5 DEG AND DIVERGING (H60-603)<br>2. ATTITUDE ERROR SIGNALS 2.5 DEG IN PITCH AND YAW, 3.5 DEG IN ROLL AND ARE NOT DECREASING (H54-603 THRU H56-603; H69-602 THRU H71-602)<br>3. VEHICLE ANGULAR RATES GREATER THAN 1.2 DEG/SEC AND ARE NOT DECREASING (R4-602; R5-602; R6-602; R8-602; R12-602; R13-602)<br>4. FLIGHT CONTROL COMPUTER NOT IN CORRECT MODE (K20-602)<br>5. EMR BITS D26, D25, AND D24 SET TO ONE (H60-603)<br>6. GUIDANCE STATUS WORD (MODE CODE 24) BITS D16, D18, OR D20 SET TO ONE<br>7. GUIDANCE FAILURE DISCRETE (D04) MODE CODE 26, BIT 8 SET TO ONE (H60-603)<br>NOTES:<br>1. THE SLV YAW GIMBAL (Z - AXIS) IS CRITICAL BEYOND ± 45 DEG<br>2. DURING PERIODS OF NO GROUND COMMUNICATIONS CREW MAY ATTEMPT ATTITUDE CONTROL SWITCH OVER TO ALLOW SEPARATION OVER A GROUND STATION |
| | | B. BEFORE DOCKING | TD&E | B. CONTINUE MISSION<br>1. BSE INFORM FLIGHT AND FIDO<br>2. BSE MAY RECOMMEND NO DOCK FOR LVDC FAILURE<br>3. CAPCOM ADVISE CREW | |
| | | C. DURING LM EXTRACTION | TD&E | C. CONTINUE MISSION<br>1. BSE INFORM FLIGHT AND FIDO<br>2. CAPCOM ADVISE CREW | |
| | | D. AFTER LM EXTRACTION | TLI | D. CONTINUE MISSION<br><br>BSE INFORM FLIGHT | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 7-6 | CONTINUOUS VENT SYSTEM (CVS) REGULATOR FAILS TO OPEN | ORBIT TLI | | CUES:<br>1. $LH_2$ ULLAGE PRESSURE (D177-408; D178-408)<br>2. CVS NOZZLE PRESSURE (D181-409; D182-409)<br>3. CVS REGULATOR CLOSED (K154-411)<br><br>NOTES:<br>1. IF THE CVS REGULATOR FAILS TO OPEN, THE $LH_2$ SATURATION TEMPERATURE WILL INCREASE ABOVE RESTART LIMITS TO INSURE A COMPLETE BURN<br>2. BLOWDOWN OF $LH_2$ TANK BELOW 19 PSIA WILL RESULT IN A LOSS OF 150 LBM OF USABLE $LH_2$ PROPELLANT PER PSIA<br>3. CVS NOZZLE PRESSURES SHORTLY AFTER CUTOFF (AFTER SEQUENCED OPENING OF CVS)<br>A. BOTH LEGS OPEN 15-20 PSIA<br>B. ORIFICE ONLY OPEN 4 PSIA<br>C. BOTH LEGS CLOSED -0 PSIA |
| | | A. TB5 + 59 SEC | | A. CONTINUE MISSION<br>BSE INFORM FLIGHT AND COMMAND:<br>1. CVS RELIEF OVERRIDE SHUT-OFF VALVE OPEN<br>IF UNSUCCESSFUL, BSE COMMAND:<br>2. VENT THE $LH_2$ TANK PRIOR TO TB6 TO A PRESSURE BELOW THE VALUE THAT SATISFIES THE CURVE (SEE BSE PROCEDURES)<br>3. IF THE $LH_2$ BLOWDOWN IS COMPLETED WITHIN 30 MIN PRIOR TO TB6 INITIATE COMMAND<br>(A) ULLAGE ENGINES ON<br>(B) AFTER 90 SEC OF ULLAGING COMMAND ULLAGE ENGINES OFF.<br>ULLAGING SHOULD BE COMPLETED PRIOR TO THE AMBIENT REPRESSURIZATION | |
| | | B. TB7 + 0.5 SEC | ORBIT | B. CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>AT TB7 + 60 MIN<br>1. $LH_2$ VENT VALVE OPEN ON<br>AT 21 PSIA<br>2. $LH_2$ VENT VALVE CLOSE AT TB8 + 6 MIN<br>3. S-IVB ULLAGE ENGINES ON | |

| MISSION | REV | DATE | SECTION | GROUP | PAGE |
|---|---|---|---|---|---|
| APOLLO 9 | A | 2/15/69 | SLV - TB5 AND TB7 | | 7-3 |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 7-7 | CVS ORIFICE LEG FAILS TO OPEN (TB5 OR TB7) | ORBIT<br>TD&E<br>TLI | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND TRANSMIT:<br>$LH_2$ TANK CONTINUOUS VENT ORIFICE SHUTOFF VALVE OPEN | CUES:<br>1. CVS NOZZLE PRESSURE (D181-409; D182-409)<br>2. $LH_2$ TANK CONTINUOUS VENT ORIFICE VALVE CLOSED (K155-411) |
| A | 7-8 | FAILURE TO TERMINATE APS ULLAGE ENGINE(S) THRUST AT TB5 + 1 MIN 27 SEC, TB7 + 19 SEC, TB8 + 7 MIN 33 SEC OR TB9 + 0 SEC. | ORBIT | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>S-IVB ULLAGE ENGINES OFF<br>IF UNSUCCESSFUL, BSE INFORM FLIGHT OF IMPENDING LOSS OF ATTITUDE CONTROL | CUES:<br>1. ULLAGE ENGINE THRUST CHAMBER PRESSURE GREATER THAN 20 PSIA (D220-414; D221-415)<br>2. APS HELIUM SPHERE PRESSURE DECREASING (D35-414; D36-415; D250-414; D251-415)<br>NOTE:<br>FAILURE TO TERMINATE THRUST IN EITHER APS MODULE WILL RESULT IN APS PROPELLANT DEPLETION AT APPROXIMATELY TB5 + 14 MIN AND TB7 +3.6 MIN. FAILURE TO TERMINATE THRUST IN BOTH MODULES RESULT IN DEPLETION AT APPROXIMATELY TB5 + 18 MIN AND TB7 + 7 MIN |
| | | RULE NUMBER 7-9 IS RESERVED | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 7-10 | IU ECS WATER VALVE FAILS TO CYCLE OPEN AND CLOSED. | | | <u>CUES</u>:<br>1. WATER VALVE CLOSED/OPEN (G5-601; G6-601)<br>2. ME/$H_2O$ TEMP (C15-601)<br>3. OMW MODE CODE 27 BIT D8 SET TO ZERO (H60-603)<br>4. ST-124 INERTIAL GIMBAL TEMP (C34-603)<br>5. SUBLIMATER INLET TEMP (C11-601)<br>6. LVDC MEMORY TEMP (C54-603)<br>7. LVDA TEMP #1 (C55-603)<br>8. LVDA TEMP #2 (C56-603) |
| | | A. WATER VALVE CLOSED AND COOLANT INLET CONTROL TEMPERATURE IS 64°F OR HIGHER, AND<br>THE INERTIAL GIMBAL TEMPERATURE IS PREDICTED TO BE EQUAL TO OR GREATER THAN 115°F BEFORE THE NEXT SITE AOS, OR<br>THE LVDC MEMORY TEMPERATURE IS PREDICTED TO BE EQUAL TO OR GREATER THAN 124°F BEFORE THE NEXT SITE AOS. | ALL | A. <u>CONTINUE MISSION</u>.<br>BSE INFORM FLIGHT AND COMMAND:<br>1. ECS LOGIC INHIBIT COMMAND<br>2. WATER VALVE OPEN | |
| | | B. WATER VALVE OPEN AND COOLANT INLET CONTROL TEMP IS 55°F OR LESS, AND<br>THE INERTIAL GIMBAL TEMPERATURE IS PREDICTED TO BE 104°F OR LESS BEFORE THE NEXT SITE AOS, OR<br>THE LVDC MEMORY TEMPERATURE IS PREDICTED TO BE 32°F OR LESS BEFORE THE NEXT SITE AOS. | ALL | B. <u>CONTINUE MISSION</u>.<br>BSE INFORM FLIGHT AND COMMAND:<br>1. ECS LOGIC INHIBIT COMMAND<br>2. WATER VALVE CLOSED | |
| | | RULE NUMBER 7-11 IS RESERVED | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 7-12 | ENGINE PUMP PURGE FAILS ON AT TB5 + 10 MIN 3 SEC AND TB7 + 10 MIN 3 SEC | ORBIT<br>TLI | CONTINUE MISSION.<br><br>BSE INFORM FLIGHT AND COMMAND:<br><br>ENGINE PUMP PURGE CONTROL VALVE CLOSED. | CUES:<br>1. ENGINE PUMP PURGE REGULATOR PRESSURE FAILS TO DECREASE FROM ABOUT 100 PSIA TO ABOUT 10 PSIA. (D50-403)<br>2. AMBIENT BOTTLE PRESSURE DECREASING AT A RATE OF 23 PSIA/MIN (D236-403; D256-403).<br><br>NOTE:<br>IF NOT TERMINATED, THE PURGE WILL CAUSE THE DEPLETION OF THE AMBIENT HELIUM PNEUMATIC SUPPLY AT THE RATE OF 23 PSI/MIN. |
| | 7-13 | S-IVB STAGE COMMON BULKHEAD DELTA PRESSURE REACHES OR EXCEEDS:<br><br>A. MINUS 20 PSID<br>PLUS 30 PSID<br><br>B. MINUS 26 PSID<br>PLUS 36 PSID | ORBIT<br>TLI<br><br><br><br><br>ALL | A. CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>$LH_2$ AND/OR LOX TANK VENT VALVES OPEN OR CLOSED TO PRECLUDE REACHING THE SEPARATION LIMITS.<br><br>B. CONTINUE MISSION.<br>BSE INFORM FLIGHT AND FIDO AND RECOMMEND SPACECRAFT SEPARATION TO A SAFE DISTANCE. | CUES:<br>1. $LH_2$ TANK ULLAGE PRESSURE (D0177-408, D0178-408)<br>2. $LH_2$ PUMP INLET PRESSURE (D0002-403)<br>3. LOX TANK ULLAGE PRESSURE (D0180-406, D0179-406)<br>4. LOX PUMP INLET PRESSURE (D0003-403)<br><br>NOTES:<br>1. MINUS DELTA PRESSURE IS DEFINED AS A FUEL TANK ULLAGE PRESSURE GREATER THAN THE LOX TANK ULLAGE PRESSURE.<br>2. PLUS DELTA PRESSURE IS DEFINED AS A LOX TANK ULLAGE PRESSURE GREATER THAN THE FUEL TANK ULLAGE PRESSURE.<br>3. THE MINIMUM RECOMMENDED DISTANCE BETWEEN THE S-IVB AND THE SPACECRAFT IS 7000 FEET.<br>4. THE BULKHEAD WILL STRUCTURALLY FAIL AT THE ULTIMATE LIMITS OF MINUS 32.5 PSID OR PLUS 42.0 PSID. |
| | | RULE NUMBER 7-14<br>IS RESERVED | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 7-15 | S-IVB HYDRAULIC FLUID IS BELOW OR PREDICTED TO DROP BELOW 10 DEG F BEFORE NEXT AOS | ORBIT<br>TLI | <u>CONTINUE MISSION</u>.<br><br>BSE INFORM FLIGHT AND COMMAND:<br><br>AUXILIARY HYDRAULIC PUMP FLIGHT MODE ON AND OFF AS REQUIRED FOR THERMAL CONDITIONING | <u>CUES</u>:<br><br>1. HYDRAULIC PUMP INLET OIL TEMP (C50-401)<br><br>2. RESERVOIR OIL TEMP (C51-403) |
| | 7-16 | LOX NPV NOT OPEN AT TB5 + 6 HRS 18 MIN 55 SEC AND $LH_2$ VENT OPEN AS PROGRAMED.<br><br>RULE NUMBER 7-17 THROUGH 7-18 ARE RESERVED | TLI | <u>CONTINUE MISSION</u>.<br><br>BSE INFORM FLIGHT AND FIDO AND COMMAND:<br><br>A. LOX NPV OPENED AND LATCHED<br><br>IF UNSUCCESSFUL, BSE COMMAND:<br><br>B. CLOSE $LH_2$ TANK LATCHING RELIEF VALVE<br><br>C. CLOSE CVS | <u>CUES</u>:<br><br>1. LOX ULLAGE PRESSURE (D179-406, D180-406)<br><br>2. LOX NPV NOZZLE PRESSURE (D243-404, D244-404)<br><br>3. LOX NPV DISCRETES (K198-403, K199-403) |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 7-19 | $LH_2$ ULLAGE PRESSURE LESS THAN 18 PSIA DURING ORBITAL COAST (TB5 OR TB7) | EARTH ORBIT | CONTINUE MISSION<br>BSE INFORM FLIGHT AND COMMAND CVS CLOSED, AND CVS ORIFICE LEG OPEN. IF PRESSURE RISES TO 21 PSIA, COMMAND CVS REGULATOR LEG OPEN. REPEAT AS NECESSARY TO MAINTAIN ULLAGE PRESSURE BETWEEN 18 AND 21 PSIA PRIOR TO INITIATION OF RESTART PREPS. | CUES:<br>1. FUEL TANK ULLAGE EDS NOS. 1 AND 2 PRESSURE (D0177-408, D0178-408).<br>2. FUEL PUMP INLET PRESSURE D0002-403). |
| A | 7-20 | FAILURE TO SAFE THE RANGE SAFETY RECEIVERS AT INSERTION.<br>SAFING IS TO BE ACCOMPLISHED ON SUBSEQUENT PASSES OVER KSC.<br>A. PROPELLANT DISPERSION SYSTEM NOT ARMED<br>B. PROPELLANT DISPERSION SYSTEM ARMED | ORBIT | A. CONTINUE MISSION<br>BSE INFORM FLIGHT AND RECOMMEND RSO SEND SAFE COMMAND<br>B. SPACECRAFT SEPARATION<br>BSE INFORM FLIGHT AND:<br>1. RECOMMEND SPACECRAFT SEPARATION TO A SAFE DISTANCE (7000 FT)<br>2. WHEN SPACECRAFT HAS REACHED A SAFE DISTANCE, RECOMMEND RSO SEND SAFE COMMAND | CUES:<br>1. FIRING UNIT 1 RS EBW (M30-411) >1.6 VOLTS<br>2. FIRING UNIT 2 RS EBW (M31-411) >1.6 VOLTS<br>3. RANGE SAFETY RECEIVER #1 ENABLE (N057-411) BETWEEN 2.4 AND 4.5 VOLTS<br>4. RANGE SAFETY RECEIVER #2 ENABLE (N062-411) BETWEEN 2.4 AND 4.5 VOLTS<br>5. RSO DISPLAY AND COMMAND SYSTEM STATUS<br>NOTES:<br>1. RSO SHOULD NOT ATTEMPT TO SAFE THE RANGE SAFETY RECEIVERS ON REVS 1 AND 2 UNTIL MCC CONFIRMS THE PROPELLANT DISPERSION SYSTEM IS NOT ARMED<br>2. EITHER CUE 1 OR CUE 2 IS SUFFICIENT FOR IMPLEMENTING THIS RULE |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 7-21 | J-2 ENGINE MAIN FUEL VALVE FAILS TO CLOSE AT S-IVB FIRST OR SECOND CUTOFF. | ORBIT | CONTINUE MISSION.<br>A. BSE INFORM FLIGHT AND COMMAND PREVALVES AND RECIRC SHUTOFF VALVES CLOSED, AND CYCLE THE MAIN FUEL VALVES OPEN AND CLOSED.<br>B. IF SUCCESSFUL, COMMAND PRE-VALVES AND RECIRC VALVES OPEN.<br>C. IF UNSUCCESSFUL AT TB6/8 + __ COMMAND RECIRC VALVES OPEN. | CUES:<br>1. MAIN FUEL VALVE POSITION (G004-401)<br>2. MAIN FUEL VALVE OPEN DISCRETE (K118-401)<br>3. FUEL PUMP DISCHARGE TEMP (C134-401)<br>4. FUEL CIRCULATION PUMP FLOWMETER (F5-406)<br>NOTE:<br>NO COMMAND ACTION IS REQUIRED SHOULD FAILURE OCCUR FOLLOWING THIRD S-IVB CUTOFF |
| A | 7-22 | J-2 ENGINE MAIN OXIDIZER VALVE FAILS TO CLOSE AT S-IVB FIRST OR SECOND CUTOFF | ORBIT<br>TLI | CONTINUE MISSION.<br>A. BSE INFORM FLIGHT AND COMMAND (ASAP): PREVALVES AND RECIRC SHUTOFF VALVES CLOSED<br>B. BSE ATTEMPT TO CYCLE MOV OPEN AND CLOSED. IF SUCCESS-FUL, BSE COMMAND:<br>a. ENGINE MOV CLOSED<br>b. PREVALVE AND RECIRC SHUTOFF VALVES OPEN | CUES:<br>1. MAIN OXIDIZER VALVE POSITION (G3-401)<br>2. MAIN OXIDIZER VALVE OPEN (K120-401)<br>3. LOX PUMP DISCHARGE TEMP (C133-401)<br>4. LOX CIRCULATION PUMP FLOWRATE (F4-424)<br>NOTES:<br>1.<br>2.<br>3. NO COMMAND ACTION IS REQUIRED SHOULD FAILURE OCCUR FOLLOWING 3RD S-IVB CUTOFF. |
| | 7-23 | S-IVB STAGE PNEUMATIC REGU-LATOR OUTLET PRESSURE LESS THAN 400 PSIA AND DECREAS-ING IMMEDIATELY AFTER S-IVB CUTOFF (FIRST BURN) | ORBIT | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>$LH_2$ CONTINUOUS VENT SYSTEM OPEN | CUES:<br>STAGE PNEUMATIC REG OUTLET PRESSURE (D014-403, D247-403)<br>NOTES:<br>IF PNEUMATIC REGULATOR HAS FAILED CLOSED, THE J-2 ENGINE PUMP PURGE WILL DEPLETE PRES-SURE DOWNSTREAM OF THE REGU-LATOR IN 45 SEC |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 7-24 | DELETED | | | |

8 SLV – TB6/TB8/
TB8A

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 8-1 | S-IVB STAGE $O_2/H_2$ BURNER FUEL PROPELLANT VALVE FAILS CLOSED | TLI | CONTINUE MISSION.<br><br>BSE INFORM FLIGHT AND COMMAND:<br><br>BURNER SHUTDOWN SEQUENCE | CUES:<br><br>1. BURNER CHAMBER DOME TEMPERATURE INDICATES 460 DEG R OR LESS (C382-403)<br><br>2. BURNER NOZZLE TEMPERATURE OFF SCALE LOW (C380-403)<br><br>3. BURNER $GH_2$ INJECTOR TEMPERATURE (C383-403)<br><br>4. AMBIENT REPRESSURIZATION MODE SELECT (K195-404)<br><br>5. BURNER $LH_2$ PRESSURIZATION COIL TEMPERATURE (C379-403)<br><br>6. BURNER PROPELLANT VALVES POSITIONS (K180-404, K192-403)<br><br>NOTE:<br><br>THE $O_2/H_2$ BURNER VOTING CIRCUIT WILL NOT DETECT FAILURE OF THE BURNER TO IGNITE OR BURNER FLAME-OUT IN THE EVENT THE FUEL PROPELLANT VALVE FAILS CLOSED. |
| | | RULE NUMBER 8-2 IS RESERVED | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 8-3 | CONTINUOUS VENT REGULATOR FAILS TO CLOSE DURING TB6/8/8A | ORBIT | CONTINUE MISSION.<br><br>BSE INFORM FLIGHT AND COMMAND IMMEDIATELY:<br><br>A. CONTINUOUS VENT VALVE CLOSE<br><br>B. IF UNSUCCESSFUL BSE COMMAND SECOND BURN RELAY OFF AFTER TB6/8/8A + 45 SECONDS | CUES:<br><br>1. CVS VALVE POSITION (K154-411)<br><br>2. CVS NOZZLE PRESSURE (D181-409, D182-409)<br><br>NOTES:<br><br>1. CVS NOZZLE PRESSURES SHOULD DROP TO ZERO AT TB6/TB8A + 42.2 SEC OR TB8 + 6 MIN 24.4 SEC<br><br>2. POSITIVE INDICATION OF A FAILED OPEN REGULATOR IS NOZZLE PRESSURES GREATER THAN 3 PSIA AND OSCILLATING AT ABOUT 1 CPS<br><br>3. IF D181 AND D182 SHOW STEADY PRESSURE GREATER THAN 3 PSIA, THE REGULATOR MAY BE OPEN |
| A | 8-4 | S-IVB STAGE FAILS TO ATTAIN THRUST OR LOSS OF THRUST AFTER MAINSTAGE "OK"<br><br>RULE NUMBERS 8-5 THROUGH 8-10 ARE RESERVED. | TLI | CONTINUE MISSION.<br><br>BSE INFORM FLIGHT | CUES:<br><br>1. THRUST CHAMBER PRESSURE <300 PSIA (D1-403)<br><br>2. THRUST OK SWITCHES OFF (K14-401, K157-401)<br><br>3. LONGITUDINAL ACCELERATION <3g (VA2-603)<br><br>4. TB7/TB9 INITIATED (MODE CODE 26) BIT 20 EQUAL TO ONE (460-603)<br><br>NOTE:<br><br>IF THE S-IVB HAS FAILED TO ATTAIN THRUST BY:<br>1. TB6 PLUS 9 MIN 49 SEC, TB7 IS INITIATED.<br>2. TB8 PLUS 7 MIN 48 SEC, TB9 IS INITIATED.<br>3. TB8A PLUS 9 MIN 49 SEC, TB9 IS INITIATED. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 8-11 | $LH_2$ CHILLDOWN SYSTEM FAILS DURING RESTART PREPARATIONS | TLI | CONTINUE MISSION.<br><br>BSE INFORM FLIGHT AND AT TB6/TB8A + 8 MIN 45 SEC OR TB8 + 6 MIN 45 SEC COMMAND:<br><br>A. S-IVB ENGINE CUTOFF OFF<br><br>B. ENGINE READY BYPASS<br><br>C. PREVALVES OPEN<br><br>D. ENGINE START ON | CUES:<br><br>1. $LH_2$ PREVALVE OPEN (K111-404)<br><br>2. $LH_2$ PREVALVE CLOSE (K112-404)<br><br>3. $LH_2$ BLEED VALVE CLOSE (K127-401)<br><br>4. $LH_2$ RECIRC. VALVE CLOSE (K136-409)<br><br>5. $LH_2$ RECIRC. FLOW (F005-404)<br><br>6. $LH_2$ PUMP INLET PRESS (D002-403)<br><br>7. $LH_2$ ULLAGE PRESSURE (D177-408, D178-408)<br><br>NOTES:<br><br>$LH_2$ CHILLDOWN WILL NOT BE SATISFACTORY IF:<br><br>A. PREVALVE IS OPEN<br><br>B. RECIRC. VALVE IS CLOSED<br><br>C. BLEED VALVE IS CLOSED<br><br>D. CHILLDOWN PUMP IS NOT ON |
| A | 8-12 | S-IVB AUXILIARY HYDRAULIC PUMP FAILS TO TURN ON AT:<br><br>TB6 + 3 MIN 39 SEC,<br>TB8 + 1 MIN 39 SEC, OR<br>TB8A + 3 MIN 39 SEC. | TLI | CONTINUE MISSION.<br><br>BSE INFORM FLIGHT AND SEND:<br><br>AUXILIARY HYDRAULIC PUMP FLIGHT MODE OFF. | CUES:<br><br>1. HYDRAULIC SYSTEM PRESSURE (D0041-403) <1700 PSIA<br><br>2. RESERVOIR OIL LEVEL (L0007-403). >50%<br><br>3. AFT BATTERY NO. 2 CURRENT (M022-404) ZERO AMPS<br><br>4. RESERVOIR OIL PRESSURE (D0042-403). <89 PSIA<br><br>NOTES:<br><br>IN THE EVENT THE AUXILIARY HYDRAULIC PUMP FAILS TO TURN ON DURING RESTART PREPARATIONS, FLIGHT MODE OFF SHOULD BE SENT TO PRECLUDE THE POSSIBILITY OF THE AUXILIARY HYDRAULIC PUMP STARTING WHILE THE CHILLDOWN PUMPS ARE OPERATING. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 8-13 | $LH_2$ AMBIENT REPRESS SUPPLY IS LESS THAN 1500 PSIA AT TB8. | TLI | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>A. AT TB8 + 3 MIN:<br>1. AMBIENT REPRESS MODE SELECT OFF.<br>2. $LH_2$ TANK REPRESS CONTROL VALVES OPEN ON.<br>3. CVS CLOSE.<br>B. AT TB8 + 7 MIN:<br>AMBIENT REPRESS MODE SELECT ON. | CUES:<br>1. FUEL TANK HELIUM BOTTLE REPRESSURIZATION PRESSURE (D0020-403, D0249-403).<br>2. LOX TANK REPRESSURIZATION SPHERES PRESSURE (D0088-403, D0254-403). |
| | 8-14 | PRESSURE SWITCHES FAIL TO TERMINATE LOX OR FUEL AMBIENT REPRESSURIZATION. | TLI | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>A. LOX TANK REPRESSURIZATION CONTROL VALVES CLOSED<br>OR<br>B. $LH_2$ TANK REPRESSURIZATION CONTROL VALVES CLOSED | CUES:<br>1. LOX TANK ULLAGE PRESSURES (D179-406, D180-406)<br>2. $LH_2$ TANK ULLAGE PRESSURES (D177-408, D178-408) |

9 SLV - TB9

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 9-1 | CONTINUOUS VENT VALVE REGULATOR FAILS CLOSED | TLI | <u>CONTINUE MISSION</u>.<br><br>BSE INFORM FLIGHT AND TRANSMIT:<br><br>A. CONTINUOUS VENT RELIEF OVERRIDE SHUTOFF VALVE OPEN<br><br>B. IF THE CVS REG REMAINS CLOSED, COMMAND THE $LH_2$ VENT VALVE OPEN AND CLOSED TO MAINTAIN AN ULLAGE PRESSURE OF 15-20 PSIA | <u>CUES</u>:<br><br>1. $LH_2$ TANK ULLAGE PRESSURES (D177-408, D178-408)<br><br>2. CVS VALVE POSITION (K154-411)<br><br>3. CVS NOZZLE PRESSURE (D181-409, D182-409)<br><br>4. CVS NOZZLE TEMPERATURES (C256-409, C257-409)<br><br><u>NOTE</u>:<br><br>MUST MAINTAIN 15 PSIA IN $LH_2$ TANK FOR ACCEPTABLE $LH_2$ DUMP |
| | | RULE NUMBER 9-2 IS RESERVED | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 9-3 | FAILURE OF LOX NONPROPULSIVE VENT TO LATCH OPEN (TB9 + 12 MIN 42 SEC) | TLI | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>1. LOX NPV VALVE OPEN AND LATCHED.<br>IF UNSUCCESSFUL, BSE COMMAND:<br>2. LOX NPV OPEN<br>IF 1 AND 2 ARE UNSUCCESSFUL, SEND:<br>3. LOX VENT VALVE OPEN | CUES:<br>1. LOX TANK ULLAGE PRESSURE (D179-406, D180-406)<br>2. LOX NPV NOZZLE PRESSURES (D243-404, D244-404)<br>3. LOX NPV DISCRETES (K198-403, K199-403) |
| A | 9-4 | FAILURE OF S-IVB LOX DUMP TO INITIATE AT TB9 + 1 MIN 30 SEC | TLI | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>ENGINE MAIN LOX VALVE OPEN | CUES:<br>1. MAIN OXIDIZER VALVE OPEN - CLOSED (G3-401)<br>2. LOX PUMP DISCHARGE TEMPERATURE (C133-401)<br>3. MAIN OXIDIZER VALVE OPEN/CLOSED DISCRETE (K120-401) |
| A | 9-5 | FAILURE OF $LH_2$ DUMP TO INITIATE AT TB9 + 12 MIN 50 SEC | TLI | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>ENGINE MAIN FUEL VALVE OPEN | CUES:<br>1. MAIN FUEL VALVE OPEN - CLOSED (G4-401)<br>2. $LH_2$ PUMP DISCHARGE TEMPERATURE (C134-401)<br>3. MAIN FUEL VALVE OPEN/CLOSED DISCRETE (K118-401) |
| | 9-6 | FAILURE OF COLD HELIUM DUMP TO INITIATE | TLI | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>1. COLD HELIUM DUMP THRU BURNER<br>IF UNSUCCESSFUL, BSE COMMAND AFTER TB9 + 12 MIN 40 SEC:<br>2. LOX TANK FLIGHT PRESSURIZATION SHUTOFF VALVE OPEN | CUES:<br>1. COLD HELIUM BOTTLE PRESSURE (D16-425, D248-405)<br>2. $GOX/GH_2$ BURNER $LH_2$ PRESSURE COIL (D231-403) |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 9-7 | FAILURE ENGINE START BOTTLE DUMP TO INITIATE | TLI | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>START BOTTLE VENT CONTROL VALVE OPEN | CUES:<br>$GH_2$ START BOTTLE PRESSURE (D17-401, D241-401) |
| | 9-8 | FAILURE OF S-IVB STAGE CONTROL PNEUMATIC DUMP TO INITIATE. | TLI | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>1. ENGINE PUMP SEAL PURGE ON<br>IF UNSUCCESSFUL, BSE COMMAND:<br>2. LOX SHUTDOWN VALVE CLOSED | CUES:<br>1. HELIUM AMBIENT SPHERE PRESSURE NOT DECREASING (D236-403, D256-403)<br>2. ENGINE PUMP PURGE (D50-403) |
| | 9-9 | FAILURE OF ENGINE CONTROL BOTTLE HELIUM DUMP TO INITIATE | TLI | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>1. ENGINE PNEUMATIC SYSTEM VENT OPEN<br>IF UNSUCCESSFUL, BSE COMMAND:<br>2. ENGINE HELIUM CONTROL SHUTOFF VALVE OPEN | CUE:<br>ENGINE CONTROL HELIUM SPHERE PRESSURE (D19-401, D242-401) |
| A | 9-10 | LOSS OF EITHER OR BOTH APS MODULES PRIOR TO OR DURING PROPELLANT DUMP<br><br>RULE NUMBERS 9-11 THROUGH 9-15 ARE RESERVED | TLI | CONTINUE MISSION.<br>BSE INFORM FLIGHT AND COMMAND:<br>S-IVB BURN MODE ON | CUES:<br>1. ATTITUDE CONTROL HELIUM CONTROL PRESSURE TANK 1 LESS THAN 1100 PSIA (D35-414, D250-414)<br>2. MANIFOLD PRESSURE MOD 1 LESS THAN 160 PSIA (OXID-FUEL) (D70-414, D71-414)<br>3. ATTITUDE CONTROL HELIUM CONTROL PRESSURE TANK 2 LESS THAN 1100 PSIA (D36-415, D251-415)<br>4. MANIFOLD PRESSURE MOD 2 LESS THAN 160 PSIA (OXID-FUEL) (D72-415, D73-415) |

| REV | ITEM | | | | | | |
|---|---|---|---|---|---|---|---|
| | | **PRELAUNCH INSTRUMENTATION** | | | | | |
| A | 9-16 | MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
| | | S-IC STAGE SYSTEMS | | | | | |
| | | PRESS, COMBUSTION CHAMBER | D8-101 | | | HD | |
| | | PRESS, COMBUSTION CHAMBER | D8-102 | | | HD | |
| | | PRESS, COMBUSTION CHAMBER | D8-103 | | | HD | |
| | | PRESS, COMBUSTION CHAMBER | D8-104 | | | HD | |
| | | PRESS, COMBUSTION CHAMBER | D8-105 | | | HD | |
| | | FINAL THRUST OK CUTOFF ENG NO. 1 | VK52-115 | | | HD | |
| | | FINAL THRUST OK CUTOFF ENG NO. 2 | VK53-115 | | | HD | |
| | | FINAL THRUST OK CUTOFF ENG NO. 3 | VK54-115 | | | HD | |
| | | FINAL THRUST OK CUTOFF ENG NO. 4 | VK55-115 | | | HD | |
| | | FINAL THRUST OK CUTOFF ENG NO. 5 | VK56-115 | | | HD | |
| | | S-II STAGE SYSTEMS | | | | | |
| | | TEMP, RECIRCULATION BATTERY 1 | C540-200 | | | HD | |
| | | TEMP, RECIRCULATION BATTERY 2 | C541-200 | | | HD | |
| | | PRESS, THRUST CHAMBER, ENG 1 | D13-201 | | | HD | |
| | | PRESS, THRUST CHAMBER, ENG 2 | D13-202 | | | HD | |
| | | PRESS, THRUST CHAMBER, ENG 3 | D13-203 | | | HD | |
| | | PRESS, THRUST CHAMBER, ENG 4 | D13-204 | | | HD | |
| | | PRESS, THRUST CHAMBER, ENG 5 | D13-205 | | | HD | |
| | | POSITION, YAW ACTUATOR | VG8-201 | | | HD | |
| | | | G30-201 | | | HD | |
| | | POSITION, YAW ACTUATOR | VG8-202 | | | HD | |
| | | | G30-202 | | | HD | |
| | | POSITION, YAW ACTUATOR | VG8-203 | | | HD | |
| | | | G30-203 | | | HD | |
| | | POSITION, YAW ACTUATOR | VG8-204 | | | HD | |
| | | | G30-204 | | | HD | |
| | | POSITION, PITCH ACTUATOR | VG9-201 | | | HD | |
| | | | G31-201 | | | HD | |
| | | POSITION, PITCH ACTUATOR | VG9-202 | | | HD | |
| | | | G31-202 | | | HD | |
| | | POSITION, PITCH ACTUATOR | VG9-203 | | | HD | |
| | | | G31-203 | | | HD | |
| | | POSITION, PITCH ACTUATOR | VG9-204 | | | HD | |
| | | | G31-204 | | | HD | |
| | | DEPRESS, MAINSTAGE OK SW A, ENG 1 | K285-201 | | | HD | |
| | | DEPRESS, MAINSTAGE OK SW B, ENG 1 | K286-201 | | | HD | |
| | | DEPRESS, MAINSTAGE OK SW A, ENG 2 | K285-202 | | | HD | |
| | | DEPRESS, MAINSTAGE OK SW B, ENG 2 | K286-202 | | | HD | |
| | | DEPRESS, MAINSTAGE OK SW A, ENG 3 | K285-203 | | | HD | |
| | | DEPRESS, MAINSTAGE OK SW B, ENG 3 | K286-203 | | | HD | |
| | | DEPRESS, MAINSTAGE OK SW A, ENG 4 | K285-204 | | | HD | |
| | | DEPRESS, MAINSTAGE OK SW B, ENG 4 | K286-204 | | | HD | |
| | | DEPRESS, MAINSTAGE OK SW A, ENG 5 | K285-205 | | | HD | |
| | | DEPRESS, MAINSTAGE OK SW B, ENG 5 | K286-205 | | | HD | |
| | | VOLTAGE, RECIRC BATTERY | XM111-207 | | | HD | |

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**MISSION RULES**

| REV | ITEM | MEAS DESCRIPTION | MEAS NO. | ONBOARD | TRANSDUCER | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|---|---|
| A | 9-16 (CONT'D) | S-IVB STAGE SYSTEMS | | | | | |
| | | LINK CP1 | | | | HD | |
| | | MUX CP1AO | | | | HD | |
| | | MUX CP1BO | | | | HD | |
| | | MUX RDSM | | | | HD | |
| | | MUX RLSM | | | | HD | |
| | | PRESS, FUEL TANK ULLAGE EDS 1 | VD177-408 | | | HD | |
| | | PRESS, HYDRAULIC RESERVOIR | D042-403 | | | HD | |
| | | PRESS, HYDRAULIC SYSTEM | D041-403 | | | | |
| | | PRESS, FUEL TANK ULLAGE EDS 2 | VD178-408 | | | HD | |
| | | PRESS, OXID TANK ULLAGE EDS 1 | VD179-408 | | | HD | |
| | | PRESS, OXID TANK ULLAGE EDS 2 | VD180-406 | | | HD | |
| | | LEVEL, RESERVOIR OIL | VXL7-403 | | | HD | |
| | | VOLT, F/V 1 ESW RANGE SAFETY | XM30-411 | | | HD | |
| | | VOLT, F/V 2 ESW RANGE SAFETY | XM31-411 | | | HD | |
| | | MISC, SEC R/S RCVR 1 L/L SIG STR | VN57-411 | | | HD | |
| | | MISC, SEC R/S RCVR 2 L/L SIG STR | VN62-411 | | | HD | |

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**MISSION RULES**

| REV | ITEM | MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|---|---|
| A | 9-16 (CONT'D) | IU STAGE SYSTEMS | | | | | |
| | | LINK DP1 | | | | 1 OF 2 M | |
| | | LINK DP-1A | | | | | |
| | | LINK DP-1B | | | | HD | |
| | | MUX DP1A0 | | | | HD | |
| | | MUX DP1B0 | | | | HD | |
| | | EDS | | | | M | |
| | | CCS DIGITAL COMMAND SYSTEM | | | | M | |
| | | ATT PITCH, LADDER OUTPUT GUID COMP | VH54-603 | | | HD | |
| | | ATT YAW, LADDER OUTPUT GUID COMP | VH55-603 | | | HD | |
| | | ATT ROLL, LADDER OUTPUT GUID COMP | VH56-603 | | | HD | |
| | | GUIDANCE COMPUTER OPERATION | H60-603 | | | M | |
| | | ATT ERROR SIGNAL ANG POS ROLL | VH69-603 | | | HD | |
| | | ATT ERROR SIGNAL ANG POS YAW | VH70-603 | | | HD | |
| | | ATT ERROR SIGNAL ANG POS PITCH | VH71-603 | | | HD | |
| | | COMPUTER RESET PULSE #1 GUIDANCE DECODER | J71-603 | | | 1 OF 2 M | |
| | | COMPUTER RESET PULSE #2 GUIDANCE DECODER | J72-603 | | | | |
| | | ANG VEL, PITCH CONTROL | VR4-602 | | | HD | |
| | | ANG VEL, PITCH EDS GROUP 3 (REF) | VR13-602 | | | HD | |
| | | ANG VEL, YAW CONTROL | VR5-602 | | | HD | |
| | | ANG VEL, YAW EDS GROUP 1 (REF) | VR8-602 | | | HD | |
| | | ANG VEL, ROLL CONTROL | VR6-602 | | | HD | |
| | | ANG VEL, ROLL EDS GROUP 2 (REF) | VR12-602 | | | HD | |

10 CSM ENVIRONMENTAL CONTROL

| REV | ITEM | GENERAL |
|---|---|---|
| | 10-1 | LAUNCH |

## GENERAL

10-1 LAUNCH

LAUNCH WILL BE CONTINUED AS LONG AS THE SUIT CIRCUIT AND $O_2$ SUPPLY WILL SUPPORT FLIGHT CREW DEMANDS FOR AT LEAST ONE REV AND ENTRY INTO 2-1. THERE ARE NO COOLANT FAILURES FOR WHICH LAUNCH/INSERTION PHASE WILL BE TERMINATED.

ALL MISSION PHASES

TO CONTINUE THE MISSION THE CABIN AND SUIT CIRCUIT INCLUDING THE $O_2$ MANIFOLD AND SURGE TANK OR REPRESS PACK MUST BE CAPABLE OF PROVIDING A CONTAMINANT - FREE, LIFE - SUSTAINING ENVIRONMENT.

THE COOLANT SYSTEM LOOP MUST BE CAPABLE OF PROVIDING AN ADEQUATE THERMAL ENVIRONMENT FOR CREW AND COLDPLATED EQUIPMENT. SUFFICIENT WATER MUST BE AVAILABLE FOR CREW CONSUMPTION AND EVAPORATIVE COOLING REQUIREMENTS TO COMPLETE THE SCHEDULED PHASE OR TO ACHIEVE THE NEXT GO/NO-GO PTP; URINE DUMP CAPABILITY OR URINE STORAGE CAPABILITY IN LM MUST BE AVAILABLE TO CONTINUE.

TD&E

UNDOCKING

RENDEZVOUS

IVT

DOCKED DPS BURN

EVA

IN ADDITION TO THE PRECEDING REQUIREMENTS, SUIT INTEGRITY IS REQUIRED TO ENTER THESE PHASES.

RENDEZVOUS

IN ADDITION TO THE PRECEDING REQUIREMENTS, THE PRIMARY LOOP COOLING IS REQUIRED.

EVA

IN ADDITION TO THE PRECEDING REQUIREMENTS, BOTH THE SURGE TANK AND THE REPRESS PACK ARE REQUIRED FOR EVA.

| REV | ITEM | |
|---|---|---|
| | 10-2 | DEFINITIONS |

LOSS OF CABIN INTEGRITY: CM PRESSURE VESSEL LEAKAGE SUCH THAT CABIN PRESSURE CANNOT BE MAINTAINED ≥4.5 PSIA BY CABIN PRESSURE REGULATORS (1.2 LB/HR TOTAL)

LOSS OF SUIT INTEGRITY: TOTAL PGA AND SUIT LOOP LEAKAGE >0.5 PSI/MIN (1.5 LB/HR) DURING PGA SUIT LOOP PRESSURE CHECK.

LOSS OF SUIT CIRCUIT: INABILITY OF THE SUIT CIRCUIT TO MAINTAIN ADEQUATE CREW COMFORT AND/OR $CO_2$ REMOVAL WITHOUT USING DIRECT $O_2$.

LOSS OF $O_2$ MANIFOLD: AN $O_2$ MANIFOLD OR REGULATOR FAILURE WITH WHICH THE SUIT CIRCUIT $O_2$ DEMANDS CANNOT BE SUPPLIED FOR ENTRY.

LOSS OF PRIMARY LOOP COOLING: LOSS OF ALL FLOW, A LEAK WHICH CANNOT BE ISOLATED, OR COMBINED FAILURES SUCH THAT RADIATORS AND EVAPORATOR PROVIDE NO COOLING.

LOSS OF SECONDARY LOOP COOLING: LOSS OF ALL FLOW, A LEAK WHICH CANNOT BE ISOLATED, OR COMBINED FAILURES SUCH THAT RADIATOR AND EVAPORATOR PROVIDE NO COOLING.

LOSS OF COOLANT LOOP RADIATORS: RADIATOR LEAK, BLOCKAGE OF ALL FLOW THROUGH RADIATORS, OR RADIATOR DEGRADATION SUCH THAT TOTAL LONG TERM USAGE OF WATER IS MORE THAN IS BEING PRODUCED.

LOSS OF ALL COOLING: LOSS OF PRIMARY AND SECONDARY LOOP COOLING.

LOSS OF SURGE TANK AND/OR REPRESS PACK: SURGE TANK, REPRESS PACK, OR PLUMBING FAILURES WHICH REQUIRE ISOLATION OF THE SURGE TANK AND/OR REPRESS PACK.

RULES 10-3 THROUGH 10-9 ARE RESERVED.

| REV | ITEM | |
|---|---|---|

## SYSTEMS MANAGEMENT

10-10 $O_2$ SYSTEM

A. SUIT FLOW RELIEF VALVE WILL REMAIN CLOSED FOR DURATION OF FLIGHT.

B. NORMAL CM REPRESSURIZATION WITH LM MANNED WILL UTILIZE THE REPRESS PACK.

C. SURGE TANK WILL BE ON LINE EXCEPT DURING LM PRESSURIZATION OR CM PRESSURIZATION WITH THE LM MANNED, WHEN IT WILL BE ISOLATED TO MAINTAIN QUANTITY >500 PSIA.

D. THE PLSS VALVE WILL BE IN OFF POSITION FOR ORBIT.

E. THE SUIT CIRCUIT MUST BE PURGED OF ACCUMULATED $H_2$ ONCE EVERY 6 HOURS FOR ONE MINUTE WHEN ALL CREWMEN ARE SUITED AND THE SUIT CIRCUIT IS ISOLATED.

F. THE SURGE TANK AND REPRESS PACK WILL NORMALLY BE RECHARGED SIMULTANEOUSLY.

G. CM CABIN PRESSURE WILL NOT BE ALLOWED TO DROP BELOW 4.0 PSIA DURING NORMAL LM PRESSURIZATION EXCEPT DURING TD&E.

H. THE CM ECS WILL NORMALLY SUPPLY ALL $O_2$ FOR CONSUMPTION AND LEAKAGE DURING IVT PHASES.

I. CSM FORWARD HATCH WILL BE INSTALLED FOR EVA.

J. THE FLIGHT CREW WILL DON SUITS FOR THE FOLLOWING:

1. INABILITY TO MAINTAIN CABIN PRESSURE ABOVE 4.5 PSIA
2. ALL LM MANNING AND EVA OPERATIONS
3. TD&E
4. GLYCOL LEAKS IN COMMAND MODULE
5. FIRE, SMOKE, CONTAMINATION IN CABIN

K. THE FLIGHT CREW WILL DOFF SUITS (TIME AND CONDITIONS PERMITTING) FOR THE FOLLOWING:

1. LOSS OF SUIT CIRCUIT
2. CONFIRMED LEAK OF GLYCOL IN SUIT CIRCUIT.

COOLANT MANAGEMENT

A. FOR SIMULATANEOUS PRIMARY AND SECONDARY LOOP OPERATION, NORMALLY EITHER THE PRIMARY OR SECONDARY LOOP RADIATOR WILL BE ISOLATED.

B. GLYCOL RESERVOIR WILL BE ON LINE AND RADIATORS WILL BE BYPASSED FOR LAUNCH.

C. INDICATED GLYCOL ACCUMULATOR QUANTITY WILL BE MAINTAINED BETWEEN 30% AND 65%.

D. SECONDARY COOLANT WILL BE OFF FOR LAUNCH.

E. ADDITIONAL POWER LOADS WILL BE ADDED AS REQUIRED IN AN ATTEMPT TO MAINTAIN PRIMARY RADIATOR OUTLET TEMPERATURE >-20 DEGREES.

F. SIMULTANEOUS PRIMARY AND SECONDARY LOOP OPERATION WILL BE USED FOR ENTRY.

WATER SYSTEM

A. WASTE WATER WILL BE DUMPED OVERBOARD AS REQUIRED TO MAINTAIN INDICATED QUANTITY <85-90%. WASTE WATER WILL NORMALLY BE DUMPED TO 25%; HOWEVER, IF WASTE WATER QUANTITY INSTRUMENTATION (CF0009) IS LOST, WASTE WATER WILL BE DUMPED UNTIL POTABLE WATER QUANTITY (CF0010) BEGINS TO DECREASE.

B. WATER DUMPS WILL BE MANAGED SO THAT CM-SM SEPARATION THE POTABLE WATER TANK WILL BE FULL AND THE WASTE WATER TANK WILL BE 90% FULL.

RULE NUMBERS 10-11 THROUGH 10-19 ARE RESERVED.

