FC021
4/15/69

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FINAL
FLIGHT MISSION RULES

APOLLO 10
(AS-505/106/LM-4)

APRIL 15, 1969

PREPARED BY

FLIGHT CONTROL DIVISION

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

FOR NASA/DOD INTERNAL USE ONLY
INCLUDING APPROPRIATE CONTRACTORS

APOLLO 10

FC021
4/23/69

FINAL FLIGHT MISSION RULES

REVISION A

PREFACE

THIS DOCUMENT CONTAINS REVISION A TO THE FLIGHT MISSION RULES FOR APOLLO 10 AS OF APRIL 23, 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. JOHN H. TEMPLE, FLIGHT CONTROL OPERATIONS BRANCH, BUILDING 45, ROOM 635, PHONE HU3-2267.

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.

APPROVED BY:

Christopher C. Kraft Jr.

CHRISTOPHER C. KRAFT, JR.
DIRECTOR OF FLIGHT OPERATIONS

REV	ITEM

TABLE OF CONTENTS

CSM - APOLLO 10 FINAL MISSION RULES	ABORT LAUNCH FOR LOSS OF:	INHIBIT TLI FOR LOSS OF:	CONSIDER TLC ABORT FOR LOSS OF:	INHIBIT LOI FOR LOSS OF: *(See foot note)	DO EARLY TEI FOR LOSS OF: •(See foot note)	DO NOT UNDOCK OR RNDZ FOR LOSS OF:	SAVE DPS/APS FOR LOSS OF:
CABIN INTEGRITY	ANY COMB	X	X	X	X	X	X
FIRE/SMOKE/CONT	X	X	X	X	X	X	X
SUIT INTEGRITY						X	
SUIT CIRCULATION	(BOTH)	X (1 of 2)	X (BOTH)	X (BOTH)	X (1 of 2)•	X (1 of 2)•	X (BOTH)
O_2 MFLD	(>#/HR)	X	X	X	X	X	X
SURGE/REPRESS							
MAIN REGULATORS		X (1 of 2)	X (1 of 2)	X (1 of 2)	X (BOTH)	X (BOTH)	
CYCLIC ACCUM		X (BOTH)		X (BOTH)			
PRI LOOP		X	X	X	X	X	
RAD		X	X	X	X	X	
EVAP		(BOTH)		BOTH	(BOTH)	(BOTH	
SEC LOOP		X	X	X	X	X	
RAD		X	X	X	X •	X •	
EVAP							
POT TANK		X	X	X	X	X	
WASTE TANK		X	X	X	X	X	
O/B DUMP		X	X	X	X •	X	
O_2		X	X		X	X	X
H_2		X	X		X	X	X
FUEL CELLS	3 FC +	X (1 of 3)	X (2 of 3)	*X (1 of 3)	X (1 of 3)•	X (1 of 3)•	X (2 of 3)
ENTRY BATS	1 BAT	X (1 of 3)	X (2 of 3)	*X (1 of 3)	X (1 of 3)•	X (1 of 3)•	
BUS-MAIN-BATT-BATT RELAY		X (ANY 1)	X (ANY 1)	X (ANY 1)	X (ANY 1)	X (ANY 1)	
AC BUS	X(BOTH WHILE MODE I OR 2)	X (1 of 2) X ØA	X (1 of 2)	X (1 of 2) X ØA	X (1 of 2) X ØA	X (1 of 2) X ØA	X (1 of 2) X ØA
INVERTERS		X (2 of 3)	X (2 of 3)	X (2 of 3)	X (2 of 3)	X (2 of 3)	X (2 of 3)
BTRY CHRGR				X (+ SUM OF 2 BATTS)	X (+SUM OF 2 BATTS)	X (+SUM OF 2 BATTS)	
SEQ LOGIC		X	X	X	X •	X •	
PYRO		X	X	X	X •	X •	
SMJC ACT		X	X	X	X •	X •	
RELAYS ACT							
HBR		(BOTH)	(BOTH)	(BOTH)	(BOTH)	(BOTH)	
LBR							
SBAND VOICE		X (ALL VOICE)	X (ALL VOICE)	X (ALL VOICE)	X (ALL VOICE)	X (ALL VOICE)	X (CSM SBAND)
VHF VOICE							
CMD							
CRITICAL ONBOARD		X		X	X	X	
SCE		X	X	X	X •	X	
IMU		X		X	X •	X •	
CMC		X		X	X •	X •	
OPTICS		X		X	X •	X •	
DSKY(CMC WNG RELAY)		X (BOTH)		X (NAVDSKY)	X (NAVDSKY)	X (NAVDSKY)•	
FDAI		X (BOTH)		X (BOTH)	X (BOTH)	X (BOTH)	
TVC SERVO LOOPS		X (1 of 2)		X (1 of 2)	X (1 of 2)	X (1 of 2)	X (1 of 2)
DIRECT RCS			X (BOTH RHC)	X (BOTH RHC)	X (BOTH RHC)	X (BOTH RHC)	
AUTO, RATE RCS			X (P + Y)	X (P + Y)	X (P + Y)	X (P + Y)	
TRANSLATION CAP				X (ULLAGE)	X (ULLAGE)	X (ANY AXIS)	
BMAGS		X(BOTH IN ANY AXIS)		X(BOTH IN ANY AXIS)	X(BOTH IN ANY AXIS) •	X(BOTH IN ANY AXIS) •	
RHC				X (1 of 2)			
GROUND AT SPS SOLND		X		X	X	X	
VHF RANGING							
SOURCE HELIUM		X		X	X •	X •	X
TANK PRESS		X		X	X	X	X
TANK ΔP		X		X	X	X	X
FEEDLINE TEMPS		X		X	X	X	X
BALL VALVES				X (1 of 2)	X (1 of 2)	X (1 of 2)	X (1 of 2)
GN_2 TANKS		X (BOTH)		X (BOTH)	X (BOTH)	X (BOTH)	X (BOTH)
PREVIOUS PERF				X	X	X	
SOURCE HELIUM QUADS		X (1 of 4)	X (1 of 4)	X (1 of 4)	X (1 of 4)	X (1 of 4)	X (2 of 4)
THRUSTERS		X (1P, 1Y or 2R)		X (2P or 2Y, 1P + 1Y, 1P or 1Y + 2R, 3R)		X (ANY 1)	
DOCKING LATCHES				X (4 of 12)		X (9 of 12)	
DOCKING MECH						X (BOTH)	
N_2 BOTTLES						X (3 SQUIBS)	
SOURCE HELIUM	X (BOTH RINGS	X (1 of 2)	X (I of 2)	X (1 of 2)	X (1 of 2)•	X (1 of 2)•	
MFLD PRESS	X WHILE MODE 1)	X (1 of 2)	X (1 of 2)	X (1 of 2)	X (1 of 2)•	X (1 of 2)•	
ARMED		X	X	X	X •	X •	

O - STILL UNDER DISCUSSION

* - DEPENDS UPON REALTIME UNDERSTANDING OF FAILURE MODE

• - FOR THESE ITEMS, EARLY TEI WILL BE DELAYED A REASONABLE TIME PENDING COMPLETION OF VARIOUS L/O ACTIVITY.

LM - APOLLO 10 FINAL MISSION RULES	DO NOT UNDOCK FOR LOSS OF:	DO NOT PERFORM NOM RNDZ FOR LOSS OF:	(PRE DOI) DO PDI ABORT SEQUENCE FOR LOSS OF:	(POST DOI) DO PDI ABORT SEQUENCE FOR LOSS OF:	DO DIRECT RETURN ABORT FOR LOSS OF:	INHIBIT STAGING FOR LOSS OF:	INHIBIT STAGING OR DELAY UNTIL TPI IF OTHER CONSIDERATIONS JUSTIFY STAGING:	DO NOT DO UNMANNED APS BURN FOR LOSS OF:
CABIN INTEGRITY	X	X		X	X		X	
FIRE/SMOKE/CONT	X	X			X			
SUIT INTEGRITY	X	X		X			X	
SUIT CIRCULATION	X (BOTH)	X (BOTH)		X (BOTH)			X (BOTH)	
DESCENT O_2	ANY 2of3	ANY 2of3		ANY 2of3			INSUFFICIENT	
ASCENT O_2 (2)							X (1 of 2)	
DEMAND REGULATORS	X (BOTH)	X (BOTH)		X (BOTH)			X (BOTH)	
H_2O SEPARATORS		X (BOTH)		X (BOTH)			X (BOTH)	
PRI LOOP	BOTH	(1 of 2)		X	X		BOTH LOOPS	
PRI H_2O FEEDPATH		X		X				
SEC LOOP								
DESC H_2O	ALL 3	ANY 2of3		ANY 2of3			INSUFFICIENT	
ASC H_2O							X (BOTH)	
EVA EQPT (OPS, PLSS)	X (2 of 3)							
DESCENT BATS	REQ 2 DES	REQ 2D+2A		REQ 2D+2A				
ASCENT BATS	& 1 ASC	OR 4D+1A		OR 4D+1A		X (BOTH)	X (1 of 2)	
DESCENT FEEDERS	X (BOTH)	X (BOTH OR 1 TO HARD SHT)	X (BOTH OR 1 TO HARD SHT)					
ASCENT FEEDERS	X (1 of 2)	X (1 of 2)		X (1 of 2)		X (BOTH)	~~X (1 of 2)~~	
ECA PROTECTION :							X	
CDR BUS	X	X		X			X	X
LMP BUS	X	X		X			X	X
AC BUS		X (1 of 2)						
INVERTERS		X (BOTH)						
PYRO SYSTEMS	X (BOTH)					X (BOTH)	X (1 of 2)	
EDS RELAYS								
HBR		X						BOTH
LBR								
SBAND VOICE		X						
VHF VOICE	X	X						
CMD								X
CRIT ONBOARD DISP	X	X		X				
IMU		X		X	X			BOTH
LGC		X		X X	X			PNGS
OPTICS		X (AOT+COAS)	X					AGS
DSKY		X		X	X			
FDAI		X (BOTH)						
GIMBAL DRIVE CAP		X (+RCS IMP)	X (+RCS IMP)					
RNDT 3 AXIS ATT CNTL	X	X				LOSS OF CNTL		LOSS OF CNTL
3 AXIS TRANS CAP	X (ANY AXIS) +X ONLY	X (ANY AXIS) +X ONLY				X (ANY AXIS) +X ONLY		
AGS								
RATE GYRO PKG BOTH RGC	X							
ACA		X (BOTH)						
THROTTLE CAP								
RNDZ RADAR		X						
FLASHING LITE		X						
SHe TANK		X	X	O				
START TANK								
TANK PRESS (LEAKS)	X	X	X					
TANK ΔP		X	X					
PROP TEMPS		X	X					
PROP ΔT		X	X					
SOURCE HELIUM								
TANK PRESSURE (LEAKS)	X					X	X	X
TANK ΔP							X	X
PROP TEMPS							X	
PROP ΔT							X	
RCS SYSTEMS	X (1 of 2)	X		X		X (BOTH)		
THRUSTER PAIRISOL	X	X						

O - STILL UNDER DISCUSSION

REV	ITEM

REV	ITEM

REV	ITEM

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 MISSION 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	
	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	
	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.
	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.
A	I-57	SEMI-SYNCHRONOUS: AN ORBIT WITH A PERIOD OF 12 HOURS. THE PERIGEE POSITIONS ARE FIXED RELATIVE TO EARTH AND 180° APART IN LONGITUDE.

PART II

1 GENERAL RULES AND SOP'S

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.
	1-4	SPACECRAFT LAUNCH WILL NOT BE ATTEMPTED IF KNOWN SPACECRAFT SYSTEMS MALFUNCTIONS WILL LIMIT THE MISSION DURATION SUCH THAT ACCOMPLISHMENT OF THE PRINCIPAL OR MANDATORY 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 FLIGHT DIRECTOR MAY, AFTER ANALYSIS OF THE FLIGHT, CHOOSE TO TAKE ANY NECESSARY ACTION REQUIRED FOR THE SUCCESSFUL COMPLETION OF THE MISSION.
	1-8	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.
	1-9	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 INSTRUMENTATION ERRORS WITHIN THE SPACECRAFT AND MSFN DATA/DISPLAY SYSTEMS.

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
	1-10	UNLESS STATED OTHERWISE, MANDATORY AND HIGHLY DESIRABLE INSTRUMENTATION REQUIREMENTS ARE SATISFIED BY EITHER ONBOARD OR PCM CAPABILITY.
	1-11	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). A. REQUIRED TO INSURE FLIGHT CREW SAFETY. B. REQUIRED TO IMPLEMENT RULES RESULTING IN LAUNCH ABORTS. C. REQUIRED TO IMPLEMENT RULES RESULTING IN EARLY MISSION TERMINATION. D. REQUIRED TO MAKE DECISION TO CONTINUE TO THE NEXT MISSION PHASE. THE MANDATORY INSTRUMENTATION LISTINGS IN THIS DOCUMENT WILL BE CROSS-REFERENCED TO THE APPROPRIATE MISSION RULE MEETING THE ABOVE CRITERIA.
	1-12	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.
	1-13	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.
	1-14	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.
	1-15	THE COMMAND PILOT MAY INITIATE SUCH INFLIGHT ACTION AS HE DEEMS ESSENTIAL FOR CREW SAFETY.
	1-16	IN THE EVENT OF LOSS OF COMMUNICATIONS BETWEEN THE MSFN AND THE S/C, THE COMMAND PILOT WILL ASSUME RESPONSIBILITY OF MISSION DIRECTION WITHIN THE FRAME WORK OF THE MISSION RULES.
		RULE NUMBERS 1-17 THROUGH 1-23 ARE RESERVED.

REV	ITEM	DEFINITIONS
	1-24	ASAP: AS SOON AS PRACTICABLE (I.E., AS SOON AS POSSIBLE AND REASONABLE).
	1-25	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.
	1-26	ATP: AN "ALTERNATE TARGET POINT" IS A STRATEGICALLY LOCATED SET OF COORDINATES CHOSEN TO PROVIDE A SPACECRAFT TARGET POINT MIDWAY BETWEEN PTP'S.
	1-27	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. THE MISSION WILL NOT PROCEED TO THE NEXT PHASE UNLESS SPECIFICALLY NOTED.
	1-28	REENTER ASAP: REENTER AS SOON AS PRACTICABLE (I.E., AS SOON AS POSSIBLE AND REASONABLE).
	1-29	TERMINATE ASAP: REENTER WITH THE MINIMUM TRIP TIME TO AN UNSPECIFIED LANDING AREA.
	1-30	CRITICAL MANEUVERS: FOR THE PURPOSE OF MISSION RULE ACTION, CRITICAL MANEUVERS ARE DEFINED AS THOSE MANEUVERS REQUIRED TO INSURE CREW SAFETY. THE VIOLATION OF PROPULSION SYSTEM LIMITS WILL BE ACCEPTED AS NECESSARY FOR SUCH BURNS. ALL MANEUVERS ARE CONSIDERED CRITICAL EXCEPT LOI AND MCC'S NOT REQUIRED FOR ENTRY CORRIDOR CONTROL.
	1-31	NON-CRITICAL BURN: A BURN WHICH NEED NOT BE ACCOMPLISHED TO MAINTAIN AN ACCEPTABLE LEVEL OF CREW SAFETY.

REV	ITEM	
	1-32	EARLY STAGING: UNSCHEDULED INTENTIONAL SEPARATION OF THE S-IVB STAGE FROM THE S-II STAGE.
	1-33	CONTINGENCY ORBIT INSERTION (COI): AN SPS PROPULSIVE MANEUVER WHICH WILL PROVIDE CSM INSERTION INTO A SAFE ORBIT ($H_p \geq$ 75NM) IN THE EVENT OF AN SLV FAILURE OCCURRING IMMEDIATELY PRIOR TO INSERTION, OR IN THE EVENT OF DEGRADED SLV PERFORMANCE.
	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 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.
A	1-37	FLIGHT PHASE: THE INTERVAL FROM LIFTOFF THROUGH SPLASHDOWN. FOR MISSION RULE PURPOSES THE FLIGHT PHASE IS FURTHER SUBDIVIDED AS SHOWN BELOW: A. LAUNCH PHASE: FROM LIFTOFF THROUGH INSERTION (TB1 THROUGH TB4). B. EARTH ORBIT PHASE: FROM INSERTION THROUGH S-IVB CUTOFF FOR TRANSLUNAR INJECTION (TLI). C. TD&E PHASE: FROM CSM/S-IVB SEPARATION THROUGH LM EJECTION FROM SLA. D. TRANSLUNAR COAST PHASE: FROM S-IVB CUTOFF FOR TLI THROUGH LOI_1 CUTOFF. E. DOCKED PHASE: THE TIME INTERVALS DURING WHICH THE LM AND CSM ARE DOCKED. F. LUNAR ORBIT PHASE: FROM LOI_1 CUTOFF TO UNDOCKING AND FROM FINAL LM ACTIVITIES TO TEI CUTOFF. G. UNDOCKED PHASE: THE TIME INTERVAL DURING WHI H A MANNED LM IS SEPARATED FROM THE CSM FOR STATION KEEPING (MAXIMUM SEPARATION DISTANCE OF ≈500FT.). H. RENDEZVOUS PHASE: FROM THE CSM PRE-DOI SEPARATION MANEUVER THROUGH CSM/LM DOCKING AT END OF RENDEZVOUS. I. UNMANNED PHASE: FROM FINAL CSM/LM SEPARATION TO COMPLETION OF LM ACTIVITIES (INCLUDIN LM APS BURN TO DEPLETION). J. TRANSEARTH COAST PHASE: FROM TEI CUTOFF TO M/SM SEPARATION. K. ENTRY PHASE: FROM CM/SM SEPARATION TO SPLASHDOWN.

REV	ITEM	
	1-38	RECOVERY PHASE: THE TIME INTERVAL FROM SPLASHDOWN TO DELIVERY OF THE FLIGHT CREW AND SPACECRAFT TO DESIGNATED LANDBASED INSTALLATIONS.
	1-39	REENTRY DEFINITIONS: A. AUTOMATIC - REENTRY CONTROLLED BY CMC WHICH OUTPUTS BANK ANGLE COMMAND TO THE RCS. B. CLOSED LOOP - REENTRY CONTROLLED BY THE CREW MANUALLY FLYING BANK ANGLE MODULATION USING CMC ENTRY PROGRAM OUTPUTS. C. OPEN LOOP REENTRY - REENTRY CONTROLLED BY THE CREW USING SPACECRAFT DISPLAYS AND FLYING: 1. BANK ANGLE (RR 0-90) AND RETRB (RL 0-90). 2. CONSTANT BANK ANGLE - CREW ESTABLISHES AND MAINTAINS A CONSTANT BANK ANGLE. (CONSTANT BANK ANGLES >90 DEGREES WILL NOT BE FLOWN EXCEPT WHEN SKIPOUT RULE IS VIOLATED.) 3. ROLLING REENTRY - MAINTAIN CONSTANT 18 DEGREES PER SECOND ROLL RATE. 4. EMS RANGING - CONSTANT BANK ANGLE IS HELD TO 1G; 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 RESERVED. D. CONSTANT G ENTRY: CREW CONTROLS THE BANK ANGLE TO MAINTAIN A SPECIFIED G LEVEL. E. EMS REENTRY: CREW CONTROLS THE BANK ANGLE TO MAINTAIN A CONSTANT G UNTIL VELOCITY <25,500 FPS. THE EMS IS THEN USED TO CONTROL RANGE BY NULLING THE DIFFERENCE BETWEEN THE RANGE TO GO COUNTER AND THE RANGE POTENTIAL GUIDELINES. ALL MANEUVERS ARE OVERRIDDEN AS NECESSARY TO PREVENT AN ONSET OR OFFSET VIOLATION.
	1-40	ALTERNATE MISSION: ANY DEVIATION FROM THE NOMINAL MISSION TIMELINE WHERE FURTHER MISSION OBJECTIVES ARE CONSIDERED BEFORE THE END OF THE MISSION.
	1-41	CONTINUE MISSION: 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 CHOICE.
	1-42	SLINGSHOT MANEUVER: USE OF RESIDUAL S-IVB PROPELLANTS TO PLACE THE SPENT STAGE IN A SOLAR OR NON-LUNAR IMPACTING TRAJECTORY.
	1-43	LUNAR ABORT MODES AFTER DISPERSED LOI_1 A. SPS ABORT 15 MIN ABORT - SPS RESTART FOR DIRECT RETURN. (DOCKED SPS ABORT MAY BE EXECUTED IN MODES I OR II) B. DPS ABORT 1. MODE I - DIRECT RETURN USING DPS, BURN AT APPROXIMATELY LOI + 2 HRS. 2. MODE II - TWO IMPULSE DPS ABORT FOR EARTH RETURN, FIRST BURN AT APPROXIMATELY LOI + 2 HRS, SECOND BURN AT NEXT PERICYNTHION. 3. MODE III - DPS TEI, BURN AT APPROXIMATELY LOI + 15 HRS. NOTE: HANDOVER BETWEEN MODES I, II, AND III IS FUNCTION OF ACCUMULATED LOI_1 ΔV (REF RULE 5-62)
		RULE NUMBERS 1-44 THROUGH 1-47 ARE RESERVED.

REV	ITEM	
		CRITERIA FOR TARGET POINT SELECTION
A	1-48	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.

	PRIORITY
ACCEPTABLE LAND MASS CLEARANCE	1
ACCEPTABLE WEATHER CONDITIONS FOR RECOVERY OPERATIONS AND CM STRUCTURAL INTEGRITY	2
CAPABILITY OF RECOVERY FORCES	3
COMMUNICATION WITH THE SPACECRAFT FROM A GROUND STATION AT LEAST 40 MINUTES PRIOR TO DEORBIT BURN*	4
SUFFICIENT DAYLIGHT FOR RECOVERY OPERATIONS	5
A GROUND STATION FOR POST-DEORBIT BURN* TRACKING	6
VOICE CONTACT PRIOR TO AND DURING DEORBIT BURN*	7
POST-BLACKOUT TRACKING DATA AVAILABLE FOR REENTRY (ASSUMES PRE-BLACKOUT ACQUISITION)	8
GROUND STATIONS AVAILABLE TO OBTAIN DELTA V_C READOUTS AND TO PASS CREW BACKUP GUIDANCE QUANTITIES	9

*OR FINAL MCC MANEUVER

1-49 LUNAR RETURN ENTRY RANGE PRIORITY: THE RELATIVE ENTRY RANGE (400,000 FEET TO SPLASH) PRIORITY IS AS FOLLOWS:

A. 1200 - 1400 NM (NOMINAL)

B. 1400 - 1800 NM (USED TO AVOID WEATHER VIOLATIONS IN PRIORITY A.)

C. 1800 - 2500 NM (USED TO AVOID EXTREME WEATHER VIOLATIONS IN PRIORITY A AND B.)

RULE NUMBERS 1-50 THROUGH 1-55 ARE RESERVED

REV	ITEM	PRELAUNCH RULES
A	1-56	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 THE LAUNCH MISSION RULES DOCUMENT FOR SPECIFIC PROCEDURES.
	1-57	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.
	1-58	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.
	1-59	MANUAL CUTOFF WILL NOT BE ATTEMPTED FROM T-11 SECONDS (ENGINE IGNITION) TO T-0.
		RULE NUMBERS 1-60 THROUGH 1-65 ARE RESERVED.

REV	ITEM	
		LAUNCH ABORTS
	1-66	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.
	1-67	ABORT ACTION CAN BE INITIATED ONLY BY THE CREW OR THE EDS.
	1-68	WHENEVER POSSIBLE, ALL ABORTS AND EARLY MISSION TERMINATIONS WILL BE TIMED FOR A WATER LANDING.
	1-69	THE FLIGHT DIRECTOR WILL INITIATE THE ABORT REQUEST FOR SPACECRAFT SYSTEM MALFUNCTIONS.
	1-70	THE FLIGHT DYNAMICS OFFICER WILL INITIATE THE ABORT REQUEST COMMAND DURING THE FLIGHT PHASE IF THE SPACE VEHICLE EXCEEDS THE FLIGHT DYNAMICS ENVELOPE.
	1-71	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 OR CONTINUATION TO A FLIGHT DYNAMICS LIMIT LINE.
A	1-72	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 CRITERIA DEFINED IN THE LMRD. THESE INCLUDE: A. UNCONTROLLABLE FIRE B. SLV EXPLOSION C. SLV STRUCTURAL FAILURE D. SLV TIPOVER E. SLV FALLBACK
	1-73	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 4.1 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.
	1-74	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.