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 10-20 | CABIN PRESSURE CANNOT BE RELIEVED | LAUNCH | CONTINUE MISSION | NORMAL RELIEF STARTS AT 50 SECONDS |
| | 10-21 | CABIN PRESSURE DECREASING AND/OR <4.5 PSIA AND: | | | |
| | | A. SUIT PRESSURE ≥3.5 PSIA | LAUNCH | A.1. CONTINUE MISSION | |
| | | | ALL | 2. ENTER NEXT BEST PTP IF CABIN PRESS NOT RESTORED >4.5 PSIA. | |
| | | B. SUIT PRESSURE <3.5 PSIA | LAUNCH | B.1. ABORT ASAP | |
| | | | ALL | 2. ENTER ASAP | |
| | | C. LOSS OF SUIT CIRCUIT | LAUNCH | C.1. ABORT ASAP OPEN DIRECT $O_2$ 45 DEG FROM LAUNCH SETTING. | C.1. CORRESPONDS TO 12.6 LB/HR (APPROX 3 CFM/CREWMAN) |
| | | | ALL | 2. ENTER ASAP | |
| | 10-22 | LOSS OF SUIT CIRCUIT, CABIN STABLE AND >4.5 PSIA | LAUNCH | A. CONTINUE MISSION OPEN DIRECT $O_2$ VALVE 45 DEG FROM LAUNCH SETTING | A. CORRESPONDS TO 12.6 LB/HR (APPROX. 3 CFM/CREWMAN) |
| | | | ALL | B. TERMINATE PHASE<br>1. IF LM IS MANNED, SET UP FOR APS BURN<br>2. DOFF SUITS<br>3. OPEN WASTE OVERBOARD DRAIN VALVE TO OBTAIN CABIN BLEED FLOW.<br>4. DON FACE MASKS AFTER 1 HOUR. | B.3. WASTE OVERBOARD BLEED = 0.67 LB [illegible]<br>4. TIME REQUIRED FOR CM $CO_2$ PARTIAL PRESSURE TO INCREASE TO 7.6 MM HG:<br>1 CREWMAN: 4 HR.<br>3 CREWMAN: 80 MIN. |
| | | | | C. ENTER NEXT BEST PTP | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 10-23 | LOSS OF SURGE TANK AND REPRESS PACK | LAUNCH<br>EVA<br>ALL | A. <u>CONTINUE MISSION</u><br>B. <u>TERMINATE EVA</u><br>C. <u>CONTINUE MISSION</u> | FOR LEAK IN SURGE TANK, ISOLATE SURGE TANK AND PLACE PLSS VALVE TO FILL.<br>C. IF LOST PRIOR TO LM FINAL SEP, TRANSFER ONE OPS BOTTLE TO CM AFTER RENDEZVOUS |
| | 10-24 | LOSS OF SURGE TANK AND REPRESS PACK | LAUNCH<br>ALL | A. <u>CONTINUE MISSION</u><br>B. <u>TERMINATE PHASE</u><br>ENTER NEXT BEST PTP. IF LM IS MANNED, SET UP FOR APS BURN. | |
| | 10-25 | FIRE OR SMOKE IN COMMAND MODULE | LAUNCH<br>ALL | A. <u>ABORT</u><br>1. DECOMPRESS CABIN<br>2. TROUBLESHOOT ELECTRICAL SYSTEM PER FLIGHT CREW CHECKLIST BOOST FIRE PROCEDURES.<br>B. <u>TERMINATE PHASE</u><br>1. TROUBLESHOOT/COMBAT FIRE PER FLIGHT CREW CHECKLIST EMERGENCY PROCEDURES.<br>2. ASSESS DAMAGE AND REMOVE POWER FROM AFFECTED SYSTEMS.<br>3. <u>ENTER NEXT BEST PTP</u> | |
| | 10-26 | CONTAMINATION IN CABIN | LAUNCH<br>ALL | A. <u>CREW MAY ELECT TO DECOMPRESS</u><br>B. <u>CREW MAY ELECT TO DECOMPRESS</u> | B. IF UNABLE TO CLEAR CONTAMINATION, MISSION MAY BE TERMINATED EARLY. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 10-27 | LOSS OF SUIT INTEGRITY | | | CONTINUE MISSION EXCEPT FOR MAJOR CSM PRESSURE VESSEL CONFIGURATION CHANGES |
| | | | LAUNCH | A. CONTINUE MISSION | |
| | | | ORBIT (S-IVB) | B. INHIBIT TD&E | B. REF ALTERNATE MISSION A |
| | | | DOCKED | C. CONTINUE MISSION DO NOT UNDOCK | C. 1. INHIBIT DOCKED DPS AND SPS BURNS<br>2. NO-GO FOR EVA OR UNDOCKING |
| | | | TD&E | D. TERMINATE PHASE CONTINUE LM EJECTION IF LM IS PRESSURIZED AND TUNNEL WORK IS COMPLETE | |
| | | | ALL | E. CONTINUE MISSION | |
| | 10-28 | LOSS OF $O_2$ MANIFOLD | | | |
| | | A. WITHOUT LOSS OF CABIN INTEGRITY | LAUNCH | A. 1. CONTINUE MISSION | |
| | | | ALL | 2. ENTER NEXT BEST PTP | A. 2. APPROXIMATELY 5 HOURS ARE REQUIRED TO DE-PLETE CABIN $O_2$ FROM 4.3 TO 3.5 PSIA, WITH 0.456 LB/HR USAGE RATE (CREW + CABIN LEAK + TANK PRESS BLEED) |
| | | B. WITH LOSS OF CABIN INTEGRITY | LAUNCH | B. 1. ABORT ASAP | |
| | | | ALL | 2. ENTER ASAP | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 10-29 | PRIMARY COOLANT LOOP MALFUNCTIONS | | | |
| | | A. LOSS OF EVAPORATOR | LAUNCH | A.1. CONTINUE MISSION | A.1. REF MALF PROC ____ |
| | | | ALL | 2. CONTINUE MISSION ACTIVATE SECONDARY COOLANT LOOP WITH RADIATORS IN BY-PASS AS REQUIRED TO MAINTAIN PRIMARY EVAPORATOR OUT TEMP <60°F. | 2. (A) MAINTAIN PRI RAD OUT TEMP >-20°F. (B) WATER MANAGEMENT MAY DICTATE ACTIVATION AND DEACTIVATION OF SECONDARY LOOP TO MAINTAIN PRI RAD OUT TEMP BETWEEN 45 AND 60°F. |
| | | B. LOSS OF RADIATORS | ALL | B. CONTINUE MISSION | B. REF MALF PROC ECS-14, 15 USE PRIMARY LOOP IN ADDITION TO SECONDARY LOOP FOR G&N OPERATIONS |
| | | C. TOTAL LOSS OF LOOP | LAUNCH | C.1. CONTINUE MISSION | |
| | | | DOCKED | 2. CONTINUE MISSION | C.2. UNDOCKING AND STATION KEEPING MAY BE PERFORMED |
| | | | RNDZ | 3. TERMINATE PHASE | |
| \| | | | EVA | 4. CONTINUE MISSION | |
| | | | ALL | 5. CONTINUE MISSION | |
| | 10-30 | SECONDARY LOOP MALFUNCTIONS | | | |
| | | TOTAL LOSS OF LOOP | ALL | CONTINUE MISSION | |
| | 10-31 | LOSS OF ALL COOLING, PRIMARY AND SECONDARY | LAUNCH | A. CONTINUE MISSION | |
| | | | ALL | B. TERMINATE PHASE ENTER NEXT BEST PTP OR ATP. MAXIMUM ORBIT TIME: 4 HOURS EMERGENCY POWER DOWN FOLLOWED BY 1.5 HOURS OF POWER UP FOR ENTRY. | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 10-32 | CONFIRMED LEAK OF GLYCOL COOLANT | | | |
| | | A. IN COMMAND MODULE | LAUNCH | A.1. CONTINUE MISSION | |
| | | | ALL | 2. TERMINATE PHASE<br>ENTER NEXT BEST PTP. SELECT ALTERNATE MISSION BASED ON TIME AVAILABLE | 2. DON SUITS AND PURGE DIRECT $O_2$ |
| | | B. IN SUIT CIRCUIT | ALL | B. TERMINATE PHASE<br>ENTER NEXT BEST PTP. DOFF SUITS AND USE FACE MASKS IF REQUIRED. | |
| | | RULE NUMBERS 10-33 THROUGH 10-39 ARE RESERVED | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 10-40 | LOSS OF OVERBOARD DUMPS | | | |
| | | A. NORMAL OVERBOARD DUMPS FROZEN OR BLOCKED | ALL | A. CONTINUE MISSION | A.1. UTILIZE AUXILIARY DUMP FOR URINE AND WASTE WATER DISPOSAL.<br>2. BLEED $O_2$ FROM WATER TANK THROUGH WASTE MANAGEMENT OVERBOARD DRAIN VALVE INTO CABIN. |
| | | B. LOSS OF ALL OVERBOARD DUMP CAPABILITY | ORBIT (SOLO) | B.1. ENTER NEXT BEST PTP | B.1. IF POTABLE AND WASTE TANKS...OR WASTE TANK ALONE...BECOMES FULL, FORCED WATER BOILING WILL BE NECESSARY TO ALLOW FUEL CELL AND/OR CYCLIC ACCUMULATOR OPERATION. |
| | | | ALL | 2. CONTINUE MISSION<br>(A) IF LM IS UNMANNED, ENTER LM EARLY IF REQUIRED TO USE LM URINE STORAGE BAGS.<br>(B) IF LM IS MANNED, TRANSFER URINE COLLECTION BAG FROM LM TO CM CREWMAN. | 2. MISSION DURATION WILL BE DETERMINED BY REMAINING LM URINE STORAGE CAPACITY. |
| A | 10-41 | WASTE WATER TANK LEAK OR LOSS OF WASTE WATER STORAGE CAPABILITY | ALL | CONTINUE MISSION | WHEN POTABLE WATER TANK BECOMES FULL, FUEL CELL WATER WILL BE DUMPED THROUGH OVERBOARD PRESSURE RELIEF VALVES. |
| | 10-42 | CONFIRMED LEAK IN POTABLE TANK OR UNABLE TO TRANSFER FUEL CELL WATER TO POTABLE TANK | | | |
| | | | LAUNCH ORBIT (S-IVB) TD&E | A. CONTINUE MISSION | |
| | | | ALL | B. ENTER NEXT BEST PTP AFTER TANK IS DEPLETED. | |
| | 10-43 | LOSS OF SUIT LOOP WATER REMOVAL CAPABILITY | LAUNCH | A. CONTINUE MISSION | |
| | | | ALL | B. ENTER NEXT BEST PTP TERMINATE SUITED OPERATIONS | |
| A | 10-44 | UNABLE TO VENT SIDE HATCH COUNTERBALANCE MECHANISM | EVA | CONTINUE MISSION<br>DO NOT OPEN SIDE HATCH | |
| A | | RULE NUMBERS 10-45 THROUGH 10-49 ARE RESERVED. | | | |

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**MISSION RULES**

## INSTRUMENTATION REQUIREMENTS

| REV | ITEM | MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | REFERENCE |
|---|---|---|---|---|---|---|---|
| | 10-50 | CABIN PRESS | CF0001P | METER | COMMON | 1 OF 3 M | 10-20 |
| | | SUIT PRESS | CF0012P | METER | COMMON | | |
| | | TANK BLADDER PRESS | CF0120P | ----- | ------ | | |
| | NOT IN LMH | SUIT PRESS (CUFF GAGES) | ------- | ----- | ------ | MANDATORY (EACH CREWMAN) | 10-21 |
| | | SURGE TANK PRESS | CF0006P | METER | COMMON | 1 OF 2 M | 10-28 |
| | | OXYGEN REPRESS PRESS | ------- | METER | ------ | | |
| | | PRIM ACCUM QTY | CF0019Q | METER | COMMON | 1 OF 2 M | 10-29, 10-32 |
| | | PRIM PUMP OUT PRESS | CF0016P | METER | COMMON | | |
| | | POTABLE $H_2O$ QTY | CF0010Q | METER | COMMON | 1 OF 2 M | 10-41, 10-42 |
| | | WASTE $H_2O$ QTY | CF0009Q | METER | COMMON | | |
| | | SEC STEAM PRESS | CF0073P | METER | COMMON | 1 OF 2 M | 10-30 |
| | | SEC EVAP OUT TEMP | CF0071T | METER | COMMON | | |
| | | SEC ACCUM QTY | CF0072Q | METER | COMMON | HD | |
| | | SEC PUMP OUT PRESS | CF0070P | METER | COMMON | HD | |
| | | PRIM EVAP OUT TEMP | CF0018T | METER | COMMON | HD | |
| | | PRIM STEAM PRESS | CF0034 | METER | COMMON | HD | |
| | | ECS $O_2$ FLOW | CF0035R | METER | COMMON | HD | |
| | | $O_2$ MANIFOLD PRESS | CF0036P | ----- | ------ | HD | |
| | | SUIT COMP PRESS | CF0015P | METER | COMMON | HD | |
| | | PRIM RAD OUT TEMP | CF0020T | METER | COMMON | HD | |
| | | PRIM EVAP INLET TEMP | CF0181T | ----- | ------ | HD | |
| | | STEAM DUCT TEMP | CF0017T | ----- | ------ | HD | |
| | | SEC RAD OUT TEMP | SF0236T 2631 | METER | ------ | HD | |

| MISSION | REV | DATE | SECTION | GROUP | PAGE |
|---|---|---|---|---|---|
| APOLLO 9 | FINAL | 12/15/68 | CSM ENVIRONMENTAL CONTROL SYSTEM | INSTRUMENTATION REQUIREMENTS | 10-10 |

MSC/TCS Form 292 (AUG 68)

11 CSM CRYOGENICS

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | | **GENERAL** |
| | 11-1 | LAUNCH<br><br>THERE ARE NO CRYO FAILURES FOR WHICH THE LAUNCH/INSERTION PHASE WILL BE TERMINATED. FOR COMPLETE LOSS OF THE SYSTEM RESULTING IN THREE FUEL CELL FAILURES, ENTRY WILL BE PLANNED INTO PTP 2-1. THREE ENTRY BATTERIES ARE CAPABLE OF SUPPORTING THE LAUNCH, ONE REV OF POWER DOWN AND SCS ENTRY. |
| | 11-2 | ORBIT<br><br>THE CRYOGENICS SYSTEM IS REQUIRED UNTIL CM/SM SEP SO THAT THE ENTRY AND LANDING PHASES WILL BE ENTERED INTO WITH FULL CONSUMABLES POTENTIAL, THAT IS, FULLY CHARGED ENTRY BATTERIES AND ENTRY $O_2$ TANKS. IF THIS CAPABILITY IS POTENTIALLY JEOPARDIZED BY CRYO SYSTEMS DEPLETION OR MALFUNCTION, MISSION TERMINATION PROCEDURES WILL BE ENACTED IN WHATEVER TIME FRAME IS APPROPRIATE OR AVAILABLE. ANY ENTRY BATTERY OR ENTRY $O_2$ USAGE IN ORBIT AFTER LOSS OF RECHARGE CAPABILITY FROM THE CRYO SYSTEM WILL REDUCE SUPPLY AVAILABLE FOR ENTRY, LANDING, AND POSTLANDING. |
| | 11-3 | LOSS OF A CRYOGENIC TANK IS DEFINED AS: PRESSURE CANNOT BE MAINTAINED ABOVE 150 PSIA FOR $O_2$ AND 100 PSIA FOR $H_2$. |
| | 11-4 | MINIMUM REQUIREMENT TO CONTINUE BEYOND A DAILY GO/NO-GO POINT IS SUFFICIENT OXYGEN AND HYDROGEN TO SUPPLY FUEL CELL AND ECS DEMANDS TO THE NEXT GO/NO-GO PTP PLUS 2 REVS (DRIFTING FLIGHT PLUS GUIDED ENTRY MANEUVER.) MINIMUM REQUIREMENT TO CONTINUE BEYOND A SPECIFIC ACTIVITY PHASE GO/NO-GO POINT IS SUFFICIENT OXYGEN AND HYDROGEN TO SUPPLY EPS AND ECS DEMANDS DURING THAT PHASE PLUS THE TIME REQUIRED TO RECOVER FROM THE PHASE AND PREPARE FOR ENTRY. |
| | | RULE NUMBERS 11-5 THROUGH 11-9 ARE RESERVED. |

| REV | ITEM | |
|---|---|---|
| | | SYSTEMS MANAGEMENT |
| | 11-10 | CRYO MANAGEMENT<br>A. MANUAL PRESSURE CONTROL WILL BE USED AS REQUIRED TO MAINTAIN:<br>1. TANK PRESSURES GREATER THAN 750 PSIA $O_2$ AND 200 PSIA FOR $H_2$<br>2. QUANTITY BALANCE WITHIN 4 PERCENT $O_2$ AND 3 PCT FOR $H_2$<br>B. CRYO TANKS WILL BE ALLOWED TO VENT NORMALLY THROUGH TANK RELIEF VALVES.<br>C. $O_2$ TANK FANS AND $H_2$ TANK FANS NORMALLY WILL NOT BE OPERATED IN THE AUTO MODE.<br>D. $O_2$ TANK HEATERS AND $H_2$ TANK HEATERS NORMALLY WILL BE OPERATED IN THE AUTO MODE. |
| | 11-11 | CRYO GAGING<br>A. ONBOARD CRYOGENIC QUANTITY GAGING IS PRIME. ACCURACY IS ±2.65 PERCENT (±8.48 LBS $O_2$, ±0.72 LBS $H_2$) PER TANK.<br>B. MCC CALCULATED QUANTITY USING PRESSURE VERSUS TEMPERATURE IS BACKUP.<br><br>RULE NUMBERS 11-12 THROUGH 11-19 ARE RESERVED. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 11-20 | LOSS OF ONE $O_2$ AND/OR $H_2$ CRYO TANK | LAUNCH<br><br>ALL | A. <u>CONTINUE MISSION</u><br><br>B. <u>CONTINUE MISSION</u><br>MISSION DURATION IS FUNCTION OF CRYO REMAINING. | <br><br>B.1. REF <u>MR 11-4</u><br>2. REF ALTERNATE MISSION B |
| | 11-21 | LOSS OF BOTH $O_2$ AND/OR $H_2$ CRYO TANK<br><br>RULE NUMBERS 11-22 THROUGH 11-49 ARE RESERVED | LAUNCH<br><br>ALL | A. <u>CONTINUE MISSION</u><br>IF LOSS IS $O_2$ ISOLATE SURGE TANK PRIOR TO 800 PSIA. ENTER 2-1<br><br>B. <u>TERMINATE PHASE</u><br>ENTER NEXT BEST PTP. MAXIMUM ORBIT TIME IS 4.75 HRS FOR LOSS OF THREE FUEL CELLS. | A. REF <u>MR 11-1</u><br><br>B. IF 3 FUEL CELLS ARE LOST PRIOR TO CM/SM SEP, SMJC'S WILL BE INOPERATIVE. |

| REV | ITEM | |
|---|---|---|
| | 11-50 | **INSTRUMENTATION REQUIREMENTS** |

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| $O_2$ TANK 1 QTY | SC0032Q | METER | COMMON | 1 OF 2 | 11-4 |
| $O_2$ TANK 2 QTY | SC0033Q | METER | COMMON | MANDATORY | |
| $O_2$ TANK 1 TEMP | SC0041T | ----- | ------ | HIGHLY DESIRABLE | 11-4 |
| $O_2$ TANK 2 TEMP | SC0042T | ----- | ------ | HIGHLY DESIRABLE | |
| $H_2$ TANK 1 QTY | SC0030Q | METER | COMMON | 1 OF 2 | 11-4 |
| $H_2$ TANK 2 QTY | SC0031Q | METER | COMMON | MANDATORY | |
| $H_2$ TANK 1 TEMP | SC0043T | ----- | ------ | HIGHLY DESIRABLE | 11-4 |
| $H_2$ TANK 2 TEMP | SC0044T | ----- | ------ | HIGHLY DESIRABLE | |
| $O_2$ TANK 1 PRESS | SC0037P | METER | COMMON | 1 OF 2 | 11-3,4 |
| $O_2$ TANK 2 PRESS | SC0038P | METER | COMMON | MANDATORY | |
| $H_2$ TANK 1 PRESS | SC0039P | METER | COMMON | 1 OF 2 | 11-3,4 |
| $H_2$ TANK 2 PRESS | SC0040P | METER | COMMON | MANDATORY | |

12 CSM ELECTRICAL POWER SYSTEM

| REV | ITEM | |
|---|---|---|
| | | GENERAL |
| A | 12-1 | LAUNCH<br><br>LAUNCH WILL BE CONTINUED AS LONG AS SUFFICIENT ENERGY IS AVAILABLE TO PERFORM AN ENTRY INTO AT LEAST PTP 2-1. THERE MUST BE AT LEAST ONE MAIN BUS AND ONE AC BUS OPERATIONAL TO CONTINUE. |
| | 12-2 | THERE ARE NO FUEL CELL FAILURES FOR WHICH THE LAUNCH PHASE WILL BE TERMINATED AS LONG AS THREE ENTRY BATTERIES ARE REMAINING TO SUPPLY MAIN BUS LOADS. |
| A | 12-3 | ALL MISSION PHASES<br><br>TO CONTINUE THE MISSION THE FOLLOWING MUST BE AVAILABLE: BOTH MAIN BUSES, BOTH BATTERY BUSES, BOTH AC BUSES, THE BATTERY RELAY BUS, AND AT LEAST TWO FUEL CELLS, TWO BATTERIES, AND TWO INVERTERS.<br><br>MISSION WILL BE CONTINUED AS LONG AS THE FUEL CELLS ARE CAPABLE OF SUPPORTING DRIFTING FLIGHT REQUIREMENTS (WITHOUT BATTERY SUPPLEMENT, AS DEFINED IN THE FLIGHT PLAN) AND ENOUGH BATTERY ENERGY IS AVAILABLE TO PERFORM A HYBRID DEORBIT (80 FT/SEC CM RCS) AND ENTRY PLUS 18 HRS POSTLANDING AND A ONE BAG FAILURE UPRIGHTING (70 AMP-HRS TOTAL IN THREE BATTERIES, OR 74 AMP-HRS TOTAL IN TWO BATTERIES). IF SM RCS ONLY DEORBIT CAPABILITY IS RESERVED, BATTERY REQUIREMENT CAN BE DOWNGRADED TO 52 AMP-HRS TOTAL IN THREE BATTERIES OR 56 AMP-HRS TOTAL IN TWO BATTERIES.<br><br>RENDEZVOUS<br><br>IN ADDITION TO THE PRECEDING, TO BEGIN AND CONTINUE RENDEZVOUS ACTIVITIES TWO FUEL CELLS ARE REQUIRED, AND EITHER THREE BATTERIES OR TWO BATTERIES AND THE BATTERY CHARGER ARE REQUIRED. |
| | 12-4 | BATTERY IS CONSIDERED FAILED IF:<br><br>A. OUTPUT <3 AMPS WHEN CONNECTED TO A MAIN BUS DURING SPS MANEUVERS (NOMINAL TOTAL BATTERY CURRENT FOR SPS MANEUVERS IS 20 ± 2 AMPS).<br><br>B. SUSTAINED BATTERY CHARGER OUTPUT >2.0 AMPS AND ALL LOADS REMOVED. |
| | 12-5 | AN AC BUS IS CONSIDERED FAILED IF ANY TWO PHASES CANNOT BE MAINTAINED >95 VOLTS. |
| | 12-6 | AN INVERTER IS CONSIDERED FAILED IF:<br><br>A. OUTPUT VOLTAGE ON ANY PHASE >130 VAC.<br><br>B. OUTPUT VOLTAGE ON ANY TWO PHASES <95 VAC. |

| REV | ITEM | |
|---|---|---|
| | 12-7 | FUEL CELL IS CONSIDERED FAILED FOR MISSION PLANNING IF:<br>A. FUEL CELL CANNOT SUPPLY SUFFICIENT POWER TO MEET ITS OWN PARASITIC LOADS (5 AMPS PLUS INLINE HEATER POWER AS REQUIRED).<br>B. FUEL CELL $H_2$ LOOP IS CONTAMINATED WITH KOH.<br><br>RULE NUMBERS 12-8 THROUGH 12-19 ARE RESERVED |
| | | SYSTEMS MANAGEMENT |
| | 12-20 | BUS MANAGEMENT<br>A. FOR THREE FUEL CELL OPERATION, ONLY ONE FUEL CELL WILL BE TIED TO BOTH MAIN BUSES. FOR TWO FUEL CELL OPERATION, ONE FUEL CELL WILL BE TIED TO EACH MAIN BUS.<br>B. INVERTERS WILL BE CONFIGURED SUCH THAT MAIN BUS A WILL SUPPLY AC BUS 1 AND MAIN BUS B WILL SUPPLY AC BUS 2.<br>C. MAIN BUS VOLTAGE WILL BE MAINTAINED >26.5 VDC AND <31 VDC. ONE FUEL CELL MAY BE OPEN CIRCUITED FOR OPTIMUM VOLTAGE AND POWER MANAGEMENT.<br>D. THE BATTERY CHARGER WILL BE USED TO CHECK OUT A SUSPECTED SHORTED BUS (EXCEPT MAIN BUSES) AFTER ALL EQUIPMENT AND POWER SOURCES HAVE BEEN REMOVED FROM BUS. |
| A | 12-21 | BATTERY MANAGEMENT<br>A. BATTERIES A AND B WILL BE USED TO SUPPLEMENT MAIN BUS LOADS FROM T-75 SECONDS TO INSERTION.<br>B. BATTERIES A AND B WILL BE USED TO SUPPLEMENT MAIN BUS LOADS FOR SPS MANEUVERS. BATTERY C WILL BE ROTATED IN THE EVENT THE BATTERY CHARGER FAILS TO MAINTAIN BATTERY BALANCE.<br>C. BATTERY CHARGING WILL BE TERMINATED FOR ONE OF THE FOLLOWING, WHICHEVER OCCURS FIRST:<br>1. INTEGRATED AMP-HOURS INTO BATTERY BY CHARGER EQUALS INTEGRATED AMP-HOURS OUT OF BATTERY BY LOADS.<br>2. BATTERY CHARGER CURRENT DROPS TO 0.4 AMPS<br>D. THREE BATTERIES WILL BE TIED TO THE MAIN BUSES FOR DEORBIT MANEUVER AND ENTRY.<br>E. BATTERIES ARE CONSIDERED TO HAVE 40 AMP-HR CAPABILITY INFLIGHT AND 45 AMP-HR CAPABILITY FOR POSTLANDING.<br>F. A SINGLE BATTERY THAT CANNOT BE RECHARGED WILL NOT BE USED EXCEPT DURING DEORBIT, ENTRY, AND POST-LANDING. |

| REV | ITEM | |
|---|---|---|
| | 12-22 | FUEL CELL MANAGEMENT |

A. FUEL CELL WILL BE "SHUTDOWN" FOR THE FOLLOWING:

1. SUSTAINED CURRENT OUTPUT LESS THAN 5 AMPS.
2. FUEL CELL $H_2$ LOOP IS CONTAMINATED WITH KOH.
3. REACTANT LEAKAGE JEOPARDIZING MISSION DURATION.

B. FUEL CELL MAY BE "OPEN CIRCUITED" FOR THE FOLLOWING:

1. SKIN TEMP >475°F.
2. TCE TEMP >200°F.
3. FAILURE OF $H_2$ PUMP OR GLYCOL PUMP.
4. VOLTAGE MANAGEMENT.
5. FUEL CELL CANNOT BE PURGED AND TIME TO GO IS GREATER THAN PREDICTED FUEL CELL LIFETIME.

C. FUEL CELL $O_2$ PURGES WILL BE DONE AT 12 HOUR INTERVALS. FUEL CELL $H_2$ PURGES WILL BE DONE AT 48 HOUR INTERVALS.

D. ADDITIONAL PURGES WILL BE INITIATED AS OPERATIONAL CONDITIONS DICTATE.

E. FUEL CELLS WILL NOT BE PURGED UNDER THE FOLLOWING CONDITIONS:

1. CONFIRMED HIGH PH INDICATION.
2. ANY CONDITION WHERE KOH IS LIKELY TO BE VENTED INTO THE $H_2$ OR $O_2$ MANIFOLD.

F. EACH $H_2$ PURGE WILL NORMALLY BE PRECEDED BY 20 MINUTES OF $H_2$ VENT HEATER OPERATION.

G. FC INLINE HEATERS WILL NORMALLY OPERATE IN "AUTO" CONTINUOUSLY.

H. REACTANT VALVES MUST REMAIN OPEN AT ALL TIMES UNLESS THE FUEL CELL IS DECLARED FAILED.

I. ADDITIONAL POWER LOADS WILL BE ADDED AS REQUIRED TO MAINTAIN FC RAD OUT TEMP >-40 DEGREES. IF CRYO BUDGET JEOPARDIZED OR RAD OUT TEMPS NOT MAINTAINED >-40 DEGREES, FC RAD WILL BE PLACED IN EMERGENCY BYPASS.

J. FUEL CELLS MAY BE PURGED TO PRECLUDE VENTING OF CRYO TANKS.

| REV | ITEM | |
|---|---|---|
| | 12-23 | INVERTER MANAGEMENT |

INVERTERS MAY BE REMOVED FROM LINE FOR ANY OF THE FOLLOWING REASONS:

A. INVERTER TEMP >199°F

B. SPACECRAFT LOAD MANAGEMENT

RULE NUMBERS 12-24 THROUGH 12-29 ARE RESERVED

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| | 12-30 | LOSS OF ONE FUEL CELL OUTPUT <5 AMPS | LAUNCH | A. CONTINUE MISSION | |
| | | | ALL | B. CONTINUE MISSION<br>1. OPEN CIRCUIT FUEL CELL.<br>2. RECONFIGURE REMAINING TWO FUEL CELLS TO ONE FUEL CELL PER MAIN BUS ONLY.<br>3. IF FUEL CELL CANNOT BE RESTORED PERFORM SHUTDOWN. | B.1. REF MALF PROC EPS 5<br>2. REF ALTERNATE MISSION B |
| | 12-31 | LOSS OF TWO FUEL CELLS OUTPUT <5 AMPS EACH | LAUNCH | A. CONTINUE MISSION<br>AFTER 2 + 00 GET PERFORM:<br>1. EDS AUTO/OFF TO OFF.<br>2. IF LOSS OF FC 1 AND 2, TIE BAT C TO MAIN A.<br>3. IF LOSS OF FC 2 AND 3, TIE BAT C TO MAIN B.<br>4. IF LOSS OF FC 1 AND 3, TIE BAT C TO BOTH MAIN BUSES. | |
| | | | ORBIT (S-IVB)<br>ORBIT (SOLO) | B. ENTER NEXT BEST PTP<br>CONNECT REMAINING FUEL CELL TO BOTH MAIN BUSES | B. ONE ENTRY BATTERY MAY BE USED TO SUPPLEMENT REMAINING FC FOR G&N ALIGNMENT PRIOR TO DEORBIT. |
| | | | TD&E | C. ENTER NEXT BEST PTP<br>TERMINATE TD & E | |
| | | | DOCKED EVA | D. ENTER NEXT BEST PTP | D. IVT AND SETUP FOR UNMANNED APS BURN MAY BE PERFORMED. |
| | | | UNDOCKED RNDZ | E. ENTER NEXT BEST PTP<br>1. TERMINATE RNDZ<br>2. PERFORM CSM/LM FINAL SEP | E.2. SETUP FOR UNMANNED APS BURN MAY BE PERFORMED. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 12-32 | LOSS OF THREE FUEL CELLS | | | |
| | | A. OUTPUT $<$10 AMPS EACH | LAUNCH | A.1. CONTINUE MISSION<br>(A) AFTER 2 + 00 EDS AUTO/OFF TO OFF.<br>(B) TIE BAT C TO BOTH MAIN BUSES<br>(C) POWER DOWN AT INSERTION ENTER 2-1 IF FUEL CELLS CANNOT BE RESTORED. | A.1.(A) IF TOTAL OUTPUT CAPABILITY LESS THAN 8 AMPS AT 22 VDC, SMJC WILL BE INOPERATIVE FOR CM/SM SEP. |
| | | | ALL | 2. ENTER NEXT BEST PTP | A.2. 4.75 HOURS LEFT IN ORBIT BEFORE DEORBIT MANEUVER. |
| | | B. TOTAL OUTPUT CAPABILITY INSUFFICIENT TO SUPPORT DRIFTING FLIGHT LOADS | ALL | B.1. ENTER NEXT BEST PTP<br>MANIPULATION OF CYCLIC LOADS WILL BE ATTEMPTED TO MAINTAIN VM $>$26.5 VDC | B.1. 89 AMPS REPRESENTS MAXIMUM DRIFTING FLIGHT REQUIREMENTS (63 AMPS AVERAGE). |
| | | | LAUNCH | 2. NOT APPLICABLE | |
| | | C. TOTAL OUTPUT CAPABILITY $<$36 AMPS AT MAIN BUS VOLTAGE OF 26.5 VDC | ALL | C.1. ENTER NEXT BEST ATP OR PTP | C.1. BASED ON FC OUTPUT AND BATTERY ENERGY REMAINING, 36 AMPS REPRESENTS MINIMUM POWER TO SUPPORT S/C SYSTEMS IN ORBIT. |
| | | | LAUNCH | 2. NOT APPLICABLE | |
| | 12-23 | LOSS OF THREE FUEL CELLS PLUS ONE BATTERY CURRENT $>$50% OF LOAD ON EITHER REMAINING BATTERY | LAUNCH | A. ABORT | A. ASSUMES ALL THREE FUEL CELL CURRENTS $\leq$5 AND BATTERY C TIED TO BOTH MAINS. |
| | | | ALL | B. ENTER NEXT BEST ATP OR PTP<br>PERFORM EMERGENCY POWER DOWN | B. 2.4 HOURS LEFT IN ORBIT BEFORE DEORBIT MANEUVER. |
| | | RULE NUMBERS 12-24 THROUGH 12-39 ARE RESERVED. | | | |

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 12-40 | LOSS OF ONE ENTRY BATTERY (OUTPUT <3 AMPS WHEN TIED TO MAIN BUS) | LAUNCH | A. <u>CONTINUE MISSION</u><br>1. EDS AUTO/OFF TO OFF<br>2. IF LOSS OF BAT A, TIE BAT C TO MAIN A<br>3. IF LOSS OF BAT B, TIE BAT C TO MAIN B. | |
| | | | SPS MANEUVER | B. <u>CONTINUE MISSION</u><br>MANEUVER ON REMAINING BATTERY | |
| | | | ALL | C. <u>CONTINUE MISSION</u><br>USE REMAINING TWO BATS DURING SPS BURNS AND ENTRY. | |
| | 12-41 | LOSS OF TWO ENTRY BATTERIES (OUTPUT <3 AMPS EACH WHEN CONNECTED TO MAIN BUS) | LAUNCH | A. <u>CONTINUE MISSION</u><br>1. EDS AUTO/OFF TO OFF.<br>2. ENTER 2-1 POWERED DOWN. | |
| | | | SPS MANEUVER | B. <u>CONTINUE MANEUVER</u><br>ENTER NEXT BEST PTP IF AT LEAST TWO BATTERIES CANNOT BE RESTORED | |
| | | | ALL | C. <u>ENTER NEXT BEST PTP</u><br>IF AT LEAST TWO BATTERIES CANNOT BE RESTORED | |
| | 12-42 | LOSS OF BATTERY CHARGER | ALL | <u>CONTINUE MISSION</u><br>ROTATE BATTERY C FOR BURNS TO MAINTAIN BALANCED BATTERIES | REF MALF PROC <u>EPS-5</u><br>BATTERY CHARGING NOT REQUIRED FOR NOMINAL MISSION PLUS HYBRID DEORBIT AND 18 HOURS POSTLANDING WITH ONE BAG FAILURE UPRIGHTING. |
| | | RULE NUMBERS 12-43 THROUGH 12-49 ARE RESERVED. | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 12-50 | MAIN BUS TIE MOTOR SWITCH FAILURES | | | |
| | | A. ONE MOTOR SWITCH FAILS OPEN | LAUNCH | A.1. CONTINUE MISSION<br>(A) IF MOTOR SW A/C, TIE BAT C TO MAIN BUS A<br>(B) IF MOTOR SW B/C, TIE BAT C TO MAIN BUS B | |
| | | | ALL | 2. CONTINUE MISSION<br>CLOSE ALTERNATE MOTOR SW AND USE MAIN BUS TIE CB'S AS MOTOR SWITCHES | A.2. BATTERIES MUST BE CHARGED THROUGH OPEN MOTOR SW. LEAVE BAT RLY C.B. CLOSED FOR CHARGING. |
| | | B. ONE OR BOTH MOTOR SW FAILED CLOSED | ALL | B. CONTINUE MISSION<br>USE CB'S AS MOTOR SWITCHES | B. IF BOTH MOTOR SWITCHES FAIL CLOSED, BATTERIES CANNOT BE CHARGED. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 12-51 | MAIN BUS SHORTED CAUSING FUEL CELL REVERSE CURRENT DISCONNECT | | | |
| | | A. FUEL CELL 2 DISCONNECTS FROM MAIN A | LAUNCH | A.1. CONTINUE MISSION<br>(A) PLACE EDS AUTO/OFF TO OFF.<br>(B) TIE BAT C TO MAIN A.<br>(C) INVERTER 3 TO AC BUS NO. 2.<br>(D) POWER DOWN MAIN BUS B. | A.1. >85 AMPS SHORT ON MAIN B WILL CAUSE REVERSE DISCONNECT DURING LAUNCH MALF EPS-3. |
| | | | ALL | 2. ENTER NEXT BEST PTP IF BUS NOT RESTORED.<br>POWER DOWN MAIN BUS B. | 2. REF MALF PROC EPS SSR-2 |
| | | B. FUEL CELL 2 DISCONNECTS FROM MAIN B | LAUNCH | B.1. CONTINUE MISSION<br>(A) PLACE EDS AUTO/OFF TO OFF.<br>(B) TIE BAT C TO MAIN BUS B.<br>(C) INVERTER 3 TO AC BUS NO. 1.<br>(D) POWER DOWN MAIN BUS A.<br>(E) SWITCH TO SECONDARY GMBL SYSTEM. | B.1. >79 AMPS SHORT ON MAIN A WILL CAUSE REVERSE DISCONNECT DURING LAUNCH<br>B.1.(E) TVC GMBL DRIVE, P, Y -2. |
| | | | ALL | 2. ENTER NEXT BEST PTP IF BUS NOT RESTORED.<br>POWER DOWN MAIN BUS A | |
| | | C. MAIN BUS SHORTED >2[illegible] AMPS AND FUEL CELLS CANNOT BE DISCONNECTED FROM SHORTED BUS. | LAUNCH | C.1. ABORT | C.1. FAILURE OF MOTOR SWITCH TO DISCONNECT FROM SHORTED BUS INDICATED BY FC SHORTED BUS T/B GRAY. |
| | | | ALL | 2. ENTER NEXT BEST PTP IF MAIN BUS NOT RESTORED. | C.2. IF FUEL CELL FEED CIRCUITRY SHORTED, CLOSE FC REACTANT VALVES. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 12-52 | A. BATTERY BUS SHORTED [illegible]5 AMPS | LAUNCH | A.1. <u>CONTINUE MISSION</u><br>(A) PLACE EDS AUTO/OFF TO OFF.<br>(B) OPEN ASSOCIATED MAIN BUS TO BAT BUS C.B.<br>(C) TIE BAT C TO ASSOCIATED MAIN BUS. | A.1. >22 AMPS WILL CAUSE BATTERY BUS VOLTAGE TO BE ≤ MAIN BUS VOLTAGE. |
| | | | ALL | 2. <u>ENTER NEXT BEST PTP</u><br><u>IF BUS NOT RESTORED</u> | A.2. REMOVE POWER FROM BUS, IF SHORTED ≤ 10 AMPS. POWER BUS JUST PRIOR TO ENTRY TO MAINTAIN SECS REDUNDANCY. |
| | | B. BATTERY BUS SHORTED [illegible]5 AMPS | ALL | B. <u>CONTINUE MISSION</u><br>REMOVE POWER FROM BUS EXCEPT FOR MANEUVERS AND ENTRY | |
| | 12-53 | BATTERY RELAY BUS | | | |
| | | A. SHORT >2.0 AMPS | LAUNCH | A.1. <u>CONTINUE MISSION</u> | |
| | | | ALL | 2. <u>ENTER NEXT BEST PTP</u><br>OPEN BATTERY BUS TO BATTERY RELAY BUS CB'S. | A.2. REF MALF PROC <u>EPS-SSR-2</u> |
| | | B. SHORT <2.0 AMPS | ALL | B. <u>CONTINUE MISSION</u> | B. PLACE BATTERY A ONLY TO BAT RELAY BUS AND CHARGE BAT B CONTINUOUSLY WITH BAT B POWER ENTRY AND POST LANDING CB OPEN. CONSIDER BATTERY CHARGER LOST FOR MISSION PLANNING. MALF <u>EPS SSR-2</u> |
| | | RULE NUMBERS 12-54 THROUGH 12-59 ARE RESERVED. | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 12-60 | LOSS OF TWO INVERTERS | LAUNCH | A. CONTINUE MISSION | A. REF MALF PROC ______ PLACE REMAINING INVERTER ON BOTH AC BUSES. |
| | | | ALL | B. ENTER NEXT BEST PTP | |
| | 12-61 | LOSS OF ONE AC BUS (TWO PHASES CANNOT BE MAINTAINED >95 VAC) | LAUNCH | A. CONTINUE MISSION | |
| | | | ALL | B. ENTER NEXT BEST PTP | |
| | 12-62 | LOSS OF BOTH AC BUSES | LAUNCH | A. ABORT MODE I OR MODE II | A. REF MR ________ |
| | | | | 1. OPEN DIRECT $O_2$ FOR SUIT VENTILATION. | |
| | | | | 2. IF AFTER MODE II, ENTER 2-1 PTP. | A.2. INITIATE CONTINUOUS FC $H_2$ PURGE FOR COOLING. |
| | | | ALL | B. ENTER NEXT BEST PTP OR ATP<br>IF SUITED, REMOVE HELMET AND GLOVES. IF TIME PERMITS, REMOVE SUITS. IF CABIN DEPRESSURIZED, USE DIRECT $O_2$ UNTIL CABIN IS REPRESSURIZED. | B. ENTER WITHIN 1-1/2 HOURS. INITIATE CONTINUOUS FC $H_2$ PURGE FOR COOLING. |
| | | RULE NUMBERS 12-63 THROUGH 12-69 ARE RESERVED. | | | |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 12-70 | INSTRUMENTATION REQUIREMENTS |

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| AC BUS 1 YELLOW | ------- | MCWS | ----------- | HIGHLY DESIRABLE | |
| AC BUS 1 $\phi$A VAC | CC0200V | METER | SEPARATE | HIGHLY DESIRABLE | 12-5,6,61 |
| AC BUS 1 $\phi$B VAC | ------- | METER | ----------- | HIGHLY DESIRABLE | |
| AC BUS 1 $\phi$C VAC | ------- | METER | ----------- | HIGHLY DESIRABLE | |
| | | COMMON METER | | | |
| AC BUS 2 $\phi$A VAC | CC0203V | METER | SEPARATE | HIGHLY DESIRABLE | |
| AC BUS 2 $\phi$B VAC | ------- | METER | ----------- | HIGHLY DESIRABLE | |
| AC BUS 2 $\phi$C VAC | ------- | METER | ----------- | HIGHLY DESIRABLE | 12-5,6,61 |
| AC BUS 2 YELLOW | ------- | MCWS | ----------- | HIGHLY DESIRABLE | |
| MAIN BUS A VDC | CC0206V | METER | SEPARATE | 1 OF 2 MANDATORY | 12-32,52,20C |
| MAIN BUS B VDC | CC0207V | METER | SEPARATE | | 12-22 |
| BAT BUS A VDC | CC0210V | METER | SEPARATE | HIGHLY DESIRABLE | |
| BAT BUS B VDC | CC0211V | METER | SEPARATE | HIGHLY DESIRABLE | |
| BAT RELAY BUS VDC | CC0232V | METER | SEPARATE | HIGHLY DESIRABLE | |
| BAT A CURRENT | CC0222C | METER | COMMON | | |
| BAT B CURRENT | CC0223C | METER | COMMON | 2 OF 3 MANDATORY | 12-4,33,40,41 |
| BAT C CURRENT | CC0224C | METER | COMMON | | |
| FC 1 CURRENT | SC2113C | METER | COMMON | | |
| FC 1 $O_2$ FLO | SC2142R | METER | COMMON | 1 OF 3 MANDATORY | 12-7,31,32,33, 22A |
| FC 1 $H_2$ FLO | SC2139R | METER | COMMON | | |
| FC 2 CURRENT | SC2114C | METER | COMMON | | |
| FC 2 $O_2$ FLO | SC2143R | METER | COMMON | 1 OF 3 MANDATORY | 12-7,31,32,33, 22A |
| FC 2 $H_2$ FLO | SC2140R | METER | COMMON | | |
| FC 3 CURRENT | SC2115C | METER | COMMON | | |
| FC 3 $O_2$ FLO | SC2144R | METER | COMMON | 1 OF 3 MANDATORY | 12-7,31,32,33, 22A |
| FC 3 $H_2$ FLO | SC2141R | METER | COMMON | | |
| BAT CHARGER CURRENT | CC0215C | METER | COMMON | HIGHLY DESIRABLE | |
| FC 1 SKIN TEMP | SC2084T | METER | COMMON | HIGHLY DESIRABLE | |
| FC 2 SKIN TEMP | SC2085T | METER | COMMON | HIGHLY DESIRABLE | 12-22B |
| FC 3 SKIN TEMP | SC2086T | METER | COMMON | HIGHLY DESIRABLE | |
| FC 1 COND TEMP | SC2081T | METER | COMMON | HIGHLY DESIRABLE | |
| FC 2 COND TEMP | SC2082T | METER | COMMON | HIGHLY DESIRABLE | 12-22B |
| FC 3 COND TEMP | SC2083T | METER | COMMON | HIGHLY DESIRABLE | |
| FC 1 RAD OUT TEMP | SC2087T | METER | COMMON | HIGHLY DESIRABLE | |
| FC 2 RAD OUT TEMP | SC2088T | METER | COMMON | HIGHLY DESIRABLE | 12-22I |
| FC 3 RAD OUT TEMP | SC2089T | METER | COMMON | HIGHLY DESIRABLE | |
| BAT MANIFOLD PRESS | ------- | METER | ------ | HIGHLY DESIRABLE | ------- |
| INV 1 TEMP | CC0175T | MCWS | COMMON | HIGHLY DESIRABLE | ------- |
| INV 2 TEMP | CC0176T | MCWS | COMMON | HIGHLY DESIRABLE | ------- |
| INV 3 TEMP | CC0177T | MCWS | COMMON | HIGHLY DESIRABLE | ------- |
| FC 1 PH | SC2160X | TALKBACK | COMMON | HIGHLY DESIRABLE | |
| FC 2 PH | SC2161X | TALKBACK | COMMON | HIGHLY DESIRABLE | 12-22E |
| FC 3 PH | SC2162X | TALKBACK | COMMON | HIGHLY DESIRABLE | |

NOTE: USE BAT C IN LIEU OF BATTERY WITH LOST INST

13 CSM COMM/
INSTRUMENTATION
(SEE SECTION 32)

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|

THIS
SECTION
HAS BEEN
DELETED

ALL DATA FORMERLY CONTAINED
IN THIS SECTION IS NOW IN
SECTION 32.