REV	ITEM	
A	1-75	EMERGENCY ENGINE SHUTDOWN METHODS.

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

A | 1-76

THE AUTOMATIC EDS (TWO ENGINE OUT AND OVERRATE AUTO-ABORT CAPABILITIES) WILL BE FLOWN CLOSED LOOP UNTIL T + 02:00. DURING LAUNCH, MALFUNCTIONS EFFECTING EDS OPERATION WILL BE MANAGED AS FOLLOWS:

THE EDS AUTO SWITCH WILL BE TURNED OFF WHENEVER ANY TWO CSM ENTRY BATTERIES ARE TIED TO THE SAME MAIN BUS OR FOR CONFIRMED LOSS OF ANY CSM ENTRY BATTERY.

A | 1-77

ABORT MODES:

MODE I	BOUNDARY OF APPLICATION
1A	LES ABORT ENABLE (≈T-45 MIN) TO GET 42 SEC. (10 K FEET)
1B	GET 42 SEC TO 100K FEET ALTITUDE (GET ≈1 + 50)
1C	100K FEET ALTITUDE TO TOWER JETTISON (GET≈ 1 + 16)

A | 1-78

MODE II	BOUNDARY OF APPLICATION	PROCEDURES
	TOWER JETTISON (GET ≈1 + 16) UNTIL FULL LIFT SPLASHPOINT IS 3200 NM DOWNRANGE (GET ≈10 + 13)	A. MCC PROVIDES 1. GET OF 400K 2. PITCH AT .05G 3. GET DROGUE B. ENTRY IS FULL LIFT

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM		BOUNDARY OF APPLICATION	PROCEDURES
A	1-79	MODE III	BETWEEN FULL LIFT SPLASH POINT =3200 NM AND INSERTION.	A. REFERENCE AOH TBD B. MCC PROVIDES: 1. GETI AT S-IVB CUTOFF PLUS 2:05 2. DELTA V FOR 3350 NM SPLASH-POINT 3. BURN DURATION 4. GET OF 400K 5. PITCH AT .05G 6. GET DROGUE C. MANEUVER IS SCS AUTO. D. ENTRY IS ROLL LEFT 55 DEGREES.
			NOTE MODE III "NO BURN" WILL BE CALLED IF THE ROLL LEFT 55° ENTRY RANGE IS <3350 NM.	
A	1-80	MODE IV	CONTINGENCY ORBIT INSERTION CAPABILITY TO INSERTION (BASED ON COI LINE ON γ VS V PLOT FOR NEAR NOMINAL ALTITUDE	A. MCC PROVIDES: 1. GETI AT S-IVB CUTOFF PLUS 2:05 2. DELTA V REQUIRED TO ACHIEVE PERIGEE $\geq$75 NM 3. BURN DURATION 4. PITCH AT GETI B. MANEUVER IS SCS AUTO
A	1-81	MODE APOGEE KICK	PRE-APOGEE CUTOFFS, OUTSIDE THE COI BOUNDARY, CORRECTABLE TO SAFE ORBITAL CONDITIONS BY A MANEUVER AT APOGEE.	A. MCC PROVIDES: 1. GETI FOR BURN AT APOGEE 2. DELTA V REQUIRED TO ACHIEVE PERIGEE $\geq$75 NM 3. BURN DURATION 4. PITCH ATTITUDE B. MANEUVER IS SCS AUTO
		RULES 1-82 THROUGH 1-86 ARE RESERVED		

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM		
		CREW ABORT LIMITS	
	1-87	MAX Q REGION	PROCEDURES
		A. (00:50 TO 02:00) AOA ≥100 PCT AND ROLL, PITCH, OR YAW ERROR ≥5 DEGREES	ABORT MODE I (ACTION ONLY AFTER BOTH HAVE REACHED THRESHOLD.)
		NOTE: NOT APPLICABLE FOR ANY ENGINE OUT PRIOR TO 50 SEC.	
A	1-88	RATES AND ATTITUDE	PROCEDURES
		A. PITCH AND YAW	ABORT MODE I
		1. L/O TO S-IC/S-II STAGING - 4 DEG/SEC 2. S-IC/S-II STAGING TO S-IVB CUTOFF 9 DEG/SEC 3. YAW ERROR >45°	ABORT MODE I, MODE II, MODE III, OR MODE IV
		B. ROLL	
		1. L/O TO S-IVB CUTOFF - 20 DEG/SEC	ABORT MODE I, MODE II, MODE III, OR MODE IV
A	1-89	EDS AUTOMATIC ABORT LIMITS (UNTIL MANUAL DEACTIVATION OF TWO ENGINES OUT AUTO AND LV RATES AT 2:00 MIN)	
		BOUNDARY OF APPLICATION	
		A. RATES PITCH AND YAW 4.0 ± .5 DEG/SEC ROLL 20.0 ± .5 DEG/SEC	
		B. ANY TWO ENGINES OUT	
		C. CM TO IU BREAKUP	
	1-90	S-IVB TANK PRESSURE LIMITS (S-II/S-IVB SEP TO CSM/LV SEP)	
		A. BULKHEAD ΔP FUEL > OXID = 26 PSID OXID > FUEL = 36 PSID	
		B. LOX TANK PRESS ≥50 PSIA	
	1-91	ENGINE FAILURES	PROCEDURES
		LOSS OF 3 OR MORE S-II ENGINES PRIOR TO S-IVB TO ORBIT	ABORT MODE I, MODE II

2 FLIGHT OPERATIONS RULES

REV	ITEM		FLIGHT OPERATIONS RULES
A	2-1	MISSION GO/NO-GO	A. GO/NO-GO DECISIONS WILL BE MADE BY THE FLIGHT CREW AND THE MCC PRIOR TO PROCEEDING BEYOND THE NEXT BEST DEORBIT OR DIRECT ABORT OPPORTUNITY, PRIOR TO ENTERING ANY CRITICAL MISSION SEQUENCE, AND PRIOR TO EXECUTING ANY PROPULSIVE MANEUVER. FORMAL GO/NO-GO POINTS ARE SUMMARIZED IN SECTION 3. 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. C. THE LIFETIME REQUIREMENTS AND CONSUMABLES ESTABLISHED FOR THE GO/NO-GO CRITERIA MUST ACCOUNT FOR THE NOMINAL ACTIVITIES PLANNED FOR COMPLETION, SUFFICIENT TIME AND CONSUMABLES TO PREPARE AND CONDUCT A CSM LM RESCUE, TEI, AND ENTRY FROM ANY POINT IN THE NOMINAL ACTIVITIES PLUS 12 HRS.
A	2-2	PRELAUNCH	A. LAUNCH AZIMUTH LIMITATIONS RESTRICT LAUNCHES TO OCCUR BETWEEN 72° AND 107°. B. THE FLIGHT DIRECTOR WILL EVALUATE WIND SIMULATIONS ALONG THE MODE I (TOWER) ABORT TRACK 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. C. THE LAUNCH WILL NOT BE ATTEMPTED IF THE MINIMUM GROUND INSTRUMENTATION CAPABILITY IS COMPROMISED. (REFERENCE SECTION 4 - GROUND INSTRUMENTATION REQUIREMENTS.) CONTINUOUS VOICE, TELEMETRY, AND TRACKING COVERAGE FOR THE SPACECRAFT IS REQUIRED FROM LIFTOFF THROUGH INSERTION PLUS 60 SEC. CONTINUOUS TM AND TRACKING COVERAGE IS REQUIRED FROM THE SLV FROM LIFTOFF THROUGH INSERTION PLUS 60 SEC. COMMAND IS HIGHLY DESIRABLE.
	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.
	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 OR S-IVB LOX TANK PRESS LIMITS EXCEEDED AFTER TOWER JETTISON.

REV	ITEM		
A	2-5	EARTH ORBIT	A. ENTRY WILL BE MADE WHEN ONE MORE CSM FAILURE WILL RESULT IN AN ASAP ENTRY OR UNCONTROLLABLE CONDITIONS. B. ADEQUATE CONSUMABLES WILL BE MAINTAINED FOR ENTRY IN THE NEXT PTP, MAKING ALLOWANCES FOR SETUP AND ENTRY PLUS 12 HRS. C. THE DEORBIT CAPABILITIES REQUIREMENTS FOR EARTH ORBIT ARE: 1. TWO METHODS OF DEORBIT ARE REQUIRED (SPS PLUS ONE OTHER). 2. IF A SUBSEQUENT SINGLE FAILURE WOULD PRECLUDE DEORBIT BY EITHER METHOD REMAINING, THE CSM WILL DEORBIT. 3. SPS IS THE PRIME METHOD OF DEORBIT AND SUFFICIENT ΔV WILL BE RESERVED FOR THIS MANEUVER. 4. 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 INTEGRITY IS MAINTAINED AND SUFFICIENT RCS PROPELLANT IS AVAILABLE. 5. THE LM PROPULSION SYSTEM (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. 6. UTILIZATION OF BACKUP DEORBIT METHODS WILL BE BASED ON THE FOLLOWING PRIORITIES: (A) SM-RCS (B) LM PROP PLUS SM-RCS (C) SM-CM/RCS HYBRID (D) LM PROP PLUS SM-CM/RCS HYBRID
A	2-6	EARLY CSM/S-IVB SEPARATION (NO LM EXTRACTION), EARTH ORBIT	A. AN 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. MINIMUM SAFE DISTANCE IS CONSIDERED TO BE 7,000 FT. B. LOSS OF ATTITUDE CONTROL DURING TB5.

REV	ITEM		
A	2-7	TRANSLUNAR INJECTION	A. THE TLI WILL BE GO IF THE S/C AND L/V SATISFY THE FOLLOWING CRITERIA: 1. THERE ARE ADEQUATE S-IVB CONSUMABLES TO PROVIDE A ONE SIGMA PROBABILITY OF A GUIDED CUTOFF. 2. THERE HAVE BEEN NO FAILURES IN THE LAUNCH VEHICLE WHICH WOULD RESULT IN A CATASTROPHIC HAZARD. 3. THERE HAS BEEN NO MALFUNCTION IN THE LAUNCH VEHICLE WHICH RESULTS IN ANY CONDITION FOR WHICH A GUIDED CUTOFF WILL DEFINITELY NOT BE ACHIEVED. 4. THE CSM HAS TOTAL SYSTEMS CAPABILITY WITH REDUNDANCY. REDUNDANCY VERIFICATION IS SUBJECT TO THE NUMBER AND TYPE OF REDUNDANT COMPONENT CHECKS WHICH CAN BE PERFORMED IN EARTH ORBIT. (REF RULE 3-138) B. THE TLI MANEUVER WILL BE DELAYED UNTIL THE SECOND OPPORTUNITY FOR SUSPECTED FAILURE OF A CRITICAL SYSTEMS (PRIME OR BACKUP) (MANEUVER, LIFE SUPPORT, COOLING, POWER, SEQUENTIAL, COMMUNICATIONS) WHICH REQUIRES TIME FOR EVALUATION.
A	2-8	TRANSPOSITION, DOCKING, AND EJECTION (TD&E)	A. IN THE EVENT OF ADVERSE LIGHTING, ATTITUDES, RATES, OR MECHANICAL ANOMALIES, THE FLIGHT CREW WILL MAKE THE FINAL DECISION TO ATTEMPT DOCKING AND EXTRACTION. B. 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. C. IF NORMAL LM EJECTION IS NOT SUCCESSFUL, NO ATTEMPT WILL BE MADE TO MAN THE LM AND "STAGE" TO RECOVER THE ASCENT STAGE. D. THREE LATCHES LOCATED 120° APART ARE REQUIRED TO PERFORM TD&E.
A	2-9	TRANSLUNAR COAST	A. AN SPS BURN OF APPROXIMATELY 20 FPS IS PLANNED AFTER TLI TO PROVIDE A SEPARATION DISTANCE FROM THE S-IVB AND TO ESTABLISH A NOMINAL FREE RETURN. B. NO MCC WILL BE PERFORMED IF LOI CAN BE TARGETED WITHIN OPERATION L CONSTRAINTS. C. TRANSLUNAR COAST WILL BE TERMINATED IF ADEQUATE CONSUMABLES DO NOT EXIST FOR A FREE RETURN +12 HRS. D. THE CREW WILL USE THEIR DISCRETION TO MAN THE LM FOR BACKUP COMMUNICATIONS IF CSM COMMUNICATIONS ARE LOST WITH THE MSFN. E. LM PROPULSION CAPABILITY CANNOT BE CONSIDERED AS ACCEPTABLE BACKUP TO CSM SYSTEMS UNTIL AFTER IVT AND LM SYSTEMS CHECKOUT.

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM		
A	2-10	LUNAR ORBIT INSERTION	LOI WILL BE INHIBITED AND A LUNAR FLYBY PERFORMED IF THE CSM DOES NOT SATISFY ANY OF THE FOLLOWING CONDITIONS: A. FULL CRITICAL SYSTEMS REDUNDANCY. B. ADEQUATE CONSUMABLES FOR MINIMUM LUNAR ORBIT OPERATIONS PLUS 12 HOURS. C. SPS PROPELLANT RESERVE CAPABILITY FOR TEI AND TRANSEARTH MCC'S. D. RCS PROPELLANT RESERVE TO ACCOMPLISH TEI CONTROL, TRANSEARTH MCC CONTROL, PTC, AND MINIMUM LUNAR ORBIT OPERATIONS. E. MINIMUM OF 9 DOCKING RING LATCHES.
	2-11	LUNAR ORBIT	A. LOI DISPERSIONS 1. IF A STABLE ORBIT HAS NOT BEEN ACHIEVED, AN SPS OR DPS ABORT WILL BE EXECUTED. 2. IF A STABLE ORBIT HAS BEEN ACHIEVED, AN SPS OR DPS TEI WILL BE PERFORMED AT THE NEXT PERICYNTHIAN OR AN ALTERNATE MISSION WILL BE FLOWN. B. DESIGNED REDUNDANT CAPABILITY MUST BE MAINTAINED IN ALL CRITICAL CSM SYSTEMS. C. SUFFICIENT CONSUMABLES MUST REMAIN TO COMPLETE THE NEXT MISSION PHASE AND EARTH RETURN +12 HRS FOR CONTINUATION TO THE NEXT MISSION PHASE. D. THE CSM MUST MAINTAIN AN SPS FUEL RESERVE CAPABILITY FOR THE TEI MANEUVERS AND TRANSEARTH MCC'S. E. THE CSM MUST MAINTAIN RCS PROPELLANT RESERVE TO ACCOMPLISH TEI CONTROL, TRANSEARTH MCC CONTROL, PTC, AND MINIMAL TRANSEARTH OPERATIONS. F. IF NORMAL RENDEZVOUS OPERATIONS ARE INHIBITED, THE DPS WILL BE USED FOR TEI WHEN THERE IS A CHOICE BETWEEN THE DPS AND SPS.
	2-12	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. IF THE PROBLEM CANNOT BE CORRECTED, THE LM SYSTEMS WILL BE ACTIVATED AND THE LM WILL BE STAGED AND SET UP FOR THE UNMANNED OPERATION.
	2-13	DOCKED LM OPERATION	A. LIMITED EVALUATION OF LM SYSTEMS PERFORMANCE, UTILIZING ONE LM CREWMAN, WILL CONTINUE AS LONG AS LIFE SUPPORT CAN BE PROVIDED TO THREE SUITED CREWMEN AND AS LONG AS LM/CSM VOICE COMMUNICATIONS ARE AVAILABLE AND NO HAZARDOUS, CREW SAFETY SITUATIONS EXIST. B. FOR AN IMPENDING HAZARDOUS SITUATION RESULTING FROM A DESCENT STAGE PROBLEM, THE STAGE WILL BE JETTISONED AND ASC STAGE OPERATIONS WILL CONTINUE AFTER THE VEHICLE HAS MOVED TO A SAFE DISTANCE (____FT). C. BEFORE CSM/LM UNDOCKING, LIFE SUPPORT CAPABILITY FOR CONTINGENCY EVT MUST BE VERIFIED.

REV	ITEM		
	2-14	CSM/LM UNDOCKING AND SEPARATION	A. A MANNED LM WILL NOT BE UNDOCKED FROM THE CSM WITHOUT INDEPENDENT MANEUVER CAPABILITY OF BOTH VEHICLES TO TERMINATE UNDOCKED ACTIVITIES AND TO ACCOMPLISH DOCKING. B. VHF VOICE COMMUNICATIONS BETWEEN THE LM AND CSM ARE MANDATORY FOR UN-DOCKING. C. CM AND LM SUIT LOOP INTEGRITY IS REQUIRED FOR MANNED UNDOCKING. D. CREWMEN WILL BE SUITED WHILE IN THE UNDOCKED CONFIGURATION AND UNTIL CM INTEGRITY IS ESTABLISHED AFTER RENDEZVOUS AND DOCKING. E. THE CAPABILITY TO REDOCK WITH THE ASCENT STAGE ONLY MUST BE ESTABLISHED BEFORE UNDOCKING WILL BE PERFORMED.
	2-15	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. FOR LM CONDITIONS REQUIRING MANUAL CONTROL OF AN APS/DPS TRANSLATION MANEUVER. IT IS PREFERRED TO RETAIN THE DPS FOR EASE OF CONTROL AND STAGE CONSUMABLES. B. BOTH VEHICLES MUST HAVE INDEPENDENT CAPABILITY TO COMPLETE RENDEZVOUS AND DOCKING. C. 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. D. FITH STAGING FROM EITHER AN INACTIVE DPS OR AN ACTIVE DPS WILL NOT BE PERFORMED, EXCEPT FOR IMPENDING CATASTROPHIC FAILURE OF THE DESCENT STAGE. E. FOR CONDITIONS INHIBITING LM STAGING, THE CSM WILL EXECUTE THE MCC AND BRAKING MANEUVERS.
	2-16	UNMANNED PHASE	A. THE APS BURN TO DEPLETION WILL BE ACCOMPLISHED UNLESS LOSS OF ATTITUDE CONTROL OR TLM. IF IGNITION WOULD RESULT IN STAGE DESTRUCTION IN LUNAR ORBIT, THE MANEUVER WILL BE INHIBITED. B. IF TEI IS ACCOMPLISHED WITH THE DPS AND TEH ASCENT STAGE IS NOT REQUIRED FOR CSM PROBLEMS, THE APS UNMANNED BURN TO DEPLETION WILL BE PERFORMED DURING THE TEC PHASE.
	2-17	TRANSEARTH COAST	A. THE STEEP TARGET LINE WILL BE USED FOR MCC'S UNLESS THE VELOCITY AT ENTRY INTERFACE IS LESS THAN 30,000 FPS AND THE G&N IS GO; THEN THE SHALLOW TARGET LINE WILL BE USED. B. MCC'S MAY BE USED FOR LANDING AREA CONTROL PRIOR TO ENTRY INTERFACE MINUS 24 HOURS FOR RECOVERY ACCESS VIOLATIONS, UNACCEPTABLE WEATHER, OR LAND MASSES IN ANY PART OF THE OPERATIONAL FOOTPRINT. C. IF THE FLIGHT PATH ANGLE IS OUTSIDE THE ENTRY CORRIDOR, AN MCC WILL BE EXECUTED AS SOON AS PRACTICAL. D. MCC'S WILL BE ACCOMPLISHED BY THE SPS IF NECESSARY TO MAINTAIN RCS REDLINES.

REV	ITEM		
A	2-18	ALTERNATE MISSIONS	A. ALTERNATE MISSION GUIDELINES 1. THE LM RENDEZVOUS WILL HAVE FIRST PRIORITY IN ALTERNATE MISSIONS, AND TLI WILL BE INHIBITED IF A FAILURE SHOULD OCCUR WHICH WOULD INHIBIT LOI. LM SYSTEMS EVALUATION WILL HAVE SECOND PRIORITY. 2. THE LM WILL BE UNDOCKED IN LUNAR OR LOW EARTH ORBIT (H_a <400 NM) ONLY. 3. WHENEVER POSSIBLE, THE SPS WILL BE USED TO RETURN TO LOW EARTH ORBIT (H_a <400 NM) FROM DISPERSED TLI CUTOFFS. WHEN THIS IS NOT POSSIBLE, THE CSM/LM WILL BE PLACED IN A SEMI-SYNCHRONOUS ORBIT AND DOCKED LM SYSTEMS EVALUATIONS CONDUCTED. 4. SHOULD SPS PROBLEMS OCCUR IN ANY MISSION PHASE, CONSIDERATION WILL BE GIVEN TO USING THE DPS ENGINE. 5. SHOULD CSM FAILURES OCCUR IN ANY MISSION PHASE, CONSIDERATION WILL BE GIVEN TO USING THE LM SYSTEMS. 6. THE DPS WILL BE USED TO EXECUTE TEI WHENEVER AVAILABLE. B. ALTERNATE MISSION DESCRIPTIONS THE FOLLOWING CLASSES OF ALTERNATE MISSIONS ARE AVAILABLE, AND ARE NOT LISTED IN ORDER OF PRIORITY. SEE REFERENCE 2-18A FOR ALTERNATE MISSION GUIDELINES. (RULE 2-18 CONTINUED ON FOLLOWING PAGE.)

REV	ITEM			
A	2-18 (CONT'D)	ALTERNATE MISSIONS	B.1. EARTH ORBIT MISSIONS	
			CONTINGENCY/FAILURE	ACTION/MISSION
			(A) NO LM EXTRACTION AFTER PARTIAL TLI (H_a < 25,000 NM) OR SPS COI	1. SPS PHASING BURN 2. SPS "LOI" TO ACHIEVE 400 X 100 NM ORBIT 3. SPS "MCC" TO ACHIEVE 240 X 100 NM ORBIT 4. 10 DAY MISSION
			(B) NO LM EXTRACTION AFTER PARTIAL TLI (H_a > 25,000 NM)	1. SPS PHASING BURN 2. SPS "LOI" TO ACHIEVE SEMI-SYNCHRONOUS ORBIT (PARTIALLY OUT OF PLANE) 3. SPS PHASING TO ACHIEVE $LONGITUDE_p$ = 165 W
			(C) LM EXTRACTION AFTER NO TLI OR PARTIAL TLI (H_a < 4000 NM)	1. SPS FOR APOGEE RAISE (IF NECESSARY) 2. SPS "LOI" TO ACHIEVE APOGEE = 400 NM (PARTIALLY OUT OF PLANE) 3. DPS "DOI" (DOCKED) 4. DPS POWERED DESCENT (DOCKED) 5. SPS CIRCULARIZATION AT 140 NM 6. LM ACTIVE RENDEZVOUS 7. APS BTD - AGS (UNMANNED) 8. SPS TO ACHIEVE 240 X 90 NM ORBIT 9. 10 DAY MISSION
			(D) LM EXTRACTION AFTER PARTIAL TLI (4000 < H_a < 10,000 NM)	1. SPS PHASING 2. DPS "DOI" (DOCKED) 3. DPS "PD" (DOCKED) TO ACHIEVE APOGEE = 4000 NM (PARTIALLY OUT OF PLANE) 4. SPS PHASING 5. SPS "LOI" TO ACHIEVE APOGEE = 400 NM 6. SPS CIRCULARIZATION AT 150 NM 7. LM ACTIVE RENDEZVOUS 8. APS BTD - AGS (UNMANNED) 9. SPS TO 240 X 90 ORBIT 10. 10 DAY MISSION
			(E) LM EXTRACTION AFTER PARTIAL TLI (10,000 < H_a < 50,000 NM)	1. SPS PHASING 2. SPS "LOI" TO SEMI-SYNC (PARTIALLY OUT OF PLANE) 3. SPS PHASING 4. DPS "DOI" (DOCKED) 5. DPS "PD" (DOCKED) 6. SPS PHASING 7. SPS BURN TO ACHIEVE $LONGITUDE_p$ = 165 W 8. 10 DAY MISSION

NOTE

THE LM ACTIVE RENDEZVOUS FOR THESE ALTERNATES WILL BE:

1. SEP - CSM ACTIVE - ΔV = 5 FPS
2. PHASING - LM ACTIVE - ΔV = 178 FPS
3. CSI - ΔV = 0 FPS
4. CDH - ΔV = 103 FPS (Δh = 11 NM)
5. TPI - ΔV = 24 FPS
6. TPF - ΔV = 32 FPS