14 CSM SEQUENTIAL

| REV | ITEM | |
|---|---|---|
| | | **GENERAL** |
| | 14-1 | <u>LAUNCH</u><br>THERE ARE NO SEQUENTIAL MALFUNCTIONS FOR WHICH LAUNCH WILL BE TERMINATED. |
| | 14-2 | IF AN ENTRY BATTERY IS LOST, THE EDS WILL BE FLOWN OPEN LOOP. |
| | 14-3 | <u>ALL MISSION PHASES</u><br>TO CONTINUE THE MISSION, BOTH PYRO BUSES AND BOTH LOGIC BUSES ARE REQUIRED. |
| | 14-4 | SEQUENTIAL LOGIC BUS IS CONSIDERED FAILED IF:<br>A. VOLTAGE <22 VDC AND UNABLE TO ACTIVATE RCS ENABLE AND/OR SLA SEP RELAYS (CD0170X AND/OR CD0123X SYSTEM A, CD0171X AND/OR CD0124X SYSTEM B).<br>B. LOGIC BUS SHORTED >10 AMPS. |
| | 14-5 | PYRO BUS IS CONSIDERED FAILED IF:<br>A. SHORTED >10 AMPS<br>B. FAILURE TO PERFORM ANY SEQUENTIAL FUNCTION WITH SUSPECTED FAILED PYRO SYSTEM. |
| | | RULE NUMBERS 14-6 THROUGH 14-9 ARE RESERVED |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | | **MANAGEMENT** |
| | 14-10 | ARMING OF THE SEQUENTIAL SYSTEM WILL BE PERFORMED WHILE IN CONTACT WITH A GROUND TELEMETRY SITE. THE FLIGHT CREW WILL ARM THE LOGIC BUSES AND THE STAND BY FOR A GO FROM THE GROUND TO PROCEED WITH ARMING THE PYRO BUSES. |
| | | RULE NUMBERS 14-11 THROUGH 14-19 ARE RESERVED |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| | 14-20 | SEQUENTIAL LOGIC BUS A OR B ≤22 VDC AND UNABLE TO ACTIVATE RCS ENABLE AND/OR SLA SEP RELAYS | | | CD0170X AND/OR CD0123X SYSTEM A, CD0171X AND/OR CD0124X SYSTEM B |
| | | | LAUNCH | A. CONTINUE MISSION<br>ENTER 3-1 IS BUS NOT RESTORED | |
| | | | ALL | B. TERMINATE OPERATIONS<br>ENTER NEXT BEST PTP IF BUS NOT RESTORED | |
| | 14-21 | PYRO BUS A OR B ≤35 VDC | | | |
| | | A. SHORTED >10 AMPS | LAUNCH | A.1. CONTINUE MISSION | |
| | | | ALL | 2. TERMINATE OPERATIONS<br>ENTER NEXT BEST PTP | A.2. USE BATTERY TIE FOR PYRO POWER TO AFFECTED BUS |
| | | B. SHORTED <10 AMPS | ALL | B. CONTINUE MISSION | B. USE BATTERY TIE FOR PYRO POWER TO AFFECTED BUS |
| | | C. PYRO BUS TM READS 0 VDC AND PYRO BAT ONBOARD >35 VDC | LAUNCH | C.1. CONTINUE MISSION | |
| | | | ALL | 2. ATTEMPT FUNCTION USING SUSPECTED FAILED BUS ONLY:<br>(A) IF FUNCTION NORMAL, CONTINUE MISSION<br>(B) IF FUNCTION DOES NOT WORK NORMALLY, ENTER NEXT BEST PTP | C.2. ASSUME PYRO BAT VERIFIED >35 VDC PRIOR TO ARMING. IF ENTRY BAT USED IN LIEU OF PYRO BAT, VOLTAGE SHOULD BE APPROXIMATELY = TO BAT BUS VOLTAGE. |
| | 14-22 | TELEMETRY INDICATES AN EDS VOTE INPUT 1, 2, OR 3 | LAUNCH | CONTINUE MISSION | PARAMETERS ARE CD0132X, CD0133X, AND CD0134X RESPECTIVELY. |
| | | | | A. IF ANY ENTRY BATTERY <22 VDC, EDS AUTO/OFF SWITCH TO OFF | A. BAT C VOLTAGE CAN ONLY BE MONITORED ONBOARD |
| | | | | B. ALL ENTRY BATTERIES >22 VDC: CHECK CORRESPONDING EDS C.B.'S 1, 2, OR 3 CLOSED | |
| | 14-23 | LET JETTISON MOTOR DOES NOT FIRE | LAUNCH | CONTINUE MISSION<br>ATTEMPT JETTISON PER CREW CHECKLIST EMERGENCY PROCEDURE | |

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 14-24 | SMJC ACTIVATES PREMATURELY | ALL | ENTER NEXT BEST PTP<br>A. TERMINATE OPERATIONS AND POWER DOWN AFFECTED MAIN BUS. DO NOT ARM AFFECTED PYRO BUS<br>B. IF UNDOCKED, RETURN TO CSM AND PERFORM CSM/LM FINAL SEP<br>C. REPOWER AFFECTED MAIN BUS AFTER CM/SM SEP | A. USE GOOD SEQUENTIAL SYSTEM IF IN CONTACT WITH MSFN, ARMING OF LOGIC BUSES WILL INDICATE WHICH MAIN BUS MUST BE POWERED DOWN. MAIN A IF SYSTEM A CM/SM SEP. MAIN B IF SYSTEM B CM/SM SEP EVENT IS ACTIVATED.<br>B. USE GOOD SEQUENTIAL SYSTEM |
| | 14-25 | ACTIVATED CM RCS PRESS LOGIC RELAYS. | ALL | CONTINUE MISSION<br>A. PRIOR TO CM RCS PRESS: DO NOT ARM RESPECTIVE PYRO BUS<br>(FOR BOTH INDICATIONS PERFORM SLA SEP WITH SECS ARM CB'S OPEN.)<br>B. **AT CM RCS PRESS: ARM** RESPECTIVE PYRO BUS | CD0173X AND/OR CD0174X |
| | 14-26 | ACTIVATED SLA DEPLOY LOGIC RELAYS | ALL | CONTINUE MISSION<br>A. PRIOR TO SLA SEP: DO NOT ARM RESPECTIVE PYRO BUS<br>B. FOR SLA SEP: ARM RESPECTIVE PYRO BUS FIRST | CD0123X AND/OR CD0124X |
| | 14-27 | UNABLE TO PERFORM SLA SEPARATION | ORBIT (S-IVB) | ENTER NEXT BEST PTP | REF MR ____ |
| | 14-28 | LOST GROUND TO RESISTER NETWORK FOR LOGIC OR PYRO BUS VOLTS MEASUREMENTS<br><br>RULE NUMBERS 14-29 THROUGH 14-39 ARE RESERVED | ALL | CONTINUE MISSION<br>DO NOT ARM AFFECTED SYSTEM UNTIL CM/SM SEP UNLESS OTHER SYSTEM FAILS<br>IF PYRO BUS: USE BAT BUS TO PYRO TIE. DO NOT ARM UNTIL CM/SM SEP UNLESS OTHER SYSTEM FAILS. | ARMING SYSTEM WITH VOLTAGE >30 VDC WILL RESULT IN PERMANENT LOSS OF ALL ANALOG TELEMETRY PARAMETERS. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 14-40 | ACTIVATED APEX JETTISON LOGIC RELAYS | ALL | <u>ENTER NEXT BEST PTP</u><br>DO NOT ARM PYRO BUSES UNTIL MALFUNCTION HAS BEEN ISOLATED | DETECTED AT SECS POWER UP (CD0230X AND CD023X) |
| | 14-41 | ACTIVATED DROGUE CHUTE DEPLOY LOGIC RELAYS | ALL | <u>ENTER NEXT BEST PTP</u><br>DO NOT ARM PYRO BUSES UNTIL MALFUNCTION HAS BEEN ISOLATED | MAY BE DETECTED AT ANY TIME (CE0001X AND/OR CE0002X) |
| | 14-42 | ACTIVATED PILOT CHUTE DEPLOY LOGIC RELAYS | ORBIT (SOLO) | <u>ENTER NEXT BEST PTP</u><br>DO NOT ARM PYRO BUSES UNTIL MALFUNCTION HAS BEEN ISOLATED | DETECTED AT SECS POWER UP PRIOR TO ENTRY (CE0003X AND/OR CE0004X) WITH ELS BAT A(B) C.B. CLOSED. |
| | | RULE NUMBERS 14-43 THROUGH 14-49 ARE RESERVED | | | |

| REV | ITEM | |
|---|---|---|
| A | 14-50 | INSTRUMENTATION REQUIREMENTS |

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| PYRO BUS A VOLTS | CD0005V | ------- | ----------- | 1 OF | 14-21 |
| PYRO BUS B VOLTS | CD0006V | ------- | ----------- | 2 M | 14-21 |
| SEQ LOGIC BUS A VOLTS | CD0200V | ------- | ----------- | HD | 14-20, 14-12 |
| SEQ LOGIC BUS B VOLTS | CD0201V | ------- | ----------- | HD | 14-20, 14-12 |
| APEX JET A | CD0230X | ------- | ----------- | HD | 14-40 |
| APEX JET B | CD0231X | ------- | ----------- | HD | 14-40 |
| DROGUE DEPLOY A | CE0001X | ------- | ----------- | HD | 14-41 |
| DROGUE DEPLOY B | CE0002X | ------- | ----------- | HD | 14-41 |
| PILOT CHUTE DEPLOY A | CE0003X | ------- | ----------- | HD | 14-42 |
| PILOT CHUTE DEPLOY B | CE0004X | ------- | ----------- | HD | 14-42 |
| SLA SEP RELAY A | CD0123X | ------- | ----------- | HD | 14-26 |
| RCS/SCS ACTIVATE A | CD0170X | ------- | ----------- | HD | ----- |
| SLA SEP RELAY B | CD0124X | ------- | ----------- | HD | 14-26 |
| RCS/SCS ACTIVATE B | CD0171X | ------- | ----------- | HD | ----- |
| CM RCS PRESS SIG A | CD0173X | ------- | ----------- | HD | 14-25 |
| CM RCS PRESS SIG B | CD0174X | ------- | ----------- | HD | 14-25 |
| CM-SM SEP RELAY A | CD0023X | ------- | ----------- | HD | ---- |
| CM-SM SEP RELAY B | CD0024X | ------- | ----------- | HD | ----- |
| CREW ABORT A | CD0130X | ------- | ----------- | HD | ----- |
| CREW ABORT B | CD0131X | ------- | ----------- | HD | ----- |
| EDS ABORT VOTE 1 | CD0132X | ------- | ----------- | HD | 14-22 |
| EDS ABORT VOTE 2 | CD0133X | ------- | ----------- | HD | 14-22 |
| EDS ABORT VOTE 3 | CD0134X | ------- | ----------- | HD | 14-22 |
| EDS ABORT A | CD0135X | ------- | ----------- | HD | ----- |
| EDS ABORT B | CD0136X | ------- | ----------- | HD | ----- |
| MAIN CHUTE DISC A | CE0321X | ------- | ----------- | HD | ----- |
| MAIN CHUTE DISC B | CE0322X | ------- | ----------- | HD | ----- |
| EDS ABORT REQ A | BS0080X | ------- | ----------- | HD | ----- |
| EDS ABORT REQ B | BS0081X | ------- | ----------- | HD | ----- |
| DOCKING PROBE TEMP | CS0220T | ------- | ----------- | HD | ----- |
| CSM-LM LOCK RING SEP RELAY A | CD1154X | ------- | ----------- | HD | 19-16 |
| CSM-LM LOCK RING SEP RELAY B | CD1155X | ------- | ----------- | HD | 19-16 |
| LM CURRENT | SC2962C | METER | COMMON | HD | ----- |

15 CSM GUIDANCE AND CONTROL

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | | GENERAL |
| | 15-1 | LAUNCH<br><br>THERE ARE NO FAILURES OF THE CSM GUIDANCE AND CONTROL SYSTEM WHICH ARE CAUSE FOR ABORT. |
| | 15-2 | ALL ORBIT PHASES<br><br>A. IN ORDER TO CONTINUE THE MISSION PAST THE NEXT BEST PTP, THE GUIDANCE AND CONTROL SYSTEMS MUST SUPPORT TWO METHODS OF DEORBIT (SPS, SM, OR HYBRID). THE FOLLOWING MINIMUM CAPABILITIES MUST BE AVAILABLE.<br><br>1. ATTITUDE CONTROL: DIRECT RCS AND RATE DAMPING IN EACH AXIS.<br><br>2. SPS DEORBIT: ONE TVC SERVO LOOP IN EACH AXIS AND ONE TVC CONTROL MODE (MTVC ACCEL CMD EXCLUDED).<br><br>3. BACKUP DEORBIT: AS LONG AS ENOUGH PROPELLANT IS AVAILABLE FOR AN SM DEORBIT, THE G&C SYSTEMS MUST PROVIDE CAPABILITY FOR AN SM DEORBIT. IF SM DEORBIT IS NOT POSSIBLE, THE G&C SYSTEM MUST PROVIDE CAPABILITY FOR A HYBRID DEORBIT.<br><br>(A) SM DEORBIT REQUIREMENTS:<br>• TRANSLATION CAPABILITY<br>• ONE OPERATIONAL FDAI<br>• RATE DAMPING IN ALL THREE AXES (DAP OR SCS)<br><br>(B) HYBRID DEORBIT REQUIREMENTS:<br>• ALL SM DEORBIT REQUIREMENTS (RATE DAMPING MUST BE SCS)<br>• OPERATIONAL IMU, CMC, AND DSKY<br>• TWO OPERATIONAL RHC'S<br><br>B. IN ORDER TO PERFORM A NON-CRITICAL BURN, THE G&C SYSTEMS MUST PROVIDE THE CAPABILITY TO EXECUTE AN ULLAGE MANEUVER BY EITHER CMC AUTO (RCS DAP), SCS AUTO, OR DIRECT ULLAGE.<br><br>C. THE SPS WILL NOT BE SHUTDOWN FOR AN FCSM INDICATION. |
| A | 15-3 | DELETED |
| A | 15-4 | UNDOCKED<br><br>THE UNDOCKED PHASE WILL BE DELETED OR TERMINATED IF THE G&C SYSTEMS CANNOT PROVIDE REDOCKING CAPABILITY. THE G&C SYSTEMS MUST PROVIDE DIRECT RCS AND RATE DAMPING IN EACH AXIS AND TRANSLATION CAPABILITY IN THE X-AXIS FOR DOCKING/UNDOCKING CONTROL. |
| | 15-5 | RENDEZVOUS<br><br>THE RENDEZVOUS PHASE WILL BE DELETED OR TERMINATED IF THE G&C SYSTEM CANNOT PROVIDE AN SPS CRITICAL BURN CAPABILITY. IN ADDITION, THE GUIDANCE AND CONTROL SYSTEMS MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES FOR LM RESCUE:<br>• OPERATIONAL OPTICS SUBSYSTEM<br>• ONE DSKY<br>• TRANSLATION CAPABILITY<br>• RATE DAMPING IN ALL THREE AXIS<br>• OPERATIONAL IMU AND CMC<br>• ONE OPERATIONAL RHC<br>• ONE OPERATIONAL FDAI<br><br>RULE NUMBERS 15-6 THROUGH 15-9 ARE RESERVED. |

| REV | ITEM | |
|---|---|---|
| | | **SYSTEMS MANAGEMENT** |
| | 15-10 | ATTITUDE CONTROL: CSM IN ACTIVE RCS CONTROL; LM WILL NOT BE IN ACTIVE ATTITUDE HOLD.<br>LM IN ACTIVE RCS CONTROL; CSM WILL NOT BE IN ACTIVE ATTITUDE HOLD.<br>FOR DOCKED ACTIVITIES AFTER OPENING THE APS INTERCONNECT (BOTH VEHICLES IN ACTIVE RCS CONTROL), THE CSM MUST BE IN A TIGHTER DEADBAND THAN THE LM. |
| | 15-11 | PIPA AND IRIG BIAS WILL BE UPDATED WHEN ACTUAL BIASES DIFFER FROM VALUES IN CMC ERASABLE BY .02 FT/SEC$^2$ AND 0.075 DEG/HR RESPECTIVELY. |
| | 15-12 | $\Delta$V COUNTER DRIFT<br>SHOULD THE $\Delta$V COUNTER DRIFT BE >0.01 FT/SEC$^2$ FOR AN RCS MANEUVER, THE Vc SETTING WILL BE APPROPRIATELY BIASED. SHOULD THE DRIFT BE >0.1 FT/SEC$^2$, THE EMS WILL BE CONSIDERED FAILED. |
| | 15-13 | DAP INITIALIZATION<br>GIMBAL TRIMS: WILL BE UPDATED FOR EVERY SPS MANEUVER BASED ON FINAL TRIM POSITIONS OF THE PREVIOUS MANEUVER AS MONITORED ON TELEMETRY, IF THE PREVIOUS MANEUVER WAS SCS CONTROLLED. IF THE PREVIOUS MANEUVER WAS G&N CONTROLLED, THE CMC STORED VALUES WILL BE USED. TRIMS WILL BE REINITIALIZED FROM THE GROUND AFTER EACH VEHICLE CONFIGURATION CHANGE AND AFTER EACH WEIGHT UPDATE. TRIMS MUST BE UPDATED WHEN GROUND COMPUTED VALUES DIFFER FROM CMC STORED VALUES BY 0.5 DEGREE.<br>CSM, LM WEIGHT: WILL BE UPDATED WHEN GROUND COMPUTED VALUES DIFFER FROM CMC STORED VALUES BY 1.0 PERCENT WEIGHTS MUST BE UPDATED WHEN GROUND VALUES DIFFER FROM CMC STORED VALUES BY 10.0 PERCENT |
| | | RULE NUMBERS 15-14 THROUGH 15-19 RESERVED. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 15-20 | LOSS OF EITHER BMAG 1 OR 2 IN EITHER PITCH OR YAW CHANNEL | ALL | CONTINUE MISSION | A. REF MALF PROC G&C 1,2,3,4<br>B. NO SCS AUTO TVC<br>C. IF IN YAW CHANNEL, AFTER .05G, RSI IS USABLE IF REMAINING GYRO IS SELECTED FOR RATE. RSI MUST BE RE-ALIGNED IN ADDITION TO THE ABOVE, FOR YAW FAILURE AFTER .05G. |
| A | 15-21 | LOSS OF BOTH BMAG 1 AND 2 IN EITHER PITCH OR YAW CHANNEL | | | • REF MALF PROC G&C 1,2,3,4 |
| | | | LAUNCH | A. CONTINUE MISSION | A. MTVC ACCEL CMD IS ONLY MODE III OR MODE IV SPS CONTROL MODE. |
| | | | ALL | B.1. TERMINATE PHASE | B.1. LOSS OF PITCH CHANNEL RESULTS IN ALL THREE DEORBIT METHODS BEING SUBJECTED TO SINGLE FAILURES IN THE G&N SYSTEM. THE YAW LOSS PRECLUDES HYBRID DEORBIT AND SUBJECTS BOTH RE-MAINING DEORBIT METHODS TO SINGLE FAILURES IN THE G&N SYSTEM |
| | | | | 2. ENTER NEXT BEST PTP | |
| | | | ENTRY | C. CONTINUE MISSION | C. RSI AND SCS FDAI ROLL UNUSABLE WITH YAW CHANNEL FAILURES. |
| A | 15-22 | LOSS OF ROLL BMAG | | | • REF MALF PROC G&C 1,2,3,4 |
| | | A. NUMBER ONE | ALL | A.1. CONTINUE MISSION | A.1. MANUAL ROLL ATTITUDE CONTROL REQUIRED IN ALL SCS MODES.<br>2. NO SCS FDAI ROLL. RSI VALID. |
| | | B. NUMBER TWO | ALL | B.1. CONTINUE MISSION | B.1. USE OF ATT 1/RATE 2 AND LIM CYCLE MAY PROVIDE RATE DAMPED ATTITUDE HOLD WHEN RCS DAP IS NOT USED. GYRO PACKAGE 2 MUST BE POWERED DOWN TO EFFECT ATTITUDE HOLD IF FAILURE IS HARDOVER.<br>2. SELECTION OF RATE 1 WILL PROVIDE BOTH RSI AND SCS FDAI ROLL FOR ENTRY. RSI MUST BE REALIGNED FOR ROLL FAILURE AFTER .05G. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 15-23 | LOSS OF BOTH ROLL BMAG'S | | | • VIOLATES HYBRID DEORBIT MINIMUM REQUIREMENTS |
| \| | | | LAUNCH | A. CONTINUE MISSION | • REF MALF PROC G&C 1,2,3,4 |
| | | | ALL | B.1. CONTINUE MISSION IF BOTH SPS AND SM DEORBIT ARE AVAILABLE. | |
| | | | | 2. TERMINATE PHASE AND ENTER NEXT BEST PTP. IF EITHER SPS OR SM DEORBIT IS NOT AVAILABLE. | |
| | | | ENTRY | C. CONTINUE MISSION | C. NO SCS FDAI ROLL OR RSI AVAILABLE. |
| A | 15-24 | LOSS OF EITHER TVC SERVO LOOP IN EITHER PITCH OR YAW AXIS | ALL | CONTINUE MISSION SELECT 1 OR 2 ON TVC GMBL DR SWITCH IN APPROPRIATE AXIS. | MAINTAIN 20 LBS/QUAD/AXIS FOR HARDOVER RECOVERY FOR UNDOCKED AND ____ LBS/QUAD/AXIS FOR HARDOVER RECOVERY FOR DOCKED SPS MANEUVERS |
| \| | | | | | • REF MALF PROC G&C 1 |
| A \| | 15-25 | LOSS OF BOTH TVC SERVO LOOPS | | | • REF MALF PROC G&C 1 |
| \| | | | LAUNCH | A. CONTINUE MISSION | |
| | | | | | 2. NO MODE III OR IV CAPABILITY. LIMITED LANDING POINT CONTROL IN MODE III OR IV WITH SM-RCS. |
| | | | ALL | B.1. CONTINUE MISSION IF BOTH SM AND HYBRID DEORBIT AVAILABLE. | |
| | | | | 2. ENTER NEXT BEST PTP IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE. RCS DEORBIT. | |
| | | | DOCKED | C.1. CONTINUE MISSION IF BOTH SM AND HYBRID DEORBIT AND CSM ACTIVE DOCKING CAPABILITY AVAILABLE. | C.1. REF ALTERNATE MISSION B MAINTAINED 30 LBS RCS FOR CSM ACTIVE DOCKING. |
| | | | | 2. DO NOT UNDOCK IF CSM ACTIVE DOCKING CAPABILITY NOT AVAILABLE. | 2. REF ALTERNATE MISSION D |
| | | | RENDZ | D. TERMINATE AT NEXT POINT | |
| | | | CSM (SOLO) | E. ENTER NEXT BEST PTP RCS DEORBIT | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 15-26 | LOSS OF PROPORTIONAL CONTROL FROM:<br>A. EITHER RHC<br>B. BOTH RHC'S | <br>ALL<br>ALL | <br>A. CONTINUE MISSION<br>USE REMAINING RHC.<br>B. CONTINUE MISSION<br>USE DIRECT RCS OR ACCEL CMD FOR MANUAL MANEUVERS. | • REF MALF PROC G&C 1<br>B. NO MTVC RATE OR MTVC ACCEL CMD CAPABILITY. |
| A | 15-27 | LOSS OF DIRECT RCS CONTROL FROM:<br>A. EITHER RHC<br>B. BOTH RHC'S | <br>ALL<br>LAUNCH<br>ALL | <br>A. CONTINUE MISSION<br>B.1. CONTINUE MISSION<br>2. TERMINATE PHASE AND ENTER NEXT BEST PTP | • REF MALF PROC SCS 5<br>B.2. VIOLATES DIRECT RCS REQUIREMENT. |
| A | 15-28 | COMPLETE LOSS OF AUTO ATTITUDE CONTROL IN PITCH AND YAW CHANNELS.<br>A. CONTROL IS REGAINED BY OPENING EMS CB'S.<br>B. CONTROL IS REGAINED BY PLACING S/C CONTROL SWITCH TO CMC.<br>C. CONTROL IS NOT REGAINED | <br>ALL<br>ALL<br>ALL | <br>A. CONTINUE MISSION<br>AFTER SM JETTISON EMS MAY BE REENABLED WITHOUT LOSS OF AUTO RCS.<br>B. CONTINUE MISSION<br>C. TERMINATE PHASE AND ENTER NEXT BEST PTP<br>USE DIRECT ULLAGE AND DIRECT RCS. | • SUSPECTED FAILURE WOULD BE AUTO INHIBIT CIRCUITRY.<br>B. NO SCS ATTITUDE OR TVC CONTROL<br>C. FAILURE VIOLATES MINIMUM CAPABILITY CRITERIA FOR BOTH SM AND HYBRID DEORBIT. |
| A | 15-29 | LOSS OF FLIGHT DIRECTOR ATTITUDE INDICATORS<br>A. ONE<br>B. BOTH | <br>LAUNCH<br>ALL<br>LAUNCH<br>ALL | <br>A.1. CONTINUE MISSION<br>2.(A) CONTINUE MISSION IF SPS DEORBIT AVAILABLE.<br>(B) TERMINATE PHASE AND ENTER NEXT BEST PTP IF SPS DEORBIT NOT AVAILABLE.<br>B.1. CONTINUE MISSION<br>2. TERMINATE PHASE AND ENTER NEXT BEST PTP | • REF MALF PROC G&C 4<br>A.2.(B) REMAINING DEORBIT METHODS SUBJECT TO THE SAME SINGLE FAILURES IN SCS SYSTEM.<br>B.2. USE WINDOW REF |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 15-30 | LOSS OF AC1 φA | | | • LOSS OF AC1 φA RESULTS IN THE LOSS OF:<br>A. REDUNDANT SERVO LOOP POWER. BOTH SERVO LOOPS MUST BE POWERED BY THE SAME BUS.<br>B. PROPORTIONAL ATTITUDE CONTROL FROM BOTH RHC'S. ALL PROPORTIONAL CONTROL FROM RHC #1<br>C. FDAI #1<br>D. GYRO ASSEMBLY #1<br>E. SCS TOTAL ATTITUDE ERROR<br>F. SCS TOTAL ATTITUDE<br>G. SCS AUTO TVC CAPABILITY<br>H. SCS MINIMUM IMPULSE CAPABILITY<br>I. SCS ATTITUDE CONTROL RATE DAMPING<br>J. GPI PSY DRIVE #1.<br>• LOSS OF AC1 PRECLUDES HYBRID DEORBIT AND SUBJECTS BOTH REMAINING DEORBIT METHODS TO A SINGLE FAILURE (AC2 φA). |
| | | | LAUNCH | A. CONTINUE MISSION | |
| | | | ALL | B. TERMINATE PHASE AND ENTER NEXT BEST PTP | |
| | 15-31 | LOSS OF AC2 φA | | | • LOSS OF AC2 φA RESULTS IN THE LOSS OF:<br>A. REDUNDANT SERVO LOOP POWER<br>B. ALL PROPORTIONAL CONTROL<br>C. FDAI #2<br>D. GYRO ASSEMBLY #2<br>E. SCS PITCH AND YAW TOTAL ATTITUDE<br>F. ALL SCS TVC CAPABILITY (AUTO, RATE AND ACCEL CMD)<br>G. RSI<br>H. GPI PSY DRIVE #2<br>• LOSS OF AC2 RESULTS IN ALL THREE DEORBIT METHODS BEING SUBJECTED TO A SINGLE FAILURE (AC1 φA). |
| | | | LAUNCH | A. CONTINUE MISSION | |
| | | | ALL | B. TERMINATE PHASE AND ENTER NEXT BEST PTP | |
| | 15-32 | LOSS OF ORBIT RATE DISPLAY (ORDEAL) EARTH AND LUNAR | ALL | CONTINUE MISSION | REF MALF PROC SCS ______ |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 15-33 | LOSS OF ENTRY MONITOR SYSTEM | ALL | CONTINUE MISSION | • REF MALF PROC EMS 1 THRU 15 |
| A | 15-34 | GROUND AT EITHER SPS SOL DRIVER OUTPUT AND UNABLE TO REMOVE. | LAUNCH<br>ALL | A. CONTINUE MISSION<br>B. CONTINUE MISSION USE OTHER SPS BANK FOR ENGINE OPERATION. | • REF MALF PROC SPS 3 |
| A | 15-35 | LOSS OF TRANSLATION HAND CONTROLLER | LAUNCH<br>ALL | A. CONTINUE MISSION<br>B. TERMINATE PHASE AND ENTER NEXT BEST PTP | • VIOLATES BOTH SM AND HYBRID DEORBIT MINIMUM REQUIREMENTS.<br>• REF MALF PROC SCS 7 |
| | | RULE NUMBERS 15-36 THROUGH 15-49 ARE RESERVED. | | | |

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 15-50 | LOSS OF COMMAND MODULE COMPUTER | | | • REF MALF PROC G&N 5 |
| | | | LAUNCH | A. CONTINUE MISSION | |
| | | | ALL | B.1. CONTINUE MISSION IF BOTH SPS AND SM DEORBIT CAPABILITY AVAILABLE. | |
| | | | | 2. TERMINATE PHASE AND ENTER NEXT BEST PTP IF EITHER SPS OR SM CAPABILITY NOT AVAILABLE | B.2. VIOLATES HYBRID DEORBIT MINIMUM REQUIREMENTS. |
| | | | UNDOCKED | C. INHIBIT PHASING MANEUVER REF ALTERNATE MISSION B. | C. VIOLATES RESCUE MINIMUM REQUIREMENTS |
| | | | RENDZ | D. TERMINATE AT NEXT EXIT POINT | |
| | | | ENTRY | E. PERFORM BACKUP ENTRY | |
| A | 15-51 | LOSS OF DSKY | | | |
| | | A. EITHER MDC OR LEB DSKY | ALL | A. CONTINUE MISSION | |
| | | B. BOTH MDC AND LEB DSKY | ALL | B.1.(A) CONTINUE MISSION IF BOTH SPS AND SM DEORBIT CAPABILITY AVAILABLE. | |
| | | | | (B) TERMINATE PHASE AND ENTER NEXT BEST PTP IF EITHER SPS OR SM DEORBIT CAPABILITY NOT AVAILABLE. | B.1.(B) VIOLATES HYBRID DEORBIT MINIMUM REQUIREMENTS. |
| | | | UNDOCKED | 2. INHIBIT PHASING MANEUVER REF ALTERNATE MISSION B | B.2. VIOLATES RESCUE MINIMUM REQUIREMENTS |
| | | | RNDZ | 3. TERMINATE AT NEXT EXIT POINT. | |
| | | | ENTRY | 4. PERFORM BACKUP ENTRY. | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 15-52 | CMC WARNING RELAY IN NAV DSKY CLOSED | | | • CONSTITUTES LOSS OF PIPA'S G&N TVC, ENTRY GUIDANCE AND FINE ALIGN. |
| | | | LAUNCH | A.1. CONTINUE MISSION. | |
| | | | ALL | A.2.(A) CONTINUE MISSION IF BOTH SPS AND SM DEORBIT CAPABILITY AVAILABLE | |
| | | | | (B) TERMINATE PHASE AND ENTER NEXT BEST PTP IF EITHER SPS OR SM DEORBIT NOT AVAILABLE. | A.2.(B) PIPA'S ARE REQUIRED FOR ΔV SENSING IN HYBRID DEORBIT |
| | | | UNDOCKED | 3. INHIBIT PHASING MANEUVER. REF ALTERNATE MISSION B. | |
| | | | RNDZ | 4. TERMINATE AT NEXT EXIT POINT. | |
| | | | ENTRY | 5. PERFORM BACKUP ENTRY. | |
| A | 15-53 | LOSS OF INERTIAL SUBSYSTEM | | | • REF MALF PROC G&N 6 |
| | | | LAUNCH | A. CONTINUE MISSION. | |
| | | | ALL | B.1. CONTINUE MISSION. IF BOTH SPS AND SM DEORBIT CAPABILITY AVAILABLE. | |
| | | | | 2. TERMINATE PHASE AND ENTER NEXT BEST PTP IF EITHER SPS OR SM CAPABILITY NOT AVAILABLE. | B.2. VIOLATES HYBRID DEORBIT MINIMUM REQUIREMENTS. |
| | | | UNDOCKED | C. INHIBIT PHASING MANEUVER REF ALTERNATE MISSION B | C. VIOLATES RESCUE MINIMUM REQUIREMENTS |
| | | | RNDZ | D. TERMINATE AT NEXT EXIT POINT | |
| | | | ENTRY | E. PERFORM BACKUP ENTRY. | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 15-54 | LOSS OF OPTICS SUBSYSTEM | | | |
| | | | ALL | A. CONTINUE MISSION. USE BACKUP ALIGNMENT PROCEDURE. (COAS) | |
| | | | UNDOCKED | B. INHIBIT PHASING MANEUVER REF ALTERNATE MISSION B. | B. VIOLATES RESCUE MINIMUM REQUIREMENTS |
| | | | RNDZ | C. TERMINATE AT NEXT EXIT POINT. | |
| A | 15-55 | LOSS OF OPTICS SUBSYSTEM COUPLING DATA UNIT DIGITAL TO ANALOG CONVERTER. | ALL | CONTINUE MISSION. DELETE PLANNED TVC DAP MANEUVERS. | • REF MALF PROC G&N 10 CONSTITUTES LOSS OF TVC DAP. REF ALTERNATE MISSION B |
| | | RULE NUMBERS 15-56 THROUGH 15-59 ARE RESERVED. | | | |

| REV | ITEM | |
|---|---|---|
| | 15-60 | **INSTRUMENTATION REQUIREMENTS** |

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| CMC DIGITAL DATA | CG0001V | - | - | MANDATORY | - |
| SPS SOL DRIVER 1 | CH3604X | EMS-SPS ON | SEPARATE | HIGHLY DESIRABLE | - |
| SPS SOL DRIVER 2 | CH3605X | EMS-SPS ON | SEPARATE | HIGHLY DESIRABLE | - |
| PITCH GIMBAL POS 1 & 2 | CH3517H | GPI | COMMON 1 OF 2 | MANDATORY-OB/H.D.-PCM | 15-24/25 |
| YAW GIMBAL POS 1 & 2 | CH3518H | GPI | COMMON 1 OF 2 | MANDATORY-OB/H.D.-PCM | 15-24/25 |
| TM BIAS 2.5 VDC | CG1110V | - | - | HIGHLY DESIRABLE | 15-53/54/55 |
| PIPA TEMP | CG2300T | - | - | HIGHLY DESIRABLE | 15-53 |
| IMU HTR +28 VDC | CG1513X | - | - | HIGHLY DESIRABLE | 15-53 |
| CMC OPERATE +28 VDC | CG1523X | - | - | HIGHLY DESIRABLE | 15-50 |
| OPTX OPERATE 28 VAC | CG1533X | - | - | HIGHLY DESIRABLE | 15-55 |
| IG 1X RSVR OUT SIN | CG2112V | FDAI | COMMON | HIGHLY DESIRABLE | 15-53 |
| IG 1X RSVR OUT COS | CG2113V | FDAI | COMMON | HIGHLY DESIRABLE | 15-53 |
| MG 1X RSVR OUT SIN | CG2142V | FDAI | COMMON | HIGHLY DESIRABLE | 15-53 |
| MG 1X RSVR OUT COS | CG2143V | FDAI | COMMON | HIGHLY DESIRABLE | 15-53 |
| OG 1X RSVR OUT SIN | CG2172V | FDAI | COMMON | HIGHLY DESIRABLE | 15-53 |
| OG 1X RSVR OUT COS | CG2173V | FDAI | COMMON | HIGHLY DESIRABLE | 15-53 |
| SHAFT CDU DAC OUT | CG3721V | - | - | HIGHLY DESIRABLE | 15-55 |
| TRUNNION CDU DAC OUT | CG3722V | - | - | HIGHLY DESIRABLE | 15-55 |
| CMC WARNING | CG5040X | C&W | COMMON | HIGHLY DESIRABLE | 15-52 |
| PITCH ATT ERROR | CH3500H | FDAI | COMMON | HIGHLY DESIRABLE | 15-20/21/22/23 |
| YAW ATT ERROR | CH3501H | FDAI | COMMON | HIGHLY DESIRABLE | 15-20/21/22/23 |
| ROLL ATT ERROR | CH3502H | FDAI | COMMON | HIGHLY DESIRABLE | 15-20/21/22/23 |
| SCS PITCH BODY RATE | CH3503R | FDAI | COMMON | HIGHLY DESIRABLE | 15-20/21/22/23 |
| SCS YAW BODY RATE | CH3504R | FDAI | COMMON | HIGHLY DESIRABLE | 15-20/21/22/23 |
| SCS ROLL BODY RATE | CH3505R | FDAI | COMMON | HIGHLY DESIRABLE | 15-20/21/22/23 |
| SCS TVC PITCH AUTO CMD | CH3582V | - | - | HIGHLY DESIRABLE | 15-2/24/25 |
| SCS TVC YAW AUTO CMD | CH3583V | - | - | HIGHLY DESIRABLE | 15-2/24/25 |
| MTVC PITCH CMD | CH3585H | - | - | HIGHLY DESIRABLE | 15-2/24/25 |
| MTVC YAW CMD | CH3586H | - | - | HIGHLY DESIRABLE | 15-2/24/25 |
| FDAI ERROR 5, RATE 5 | CH3592X | - | - | HIGHLY DESIRABLE | 15-20/21/22/23 |
| FDAI ERROR 50/15, RATE 50/10 | CH3593X | - | - | HIGHLY DESIRABLE | 15-20/21/22/23 |
| PITCH DIFF CLUTCH CUR | CH3666C | - | - | HIGHLY DESIRABLE | 15-2/24/25 |
| YAW DIFF CLUTCH CUR | CH3667C | - | - | HIGHLY DESIRABLE | 15-2/24/25 |

16 CSM SERVICE PROPULSION SYSTEM

| REV | ITEM | |
|---|---|---|
| | | GENERAL |
| | 16-1 | LAUNCH<br><br>THERE ARE NO SPS FAILURES WHICH ARE CONSIDERED CAUSE FOR ABORT. |
| A | 16-2 | REMAINING MISSION PHASES<br><br>A. FAILURES AFFECTING THE SPS FALL INTO ONE OF THREE CATEGORIES:<br><br>1. FAILURES WHICH CAUSE THE SPS TO BE UNSAFE. FAILURES IN THIS CATEGORY CAUSE THE MISSION TO BE TERMINATED BY ENTRY INTO THE NEXT BEST PTP, USING THE SM OR HYBRID DEORBIT TECHNIQUES. THIS CATEGORY OF FAILURES WILL NECESSARILY CAUSE TERMINATION OF ALL OTHER MISSION PHASES.<br><br>2. FAILURES WHICH CAUSE THE SPS TO BE INOPERABLE OR UNSAFE TO OPERATE. FAILURES IN THIS CATEGORY, WILL ALLOW THE MISSION TO CONTINUE IF BOTH SM AND HYBRID DEORBIT CAPABILITY IS AVAILABLE; HOWEVER, THE RENDEZVOUS AND CSM SOLO PHASES WILL BE TERMINATED. IN ORDER TO PROVIDE THE TOTAL CAPABILITY TO DEORBIT FROM ANY POINT IN THE MISSION, THE LM DPS AND LM RCS MAY BE USED FOR ORBIT SHAPING.<br><br>3. FAILURES WHICH DEGRADE THE CAPABILITY OF THE SPS TO A DEGREE THAT REQUIRES THAT ALL PLANNED SPS BURNS, EXCEPT THE DEORBIT, APOGEE KICK, OR LM RESCUE BURN(S), BE DELETED. MAXIMUM ALLOWABLE TIME BETWEEN THE LAST BURN AND THE DEORBIT MANEUVER IS CONSTRAINED BY PROPELLANT BULK TEMPERATURE AND IS A FUNCTION OF PROPELLANT REMAINING.<br><br>B. WITH STORAGE TANKS EMPTY, EITHER A TWO-JET OR FOUR-JET ULLAGE MANEUVER IS REQUIRED PRIOR TO ALL NON-CRITICAL MANEUVERS. LACK OF CAPABILITY TO PERFORM AN ULLAGE MANEUVER WILL NOT BE CAUSE FOR INHIBITING A CRITICAL BURN.<br><br>C. SPS ANOMALIES OR DEGRADING ARE NOT CAUSE FOR TERMINATING A CRITICAL BURN. NONCRITICAL BURNS WILL BE TERMINATED FOR SPS ANOMALIES OR DEGRADATIONS WHICH CAUSE OR COULD LEAD TO UNSAFE CONDITIONS.<br><br>D. A 40 SECOND SPS BURN IS REQUIRED AFTER THE LM DOCKED DPS MANEUVER TO PURGE THE SYSTEM OF TRAPPED HELIUM.<br><br>RULE NUMBERS 16-3 THROUGH 16-9 ARE RESERVED. |
| | | SYSTEM MANAGEMENT |
| A | 16-10 | PROPELLANT GAGING<br><br>A. PRIME METHOD: ONBOARD GAGING SYSTEM (1%)<br><br>B. BACKUP METHOD: FLOW RATE X BURN TIME (3%) |
| | 16-11 | PROPELLANT UTILIZATION VALVE<br><br>THE PU VALVE WILL BE USED TO CONTROL THE O/F MIXTURE RATIO TO MAINTAIN OXIDIZER IMBALANCE WITHIN +100 POUNDS. |
| A | 16-12 | DUAL BANK VS SINGLE BANK OPERATION<br><br>ALL SPS BURNS WILL BE STARTED SINGLE BANK, USING BANK A. BANK B WILL BE BROUGHT ONLINE APPROXIMATELY 3 SECONDS AFTER THRUST ONSET FOR THE FIRST SPS BURN FOLLOWING THE DOCKED DPS MANEUVER AND FOR THE DEORBIT BURN. BANK B MAY ALSO BE BROUGHT ONLINE APPROXIMATELY 3 SECONDS AFTER THRUST ONSET FOR ANY SPS BURN OF SUFFICIENT DURATION HAT ALLOWS THE CREW TO EFFECTIVELY PERFORM THE PROCEDURE. |

| REV | ITEM | |
|---|---|---|
| | 16-13 | PROPELLANT MANAGEMENT<br><br>A. THE SPS PROPELLANT REDLINE TO PROVIDE A MINIMUM 40-SECOND POST-DOCKED DPS BURN, LM RESCUE, AND DEORBIT CAPABILITY FROM ANY POINT IN THE MOST STRINGENT NOMINAL ORBIT IS 14.1 PERCENT INDICATED PROPELLANT REMAINING.<br><br>B. THE SPS PROPELLANT REDLINE TO PROVIDE 21 SECONDS OF BURN FOR LM RESCUE PLUS DEORBIT CAPABILITY FROM ANY POINT IN THE MOST STRINGENT NOMINAL ORBIT IS 7.3 PERCENT INDICATED PROPELLANT REMAINING.<br><br>C. THE SPS PROPELLANT REDLINE TO PROVIDE A DEORBIT CAPABILITY OF 620 FPS IS 3.6 PERCENT INDICATED PROPELLANT REMAINING AND IS SUFFICIENT TO ACCOMPLISH DEORBIT FROM ANY POINT IN THE MOST STRINGENT NOMINAL ORBIT. |
| | 16-14 | PROPELLANT FEEDLINE TEMPERATURE MANAGEMENT<br><br>SPS LINE HEATERS WILL BE MANUALLY CYCLED TO MAINTAIN FEEDLINE TEMPERATURES BETWEEN 55°F AND 75°F AND ENGINE VALVE TEMPERATURE ABOVE 50°F. |
| | 16-15 | ULLAGE MANAGEMENT<br><br>IN GENERAL DOCKED SPS BURNS REQUIRING ULLAGE WILL BE PRECEDED BY A FOUR-JET ULLAGE; UNDOCKED SPS BURNS BY A TWO-JET ULLAGE. TWO-JET ULLAGE WILL BE USED WHENEVER NECESSARY TO IMPROVE SM-RCS PROPELLANT CAPABILITY. |
| | | RULE NUMBERS 16-16 THROUGH 16-19 ARE RESERVED. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| A | 16-20 | SUSTAINED PRESSURE DECAY IN EITHER THE FUEL OR OXIDIZER TANK (COULD BE HELIUM OR FUEL OR OXIDIZER). | | | • REF MALF PROC SPS 1 |
| | | | LAUNCH | CONTINUE MISSION<br>• PLAN RCS DEORBIT INTO PTP 2-1 RCS DEORBIT<br>• IF LAND IP IS UNAVOIDABLE AFTER ABORT, REPRESSURIZE TANKS MANUALLY | |
| | | A. COAST | ALL | A.1. TERMINATE PHASE<br>2. ENTER NEXT BEST PTP RCS DEORBIT | |
| | | B. NON-CRITICAL BURN | ALL | B.1. TERMINATE BURN<br>2. ENTER NEXT BEST PTP RCS DEORBIT | |
| | | C. CRITICAL BURN | ALL | C.1. CONTINUE BURN<br>2. ENTER NEXT BEST PTP RCS DEORBIT | |
| A | 16-21 | LOSS OF BOTH $GN_2$ TANK PRESSURES (<400 PSI). | LAUNCH | A. CONTINUE MISSION | |
| | | | ALL | B.1. CONTINUE MISSION IF BOTH SM AND HYBRID DE-ORBIT AVAILABLE.<br>2. ENTER NEXT BEST PTP IF EITHER SM OR HYBRID DE-ORBIT NOT AVAILABLE. RCS DEORBIT. | |
| | | | DOCKED | C.1. CONTINUE MISSION<br>2. REF ALTERNATE MISSION B | C. MAINTAIN 30 LBS RCS FOR CSM ACTIVE DOCKING. |
| | | | RENDZ | D. TERMINATE AT NEXT EXIT POINT | |
| | | | CSM SOLO | E. ENTER NEXT BEST PTP RCS DEORBIT | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 16-22 | FUEL FEEDLINE AND/OR OXIDIZER FEEDLINE TEMP <27°F AND UNABLE TO INCREASE. | LAUNCH | A. CONTINUE MISSION | |
| | | | ALL | B.1. CONTINUE MISSION<br>IF BOTH SM AND HYBRID DE-ORBIT AVAILABLE.<br>2. ENTER NEXT BEST PTP<br>IF EITHER SM OR HYBRID DE-ORBIT NOT AVAILABLE. RCS DEORBIT. | |
| | | | DOCKED | C.1. CONTINUE MISSION<br>2. REF ALTERNATE MISSION B | C. MAINTAIN 30 LBS RCS FOR CSM ACTIVE DOCKING. |
| | | | RENDZ | D. TERMINATE AT NEXT EXIT POINT | |
| | | | CSM SOLO | E. ENTER NEXT BEST PTP<br>RCS DEORBIT | |
| A | 16-23 | ENGINE FLANGE TEMP GOES HIGHER THAN 480°F DURING AN SPS BURN. | LAUNCH | NOT APPLICABLE | MALF PROC SPS 5 |
| | | A. COAST | ALL | A.1.(A) CONTINUE MISSION<br>IF BOTH SM AND HYBRID DEORBIT AVAILABLE.<br>(B) ENTER NEXT BEST PTP<br>IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE. RCS DEORBIT | |
| | | | DOCKED | 2.(A) CONTINUE MISSION<br>(B) REF ALTERNATE MISSION B | A.2.(A) MAINTAIN 30 LBS RCS FOR CSM ACTIVE DOCKING. |
| | | | CSM SOLO | 3. ENTER NEXT BEST PTP<br>RCS DEORBIT | |
| | | B. NON-CRITICAL BURN | ALL | B. TERMINATE BURN<br>INHIBIT FURTHER BURNS. | |
| | | C. CRITICAL BURN | ALL | C. CONTINUE BURN<br>INHIBIT FURTHER BURNS. | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 16-24 | UNABLE TO IGNITE SPS | LAUNCH | NOT APPLICABLE | |
| | | | ALL | A.1. <u>CONTINUE MISSION</u> IF BOTH SM AND HYBRID DEORBIT AVAILABLE | |
| | | | | 2. <u>ENTER NEXT BEST PTP</u> IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE. RCS DEORBIT. | |
| \| | | | DOCKED | B.1. <u>CONTINUE MISSION</u> | B.1. MAINTAIN 30 LBS RCS FOR CSM ACTIVE DOCKING. |
| | | | | 2. <u>REF ALTERNATE MISSION B</u> | |
| | | | CSM SOLO | C. <u>ENTER NEXT BEST PTP</u> RCS DEORBIT | |
| A \| | 16-25 | THRUST CHAMBER PRESSURE <70 PSI CONFIRMED BY OTHER INSTRUMENTATION | LAUNCH | NOT APPLICABLE | • REF MALF PROC SPS 6 |
| | | A. COAST | ALL | A.1.(A) <u>CONTINUE MISSION</u> IF BOTH SM AND HYBRID DEORBIT AVAILABLE. | CONFIRMING INSTRUMENTATION INCLUDES ONBOARD PC METER, CREW, DEGRADED THRUST, FU AND OX INTERFACE PRESSURES, F/O VALVE POSITIONS, FU AND OX TANK PRESSURES. |
| | | | | (B) <u>ENTER NEXT BEST PTP</u> IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE. RCS DEORBIT. | |
| \| | | | DOCKED | 2.(A) <u>CONTINUE MISSION</u> | A.2.(A) MAINTAIN 30 LBS RCS FOR CSM ACTIVE DOCKING. |
| | | | | (B) <u>REF ALTERNATE MISSION B</u> | |
| | | | CSM SOLO | 3. <u>ENTER NEXT BEST PTP</u> RCS DEORBIT | |
| | | B. NON-CRITICAL BURN | ALL | B. <u>TERMINATE BURN</u> INHIBIT FURTHER BURNS | |
| | | C. CRITICAL BURN | ALL | C. <u>CONTINUE BURN</u> INHIBIT FURTHER BURNS | |
| A \| | 16-26 | LACK OF ULLAGE CAPABILITY AFTER STORAGE TANK EMPTY #1 | ALL | <u>CONTINUE MISSION</u> INHIBIT ALL NON-CRITICAL SPS BURNS. | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 16-27 | FIRST BURN SUBSEQUENT TO DOCKED DPS MANEUVER WAS LESS THAN 40 SEC. | ALL | A.1. INHIBIT ALL BURNS<br>2. CONTINUE MISSION IF BOTH SM AND HYBRID DEORBIT AVAILABLE<br>3. ENTER NEXT BEST PTP IF EITHER SM OR HYBRID NOT AVAILABLE. RCS DEORBIT. | A. IF BURN IS TERMINATED FOR ANY REASON:<br>1. BEFORE 4 SECONDS - REPEAT ENTIRE 40 SECOND BURN WITH ULLAGE. NO CONSTRAINT ON REIGNITION TIME.<br>2. AFTER 4 SECONDS COMPLETE REMAINDER OF BURN WITH NO ULLAGE REIGNITE AS SOON AS POSSIBLE.<br>3. AFTER 9 SECONDS, BUT BEFORE 40 SECONDS - COMPLETE REMAINDER OF BURN WITH NO ULLAGE. REIGNITE AS SOON AS POSSIBLE. |
| | | | DOCKED | B.1. CONTINUE MISSION<br>2. REF ALTERNATE MISSION B | B.1. MAINTAIN 30 LBS RCS FOR CSM ACTIVE DOCKING. |
| | | | CSM SOLO | C. ENTER NEXT BEST PTP RCS DEORBIT | |
| A | 16-28 | ΔP BETWEEN FUEL AND OXIDIZER TANK PRESSURES >20 PSI AND UNABLE TO DECREASE. | LAUNCH | CONTINUE MISSION | • REF MALF PROC SPS 1c |
| | | A. COAST | ALL | A.1.(A) CONTINUE MISSION IF BOTH SM AND HYBRID DEORBIT AVAILABLE.<br>(B) ENTER NEXT BEST PTP IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE. RCS DEORBIT. | |
| | | | DOCKED | 2.(A) CONTINUE MISSION<br>(B) REF ALTERNATE MISSION B | A.2.(A) MAINTAIN 30 LBS RCS FOR CSM ACTIVE DOCKING. |
| | | | CSM SOLO | 3. ENTER NEXT BEST PTP RCS DEORBIT | |
| | | B. NON-CRITICAL BURN | | B. INHIBIT OR TERMINATE BURN | |
| | | C. CRITICAL BURN | | C. CONTINUE BURN | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 16-29 | LEAK OR COMPLETE LOSS OF HELIUM SUPPLY PRESSURE OR BOTH HELIUM VALVES FAIL CLOSED. | | | |
| | | A. ΔV CAPABILITY GREATER THAN 620 F^T/SEC. | ALL | A. CONTINUE MISSION<br>PLAN SPS PROFILE TO MAINTAIN 620 FT/SEC FOR SPS DEORBIT. | A. BLOW DOWN ΔV REMAINING IS A FUNCTION OF ULLAGE VOLUME AT TIME OF FAILURE. |
| | | B. ΔV CAPABILITY LESS THAN 620 FT/SEC. | ALL | B.1.(A) CONTINUE MISSION<br>IF BOTH SM AND HYBRID DEORBIT AVAILABLE<br>(B) ENTER NEXT BEST PTP<br>IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE | |
| \| | | | DOCKED | 2.(A) CONTINUE MISSION<br>(B) REF ALTERNATE MISSION B | B.2.(A) MAINTAIN 30 LBS RCS FOR CSM ACTIVE DOCKING. |
| | | | RNDZ | TERMINATE AT NEXT EXIT POINT | |
| | | | CSM SOLO | ENTER NEXT BEST PTP | |
| | | RULE NUMBERS 16-30 THROUGH 16-49 ARE RESERVED. | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 16-29 | LEAK OR COMPLETE LOSS OF HELIUM SUPPLY PRESSURE OR BOTH HELIUM VALVES FAIL CLOSED. | | | |
| | | A. ΔV CAPABILITY GREATER THAN <u>620</u> FT/SEC. | ALL | A. <u>CONTINUE MISSION</u><br>PLAN SPS PROFILE TO MAINTAIN <u>620</u> FT/SEC FOR SPS DEORBIT. | A. BLOW DOWN ΔV REMAINING IS A FUNCTION OF ULLAGE VOLUME AT TIME OF FAILURE. |
| | | B. ΔV CAPABILITY LESS THAN <u>620</u> FT/SEC. | ALL | B.1.(A) <u>CONTINUE MISSION</u><br>IF BOTH SM AND HYBRID DEORBIT AVAILABLE<br>(B) <u>ENTER NEXT BEST PTP</u><br>IF EITHER SM OR HYBRID DEORBIT NOT AVAILABLE | |
| | | | DOCKED | 2.(A) <u>CONTINUE MISSION</u><br>(B) <u>PRE ALTERNATE MISSION B</u> | B.2.(A) MAINTAIN ___ LBS RCS FOR CSM ACTIVE DOCKING. |
| | | | RNDZ | <u>TERMINATE AT NEXT EXIT POINT</u> | |
| | | | CSM SOLO | <u>ENTER NEXT BEST PTP</u> | |
| | | RULE NUMBERS 16-30 THROUGH 16-49 ARE RESERVED. | | | |

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**MISSION RULES**

| REV | ITEM |
|---|---|

## INSTRUMENTATION REQUIREMENTS

16-50

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| OX TK PRESS | SP0003P | METER/C&W | COMMON | } -1 OF 2 M | 16-20 |
| OX SM/ENG INTERFACE P | SP0931P | - | - | | |
| FU TK PRESS | SP0006P | METER/C&W | COMMON | } -1 OF 2 M | 16-20 |
| FU SM/ENG INTERFACE P | SP0930P | - | - | | |
| SPS VLV ACT PRESS-PRI | SP0600P | METER | COMMON | } -1 OF 2 M | 16-21 |
| SPS VLV ACT PRESS-SEC | SP0601P | METER | COMMON | | 16-21 |
| SPS FU FEEDLINE TEMP | SP0048T | METER | COMMON | } -1 OF 2 M | 16-22 |
| SPS OX FEEDLINE TEMP | SP0049T | SYS TEST | COMMON | | |
| SPS INJ FLANGE TEMP 1 | SP0061T | C&W | COMMON | } -1 OF 2 M | 16-23 |
| SPS INJ FLANGE TEMP 2 | SP0062T | C&W | COMMON | | |
| ENG CHAMBER PRESS | SP0661P | METER | COMMON | PCM HD - METER HAND | 16-25 |
| HE TK PRESS | SP0001P | METER | SEPARATE | HD | 16-30 |
| FU/OX VLV 1 POS | SP0022H | DISPLAY | SEPARATE | HD | 16-32 |
| FU/OX VLV 2 POS | SP0023H | DISPLAY | SEPARATE | HD | 16-32 |
| FU/OX VLV 3 POS | SP0024H | DISPLAY | SEPARATE | HD | 16-32 |
| FU/OX VLV 4 POS | SP0025H | DISPLAY | SEPARATE | HD | 16-32 |
| OX TK 1 QTY - TOTAL AUX | SP0655Q | DISPLAY | COMMON | HD | 16-10/11/13 |
| OX TK 2 QTY | SP0656Q | DISPLAY | COMMON | HD | 16-10/11/13 |
| FU TK 1 QTY - TOTAL AUX | SP0657Q | DISPLAY | COMMON | HD | 16-10/11/13 |
| FU TK 2 QTY | SP0658Q | DISPLAY | COMMON | HD | 16-10/11/13 |

17 CSM SM-RCS

| REV | ITEM | |
|---|---|---|
| | | **GENERAL** |
| | 17-1 | LAUNCH<br>THE LOSS OF ONE QUAD IS NOT CAUSE FOR ABORT. THERE ARE NO SINGLE FAILURES NOR ANY REASONABLE OR REALISTIC COMBINATION OF FAILURES WHICH LEAD ONLY TO LOSS OF MULTIPLE QUADS. THEREFORE, THERE ARE NO SM-RCS FAILURES WHICH ARE CONSIDERED CAUSE FOR ABORT. |
| | 17-2 | ALL ORBIT PHASES<br>A. LOSS OF ONE QUAD, IN ITSELF, IS NOT NECESSARILY CAUSE FOR EARLY TERMINATION OF THE MISSION. THE GUIDELINE IS THAT AS LONG AS THE SPACECRAFT ATTITUDE CAN BE CONTROLLED AND THE SPS CAN BE BURNED THE MISSION NEED NOT BE TERMINATED EARLY. HOWEVER, LOSS OF ONE QUAD WILL RESULT IN REDUCED PROPELLANT AVAILABLE, AND MAY LEAD TO EARLY MISSION TERMINATION SINCE THE CAPABILITY TO PERFORM SM OR HYBRID DEORBIT WILL BE AFFECTED.<br>B. LOSS OF TWO OR MORE QUADS IS CAUSE FOR ENTRY INTO NEXT BEST PTP.<br>1. LOSS OF TWO ADJACENT QUADS WILL DESTROY THE CAPABILITY TO PERFORM ULLAGE MANEUVERS AND WILL REQUIRE DELETION OF NON-CRITICAL SPS BURNS. LOSS OF TWO ADJACENT QUADS PRECLUDES SM AND HYBRID DEORBIT, OR LM RESCUE.<br>2. LOSS OF TWO OPPOSITE QUADS WILL DESTROY THE CAPABILITY TO PERFORM PRECISE 3-AXIS ATTITUDE CONTROL AND PRECLUDES SM AND HYBRID DEORBIT, OR LM RESCUE. |
| | 17-3 | EVA<br>SINGLE JET CONTROL CAPABILITY IN ALL AXES, WITH NO POSSIBLE THRUSTER IMPINGEMENT INTO THE EVT PATH, IS REQUIRED TO INITIATE EVA. IF A FAILURE OCCURS DURING EVA WHICH VIOLATES THIS CONSTRAINT, THE S/C WILL BE ALLOWED TO DRIFT IN THAT AXIS UNTIL EVT IS COMPLETE. |
| | 17-4 | DOCKING/UNDOCKING<br>A. SHOULD ONE QUAD FAIL, UNDOCKING, STATION KEEPING, AND ASSOCIATED LM ACTIVITIES WILL BE ALLOWED. IF SPS CRITICAL CAPABILITY IS NOT AVAILABLE, PROPELLANT REMAINING MUST BE GREATER THAN SM DEORBIT PLUS CSM ACTIVE DOCKING.<br>B. IF TWO QUADS FAIL THE VEHICLES WILL NOT UNDOCK. IF TWO QUADS FAIL AFTER UNDOCKING, THE VEHICLES WILL REDOCK ASAP. FAILURE OF OPPOSITE QUADS MAY REQUIRE USE OF THE CM RCS SYSTEMS FOR DOCKING. REF MR 17-28. |
| | | RULE NUMBERS 17-5 THROUGH 17-9 ARE RESERVED. |

| REV | ITEM | |
|---|---|---|
| | | **SYSTEMS MANAGEMENT** |
| | 17-10 | PROPELLANT GAGING<br>A. PRIME METHOD: RTCC EQUATION (6%)<br>B. BACKUP METHOD: (ONBOARD) HELIUM PRESSURE/TEMPERATURE (11%) |
| | 17-11 | QUAD PROPELLANT BALANCE<br>PROP ISOLATION VALVES WILL NOT BE USED FOR QUAD PROPELLANT BALANCE. PROPELLANT BALANCE WILL BE ACCOMPLISHED BY SELECTING TWO-JET +X AND -X TRANSLATIONS WITH EITHER THE PITCH OR YAW QUAD AND BY CHOOSING SUITABLE JETS FOR ATTITUDE CONTROL. PROPELLANT DIFFERENCES BETWEEN QUADS WILL BE MAINTAINED WITHIN ±50 POUNDS. |
| | 17-12 | SECONDARY PROPELLANT FUEL PRESSURE VALVE<br>THE RCS SECONDARY FUEL PRESSURIZATION VALVE WILL BE OPENED WHEN THE PRIMARY FUEL MANIFOLD PRESSURE REACHES 150 PSIA. |
| | | RULE NUMBERS 17-13 THROUGH 17-19 ARE RESERVED. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| A | 17-20 | SUSTAINED LEAK IN HELIUM TANK | | | • REF MALF PROC RCS 1C QUAD WILL REMAIN USABLE UNTIL HE MANIFOLD PRESSURE REACHES 75 PSI. |
| | | A. ONE QUAD (ALL OTHER QUADS NORMAL) | LAUNCH | A.1. CONTINUE MISSION | |
| | | | ALL | 2. CONTINUE MISSION | |
| | | | TD&E | 3.(A) ATTEMPT TD&E | |
| | | | | (B) DISCONTINUE DOCKING ATTEMPT WHEN PROPELLANT REMAINING IN EITHER ADJACENT QUAD = ____ LBS. | |
| | | | UNDOCKED | 4.(A) INHIBIT PHASING MANEUVER | |
| | | | RNDZ | 5. TERMINATE AT NEXT EXIT POINT | |
| | | B. MORE THAN ONE QUAD AND | | | |
| | | 1. HE TNK PRESS > HE MNFLD PRES IN AT LEAST THREE QUADS AND HYBRID DEORBIT STILL AVAILABLE | LAUNCH | B.1.(A) CONTINUE MISSION | |
| | | | ALL | (B) CONTINUE MISSION | |
| | | | TD&E | (C)(1) CONTINUE MISSION IF DOCKED | |
| | | | | (2) TERMINATE PHASE IF NOT DOCKED | |
| | | | DOCKED | (D)(1) DO NOT UNDOCK | |
| | | | | (2) REFERENCE ALTERNATE MISSION D | |
| | | | UNDOCKED | (E)(1) REDOCK LM ACTIVE | |
| | | | | (2) REFERENCE ALTERNATE MISSION D | |
| | | | RNDZ | (F) TERMINATE AT NEXT EXIT | |
| | | 2. HE TNK PRESS < HE MNFLD PRESS IN TWO OR MORE QUADS | LAUNCH | B.2.(A) CONTINUE MISSION | |
| | | | ALL | (B) TERMINATE PHASE AND ENTER NEXT BEST PTP | |

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### MISSION RULES

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 17-21 | SUSTAINED LEAK BELOW HELIUM ISOLATION VALVE (COULD BE HELIUM OR FUEL OR OXIDIZER). | | | • REF MALF PROC RCS 2 |
| | | A. ONE QUAD (ALL OTHER QUADS NORMAL). | LAUNCH | A.1. CONTINUE MISSION | QUAD WILL REMAIN USABLE UNTIL He MANIFOLD PRESSURE REACHES 75 PSI. |
| | | | ALL | 2. CONTINUE MISSION | |
| | | | TD&E | 3.(A) ATTEMPT TD&E. | |
| | | | | (B) DISCONTINUE DOCKING ATTEMPT WHEN PROPELLANT REMAINING IN EITHER ADJACENT QUAD = TBD LBS. | |
| | | | EVT | 4. TERMINATE EVT | |
| | | | UNDOCKED | 5.(A) INHIBIT PHASING MANEUVER. | |
| | | | RENDZ | 6. TERMINATE AT NEXT EXIT POINT. | |
| | | B. MORE THAN ONE QUAD | LAUNCH | B.1. CONTINUE MISSION | |
| | | | ALL | 2. TERMINATE PHASE AND ENTER NEXT BEST PTP. | |
| A | 17-22 | PACKAGE TEMP <70°F AND UNABLE TO INCREASE | | | • REF MALF PROC RCS 1A |
| | | A. ONE QUAD (ALL OTHER QUADS NORMAL). | ALL | A.1. CONTINUE MISSION | |
| | | | TD&E | 2.(A) ATTEMPT TD&E | |
| | | | | (B) DISCONTINUE DOCKING ATTEMPT WHEN PROPELLANT REMAINING IN EITHER ADJACENT QUAD = TBD LBS. | |
| | | | UNDOCKED | 3.(A) INHIBIT PHASING MANEUVER | |
| | | | RENDZ | 4. TERMINATE AT NEXT EXIT POINT | |
| | | B. MORE THAN ONE QUAD | ALL | B. TERMINATE PHASE AND ENTER NEXT BEST PTP. | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 17-23 | LOSS OF INDIVIDUAL THRUSTERS AS A RESULT OF CLOGGING, FREEZING, OR BURNOUT WHICH RESULT IN: | | | |
| | | A. LOSS OF ULLAGE CAPABILITY | ALL | A. CONTINUE MISSION | A. REF MR 16-26, 27 |
| | | B. LOSS OF ATTITUDE CONTROL IN ONE OR MORE AXES (P, Y, R) | ALL | B. TERMINATE PHASE AND ENTER NEXT BEST PTP | |
| | | C. LOSS OF ATTITUDE CONTROL IN ONE OR MORE AXES WITHOUT THRUSTER IMPINGEMENT IN THE EVT PATH. | EVA | C. CONTINUE EVA | C. S/C WILL BE ALLOWED TO DRIFT IN THAT AXIS UNTIL EVT IS COMPLETE. |
| | | RULE NUMBERS 17-24 THROUGH 17-49 ARE RESERVED. | | | |

| REV | ITEM | |
|---|---|---|
| | 17-50 | INSTRUMENTATION REQUIREMENTS |

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REF |
|---|---|---|---|---|---|
| SM HE TK A PRESS | SR5001P | METER | COMMON | -1 OF | 17-20 |
| QTY SM-RCS PROP SYS A | SR5025Q | METER | COMMON | 2 M | 17-21 |
| SM HE TK B PRESS | SR5002P | METER | COMMON | -1 OF | 17-20 |
| QTY SM-RCS PROP SYS B | SR5026Q | METER | COMMON | 2 M | 17-21 |
| SM HE TK C PRESS | SR5003P | METER | COMMON | -1 OF | 17-20 |
| QTY SM-RCS PROP SYS C | SR5027Q | METER | COMMON | 2 M | 17-21 |
| SM HE TK D PRESS | SR5004P | METER | COMMON | -1 OF | 17-20 |
| QTY SM-RCS PROP SYS D | SR5028Q | METER | COMMON | 2 M | 17-21 |
| SM ENG PKG A TEMP | SR5065T | METER/C&W | COMMON | M | 17-22 |
| SM ENG PKG B TEMP | SR5066T | METER/C&W | COMMON | M | 17-22 |
| SM ENG PKG C TEMP | SR5067T | METER/C&W | COMMON | M | 17-22 |
| SM ENG PKG D TEMP | SR5068T | METER/C&W | COMMON | M | 17-22 |
| SM HE TK A TEMP | SR5013T | METER | COMMON | M | 17-20/21 |
| SM HE TK B TEMP | SR5014T | METER | COMMON | M | 17-20/21 |
| SM HE TK C TEMP | SR5015T | METER | COMMON | M | 17-20/21 |
| SM HE TK D TEMP | SR5016T | METER | COMMON | M | 17-20/21 |
| SM HE MAN A PRESS | SR5729P | ----- | ------ | HD | 17-20/21 |
| SM HE MAN B PRESS | SR5776P | ----- | ------ | HD | 17-20/21 |
| SM HE MAN C PRESS | SR5817P | ----- | ------ | HD | 17-20/21 |
| SM HE MAN D PRESS | SR5830P | ----- | ------ | HD | 17-20/21 |
| SM FU MAN A PRESS | SR5737P | METER/C&W | COMMON | HD | 17-12 |
| SM FU MAN B PRESS | SR5784P | METER/C&W | COMMON | HD | 17-12 |
| SM FU MAN C PRESS | SR5822P | METER/C&W | COMMON | HD | 17-12 |
| SM FU MAN D PRESS | SR5823P | METER/C&W | COMMON | HD | 17-12 |
| SM OX MAN A PRESS | SR5733P | ---- | ---- | HD | 17-21 |
| SM OX MAN B PRESS | SR5780P | ---- | ---- | HD | 17-21 |
| SM OX MAN C PRESS | SR5820P | ---- | ---- | HD | 17-21 |
| SM OX MAN D PRESS | SR5821P | ---- | ---- | HD | 17-21 |

18 CSM CM-RCS

| REV | ITEM | |
|---|---|---|
| | | **GENERAL** |
| | 18-1 | LAUNCH<br><br>A. A SUSTAINED LEAK IN OR THE LOSS OF HELIUM SUPPLY PRESSURE OR HELIUM MANIFOLD PRESSURE IN ONE CM RCS RING IS NOT CAUSE FOR ABORT SINCE THE REMAINING RING IS CAPABLE OF ABORT OR ENTRY ATTITUDE CONTROL; THIS FAILURE WILL REQUIRE ENTRY INTO PTP 6-4 SINCE SYSTEMS ARE NOT LONGER REDUNDANT.<br><br>B. A SUSTAINED LEAK IN OR THE LOSS OF HELIUM SUPPLY PRESSURE OR HELIUM MANIFOLD PRESSURE IN BOTH CM RCS RINGS PRIOR TO TOWER JETTISON IS JUSTIFICATION FOR A MODE I ABORT. AFTER TOWER JETTISON, IT IS NOT CAUSE FOR ABORT SINCE THE ABILITY TO PERFORM A SAFE ENTRY INTO THE ATLANTIC AT THE END OF THE FIRST REV STILL EXISTS BY USING THE CONTINGENCY SM RCS SPINUP PRIOR TO CM/SM SEP. THIS METHOD OF ENTRY IS CONSIDERED OPERATIONALLY PREFERABLE TO PERFORMING AN ABORT AND PRESENTS LESS POTENTIAL HAZARD TO CREW RECOVERY. FURTHERMORE, CM RCS CONTROL IS REQUIRED FOR ABORTS IN THE MODE II AND MODE III REGIONS, AND TO ABORT THE LAUNCH IN THESE REGIONS FOR LOSS OF CM RCS CAPABILITY WOULD PLACE THE SPACECRAFT AND CREW INTO AN UNSAFE ENVIRONMENT. |
| | 18-2 | ALL ORBIT PHASES<br><br>A. SUSTAINED LEAK IN OR LOSS OF HELIUM SUPPLY PRESSURE OR HELIUM MANIFOLD PRESSURE (COULD BE EITHER FUEL OR OXIDIZER) IN ONE CM RCS RING DELETES THE REDUNDANCY OF THE ENTRY ATTITUDE CONTROL SYSTEM AND REDUCES THE ΔV AVAILABLE FOR HYBRID DEORBIT. LOSS OF HELIUM SUPPLY PRESSURE OR HELIUM MANIFOLD PRESSURE IN BOTH CM RCS RINGS DELETES ALL ENTRY ATTITUDE CONTROL CAPABILITY REQUIRING CONTINGENCY SM RCS SPIN-UP PRIOR TO CM/SM SEP. THE LOSS OF ONE OR BOTH CM RCS RINGS IS CAUSE FOR TERMINATING THE PHASE AND MISSION BY ENTRY INTO THE NEXT BEST PTP.<br><br>B. ARMING OF THE CM RCS RINGS, WHETHER THE PROPELLANT ISOLATION VALVES ARE OPENED OR CLOSED, IS CAUSE FOR TERMINATING THE PHASE AND MISSION INTO THE NEXT BEST PTP.<br><br>RULE NUMBERS 18-3 THROUGH 18-9 ARE RESERVED |
| | | **SYSTEMS MANAGEMENT** |
| A | 18-10 | THRUSTER TEMP CONTROL<br><br>CM RCS THRUSTERS WILL BE HEATED PRIOR TO ENTRY FOR 20 MINUTES OR UNTIL THE LOWEST INDICATED TEMPERATURE IS ≥28°F, WHICHEVER COMES FIRST. IF THRUSTER(S) HEATER FUNCTION FAILS, CM RCS IS STILL CONSIDERED OPERATIONAL PENDING RESULTS OF CM RCS CHECKOUT PRIOR TO DEORBIT. REF MALF PROC RCS 5 |
| A | 18-11 | HELIUM INTERCONNECT<br><br>AS A LAST RESORT, IF THE HELIUM IN ONE RING IS DEPLETED DUE TO A LEAK AND PROPELLANT IS DEPLETED IN THE OTHER RING, THE SYSTEMS MAY BE INTERCONNECTED IF THE REMAINING PROPELLANT IS REQUIRED FOR CONTROL. ONCE INTERCONNECTED, THE RINGS CANNOT BE ISOLATED. REF MALF PROC RCS 4<br><br>RULE NUMBERS 18-12 THROUGH 18-19 ARE RESERVED. |

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| | 18-20 | SUSTAINED LEAK IN OR COMPLETE LOSS OF HELIUM SUPPLY PRESSURE. | | | |
| | | A. ONE RING | LAUNCH | A.1. CONTINUE MISSION AND ENTER PTP 6-4 | |
| | | | ALL | 2. TERMINATE PHASE AND ENTER NEXT BEST PTP | A.2. NORMAL ENTRY |
| | | B. BOTH RINGS | LAUNCH | B.1. CONTINUE MISSION AND ENTER PTP 2-1 UNLESS PRIOR TO TOWER JETTISON. IF PRIOR TO TOWER JETTISON, ABORT. | |
| | | | ALL | 2. TERMINATE PHASE AND ENTER NEXT BEST PTP | B.2. CONTINGENCY SM RCS SPIN-UP PRIOR TO CM/SM SEP. |
| | 18-21 | SUSTAINED LEAK IN OR COMPLETE LOSS OF HELIUM MANIFOLD PRESSURE (COULD BE EITHER FUEL OR OXIDIZER). | | | |
| | | A. ONE RING | LAUNCH | A.1. CONTINUE MISSION AND ENTER PTP 6-4 | |
| | | | ALL | 2. TERMINATE PHASE AND ENTER NEXT BEST PTP | |
| | | B. BOTH RINGS | LAUNCH | B.1. CONTINUE MISSION AND ENTER PTP 2-1 UNLESS PRIOR TO TOWER JETTISON. IF PRIOR TO TOWER JETTISON, ABORT. | |
| | | | ALL | 2. TERMINATE PHASE AND ENTER NEXT BEST PTP | B.2. CONTINGENCY SM RCS SPIN-UP PRIOR TO CM/SM SEP |
| | 18-22 | CM RCS IS ARMED FOR ANY REASON | ALL | TERMINATE PHASE AND ENTER NEXT BEST PTP | |
| | | RULE NUMBERS 18-23 THROUGH 18-49 ARE RESERVED. | | | |

| REV | ITEM | |
|---|---|---|
| | 18-50 | **INSTRUMENTATION REQUIREMENTS** |

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| ✓CM HE TK A PRESS | CR0001P | METER | COMMON | M | 18-20 |
| ✓CM HE TK B PRESS | CR0002P | METER | COMMON | M | 18-20 |
| ✓CM HE TK A TEMP | CR0003T | METER | COMMON | M | 18-20 |
| ✓CM HE TK B TEMP | CR0004T | METER | COMMON | M | 18-20 |
| ✓CM HE MNFLD A PRESS | CR0035P | METER/C/W | SEPARATE | M (BOTH) | 18-21 |
| ✓CM HE MNFLD B PRESS | CR0036P | METER/C/W | SEPARATE | M (BOTH) | 18-21 |

19 DOCKING AND UMBILICAL

| REV | ITEM | |
|---|---|---|
| | | **GENERAL** |
| | 19-1 | THREE GOOD DOCKING RING LATCHES 120 DEGREES APART ARE REQUIRED FOR AN IVT. |
| | 19-2 | THREE GOOD DOCKING RING LATCHES 120 DEGREES APART ARE REQUIRED FOR A DOCKED RCS MANEUVER. |
| A | 19-3 | THE DOCKED SPS OR DPS BURNS REQUIRE THAT NO MORE THAN THREE DOCKING RING LATCHES BE UNLATCHED. |
| | 19-4 | MANNED UNDOCKING OPERATIONS WILL BE TERMINATED FOR ANY FAILURE OF A DOCKING RING LATCH TO RELEASE. NO ATTEMPT WILL BE MADE TO DISASSEMBLE A DOCKING RING LATCH. |
| A | 19-5 | WITH FAILURE OF THE CSM FORWARD HATCH PRIMARY LOCK/UNLOCK MECHANISM, THE SECONDARY LOCK/UNLOCK MECHANISM WILL ONLY BE USED TO LOCK THE HATCH, WITH THE EXCEPTION THAT THE SECONDARY LOCK/UNLOCK MECHANISM MAY BE USED TO UNLOCK THE HATCH TO PERFORM AN IVT FROM THE LM. |
| | 19-6 | LOSS OF VISUAL DOCKING AIDS (COAS AND TARGETS) WILL NOT INHIBIT DOCKING, AND UNDOCKING. |
| A | 19-7 | FOR CASES WHERE "FINAL" LM SEPARATION IS NOT ATTEMPTED, THE DOCKING RING WILL BE JETTISONED 20 MIN PRIOR TO RETROFIRE. REF MR 5-21E |
| | 19-8 | IF THE DOCKING PROBE FAILS TO INDICATE EXTENSION OR IF BOTH TALK BACK INDICATORS* ARE BARBER POLE, TD&E WILL BE ATTEMPTED.<br><br>*NOTE: THE ONLY DOCKING PROBE INSTRUMENTATION CONSISTS OF TWO TALK BACK INDICATORS IN THE CSM. |
| | | RULE NUMBERS 19-9 THROUGH 19-10 ARE RESERVED. |
| | | **MANAGEMENT MISSION RULES** |
| | 19-11 | FOR MISFIRE OF A DOCKING RETRACT SQUIB, THE REMAINING SQUIB IN THE SAME SYSTEM WILL BE USED TO COMPLETE DOCKING. SUBSEQUENT UNDOCKING WILL BE GO SINCE REDUNDANT SQUIBS EXIST IN THE REMAINING SYSTEM. |
| | 19-12 | THE CM FORWARD AND LM UPPER HATCH NORMALLY WILL BE INSTALLED FOR ANY TYPE OF MANEUVER OR DOCKING. |
| | | RULE NUMBERS 19-13 THROUGH 19-19 ARE RESERVED. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| A | 19-20 | FAILURE TO MATE LM UMBILICAL | | | |
| | | A. PLUG P23 | TD&E | A. CONTINUE MISSION | A. P23 IS LOCATED BETWEEN CSM -Y AND -Z AXIS |
| | | B. PLUS P24 | TD&E | B. CONTINUE MISSION INGRESS LM WITHIN 30 HRS AND TURN OFF LM DESCENT BATTERIES TO EFFECT X-LUNAR BUS TRANSFER TO CSM POWER | B. P24 IS LOCATED BETWEEN CSM -Z AND +Y AXIS. P24 UMBILICAL CONTAINS LM DESCENT BATTERY RESET FUNCTION. |
| | | C. BOTH P23 AND P24 | TD&E | C. PERFORM CSM/LM FINAL SEP REF ALTERNATE MISSION A | C. S-IVB/LM SEP CANNOT BE ACHIEVED WITHOUT MATING AT LEAST ONE UMBILICAL |
| A | 19-21 | FAILURE TO MAINTAIN LM X-LUNAR BUS POWER FROM CSM | DOCKED | 1. CONTINUE MISSION IF UNABLE TO TRANSFER POWER FROM CSM TO LM DESCENT BATTERY, INGRESS LM WITHIN 10 HRS AND TURN LM DESCENT BATTERY ON | LM DESCENT STAGE LIFETIME IS CRITICAL<br>MAX LIFETIME OF CRITICAL EQUIPMENT WITHOUT HEATERS IS 10 HOURS |
| | 19-22 | FAILURE TO ACHIEVE S-IVB/LM SEPARATION | TD&E | PERFORM CSM/LM FINAL SEP REF ALT MISSION A | |
| | 19-23 | FAILURE TO ACHIEVE CSM/LM FINAL SEPARATION | DOCKED | MUST PERFORM NORMAL UNDOCKING<br>A. RETRIEVE PROBE AND DROGUE AND INSTALL.<br>B. AFTER UNDOCKING, DEPRESS CSM AND JETTISON PROBE OVERBOARD. | LM MASS MAY HAVE TO BE MODIFIED FOR APS BURN |
| | 19-24 | FAILURE TO INDICATE DOCKING PROBE EXTEND OR BOTH TALK BACK INDICATORS ARE BARBER POLE. | TD&E | A. CONTINUE MISSION ATTEMPT TD&E | DOCKING RING/TUNNEL STRUCTURE DAMAGE MAY OCCUR TO THE EXTENT THAT TUNNEL PRESSURE CAN NOT BE MAINTAINED. |
| | | | UNDOCKED | B. CONTINUE MISSION ATTEMPT DOCKING | |
| | 19-25 | FAILURE TO CAPTURE OR TO ACHIEVE DOCKING | TD&E | TERMINATE TD&E . | |
| | | | UNDOCKED | PERFORM EVT | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 19-26 | CANNOT REMOVE CSM FORWARD HATCH | TD&E<br>DOCKED | A. PERFORM CSM/LM FINAL SEP<br>B. PERFORM CSM/LM FINAL SEP<br>IF LM MANNED, PERFORM EVT TO CSM. | |
| | 19-27 | CANNOT REMOVE DOCKING PROBE, LM DROGUE, AND/OR LM UPPER HATCH. | TD&E<br>DOCKED | A. CONTINUE MISSION<br>B. CONTINUE MISSION<br>REF ALTERNATE MISSION ____ | B. SPS AND CM RCS MANEUVERS MAY BE PERFORMED |
| | 19-28 | FAILURE TO ACHIEVE CSM/LM UNDOCKING | DOCKED | NO UNDOCKED ACTIVITIES<br>REF ALTERNATE MISSION D | |
| | 19-29 | FAILURE TO RELEASE CAPTURE LATCHES | DOCKED | NO UNDOCKING<br>1. PERFORM RETRACTION<br>2. REF ALTERNATE MISSION D | |
| | 19-30 | PRIMARY FORWARD HATCH LOCK/UNLOCK MECHANICSM INOPERATIVE | ALL | CONTINUE MISSION<br>IF LM MANNED, CONTINUE EXTENDED LM EVALUATION AND THEN SETUP FOR UNMANNED APS BURN. TERMINATE MANNED LM ACTIVITY. SECURE HATCH USING SECONDARY LOCK/UNLOCK MECHANISM. | SECONDARY MECHANISM WILL ONLY BE USED TO ACCOMPLISH FINAL EGRESS OF LM. |
| | 19-31 | FAILURE TO REINSTALL CSM FORWARD HATCH | TD&E<br>DOCKED | ENTER NEXT BEST PTP | REF BACKUP PROCEDURES |
| | 19-32 | FAILURE TO REINSTALL PROBE AND/OR DROGUE OR FAILURE TO CLOSE LM UPPER HATCH | DOCKED | NO UNDOCKING<br>REF ALTERNATE MISSION D. | |

20 EMU/EVA

| REV | ITEM | |
|---|---|---|
| | | **GENERAL** |
| | 20-1 | TO INITIATE AND CONTINUE THE FOLLOWING MISSION PHASES, THE EXTRAVEHICULAR MOBILITY UNIT (EMU) MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES:<br><br>A. DOCKED<br><br>TWO LIFE SUPPORT UNITS (PLSS AND OPS OR 2 OPS) PROVIDING SUFFICIENT CONSUMABLES TO SUPPORT A 30 MINUTE CONTINGENCY TRANSFER.<br><br>B. EVA<br><br>SUFFICIENT PLSS CONSUMABLES TO SUPPORT ORBITAL CHECKOUT AND PLANNED EVA<br><br>C. UNDOCKED/RNDZ<br><br>TWO LIFE SUPPORT UNITS (PLSS AND OPS OR 2 OPS) PROVIDING SUFFICIENT CONSUMABLES TO SUPPORT A CONTINGENCY TRANSFER, OR ONE UNIT FOR SINGLE MAN UNDOCKED OPERATION. |
| | | **MANAGEMENT** |
| | 20-2 | THE PLSS BATTERY IS CONSIDERED TO HAVE A MINIMUM OF 14.3 AMP-HR CAPABILITY. THIS CONSUMABLE IS GAGED BY MONITORING GT8140C AND PROCESSING IN THE RTCC TO OBTAIN AMP-HRS. |
| | 20-3 | THE PLSS PRIMARY OXYGEN SUBSYSTEM (POS) IS CONSIDERED TO HAVE A NOMINAL SOURCE PRESSURE OF 850 PSIA. THIS CONSUMABLE IS GAGED BY MONITORING GT8182P AND PROCESSING IN THE RTCC TO OBTAIN LBS MASS. |
| | 20-4 | THE PLSS FEEDWATER RESERVOIR IS CONSIDERED TO HAVE A NOMINAL LOADING OF 8.3 LBS. THIS CONSUMABLE IS GAGED BY MONITORING GT8154T, GT8196T, GT8182P, GT8110P AND PROCESSING IN THE RTACF TO OBTAIN LBS REMAINING. |

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 20-20 | LOSS OF PRESSURE INTEGRITY | EVA | | • REF MALF EMU 5-4, 5-9, 5-24 |
| | | A. PGA PRESS <3.75 PSIA (TM) AND DECREASING OR PGA PRESS GAUGE OF <3.7 PSIA AND DECREASING | | A. TERMINATE EVA<br>1. ACTIVATE OPS<br>2. INGRESS S/C | A. GT8168P PGA PRESS<br>PGA PRESS GAUGE<br>LOW PGA PRESS TONE (3.0 KHZ)<br>• REF MALF PROC 5-13, 5-23 |
| | | B. PGA PRESS >4.05 PSIA (TM) AND INCREASING OR PGA PRESS GAUGE OF >4.0 PSIA AND INCREASING | | B. TERMINATE EVA<br>1. ACTIVATE OPS<br>2. CLOSE POS SHUTOFF VALVE<br>3. INGRESS S/C | B. GT8168P PGA PRESS<br>PGA PRESS GAUGE<br>CREW SENSIBLE DETECTION |
| A | 20-21 | LOSS OF OXYGEN VENTILATION | | | REF MALF EMU 5-4, 5-32, 5-34 |
| | | A. FAN FAILURE | EVA | A. TERMINATE EVA<br>1. ACTIVATE OPS<br>2. OPEN PGA PURGE VALVE<br>3. INGRESS S/C ASAP | A. GT8140C PLSS BAT CUR<br>GT8141V PLSS BAT VOLT<br>LOW VENT FLOW TONE (3.0 KHZ) |
| | | B. NOXIOUS ODOR | EVA | B. TERMINATE EVA<br>1. ACTIVATE OPS<br>2. OPEN PGA PURGE VALVE<br>3. INGRESS S/C ASAP | B. CREW SENSIBLE DETECTION |
| A | 20-22 | HUMIDITY CONTROL MALFUNCTION | | | REF MALF EMU 5-14, 5-29 |
| | | A. DEGRADED OPERATION OF WATER SEPARATOR | EVA | A. CONTINUE MISSION<br>REDUCE WORK PROFILE TO COMPENSATE FOR INCREASED HUMIDITY | A. CREW SENSIBLE DETECTION |
| | | B. TOTAL LOSS OF WATER SEPARATOR | EVA | B. TERMINATE EVA<br>1. IF DEHUMIDIFICATION IS REQUIRED, ACTIVATE OPS IN PURGE MODE<br>2. INGRESS S/C ASAP | B. CREW SENSIBLE DETECTION<br>GT8110P FEED $H_2O$ PRESS<br>GT8140C PLSS BAT CUR<br>GT8196T LCG $H_2O$ $\Delta T$<br>LOW FEED $H_2O$ PRESS TONE (1.5 KHZ) |
| | | RULES 20-23 THROUGH 20-29 ARE RESERVED. | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 20-30 | LOSS OF LIQUID TRANSPORT LOOP THERMAL CONTROL | | | REF MALF EMU 5-17, 5-31, 5-32 5-34 |
| | | A. DEGRADED CIRCULATION (<3.5 LBS/MIN AND DECREASING) | EVA | A. CONTINUE MISSION<br>ADJUST WORK PROFILE TO COMPENSATE FOR DEGRADED COOLING | A. GT8154T LCG $H_2O$ TEMP<br>GT8196T LCG $H_2O$ $\Delta T$<br>GT8140C PLSS BAT CUR<br>CREW SENSIBLE DETECTION<br>GT8141V PLSS BAT VOLT |
| | | B. LOSS OF CIRCULATION | EVA | B. TERMINATE EVA<br>1. IF ADDITIONAL COOLING IS REQUIRED, ACTIVATE OPS IN PURGE MODE<br>2. INGRESS S/C ASAP | REF MALF EMU 5-16, 5-34<br>B. GT8154T LCG $H_2O$ TEMP<br>GT8196T LCG $H_2O$ $\Delta T$<br>GT8140C PLSS BAT CUR<br>GT8141V PLSS BAT VOLT<br>CREW SENSIBLE DETECTION |
| | | C. DEGRADED SUBLIMATOR (LIQUID TRANSPORT LOOP HEAT REJECTION <1250 BTU/HR IN MAX $H_2O$ DIVERTER VALVE POSITION) | EVA | C. CONTINUE MISSION<br>1. ADJUST WORK PROFILE TO COMPENSATE FOR DEGRADED COOLING<br>2. IF COOLING IS INADEQUATE, CREWMAN MAY ATTEMPT A WET SUBLIMATOR RESTART | REF MALF EMU 5-17, 5-30<br>C. GT8154T LCG $H_2O$ TEMP<br>GT8196T LCG $H_2O$ $\Delta T$<br>GT8110P FEED $H_2O$ PRESS<br>CREW SENSIBLE DETECTION |
| | | D. SUBLIMATOR FAILURE | EVA | D. TERMINATE EVA<br>1. IF ADDITIONAL COOLING IS REQUIRED, ACTIVATE OPS IN PURGE MODE<br>2. INGRESS S/C ASAP | REF MALF EMU 5-14<br>D. GT8154T LCG $H_2O$ TEMP<br>GT8196T LCG $H_2O$ $\Delta T$<br>GT8110P FEED $H_2O$ PRESS<br>LOW FEED $H_2O$ PRESS TONE (1.5 KHZ) |
| A | 20-31 | FEED $H_2O$ PRESSURE DECAY | | | • REF MAL EMU 5-14, 5-29 |
| | | A. FEED $H_2O$ PRESSURE <2.0 PSIA | EVA | A. CONTINUE MISSION<br>1. ADJUST WORK PROFILE TO COMPENSATE FOR HIGH FEED $H_2O$ CONSUMPTION RATE AND DEGRADED COOLING.<br>2. IF COOLING INADEQUATE, CREWMAN MAY ATTEMPT A WET SUBLIMATOR RESTART | A. GT8110P FEED $H_2O$ PRESS<br>CREW SENSIBLE DETECTION |
| | | B. FEED $H_2O$ PRESSURE <1.6 PSIA AND DECREASING | EVA | B. TERMINATE EVA<br>1. IF ADDITIONAL COOLING IS REQUIRED, ACTIVATE OPS IN PURGE MODE.<br>2. INGRESS S/C ASAP | B. GT8110P FEED $H_2O$ PRESS<br>LOW FEED $H_2O$ PRESS TONE (1.5 KHZ)<br>CREW SENSIBLE DETECTION |
| A | 20-32 | DEPLETION OF POS | | | • REF MALF EMU 5-4, 5-10, 5-27 |
| | | A. POS PRESS <130 PSIA | EVA | TERMINATE EVA<br>A. ACTIVATE OPS<br>B. INGRESS S/C | A. GT8182P PLSS $O_2$ PRESS<br>GT8168P PGA PRESS<br>PGA PRESS GAUGE<br>LOW PGA PRESS TONE (3.0 KHZ)<br>B. PLSS $O_2$ QTY IND |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 20-33 | LOSS OF MAIN POWER SUPPLY | | | • REF MALF EMU 5-36 |
| | | A. PLSS BAT VOLT <16.0 VDC AND DECREASING | EVA | A. TERMINATE EVA<br>1. ACTIVATE OPS IN A PURGE MODE<br>2. INGRESS S/C ASAP | A. GT8141V PLSS BAT VOLT<br>GT8140C PLSS BAT CUR<br>CREW SENSIBLE DETECTION<br>LOW VENT FLOW (3.0 KHZ) |
| | | B. TOTAL AMP-HRS REMAINING <4.3 AMP-HRS | DOCKED UNDOCKED | B. REPLACE PLSS BATTERY IF ONE OPS FAILS TO CHECK OUT PRIOR TO UNDOCKING. | B. GT8140C PLSS BAT CUR |
| | | C. TOTAL AMP-HRS REMAINING ≤1.4 AMP-HRS | EVA | C. TERMINATE EVA | C. GT8140C PLSS BAT CUR |
| A | 20-34 | DEGRADED POWER PROFILE<br>CUR <2.0 AMP OR<br>CUR >3.0 AMP | EVA | CONTINUE MISSION<br>VERIFY PERFORMANCE OF FAN, PUMP, AND SSC | • REF MALF EMU 5-32 - 5-34<br>GT8140C PLSS BAT CUR |
| | 20-35 | LOSS OF TM | EVA | CONTINUE MISSION | |
| A | 20-36 | LOSS OF ANY CRITICAL INSTRUMENTATION | EVA | TERMINATE EVA | REF MR 20-42 |
| A | | NOTE: | REF SECTION 32 FOR EVA COMMUNICATIONS RULES | | |
| | | RULES 20-37 THROUGH 20-40 ARE RESERVED. | | | |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 20-41 | INSTRUMENTATION REQUIREMENTS |

| MEAS DESCRIPTION | FM/FM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| FEED $H_2O$ PRESS | GT8110P | | COMMON | HD | 20-22,30,31 |
| LOW FEED $H_2O$ PRESS | | WARNING TONE (1.5 KHZ) | | M | 20-22,30,31 |
| PLSS EKG | GT8124J | | | * | |
| PLSS BAT CUR | GT8140C | | | HD | 20-21,22,30,33,34 |
| PLSS BAT VOLT | GT8141V | | | HD | 20-21,30,33 |
| LCG $H_2O$ TEMP | GT8154T | | | HD | 20-30 |
| PGA PRESS | GT8168P | | | HD | 20-20,32 |
| PLSS $O_2$ PRESS | GT8182P | METER | COMMON | HD | 20-32 |
| PLSS $O_2$ QTY IND | | | | M | 20-32 |
| LCG $H_2O$ $\Delta T$ | GT8196T | | | HD | 20-22,30 |
| LOW VENT FLOW | | WARNING TONE (3.0 KHZ) | | M | 20-21,33 |
| PGA PRESS GAUGE | | METER | | M | 20-20,32 |
| LOW PGA PRESS | | WARNING TONE (3.0 KHZ) | | M | 20-20,32 |
| OPS PRESS GAUGE | | METER | | M | |
| OPS REG PRESS GAUGE | | METER | | **M | |
| HEATER STATUS CHECK | | GREEN LIGHTS | | 1 OF 2 M | |

*AEROMEDICAL PARAMETER REFERENCE SECTION 31.