(RULE 2-18 CONTINUED ON FOLLOWING PAGE)

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM			
A	2-18 (CONT'D)	ALTERNATE MISSIONS	B.2. LUNAR MISSIONS	
			CONTINGENCY/FAILURE	ACTION/MISSION
			(A)(1) LM EXTRACTION AFTER NON-NOMINAL TLI WHERE EOMFR AFTER BAP MCC, LOI_1, LOI_2, AND TEI <500 FPS (NOTE: SPS DOCKED ΔV = 2400 IS MANDATORY)	1. DPS LOI (DOCKED) WHERE APOCYNTHION = 2000 NM 2. SPS LOI_2 3. NOMINAL MISSION
			(2) LM EXTRACTION AFTER NON-NOMINAL TLI WHERE (1) IS NOT PERFORMED	1. LM CHECKOUT 2. APS BTD (UNMANNED) 3. CSM-ONLY LUNAR ORBIT MISSION (SEE ALT B.2.(B)1)
			(3) LM EXTRACTION AFTER NON-NOMINAL TLI WHERE (1) AND (2) ARE NOT PERFORMED	1. LM CHECKOUT 2. DPS FLYBY MCC 3. APS BTD (UNMANNED) 4. SPS FOR FASTER RETURN (IF DESIRED)
			(B) NO LM EXTRACTION AFTER NOMINAL TLI OR AFTER NON-NOMINAL TLI WHERE EOMFR AFTER SPS BAP MCC, LOI_1, LOI_2, AND TEI >500 FPS (NOTE: FAILURE OF THIS TEST DICTATES LUNAR FLYBY MCC WITH POSSIBLE SPS FOR FASTER RETURN POST-PERICYTHION)	1. CSM-ONLY LUNAR MISSION WITH SPS DOI AND SUBSEQUENT CIRCULARIZATION
			(C)(1) ANY SITUATION WHICH WARRANTS A DPS TEI (REFERENCE MISSION RULES)	1. DPS TEI 2. APS BTD (UNMANNED) (IF POSSIBLE) 3. SPS FOR FASTER RETURN (IF DESIRED)
			(2) LM NO-GO FOR RENDEZVOUS AND TEI	1. EXTENDED LM CHECKOUT 2. APS BTD (UNMANNED)
			(D) ANY SITUATION WHICH WARRANTS THE RETENTION OF THE ASCENT STAGE ON TEC	1. SPS TEI WITH THE ASCENT STAGE RETAINED
			3. RENDEZVOUS ALTERNATES	
			CONTINGENCY/FAILURE	ACTION/MISSION
			(A) ANY SITUATION WHICH DICTATES NO LM STAGING (REFERENCE MISSION RULES)	1. NOMINAL RENDEZVOUS WITHOUT STAGING (NOTE: DPS MAY BE STAGED 7 MINUTES PRIOR TO TPI IN SOME INSTANCES)
			(B) APS ONLY PROFILE (DPS NOT AVAILABLE FOR DOI)	1. APS DOI 2. PDI ABORT PROFILE
		RULE NUMBERS 2-19 THROUGH 2-30 ARE RESERVED.		

3 MISSION RULE SUMMARY

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
		LAUNCH PHASE
A	3-1	THE LAUNCH WILL BE ABORTED FOR THE FOLLOWING REASONS:

CONDITION — RULES

A. SLV

S-II GIMBAL ACTUATOR HARDOVER INBOARD (TIME DEPENDENT)
VIOLATION OF AUTO/MANUAL EDS LIMITS
S-II ENGINE FAILURES (TIME DEPENDENT)
FAILURE OF SECOND PLANE SEPARATION
S-IVB LOSS OF HYDRAULIC FLUID (PRIOR TO S-IVB IGNITION), POSSIBLE COI CONDITION
S-IVB LOSS OF THRUST (TIME DEPENDENT), POSSIBLE COI CONDITION
S-IVB LOX TANK PRESSURE >50 PSI (THROUGH TWR JETT)

B. CSM

1. ENVIRONMENTAL

LOSS OF CABIN PRESSURE AND SUIT PRESSURE
LOSS OF CABIN PRESSURE AND SUIT CIRCULATION
FIRE/SMOKE IN CM
LOSS OF CABIN PRESSURE AND O_2 MANIFOLD LEAK

2. ELECTRICAL

LOSS OF 3 FUEL CELLS AND 1 BATTERY
UNCONTROLLABLE SHORTED MAIN BUS
LOSS OF BOTH AC BUSES DURING MODE 1 OR MODE II

3. PROPULSION

SUSTAINED LEAK OR LOSS OF He PRESSURE IN BOTH CM-RCS RINGS (MODE I ONLY)

C. VIOLATION OF TRAJECTORY LIMIT LINES

D. TEAM DISCRETION WILL BE USED FOR:

1. SUIT/CABIN CONTAMINATION
2. MEDICAL PROBLEMS

3-2 THE S-IVB EARLY STAGING WILL BE USED AFTER "S-IVB TO-ORBIT" CAPABILITY FOR THE FOLLOWING REASONS:

CONDITIONS — RULES

S-II GIMBAL ACTUATOR INBOARD HARDOVER
S-II ENGINE FAILURES (TIME DEPENDENT)
S-IVB LOX TANK PRESS >50 PSI (UPSTAGE AFTER TWR JETT)

A 3-3 SWITCHOVER TO CSM GUIDANCE WILL BE PERFORMED FOR:

SATURN GUIDANCE REFERENCE FAILURE

RULE NUMBERS 3-4 THROUGH 3-9 ARE RESERVED.

REV	ITEM	
		EARTH ORBIT

A 3-10 THE CSM WILL BE NO-GO FOR CONTINUING THE MISSION IF ANY OF THE FOLLOWING CONDITIONS EXIST:

RULES

A. ECS

LOSS OF CABIN INTEGRITY
LOSS OF SUIT CIRCUIT
LOSS OF 02 MANIFOLD
LOSS OF SURGE TANK AND REPRESS PACK
LOSS OF CYCLIC ACCUMULATOR OPERATION
POTABLE WATER TANK QUANTITY PLUS FUEL CELL PRODUCTION TO THE NEXT PTP WILL TOTAL 20 LB
LOSS OF URINE DUMP CAPABILITY FOR PTP'S SUBSEQUENT TO LM JETTISON
LOSS OF PRIMARY COOLING
CONFIRMED LEAK OF GLYCOL IN EITHER COMMAND MODULE OR SUIT CIRCUIT

B. CRYO

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)

C. EPS

LOSS OF TWO FUEL CELLS
LOSS OF TWO ENTRY BATTERIES
LOSS OF ONE MAIN BUS, ONE AC BUS, OR THE BATTERY RELAY BUS
LOSS OF TWO INVERTERS
LOSS OF BATT CHARGER AND TOTAL BATT AMP-HRS ≤ 73 (REF. RULE 12-42)

D. COMM/INSTRUMENTATION

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
LOSS OF TWO-WAY VOICE COMMUNICATION AFTER LM JETTISON (CSM/MSFN)

E. SEQUENTIAL

LOSS OF ONE SEQUENTIAL SYSTEM

F. G&C

LOSS OF DIRECT RCS (ANY AXIS)
LOSS OF RATE DAMPING (ANY AXIS)
LOSS OF TWO DEORBIT METHODS

G. SPS

LOSS OF CAPABILITY TO PERFORM CRITICAL MANEUVERS
ΔV REMAINING LESS THAN SPS DEORBIT REQUIREMENTS

H. SM-RCS

LOSS OF TWO QUADS
LOSS OF ATTITUDE CONTROL IN ONE OR MORE AXES
PROPELLANT REMAINING LESS THAN HYBRID DEORBIT REQUIREMENT, IF HYBRID AND SPS DEORBIT AVAILABLE. OTHERWISE PROPELLANT REMAINING LESS THAN SM DEORBIT REQUIREMENT.

I. CM-RCS

LOSS OF SOURCE PRESSURE - ONE RING
LOSS OF MANIFOLD PRESSURE - ONE RING
CM-RCS ARMED

J. UNSATISFACTORY CREW CONDITION

K. TWO SATISFACTORY METHODS OF DEORBIT ARE NOT AVAILABLE (SPS AND ONE ALTERNATE)

L. A SUBSEQUENT SINGLE FAILURE WOULD REQUIRE ENTRY IN ONE REV OR LESS

REV	ITEM	
	3-11	CSM SEPARATION FROM THE S-IVB (WITHOUT LM EXTRACTION) WILL BE PERFORMED EARLY FOR THE FOLLOWING SLV CONDITIONS (CONSIDERATION WILL BE GIVEN TO EXTRACTING THE LM LATER IF THE CONDITION CAN BE CORRECTED):

NOTE

THOSE CONDITIONS MARKED BY AN ASTERISK REQUIRE AN SPS SEPARATION MANEUVER.

CONDITION — RULES

TIME BASE 5 FAILS TO INITIATE AT CUTOFF
*S-IVB RANGE SAFETY PROPELLANT DISPERSAL SYSTEM ARMS INADVERTENTLY AFTER INSERTION AND PRIOR TO SAFING
*S-IVB LOX TANK PRESS >50 PSI
LOSS OF ATTITUDE CONTROL DURING TB5
*S-IVB COMMON BULKHEAD DELTA PRESSURE EXCEEDS LIMITS
*START BOTTLE ABOVE 1800 PSIA

3-12 CSM SEPARATION FROM THE S-IVB (WITH LM EXTRACTION) WILL BE PERFORMED EARLY FOR:

CONDITION — RULES

A. S-IVB NO-GO FOR TLI

B. CSM NO-GO FOR TLI BUT GO FOR EARTH ORBIT MISSION

A 3-13 TLI WILL BE INHIBITED FOR:

CONDITION — RULES

A. SLV

INSUFFICIENT PROPELLANT FOR TLI GUIDANCE CUTOFF
S-IVB ENGINE MAIN LOX VALVE FAILS TO CLOSE AT CUTOFF
LOSS OF ATTITUDE CONTROL
CONTINUOUS VENT SYSTEM REGULATOR FAILS

LOSS OF ENGINE CONTROL BOTTLE PRESSURE
CONFIRMED ACTUATOR HARDOVER
LOSS OF ENGINE HYDRAULIC FLUID
COLD He SPHERE PRESS LOW
H_2 ULLAGE PRESS LOW
LOX ULLAGE PRESS LOW

MISALIGNMENT RATE BETWEEN THE IU AND IMU IS OUTSIDE LIMITS
UNACCEPTABLE DIFFERENCES BETWEEN CMC AND IU P ATFORM VELOCITY COMPONENTS OR TOTAL VELOCITY AT INSERTION
UNACCEPTABLE DIFFERENCE BETWEEN MSFN AND IU ORBITAL DECISION PARAMETERS
IU PLATFORM ACCELEROMETER FAILURE

B. CSM

1. ECS

LOSS OF CABIN INTEGRITY
LOSS OF SUIT CIRCULATION
FIRE OR SMOKE IN THE CABIN
O_2 MANIFOLD LEAK
LOSS OF ONE MAIN O_2 REGULATOR
LOSS OF ONE SUIT COMPRESSOR
LOSS OF PRIMARY RADIATOR
LOSS OF PRIMARY COOLANT LOOP

REV	ITEM		RULES
A	3-13 (CONT'D)	LOSS OF SECONDARY RADIATOR LOSS OF SECONDARY LOOP LEAK OF GLYCOL COOLANT FAILURE OF BOTH H_2O ACCUMULATORS LOSS OF POTABLE OR WASTE H_2O TANK LOSS OF BOTH H2O EVAPORATORS (BECAUSE NO-GO FOR LUNAR RNDZ) LOSS OF ALL OVERBOARD DUMP CAPABILITY 2. CRYO LOSS OF ANY CRYO TANK 3. EPS LOSS OF ONE FUEL CELL LOSS OF ONE ENTRY BATTERY LOSS OF ONE BATTERY, MAIN OR BATTERY RELAY BUS LOSS OF TWO INVERTERS LOSS OF ONE A/C BUS LOSS OF AC1 PHASE A LOSS OF AC2 PHASE A 4. COMM/INSTRUMENTATION LOSS OF BOTH POWER AMPLIFIERS LOSS OF THE SCE LOSS OF TWO AUDIO CENTERS LOSS OF CRITICAL INSTRUMENTATION (REQUIRED FOR GO/NO-GO DECISION) 5. SEQUENTIAL SMJC ACTIVATED LOSS OF ONE SEQUENTIAL SYSTEM 6. G&C LOSS OF BOTH BMAGS IN PITCH, YAW, OR ROLL LOSS OF BOTH FDAI'S GROUND AT EITHER SPS SOL DRIVER OUTPUT LOSS OF CMC LOSS OF NAV DSKY (CMC WARNING RELAY) LOSS OF BOTH DSKY'S LOSS OF ISS LOSS OF OPTICS SUBSYSTEM LOSS OF OPTICS CDU DAC LOSS OF EITHER TVC SERVO LOOP 7. SPS SUSTAINED PRESSURE DECAY IN SPS FUEL OR OX TANK LOSS OF BOTH GN_2 TANK PRESSURES FUEL FEEDLINE AND/OR OXID FEEDLINE TEMP 40°F AND UNABLE TO INCREASE FUEL/OXIDIZER ΔP GREATER THAN 20 PSI LOSS OF He SOURCE PRESSURE 8. SM RCS HELIUM TANK LEAK IN ONE QUAD LEAK DOWNSTREAM OF He ISOLATION VALVE PACKAGE TEMP <70°F AND UNABLE TO INCREASE LOSS OF FOLLOWING THRUSTER COMBINATIONS: 2P OR 2Y 1P AND 1Y 1P OR 1Y AND 2 ROLL IN SAME DIRECTION 3 ROLL IN SAME DIRECTION 9. CM RCS LOSS OF HELIUM SOURCE PRESS - ONE RING CM-RCS ARMED LOSS OF He MANIFOLD PRESS ONE RING	

REV	ITEM	
	3-13 (CONT'D)	10. INTERFACE CONDITIONS LOSS OF TWO-WAY S-BAND VOICE LOSS OF ALL TM
	3-14	TLI WILL BE TERMINATED FOR: RULES A. PITCH OR YAW BODY RATES GREATER THAN 10°/SEC B. PITCH OR YAW ATTITUDE DEVIATIONS FROM NOMINAL PROFILES EXCEED 45° C. ROLL BODY RATE GREATER THAN 20°/SEC
A	3-15	SWITCHOVER TO CSM GUIDANCE DURING THE TLI BURN WILL BE PERFORMED FOR: SATURN GUIDANCE REFERENCE FAILURE
A		RULE NUMBERS 3-16 THROUGH 3-20 ARE RESERVED.

REV	ITEM	TD & E	
A	3-21	TD&E WILL BE PERFORMED IF NO IMMEDIATE ABORT RETURNS (CSM CONDITIONS) EXIST. TD&E WILL NOT BE PERFORMED FOR: A. PILOT'S EVALUATION OF RATES AND ATTITUDES, AND SLA CONFIGURATION NOT ACCEPTABLE. B. LESS THAN THREE GOOD DOCKING RING LATCHES LESS THAN 120° APART. C. THE SLV WILL BE NO-GO FOR: 1. VIOLATION OF S-IVB BULKHEAD ΔP LIMITS 2. LOX TANK OVERPRESSURE >50 PSI 3. TB7 FAILS TO INITIATE D. THE CSM WILL BE NO-GO FOR: 1. LOSS OF SUIT INTEGRITY 2. LOSS OF TRANSLATION HAND CONTROLLER	RULES
		RULE NUMBERS 3-22 THROUGH 3-27 ARE RESERVED.	

REV	ITEM	
		TRANSLUNAR COAST

3-28 TRANSLUNAR COAST WILL BE TERMINATED AND ENTRY INTO THE NEXT BEST PTP ACCOMPLISHED FOR THE LISTED CSM FAILURES. THE NEXT BEST PTP COULD INCLUDE A CIRCUMLUNAR FLIGHT DEPENDENT ON INFLIGHT ANALYSIS AND EVALUATION OF THE FOLLOWING TRADEOFFS:

A. FLIGHT TIME REMAINING

B. ABORT MANEUVER REQUIRED

C. SYSTEMS REDUNDANCY REMAINING

(NOTE: FOR CSM PROBLEMS, CONSIDERATION WILL BE GIVEN TO EARLY TRANSFER TO THE LM TO ALLEVIATE THE CONDITION.)

CSM CONDITION — RULES

A. ECS

LOSS OF CABIN INTEGRITY
FIRE OR SMOKE IN THE CABIN
O_2 MANIFOLD LEAK
LOSS OF ONE MAIN O2 REGULATOR
LOSS OF PRIMARY RADIATOR
LOSS OF PRIMARY COOLANT LOOP
LOSS OF SECONDARY RADIATOR
LOSS OF SECONDARY LOOP
LEAK OF GLYCOL COOLANT
EXCESSIVE CABIN HUMIDITY
LOSS OF POTABLE OR WASTE H_2O TANK
LOSS OF SUIT CIRCULATION
LOSS OF ALL OVERBOARD DUMP CAPABILITY

B. CRYO

LOSS OF ANY CRYO TANK

C. EPS

LOSS OF TWO FUEL CELLS
LOSS OF ONE BATTERY, MAIN, OR BATTERY RELAY BUS
LOSS OF TWO INVERTERS
LOSS OF ONE A/C BUS
LOSS OF TWO ENTRY BATTERIES

D. COMM/INSTRUMENTATION

LOSS OF SCE

E. SEQUENTIAL

LOSS OF ONE SEQUENTIAL SYSTEM
SMJC ACTIVATED PREMATURELY

F. G&C

LOSS OF DIRECT RCS CONTROL, BOTH RHC'S (CHECK ONCE POST TLI)
LOSS OF AUTO ATTITUDE CONTROL PITCH AND YAW

G. SPS

NONE

H. SM-RCS

LOSS OF ONE QUAD
LEAK DOWNSTREAM OF HELIUM ISOLATION VALVE

I. CM-RCS

LOSS OF HELIUM SOURCE PRESSURE - ONE RING
CM-RCS ARMED
LOSS OF HELIUM MANIFOLD PRESSURE - ONE RING

REV	ITEM	
A	3-28 (CONT'D	J. INTERFACE CONDITION LOSS OF ALL TWO-WAY VOICE CSM OR LM/MSFN (CREW NOT UPDATED WITH FLYBY PAD)
A	3-29	LOI WILL BE INHIBITED AND A CIRCUMLUNAR FLIGHT ACCOMPLISHED FOR ANY CONSUMABLE PROBLEM PREVENTING MINIMUM LUNAR ORBIT OPERATIONS OR ANY CONDITION REQUIRING TERMINATION OF TLC. THE FOLLOWING CSM CONDITIONS WILL ALSO CAUSE LOI TO BE INHIBITED: A. CSM CONDITION — RULES 1. ECS LOSS OF PRIMARY AND SECONDARY EVAPORATORS 2. EPS LOSS OF ONE ENTRY BATTERY (BASED ON FAILURE MODE, CONSIDERATION WILL BE GIVEN TO CONTINUING WITH LOI) LOSS OF ONE FUEL CELL (BASED ON FAILURE MODE, CONSIDERATION WILL BE GIVEN TO CONTINUING WITH LOI) LOSS OF AC 1 PHASE A LOSS OF AC 2 PHASE A LOSS OF BATT CHARGER (IF SUM OF TWO LOWEST ENTRY BATT $\leq$56 AMP HRS) 3. COMM/INSTRUMENTATION LOSS OF CRITICAL INSTRUMENTATION (REQUIRED FOR GO/NO-GO DECISION) 4. G&C LOSS OF BOTH BMAGS IN ROLL LOSS OF BOTH BMAGS IN PITCH OR YAW AXIS LOSS OF BOTH FDAI'S LOSS OF CMC LOSS OF NAV DSKY (CMC WARNING RELAY) LOSS OF ISS LOSS OF OPTICS SUBSYSTEM LOSS OF OPTICS CDU D/A (CHECK PRE-SPS BURN) GROUND AT EITHER SPS SOL DRIVER OUTPUT AND UNABLE TO REMOVE LOSS OF EITHER TVC SERVO LOOP DURING A PREVIOUS BURN 5. SPS SUSTAINED PRESSURE DECAY IN SPS FUEL OR OX TANK LOSS OF ONE BANK OF BALL VALVES FUEL FEEDLINE TEMP 40°F AND UNABLE TO INCREASE ENGINE FLANGE OVERTEMP DURING A PREVIOUS BURN THRUST CHAMBER PRESSURE BELOW 70 PSI DURING A PREVIOUS BURN FUEL/OXIDIZER ΔP GREATER THAN 20 PSI LOSS OF HELIUM SOURCE PRESSURE (SPS) LOSS OF BOTH GN_2 TANKS 6. SM-RCS LOSS OF ULLAGE CAPABILITY LOSS OF FOLLOWING THRUSTER COMBINATIONS: 2P OR 2Y 1P AND 1Y 1P OR 1Y AND 2 ROLL IN SAME DIRECTION 3 ROLL IN SAME DIRECTION 7. CM-RCS LOSS OF HELIUM SOURCE PRESSURE - ONE RING CM-RCS ARMED LOSS OF HELIUM MANIFOLD PRESSURE - ONE RING

REV	ITEM	
	3-29 (CONT'D)	B. INTERFACE CONDITION: 1. DOCKING LOSS OF 4 DOCKING LATCHES 2. COMMUNICATIONS LOSS OF ALL TM LOSS OF ALL TWO-WAY VOICE CSM/MSFN
A	3-30	DURING THE LOI BURN, THE FLIGHT CREW WILL TAKE THE FOLLOWING ACTION: A. TERMINATE LOI FOR THE FOLLOWING SPS PROBLEMS (PERFORM THE 15 MINUTE ABORT IF THE BURN IS TERMINATED IN THE MODE I OR MODE II REGION): *SEE MALFUNCTION PROCEDURE #1 1. LOSS ONE GN_2 BOTTLE (<400 PSI) AND DECAY IN OTHER (TERMINATE ONLY WHILE IN THE MODE I OR MODE II REGION) 2. PRESSURE DECAY IN EITHER SPS PROPELLANT TANK TO 140 PSI (AFTER MANUAL REPRESS ATTEMPT) *3. FUEL - OXIDIZER ΔP>20 PSI *4. CHAMBER PRESSURE <80 PSI OR DECAY OF 10 PSI DURING BURN 5. ANY BALL VALVE(S) FAILS TO OPEN AFTER ITS RESPECTIVE BANK IS COMMANDED ON OR FAILS CLOSED (TERMINATE ONLY WHILE IN THE MODE I OR MODE II REGION) 6. FLANGE TEMPERATURE LIGHT B. PERFORM MTVC TAKEOVER AND COMPLETE THE BURN FOR THE FOLLOWING CONTROL PROBLEMS: 1. G&N NO-GO 2. ATTITUDE EXCURSION >10° 3. RATES >10°/SEC C. RESTART THE BURN AND COMPLETE UNDER SCS CONTROL FOR AN SPS SHUTDOWN.
		RULE NUMBERS 3-31 THROUGH 3-36 ARE RESERVED.

REV	ITEM	

LUNAR ORBIT

3-37 DEPENDING ON THE ANALYSIS OF A NON-NOMINAL LOI BURN, THE FOLLOWING COURSES OF ACTION ARE AVAILABLE:

A. UNLESS A STABLE ORBIT HAS BEEN ACHIEVED, DIRECT (SPS OR DPS) ABORTS OR DPS TWO IMPULSE CIRCUMLUNAR ABORTS WILL BE EXECUTED.

B. IF STABLE ORBIT HAS BEEN ACHIEVED, TEI (DPS OR SPS) WILL BE EXECUTED AT NEXT PERICYNTHION OR AN ALTERNATE MISSION WILL BE INITIATED.

A 3-38 TEI WILL BE PERFORMED AT THE NEXT BEST OPPORTUNITY FOR THE FOLLOWING CSM CONDITIONS:

NOTE 1

FOR CSM PROBLEMS, CONSIDERATION WILL BE GIVEN TO RETAINING THE LM FOR THE TRANSEARTH PHASE TO ALLEVIATE THE CONDITION AND/OR PROVIDE A BACKUP CAPABILITY.

NOTE 2

FOR THOSE CONDITIONS MARKED BY AN ASTERISK, EARLY TEI WILL BE EXECUTED ONLY AFTER MISSION CRITICAL LUNAR ORBIT OPERATIONS HAVE BEEN COMPLETED (I.E., LM CHECKOUT, RNDZ, LANDMARK TRACKING).