**NOTE: 1 OF 2 OPS REG PRESS GAUGES IS MANDATORY.

20-42 CRITICAL INSTRUMENTATION

| MEAS DESCRIPTION | FM/FM | ONBOARD | TRANSDUCER |
|---|---|---|---|
| PLSS $O_2$ PRESS/PLSS $O_2$ QTY IND | GT8182P | METER | COMMON |
| PGA PRESS GAUGE | | METER | |
| LOW VENT FLOW | | WARNING TONE (3.0 KHZ) | |

21 LM SEQUENTIAL AND PYROTECHNIC

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | | **GENERAL MISSION RULES** |
| A | 21-1 | TO INITIATE THE FOLLOWING MISSION EVENTS, THE PYROTECHNIC SYSTEM MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES:<br>A. DOCKED<br>ONE OPERATIONAL PYRO SYSTEM<br>B. INSERTION AND/OR NORMAL STAGING<br>TWO OPERATIONAL PYRO SYSTEMS |
| A | 21-2 | A PYRO SYSTEM IS CONSIDERED LOST IF:<br>A. PYRO BATTERY OPEN CIRCUIT VOLTAGE <35 VDC<br>B. UNABLE TO ARM SYSTEM |
| A | 21-3 | A PYRO SYSTEM WILL BE DISABLED IF:<br>A. ANY RELAY K2 THROUGH K6 INADVERTANTLY CLOSES<br>B. ANY RELAY K7 THROUGH K15 INADVERTANTLY CLOSES<br>SYSTEM WILL BE USED FOR APS PRESSURIZATION AND STAGING. |
| A | 21-4 | THE ASCENT AND DESCENT STAGES ARE CONSIDERED RIGIDLY ATTACHED WITH ONLY ONE BOLT/NUT COMBINATION INTACT. |
| A | 21-5 | THE ASCENT AND DESCENT STAGES ARE CONSIDERED NON-RIGIDLY ATTACHED IF THE GUILLOTINE FAILS TO SEVER THE INTERSTAGE UMBILICALS. |
| | | RULE NUMBERS 21-6 THROUGH 21-9 ARE RESERVED. |
| | | **MANAGEMENT MISSION RULES** |
| A | 21-10 | APS WILL BE PRESSURIZED PRIOR TO UNDOCKING/STAGING. APS WILL NOT NORMALLY BE PRESSURIZED MORE THAN 24 HOURS PRIOR TO THE LAST APS BURN; HOWEVER, IN A CONTINGENCY CASE, THE APS MAY BE PRESSURIZED UP TO 3-1/2 DAYS PRIOR TO THE LAST APS BURN. |
| A | 21-11 | IF UNABLE TO DEPLOY ONE OR MORE LANDING GEAR, DESCENT ENGINE BURNS WILL BE CONTINUED SINCE CONTROL PROBLEMS ARE NOT EXPECTED TO EXIST AND DAMAGE TO THE LANDING GEAR FROM THE BURN WILL NOT AFFECT THE MISSION. |
| A | 21-12 | UNDOCKED STAGING WITH ONE PYRO SYSTEM WILL BE PERFORMED ONLY IF ABSOLUTELY NECESSARY TO MAINTAIN CREW SAFETY. |
| A | 21-13 | FOR A K1 THROUGH K6 FAILURE, THE GOOD SYSTEM WILL BE DISABLED AND A PYRO FUNCTION, OTHER THAN STAGING, ATTEMPTED TO DETERMINE IF K1 HAS FAILED CLOSED. IF BOTH SYSTEMS ARE FAILED IN THIS MODE, THEY MUST BOTH BE TESTED FOR A K1 FAILURE INDEPENDENTLY. A PYRO SYSTEM CANNOT BE DISABLED FOR A K1 FAILURE. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| A | 21-20 | PYRO BATTERY VOLTAGE <35 VDC | | | |
| | | A. ONE SYSTEM | DOCKED UNDOCKED | A.1. CONTINUE MISSION DO NOT STAGE | |
| | | | RNDZ | 2. SEPARATION - CONTINUE MISSION DO NOT STAGE | |
| | | | | 3. PHASING - DO NOT PERFORM INSERTION DO NOT STAGE | |
| | | | | 4. INSERTION - DELAY STAGING AS LONG AS POSSIBLE | |
| | | B. TWO SYSTEMS | ALL | B. CONTINUE MISSION DO NOT STAGE | |
| A | 21-21 | UNABLE TO ARM PYRO SYSTEM(S) | | | |
| | | A. ONE SYSTEM | DOCKED UNDOCKED | A.1. CONTINUE MISSION DO NOT STAGE | |
| | | | RNDZ | 2. SEPARATION - CONTINUE MISSION DO NOT STAGE | |
| | | | | 3. PHASING - DO NOT PERFORM INSERTION DO NOT STAGE | |
| | | | | 4. INSERTION - DELAY STAGING AS LONG AS POSSIBLE | |
| | | B. BOTH SYSTEMS PRIOR TO: | | | |
| | | 1. RCS PRESSURIZATION | DOCKED | B.1. CONTINUE MISSION PERFORM EVA AND DOCKED LM SYSTEMS ACTIVITIES EXCEPT DPS BURN. DO NOT UNDOCK | |
| | | 2. DPS PRESSURIZATION | DOCKED | 2. CONTINUE MISSION PERFORM EVA AND LM SYSTEMS ACTIVITIES EXCEPT DPS BURN. | |
| | | 3. APS PRESSURIZATION | DOCKED | 3. CONTINUE MISSION PERFORM SINGLE OR DOUBLE FOOTBALL | |
| | | 4. STAGING | RNDZ | 4. CONTINUE MISSION DO NOT ATTEMPT STAGING | 4. CSM RESCUE MAY BE REQUIRED DUE TO RCS RED-LINES. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 21-22 | UNABLE TO DISARM PYRO SYSTEM(S) | DOCKED | A. CONTINUE MISSION<br>DO NOT PERFORM EVA | REF MALF PROCED ED 1<br>K1 = MASTER ARM RELAY |
| | | | EVA | B. TERMINATE EVA | |
| | | | RNDZ | C. CONTINUE MISSION<br>STAGE NORMALLY | |
| A | 21-23 | RELAY K2 THROUGH K6 (OR K1 THROUGH K6 AFTER APS PRESS) INADVERTANTLY CLOSED AND CANNOT BE RESET | | | RELAYS<br>K2 = STAGE<br>K3 = STAGE SEQUENCE<br>K4 = 1 GUILLOTINE<br>K5 = 2 BOLTS (SYS A) AND 2 NUTS (SYS B)<br>K5A = 2 BOLTS (SYS A) AND 2 NUTS (SYS B)<br>K6 = 3 ELECTRICAL CIRCUIT INTERRUPTERS |
| | | | DOCKED | CONTINUE MISSION<br>DO NOT PERFORM EVA | |
| | | | EVA | TERMINATE EVA | |
| | | A. SYSTEM A (DESCENT STAGE) | ALL | A. CONTINUE MISSION<br>OPEN LOGIC POWER A C/B UNTIL TIME TO STAGE, THEN:<br>1. CLOSE LOGIC POWER A AND B CB/'S<br>2. PLACE STAGE SW TO FIRE<br>3. PLACE MASTER ARM SW TO ON | A. ALL PYRO FUNCTIONS EXCEPT STAGING WILL BE PERFORMED ON SYSTEM B |
| | | B. SYSTEM B (ASCENT STAGE) | ALL | B. CONTINUE MISSION<br>OPEN LOGIC POWER B C/B UNTIL TIME TO STAGE, THEN:<br>1. CLOSE LOGIC POWER A C/B<br>2. PLACE MASTER ARM SW TO ON<br>3. PLACE STAGE SW TO FIRE<br>4. CLOSE LOGIC POWER B C/B | B. ALL PYRO FUNCTIONS EXCEPT STAGING WILL BE PERFORMED ON SYSTEM A |
| | | C. BOTH SYSTEMS | ALL | C. CONTINUE MISSION<br>OPEN BOTH LOGIC POWER A & B C/B'S UNTIL TIME TC STAGE, THEN:<br>1. CLOSE LOGIC POWER A C/B'<br>2. PLACE STAGE SW TO FIRE<br>3. PLACE MASTER ARM SW TO ON<br>4. CLOSE LOGIC POWER B C/B | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 21-24 | A RELAY K7 THROUGH K15 INADVERTANTLY CLOSES | ALL | | RELAYS<br>K7 = RCS PRESS<br>K8 = LAND GEAR DEPLOY<br>K8A = LAND GEAR DEPLOY<br>K9 = DPS CRYO He PRESS<br>K10 = ASC He TANK 1<br>K11 = ASC He TANK 2<br>K12 = ASC FUEL & OX COMP VALVE<br>K12A = ASC FUEL & OX COMP VALVES (SYSTEM A ONLY)<br>K13 = DPS FU & OX VENT<br>K14 = DPS AMBIENT He<br>K15 = DPS FU & OX COMP VALVES |
| | | A. SYSTEM A | | A. CONTINUE MISSION<br>OPEN LOGIC POWER A C/B UNTIL DPS He PRESSURIZATION ACCOMPLISHED | A. ALL PYRO FUNCTIONS EXCEPT STAGING WILL BE PERFORMED ON SYSTEM B |
| | | B. SYSTEM B | | B. CONTINUE MISSION<br>OPEN LOGIC POWER B C/B UNTIL DPS CRYO He PRESSURIZATION ACCOMPLISHED | B. ALL PYRO FUNCTIONS EXCEPT STAGING WILL BE PERFORMED ON SYSTEM A |
| | | C. BOTH SYSTEMS | | C.1. CONTINUE MISSION<br>2. PRIOR TO POSITIONING MASTER ARM SW TO ON: CLOSE DESC He REG 1 & 2<br>3. OPEN DESC He REG 1 AT Tig OF DPS 1 BURN. | |
| A | 21-25 | UNABLE TO STAGE | | | |
| | | A. ASCENT AND DESCENT STAGE STILL RIGIDLY TIED TOGETHER | RNDZ | A.1. CONTINUE MISSION<br>2. USE RCS FOR MANEUVERS | A. CSM RESCUE MAY BE INITIATED DUE TO RCS REDLINES |
| | | B. INCOMPLETE STAGING, VEHICLE NOT RIGID | RNDZ | B.1. EXECUTE CSM RESCUE<br>2. GO TO DRIFTING FLIGHT | B. EVT MAY BE REQUIRED |
| | | RULE NUMBERS 21-26 THROUGH 21-49 ARE RESERVED | | | |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|

## INSTRUMENTATION REQUIREMENTS

A 21-50

| MEAS DESCRIPTION | PCM | ONBOARD | | CATEGORY | MISSION RULE EFERENCE |
|---|---|---|---|---|---|
| ED RLY A K1-K6 | GY0201X | SYS A STAGING LIGHT CAUTION | COMMON CAUTION LIGHT | M HD | 21-1, 2, 3, 13, 21, 22, 23 |
| ED RLY B K1-K6 | GY0202X | SYS B STAGING LIGHT CAUTIO | | M HD | 21-1, 2, 3, 13, 21, 22, 23 |
| ED RLY A K7-K15 | GY0231X | -------- | | M | 21-1, 3, 24 |
| ED RLY B K7-K15 | GY0232X | -------- | | M | 21-1, 3, 24 |
| SELECTED ED BAT VOLT | ------- | METER | | M | 21-1, 2, 20 |

22 LM ELECTRICAL POWER

| REV | ITEM | GENERAL |
|---|---|---|
| A | 22-1 | TO INITIATE THE FOLLOWING MISSION EVENTS, THE ELECTRICAL POWER SYSTEM MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES:<br><br>A. DOCKED WITH HATCH CLOSED<br>1. CDR AND LMP BUSES<br>2. TWO DESCENT BATTERIES PLUS TWO ASCENT BATTERIES OR THREE DESCENT BATTERIES PLUS ONE ASCENT BATTERY<br>3. BOTH ASCENT FEEDERS PLUS ONE DESCENT FEEDER<br>4. ONE INVERTER AND AC BUS A (DPS BURN ONLY)<br>5. SUFFICIENT AVAILABLE ELECTRICAL ENERGY TO POWER THE LM FOR ONE REV (1.5 HOURS) BEYOND THE PLANNED LM TO CSM CREW TRANSFER<br><br>B. DOCKED WITH HATCH OPEN AND ONE CREWMAN IN LM ON TRANSFER UMBILICAL<br>1. CDR OR LMP BUS (CDR BUS FOR DPS BURN)<br>2. TWO DESCENT BATTERIES WITH ASSOCIATED FEEDER OR ONE ASCENT BATTERY WITH ASSOCIATED FEEDER<br>3.<br>4. ONE INVERTER AND AC BUS A (DPS BURN ONLY)<br><br>C. EVA<br>1. CDR AND LMP BUSES<br>2. TWO DESCENT BATTERIES PLUS TWO ASCENT BATTERIES OR THREE DESCENT BATTERIES PLUS ONE ASCENT BATTERY<br>3. BOTH ASCENT FEEDERS PLUS ONE DESCENT FEEDER<br>4. SUFFICIENT AVAILABLE ELECTRICAL ENERGY TO POWER THE LM FOR ONE REV (1.5 HOURS) BEYOND THE PLANNED LM TO CSM CREW TRANSFER<br><br>D. UNDOCKING<br>1. CDR AND LMP BUSES<br>2. TWO DESCENT BATTERIES PLUS TWO ASCENT BATTERIES OR THREE DESCENT BATTERIES PLUS ONE ASCENT BATTERY<br>3. BOTH ASCENT FEEDERS PLUS ONE DESCENT FEEDER<br>4. SUFFICIENT AVAILABLE ASCENT ELECTRICAL ENERGY TO POWER THE LM FOR TWO REVS (3.0 HOURS) BEYOND THE PLANNED CONTINGENCY LM TO CSM CREW TRANSFER<br><br>E. SEPARATION<br>1. CDR AND LMP BUSES<br>2. TWO DESCENT BATTERIES PLUS TWO ASCENT BATTERIES OR THREE DESCENT BATTERIES PLUS ONE ASCENT BATTERY<br>3. BOTH ASCENT FEEDERS PLUS ONE DESCENT FEEDER<br>4. ONE INVERTER AND AC BUS A<br>5. SUFFICIENT AVAILABLE ASCENT ELECTRICAL ENERGY TO POWER THE LM FOR 2 REVS (3.0 HOURS) BEYOND THE PLANNED CONTINGENCY LM TO CSM TRANSFER |

| REV | ITEM | |
|---|---|---|
| A | 22-1 CONT | F. PHASING<br>1. CDR AND LMP BUSES<br>2. TWO DESCENT BATTERIES PLUS TWO ASCENT BATTERIES OR THREE DESCENT BATTERIES PLUS ONE ASCENT BATTERY<br>3. BOTH ASCENT FEEDERS PLUS ONE DESCENT FEEDER<br>4. ONE INVERTER AND AC BUS A<br>5. TRACKING LIGHT<br>6. SUFFICIENT AVAILABLE ASCENT ELECTRICAL ENERGY TO POWER THE LM FOR TWO REVS (3.0 HOURS) BEYOND THE PLANNED CONTINGENCY LM TO CSM CREW TRANSFER<br>G. INSERTION<br>1. CDR AND LMP BUSES<br>2. THREE DESCENT BATTERIES PLUS BOTH ASCENT BATTERIES<br>3. BOTH ASCENT FEEDERS PLUS ONE DESCENT FEEDER<br>4. BOTH INVERTERS AND BOTH AC BUSES<br>5. TRACKING LIGHT<br>6. SUFFICIENT AVAILABLE ASCENT ELECTRICAL ENERGY TO POWER THE LM FOR TWO REVS (3.0 HOURS) BEYOND THE PLANNED LM TO CSM CREW TRANSFER<br>H. STAGING (UNDOCKED, NORMAL OR DELAYED)<br>1. CDR AND LMP BUSES<br>2. BOTH ASCENT BATTERIES OR ONE ASCENT BATTERY IF NO DESCENT ENERGY REMAINS AND DESCENT $O_2$ TANK IS DEPLETED<br>3. BOTH ASCENT FEEDERS<br>4. SUFFICIENT AVAILABLE ASCENT ELECTRICAL ENERGY TO POWER THE LM FOR TWO REVS (3.0 HOURS) BEYOND THE PLANNED LM TO CSM CREW TRANSFER<br>I. STAGING (DOCKED, HATCH OPEN, CDR IN CSM AND LMP ON TRANSFER UMBILICAL)<br>1. CDR AND LMP BUSES<br>2. ONE ASCENT BATTERY<br>3. ONE ASCENT FEEDER<br>4. SUFFICIENT AVAILABLE ASCENT ELECTRICAL ENERGY TO POWER THE LM FOR ONE REV (1.5 HOURS) BEYOND THE PLANNED LM TO CSM CREW TRANSFER<br>J. UNMANNED APS BURN<br>1. CDR BUS<br>2. ONE ASCENT BATTERY<br>3. ONE ASCENT FEEDER |
| A | 22-2 | THE CDR OR LMP BUS IS CONSIDERED LOST IF:<br>A. BUS VOLTAGE CANNOT BE MAINTAINED ABOVE 26.5 VDC<br>B. BUS CURRENT $\geq$90 AMPS |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 22-3 | A BATTERY IS CONSIDERED LOST IF:<br>A. OUTPUT $\leq$2 AMPS WHEN CONNECTED TO THE BUS<br>B. TEMPERATURE IS $\geq$145°F<br>C. CANNOT MEET VOLTAGE REGULATION AT REQUIRED LOAD<br>D. CANNOT BE CONNECTED TO A FEEDER DUE TO A MALFUNCTIONING ECA |
| A | 22-4 | A DC BUS FEEDER IS CONSIDERED LOST IF:<br>CANNOT BE USED AS A POWER PATH |
| A | 22-5 | AN INVERTER AND/OR ASSOCIATED AC DISTRIBUTION SYSTEM IS CONSIDERED LOST IF:<br>A. AC BUS VOLTAGE $\leq$110.5 OR $\geq$120 VAC<br>B. AC BUS FREQUENCY $\leq$390 OR $\geq$410 HZ<br>C. POWER CANNOT BE SUPPLIED TO AN AC BUS |
| A | 22-6 | A. ECA OVERCURRENT PROTECTION IS <u>DEFINITELY</u> LOST IF:<br>BOTH CIRCUIT BREAKERS POWERING THE ECA'S FAIL OPEN (ALL DESCENT OR ALL ASCENT ECA'S, WHICHEVER IS APPLICABLE)<br>B. ECA OVERCURRENT PROTECTION IS <u>PROBABLY</u> LOST IF:<br>1. UNABLE TO MEASURE A BATTERY CURRENT BOTH ONBOARD AND ON TELEMETRY<br>2. UNABLE TO TAKE THE BATTERY OFF LINE |
| A | | RULE NUMBERS 22-7 THROUGH 22-9 ARE RESERVED. |

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**MISSION RULES**

| REV | ITEM | MANAGEMENT RULES |
|---|---|---|
| A | 22-10 | THE MISSION WILL BE CONTINUED WITH THE PROBABLE LOSS OF OVERCURRENT PROTECTION. IF THIS PROTECTION IS LOST PRIOR TO LIFTOFF, A HOLD WILL BE CALLED. (REF MR 22-22 FOR DEFINITE LOSS OF OVERCURRENT PROTECTION) |
| | 22-11 | FOR NOMINAL STAGING, THE ASCENT BATTERIES WILL BE PRECONDITIONED FOR ONE ASCENT BATTERY OPERATION BY REMOVING 20 AMP-HRS FROM EACH BATTERY IMMEDIATELY PRIOR TO THE EVENT. |
| | 22-12 | FOR CONTINGENCY STAGING, THE ASCENT BATTERIES WILL BE PRECONDITIONED FOR TWO ASCENT BATTERY OPERATION BY REMOVING 5 AMP-HRS FROM EACH BATTERY IMMEDIATELY PRIOR TO THE EVENT. THIS IS PRESENTLY PLANNED TO BE ACCOMPLISHED ONLY FOR THE INSERTION MANUEVER. |
| | 22-13 | STAGED OPERATION WILL BE SPLIT-BUS CONFIGURATION UNTIL 20 AMP-HRS HAVE BEEN REMOVED FROM EACH ASCENT BATTERY. |
| | | NOTE: DUE TO A LACK OF DATA ON THE EFFECTS OF UNDERVOLTAGE SPIKES ON LM COMPUTERS MR'S 22-11, 12, 13 WERE WRITTEN IN ORDER TO PREVENT THE SPIKES. |
| | | RULE NUMBERS 22-14 THROUGH 22-19 ARE RESERVED. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| A | 22-20 | LOSS OF EITHER DC BUS | ALL | A. DO NOT STAGE | • REF MALF PROC EPS:<br>1 UNSTAGED DC BUS<br>2 STAGED DC BUS<br>3 UNSTAGED DC BUS W/BUS FAULT<br>4 STAGED DC BUS W/BUS FAULT<br>5 UNSTAGED DC BUS W/BAT FAULT<br>6 STAGED DC BUS W/BAT FAULT<br>7 UNSTAGED C&W PWR<br>8 STAGED C&W PWR<br>9 BATTERY<br>• LOSS OF DC BUS RESULTS IN LOSS OF ONE PYRO SYSTEM |
| | | | DOCKED | B. CONTINUE MISSION<br>1. DO NOT UNDOCK<br>2. DO NOT PERFORM EVA<br>3. ONE CREWMAN RETURN TO CSM<br>4. REMAINING CREWMAN CONNECT TO CSM TRANSFER UMBILICAL, OPERATE WITH CONNECTING HATCHES OPEN AND TUNNEL CLEAR<br>5. PERFORM LIMITED SYSTEMS EVALUATION | |
| | | | EVA | C. TERMINATE EVA | |
| | | | UNDOCKED RNDZ | D. DOCK ASAP | |
| A | 22-21 | SHORTED DC BUS FEEDER | | | • REF MALF PROC EPS:<br>5 UNSTAGED DC BUS W/BAT FAULT<br>6 STAGED DC BUS W/BAT FAULT<br>7 UNSTAGED C&W PWR<br>8 STAGED C&W PWR |
| | | A. DESCENT | ALL | A. CONTINUE MISSION<br>PUT BOTH ASCENT BATTERIES ON NORMAL FEED AND ISOLATE SHORT WITH DFR | |
| | | B. ASCENT | ALL | B.1. SET UP FOR UNMANNED APS BURN | |
| | | | DOCKED | 2. CONTINUE MISSION<br>(A) DO NOT UNDOCK<br>(B) DO NOT PERFORM EVA<br>(C) POWER AFFECTED BUS FROM OTHER BUS VIA 100 AMP CROSSTIE C/B'S<br>(D) ONE CREWMAN RETURN TO CSM<br>(E) REMAINING CREWMAN CONNECT TO CSM TRANSFER UMBILICAL, OPERATE WITH CONNECTING HATCHES OPEN AND TUNNEL CLEAR.<br>(F) CONNECT LM/CSM ELECTRICAL UMBILICAL<br>(G) PERFORM SYSTEMS EVALUATION AND DOCKED DPS BURN | |
| | | | EVA | 3. TERMINATE EVA | |
| | | | UNDOCKED RNDZ | 4. DOCK ASAP | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 22-22 | DEFINITE LOSS OF OVER-CURRENT PROTECTION | | | • NO APPLICABLE MALF PROC<br>REF MR 22-6 |
| | | A. DESCENT BATTERIES | ALL | A. CONTINUE MISSION | |
| | | B. ASCENT BATTERIES | ALL | B.1. DO NOT STAGE UNDOCKED | |
| | | | UNDOCKED | 2. CONTINUE MISSION<br>DO NOT PERFORM SEPARATION | |
| | | | RNDZ | 3. RETURN TO VICINTY OF CSM ASAP | |
| A | 22-23 | LOSS OF ASCENT BATTERIES: | | | • REF MALF PROC EPS:<br>2 STAGED DC BUS<br>4 STAGED DC BUS W/BUS FAULT<br>6 STAGED DC BUS W/BATTERY FAULT<br>8 STAGED C&W POWER<br>9 BATTERY |
| | | A. LOSS OF ONE ASCENT BATTERY | DOCKED<br>EVA<br>UNDOCKED | A.1. CONTINUE MISSION | |
| | | | RNDZ | 2. SEPARATION - CONTINUE MISSION | |
| | | | | 3. PHASING - DO NOT PERFORM INSERTION | |
| | | | | 4. INSERTION - CONTINUE MISSION<br>DO NOT STAGE UNLESS DESCENT BATTERIES ARE DEPLETED AND DESCENT $O_2$ TANK DEPLETED | |
| | | B. LOSS OF TWO ASCENT BATTERIES | ALL | B.1. DO NOT STAGE | |
| | | | | 2. CONTINUE MISSION<br>(A) DO NOT UNDOCK<br>(B) DO NOT PERFORM EVA<br>(C) ONE CREWMAN RETURN TO CSM<br>(D) REMAINING CREWMAN CONNECT TO CSM TRANSFER UMBILICAL, OPERATE WITH CONNECTING HATCHES OPEN AND TUNNEL CLEAR.<br>(E) CONNECT LM/CSM ELECTRICAL UMBILICAL<br>(F) PERFORM SYSTEMS EVALUATION AND DOCKED DPS BURN | |
| | | | EVA | 3. TERMINATE EVA<br>TERMINATE LM ACTIVITIES | |
| | | | UNDOCKED<br>RNDZ | 4. DOCK ASAP<br>TERMINATE LM ACTIVITIES | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 22-24 | LOSS OF DESCENT BATTERIES: | | | • REF MALF PROC EPS: |
| | | A. LOSS OF ONE DESCENT BATTERY | ALL | A. CONTINUE MISSION | 1 UNSTAGED DC BUS |
| | | B. LOSS OF TWO DESCENT BATTERIES | DOCKED<br>EVA<br>UNDOCKED | B.1. CONTINUE MISSION | 3 UNSTAGED DC BUS W/BUS FAULT<br>5 UNSTAGED DC BUS W/BATTERY FAULT |
| | | | RNDZ | 2. CONTINUE MISSION<br>DO NOT PERFORM INSERTION | 7 UNSTAGED C&W POWER |
| | | C. LOSS OF THREE OR MORE DESCENT BATTERIES | ALL<br>DOCKED | C.1. SETUP FOR UNMANNED APS BURN<br>2. CONTINUE MISSION<br>(A) DO NOT UNDOCK<br>(B) DO NOT PERFORM EVA<br>(C) ONE CREWMAN RETURN TO CSM<br>(D) REMAINING CREWMAN CONNECT TO CSM TRANSFER UMBILICAL, OPERATE WITH CONNECTING HATCHES OPEN AND TUNNEL CLEAR.<br>(E) PERFORM SYSTEMS EVALUATION AND DOCKED DPS BURN | 9 BATTERY |
| | | | EVA | 3. TERMINATE EVA | |
| | | | UNDOCKED<br>RNDZ | 4. DOCK ASAP | |
| A | 22-25 | LOSS OF INVERTERS | ALL | CONTINUE MISSION | • REF MALF PROC EPS: |
| | | A. LOSS OF ONE INVERTER | RNDZ | A.1. SEPARATION - CONTINUE MISSION<br>2. PHASING - CONTINUE MISSION<br>DO NOT PERFORM INSERTION<br>3. INSERTION - CONTINUE MISSION | 10 INVERTER |
| | | B. LOSS OF BOTH INVERTERS | DOCKED | B.1. DO NOT BURN DPS<br>(A) DO NOT PERFORM RENDEZVOUS<br>(B) UNDOCKING IS PERMITTED | |
| | | | RNDZ | 2. RETURN TO VICINITY OF CSM ASAP | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 22-26 | LOSS OF AC BUSES | | | • REF MALF PROC EPS: |
| | | A. LOSS OF BUS A | DOCKED | A.1. DO NOT BURN DPS | 10 INVERTER |
| | | | EVA<br>UNDOCKED | 2. CONTINUE MISSION | BUS A REQUIRED FOR ONBOARD ATTITUDE READOUT |
| | | | RNDZ | 3. RETURN TO VICINITY OF CSM ASAP | |
| | | B. LOSS OF BUS B | DOCKED<br>EVA<br>UNDOCKED | B.1. CONTINUE MISSION | |
| | | | RNDZ | 2. SEPARATION - CONTINUE MISSION | |
| | | | | 3. PHASING - RETURN TO VICINITY OF CSM ASAP<br>DO NOT PERFORM INSERTION | |
| | | | | 4. INSERTION - CONTINUE MISSION | |
| | | C. LOSS OF BOTH AC BUSES | DOCKED<br>EVA<br>UNDOCKED | C.1. CONTINUE MISSION<br>UNDOCKING IS PERMITTED<br>DO NOT PERFORM RENDEZVOUS | |
| | | | RNDZ | 2. RETURN TO VICINITY OF CSM ASAP | |
| | | RULE NUMBERS 22-27 THROUGH 22-49 ARE RESERVED. | | | |

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**MISSION RULES**

| REV | ITEM | | | | | |
|---|---|---|---|---|---|---|
| | | **INSTRUMENTATION REQUIREMENTS** | | | | |
| A | 22-50 | MEAS DESCRIPTION | PCM | ONBOARD | CATEGORY | MISSION RULE REFERENCE |
| \| | | AC BUS FREQ | GC0155F | CAUTION (COMMON LIGHT) | M | 22-1,5,25,26 |
| | | AC BUS VOLTS | GC0071V | METER/CAUTION (COMMON LIGHT) | M | |
| | | BAT 1 VOLTS | GC0201V | METER (COMMON METER) | HD | 22-1,2,3,10, 20,21,22,24 |
| \| | | BAT 2 VOLTS | GC0202V | METER (COMMON METER) | HD | |
| | | BAT 3 VOLTS | GC0203V | METER (COMMON METER) | HD | |
| | | BAT 4 VOLTS | GC0204V | METER (COMMON METER) | HD | |
| | | BAT 5 VOLTS | GC0205V | METER (COMMON METER) | M | 22-1,2,3,10, 20,21,22,23 |
| \| | | BAT 6 VOLTS | GC0206V | METER (COMMON METER) | M | |
| | | CDR BUS VOLTS | GC0301V | METER/WARNING (COMMON LIGHT) | 1 OF 2 | 22-1,2,3,20, 21,22,23,24 |
| \| | | LMP BUS VOLTS | GC0302V | METER/WARNING (COMMON LIGHT) | M | |
| | | BAT 1 CUR | GC1201C | METER (COMMON METER) | M PCM | 22-1,2,3,10, 20,21,22,24 |
| \| | | BAT 2 CUR | GC1202C | METER (COMMON METER) | M PCM | |
| | | BAT 3 CUR | GC1203C | METER (COMMON METER) | M PCM | |
| | | BAT 4 CUR | GC1204C | METER (COMMON METER) | M PCM | |
| \| | | BAT 5 CUR | GC1205C | METER (COMMON METER) | M PCM | 22-1,2,3,10, 20,21,22,23 |
| | | BAT 6 CUR | GC1206C | METER (COMMON METER) | M PCM | |
| | | BAT 1 MAL | GC9961U | CAUTION/COMP (COMMON LIGHTS) | M ONBOARD | 22-1,2,3, 10,22,24 |
| \| | | BAT 2 MAL | GC9962U | CAUTION/COMP (COMMON LIGHTS) | M ONBOARD | |
| | | BAT 3 MAL | GC9963U | CAUTION/COMP (COMMON LIGHTS) | M ONBOARD | |
| | | BAT 4 MAL | GC9964U | CAUTION/COMP (COMMON LIGHTS) | M ONBOARD | |
| \| | | BAT 5 MAL | GC9965U | CAUTION/COMP (COMMON LIGHTS) | M ONBOARD | 22-1,2,3,10,22,23 |
| | | BAT 6 MAL | GC9966U | CAUTION/COMP (COMMON LIGHTS) | M ONBOARD | |
| | | BAT 1 LOW TAP | GC4362X | FLAG | HD | 22-1,2,3,10,20,22,24 |
| \| | | BAT 2 LOW TAP | GC4364X | FLAG | HD | |
| | | BAT 3 LOW TAP | GC4366X | FLAG | HD | |
| | | BAT 4 LOW TAP | GC4368X | FLAG | HD | |
| | | BAT 5 B/U CDR | GC4369X | FLAG | HD | 22-1,2,3,10,20, 21,22,23 |
| \| | | BAT 6 NORM CDR | GC4370X | FLAG | HD | |
| | | BAT 5 NORM LMP | GC4371X | FLAG | HD | |
| | | BAT 6 B/U LMP | GC4372X | FLAG | HD | |

23 LM ENVIRONMENTAL CONTROL

| REV | ITEM | GENERAL |
|---|---|---|
| A | 23-1 | TO INITIATE THE FOLLOWING NOMINAL MISSION EVENTS, THE ENVIRONMENTAL CONTROL SYSTEM MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES: |

A. DOCKED WITH HATCH CLOSED

1. CABIN PRESSURE INTEGRITY
2. SUIT LOOP/PGA PRESSURE INTEGRITY
3. ONE SUIT FAN
4. ONE DEMAND REGULATOR
5. ONE $H_2O$ SEPARATOR (CREW OPTION)
6. ONE COOLANT LOOP
7. SUFFICIENT AVAILABLE LiOH, $H_2O$ AND $O_2$ CONSUMABLES TO MAINTAIN THE LM FOR ONE REV (1.5 HOURS) BEYOND THE PLANNED LM TO CSM CREW TRANSFER

B. DOCKED WITH CONNECTING HATCH OPEN AND ONE CREWMAN IN LM ON TRANSFER UMBILICAL

1. COMBINED VEHICLE PRESSURE INTEGRITY FOR SUSTAINED OPERATIONS
2. ONE LM COOLANT LOOP FOR SUSTAINED OPERATIONS

C. EVA

1. CABIN PRESSURE INTEGRITY
2. SUIT LOOP/PGA PRESSURE INTEGRITY
3. ONE SUIT FAN
4. ONE DEMAND REGULATOR
5. ONE $H_2O$ SEPARATOR (CREW OPTION)
6. ONE COOLANT LOOP
7. GREATER THAN 1400 PSIA IN THE DESCENT $O_2$ TANK PLUS SUFFICIENT $O_2$ IN ONE ASCENT $O_2$ TANK TO SATISFY THE METABOLIC AND LEAKAGE REQUIREMENTS FOR ONE REV (1.5 HOURS) BEYOND THE PLANNED LM TO CSM CREW TRANSFER.
8. SUFFICIENT LiOH AND $H_2O$ TO MAINTAIN THE LM FOR 1 REV (1.5 HOURS) BEYOND THE PLANNED LM TO CSM CREW TRANSFER.

D. UNDOCKING

1. CABIN PRESSURE INTEGRITY
2. SUIT LOOP/PGA PRESSURE INTEGRITY
3. ONE SUIT FAN
4. ONE DEMAND REGULATOR
5. ONE $H_2O$ SEPARATOR (CREW OPTION)
6. ONE COOLANT LOOP
7. TWO OF THREE $O_2$ TANKS
8. SUFFICIENT AVAILABLE LiOH, $H_2O$ AND ASCENT $O_2$ TO MAINTAIN THE LM FOR TWO REVS (3.0 HOURS) BEYOND THE PLANNED CONTINGENCY LM TO CSM CREW TRANSFER.

| REV | ITEM | |
|---|---|---|
| A | 23-1 (CONT) | E. SEPARATION |

E. SEPARATION

1. CABIN PRESSURE INTEGRITY
2. SUIT LOOP/PGA PRESSURE INTEGRITY
3. ONE SUIT FAN
4. ONE DEMAND REGULATOR
5. ONE $H_2O$ SEPARATOR (CREW OPTION)
6. BOTH COOLANT LOOPS
7. PRIMARY $H_2O$ FEEDPATH
8. TWO OF THREE $O_2$ TANKS
9. SUFFICIENT AVAILABLE LiOH, $H_2O$ AND ASCENT $O_2$ TO MAINTAIN THE LM FOR TWO REVS (3.0 HOURS) BEYOND THE PLANNED CONTINGENCY LM TO CSM CREW TRANSFER.

F. PHASING

1. CABIN PRESSURE INTEGRITY
2. SUIT LOOP/PGA PRESSURE INTEGRITY
3. ONE SUIT FAN
4. ONE DEMAND REGULATOR
5. ONE $H_2O$ SEPARATOR
6. BOTH COOLANT LOOPS
7. PRIMARY $H_2O$ FEEDPATH
8. TWO OF THREE $O_2$ TANKS
9. SUFFICIENT AVAILABLE LiOH, $H_2O$ AND ASCENT $O_2$ TO MAINTAIN THE LM FOR TWO REVS (3.0 HOURS) BEYOND THE PLANNED CONTINGENCY LM TO CSM CREW TRANSFER.

G. INSERTION

1. CABIN PRESSURE INTEGRITY
2. SUIT LOOP/PGA PRESSURE INTEGRITY
3. ONE SUIT FAN
4. ONE DEMAND REGULATOR
5. ONE $H_2O$ SEPARATOR
6. BOTH COOLANT LOOPS
7. PRIMARY $H_2O$ FEEDPATH
8. DESCENT $O_2$ TANK*
9. ONE OF TWO ASCENT $O_2$ TANKS
10. TWO OF THREE $H_2O$ TANKS
11. SUFFICIENT AVAILABLE LiOH, ASCENT $H_2O$ AND ASCENT $O_2$ TO MAINTAIN THE LM FOR TWO REVS (3.0 HOURS) BEYOND THE PLANNED LM TO CSM CREW TRANSFER.

*IF BOTH $H_2O$ SEPARATORS AND BOTH SUIT FANS ARE FULLY OPERATIONAL AND BOTH ASCENT $O_2$ TANKS CONTAIN THE REQUIRED CONSUMABLES, THE RENDEZVOUS WILL BE PERFORMED WITHOUT THE DESCENT $O_2$ TANK. A FAILURE OF ANY OF THESE REQUIREMENTS WILL REQUIRE THE DESCENT $O_2$ TANK FOR RENDEZVOUS.

| REV | ITEM | |
|---|---|---|
| A | 23-1 (CONT) | H. STAGING (NOMINAL)<br>1. CABIN PRESSURE INTEGRITY<br>2. SUIT LOOP/PGA PRESSURE INTEGRITY<br>3. ONE SUIT FA<br>4. ONE DEMAND REGULATOR<br>5. ONE $H_2O$ SEPARATOR<br>6. ONE COOLANT LOOP<br>7. TWO ASCENT $O_2$ TANKS<br>8. SUFFICIENT AVAILABLE LiOH, ASCENT $H_2O$ AND ASCENT $O_2$ TO MAINTAIN THE LM FOR TWO REVS (3.0 HOURS) BEYOND THE PLANNED LM TO CSM CREW TRANSFER.<br>I. DELAYED STAGING<br>1. CABIN PRESSURE INTEGRITY<br>2. SUIT LOOP/PGA PRESSURE INTEGRITY<br>3. ONE SUIT FAN<br>4. ONE COOLANT LOOP<br>5. TWO ASCENT $O_2$ TANKS<br>6. SUFFICIENT AVAILABLE LiOH, ASCENT $H_2O$ AND ASCENT $O_2$ TO MAINTAIN THE LM FOR TWO REVS (3.0 HOURS) BEYOND THE PLANNED LM TO CSM CREW TRANSFER. |
| A | 23-2 | DEFINITIONS:<br>A. LOSS OF CABIN INTEGRITY — LM PRESSURE VESSEL LEAKAGE SUCH THAT CABIN PRESSURE CANNOT BE MAINTAINED $\geq$4.6 PSIA WITH AN $O_2$ FLOW RATE OF 1.2 LBS/HR. FOR DOCKED ACTIVITIES, THIS WILL BE RELAXED TO A FLOW RATE OF 6 LBS/HR.<br>B. LOSS OF SUIT LOOP/PGA INTEGRITY — TOTAL PGA/SUIT LOOP LEAKAGE $\geq$0.5 PSI/MIN (1.5 LB/HR) DURING SUIT LOOP PRESSURE CHECK OR A VISIBLE TEAR IN THE PGA. DURING EVA, INCREASE IN DESCENT TANK QUA TITY USAGE >1.2 LB/HR<br>C. LOSS OF COOLANT LOOP — SUSTAINED GLYCOL TEMPERATURE $\geq$50°F AND RISING EXCEPT DURING COOLANT LOOP STARTUP AND DRYOUT (SUBLIMATOR LOST) OR GLYCOL PUMP $\Delta P \leq 6$ PSID (CIRCULATION LOST) OR KNOWN LOSS OF $H_2O$ FEED CAPABILITY TO THE SUBLIMATOR(S)<br>D. GLYCOL COOLANT LEAK — OBSERVED FLUID IN CABIN CONFIRMED BY TASTE OR PRESENCE OF GLYCOL LOW INDICATION CONFIRMED BY STATIC PRESSURE DROP.<br>E. LOSS OF DESCENT $O_2$ TANK — INABILITY TO TRANSFER $O_2$ FROM DESCENT TANK OR MSFN CONFIRMATION OF LOSS OF DESCENT TANK PRESSURE WITH $O_2$ MANIFOLD PRESSURE<br>F. LOSS OF ASCENT $O_2$ TANK — (1) MSFN CONFIRMATION OF LOSS OF ASCENT TANK PRESSURE WITH $O_2$ MANIFOLD P ESSURE OR (2) IF UNSTAGED AND DESCENT TANK >35%, CREW CONFIRM LOSS BY BALANCING ONE TANK AGAINST THE OTHER OR (3) IF STAGED OR IF DESCENT $O_2$ <35%, LOSS OF ONBOARD AND MSFN READOUTS |

| REV | ITEM | | |
|---|---|---|---|
| A | 23-2 (CONT) | G. LOSS OF DESCENT $H_2O$ TANK | INABILITY TO SUPPLY $H_2O$ TO W/B RESULTING IN RISING GLYCOL AND SUIT LOOP TEMPERATURE (CREW AND MSFN) AND DROP IN $H_2O$ $\Delta P$ (MSFN ONLY) |
| | | H. LOSS OF ASCENT $H_2O$ TANK | LOSS OF MEASUREMENT AND REMAINING TANK FEEDING AT TWICE NORMAL RATE OR ONE TANK FEEDING TWICE NORMAL RATE AND NO CHANGE IN MEASUREMENT ON OTHER TANK |
| A | 23-3 | WITH THE LOSS OF CABIN AND/OR SUIT LOOP INTEGRITY, THE LM MUST BE DOCKED AND MANNED BY ONE CREW MEMBER ON THE CSM TRANSFER UMBILICAL BEFORE STAGING IS ATTEMPTED. | |
| A | 23-4 | IF A SUBLIMATOR IS LOST DUE TO BREAKTHROUGH, NO RESTART ATTEMPT WILL BE MADE. | |
| A | 23-5 | OXYGEN PURGE SYSTEM AND PLSS CONSUMABLES WILL BE RESERVED FOR POSSIBLE EVT AND WILL NOT BE CONSIDERED FOR NOMINAL OR REDLINE USAGE. | |
| A | | RULE NUMBERS 23-6 THROUGH 23-9 ARE RESERVED | |

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**MISSION RULES**

| REV | ITEM | MANAGEMENT |
|---|---|---|
| A | 23-10 | PRIMARY GLYCOL LOOP CIRCULATION WILL BE DISCONTINUED AT STARTUP OF THE SECONDARY LOOP BUT MAY BE REINITIATED FOLLOWING SECONDARY LOOP STABILIZATION IF DEEMED NECESSARY. |
| A | 23-11 | IF EITHER ASCENT $O_2$ TANK IS $\leq$95%, IT WILL BE REPLENISHED FROM THE DESCENT $O_2$ WHEN THE DESCENT TANK QUANTITY $\geq$35% AND AS CLOSE TO STAGING AS POSSIBLE. |
| A | 23-12 | PLSS FILL VALVE WILL BE CLOSED, EXCEPT FOR REPRESSURIZING THE PLSS AND FOR MSFN REQUESTED READOUTS OF $O_2$ MANIFOLD PRESSURE. |
| A | 23-13 | CREW WILL GO TO EGRESS MODE IF INSUFFICIENT $O_2$ IS AVAILABLE TO MAINTAIN CABIN PRESSURE FOR THE REQUIRED TIME. ADDITIONALLY, A MISSION PHASE WILL NOT BE INITIATED IF THIS CONDITION CAN BE ANTICIPATED. |
| A | 23-14 | CREW WILL BE REQUIRED TO BREATHE PURE $O_2$ FOR 2 MIN VIA PURGE MODE PRIOR TO EVA. |
| | | RULE NUMBERS 23-15 THROUGH 23-19 ARE RESERVED |

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| A | 23-20 | LOSS OF CABIN PRESSURE INTEGRITY | | | • REF MR 23-2A, 23-3, 23-14 |
| | | | ALL | A. SET UP FOR UNMANNED APS BURN | A. REF MALF PROC ECS: 1 CABIN, 17 ABNORMAL DECAY OF DESCENT $O_2$ |
| | | | DOCKED | B. CONTINUE MISSION<br>1. DO NOT UNDOCK<br>2. DO NOT PERFORM EVA<br>3. ONE CREWMAN RETURN TO CSM<br>4. REMAINING CREWMAN CONNECT TO BOTH CSM AND LM UMBILICALS, OPERATE WITH CONNECTING HATCHES OPEN AND TUNNEL CLEAR.<br>5. PERFORM SYSTEMS EVALUATION AND DOCKED DPS BURN. | |
| | | | UNDOCKED RNDZ | C. DOCK ASAP<br>DO NOT STAGE UNDOCKED | |
| A | 23-21 | LOSS OF SUIT LOOP/PGA INTEGRITY | | | • REF MR 23-2B, 23-3 |
| | | | ALL | A. SET UP FOR UNMANNED APS BURN | • REF AOH EMERGENCY PROC: SUIT LEAK IN DEPRESSURIZED CABIN |
| | | | DOCKED | B. PERFORM SYSTEMS EVALUATION<br>DO NOT PERFORM EVA, UNDOCKING, OR DOCKED DPS | |
| | | | EVA | C. TERMINATE MANNED LM ACTIVITIES<br>DO NOT PERFORM SUBSEQUENT MANNED PHASES | C. REF MALF PROC ECS: 3 SUIT/FAN |
| | | | UNDOCKED RNDZ | D. DOCK ASAP<br>DO NOT STAGE UNDOCKED | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 23-22 | SUIT FAN(S) FAILURE | | | |
| | | A. ONE SUIT FAN | ALL | A. CONTINUE MISSION | A. REF MALF PROC ECS: 5 ECS |
| | | B. TWO SUIT FANS | ALL | B.1. SET UP FOR UNMANNED APS | |
| | | | DOCKED | 2. CONTINUE MISSION<br>(A) DO NOT UNDOCK<br>(B) DO NOT PERFORM EVA<br>(C) ONE CREWMAN RETURN TO CSM<br>(D) REMAINING CREWMAN CONNECT TO CSM TRANSFER UMBILICAL, OPERATE WITH CONNECTING HATCHES OPEN AND TUNNEL CLEAR.<br>(E) PERFORM SYSTEMS EVALUATION AND DOCKED DPS BURN. | |
| | | | EVA | 3.(A) TERMINATE EVA<br>GO TO SUIT PURGE MODE UNTIL CABIN REPRESS COMPLETE.<br>(B) LMP RETURN TO NEAREST VEHICLE<br>DO NOT UNDOCK | |
| | | | UNDOCKED RNDZ | 4. DOCK ASAP<br>DO NOT STAGE UNDOCKED | |
| A | 23-23 | LOSS OF $H_2O$ SEPARATOR(S) | | | • REF MALF PROC ECS: 6 ECS |
| | | A. ONE SEPARATOR | ALL | A. CONTINUE MISSION | |
| | | B. TWO SEPARATORS | DOCKED | B.1. CONTINUE MISSION | |
| | | | EVA | 2. CONTINUE MISSION<br>AT CREW OPTION | |
| | | | UNDOCKED | 3. CONTINUE MISSION<br>AT CREW OPTION | |
| | | | RNDZ | 4.(A) SEPARATION - DO NOT PERFORM PHASING<br>(B) PHASING - DO NOT PERFORM INSERTION<br>(C) INSERTION - DELAY STAGING AS LONG AS POSSIBLE | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 23-24 | DEMAND REGULATOR(S) FAIL OPEN OF CLOSE (AUTOMATIC FUNCTION ONLY) | | | |
| | | A. ONE REGULATOR | ALL | A. CONTINUE MISSION | REF MALF PROC ECS:<br>17 ABNORMAL DECAY DESCENT $O_2$ |
| | | B. TWO REGULATORS | ALL | B.1. SET UP FOR UNMANNED APS | B. REGULATOR ON-OFF CYCLING WILL BE REQUIRED TO MAINTAIN CABIN AND/OR SUIT PRESSURE |
| | | | DOCKED | 2. CONTINUE MISSION<br>(A) DO NOT UNDOCK<br>(B) DO NOT PERFORM EVA<br>(C) ONE CREWMAN RETURN TO CSM<br>(D) REMAINING CREWMAN CONNECT TO CSM UMBILICAL; OPERATE WITH CONNECTING HATCHES OPEN AND TUNNEL CLEAR.<br>(E) PERFORM SYSTEMS EVALUATION AND DOCKED DPS BURN. | |
| | | | EVA | 3. TERMINATE EVA | |
| | | | UNDOCKED | 4. DOCK ASAP | |
| | | | RNDZ | 5.(A) SEPARATION - DO NOT PERFORM PHASING<br>(B) PHASING - DO NOT PERFORM INSERTION<br>(C) INSERTION - DELAY STAGING AS LONG AS OSSIBLE | |
| A | 23-25 | LOSS OF COOLANT LOOP(S) | | | • REF MR 23-2C, 23-2D, 23-4<br>• REF MALF PROC ECS:<br>8 ECS, 10 GLYCOL |
| | | A. PRIMARY LOOP | DOCKED<br>EVA<br>UNDOCKED | A. CONTINUE MISSION ON SECONDARY LOOP<br>DO NOT PERFORM SEPARATION | A. PGNS, DSE, DCA, LCA DFI NOT COOLED BY SECONDARY LOOP |
| | | | RNDZ | B.1. RETURN TO VICINITY OF CSM ASAP<br>2. OPERATE ON SECONDARY LOOP | |
| | | B. BOTH LOOPS (ANY COMBINATION OF LOSS OF CIRCULATION, SUBLIMATION CAPABILITY, OF $H_2O$ FEED FOR BOTH LOOPS) | DOCKED | B.1. INGRESS CSM ASAP<br>DO NOT PERFORM EVA, UNDOCKING | |
| | | | EVA | 2. TERMINATE EVA<br>(A) GO TO SUIT PURGE MODE UNTIL CABIN REPRESS COMPLETE<br>(B) LMP RETURN TO CSM | |
| | | | UNDOCKED | 3. DOCK ASAP<br>DO NOT PERFORM SEPARATION | |
| | | | RNDZ | 4. DOCK ASAP<br>(A) CONTINUE GLYCOL CIRCULATION IF POSSIBLE<br>(B) POWER DOWN SPACECRAFT FOR LIFE SUPPORT ONLY<br>(C) AWAIT CSM RESCUE | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 23-26 | LOSS OF PRIMARY $H_2O$ FEEDPATH | ALL<br>DOCKED EVA UNDOCKED<br>RNDZ | A. SET UP FOR UNMANNED APS<br>B. CONTINUE MISSION DO NOT PERFORM SEPARATION<br>C. RETURN TO VICINITY OF CSM ASAP | • REF MALF PROC ECS: 10 GLYCOL |
| A | 23-27 | FIRE OR SMOKE IN CABIN OR SUIT | ALL | A. TROUBLESHOOT/COMBAT FIRE<br>B. ASSESS DAMAGE AND TRANSFER TO CSM IF NECESSARY | • REF AOH PROC 5.3.2 |
| A | 23-28 | CONTAMINATION IN CABIN | ALL | CREW MAY ELECT TO DECOMPRESS TO CLEAR CONTAMINATION | IF UNABLE TO CLEAR CONTAMINATION, MISSION MAY BE TERMINATED EARLY. |
| A | 23-29 | GLYCOL COOLANT LEAK | ALL | TRANSFER TO CSM<br>PERFORM DOCKED ACTIVITIES ON CSM UMBILICAL AND SET UP FOR APS BURN | • REF MR 23-2D<br>• REF MALF PROC ECS: 10 GLYCOL |
| | | A. CABIN | ALL | A.1. GO TO EGRESS OPERATION (CLOSED SUIT LOOP)<br>2. PURGE SUIT LOOP WITH DESCENT $O_2$ IF UNSTAGED | |
| | | B. SUIT LOOP | ALL | B. DISCONNECT FROM SUIT LOOP | |
| | | RULE NUMBERS 23-30 THROUGH 23-49 ARE RESERVED. | | | |

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**MISSION RULES**

## INSTRUMENTATION REQUIREMENTS

| REV | ITEM | MEAS DESCRIPTION | PCM | ONBOARD | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|---|
| A | 23-50 | SUIT PRESS | GF1301P | METER | M | 23-1,2,3,20,21,22,23,24 |
| | | | | WARNING | M | 23-1,2,3,20,23,24 |
| | | CABIN PRESS | GF3571P | METER | M | 23-1,2,3,20,23,24 |
| | | REPR ELEC OPEN | GF3572X | WARNING | HD | |
| | | $CO_2$ PART PRESS | GF1521P | METER, CAUTION<br>COMP | | |
| | | $H_2O$ SEP RATE | GF9999U | CAUTION, COMP | HD | 23-1,22,23 |
| | | DES $O_2$ PRESS | GF3584P | METER, CAUTION | M | 23-1,3,20,24 |
| | | ASC 1 $O_2$ PRESS | GF3582P | METER, CAUTION | 1 OF 2 | 23-1,3,20,24 |
| | | ASC 2 $O_2$ PRESS | GF3583P | METER, CAUTION | M | 23-1,3,20,24 |
| | | $O_2$ MANIFOLD PRESS | GF3589P | ----- | M | 23-1,3,20,24 |
| | | GLYCOL PUMP ΔP | GF2021P | ----- | M | 23-25,26,29 |
| | | GLYCOL PUMP SW/O | GF2936X | COMP | HD | 23-25,26,29 |
| | | GLYCOL PUMP P | GF9997U | METER | M | 23-25,26,29 |
| | | GLYCOL LEVEL LOW | GF2041X | CAUTION | M | 23-25,26,29 |
| | | GLYCOL TEMP | GF9998U | METER, CAUTION | M PCM | 23-25,26 |
| | | DES $H_2O$ QTY | GF4581Q | METER, CAUTION | M | 23-25,26 |
| | | ASC 1 $H_2O$ QTY<br>ASC 2 $H_2O$ QTY | GF4582 } 1 OF<br>GF4583 } 2 | CAUTION | M BOTH } 1 OF 2 | 23-25,26 |
| | | | GF4582Q<br>GF4583Q | METER | M | |
| | | PRI $H_2O$ REG ΔP | GF4101P | ----- | M | 23-25,26 |
| | | SUIT DIV EGRESS | GF1221X | ----- | HD | 23-20,24 |
| | | SUIT TEMP | GF1281T | METER | HD | 23-23 |
| | | CABIN TEMP | GF1651T | METER | HD | 23-25,26 |

24 LM/COMM
INSTRUMENTATION
(SEE SECTION 32)

| REV | ITEM | |
|---|---|---|

THIS
SECTION
HAS BEEN
DELETED

ALL DATA FORMERLY
CONTAINED IN THIS
SECTION IS NOW IN
SECTION 32.

25 LM GUIDANCE AND CONTROL

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | | GENERAL |
| A | 25-1 | DOCKED<br><br>IN ORDER TO INITIATE AND CONTINUE THE DOCKED PHASE OF THE MISSION, THE G&C SYSTEMS MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES FOR THE DOCKED DPS BURN:<br><br>A. EITHER AN OPERATIONAL PGNS, WHERE AN OPERATIONAL PGNS IS DEFINED AS<br>1. NO LGC FAILURE,<br>2. NO ISS FAILURE,<br>3. 3-AXIS ATTITUDE CONTROL CAPABILITY,<br>OR MANUAL TTCA ATTITUDE CONTROL CAPABILITY.<br>B. THRUST VECTOR CONTROL, DEFINED AS:<br>1. AN OPERATIONAL PGNS OR AGS THRUST VECTOR CONTROL<br>2. A FUNCTIONAL DPS GIMBAL TRIM SYSTEM<br>C. +X ULLAGE CAPABILITY, DEFINED AS ONE OF THE FOLLOWING:<br>1. +X VIA ONE TTCA<br>2. +X TRANS OVRD SWITCH<br>3. AUTO PGNS ULLAGE CAPABILITY<br>4. CSM ULLAGE<br>D. ENG ON/OFF CAPABILITY, DEFINED AS ONE OF THE FOLLOWING:<br>1. AUTO ON/OFF CAPABILITY<br>2. MANUAL ON/OFF CAPABILITY<br>E. OPERATIONAL ENGINE THROTTLE CONTROL, DEFINED AS:<br>1. NO DPS ENGINE START GREATER THAN 60% THROTTLE ACTUATOR POSITION<br>2. NO MORE THAN 100 SECONDS MAXIMUM DPS OPERATION IN THE NON-THROTTEABLE RANGE. |
| A | 25-2 | UNDOCKED<br><br>IN ORDER TO INITIATE AND CONTINUE THE UNDOCKED PHASE, THE G&C SYSTEMS MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES:<br><br>A. REDUNDANT 3-AXIS ATTITUDE CONTROL, DEFINED AS HAVING A MINIMUM OF:<br>1. ONE HAND CONTROLLER (ACA)<br>2. EITHER AN OPERATIONAL PGNS AND AGS WHERE AN OPERATIONAL AGS IS DEFINED AS<br>(A) NO AEA FAILURE,<br>(B) NO ASA FAILURE,<br>(C) AN OPERATIONAL DEDA,<br>(D) AGS 3-AXIS ATTITUDE CONTROL CAPABILITY,<br>OR AN OPERATIONAL AGS AND SECONDARY COILS.<br>B. 3-AXIS TRANSLATION CAPABILITY, DEFINED AS HAVING A MINIMUM OF:<br>1. ONE TTCA<br>2. AN OPERATIONAL PGNS OR AGS |

| REV | ITEM | |
|---|---|---|
| A | 25-3 | <u>RNDZ</u><br><br>IN ORDER TO INITIATE AND CONTINUE THE RENDEZVOUS PHASE, THE G&C SYSTEMS MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES:<br><br>A. SEPARATION:<br>1. REDUNDANT 3-AXIS ATTITUDE CONTROL CAPABILITY<br>2. OPERATIONAL PGNS<br>3. 3-AXIS TRANSLATION CAPABILITY<br>4. OPERATIONAL RENDEZVOUS RADAR AND TRANSPONDER, DEFINED AS:<br>COMPLETION OF A VALID RR AND TRANSPONDER SELF-TEST EXCEPT FOR RR/LGC INTERFACE<br>5. ONE OPERATIONAL FDAI<br>6. AN OPERATIONAL DSKY<br><br>B. PHASING:<br>1. SAME AS SEPARATION WITH THE ADDITION OF:<br>(A) ENG ON/OFF CAPABILITY<br>(B) OPERATIONAL ENGINE THROTTLE CAPABILITY<br>(C) EITHER AN OPERATIONAL AOT OR COAS<br>(D) RR LOCK ON AND VALID RR/LGC INTERFACE<br><br>C. INSERTION:<br>1. OPERATIONAL PGNS<br>2. REDUNDANT 3-AXIS ATTITUDE CONTROL CAPABILITY<br>3. ENG ON/OFF CAPABILITY<br>4. OPERATIONAL ENGINE THROTTLE CAPABILITY<br>5. +X AXIS TRANSLATION CAPABILITY<br><br>D. STAGING:<br>1. OPERATIONAL AGS OR PGNS<br>2. +X AXIS TRANSLATION CAPABILITY |
| | 25-4 | <u>UNMANNED</u><br><br>IN ORDER TO INITIATE AND CONTINUE THE UNMANNED PHASE OF THE MISSION, THE G&C SYSTEMS MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES FOR THE UNMANNED APS BURN.<br><br>A. OPERATIONAL PGNS<br><br>B. APS ENG ARM/DEARM - ON/OFF CONTROL. |

| REV | ITEM | |
|---|---|---|
| | | SYSTEMS MANAGEMENT |
| | 25-10 | IMU<br>A. THE PIPA AND IRIG BIASES WILL BE UPDATED WHEN DIFFERENCES OF .020 FT/SEC$^2$ (.600 CM/SEC$^2$) AND .225°/HR RESPECTIVELY.<br>B. THE IMU HEATER POWER MAY BE REMOVED FOR 10 HRS WITHOUT GLYCOL COOLING TO SUPPORT THE APS BURN TO DEPLETION. |
| A | 25-11 | LGC<br>A. A MASS UPDATE IS REQUIRED IF A MASS $\Delta$ OF ± 10 PERCENT (DIFFERENCE BETWEEN GROUND CALCULATION AND LGC VALUE) EXISTS WHEN IN THE DPS CONFIGURATION, OR ± 5 PERCENT IN APS CONFIGURATION.<br>B. ALL DESCENT ENGINE STARTS MUST NOMINALLY BE PRECEDED BY A PROPELLANT SETTLING MANEUVER USING TWO SYSTEM B JETS OR TWO SYSTEM A JETS IN CASE OF A CONTINGENCY.<br>C. ULLAGE FOR ALL APS BURNS MAY BE 4 JET OR 2 JET SYSTEM A OR B.<br>D. ALL ± (U-V) JETS WILL BE INHIBITED VIA V65 DURING DOCKED DPS BURNS.<br>E. DURING DOCKED MANEUVERS, ALL DPS GIMBAL TRIMMING MUST BE DONE AT 40 PERCENT THROTTLE IN THE AUTO THROTTLE MODE. |
| | 25-12 | RENDEZVOUS RADAR<br>A. THE RR MUST NOT BE OPERATED UNTIL THE ANTENNA TEMPERATURE (X96 MULT) IS ≥15°F AND THE GYRO PACKAGE IS ESTIMATED TO BE ≥15°F.<br>B. THE RR CAN NOT BE OPERATED AT AN ANTENNA TEMPERATURE ≥145°F AND/OR A GYRO PACKAGE TEMP (CALCULATED) OF ≥200°F.<br>C. THE RR CANNOT BE OPERATED FOR MORE THAN 15 MINUTES WHEN THE ANTENNA IS STOWED. THIS TIME INCLUDES SELF TEST TIME. |
| | 25-13 | THE AGS WILL NOT BE USED FOR CONTROLLING DOCKED BURNS. |
| | 25-14 | IF THE AGS IS DECLARED NO-GO OR IS OF NO FURTHER USE TO MISSION TEST OBJECTIVES, THE AGS MAY BE POWERED DOWN. |
| | | RULE NUMBERS 25-15 THROUGH 25-19 ARE RESERVED |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| A | 25-20 | LOSS OF AN OPERATIONAL PGNS | | | • REF MAL PROC PGNS 1, ISS WARN<br>• REF MAL PROC PGNS 2,3, LGC WARN<br>• REF MAL PROC PGNS 9, TEMP CAUTION |
| | | A. IN PGNS CONTROL | DOCKED | A.1. PERFORM DPS BURN MANUALLY USING TTCA FOR ATTITUDE CONTROL | |
| | | | UNDOCKED | 2. CONTINUE MISSION<br>(A) SELECT AGS<br>(B) RNDZ NO-GO<br>(C) REF ALT MISSION F | |
| | | | RNDZ | 3. RETURN TO CSM ASAP<br>(A) SELECT AGS<br>(B) UNMANNED APS NO-GO | |
| | | | UNMANNED | 4. CONTINUE BURN UNLESS TRAJECTORY CONSTRAINTS ARE VIOLATED OR LOSS OF ATTITUDE CONTROL OCCURS | |
| | | B. IN AGS CONTROL | RNDZ | B. RETURN TO CSM ASAP | |
| A | 25-21 | LOSS OF DSKY | DOCKED | A. CONTINUE MISSION<br>1. RNDZ NO-GO<br>2. REF ALT MISSION B | • REF MAL PROC PGNS 15, ABNORMAL DSKY RESPONSE<br>• REF MAL PROC PGNS 16, MISSING NUMERICS ON DSKY<br>• REF MAL PROC PGNS 17, ABNORMAL DSKY PUSHBUTTON RESPONSE |
| | | | UNDOCKED | B. CONTINUE MISSION<br>1. SELECT AGS<br>2. RENDZ NO-GO<br>3. REF ALT MISSION B | |
| | | | RNDZ | C. RETURN TO CSM ASAP<br>1. SELECT AGS<br>2. REF ALT MISSION B | |
| | | | UNMANNED | D. CONTINUE MISSION | |
| | 25-22 | LOSS OF FDAI | | | |
| | | A. ONE | ALL | A. CONTINUE MISSION | |
| | | B. BOTH | DOCKED | B.1. CONTINUE MISSION | |
| | | | UNDOCKED | 2. CONTINUE MISSION<br>RNDZ NO-GO | |
| | | | RNDZ | 3. RETURN TO CSM ASAP | |
| | | | UNMANNED | 4. CONTINUE MISSION | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 25-23 | LOSS OF AOT AND/OR COAS | | | |
| | | A. EITHER | ALL | A. CONTINUE MISSION | |
| | | B. BOTH | DOCKED/ UNDOCKED | B.1. CONTINUE MISSION RNDZ NO-GO | |
| | | | RNDZ | 2. RETURN TO CSM ASAP REF ALT MISSION B | |
| | | | UNMANNED | 3. CONTINUE MISSION | |
| A | 25-24 | LOSS OF RENDEZVOUS RADAR AND/OR TRANSPONDER | DOCKED | A. CONTINUE MISSION | • REF MAL PROC PGNS 5, HEATER CAUTION |
| | | | UNDOCKED | B. CONTINUE MISSION<br>1. NO-GO FOR RNDZ<br>2. REF ALT MISSION B | • REF MAL PROC PGNS 6,7, RNDZ RDR CAUTION<br>• REF MAL PROC PGNS 8, NO TRACK |
| | | | RNDZ | C.1. PRIOR TO PHASING RETURN TO CSM ASAP<br>2. AFTER PHASING CONTINUE MISSION | |
| | | | UNMANNED | D. CONTINUE MISSION | |
| | 25-25 | LOSS OF REDUNDANT 3-AXIS ATTITUDE CONTROL | | | |
| | | | DOCKED | A. CONTINUE MISSION<br>1. DO NOT UNDOCK<br>2. REF ALT MISSION D PLUS EVA | |
| | | | UNDOCKED | B. RETURN TO CSM AND DOCK ASAP<br>REF ALT MISSION D | |
| | | | RNDZ | C. RETURN TO CSM ASAP | |
| | | | UNMANNED | D. CONTINUE MISSION | |

| MISSION | REV | DATE | SECTION | GROUP | PAGE |
|---|---|---|---|---|---|
| APOLLO 9 | A | 2/15/69 | LM GUIDANCE AND CONTROL | SPECIFIC - PGNS/CES/AGS | 25-5 |

MSC/TSO Form 291 (AUG 68)

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 25-26 | LOSS OF TRANSLATION CAPABILITY | | | |
| | | A. ULLAGE (+X) | DOCKED | A.1. CONTINUE MISSION<br>(A) CSM PROVIDE LM ULLAGE, LM PROVIDE ATT CONTROL<br>(B) DO NOT UNDOCK<br>(C) REF ALT MISSION D | A. MAX CSM ULLAGE TIME IS 7 SEC DUE TO LM IMPINGEMENT CONSTRAINT. |
| | | | UNDOCKED | 2. RETURN TO CSM AND DOCK ASAP<br>CSM ACTIVE DOCKING | |
| | | | RNDZ | 3. CSM RESCUE | |
| | | | UNMANNED | 4. CONTINUE MISSION | |
| | | B. EITHER ±Y, ±Z, -X TRANSLATION | DOCKED | B.1. CONTINUE MISSION<br>(A) REF ALT MISSION D<br>(B) DO NOT UNDOCK | |
| | | | UNDOCKED | 2. RETURN TO CSM AND DOCK ASAP<br>CSM PERFORM BRAKING MANEUVER AND DOCKING | |
| | | | RNDZ | 3. (A) PRIOR TO PHASING:<br>RETURN TO CSM AND DOCK ASAP<br>CSM PERFORM BRAKING MANEUVER AND DOCKING<br>(B) AFTER PHASING:<br>CONTINUE MISSION<br>CSM PERFORM TRANSLATION MANEUVERS IF REQUIRED | |
| | | | UNMANNED | 4. CONTINUE MISSION | |
| | 25-27 | LOSS OF THRUST VECTOR CONTROL | DOCKED | A. INHIBIT DPS BURN<br>IF BURNING, CONTINUE BURN UNTIL ATT ERROR OR RATE LIMIT IS EXCEEDED. | |
| | | | ALL | B. CONTINUE MISSION<br>UNLESS RCS IMPINGEMENT CONSTRAINTS ARE VIOLATED | B. RCS IMPINGEMENT CONSTRAINTS MAY BE VIOLATED BECAUSE OF RCS OPPOSING THRUST VECTOR OFFSET. |
| | 25-28 | ENG DOES NOT IGNITE AFTER START PB DEPRESSED | DOCKED | A.1. SET STOP PB<br>(A) DE-ARM DPS<br>(B) RESCHEDULE DPS BURN USING DESCENT CMD OVERRIDE SWITCH | A.1. STOP PB MUST BE SET TO RESET THE LATCHING RELAYS ENERGIZED BY START PB DEPRESSION |
| | | | RNDZ | B.1. FOR PHASING BURN, SET STOP PB<br>(A) DE-ARM DPS<br>(B) REF ALT MISSION E-5c | |
| | | | | 2. FOR BURNS AFTER PHASING, SET STOP PB<br>(A) DE-ARM DPS<br>(B) RETURN TO CSM ASAP | B.2. NO APS START CAPABILITY EXISTS |
| | | | UNMANNED | C.1. NO-GO FOR APS BURN | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 25-29 | LOSS OF OPERATIONAL AGS | ALL | CONTINUE MISSION | |
| | 25-30 | DPS BURN IN NON-THROTTLE-ABLE RANGE | | | |
| | | A. PRIOR TO TGO 4 MIN 1 SEC | DOCKED | A.1. AT TGO 4 MIN 1 SEC PERFORM MANUAL SHUTDOWN | |
| | | | RNDZ | 2. CONTINUE BURN | |
| | | B. BETWEEN TGO 4 MIN 1 SEC AND TGO 2 MIN 21 SEC | DOCKED | B. AT TGO 2 MIN 21 SEC PERFORM MANUAL SHUTDOWN IMMEDIATELY | |
| | | C. AFTER TGO 2 MIN 21 SEC | DOCKED | C. CONTINUE BURN | |
| | 25-31 | LOSS OF MANUAL THRUST CONTROL | | | |
| | | A. ZERO OUTPUT | DOCKED | A.1. IF BURN CONTINUES TO THROTTLE DOWN POINT, STOP BURN MANUALLY. | |
| | | | RNDZ | 2. CONTINUE MISSION<br>USE LOW STOP POINT | A.2. THE THROTTLE WILL MECHANICALLY GO TO APPROX 10 PERCENT WITH ZERO INPUT TO VARIABLE THROTTLE ACTUATOR ELECTRONIC CONTROLS. |
| | | B. MAXIMUM THRUST | ALL | B. IF BURNING, CONTINUE BURN UNTIL COMMAND SHUTDOWN<br>FURTHER DPS BURNS PROHIBITED | |
| A | 25-32 | LOSS OF ACA | | | |
| | | A. ONE | ALL | A. CONTINUE MISSION | |
| | | B. BOTH | DOCKED | B. CONTINUE MISSION<br>DO NOT UNDOCK<br>REF ALT MISSION D | |
| | | | UNDOCKED/ RNDZ | C. RETURN TO CSM ASAP | |
| | | | UNMANNED | D. CONTINUE MISSION | |

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 25-33 | LOSS OF TTCA | | | |
| | | A. ONE | ALL | A. CONTINUE MISSION | |
| | | B. BOTH | DOCKED | B. CONTINUE MISSION<br>DO NOT UNDOCK | |
| | | | UNDOCKED | C. RETURN TO CSM ASAP<br>REF ALT MISSION D | |
| | | | RNDZ | D. RETURN TO CSM ASAP | |
| | | | UNMANNED | E. CONTINUE MISSION | |
| | | RULE NUMBERS 25-34 THROUGH 25-39 ARE RESERVED. | | | |

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**MISSION RULES**

| REV | ITEM | | | | | | |
|---|---|---|---|---|---|---|---|
| | | **PRELAUNCH INSTRUMENTATION** | | | | | |
| | 25-40 | MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
| | | LGC DOWNLINK | GG0001X | - | - | M | 25-20 |
| | | PLS TORQ REF | GG1040V | - | - | HD | 25-20 |
| | | 2.5 VDC TM BIAS | GG1110V | - | - | HD | 25-20 |
| | | IMU 28 VAC 800 | GG1201V | - | - | HD | 25-20 |
| | | IRIG SUSP 3.2 KC | GG1331V | - | - | HD | 25-20 |
| | | IMU STBY | GG1513X | - | - | HD | 25-20 |
| | | LGC OPR | GG1523X | - | - | HD | 25-20 |
| | | X PIPA OUT IN ϕ | GG2001V | - | - | HD | 25-20 |
| | | Y PIPA OUT IN ϕ | GG2021V | - | - | HD | 25-20 |
| | | Z PIPA OUT IN ϕ | GG2041V | - | - | HD | 25-20 |
| | | IG SVO ERR IN ϕ | GG2107V | - | - | HD } 1 OF 2 | 25-20 |
| | | IG TORQ MTR CUR | GG2110C | - | - | HD } M-PCM | 25-20 |
| | | IG IX RSVR OUT SIN | GG2112V | FDAI | COMMON | M-PCM | 25-20 |
| | | IG IX RSVR OUT COS | GG2113V | FDAI | COMMON | M-PCM | 25-20 |
| | | MG SVO ERR IN ϕ | GG2137V | - | - | HD } 1 OF 2 | 25-20 |
| | | MG TORQ MTR CUR | GG2140C | - | - | HD } M-PCM | 25-20 |
| | | MG IX RSVR OUT SIN | GG2142V | FDAI | COMMON | M-PCM | 25-20 |
| | | MG IX RSVR OUT COS | GG2143V | FDAI | COMMON | M-PCM | 25-20 |
| | | OG SVO ERR IN ϕ | GG2167V | - | - | HD } 1 OF 2 | 25-20 |
| | | OG TORQ MTR CUR | GG2170C | - | - | HD } M-PCM | 25-20 |
| | | OG RSVR OUT SIN | GG2172V | FDAI | COMMON | M-PCM | 25-20 |
| | | OG RSVR OUT COS | GG2173V | FDAI | COMMON | M-PCM | 25-20 |
| | | PITCH ATT ERR | GG2219V | FDAI | COMMON | HD - PCM | 25-20 |
| | | YAW ATT ERR | GG2249V | FDAI | COMMON | HD - PCM | 25-20 |
| | | ROLL ATT ERR | GG2279V | FDAI | COMMON | HD - PCM | 25-20 |
| | | PIPA TEMP | GG2300T | C&W | SEPARATE | M-PCM | 25-20 |
| | | IRIG TEMP | GG2301T | C&W | SEPARATE | HD - PCM | 25-20 |
| | | RR SHFT SIN | GG3304V | FDAI | COMMON | HD - PCM | 25-24 |
| | | RR SHFT COS | GG3305V | FDAI | COMMON | HD - PCM | 25-24 |
| | | RR TRUN SIN | GG3324V | FDAI | COMMON | HD - PCM | 25-24 |
| | | RR TRUN COS | GG3325V | FDAI | COMMON | HD - PCM | 25-24 |
| | | PIPA CAL TEMP | GG6020T | - | - | HD - PCM | 25-20 |
| | | LGC WARNING | GG9001X | C&W | COMMON | HD - PCM | 25-20 |
| | | ISS WARNING | GG9002X | C&W | COMMON | HD - PCM | 25-20 |
| | | LR ANT TEMP | GN7563T | TEMP MONITOR | COMMON | HD - PCM | |
| | | RR NO TRACK | GN7621X | C&W | COMMON | HD - PCM | 25-24 |
| | | RR ANT TEMP | GN7723T | TEMP MONITOR | COMMON | M-PCM | 25-24 |
| | | YAW ERR CMD | GH1247V | - | - | M | 25-25 |
| | | PITCH ERR CMD | GH1248V | - | - | M | 25-25 |
| | | ROLL ERR CMD | GH1249V | - | - | M | 25-25 |
| | | JD A4D OUTPUT | GH1419V | - | - | HD | 25-25,25-26 |
| | | RCS TCP A4D | GR5032X | - | - | HD | 25-25,25-26 |
| | | JD B3D OUTPUT | GH1423V | - | - | HD | 25-25,25-26 |
| | | RCS TCP B3D | GR5036X | - | - | HD | 25-25,25-26 |
| | | JD A2D OUTPUT | GH1427V | - | - | HD | 25-25,25-26 |
| | | RCS TCP A2D | GR5040X | - | - | HD | 25-25,25-26 |
| | | JD B1D OUTPUT | GH1431V | - | - | HD | 25-25,25-26 |
| | | RCS TCP B1D | GR5044X | - | - | HD | 25-25,25-26 |
| | | JD B4U OUTPUT | GH1418V | - | - | HD | 25-25,25-26 |
| | | JD B4F OUTPUT | GH1420V | - | - | HD | 25-25,25-26 |
| | | JD A4R OUTPUT | GH1421V | - | - | HD | 25-25,25-26 |
| | | JD A3U OUTPUT | GH1422V | - | - | HD | 25-25,25-26 |
| | | JD B3A OUTPUT | GH1424V | - | - | HD | 25-25,25-26 |
| | | JD A3R OUTPUT | GH1425V | - | - | HD | 25-25,25-26 |
| | | JD B2U OUTPUT | GH1426V | - | - | HD | 25-25,25-26 |
| | | JD A2A OUTPUT | GH1428V | - | - | HD | 25-25,25-26 |
| | | JD B2L OUTPUT | GH1429V | - | - | HD | 25-25,25-26 |
| | | JD A1U OUTPUT | GH1430V | - | - | HD | 25-25,25-26 |
| | | JD A1F OUTPUT | GH1432V | - | - | HD | 25-25,25-26 |
| | | JD B1L OUTPUT | GH1433V | - | - | HD | 25-25,25-26 |
| | | RCS TCP B4U | GR5031X | - | - | HD | 25-25,25-26 |
| | | RCS TCP B4F | GR5033X | - | - | HD | 25-25,25-26 |
| | | RCS TCO A4R | GR5034X | - | - | HD | 25-25,25-26 |
| | | RCS TCP A3U | GR5035X | - | - | HD | 25-25,25-26 |
| | | RCS TCP B3A | GR5037X | - | - | HD | 25-25,25-26 |
| | | RCS TCP A3R | GR5038X | - | - | HD | 25-25,25-26 |
| | | RCS TCP B2U | GR5039X | - | - | HD | 25-25,25-26 |
| | | RCS TCP A2A | GR5041X | - | - | HD | 25-25,25-26 |
| | | RCS TCP B2L | GR5042X | - | - | HD | 25-25,25-26 |
| | | RCS TCP A1U | GR5043X | - | - | HD | 25-25,25-26 |
| | | RCS TCP A1F | GR5045X | - | - | HD | 25-25,25-26 |

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**MISSION RULES**

| REV | ITEM | MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|---|---|
| A | 25-40 (CONT'D) | RCS TCP BIL | GR5046X | - | - | HD | 25-25,25-26 |
| | | YAW ATT ERR | GH1455V | FDAI | COMMON | HD | 25-25 |
| | | PITCH ATT ERR | GH1456V | FDAI | COMMON | HD | 25-25 |
| | | ROLL ATT ERR | GH1457V | FDAI | COMMON | HD | 25-25 |
| | | RGA YAW RATE | GH1461V | FDAI | COMMON | M ON BOARD | 25-25 |
| | | RGA PITCH RATE | GH1462V | FDAI | COMMON | M PCM/HD | 25-25 |
| | | RGA ROLL RATE | GH1463V | FDAI | COMMON | M | 25-25 |
| | | AUTO MODE | GH1608X | - | - | HD | 25-25 |
| | | ATT HOLD | GH1609X | - | - | HD | 25-25 |
| | | AGS SEL | GH1621X | - | - | HD | 25-25 |
| | | ROLL PLSD/DIR | GH1628X | - | - | HD | 25-25 |
| | | PITCH PLSD/DIR | GH1629X | - | - | HD | 25-25 |
| | | YAW PLSD/DIR | GH1630X | - | - | HD | 25-25 |
| | | AUTO ON | GH1214X | - | - | M | |
| | | APS ARM | GH1230X | - | - | M | |
| | | ENG FIRE OVRD | GH1286X | - | - | HD | 25-28 |
| | | MAN THRUST CMD | GH1311V | METER | SEPARATE | M | 25-30,25-31 |
| | | PITCH GDA POS | GH1313V | - | - | M | 25-27 |
| | | ROLL GDA POS | GH1314V | - | - | M | 25-27 |
| | | P TRM FAIL | GL9003U | C&W | COMMON | HD | 25-27 |
| | | R TRM FAIL | GL9004U | C&W | COMMON | HD | 25-27 |
| | | AUTO THRUST CMD | GH1331V | METER | SEPARATE | HD | 25-31 |
| | | DPS ARM | GH1348X | - | - | M | |
| | | VAR INJ ACT POS | GQ6806H | - | - | M | 25-30 |
| | | CES AC PWR FAIL | GL4026X | C&W | COMMON | M | 25-29 |
| | | CES DC PWR FAIL | GL4027X | C&W | COMMON | M | 25-27 |
| | | AGS DOWNLINK DATA | GI0001X | - | - | M | 25-29 |
| | | ASA TEMP | GI3301T | - | - | HD | 25-29 |
| | | ASA PWR/AEA FAIL | GL4028X | C&W | COMMON | M | 25-29 |

26 LM DPS

| REV | ITEM | GENERAL |
|---|---|---|
| A | 26-1 | **DOCKED**<br>IN ORDER TO INITIATE AND CONTINUE THE DOCKED PHASE, THE DPS SUBSYSTEM MUST PROVIDE A SAFE BURN CAPABILITY DEFINED AS FOLLOWS:<br>A. NO PROPELLANT LEAKS<br>B. AN OPERATIONAL DPS DEFINED AS FOLLOWS:<br>1. FUEL AND OXID ENGINE INLET PRESSURE >100 PSI AT BURN INITIATION AND >120 PSI DURING BURN (THROTTLE SETTING LESS THAN 65 PERCENT) OR >150 PSI (THROTTLE SETTING OF MORE THAN 65 PERCENT.)<br>2. DPS PROPELLANT TEMPS >50°F AND < PROPELLANT TEMP DEFINED BY PRESSURE - TEMPERATURE CURVE, FIGURE 26-2 TBA, (ONLY TO INITIATE A BURN).<br>3. ΔT BETWEEN OXID AND FUEL TEMP LESS THAN 25°F (ONLY TO INITIATE A BURN).<br>4. ΔP BETWEEN FUEL AND OXIDIZER ENGINE INLET PRESSURE LESS THAN 12 PSID WITH OXIDIZER READING HIGH ΔP BETWEEN FUEL AND OXIDIZER ENGINE INLET PRESSURE LESS THAN 25 PSID WITH FUEL READING HIGH. |
| | 26-2 | **EVA**<br>IN ORDER TO INITIATE AND CONTINUE THE EVA PHASE, THE DPS SUBSYSTEM MUST MEET THE FOLLOWING CONDITIONS:<br>A. NO DPS PROPELLANT LEAKS<br>B. NO IMPENDING PROPELLANT VENTING (P <258 PSIA) |
| | 26-3 | **UNDOCK**<br>IN ORDER TO INITIATE AND CONTINUE THE UNDOCKED PHASE, THE DPS SUBSYSTEM MUST PROVIDE THE FOLLOWING MINIMUM CONDITION:<br>NO DPS PROPELLANT LEAK |
| | 26-4 | **RENDEZVOUS**<br>IN ORDER TO INITIATE AND CONTINUE THE RENDEZVOUS PHASE, THE DPS SUBSYSTEM MUST PROVIDE A SAFE BURN CAPABILITY AND 245 FPS ΔV CAPABILITY AND NO DPS PROPELLANT LEAKS. |
| | | RULE NUMBERS 26-5 THROUGH 26-10 ARE RESERVED. |

| REV | ITEM | MANAGEMENT |
|---|---|---|
| | 26-11 | THE LOW THROTTLE POINT IS THE MINIMUM THROTTLE POSITION THAT THE THROTTLE ACTUATOR WILL ASSUME WITH MINIMUM MANUAL THROTTLE COMMAND VOLTAGE (11.5 PERCENT FOR LM-3). |
| A | 26-12 | DPS USABLE PROPELLANT IS 17,430.4 LBS.<br>TOTAL LOADED 18,039.9 LBS<br>TRAPPED 367.5 LBS<br>TM ERROR 242.0 LBS<br>USABLE 17,430.4 LBS |
| A | 26-13 | ALL DESCENT ENGINE STARTS MUST NOMINALLY BE PRECEDED BY A PROPELLANT SETTLING MANEUVER USING TWO SYSTEM B JETS OR TWO SYSTEM A JETS IN CASE OF A CONTINGENCY. |
| | 26-14 | THE TOTAL ACCUMULATED BURN TIME OF THE DESCENT ENGINE SHALL NOT EXCEED 910 SECONDS OF OPERATION INDEPENDENT OF THRUST LEVEL. |
| A | 26-15 | THE DPS WILL NOT NORMALLY BE OPERATED FOR LESS THAN 3.5 SEC OF BURN AT THE LOW THROTTLE POINT. ONLY TWO CONSECUTIVE 3.5 SEC BURNS MAY BE PERFORMED WITH A MINIMUM COAST TIME OF 10 MINUTES. |
| | 26-16 | ALL DPS STARTS MUST BE NOMINALLY PLANNED AT THE LOW THROTTLE POINT. IN NO CASE, SHOULD THE DPS BE STARTED ABOVE THE 60 PERCENT THROTTLE POINT. |
| | 26-17 | THE DPS ENGINE MUST NOT BE OPERATED IN THE NON-THROTTLING RANGE (65 PERCENT TO FTP) FOR MORE THAN 100 SEC. |
| | 26-18 | SUPERCRITICAL HELIUM BURST DISC RUPTURE DURING MANNED OPERATION WILL NOT DAMAGE SPACECRAFT, ENDANGER CREW, OR EFFECT ATTITUDE CONTROL AND IS THEREFORE AN ALLOWABLE EVENT. |

| REV | ITEM | |
|---|---|---|
| A | 26-19 | DPS ENGINE RESTART CAN BE MADE WITH THE FOLLOWING CONSTRAINTS: |

| INITIAL BURN | REQUIRED COAST TIME | MAXIMUM RESTART BURN TIME |
|---|---|---|
| A. UP TO 190 SECS | 10 MINUTES | 400 SECS |
| B. 190 SECS TO 600 SECS | REFERENCE (SEE FIGURE BELOW) | 100 SECS |
| C. GREATER THAN 600 SECS | NO RESTART | --- |

THESE CONSTRAINTS ARE BASED ON ENGINE THRUST CHAMBER HEATING AND SOAK BACK LIMITS. TERMINATE THE BURN IF THE MAXIMUM RESTART BURN TIME IS EXCEEDED.

THERE SHALL BE NO MORE THAN 5 RESTARTS AFTER THE INITIAL BURN.

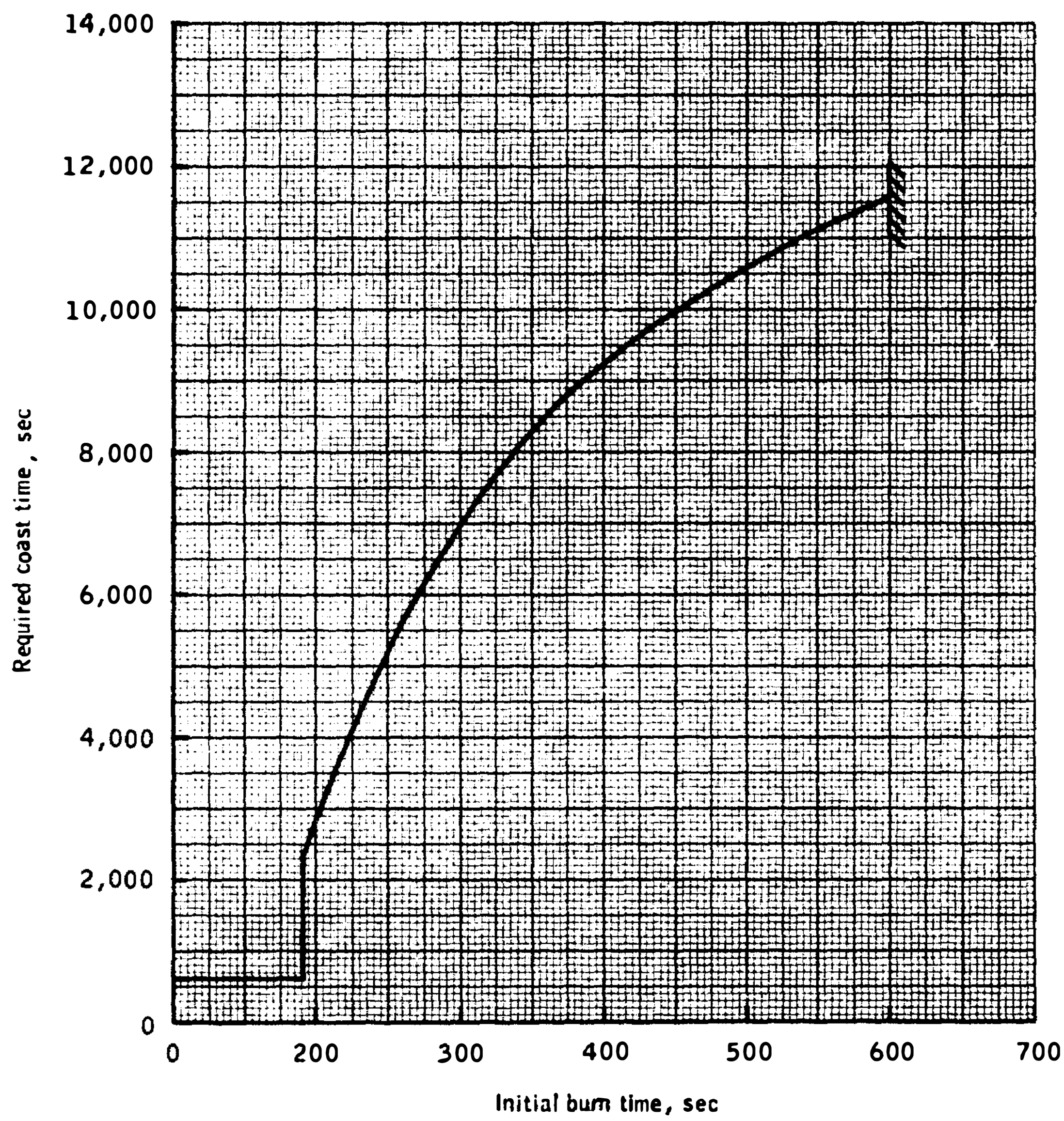


Figure 26-1.- LMDE required coast time vs initial burn time for engine chamber heating limitations.

| REV | ITEM | |
|---|---|---|
| | 26-20 | ONLY PREMISSION APPROVED ALTERNATE DPS/MULTI BURN PROFILES WILL BE EXECUTED SINCE NO DATA EXISTS TO ALLOW REAL TIME SUPPORT FOR EXAMINING DPS FREEZING, CHARING, BACKWALL TEMPERATURE CONSTRAINTS FOR MULTI BURN PROFILES. |
| | 26-21 | PROPELLANT GAGING<br>A. PRIME METHOD: PQGS (TM ONBOARD) 1.3%<br>B. BACKUP METHOD: GROUND MASS CALCULATION 5.0% |
| | | RULE NUMBERS 26-22 THROUGH 26-29 ARE RESERVED. |

**NASA — Manned Spacecraft Center**

**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC - DPS MISSION RULES | |
| A | 26-30 | LOSS OF OPERATIONAL DPS | DOCKED | A. INHIBIT DPS BURN<br>1. STOP BURN, IF IN PROGRESS<br>2. REF ALT MISSION E-5C | |
| | | | UNDOCKED/ RNDZ | B.1. PRIOR TO PHASING:<br>(A) STAGE AT PHASING<br>(B) REF ALT MISSION E-1<br>2. AFTER PHASING:<br>(A) CONTINUE MISSION<br>(B) STAGE AT INSERTION | B.2 AN OPERATIONAL APS AND RCS IS REQUIRED |
| A | 26-31 | START TANK LEAK PRIOR TO PRESS | DOCKED | | REF MAL PROC DPS, 3 AND 4 OFF-NOMINAL HELIUM PRESSURE, OR PROPELLANT TEMP OR PRESSURE INDICATION |
| | | A. FU AND OXID ENGINE INLET PRESS > 100 PSI AT IGNITION. | | A. CONTINUE MISSION<br>INHIBIT FIRING DPS START TANK SQUIB | |
| | | B. FU AND/OR OXID ENGINE INLET < 100 PSI | | B. CONTINUE MISSION<br>FIRE SQUIB TO START TANK | NOTE:<br>PRESSURIZATION SYSTEM WILL BE OPENED TO START TANK LEAK. SUBSEQUENT DPS BURN CAPABILITY WILL DEPEND UPON LENGTH OF DPS 1 BURN AND RESULTING ULLAGE VOLUME/BLOWDOWN CAPABILITY. |
| A | 26-32 | DPS FAILS TO PRESSURIZE | DOCKED | | |
| | | A. START TANK<br>1. INLET PRESS <100 PSI | | A.1. INHIBIT ALL DPS BURNS<br>REF ALT MISSION E5c AND APS UNMANNED BURN | REF MR 26-1<br>REF MAL PROC DPS 3 AND 4 OFF-NOMINAL HELIUM PRESSURE OR PROPELLANT TEMP OR PRESSURE INDICATION |
| | | 2. INLET PRESS >100 PSI | | 2. CONTINUE MISSION | |
| | | B. SUPERCRITICAL HELIUM | | B. CUTOFF BURN ON INLET PRESS<br>REF ALT MISSION E AND APS UNMANNED BURN | REF MR 26-1<br>REF MAL PROC DPS 3 AND 4 OFF-NOMINAL HELIUM PRESSURE OR PROPELLANT TEMP OR PRESSURE INDICATION |
| A | 26-33 | OFF NOMINAL SUPERCRITICAL HELIUM PRESS <350 PSI | DOCKED | CONTINUE MISSION<br>REMAIN AT 40 PERCENT THRUST UNTIL SHE PRESS >350 PSIA | REF MAL PROC DPS 3 AND 4 OFF-NOMINAL HELIUM PRESSURE, OR PROPELLANT TEMP OR PRESSURE INDICATION |

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 26-34 | DELETED | | | |
| A | 26-35 | DPS PROPELLANT/VAPOR LEAK DOWNSTREAM OF QUAD CHECK VALVES | DOCKED | A. INHIBIT DPS BURN<br>1. STOP BURN IF BURNING<br>2. STAGE ASAP<br>3. REF ALT MISSION E5c PLUS UNMANNED APS | REF MAL PROC DPS 1, 3 AND 4 OFF-NOMINAL HELIUM PRESSURE, OR PROPELLANT TEMP OR PRESSURE INDICATION AND DES REG WARNING LIGHT ILLUMINATED. |
| | | | UNDOCKED | B. STAGE ASAP<br>REF ALT MISSION E5c PLUS UNMANNED APS. | |
| | | | RNDZ | C.1. PRIOR TO INSERTION:<br>(A) STOP BURN IF BURNING<br>(B) STAGE ASAP<br>(C) RETURN TO CSM ASAP<br>2. DURING INSERTION:<br>(A) STOP BURN<br>(B) STAGE ASAP<br>(C) COMPLETE MANEUVER WITH LM RCS<br>3. AFTER INSERTION:<br>(A) STAGE ASAP<br>(B) CONTINUE MISSION | C.2.(C) REF MR 2-17 (C.10) |
| | | RULE NUMBERS 26-36 THROUGH 26-39 ARE RESERVED. | | | |

| REV | ITEM | |
|---|---|---|

## DPS - PRELAUNCH INSTRUMENTATION

26-40

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCER | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| START TNK PRESS | GQ3015P | HE MON | COMMON | M | 26-31,32 |
| HE REG PRESS | GQ3018P | C & W | COMMON | HD } 1 OF 2 | 26-34,30 |
| HE REG PRESS | GQ3025P | | | HD } M-PCM | 26-34,30 |
| HE PRESS | GQ3435P | | | HD } 1 OF 2 | 26-33 |
| HE PRESS | GQ3436P | PRESS | | HD } M | |
| FU TNK 1 QTY | GQ3603Q | QTY | COMMON | HD } 1 OF 2 | |
| FU TNK 2 QTY | GQ3604Q | QTY | COMMON | HD } M | |
| OX TNK 1 QTY | GQ4103Q | QTY | COMMON | HD } 1 OF 2 | |
| OX TNK 2 QTY | GQ4104Q | QTY | COMMON | HD } M | |
| FU 1 TEMP | GQ3718T | TEMP MON | COMMON | HD } 1 OF 2 | 26-30 |
| FU 2 TEMP | GQ3719T | TEMP MON | COMMON | HD } M | 26-30 |
| OX 1 TEMP | GQ4218T | TEMP MON | COMMON | HD } 1 OF 2 | 26-30 |
| OX 2 TEMP | GQ4219T | TEMP MON | COMMON | HD } M | 26-30 |
| FU PRESS | GQ3611P | | | M | 26-30,35 |
| OX PRESS | GQ4111P | | | M | 26-30,35 |
| TCP | GQ6510P | THRUST | COMMON | M-PCM | 26-30 |

27 LMAPS

| REV | ITEM | |
|---|---|---|
| | 27-1 | DOCKED, EVA, UNDOCKING, SEPARATION, PHASING<br><br>NO APS PROPELLANT LEAKS |
| A | 27-2 | INSERTION<br><br>IN ORDER TO INITIATE THE INSERTION MANEUVER AND CONTINUE THE RENDEZVOUS PHASE OF THE MISSION, THE APS SUBSYSTEM MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITY:<br><br>NO PROPELLANT LEAKS |
| A | 27-3 | AN OPERATIONAL APS, IS DEFINED AS FOLLOWS: |

| MANNED | START BURN | CONTINUE BURN |
|---|---|---|
| 1. APS BULK TEMP | >50°F <90°F | N/A |
| 2. OX-FUEL ΔT | <60°F | N/A |
| 3. INLET PRESS | >120<203 PSI | >115<203 PSI, NO PRESS OSCILLATIONS |
| 4. INLET PRESS ΔP | <27 PSID | <10 PSID |
| 5. TCP | N/A | >80<150 PSI, NO PRESS OSCILLATIONS |
| 6. PROPELLANT LEAK | NONE | NONE |

| UNMANNED | | |
|---|---|---|
| 1. APS BULK TEMP | N/A | N/A |
| 2. OXID-FUEL ΔT | N/A | N/A |
| 3. INLET PRESS | <203 PSI | <203 PSI, NO PRESS OSCILLATIONS |
| 4. INLET PRESS ΔP | <90 PSID | <27 PSID |
| 5. TCP | N/A | <150, NO PRESS OSCILLATIONS |
| 6. PROPELLANT LEAK | NONE | NONE |

RULE NUMBERS 27-4 THROUGH
27-9 ARE RESERVED.