CONDITION | RULES

A. ECS

O2 MANIFOLD LEAK
LOSS OF PRIMARY RADIATOR
LOSS OF PRIMARY COOLANT LOOP
CONFIRMED LEAK OF GLYCOL COOLANT
LOSS OF POTABLE OR WASTE H_2O TANK
EXCESSIVE CABIN HUMIDITY
LOSS OF CABIN INTEGRITY
LOSS OF SUIT CIRCULATION
LOSS OF BOTH EVAPORATORS
LOSS OF SECONDARY LOOP
LOSS OF BOTH MAIN REGULATORS
*LOSS OF SECONDARY RADIATOR
*LOSS OF ALL OVERBOARD D MP CAPABILITY
*LOSS OF ONE SUIT COMPRESSOR
*LOSS OF ONE MAIN REGULATOR

B. CRYO

LOSS OF ANY CRYO TANK

C. EPS

*LOSS OF BATT CHARGER AND SUM OF TWO LOWEST ENTRY BATT =52 AMP-HR
LOSS OF TWO INVERTERS
LOSS OF AC 1, PHASE A
LOSS OF AC 2, PHASE A
LOSS OF ONE MAIN OR BATTERY BUS
LOSS OF BATTERY RELAY BUS
LOSS OF 1 AC BUS
*LOSS OF ONE BATTERY (BASED ON FAILURE MODE, CONSIDERATION WILL BE GIVEN TO CONTINUING WITH THE NOMINAL MISSION)
*LOSS OF ONE FUEL CELL (BASED ON FAILURE MODE, CONSIDERATION WILL BE GIVEN TO CONTINUING WITH THE NOMINAL MISSION)

D. COMM/INSTRUMENTATION

*LOSS OF SCE
LOSS OF CRITICAL INSTRUMENTATION (REQUIRED FOR GO/NO-GO DECISION)

REV	ITEM	
A	3-38 (CONT'D)	E. SEQUENTIAL *LOSS OF ONE SEQUENTIAL SYSTEM *SMJC ACTIVATED PREMATURELY F. G&C LOSS OF BOTH BMAGS IN PITCH OR YAW *LOSS OF BOTH ROLL BMAGS LOSS OF EITHER TVC LOOP IN EITHER PITCH OR YAW (CHECKED PRE-SPS BURNS) LOSS OF DIRECT RCS CONTROL BOTH RHC COMPLETE LOSS OF AUTO ATTITUDE CONTROL IN PITCH AND YAW LOSS OF BOTH FDAI'S GROUND AT EITHER SPS SOL DRIVER OUTPUT AND ENABLE TO REMOVE *LOSS OF CMC *LOSS OF NAV DSKY (CMC WARNING RELAY) *LOSS OF INERTIAL SUBSYSTEM *LOSS OF OPTICS CDU D/A (CHECKED PRE-SPS BURNS) G. SPS SUSTAINED PRESSURE DECAY IN SPS FUEL OR OX TANK LOSS OF ONE BANK OF BALL VALVES LEAK OR LOSS OF SPS He SUPPLY PRESSURE (DEPENDENT ON ULLAGE BLOWDOWN CAPABILITY) FUEL FEEDLINE AND/OR OXIDIZER FEEDLINE TEMP 40°F AND UNABLE TO INCREASE FUEL-OXIDIZER $\Delta P > 20$ PSI CHAMBER PRESSURE <70 PSI FLANGE TEMPERATURE LIGHT LOSS OF BOTH GN_2 TANK PRESS UNABLE TO IGNITE THE SPS LOSS OF ULLAGE CAPABILITY H. SM-RCS LOSS OF ONE SM-RCS QUAD SM-RCS PACKAGE TEMP LOW AND UNABLE TO INCREASE LOSS OF FOLLOWING THRUSTER COMBINATIONS: 2P OR 2Y 1P AND 1Y 1P OR 1Y AND 2 ROLL IN SAME DIRECTION 3 ROLL IN SAME DIRECTION I. CM-RCS *LEAK IN OR LOSS OF SOURCE PRESS IN ONE CM-RCS RING *ARMING OF CM-RCS *LOSS OF He MANIFOLD PRESS ONE RING J. INTERFACE CONDITIONS 1. COMMUNICATIONS LOSS OF TWO-WAY VOICE CSM/MSFN LOSS OF ALL TM
A	3-39	IVT (CSM TO LM) WILL BE INHIBITED FOR ANY OF THE FOLLOWING: A. DOCKING SYSTEM LESS THAN <u>THREE</u> GOOD DOCKING RING LATCHES LESS THAN <u>120°</u> APART

REV	ITEM	
	3-40	THE LM WILL BE JETTISONED EARLY FOR: A. APS PROPELLANT LEAKS B. RCS PROPELLANT LEAKS
	3-41	THE ASCENT STAGE WILL BE RETAINED FOR TEC FOR THE FOLLOWING CSM CONDITIONS: A. ECS LOSS OF SUIT CIRCULATION UNCONTROLLABLE HIGH HUMIDITY B. SM-RCS LOSS OF 2 QUADS C. INTERFACE CONDITIONS LOSS OF TWO-WAY VOICE WITH MSFN
A	3-42	A DPS TEI WILL BE PERFORMED FOR: A. BEFORE UNDOCKING ALL CONDITIONS INHIBITING UNDOCKING OR REASONS FOR EARLY TEI (REF. RULE 3-49/3-38; DELETE REFERENCE TO EMU REQUIREMENTS) B. AFTER DOCKING ALL CSM CONDITIONS WHERE STAGING IS INHIBITED IN ORDER TO RETAIN THE DESCENT STAGE FOR TEI AND/OR TEC (REF. RULE 3-59)
		RULE NUMBERS 3-43 THROUGH 3-48 ARE RESERVED.

REV	ITEM	
A	3-49	UNDOCKING OF THE LM WILL BE INHIBITED FOR:

A. CSM CONDITIONS

CSM CONDITIONS CAUSING A DECISION TO PERFORM AN EARLY TEI (3-38) OR IF THE CSM OPERATIONS DEPEND ON THE LM SYSTEMS. UNDOCKING ALSO REQUIRES FULL SUIT CIRCUIT INTEGRITY, A THC, ALL SM RCS THRUSTERS OPE ATIONAL, AND TWO-WAY VOICE COMMUNICATIONS WITH LM AND MSFN.

B. LM CONDITIONS:

NOTE

THE CAPABILITY IS MAINTAINED TO STAGE THE LM IF REQUIRED.

1. SEQUENTIAL AND PYROTECHNICS

LOSS OF BOTH PYRO SYSTEMS

2. EPS

REQUIRE ONE ASCENT AND AT LEAST TWO DESCENT BATT
LOSS OF EITHER ASCENT FEEDER
LOSS OF EITHER CDR OR LMP BUS
INSUFFICIENT ELECTRICAL ENERGY TO COMPLETE THE UNDOCKED OPE ATIONS PLUS 2 HRS
LOSS OF TWO DESCENT FEEDERS

3. ECS

LOSS OF CABIN PRESSURE INTEGRITY
LOSS OF SUIT CIRCUIT INTEGRITY
LOSS OF BOTH SUIT FANS
LOSS OF BOTH DEMAND REGULATORS
LOSS OF BOTH PRIMARY AND SECONDARY COOLANT LOOP
LOSS OF ALL H_2O TANKS
LOSS OF TWO OR MORE O_2 TANKS
INSUFFICIENT CONSUMABLES (O_2, H_2O, OR LiOH) TO COMPLETE THE UNDOCKED OPERATIONS PLUS 2 HRS

4. COMM/INSTRUMENTATION

LOSS OF ONBOARD CRITICAL DISPLAYS

5. G&C

LOSS OF REDUNDANT 3-AXIS ATTITUDE CONTROL
LOSS OF 3-AXIS TRANSLATION CAPABILITY

6. DPS

PROPELLANT LEAK (JETTISON DPS AT BEST OPPORTUNITY BEFORE CONSIDERING UNDOCKING)

7. APS

PROPELLANT LEAK (JETTISON LM AT BEST OPPORTUNITY)

8. RCS

LOSS OF RCS SYS A OR B
PROPELLANT LEAK (JETTISON LM AT BEST OPPORTUNITY)
ONE RCS THRUSTER PAIR ISOLATED

C. INTERFACE CONDITIONS

1. DOCKING SYSTEM

THREE DOCKING RETRACT SQUIBS HAVE FIRED OR MISFIRED
FAILURE TO REINSTALL OR CLOSE DOCKING PROBE, DROGUE, OR LM UPPER HATCH
FAILURE OF CSM FORWARD HATCH PRIMARY AND SECONDARY LOCK/UNLOCK MECHANISM

2. COMMUNICATIONS

LOSS OF TWO-WAY VHF VOICE BETWEEN CSM AND LM

D. EMU

LOSS OF 2 OF 3 (2 OPS, 1 PLSS)

REV	ITEM	
		RENDEZVOUS PHASE
A	3-50	INITIATION OF NOMINAL RENDEZVOUS (TRAJECTORY PROFILE) WILL BE INHIBITED FOR:

NOTE

THE SEP MANEUVER AND MINI-FOOTBALL WILL BE PERFORMED FOR ALL CONDITIONS ALLOWING UNDOCKING. REFERENCE RULE 3-49.

A. CSM CONDITIONS REQUIRING TEI AT THE NEXT BEST OPPORTUNITY (3-38). RENDEZVOUS ALSO REQUIRES FULL SUIT CIRCUIT INTEGRITY, THC, SEXTANT TRACKING CAPABILITY, RR TRANSPONDER, AND TM.

B. LM CONDITIONS — RULES

1. SEQUENTIAL AND PYROTECHNICS

   LOSS OF BOTH PYRO SYSTEMS

2. EPS

   NEED TWO ASCENT AND TWO DESCENT OR FOUR DESCENT AND ONE ASCENT BATT
   LOSS OF EITHER CDR OR LMP BUS
   LOSS OF BOTH INVERTERS
   LOSS OF EITHER AC BUS A OR B
   LOSS OF EITHER ASCENT FEEDER
   INSUFFICIENT ELECTRICAL ENERGY TO COMPLETE THE NOMINAL RNDZ PLUS 2 HRS
   LOSS OF BOTH DESCENT FEEDERS OR LOSS OF ONE DESCENT FEEDER DUE TO HARD SHORT

3. ECS

   LOSS OF CABIN PRESSURE INTEGRITY
   LOSS OF SUIT LOOP INTEGRITY
   LOSS OF BOTH SUIT FANS
   LOSS OF BOTH H_2O SEPARATORS
   LOSS OF BOTH DEMAND REGULATORS
   LOSS OF EITHER COOLANT LOOP
   LOSS OF PRIMARY H_2O FEEDPATH CAPABILITY
   INSUFFICIENT CONSUMABLES (O_2, H_2O, OR LiOH) TO PERFORM NOMINAL RNDZ PLUS 2 HRS
   LOSS OF TWO O_2 TANKS
   LOSS OF TWO H_2O TANKS

4. COMM/INSTRUMENTATION

   LOSS OF CRITICAL ONBOARD DISPLAYS

5. G&C

   LOSS OF REDUNDANT 3-AXIS ATTITUDE CONTROL CAPABILITY
   LOSS OF PGNS
   LOSS OF 3-AXIS TRANSLATION CAPABILITY
   LOSS OF RR
   LOSS OF BOTH FDAI'S
   LOSS OF DSKY
   LOSS OF DPS ENG ON/OFF CAPABILITY
   LOSS OF AOT AND COAS