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | | **MANAGEMENT** |
| A | 27-10 | APS MANNED ENGINE STARTS MUST BE PRECEDED BY A PROPELLANT SETTLING MANEUVER USING 4 JET OR 2 JET ULLAGE, SYSTEM A OR B. |
| | 27-11 | APS PROPULSION SYSTEM CANNOT REMAIN ACTIVATED (COMPATABILITY SQUIB VALVES FIRED) LONGER THAN 24 HOURS BEFORE ITS USAGE IS COMPLETED NOMINALLY. IN CASE OF A CONTINGENCY, THE TIME CAN BE EXTENDED TO 3 1/2 DAYS. |
| A | 27-12 | THE USABLE PROPELLANT FOR APS IS 4103.5 LBS.<br><br>TOTAL LOADED 4150.1 LBS<br>UNUSABLE 46.6 LBS<br>USABLE 4103.5 LBS |
| A | 27-13 | THE MINIMUM IMPULSE OF THE APS ENGINE IS <u>1200</u> LBS/SEC, WHICH CORRESPONDS TO A BURN TIME OF <u>0.5</u> SEC. A MINIMUM COAST TIME OF <u>5</u> MINUTES IS REQUIRED BETWEEN MINIMUM IMPULSE FIRING AND SUBSEQUENT RESTART. |
| | 27-14 | ONLY PREMISSION APPROVED APS MULTI BURN PROFILES WILL BE EXECUTED SINCE NO DATA EXISTS TO ALLOW REAL-TIME SUPPORT FOR EXAMINING APS FREEZING, CHARRING, BACKWALL TEMPERATURE CONSTRAINTS FOR MULTI BURN PROFILES. |
| | 27-15 | <u>PROPELLANT GAGING</u> (NO ONBOARD READOUT)<br><br>A. PRIME METHOD: FLOW RATE X TIME (5%)<br><br>B. BACKUP METHOD: GROUND MASS CALCULATION (5%) |
| | | RULE NUMBERS 27-16 THROUGH 27-19 ARE RESERVED. |

**NASA — Manned Spacecraft Center**
**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC - APS MISSION RULES | |
| A | 27-20 | LOSS OF AN OPERATIONAL APS | RNDZ | A.1. STOP BURN IF POSSIBLE<br>2. INHIBIT FURTHER APS BURNS<br>3. PERFORM CDH WITH RCS | • REF MR 27-3<br>• REF MAL PROC APS 2 ASC HI REG APS 5 OFF-NOMINAL PROPELLANT TEMP OR PRESS INDICATION |
| | | | UNMANNED | B.1. STOP BURN IF IN PROGRESS<br>2. INHIBIT FURTHER APS BURNS | |
| A | 27-21 | APS HE SOURCE TEMP | | | REF MAL PROC APS 4 AND 5 OFF-NOMINAL HELIUM PRESSURE, OR PROPELLANT TEMP OR PRESSURE INDICATION. |
| | | A. ≥120°F (P 3400 PSI) | ALL | A. CONTINUE MISSION POSITION S/C TO REDUCE HEATING | |
| | | B. ≥140°F (P 3500 PSI) | ALL | B. CONTINUE MISSION PRESSURIZE APS FROM EFFECTED TANK(S) | |
| | | C. ≤ -130°F | RNDZ | C. CONTINUE MISSION<br>1. CLOSE He REG SHUTOFF VALVES<br>2. PERFORM APS BURNS IN BLOWDOWN MODE | |
| A | 27-22 | APS He SOURCE PRESSURE | | | REF MAL PROC APS 4 AND 5 OFF-NOMINAL HELIUM PRESSURE OR PROPELLANT TEMP OR PRESSURE INDICATION. |
| | | A. LEAK PRIOR TO PRESSURIZATION | ALL | A. CONTINUE MISSION INHIBIT USE OF EFFECTED TANK | |
| | | B. SOURCE PRESSURE LESS THAN ENGINE INLET PRESSURE | ALL | B.1. CONTINUE MISSION CLOSE He REG SHUTOFF VALVES | |
| | | | RNDZ | 2. CONTINUE MISSION<br>(A) CLOSE He REG SHUTOFF VALVES<br>(B) OPERATE IN BLOWDOWN MODE | |
| A | 27-23 | APS He LEAK BETWEEN QUAD CHECK VALVES AND He SHUTOFF VALVES | ALL | CONTINUE MISSION<br>A. CLOSE He REG SHUTOFF VALVES<br>B. OPEN He REG SHUTOFF VALVES PRIOR TO EACH BURN | REF MAL PROC APS 1 ASC PRESS WARNING LIGHT ILLUMINATED |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 27-24 | APS HELIUM/PROPELLANT VAPOR LEAK DOWNSTREAM OF QUAD CHECK VALVES | DOCKED | A. INHIBIT DPS BURN<br>1. STOP BURN IF BURNING<br>2. CREW EVACUATE LM ASAP<br>3. UNDOCK FROM LM<br>4. CSM SEPARATE TO SAFE DISTANCE | REF MAL PROC APS 3, 4, AND 5 OFF-NOMINAL HELIUM PRESSURE, OR PROPELLANT TEMP OR PRESSURE INDICATION, AND ASC QTY CAUTION LIGHT ILLUMINATED. |
| | | | UNDOCKED/ RNDZ | B. INHIBIT ALL BURNS<br>1. STOP BURN IF BURNING<br>2. DO NOT STAGE<br>3. RETURN TO CSM ASAP USING LM RCS IF POSSIBLE, IF NOT, CSM RESCUE | |
| | | | UNMANNED | C. INHIBIT APS BURN<br>1. STOP BURN IF BURNING | |
| | 27-25 | APS PROP VALVE MISMATCH (Δ POS) | RNDZ | A.1. CONTINUE BURN IN PROGRESS INHIBIT FURTHER MANNED APS BURNS | THIS INDICATION PRIOR TO FIRST APS ENGINE ON WILL BE CONSIDERED A TM FAILURE. |
| | | | UNMANNED | 2. CONTINUE MISSION | |
| | | RULE NUMBERS 27-26 THROUGH 27-29 ARE RESERVED. | | | |

| MISSION | REV | DATE | SECTION | GROUP | PAGE |
|---|---|---|---|---|---|
| APOLLO 9 | A | 2/15/69 | LM APS | SPECIFIC | 27-3A |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 27-30 | APS - PRELAUNCH INSTRUMENTATION |

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCER | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| APS HE 1 PRESS | GP0001P | HEL MON C&W | COMMON | M - PCM | 27-21,22,20 |
| APS HE 2 PRESS | GP0002P | HEL MON C&W | COMMON | M - PCM | 27-21,22,20 |
| APS HE REG PRESS | GP0018P | | | HD } 1 OF 2 | 27-20,23 |
| APS HE REG PRESS | GP0025P | C&W | COMMON | HC } M - PCM | 27-20,23 |
| APS HE 1 TEMP | GP0201T | HEL MON | COMMON | M - PCM | 27-21,22 |
| APS HE 2 TEMP | GP0202T | HEL MON | COMMON | M - PCM | 27-21,22 |
| APS FUEL TEMP | GP0718T | TEMP | COMMON | M - PCM | 27-20 |
| APS FUEL LOW | GP0908X | C&W | COMMON | HD | |
| APS OXID TEMP | GP1218T | TEMP | COMMON | M - PCM | 27-20 |
| APS OXID LOW | GP1408X | C&W | COMMON | HD | |
| APS FUEL PRESS | GP1501P | C&W | COMMON | M - PCM | 27-20,24 |
| APS OXID PRESS | GP1503P | C&W | COMMON | M - PCM | 27-20,24 |
| VLVS A ΔPOS | GP2997U | | | HD | 27-25 |
| VLVS B ΔPOS | GP2998U | | | HD | 27-25 |
| APS TCP | GP2010P | | | M | 27-20 |

28 LM REACTION CONTROL SYSTEM

| REV | ITEM | GENERAL |
|---|---|---|
| | 28-1 | DOCKED<br><br>IN ORDER TO INITIATE AND CONTINUE THE DOCKED PHASE OF THE MISSION, THE RCS SUBSYSTEM MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES:<br><br>A. RCS ULLAGE CAPABILITY<br><br>B. 3-AXIS ATTITUDE CONTROL CAPABILITY<br><br>C. NO PROPELLANT LEAKS |
| A | 28-2 | A. UNDOCKED/SEPARATION/PHASING/INSERTION<br><br>IN ORDER TO INITIATE AND CONTINUE THE UNDOCKED MISSION PHASE, 3-AXIS TRANSLATION CONTROL AND REDUNDANT 3-AXIS RCS ATTITUDE CONTROL CAPABILITY IS REQUIRED. TO ASSURE THAT NO SINGLE FAILURE CAN DISABLE ATTITUDE CONTROL, THE FOLLOWING MINIMUM CAPABILITIES ARE REQUIRED:<br><br>1. REDUNDANT CAPABILITY TO SUPPLY PROPELLANT FOR MAINTAINING RCS 3-AXIS ATTITUDE CONTROL VIA ONE OF THE FOLLOWING:<br><br>(A) OPERATIONAL SYSTEM A & B<br>(B) OPERATIONAL SYSTEM A OR B, PLUS CROSSFEED CAPABILITY AND ASC FEED CAPABILITY.<br><br>2. NO THRUSTER PAIRS ISOLATED OR ANY SINGLE VERTICAL JET FAILED.<br><br>3. NO PROPELLANT LEAKS<br><br>B. SEPARATION/PHASING<br><br>IN ORDER TO INITIATE AND CONTINUE THIS MISSION PHASE, 3-AXIS TRANSLATION CONTROL AND REDUNDANT 3-AXIS RCS ATTITUDE CONTROL CAPABILITY IS REQUIRED. TO ASSURE THAT NO SINGLE FAILURE CAN DISABLE ATTITUDE CONTROL, THE FOLLOWING MINIMUM CAPABILITIES ARE REQUIRED:<br><br>1. RCS SYSTEM A & B OPERATIONAL<br><br>2. NO THRUSTER PAIRS ISOLATED OR ANY SINGLE VERTICAL JET FAILED.<br><br>3. NO LEAKS<br><br>C. INSERTION<br><br>IN ORDER TO INITIATE AND CONTINUE THE INSERTION, +X-AXIS TRANSLATION CONTROL AND REDUNDANT 3-AXIS RCS ATTITUDE CONTROL IS REQUIRED. THE FOLLOWING MINIMUM CAPABILITIES ARE REQUIRED:<br><br>1. SAME AS SEPARATION/PHASING<br><br>D. STAGING<br><br>IN ORDER TO INITIATE STAGING, THE FOLLOWING MINIMUM CAPABILITIES ARE REQUIRED:<br><br>1. 3-AXIS RCS ATTITUDE CONTROL<br><br>2. +X-AXIS RCS TRANSLATION |
| | 28-3 | EVA<br><br>RCS NOMINALLY NOT REQUIRED<br><br>NO RCS PROPELLANT LEAKS |

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**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| | 28-4 | UNMANNED<br><br>IN ORDER TO INITIATE AND CONTINUE THE UNMANNED PHASE OF THE MISSION, THE RCS SUBSYSTEM MUST PROVIDE THE MINIMUM CAPABILITY OF 3-AXIS ATTITUDE CONTROL. |
| | | RULE NUMBERS 28-5 THROUGH 28-8 ARE RESERVED. |

| REV | ITEM | MANAGEMENT |
|---|---|---|
| A | 28-9 | AN OPERATIONAL RCS SYSTEM IS DEFINED AS:<br>A. PROPELLANT MANIFOLD PRESSURE >100 PSI OR ΔP BETWEEN OX AND FU <80 PSI<br>B. FUEL TEMP >40 AND <100°F<br>C. CAPABILITY TO EXPEL REQUIRED RCS PROPELLANTS FROM TANKS TO SUPPORT PLANNED GO/NO-GO'S |
| A | 28-10 | THRUSTER TEMP<br>THE RCS QUAD TEMPERATURE MUST BE BROUGHT UP TO OPERATING TEMPERATURE (>119°F) AND HAVE BEEN AT THIS TEMPERATURE FOR 25 MINUTES PRIOR TO FIRING THE RCS ENGINES. THE MAXIMUM RCS QUAD TEMPERATURE SHOULD BE MAINTAINED AT LESS THAN 190°F EXCEPT DURING PERIODS OF HEAVY DUTY CYCLE WITH EXPECTED TEMPERATURE RISES SUCH AS DURING THE RENDEZVOUS BRAKING AND DOCKING MANEUVERS. |
| A | 28-11 | USABLE RCS PROPELLANT IS 546.6 LBS<br>TOTAL LOADED 633.0 LBS<br>TRAPPED 42.1 LBS<br>TM ERROR 44.3 LBS<br>USABLE 546.6 LBS |
| | 28-12 | DO NOT NOMINALLY OPEN CROSSFEED DURING MANNED OPERATIONS. |
| | 28-13 | ASCENT FEED OPERATION IN UNMANNED COASTING FLIGHT IS PERMISSIBLE IN ORDER TO SUPPORT THE UNMANNED APS DEPLETION BURN. |
| | 28-14 | IF THE LM IS REQUIRED TO PROVIDE ATTITUDE CONTROL DURING THE EVA PHASE, THE LM WILL HAVE THE FOLLOWING RCS THRUSTER AND CONTROL MODE CONFIGURATION:<br>A. SYSTEM "A" QUAD 1 THRUSTER PAIR CLOSED<br>B. SYSTEM "B" QUAD 4 THRUSTER PAIR CLOSED<br>C. ALL OTHER QUAD THRUSTER PAIRS OPEN<br>D. AGS IN CONTROL, ATT HOLD, MAX DEADBAND. |
| A | 28-15 | PROPELLANT GAGING<br>A. PRIME METHOD: RCS GROUND PROGRAM (7.0%)<br>B. BACKUP METHOD: PQMD<br>TM (10%)<br>ONBOARD (13%) |

| REV | ITEM | |
|---|---|---|
| A | 28-16 | RCS PLUME IMPINGEMENT ON THE LM<br><br>MAXIMUM ALLOWABLE CONTINUOUS FIRING OF RCS JETS:<br><br>A. LM, +X (DOWN FIRING ENGINE): 15 SEC UNSTAGED. EXCEEDING +X IMPINGEMENT TIME COULD RESULT IN PROPELLANT LINE FREEZING AND LARGE TEMPERATURE DIFFERENCES BETWEEN PROPELLANT TANK DUE TO DAMAGE TO ASCENT AND DESCENT STAGE THERMAL INSULATION.<br><br>B. LM, +X (DOWN FIRING ENGINE): 120 SEC STAGED.<br><br>C. LM, -X (UP FIRING ENGINE) 30 SEC (-X THRUSTERS OF QUAD 1, 3, AND 4): EXCEEDING -X IMPINGEMENT TIME COULD RESULT IN DAMAGE TO S-BAND AND/OR RR ANTENNA BECAUSE OF OVERHEATING OR OVER PRESSURE DUE TO PLUME. |
| | | RULE NUMBERS 28-17 THROUGH 28-19 ARE RESERVED. |

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### MISSION RULES

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 28-20 | LOSS OF OPERATIONAL RCS SYSTEM A OR B | ALL | A.1. ISOLATE EFFECTED SYSTEM<br>2. UTILIZE GOOD SYSTEM<br>3. CROSSFEED IF POSSIBLE | |
| | | | DOCKED/ UNDOCKED | B. CONTINUE MISSION<br>REF ALT MISSION B | |
| | | | RNDZ | C. RETURN TO CSM ASAP<br>REF ALT MISSION D | |
| | | | UNMANNED | D. CONTINUE MISSION | |
| A | 28-21 | RCS THRUSTER PAIR | | | REF MALF PROC RCS 1<br>RCS TCA WARNING LIGHT |
| | | A. ONE PAIR ISOLATED | DOCKED | A.1. DO NOT UNDOCK<br>REF ALT MISSION D PLUS EVA | |
| | | | UNDOCKED/ RNDZ | 2. RETURN TO CSM ASAP<br>REF ALT MISSION D | |
| | | | UNMANNED | 3. CONTINUE MISSION | |
| | | B. COMBINATION ISOLATED RESULTING IN LOSS OF ATTITUDE CONTROL | DOCKED | B.1. INHIBIT DOCKED BURN. DO NOT UNDOCK | |
| | | | UNDOCK | 2. CSM ACTIVE DOCK ASAP | |
| | | | RNDZ | 3. CSM RESCUE | |
| | | | UNMANNED | 4. DO NOT PERFORM APS DEPLETION | |
| A | 28-22 | DELETED | | | |

**NASA — Manned Spacecraft Center**

**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| A | 28-23 | DELETED | | | |
| A | 28-24 | RCS PROPELLANT LEAK DOWN-STREAM OF MAINS | | | REF MALF PROC RCS 6<br>PQMD OFF NOMINAL |
| | | | DOCKED | A.1. CREW EVACUATE SPACECRAFT<br>(A) UNDOCK<br>(B) CSM SEPARATE FROM LM<br>(C) INHIBIT FURTHER MANNING OF LM | |
| | | | UNDOCK/ RNDZ | 2. RETURN TO CSM ASAP<br>CSM RESCUE REQUIRED | |
| | | | UNMANNED | 3. INHIBIT UNMANNED APS | |
| A | 28-25 | DELETED | | | |
| A | 28-26 | RCS QUAD TEMP <119°F OR >190°F EXCEPT DURING PERIODS OF HEAVY DUTY CYCLE WITH EXPECTED TEMP RISES SUCH AS DOCKING | ALL | ISOLATE BOTH THRUSTER PAIRS IN EFFECTED QUAD | REF MR 28-21<br>REF MAL PROC RCS 1<br>RCS TCA WARNING LIGHT<br>• QUAD TEMPS LESS THAN 199°F INDICATE THE POSSIBILITY OF INCOMPLETE COMBUSTION, WHICH COULD CAUSE HARD STARTS AND POSSIBLE EXPLOSIONS DURING MINIMUM IMPULSE FIRINGS.<br>QUAD TEMPS GREATER THAN 190°F INDICATES PREMATURE OXID VAPORIZATION AND ALSO POSSIBILITY OF VALVE SEAT DAMAGE. |
| | | RULE NUMBERS 28-27 THROUGH 28-29 ARE RESERVED. | | | |

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**MISSION RULES**

| REV | ITEM |
|---|---|
| | 28-30 |

## PRELAUNCH INSTRUMENTATION

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCER | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| RCS "A" PROP QTY | GR1085Q | QUANTITY | COMMON | M | 28-23 |
| RCS "B" PROP QTY | GR1095Q | QUANTITY | COMMON | M | 28-23 |
| RCS "A" REG PRESS | GR1201P | PRESS MON C&W | COMMON | M-PCM | 28-20,22 |
| RCS "B" REG PRESS | GR1202P | PRESS MON C&W | COMMON | M-PCM | 28-20,22 |
| RCS "A" HE PRESS | GR1101P | PRESS MON C&W | COMMON | M-PCM | 28-23,25 |
| RCS "B" HE PRESS | GR1102P | PRESS MON C&W | COMMON | M-PCM | 28-23,25 |
| RCS "A" FUEL TEMP | GR2121T | TEMP MON | COMMON | M-PCM | 28-20 |
| RCS "B" FUEL TEMP | GR2122T | TEMP MON | OMMON | M-PCM | 28-20 |
| RCS MAIN "A" CLSD | GR9609U | MAIN SOV | COMMON | HD | |
| RCS MAIN "B" CLSD | GR9610U | MAIN SOV | COMMON | HD | |
| RCS "A" FUEL MFLD PRESS | GR2201P | PRESS MON | COMMON | M | 28-20,24,25 |
| RCS "B" FUEL MFLD PRESS | GR2202P | PRESS MON | COMMON | M | 28-20,24,25 |
| RCS "A" OX MFLD PRESS | GR3201P | PRESS MON | COMMON | M | 28-20,24,25 |
| RCS "B" OX MFLD PRESS | GR3202P | PRESS MON | COMMON | M | 28-20,24,25 |
| A/B XFEED OPEN | GR9613U | CRSFD | COMMON | HD | |
| QUAD 1 "A" TCA ISOL VLV | GR9667U | SYS A QUAD 1 | COMMON | HD | 28-21 |
| QUAD 2 "A" TCA ISOL VLV | GR9665U | SYS A QUAD 2 | COMMON | HD | 28-21 |
| QUAD 3 "A" TCA ISOL VLV | GR9663U | SYS A QUAD 3 | COMMON | HD | 28-21 |
| QUAD 4 "A" TCA ISOL VLV | GR9661U | SYS A QUAD 4 | COMMON | HD | 28-21 |
| QUAD 1 "B" TCA ISOL VLV | GR9668U | SYS B QUAD 1 | COMMON | HD | 28-21 |
| QUAD 2 "B" TCA ISOL VLV | GR9666U | SYS B QUAD 2 | COMMON | HD | 28-21 |
| QUAD 3 "B" TCA ISOL VLV | GR9664U | SYS B QUAD 3 | COMMON | HD | 28-21 |
| QUAD 4 "B" TCA ISOL VLV | GR9662U | SYS B QUAD 4 | COMMON | HD | 28-21 |
| QUAD 1 TEMP | GR6004T | TEMP MON C&W | COMMON | M | 28-26 |
| QUAD 2 TEMP | GR6003T | TEMP MON C&W | COMMON | M | 28-26 |
| QUAD 3 TEMP | GR6002T | TEMP MON C&W | COMMON | M | 28-26 |
| QUAD 4 TEMP | GR6001T | TEMP MON C&W | COMMON | M | 28-26 |
| ASC FEED OXID "A" OPEN | GR9641U | SYS A ASC OXID ASC FUEL | COMMON | HD | |
| ASC FEED FUEL "A" OPEN | GR9631U | SYS A ASC OXID ASC FUEL | COMMON | HD | |
| ASC FEED FUEL "B" OPEN | GR9632U | SYS B ASC OXID ASC FUEL | COMMON | HD | |
| ASC FEED OXID "B" OPEN | GR9642U | SYS B ASC OXID ASC FUEL | COMMON | HD | |

29 SPACE
ENVIRONMENT

| REV | ITEM | |
|---|---|---|
| | | **GENERAL** |
| | 29-1 | ALL DECISIONS WILL BE BASED ON CONFIRMED MEASUREMENTS AND/OR EVENTS AND PROJECTIONS BASED ON CONFIRMED EVENTS. |
| | 29-2 | DEFINITIONS:<br>A. THE MAXIMUM OPERATIONAL DOSE (MOD) IS THE MAXIMUM RADIATION DOSE TO WHICH THE CREW WOULD BE SUBJECTED BASED ON A SKIN DOSE OF 400 RAD AND/OR A DEPTH (GASTRO INTESTINAL) DOSE OF 50 RAD.<br>B. THE PLANNING OPERATIONAL DOSE (POD) IS THE MAXIMUM RADIATION DOSE TO THE CREW WHICH ANY MISSION WOULD BE DESIGNED DURING THE PLANNING PERIOD BASED ON A SKIN DOSE OF 250 RAD AND/OR A DEPTH DOSE OF 25 RAD.<br>C. RADIATION DOSES DETERMINE THE POINT WHERE A DECISION MUST BE MADE AS TO WHETHER TO CONTINUE OR TERMINATE THE MISSION.<br>D. THE RADIATION ABSORBED DOSE (RAD) IS A UNIT OF ABSORBED DOSE WHICH IS EQUAL TO AN ENERGY DEPOSITION OF 100 ERGS/GRAM.<br>E. THE RELATIVE BIOLOGICAL EFFECTIVENESS (RBE) EXPRESSES THE EFFECTIVENESS OF PARTICULAR TYPES OF RADIATION IN PRODUCING THE SAME BIOLOGICAL RESPONSE. |
| | | **MANAGEMENT** |
| | 29-3 | THE EXISTING AND PROJECTED ENVIRONMENT WILL BE A PART OF THE GO/NO-GO DECISION PROCESS. |
| | 29-4 | DUE TO THE SHIELDING CAPABILITY OF THE VAN ALLEN BELTS, THERE ARE NO RADIATION HAZARDS TO THE APOLLO 9 MISSION FROM SOLAR FLARE PARTICLE EVENTS. |
| | 29-5 | PRIORITY OF DATA FOR ARTIFICAL RADIATION<br>A. PRELAUNCH<br>1. RIOMETERS<br>2. SOUTH ATLANTIC ANOMALY PROBE (SAAP)<br>B. EARTH ORBIT<br>1. PERSONAL RADIATION DOSIMETER (PRD) AND RATE SURVEY METER (RSM)<br>2. RIOMETERS<br>3. SOUTH ATLANTIC ANOMALY PROBE |
| | | RULE NUMBERS 29-6 THROUGH 29-9 ARE RESERVED. |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| | 29-10 | ANY SOURCE REPORTS A POSSIBLE ARTIFICAL EVENT | ALL | PROCEED UNTIL VERIFICATION FROM ALL OTHER SOURCES | |
| | 29-11 | DEFINITE ARTIFICAL EVENT CONFIRMED AND NO DIRECT S/C MEASUREMENTS ARE AVAILABLE | PRELAUNCH | A.1. HOLD UNTIL DIRECT MEASUREMENT OF SOUTH ATLANTIC ANOMALY HAS BEEN MADE AND ANALYZED<br>2. SCRUB IF ANALYSIS CONFIRMS THAT THE MOD WILL BE EXCEEDED DURING THE MISSION. | |
| | | | EARTH ORBIT | B.1. RETURN TO CSM IF LM IS MANNED<br>2. CONTINUE MISSION LOWER ORBIT TO THE MINIMUM ALTITUDE THAT CAN BE SUSTAINED. | B.1. CREW SHOULD BEGIN PERSONAL DOSIMETER READOUTS PER SOP 1-9. |
| | 29-12 | RADIATION CONFIRMED BY PRD READOUTS OR ONBOARD TM AND PROJECTED TO EXCEED THE MOD. | EARTH ORBIT | REENTER NEXT BEST PTP | |
| | 29-13 | MAJOR SOLAR FLARE PREDICTED | ALL | CONTINUE MISSION | |
| | 29-14 | MAJOR SOLAR FLARE HAS OCCURRED | ALL | | |
| | | A. UNCONFIRMED PARTICLE EVENT | | A. CONTINUE MISSION | |
| | | B. CONFIRMED PARTICLE EVENT | | B. CONTINUE MISSION | |

| REV | ITEM | |
|---|---|---|
| | 29-15 | **INSTRUMENTATION REQUIREMENTS** |

| MEAS DESCRIPTION | | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|---|
| RADIATION DOSIMETER 1 (CM DEPTH DOSE RATE) | VABD | CK1051K | - | - | H.D. | 29-12 |
| RADIATION DOSIMETER 2 (CM SKIN DOSE RATE) | VABD | CK1052K | - | - | H.D. | 29-12 |
| DOSIMETER RATE CHANGE | VABD | CK1053R | - | - | H.D. | 29-12 |
| PROTON COUNT RATE CHAN 1 | NPDS | ST0820K | - | - | H.D. | 29-12 |
| PROTON COUNT RATE CHAN 2 | NPDS | ST0821K | - | - | H.D. | 29-12 |
| PROTON COUNT RATE CHAN 3 | NPDS | ST0822K | - | - | H.D. | 29-12 |
| PROTON COUNT RATE CHAN 4 | NPDS | ST0823K | - | - | H.D. | 29-12 |
| ALPHA COUNT RATE CHAN 1 | NPDS | ST0830K | - | - | H.D. | 29-12 |
| ALPHA COUNT RATE CHAN 2 | NPDS | ST0831K | - | - | H.D. | 29-12 |
| ALPHA COUNT RATE CHAN 3 | NPDS | ST0832K | - | - | H.D. | 29-12 |
| PROTON INTEGR COUNT RATE | NPDS | ST0838K | - | - | H.D. | 29-12 |
| TEMP NUCLEAR PARTICLE DETECTOR | NPDS | ST0840T | - | - | H.D. | 29-12 |
| TEMP NUCLEAR PARTICLE ANALYSIS | NPDS | ST0841T | - | - | H.D. | 29-12 |
| PERSONAL RADIATION DOSIMETER (PRD) | | - | 3 - ONBOARD | - | MANDATORY TO BE ONBOARD | 29-12 |
| RATE SURVEY METER (RSM) | | - | 1 - ONBOARD | - | MANDATORY TO BE ONBOARD | 29-12 |

30 RECOVERY

| REV | ITEM | |
|---|---|---|
| A | 30-1 | A PREFERRED TARGET POINT (PTP) PROVIDING A WATER LANDING WILL BE CHOSEN FOR EACH REVOLUTION. AN ALTERNATE TARGET POINT (ATP) PROVIDING A WATER LANDING MAY BE CHOSEN DURING THE MISSION FOR CERTAIN REVOLUTIONS SHOULD THE NEED ARISE. |
| | 30-2 | RECOVERY CAPABILITY WILL BE BASED PRIMARILY UPON THE LOCAL RECOVERY UNIT COMMANDER'S EVALUATION OF HIS ABILITY TO PERFORM THE RECOVERY OPERATION. ONE OF THE FACTORS WHICH WILL DETERMINE RECOVERY CAPABILITY IS WEATHER. GUIDELINES USED TO INDICATE WHEN IT MAY BE NECESSARY TO REEVALUATE THIS CAPABILITY ARE:<br>SURFACE WINDS - 25 KNOTS<br>CEILING - 1500 FEET<br>VISIBILITY - 3 N.MI.<br>WAVE HEIGHT - 8 FEET |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 30-3 | RECOVERY CAPABILITY IN THE LAUNCH SITE AREA AT THE TIME OF LES ARMING | PRELAUNCH | MANDATORY | |
| | 30-4 | RECOVERY CAPABILITY IN THE LAUNCH ABORT AREA AT LAUNCH | PRELAUNCH | HIGHLY DESIRABLE | |
| | 30-5 | RECOVERY CAPABILITY IN THE WEST ATLANTIC AND MID-PACIFIC RECOVERY ZONES DURING THE FIRST 6 REVOLUTIONS WHEN LANDINGS MAY OCCUR. | PRELAUNCH | HIGHLY DESIRABLE | |
| | 30-6 | IT IS REQUIRED THAT 18 HOURS OF CM POSTLANDING POWER (35 AMP HOURS) BE AVAILABLE AT LANDING | ORBIT/ ENTRY | MANDATORY | THIS TIME MAY BE REDUCED ONLY TO PROVIDE FOR A MORE FAVORABLE LANDING POINT. |

31 AEROMEDICAL

| REV | ITEM | GENERAL |
|---|---|---|
| | 31-1 | PRELAUNCH<br><br>PRIOR TO COMMITTING TO LAUNCH, THE FOLLOWING CONDITIONS MUST BE MET:<br><br>A. SATISFACTORY FLIGHT CREW PHYSIOLOGICAL STATUS.<br><br>B. THE MINIMUM CABIN OXYGEN CONCENTRATION FOR LAUNCH IS 60 PERCENT.<br><br>C. THE MINIMUM SUIT OXYGEN CONCENTRATION FOR LAUNCH IS 95 PERCENT. |
| | 31-2 | THE SUIT CIRCUIT MUST BE MAINTAINED AT LEAST 2 IN. WATER PRESSURE ABOVE THE CABIN PRESSURE. SUIT LOOP PURGE IS REQUIRED IF THE SUIT-TO-CABIN DELTA PRESSURE REMAINS AT ZERO FOR A PERIOD OF 5 MINUTES. |
| | 31-3 | THE POTABLE WATER PH MUST BE WITHIN 6.0 TO 8.0 AT SERVICING AND FINAL SAMPLING. |
| | 31-4 | LAUNCH<br><br>THERE ARE NO MEDICAL REASONS FOR ABORTING DURING THE LAUNCH PHASE OTHER THAN THOSE CONDITIONS INTOLERABLE TO THE CREW. |
| | 31-5 | ORBIT<br><br>EARLY MISSION TERMINATION FOR MEDICAL REASONS FALL INTO TWO CATEGORIES:<br><br>A. ONSET OF CONDITIONS WHICH ADVERSELY AFFECT CREW SAFETY, HEALTH, OR FUNCTION AND PERFORMANCE.<br><br>B. FAILURE OF SPACECRAFT SYSTEMS TO MAINTAIN A PHYSIOLOGICALLY SATISFACTORY ENVIRONMENT. |
| | 31-6 | WATER PALATABILITY<br><br>CREW EVALUATION OF THE DRINKING WATER TASTE WILL BE THE BASIS FOR DETERMINING WATER PALATABILITY, EVEN FOR KOH CONTAMINATION. |
| | | RULE NUMBERS 31-7 THROUGH 31-14 ARE RESERVED |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| | 31-15 | LOSS OR UNREADABLE EKG | LAUNCH | A. CONTINUE MISSION | ARTIFACTS ANTICIPATED DURING LAUNCH. |
| | | | EVA | B. CONTINUE MISSION | ARTIFACTS ANTICIPATED AFTER TRANSFER WHILE IN LM.<br>MCC SURGEON WILL EVALUATE THE PROBLEM AND MAY RECOMMEND TERMINATION OF EVA ACTIVITY. |
| | | | ALL | C. CONTINUE MISSION | MCC SURGEON WILL EVALUATE THE PROBLEM AND MAY RECOMMEND EARLY MISSION TERMINATION IF CORRECTIVE ACTION IS NOT EFFECTIVE. |
| | 31-16 | ABNORMAL HEART RATE, RHYTHM OR EKG | ALL | CONTINUE MISSION | MCC SURGEON WILL EVALUATE THE PROBLEM AND MAY RECOMMEND EARLY MISSION TERMINATION IF CORRECTIVE ACTION IS NOT EFFECTIVE. |
| | 31-17 | ABNORMAL RESPIRATORY RATE | ALL | CONTINUE MISSION | THE ABNORMAL RATES WILL BE EVALUATED BY THE MCC SURGEON AND EARLY MISSION TERMINATION MAY BE RECOMMENDED IF CORRECTIVE ACTION IS NOT EFFECTIVE. |
| | 31-18 | ONSET OF SERIOUS MEDICAL PROBLEM | LAUNCH | A. CONTINUE MISSION<br>CREW MAY ELECT TO ABORT IF INTOLERABLE | MCC SURGEON WILL EVALUATE AND MAY RECOMMEND EARLY MISSION TERMINATION IF CORRECTIVE ACTION IF NOT EFFECTIVE. |
| | | | ALL | B. CONTINUE MISSION | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 31-19 | DYSBARISM IN ANY CREWMAN | LAUNCH | A. CONTINUE MISSION<br>CREW MAY ELECT TO ABORT IF CONDITION IS INTOLERABLE. | • CHECK SUIT INTEGRITY.<br>• IF CONDITIONS PERMIT CREW MAY ELECT TO OVER-PRESSURIZE.<br>• MCC SURGEON WILL EVALUATE AND MAY RECOMMEND EARLY MISSION TERMINATION IF CORRECTIVE ACTION IS NOT EFFECTIVE. |
| | | | ALL | B. TERMINATE PHASE<br>ENTER NEXT BEST PTP | |
| | 31-20 | ORAL TEMP EXCEEDS 101°F DESPITE CORRECTIVE ACTION. | | | MCC SURGEON MAY RECOMMEND EARLY MISSION TERMINATION IF TREATMENT IS UNSUCCESSFUL. |
| | | A. IF DUE TO ILLNESS | LAUNCH | A.1. NOT APPLICABLE | |
| | | | ALL | 2. TERMINATE PHASE<br>ENTER NEXT BEST PTP | |
| | | B. IF RESULTANT FROM THERMAL OVERLOAD | LAUNCH | B.1. NOT APPLICABLE | |
| | | | ALL | 2. TERMINATE PHASE<br>ENTER NEXT BEST PTP | |
| | | RULE NUMBERS 31-21 THROUGH 31-24 ARE RESERVED | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 31-25 | INCREASE IN $PCO_2$ | | | |
| | | A. ≥7.6 MM HG | LAUNCH | A.1. CONTINUE MISSION | A. $PCO_2$ SHOULD DECREASE BELOW 2 MM HG WITHIN 30 MINUTES. |
| | | | ALL | 2. CONTINUE MISSION<br>CHANGE LiOH CANISTER | |
| | | B. ≥7.6 MM HG AND UNABLE TO DECREASE | LAUNCH | B.1. CONTINUE MISSION | |
| | | | ALL | 2. CONTINUE MISSION<br>(A) OPEN SUITS AND BREATHE FROM CABIN<br>(B) CHANGE SECOND LiOH CANISTER<br>(C) TEST $PCO_2$ SENSOR | B.2. LiOH CANISTERS WILL NOT BE CHANGED IN AN UN-PRESSURIZED CABIN. |
| | | C. ≥10 MM HG | LAUNCH | C.1. CONTINUE MISSION | |
| | | | ALL | 2. TERMINATE PHASE<br>ENTER NEXT BEST PTP | |
| | 31-26 | $PCO_2$ INSTRUMENTATION FAILURE | ALL | CONTINUE MISSION | |
| | | RULE NUMBERS 31-27 THROUGH 31-34 ARE RESERVED | | | |

| REV | ITEM | |
|---|---|---|

## INSTRUMENTATION REQUIREMENTS

CSM

31-35

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| ELECTROCARDIOGRAM | CJ0060J | NOT DISPLAYED | | MANDATORY* | 31-15/16 |
| ELECTROCARDIOGRAM | CJ0061J | NOT DISPLAYED | | MANDATORY* | 31-15/16 |
| ELECTROCARDIOGRAM | CJ0062J | NOT DISPLAYED | | MANDATORY* | 31-15/16 |
| $CO_2$ PARTIAL PRESSURE | CJ0005P | METER | COMMON | HIGHLY DESIRABLE | 31-2/27/28 |
| SUIT CABIN DELTA PRESS | CF0003P | NOT DISPLAYED | | HIGHLY DESIRABLE | 31-3/10 |
| ORAL TEMPERATURE | | CLINICAL THERMOMETER | | MANDATORY* | 31-20 |
| PNEUMOGRAM | CJ0200R | NOT DISPLAYED | | HIGHLY DESIRABLE | 31-17 |
| PNEUMOGRAM | CJ0201R | NOT DISPLAYED | | HIGHLY DESIRABLE | 31-17 |
| PNEUMOGRAM | CJ0202R | NOT DISPLAYED | | HIGHLY DESIRABLE | 31-17 |

LM

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| $CO_2$ PARTIAL PRESSURE | GF1521P | METER | | HIGHLY DESIRABLE | |
| ELECTROCARDIOGRAM | GT9999 | NOT DISPLAYED | | HIGHLY DESIRABLE | 31-15/16 |
| PNEUMOGRAM | | NOT DISPLAYED | | HIGHLY DESIRABLE | 31-17 |

NOT IN LM (?)

PLSS

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|---|
| PLSS ELECTROCARDIOGRAM | GT8124J | | | MANDATORY | 31-15/16 |

*MANDATORY TO CABIN CLOSEOUT

32 COMMUNICATIONS/ INSTRUMENTATION

| REV | ITEM | GENERAL |
|---|---|---|
| | 32-1 | TO INITIATE AND CONTINUE THE FOLLOWING MISSION PHASES, THE CSM, LM, AND EVA COMMUNICATIONS AND INSTRUMENTATION SYSTEMS MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES:<br>A. LAUNCH<br>THERE ARE NO COMMUNICATIONS/INSTRUMENTATION FAILURES FOR WHICH THE LAUNCH/INSERTION PHASE WILL BE TERMINATED.<br>B. ALL PHASES EXCEPT LAUNCH<br>1. CRITICAL ONBOARD DISPLAYS<br>2. TWO-WAY VOICE COMM BETWEEN ALL CREWMEN/SPACECRAFT. NOTE: THIS MAY BE SATISFIED BY UMBILICAL INTERCOM EXCEPT FOR THE DOCKED DPS BURN, EVA, OR RENDEZVOUS.<br>3. TWO-WAY VOICE COMM BETWEEN CSM OR LM AND MSFN DURING ALL DOCKED ACTIVITIES AND BETWEEN BOTH SPACECRAFT AND MSFN DURING UNDOCKED ACTIVITIES.<br>C. RENDEZVOUS<br>1. TWO-WAY VOICE COMM BETWEEN CSM AND LM WITH BACKUP<br>2. LM AND CSM OPERATIONAL TELEMETRY |
| | 32-2 | LM DFI DATA IS MANDATORY TO LIFTOFF, BUT LOSS OF DFI DATA WILL NOT CONSTRAIN ORBITAL PHASES (A KSC HOLD RESPONSIBILITY). |
| | 32-3 | THE MISSION WILL BE CONTINUED WITH THE LOSS OF:<br>A. EITHER OR BOTH THE CSM AND THE LM UPDATA LINK<br>B. EITHER OR BOTH THE CSM AND THE LM CAUTION AND WARNING SYSTEM<br>C. THE CSM DATA STORAGE EQUIPMENT<br>D. PLSS TELEMETRY |
| | 32-4 | S-BAND ONE-WAY RELAY IS EXPLAINED AS:<br>A. PLANNED - CSM<br>B. BACKUP - LM |
| | 32-5 | VHF EVA COMMUNICATIONS PRIORITIES ARE:<br>A. PRIMARY (PLANNED) EMU COMMUNICATIONS ARE DUPLEX B, EMU TRANSMIT 259.7 MHZ RECEIVE 296.8 MHZ.<br>B. SECONDARY (BACKUP) EMU COMMUNICATIONS ARE DUPLEX A, EMU TRANSMIT 296.8 MHZ RECEIVE 259.7 MHZ. |
| | | RULE NUMBERS 32-6 THROUGH<br>32-9 ARE RESERVED. |

| REV | ITEM | MANAGEMENT |
|---|---|---|
| A | 32-10 | CSM/LM/PLSS COMM MANAGEMENT<br>A. RECONFIGURATION OF COMMUNICATION EQUIPMENT DURING EVA WILL BE AVOIDED IF POSSIBLE.<br>B. ANY S/C VHF (A/C VOICE) ANTENNA WILL BE DEACTIVATED IF IT WILL BE RADIATING WHEN AN OPERATING PLSS IS WITHIN 3.5 FEET. |
| A | 32-11 | VOICE CONFIGURATION<br>A. LM/CSM/MSFN CONFERENCE<br>1. VHF A SIMPLEX 296.8 MHZ IS PRIME EXCEPT:<br>(A) PRELAUNCH THRU CYI, REV 1 WHERE THE CSM/MSFN LOOP WILL BE DUPLEX B.<br>(B) OVER DSIF SITES WHERE S-BAND WILL BE USED.<br>2. S-BAND IS BACKUP TO THE VHF A AND WILL BE DOWNLINKED SIMULTANEOUSLY WHERE PRACTICAL.<br>3. VHF B SIMPLEX 295.7 MHZ IS AN ALTERNATE BACKUP TO VHF A, BUT WILL BE USED ONLY IF REQUIRED.<br>B. LM/CSM/EVA/MSFN CONFERENCE<br>1. CSM ONE-WAY RELAY WITH EMU PRIMARY IS PLANNED FOR EVA OPERATIONS; CSM: DUPLEX A, RECEIVE A ONLY; LM: TRANSMIT A, RECEIVE A AND B.<br>2. CSM ONE-WAY RELAY WITH EMU SECONDARY IS BACKUP FOR EVA; CSM: SIMPLEX B, RECEIVE A ONLY; LM: TRANSMIT B, RECEIVE A AND B.<br>3. LM ONE-WAY RELAY WITH EMU PRIMARY IS AN ALTERNATE; CSM: DUPLEX A, RECEIVE A ONLY; LM: TRANSMIT A, RECEIVE A AND B.<br>4. LM ONE-WAY RELAY WITH EMU SECONDARY IS A SECOND ALTERNATE; CSM: SIMPLEX B, RECEIVE A ONLY; LM: TRANSMIT B, RECEIVE A AND B. |
| | 32-12 | TELEMETRY CONFIGURATION<br>A. S-BAND TELEMETRY IS PRIME FOR BOTH LM AND CSM EXCEPT OVER SINGLE AND MODIFIED USB SITES WHERE THE LM DFI VHF TRANSMITTER "B" 237.8 MHZ WILL BE USED.<br>B. LM DFI POSTFLIGHT ANALYSIS DATA WILL BE PREDETECTION RECORDED FOR SPECIFIC EVENTS DURING LM CHECKOUT AND THE RENDEZVOUS. |
| | 32-13 | CSM VHF/USB MANAGEMENT<br>A. SPACECRAFT AND GROUND WILL TRANSMIT SIMULTANEOUSLY ON VHF A 296.8 MHZ AND S-BAND FOR ORBIT PHASE.<br>B. FOR CREW REST PERIODS, CSM S-BAND ANTENNA B WILL BE SELECTED. RTC CAN SWITCH TO OMNI D.<br>C. NORMAL CONTROL OF THE S-BAND MODES WILL BE BY GROUND COMMAND. CSM COMMUNICATIONS SWITCH POSITION WILL REFLECT OUT-OF-SITE CONTACT CONFIGURATION.<br>D. HIGH POWER MODE ON PM POWER AMPLIFIER WILL BE USED CONTINUOUSLY, EXCEPT DURING HGA TESTS. DURING THIS TEST, BYPASS MODE WILL BE USED. |

| REV | ITEM | |
|---|---|---|
| A | 32-14 | DSE MANAGEMENT<br>A. LM AND CSM LOW BIT RATE TELEMETRY WILL BE RECORDED CONTINUOUSLY WHEN NOT IN CONTACT WITH GROUND TELEMETRY SITES AND WILL BE PLAYED BACK AT LEAST ONCE PER REVOLUTION. DURING RENDEZVOUS, NO LM LOW-BIT RATE DATA WILL BE RECORDED ON CSM DSE.<br>B. CM HIGH BIT RATE DSE RECORDINGS WILL BE MADE DURING THE FOLLOWING OPERATIONS:<br>1. LAUNCH<br>2. S-IVB/CSM SEPARATION<br>3. ALL SPS MANEUVERS<br>4. DEORBIT MANEUVER, CM/SM SEPARATION AND ENTRY<br>5. DTO REQUIREMENTS (TBD) |
| | 32-15 | CTE AND MISSION TIMER MANAGEMENT<br>A. CTE AND THE MISSION TIMER WILL BE CONFIGURED TO CLOCK IN GET FOR FLIGHT: HOWEVER, IF A HOLD OCCURS AFTER T-15 MINUTES, CTE WILL NOT BE CORRECTED UNTIL COMPLETION OF POWERED FLIGHT.<br>B. CTE AND THE MISSION TIMER WILL BE ALLOWED TO DRIFT ±5 SECONDS BEFORE BEING UPDATED, AFTER ORBIT INSERTION. |
| | 32-16 | LM USB MANAGEMENT<br>HIGH POWER MODE WILL BE USED CONTINUOUSLY DURING PM AND FM TRANSMISSIONS EXCEPT DURING THE STEERABLE ANTENNA TEST AND MODE 7 CHECK. |
| | | RULE NUMBERS 32-17 THROUGH 32-19 ARE RESERVED. |

**NASA — Manned Spacecraft Center**

**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | SPECIFIC MISSION RULES | |
| | 32-20 | LOSS OF TWO-WAY DIRECT VOICE COMM BETWEEN S/C | DOCKED | A. CONTINUE MISSION DO NOT UNDOCK | REF MALF PROC ________. LM LOSS OF VHF A VOICE NO. 4 UTILIZE TRANSFER UMBILICAL TO MAINTAIN COMMUNICATIONS. |
| | | | UNDOCKED | B. DOCK ASAP | |
| | | | RNDZ | C. DO NOT PERFORM SEPARATION, PHASING, OR INSERTION BURNS IF AFTER INSERTION, LM PERFORMS ALL MANEUVERS. | |
| | | | EVA | D. CONTINUE MISSION LMP ACTS AS RELAY BETWEEN CDR AND CMP | |
| | 32-21 | LOSS OF VOICE COMM WITH MSFN | | | |
| | | A. EITHER S/C | DOCKED | A.1. CONTINUE MISSION DO NOT UNDOCK | REF MALF PROC LM LOSS OF VHF VOICE COMM WITH MSFN NO. 3 |
| | | | EVA | 2. TERMINATE EVA | |
| | | | UNDOCKED | 3. DOCK ASAP | |
| | | | RNDZ | 4. TERMINATE RNDZ AT NEXT EXIT POINT | |
| | | B. CSM ONLY | LAUNCH | B.1. CONTINUE MISSION | |
| | | | ORBIT (SOLO) | 2. ENTER NEXT BLOCK DATA POINT | |
| A | 32-22 | LOSS OF PRIMARY EMU TWO-WAY VOICE COMM | | | |
| | | A. WITH EITHER LM OR CSM | EVA | A. CONTINUE MISSION CMP OR CDR WILL ACT AS VOICE RELAY TO LMP | |
| \| | | B. WITH BOTH LM AND CSM | EVA | B. CONTINUE MISSION<br>1. LMP RETURN TO VISUAL VICINITY OF NEAREST CREWMAN.<br>2. RECONFIGURE TO EMU SECONDARY VOICE COMM.<br>3. IF COMMUNICATION NOT REESTABLISHED TERMINATE EVA | REF MALF PROC 5-18, 5-21 |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 32-23 | LOSS OF EITHER SPACECRAFT PCM TELEMETRY AND: | | | • MUST COMPARE GROUND AND ONBOARD SOLUTIONS VIA DSKY AND VOICE UPDATES. |
| | | A. ONBOARD DISPLAYS NORMAL AND NO PENDING SYSTEMS PROBLEMS | ALL | A.1. CONTINUE MISSION<br>REF ALTERNATE MISSION B | • MUST COMMAND UNMANNED APS BURN IN THE BLIND. |
| | | | UNDOCKED | 2. DO NOT PERFORM SEPARATION MANEUVER | • MANDATORY/DFI DATA WILL BE RETRIEVED. |
| | | | RNDZ | 3. LM RETURN TO VICINITY OF CSM ASAP | |
| | | B. LOSS OF CRITICAL ONBOARD DISPLAYS | | | |
| | | 1. CSM | LAUNCH | B.1.(A) CONTINUE MISSION<br>(B) ENTER NEXT BEST PTP | |
| | | 2. LM | ALL | 2. TRANSFER TO CSM<br>SETUP FOR UNMANNED APS BURN | B.2. WITH NO DFI TELEMETRY THE UNMANNED APS BURN WILL NOT BE ATTEMPTED. |
| A | | RULE NUMBERS 32-24 THROUGH 32-39 ARE RESERVED. | | | |

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**MISSION RULES**

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | CUES/NOTES/COMMENTS |
|---|---|---|---|---|---|
| | 32-23 | LOSS OF EITHER SPACECRAFT PCM TELEMETRY AND: | | | • MUST COMPARE GROUND AND ONBOARD SOLUTIONS VIA DSKY AND VOICE UPDATES.<br>• MUST COMMAND UNMANNED APS BURN IN THE BLIND.<br>• MANDATORY/DFI DATA WILL BE RETRIEVED. |
| | | A. ONBOARD DISPLAYS NORMAL AND NO PENDING SYSTEMS PROBLEMS | ALL | A.1. <u>CONTINUE MISSION</u><br>REF ALTERNATE MISSION B | |
| | | | UNDOCKED | 2. DO NOT PERFORM SEPARATION MANEUVER | |
| | | | RNDZ | 3. LM RETURN TO VICINITY OF CSM ASAP | |
| | | B. LOSS OF CRITICAL ONBOARD DISPLAYS | | | |
| | | 1. CSM | LAUNCH | B.1.(A) <u>CONTINUE MISSION</u><br>(B) <u>ENTER NEXT BEST PTP</u> | |
| | | 2. LM | ALL | 2. <u>TRANSFER TO CSM</u><br>SETUP FOR UNMANNED APS BURN | B.2. WITH NO DFI TELEMETRY THE UNMANNED APS BURN WILL NOT BE ATTEMPTED. |

**NASA --- Manned Spacecraft Center**

**MISSION RULES**

| REV | ITEM | |
|---|---|---|
| A | 32-40 | CSM - INSTRUMENTATION REQUIREMENTS |

| MEAS DESCRIPTION | PCM | ONBOARD | TRANSDUCERS | CATEGORY | MISSION RULE REF |
|---|---|---|---|---|---|
| UDL VALIDITY SIGNAL | CT0262V | ----- | ------- | HD | 13-10B, 10E, 11C |
| USB RECEIVER AGC | CT0620E | METER | COMMON | HD | 13-10B |
| USB RECEIVER AGC | METER | ----- | ------- | HD | 13-10B |
| USB REC ERROR | CT0640F | ----- | ------- | HD | |
| DSE TAPE MOTION | CT0012X | TB | ------- | HD | 13-11 |
| CTE TIME | CT0145F | ----- | ------- | HD | 13-11 |
| SCE 10 VDC | CT0018V | ----- | ------- | HD | |
| SCE 5 VDC | CT0017V | ----- | ------- | HD | |
| SCE 20 VDC | CT0015V | ----- | ------- | HD | |
| SCE -20 VDC | CT0016V | ----- | ------- | HD | |
| PCM HI REF 85 PERCENT | CT0125V | ----- | ------- | HD | |
| PCM HI REF 15 PERCENT | CT0126V | ----- | ------- | HD | |

| REV | ITEM | |
|---|---|---|
| A | 32-41 | **LM - INSTRUMENTATION REQUIREMENTS** |

| MEAS DESCRIPTION | PCM | ONBOARD | CATEGORY | MISSION RULE REFERENCE |
|---|---|---|---|---|
| PCM OSC FAIL 2 | GL0422V | ------- | 1 OF 2 | |
| PCM OSC FAIL 3 | GL0423V | ------- | HD | |
| CAL 85 PCT | GL0401V | ------- | HD | |
| CAL 15 PCT | GL0402V | ------- | HD | |
| MET | GL0501W | ------- | M | |
| C&W PWR FAIL | GL4054X | CAUTION | HD | 24-23 |
| MASTER ALARM | GL4069X | MASTER ALARM | HD | 24-23 |
| S-BND PWR AMP PO | GT0201E | ------- | HD | 24-14C |
| DCA STATUS | GT0441X | ------- | M | 24-22 |
| UHF SIG STR | GT0619V | ------- | M | 24-22 |
| S-BND ST PH ERR | GT0992B | ------- | HD | |
| S-BND RCVR SIG | GT0994V | METER | HD | 24-14D |

APPENDICES

A ACRONYMS AND SYMBOLS

## NASA — Manned Spacecraft Center
### MISSION RULES

| REV | ITEM | | |
|---|---|---|---|

| | |
|---|---|
| AC | ALTERNATING CURRENT |
| ACA | ATTITUDE CONTROLLER ASSEMBLY |
| ACCEL | ACCELEROMETER |
| ACCUM | ACCUMULATOR |
| ACS | ATTITUDE CONTROL AND STABILIZATION SYSTEM |
| ACT | ACTUATOR |
| ADEG | AUXILIARY DISPLAY EQUIPMENT GROUP |
| AEA | ABORT ELECTRONICS ASSEMBLY |
| AELD | ASCENT ENGINE LATCHING DEVICE |
| AFD | ASSISTANT FLIGHT DIRECTOR |
| AFETR | AIR FORCE EASTERN TEST RANGE |
| A/G | AIR-TO-GROUND |
| AGS | ABORT GUIDANCE SYSTEM |
| ALDS | APOLLO LAUNCH DATA SYSTEM |
| ALT | ALTERNATE |
| AM | AMPLITUDE MODULATION |
| AMP | AMPERE(S) |
| ANT | ANTENNA |
| AOA | ANGLE OF ATTACK |
| AOH | APOLLO OPERATIONS HANDBOOK |
| AOT | ALIGNMENT OPTICAL TELESCOPE |
| APS | ASCENT PROPULSION SYSTEM |
| APS | AUXILIARY PROPULSION SYSTEM |
| ARIA | APOLLO RANGE INSTRUMENTATION AIRCRAFT |
| ASA | ABORT SENSOR ASSEMBLY |
| ASAP | AS SOON AS PRACTICAL |
| ASC | ASCENT |
| ATCA | ATTITUDE TRANSLATION CONTROLLER ASSEMBLY |
| ATP | ALTERNATE TARGET POINT |
| ATT | ATTITUDE |
| AUX | AUXILIARY |
| AZUSA | ELECTRONIC TRACKING AND VECTORING SYSTEM (ETR) |
| BA | BANK ANGLE |
| BAT | BATTERY |
| BDA | BERMUDA (MSFN REMOTED SITE) |
| B/H | BLOCK HOUSE |
| BMAG | BODY MOUNTED ATTITUDE GYRO |
| BRSO | BERMUDA RANGE SAFETY OFFICER |
| BSE | BOOSTER SYSTEMS ENGINEER |
| BTU | BRITISH THERMAL UNIT |
| CAL | CALIBRATE |
| CASTS | COUNTDOWN AND STATUS TRANSMISSION SYSTEM |
| CB | CIRCUIT-BREAKER |
| CCATS | COMMAND, COMMUNICATIONS, AND TELEMETRY SYSTEM |
| CCW | COUNTERCLOCKWISE |
| CDH | CONSTANT DELTA HEIGHT |
| CDP | COMMAND DATA PROCESSOR |
| CDR | COMMANDER |
| CDU | COUPLING DATA UNIT |
| CES | CONTROL ELECTRONICS SYSTEM |
| CFM | CUBIC FEET PER MINUTE |
| CIF | CENTRAL INSTRUMENTATION FACILITY |
| CIM | COMPUTER INPUT MATRIX |
| CKT | CIRCUIT |
| CLTC | CHIEF LAUNCH VEHICLE TEST CONDUCTOR |
| CM | COMMAND MODULE |
| CMC | COMMAND MODULE COMPUTER |
| CMD | COMMAND |
| CMP | COMMAND MODULE PILOT |
| C/O | CUTOFF |
| $CO_2$ | CARBON DIOXIDE |
| COAS | CREW OPTICAL ALIGNMENT SIGHT |
| COI | CONTINGENCY ORBIT INSERTION |
| COMM | COMMUNICATION |
| CONF | CONFERENCE |
| CONTROL | LM GNC SYSTEMS ENGINEER |
| CP | COMMUNICATIONS PROCESSOR |
| CRO | CARNARVON (MSFN REMOTED SITE) |
| CRYO | CRYOGENICS |
| CSI | CONCENTRIC SEQUENCE INITIATE |
| CSM | COMMAND SERVICE MODULE |
| CTE | CENTRAL TIMING EQUIPMENT |
| CVS | CONTINUOUS VENT SYSTEM |
| CVTS | CHIEF VEHICLE TEST SUPERVISOR |
| CW | CLOCKWISE |
| C&W | CAUTION AND WARNING |
| CYI | CANARY ISLAND |
| DAP | DIGITAL AUTO PILOT |
| DB | DEADBAND |
| DC | DIRECT CURRENT |
| DCA | DIGITAL COMMAND ASSEMBLY |
| DCS | DIGITAL COMMAND SYSTEM |
| DDD | DIGITAL DISPLAY DRIVER |
| DECA | DESCENT ENGINE CONTROL ASSEMBLY |
| DEDA | DATA ENTRY AND DISPLAY ASSEMBLY |
| DEG | DEGREE |
| DESC | DESCENT |
| DFI | DEVELOPMENT FLIGHT INSTRUMENTATION |
| DK | DOCK |
| DKD | DOCKED |
| DOD | DEPARTMENT OF DEFENSE |
| DPS | DESCENT PROPULSION SYSTEM |
| DRA | DISCRETE RECOVERY AREA |
| DRS | DATA RECEIVING STATION |
| DSC | DYNAMIC STANDBY COMPUTER |
| DSE | DATA STORAGE EQUIPMENT |
| DSKY | DISPLAY KEYBOARD |
| DTO | DETAILED TEST OBJECTIVE |
| D/TV | DIGITAL TO TELEVISION |
| ECS | ENVIRONMENTAL CONTROL SYSTEM |
| EDS | EMERGENCY DETECTION SYSTEM |
| EECOM | ELECTRICAL, ENVIRONMENTAL, AND COMMUNICATIONS |
| EKG | ELECTROCARDIOGRAM |
| EMR | ERROR MONITOR REGISTER |
| EMS | ENTRY MONITORING SYSTEM |
| EMU | EXTRA-VEHICULAR MOBILITY UNIT |
| ENG | ENGINE |
| EPS | ELECTRICAL POWER SYSTEM |
| ERR | ERROR |
| ESE | ELECTRONIC SUPPORT EQUIPMENT |
| ETDM | RANGE SAFETY SUPERVISOR (KSC CALLOUT) |
| ETR | EASTERN TEST RANGE |
| EVA | EXTRA-VEHICULAR ACTIVITY |
| EVAP | EVAPORATOR |
| EVT | EXTRA-VEHICULAR TRANSFER |
| EVVA | EXTRA-VEHICULAR VISOR ASSEMBLY |
| F/A | FORWARD/AFT |
| FC | FUEL CELL OR FLIGHT CONTROL |
| FCSM | FLIGHT COMBUSTION STABILITY MONITOR |
| FD | FLIGHT DIRECTOR |
| FDAI | FLIGHT DIRECTOR ATTITUDE INDICATOR |
| FDO | FLIGHT DYNAMICS OFFICER |
| FIDO | FLIGHT DYNAMICS OFFICER |
| FIG | FIGURE |
| FITH | FIRE IN THE HOLE |
| FL | FULL LIFT |
| FM | FREQUENCY MODULATION |
| FPS | FEET PER SECOND |
| FQR | FLIGHT QUALIFICATION RECORDER |
| FTP | FIXED THROTTLE POINT |

| REV | ITEM | |
|---|---|---|

| | |
|---|---|
| G | GRAVITY |
| G&C | GUIDANCE AND CONTROL |
| GASTA | GIMBAL ANGLE SEQUENCE TRANSLATION ASSEMBLY |
| GBI | GRAND BAHAMA ISLAND |
| GDA | GIMBAL DRIVE ASSEMBLY |
| GDC | GYRO DISPLAY COUPLER |
| GET | GROUND ELAPSED TIME |
| GETI | GROUND ELAPSED TIME OF IGNITION |
| GMT | GREENWICH MEAN TIME |
| GMTLO | GREENWICH MEAN TIME OF LIFTOFF |
| G&N | GUIDANCE AND NAVIGATION |
| $GN_2$ | GASEOUS NITROGEN |
| GNC | GUIDANCE NAVIGATION CONTROL |
| GNCS | GUIDANCE, NAVIGATION, AND CONTROL SYSTEM |
| GND | GROUND |
| GRR | GUIDANCE REFERENCE RELEASE |
| GSFC | GODDARD SPACE FLIGHT CENTER |
| GTS | GIMBAL TRIM SYSTEM |
| GUIDO | GUIDANCE OFFICER |
| $H_2$ | HYDROGEN |
| $H_2O$ | WATER |
| $H_a$ | HEIGHT OF APOGEE |
| HAW | HAWAII |
| HBR | HIGH-BIT-RATE |
| HF | HIGH FREQUENCY |
| $H_p$ | HEIGHT OF PERIGEE |
| HS | HIGH-SPEED |
| HZ | HERTZ |
| IC | INTERCOMMUNICATIONS EQUIPMENT |
| IGA | INNER GIMBAL AXIS |
| IMU | INERTIAL MEASUREMENT UNIT |
| INJ | INJECTOR |
| INST | INSTRUMENTATION |
| INV | INVERTER |
| IP | IMPACT POINT OR IMPACT PREDICTOR |
| IRIG | INERTIAL RATE INTEGRATING GYRO |
| ISOL | ISOLATION |
| ISS | INERTIAL SUBSYSTEM |
| IU | INSTRUMENTATION UNIT |
| IVT | INTRAVEHICULAR TRANSFER |
| JD | JET-DRIVER |
| KOH | POTASSIUM HYDROXIDE |
| KSC | KENNEDY SPACE CENTER |
| LB | POUND |
| LBR | LOW-BIT-RATE |
| LCG | LIQUID COOLING GARMENT |
| LES | LAUNCH ESCAPE SYSTEM |
| LET | LAUNCH ESCAPE TOWER |
| LGC | LM GUIDANCE COMPUTER |
| $LH_2$ | LIQUID HYDROGEN |
| LiOH | LITHIUM HYDROXIDE |
| LM | LUNAR MODULE |
| LMDE | LM DESCENT ENGINE |
| LMP | LM MODULE PILOT |
| L/O | LIFTOFF |
| LOS | LINE-OF-SIGHT |
| LOX | LIQUID OXYGEN |
| L/R | LEFT/RIGHT |
| LV | LOW-VOLTAGE |
| L/V | LAUNCH VEHICLE |
| LVDA | LAUNCH VEHICLE DATA ADAPTER |
| LVDC | LAUNCH VEHICLE DIGITAL COMPUTER |
| MALF | MALFUNCTION |
| MCC | MISSION CONTROL CENTER |
| MC&W | MASTER CAUTION AND WARNING |
| MDAS | MEDICAL DATA ACQUISITION SYSTEM |
| MED | MANUAL ENTRY DEVICE |
| MESC | MASTER EVENTS SEQUENCE CONTROLLER |
| MFCO | MANUAL FUEL CUTOFF |
| MFV | MAIN FUEL VALVE |
| MGA | MIDDLE GIMBAL AXIS |
| MIL | MERRITT ISLAND |
| MITE | MASTER INSTRUMENTATION TIMING EQUIPMENT |
| MNFLD | MANIFOLD |
| M&O | MAINTENANCE AND OPERATION |
| MOC | MISSION OPERATIONS COMPUTER |
| MSFN | MANNED SPACE FLIGHT NETWORK |
| MSK | MANUAL SELECT KEYBOARD |
| MSTC | CSM SPACECRAFT TEST CONDUCTOR |
| MTVC | MANUAL THRUST VECTOR CONTROL |
| MUX | MULTIPLEXER |
| NASA | NATIONAL AERONAUTICS AND SPACE ADMINISTRATION |
| NCC | COMBINED CORRECTIVE MANEUVER |
| NM | NAUTICAL MILES |
| NPV | NON-PROPULSIVE VENT |
| NSR | COELLIPTICAL MANEUVER |
| $O_2$ | OXYGEN |
| O/B | ONBOARD |
| ODOP | OFFSET DOPPLER AND POSITION |
| OGA | OUTER GIMBAL AXIS |
| OMSF | OFFICE OF MANNED SPACE FLIGHT |
| OPS | OXYGEN PURGE SYSTEM |
| ORDEAL | ORBITAL RATE DRIVE ELECTRONICS APOLLO LM |
| OXID | OXIDIZER |
| PAFB | PATRICK AIR FORCE BASE |
| PAM | PULSE AMPLITUDE MODULATION |
| PB | PUSH-BUTTON |
| PCM | PULSE CODE MODULATION |
| PCMGS | PULSE CODE MODULATION GROUND STATION |
| $PCO_2$ | PARTIAL PRESSURE CARBON DIOXIDE |
| PDS/DD | PLOTTING DISPLAY SUBCHANNEL/DATA DISTRIBUTION |
| PGA | PRESSURE GARMENT ASSEMBLY |
| PGNCS | PRIMARY GUIDANCE AND NAVIGATION CONTROL SYSTEM (CSM) |
| PGNS | PRIMARY GUIDANCE AND NAVIGATION SYSTEM (LM) |
| PIPA | PULSE INTEGRATING PENDULOUS ACCELEROMETER |
| PLSS | PORTABLE LIFE SUPPORT SYSTEM |
| PO | POWER OUT |
| $PO_2$ | PARTIAL PRESSURE OXYGEN |
| POS | POSITION |
| POS | PRIMARY OXYGEN SYSTEM |
| PPM | PARTS PER MILLION |
| PQGS | PROPELLANT QUANTITY GAGING SYSTEM |
| PRELN | PRE-LAUNCH |
| PRESS | PRESSURE |
| PRI | PRIMARY |
| PROC | PROCEDURE |
| PROP | PROPELLANT |
| PSA | POWER SERVO AMPLIFIER |
| PSI | POUNDS PER SQUARE INCH |
| PSID | POUNDS PER SQUARE INCH DIFFERENCE |
| PSS | PAD SAFETY SUPERVISOR |
| PTA | PULSE TORQUE ASSEMBLY |
| PTP | PREFERRED TARGET POINT |

| REV | ITEM | | |
|---|---|---|---|
| | | PTV | PITCH THRUST VECTOR |
| | | PU | PROPELLANT UTILIZATION |
| | | PUGS | PROPELLANT UTILIZATION AND GAGING SYSTEM |
| | | PVT | PRESSURE-VOLUME-TEMPERATURE |
| | | PYRO | PYROTECHNICS |
| | | QTY | QUANTITY |
| | | RAD | RADIATOR |
| | | RET | RETRACT |
| | | RCS | REACTION CONTROL SYSTEM |
| | | RCU | REMOTE CONTROL UNIT |
| | | RCVR | RECEIVER |
| | | REF | REFERENCE |
| | | REFSMMAT | REFFERENCE STABLE MEMBER MATRIX |
| | | REQD | REQUIRED |
| | | RETRB | RETRO ELAPSED TIME TO REVERSE BANK |
| | | RETRO | RETROFIRE OFFICER |
| | | REV | REVOLUTION |
| | | RF | RADIO FREQUENCY |
| | | RFO | RETROFIRE OFFICER |
| | | RGA | RATE GYRO ASSEMBLY |
| | | RHC | ROTATION HAND CONTROLLER |
| | | RIP | RANGE OF IMPACT POINT |
| | | RL | ROLL LEFT |
| | | RNDZ | RENDEZVOUS |
| | | Rp-Rt | DOWNRANGE ERROR |
| | | RR | RENDEZVOUS RADAR |
| | | RR | ROLL RIGHT |
| | | RSI | ROLL STABILITY INDICATOR |
| | | RSO | RANGE SAFETY OFFICER |
| | | RSVR | RESOLVER |
| | | RTACF | REAL-TIME AUXILIARY COMPUTING FACILITY |
| | | RTC | REAL-TIME COMMAND |
| | | RTCC | REAL-TIME COMPUTER COMPLEX |
| | | S/C | SPACECRAFT |
| | | SCE | SIGNAL CONDITIONING EQUIPMENT |
| | | SCS | STABILIZATION AND CONTROL SYSTEM |
| | | SEC | SECONDARY |
| | | SEC | SECOND |
| | | SECC | SUSTAINER ENGINE CUTOFF (S-IVB CUTOFF) |
| | | SECS | SEQUENTIAL EVENTS CONTROL SYSTEM |
| | | SHe | SUPER-CRITICAL HELIUM |
| | | SIG | SIGNAL |
| | | SLA | SPACECRAFT LM ADAPTER |
| | | SLV | SATURN LAUNCH VEHICLE |
| | | SM | SERVICE MODULE |
| | | SMJC | SERVICE MODULE JETTISON CONTROLLER |
| | | SODB | SPACECRAFT OPERATIONAL DATA BOOK |
| | | SOL | SOLENOID |
| | | SOP | STANDARD OPERATING PROCEDURE |
| | | SOV | SHUT-OFF VALVE |
| | | SPAN | SPACECRAFT PLANNING AND ANALYSIS |
| | | SPS | SERVICE PROPULSION SYSTEM |
| | | SRO | SUPERINTENDENT RANGE OPERATIONS |
| | | SSC | SPACE SUIT COMMUNICATOR |
| | | STBY | STANDBY |
| | | SW | SWITCH |
| | | SXT | SEXTANT |
| | | TB | TIME BASE |
| | | TBD | TO BE DETERMINED |
| | | TC | TEST CONDUCTOR |
| | | T/C | TELEMETRY AND COMMUNICATIONS |
| | | TCE | CONDENSER EXHAUST TEMPERATURE |
| | | TCP | THRUST CHAMBER PRESSURE |
| | | TD&E | TRANSPORTATION, DOCKING AND EXTRACTION |
| | | TDP | TELEMETRY DATA PROCESSOR |

| | |
|---|---|
| TELCOM | LM EECOM |
| TEMP | TEMPERATURE |
| $T_{FF}$ | TIME OF FREE FALL |
| THC | THRUST HAND CONTROLLER |
| $T_{ig}$ | TIME OF IGNITION |
| TLI | TRANSLUNAR INJECTION |
| TM | TELEMETRY |
| TMG | THERMAL METEROID GARMENT |
| TNK | TANK |
| TOK | THRUST OKAY |
| TPF | TERMINAL PHASE FINALIZATION |
| TPI | TERMINAL PHASE INITIATE |
| TRNS | TRANSFER |
| TRUN | TRUNNION |
| TTC | TRANSLATION THRUST CONTROLLER |
| TTY | TELETYPE |
| TVC | THRUST VECTOR CONTROL |
| U/D | UP/DOWN |
| UDL | UPDATA LINK |
| UHF | ULTRA HIGH FREQUENCY |
| UNDKD | UNDOCKED |
| USB | UNIFIED S-BAND |
| Vc | VELOCITY COUNTER |
| Vgx | VELOCITY TO BE GAINED X-AXIS |
| Vgy | VELOCITY TO BE GAINED Y-AXIS |
| Vgz | VELOCITY TO BE GAINED Z-AXIS |
| VHF | VERY HIGH FREQUENCY |
| VLV | VALVE |
| VSM | VIDEO SWITCHING MATRIX |
| WBD | WIDE-BAND DATA |
| WMS | WASTE MANAGEMENT SYSTEM |
| WT | WEIGHT |
| XFEED | CROSSFEED |
| XMIT | TRANSMIT |
| XMRT | TRANSMITTER |
| Y | YAW OR Y-AXIS |
| YTV | YAW THRUST VECTOR |
| Z | Z-AXIS |

<u>SYMBOLS</u>

| | |
|---|---|
| $h$ | ALTITUDE |
| $\Delta$ | DIFFERENCE |
| $\gamma$ | FLIGHT PATH ANGLE |
| $\phi$ | LATTITUDE OR PHASE |
| $q$ | DYNAMIC PRESSURE |
| $\approx$ | APPROXIMATELY |
| $d$ | DOWNRANGE DISTANCE |
| $\pm$ | PLUS OR MINUS |
| $>$ | GREATER THAN |
| $<$ | LESS THAN |
| $\geq$ | EQUAL TO OR GREATER THAN |
| $\leq$ | EQUAL TO OR LESS THAN |
| $\lambda$ | LONGITUDE |
| $\gamma i$ | INERTIAL FLIGHT PATH ANGLE |
| $\gamma EI$ | INERTIAL FLIGHT PATH ANGLE AT ENTRY |
| $\gamma EI$ | INERTIAL VELOCITY AT ENTRY INTERFACE |
| $\Delta V_{IN}$ | DELTA VELOCITY IN INSERTION |
| $\Delta T_B$ | DELTA BURN TIME |
| $\Delta H$ | DELTA ALTITUDE |

B DISTRIBUTION LIST

| REV | ITEM |
|---|---|

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LEWIS, C.R. (9)
EALICK, P.L. (3)
PLATT, W.E. (3)

CSM SYSTEMS BRANCH

FC3/ALDRICH, A.D.
HUTCHINSON, N.B.
GLOVER, R.D.
LOE, T.R. (20)
WILLOUGHBY, B.N. (20)
BLAIR, W.L. (2)

LM SYSTEMS BRANCH

FC4/HANNIGAN, J.E. (5)
PUDDY, D.R. (20)
CARLTON, R.L. (23)
EDELIN, F. (5)

FLIGHT DYNAMICS BRANCH

FC5/BOSTICK, J.C.
SHAFFER, P.C.
LLEWELYN, J.S. (4)
PARKER, C.B. (4)
PAVELKA, E.L. (4)

MISSION SIMULATIONS BRANCH

FC6/SHELLEY, C.B. (28)

MISSION CONTROL REQUIREMENTS

FC7/PETTITT, G.I. (2)

EXPERIMENTS SYSTEMS BRANCH

FC8/SAULTZ, J.E.(12)

MSFC FLIGHT CONTROL OFFICE

I-MO-F/HAMNER, R.S. (20)

FLIGHT SUPPORT DIVISION

FS/DUNSEITH, L.C.

SYSTEMS ENGINEERING BRANCH

FS2/SATTERFIELD, J.M.

OPERATIONS SUPPORT BRANCH

FS4/FRERE, J.A.
SANBORN, S.D. (15)
RANDALL, E.L. (2)

FLIGHT SOFTWARE BRANCH

FS5/STOKES, J.D. (3)
GIBSON, T.F., JR.
GARMAN, J.R. (2)

MISSION PLANNING AND ANALYSIS DIVISION

FM/MAYER, J.P. (2)
HUSS, C. (1)
TINDALL, H.W.

FLIGHT ANALYSIS BRANCH

FM3/ALLEN, C.F. (14)

LANDING ANALYSIS BRANCH

FM2/BENNETT, F.V.
BOLT, W.M. (2)
GRAVES, C.A.
HARPOLD, J.C. (2)

MATH PHYSICS BRANCH

FM4/MCPHERSON, J.C. (2)

MISSION ANALYSIS BRANCH

FM5/BERRY, R. (2)

RENDEZVOUS ANALYSIS BRANCH

FM6/LINEBERRY, E.C. (2)
CONWAY, H.L.

GUIDANCE AND PERFORMANCE BRANCH

FM7/CASSETI, M.D. (2)

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FM13/PARTEN, R.
COLLINS, M.

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CA/SLAYTON, D.K. (2)

ASTRONAUT OFFICE

CB/SHEPARD, A.B. (20)

FLIGHT CREW SUPPORT DIVISION

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GRIMM, D.F.
BILODEAU, J.W.
DEMENT, M.E. (4)
ALLEN, L.D. (4)
KRAMER, P.C. (5)
WARREN, D.K. (3)

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SMITH, A.F.
KUEHNEL, H.A. (4)
SMITH, J.C.
VAN BOCKEL, J.J. (2)
O'NEILL, J.W. (5)
FABER, S. (3)
MITCHELL, J. (CFK-10) }
COLLINS, H.G. (CFK-15) } KSC
MCCAFFERTY, R. (CFK-6) }
CF/FRANKLIN, G.C.

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ZIEGLSCHMID, J.F., M.D. (6)

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KLEINKNECHT, K.S.
BOLENDER, C.H., BRIG. GEN.
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PD/MAYNARD, O.E.
BATTEY, R.V.
DENNETT, A.
BOND, R.L.
PD5/COREE, J.
PD7/SEGNA, D.R.
KOHRS, R.
GLANCY, C.H.
GUILD, C. (2)
SILVER, M. (40)
PD8/HAINES, C.
PD9/CRAIG, J.
PD12/PERRINE, C.H.
TOMBERLIN, J.L.
KUBICKI, R.W.
PD14/BYINGTON, H.W.
PE/MORRIS, O.E.
PE2/CORCORAN, D.M.
PF/COHEN, A.
PF2/REESE, H.F.
PP/MCCLINTOCK, J.
NA/BLAND, W.M. (2)
PT/ARABIAN, D.O.
PT3/GOLDENBEUM, D. (25)
PT4/LOBB, J. (3)
BM86 MISSION DATA PACK (15)
PD13/WESTMORELAND, P

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CHAMBERLIN, J.A.
BOND, A.C.
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EA4/BURT, R.P.
EA5/DEANS, P.M.
EB/KYLE, H.
EB3/TRAVIS, D.
STOKER, C.

**NASA — Manned Spacecraft Center**

**MISSION RULES**

| REV | ITEM |
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ED14/LAUTEN, W.
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EE4/RIEGERT, D.
JOHNSON, G.
MUFORD, R.E.
ROTRAMEL, F.
COMPOS, A.B.
DIETZ, R.H.
FENNER, R.G.
WALTER, R.T.
GIESECKE, R.L.
EE12/LUSE, M.B.
EE13/TREMONT, R.
EDMISTON, C.R.
EG/KAYTON, M.
EG23/COX, K.J., DR.
EG25/HANAWAY, J.
WASSON, C.
EG42/RICE, G. (2)
EG43/LEWIS, R.E.
KURTEN, P.M.
SHELTON, D.H.
EP/MCSHEEHY, R.
EP2/TOWNSEND, N.A.
WOOD, J.
HUMPHRIES, C.E.
HAMMOCK, W.R.
LAMBERT, C.H.
EP4/KARAKULKO, W.
EP5/BELL, D.
OWENS, S.
TROUT, B.
ES/CHAUVEN, L.
ES3/STROUHAL, G.
ES127/SMITH, J.
ES12/GLYNN, P.C.
WEISS, S.P.
PAVLOSKY, J.E.
EX/SILVERIA, M.
EX21/REDD, B.

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TA/CALIO, A.J.

TRW-HOUSTON

ROBERTSON, R.L. (3)
TRW TECHNICAL INFORMATION CENTER, HOUSTON OPERA[illegible]

NORTH AMERICAN ROCKWELL HOUSTON

HARMAN, H.A. (2)

GODDARD SPACE FLIGHT CENTER

KNOX, C.B. (9)
CODE 821.1
MANNED FLIGHT OPERATIONS DIVISION,
REQUIREMENTS SECTION

JOHN F. KENNEDY SPACE CENTER NASA - MSOB

KENNEDY SPACE CENTER, FLORIDA
ATTEN, HO/ASTRO OFI (6)
CD/DE BUS, K., DR.
AS-SAT/BARNETT, V. (2)
AP-SCO/BEDDINGFIELD, S.
AP-OPN/BLACKWOOD, H. (2)
LO/PETRONE, R.A.
KAPYRAN, W.J.
LO-OPN/DONNELLY, P.
LO-PLN-2/KNIGHT, G.[illegible] (3)
HARRINGTON, R.D.
LV/GRUENE, H., DR.
LV-TOM-3/OGLESBY, [illegible]
LS/WILLIAMS, J.J.
LS-ENG-L/GASKIN, R. (4)
LS-TOM-1/BUCKLEY (4)
WILLIAMS (4)
TS/CLARK, R.L. (5)
AP-SYM/MOORE, A.H. (6)
IN/SENDLER, K. (5)
SO/GORMAN, R. (3)
IS-TSM2/CLARK, B.
BEASON, W.P.
PSK/MORSE, A.E.
KSC MISSION DIRECTOR'S OFFICE, R3121 NSO BLDG
GAEC/LOPRESTI, R. (10), R1047 MSOB

MARSHALL SPACE FLIGHT CENTER

MSFC/I-MO-MGR, MISSION OPERATIONS OFFICE (30)

OFFICE MANNED SPACEFLIGHT

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PHILLIPS, S.C., MAJ. GEN.
SCHNEIDER, W.C.
ALLER, R.O. (12)

DOD MSF SUPPORT OFFICE PAFB, FLA

OLSON, R.G., COL. (5)
FRESE, F.J., JR., COL. MC (2)
DDMS-N/DEARMAN, J., CAPT.
ETOOP-2 PAFB FLA, 32925 (6)

MIT LABORATORIES BOSTON, MASS.

NEVINS, J. (12)
COPPS, E. (2)
SPARS, N.

NORTH AMERICAN ROCKWELL, DOWNEY, CALIF.

POTTS, J.R. CODE AB70 (1)

GRUMMAN AIRCRAFT ENGINEERING CORP., BETHPAGE, NEW YORK

PRATT, R. (35)

C CHANGE CONTROL

| REV | ITEM |
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## CHANGE CONTROL

1.0 INTRODUCTION

1.1 PURPOSE

THE PURPOSE OF THIS APPENDIX IS TO DELINEATE CHANGE CONTROL PROCEDURES FOR THE AS-504/104/LM-3 MISSION RULES. THIS WILL INSURE THE PROPER COORDINATION OF CHANGES, PROVIDE A RECORD OR PROPOSED CHANGES (INCLUDING THE RATIONALE FOR MAKING THEM), AND WILL PROVIDE A MEANS FOR PROMULGATING INDIVIDUAL RULE UPDATES BETWEEN REVISIONS (INTERIM CHANGES).

1.2 EFFECTIVITY

DECEMBER 15, 1968

2.0 CHANGE PROCEDURES

2.1 SUBMISSION OF CHANGES

PROPOSED CHANGES ARE SOLICITED FROM ANY INDIVIDUAL OR ORGANIZATION HAVING A VALID INPUT, CHANGES ORIGINATING OUTSIDE THE FLIGHT CONTROL TEAM WILL BE SUBMITTED DIRECTLY TO THE ASSISTANT FLIGHT DIRECTOR (AFD). CHANGES ORIGINATING WITHIN THE FLIGHT CONTROL TEAM WILL BE SUBMITTED TO THE AFD VIA THE PRIME MISSION OPERATIONS CONTROL ROOM (MOCR) POSITION CONCERNED.

2.1.1 <u>FORMAT</u>

PERSONS DESIRING TO SUBMIT A PROPOSED CHANGE WILL COMPLETE ALL ITEMS ON THE FORM SHOWN IN FIGURE C-1 (FORM MUST BE TYPED). ADDITIONAL PAGES MAY BE USED IF THE SPACE PROVIDED IS NOT ADEQUATE. THE COMPLETED ORIGINAL FORM AND ONE COPY WILL THEN BE FORWARDED TO THE AFD.

THE AFD WILL REVIEW THE FORM FOR COMPLETENESS AND PROPER MISSION RULE FORMAT, AND MAKE CORRECTIONS AS REQUIRED. THE ORIGINATOR WILL BE ADVISED OF ANY SUCH CHANGES.

2.2 APPROVAL

2.2.1 <u>COORDINATION</u>

THE ORIGINATOR OF THE CHANGE MAY OBTAIN PRELIMINARY CONCURRENCES. THE AFD WILL, HOWEVER, OBTAIN FORMAL CONCURRENCES OR DISAPPROVALS (VERBALLY OR BY INITIATING) FROM THE NECESSARY PERSONNEL. VERBAL CONCURRENCES WILL BE INDICATED IN THE APPROPRIATE SIGNATURE BOX.

2.2.2 <u>SIGNOFF/DISAPPROVAL</u>

UPON OBTAINING THE REQUIRED CONCURRENCES OR NEGATIVE COMMENTS, THE AFD WILL PRESENT THE PROPOSED CHANGE TO THE FLIGHT DIRECTOR FOR FINAL APPROVAL OR DISAPPROVAL. THE AFD MAY SIGN OFF OR DISAPPROVE PROPOSED CHANGES IN THE ABSENCE OF THE FLIGHT DIRECTOR.

2.2.3 <u>DISAPPROVED CHANGES</u>

IF A CHANGE IS DISAPPROVED THE AFD WILL RETURN THE COPY TO THE ORIGINATOR. THE ORIGINATOR WILL BE RETAINED FOR FUTURE REFERENCE.

2.3 <u>PUBLICATION AND DISTRIBUTION OF INTERIM CHANGES</u>

INTERIM CHANGES WILL BE DISTRIBUTED TO AN ABBREVIATED DISTRIBUTION LIST CONSISTING OF THE MISSION CONTROL TEAM, PERTINENT NASA ORGANIZATIONS, AND THE APPROPRIATE VEHICLE CONTRACTOR(S).

3.0 REVISIONS

3.1 DEVELOPMENT

THE AFD WILL COMPILE THE EFFECTIVE INTERIM CHANGES AND CORRECTIONS OF MINOR TYPOGRAPHICAL ERRORS INTO COMPLETE PAGE CHANGES TO THE BASIC DOCUMENT. ("PEN AND INK" CHANGES MAY BE USED TO CORRECT TYPOGRAPHICAL ERRORS IF THERE ARE NO OTHER CHANGES IN THE PAGE CONCERNED.)

3.2 APPROVAL

SINCE ALL INTERIM CHANGES WILL HAVE RECEIVED PRIOR CONCURRENCES AND APPROVAL, ONLY THE FLIGHT DIRECTOR (OR THE AFD IN THE FLIGHT DIRECTOR'S ABSENCE) WILL BE REQUIRED TO APPROVE REVISIONS.

3.3 PUBLICATION

3.3.1 SCHEDULE

REVISIONS WILL BE MADE ON AN "AS REQUIRED" BASIS.

3.3.2 DISTRIBUTION

REVISIONS WILL BE PRINTED AND DISTRIBUTED THROUGH THE NORMAL ADMINISTRATIVE CHANNELS.

**NASA — Manned Spacecraft Center**

**MISSION RULES**

| REV | ITEM |
|---|---|
| | |

NASA-MANNED SPACECRAFT CENTER
MISSION RULE REQUEST/REVISION

DATE ________

| REV | RULE | CONDITION/MALFUNCTION | PHASE | RULING | NOTES/COMMENTS |
|---|---|---|---|---|---|
| | | | | | |

RATIONALE: ☐ NEW TECHNICAL DATA ☐ CLARIFICATION ☐ TYPOGRAPHICAL ERROR

| ORIGINATOR: ____ NAME ____ ORGANIZATION ____ EXT | APPROVED: ____ COGNIZANT BRANCH CHIEF | APPROVED: ____ FLIGHT DIRECTOR |
|---|---|---|

| AFD: ____ | BSE: ____ | FIDO: ____ | GUIDO: ____ | RETRO: ____ | GNC: ____ | EECOM: ____ | OTHER: ____ |
|---|---|---|---|---|---|---|---|

MSC FORM 1555 (JAN 68)

FIGURE C-1.- MISSION RULE PROPOSED CHANGE REQUEST FORM.

END

DATE

FILMED

JUL 10

1972