   LOSS OF GDA WHERE RCS IMPINGEMENT CONSTRAINTS WILL BE VIOLATED
   LOSS OF BOTH TTCA
   LOSS OF BOTH HAND CONTROLLERS

6. DPS

   PROPELLANT LEAKS
   LOSS OF OPERATIONAL DPS

7. APS

   PROPELLANT LEAKS
   LOSS OF OPERATIONAL APS

REV	ITEM	
A	3-50 (CONT'D)	8. RCS REDUNDANT 3-AXIS ATTITUDE CONTROL 3-AXIS TRANSLATION CONTROL LOSS OF SYSTEMS A OR B ONE THRUSTER PAIR ISOLATED PROPELLANT LEAK C. THE RENDEZVOUS WILL BE <u>NO-GO</u> IF ANY OF THE FOLLOWING INTERFACE CONDITIONS EXIST: 1. COMMUNICATIONS LOSS OF TWO-WAY VOICE COMMUNICATION BETWEEN VEHICLES LOSS OF TWO-WAY VOICE COMMUNICATION BETWEEN MSFN AND LM LOSS OF ALL TELEMETRY (NEED BLOCK OF HBR FOR E-MEMORY DUMP BEFORE GO)
A	3-51	THE FLIGHT CREW WILL TERMINATE DOI FOR: <u>RULES</u> ATTITUDE DEVIATIONS >5° RATES >5/SEC DPS TANK PRESS <120 PSI OVERBURN IMU OR LGC FAIL DELTA PRESSURE BETWEEN FUEL AND OXIDIZER ><u>TBD</u> PSI (AFTER STEADY STATE ACHIEVED)
A	3-52	THE FLIGHT CREW WILL PERFORM THE DIRECT RETURN TO THE CSM FOR THE FOLLOWING REASONS (CAPABILITY REMAINS TILL APPROXIMATELY DOI + 10 MIN): <u>LM CONDITIONS</u> A. ECS LOSS OF BOTH COOLANT LOOPS FIRE OR SMOKE IN CABIN LOSS OF CABIN PRESSURE B. G&C PGNS FAIL ACCURACY TEST (COMPARISON WITH AGS AND RR) LOSS OF IMU LOSS OF LGC C. TRAJECTORY DOI OVERBURN >12 FPS
A	3-53	DPS PHASING BURN OPERATION A. THE DPS PHASING BURN WILL BE TERMINATED FOR THE FOLLOWING LM CONDITIONS: 1. G&C LOSS OF ALL ATTITUDE CONTROL, ATTITUDE EXCURSION >5°, RATE EXCURSION >5°/SEC LOSS OF ALL THRUST VECTOR CONTROL AND RCS PLUME IMPINGEMENT CONSTRAINT EXCEEDED 2. DPS INLET PRESSURE <120 PSI WHEN <65 PERCENT THROTTLE, <150 PSI WHEN >65 PERCENT THROTTLE DELTA PRESSURE BETWEEN FUEL AND OXIDIZER ><u>TBD</u> PSI (AFTER STEADY STATE ACHIEVED)

REV	ITEM	
A	3-53 (CONT'D)	B. AFTER PREMATURE DPS CUTOFF, THE FOLLOWING ACTION WILL BE TAKEN: 1. ATTEMPT RESTART WITH "START" BUTTON 2. ATTEMPT RESTART WITH "DES ENG CMD OVRD" SWITCH 3.(A) V_G < 5 FPS - TRIM WITH +X (B) 5 < V_G < 25 FPS - STAGE AND COMPLETE BURN VIA RCS (C) $V_G \geq$ 25 FPS - STAGE AND COMPLETE BURN VIA APS WITH AGS CONTROL 4. ACHIEVE $\Delta V_M \geq$ 40 FPS VIA RCS IF DPS AND APS FAIL TO ALLOW RNDZ PHASING ONE REV LATER THAN NOMINAL
A	3-54	APS INSERTION BURN OPERATION A. THE APS INSERTION BURN WILL BE TERMINATED FOR: 1. G&C LOSS OF ALL ATTITUDE CONTROL, ATTITUDE EXCURSION >10°, RATE EXCURSION >10°/SEC 2. APS INLET PRESSURE <115 PSI OR >250 PSI DELTA PRESSURE BETWEEN FUEL AND OXIDIZER >12 PSI B. AFTER PREMATURE CUTOFF, THE FOLLOWING ACTION WILL BE TAKEN: 1. ATTEMPT RESTART AND COMPLETE BURN IF: (A) 10 SEC > COAST TIME > 200 SEC, PROP TEMP < 65°F (B) 10 SEC > COAST TIME > 90 SEC, PROP TEMP > 65°F 2. IF V_M < 45 FPS, TRIM BACK TO ZERO WITH RCS MINUS X 3. IF V_G < 80 FPS, COMPLETE MANEUVER WITH RCS PLUS X NOTE FOR ALL CASES BETWEEN V_M > 45 FPS AND V_G > 80 FPS, A CSM RESCUE WILL BE PERFORMED. DOCKING WILL OCCUR TWO HOURS LATER THAN NOMINAL.
A	3-55	AGS TAKE-OVER WILL BE PERFORMED FOR THE FOLLOWING LM CONDITIONS EXCEPT DOI: G&C LOSS OF LGC LOSS OF ISS LOSS OF ATTITUDE CONTROL, ATTITUDE EXCURSION >10° FOR STAGED VEHICLE, >5°/SEC FOR UNSTAGED VEHICLE LOSS OF RATE CONTROL, RATE EXCURSION >10°/SEC FOR STAGED VEHICLE, >5/SEC FOR UNSTAGED VEHICLE
A	3-56	THE FIVE-IMPULSE LM ACTIVE RNDZ (WITH DOCKING 2 HOURS EARLIER THAN NOMINAL) CAN BE SELECTED AS LATE AS 5 MIN BEFORE THE PC AFTER DOI. FAILURE TO MEET THE FOLLOWING CRITERIA IN RULE 3-50 FOR THE NOMINAL RNDZ WILL BE CAUSE FOR PERFORMING THE FIVE-IMPULSE RNDZ. A. LM CONDITIONS (IF THE PROBLEM OCCURS PRIOR TO DOI): 1. EPS LOSS OF EITHER DESCENT FEEDER DUE TO A HARD SHORT INSUFFICIENT ELECTRICAL ENERGY TO COMPLETE THE NOMINAL PLUS 2 HRS BUT SUFFICIENT TO COMPLETE THE FIVE-IMPULSE PLUS 2 HRS

REV	ITEM	
A	3-56 (CONT'D)	2. ECS INSUFFICIENT CONSUMABLES (O_2, H_2O, LiOH) TO PERFORM NOMINAL RNDZ PLUS 2 HRS BUT SUFFICIENT TO COMPLETE FIVE-IMPULSE PLUS 2 HRS 3. G&C LOSS OF AOT AND COAS (IF A FINE ALIGN HAS BEEN ACCOMPLISHED BEFORE THE FAILURE) <u>LOSS OF GDA WHERE RCS IMPINGEMENT CONSTRAINTS WILL BE VIOLATED</u> 4. DPS LOSS OF OPERATIONAL DPS PROPELLANT LEAKS LOSS OF DPS ENG ON/OFF CAPABILITY B. LM CONDITIONS (IF FAILURE IS RECOGNIZED AFTER DOI) FOR FIVE-IMPULSE: 1. EPS LOSS OF ANY TWO BAT LOSS OF EITHER DC BUS LOSS OF EITHER ASCENT FEEDER INSUFFICIENT ELECTRICAL ENERGY TO COMPLETE THE NOMINAL TIMELINE PLUS 2 HRS 2. ECS LOSS OF CABIN PRESSURE INTEGRITY LOSS OF SUIT LOOP INTEGRITY LOSS OF BOTH SUIT FANS LOSS OF BOTH H_2O SEPARATORS LOSS OF BOTH DEMAND REGULATORS LOSS OF PRIMARY COOLANT LOOP LOSS OF TWO O_2 TANKS LOSS OF TWO H_2O TANKS INSUFFICIENT CONSUMABLES (O_2, H_2O, LiOH) TO PERFORM NOMINAL TIMELINE 3. COMM/INSTRUMENTATION LOSS OF CRITICAL DISPLAYS 4. G&C LOSS OF PGNS LOSS OF DSKY 5. RCS LOSS OF SYSTEM A OR B C. TRAJECTORY DOI UNDERBURN >5 FPS
A	3-57	LM STAGING WILL BE PERFORMED EARLY FOR THE FOLLOWING LM CONDITIONS: A. G&C LOSS OF GDA WHERE RCS PLUME IMPINGEMENT CONSTRAINT WILL BE VIOLATED B. DPS LOSS OF OPERATIONAL DPS PROPELLANT LEAK

REV	ITEM	
A	3-58	LM STAGING WILL BE DELAYED FOR ANY CSM RESCUE (REFERENCE RULE 3-60) AND THE FOLLOWING LM CONDITIONS:

NOTE

DELAYED STAGING WILL OCCUR AT TPI AT THE EARLIEST. IT IS PREFERABLE TO INHIBIT STAGING IF CIRCUMSTANCES WILL PERMIT.

A. SEQUENTIAL AND PYRO

LOSS OF EITHER PYRO SYSTEM

B. EPS

LOSS OF EITHER BUS
LOSS OF EITHER ASCENT BATTERY
INSUFFICIENT ASCENT ELECTRICAL ENERGY TO COMPLETE NOMINAL OPERATIONS PLUS 2 HRS
CONFIRMED LOSS OF ASCENT BATTERY OVERCURRENT PROTECTION

C. ECS

LOSS OF CABIN PRESS INTEGRITY
LOSS OF SUIT LOOP INTEGRITY
LOSS OF BOTH SUIT FANS
LOSS OF EITHER SUIT FANS
LOSS OF BOTH DEMAND REGULATORS
LOSS OF EITHER ASCENT O_2 TANK
LOSS OF EITHER ASCENT H_2O TANKS
INSUFFICIENT ASCENT O_2, H_2O, OR LiOH TO COMPLETE NOMINAL OPERATIONS PLUS 2 HRS
LOSS OF BOTH COOLANT LOOPS

D. APS

NON OPERATIONAL
DELTA V < TBD

E. RCS

LOSS OF SYSTEM A OR B

3-59 LM STAGING WILL BE INHIBITED WHILE IN THE UNDOCKED CONFIGURATION FOR THE FOLLOWING CONDITIONS:

NOTE

FOR THESE CONDITIONS, THE CSM WILL PERFORM THE MCC AND BRAKING MANEUVERS.

A. CSM CONDITIONS

1. ECS

LOSS OF CABIN INTEGRITY
FIRE OR SMOKE
LOSS OF O_2 MANIFOLD

2. CRYO

LOSS OF ANY CRYO TANK

3. EPS

LOSS OF TWO FUEL CELLS
LOSS OF TWO INVERTERS
LOSS OF ONE AC BUS
LOSS OF AC 1 ϕA OR AC 2 ϕA

4. G&C

LOSS OF EITHER TVC LOOP

REV	ITEM	
A	3-59 (CONT'D)	5. SPS SUSTAINED PRESSURE DECAY IN FUEL OR OX LOSS OF BOTH GN_2 TANK PRESSURES FUEL/OX FEEDLINE <40°F AND UNABLE TO INCREASE DELTA PRESSURE BETWEEN FUEL/OX >20 PSI LEAK OR LOSS OF SPS He SUPPLY PRESSURE B. LM CONDITIONS 1. SEQUENTIAL AND PYRO LOSS OF BOTH PYRO SYSTEMS 2. EPS LOSS OF BOTH ASCENT BATTERIES LOSS OF BOTH ASCENT FEEDERS INSUFFICIENT ASCENT ELECTRICAL ENERGY TO COMPLETE TERMINAL PHASE PLUS 2 HRS 3. ECS INSUFFICIENT ASCENT O_2 OR H_2O TO COMPLETE TERMINAL PHASE PLUS 2 HRS 4. G&C LOSS OF RCS TRANSLATION CAPABILITY LOSS OF ATTITUDE CONTROL 5. APS PROPELLANT LEAK 6. RCS PROPELLANT LEAK
	3-60	CSM MCC AND BRAKING MANEUVERS WILL BE PERFO MED FOR ANY CASE WHERE THE DPS ENGINE IS REQUIRED FOR TEI, OR THE DESCENT STAGE CONSUMABLES ARE REQUIRED FOR TEC. (REFERENCE CSM CONDITIONS IN RULE 3-59.) A CSM RESCUE (MULTIPLE BURN CONDITION) WILL BE PERFORMED FOR CONDITIONS PROHIBITING A LM ACTIVE RNDZ.
	3-61	AN EVT WILL BE PERFORMED FOR THE FOLLOWING CONDITIONS: INABILITY TO DOCK INABILITY TO PERFORM TUNNEL TRANSFER
		RULE NUMBERS 3-62 THROUGH 3-66 ARE RESERVED.

REV	ITEM	

UNMANNED PHASE

RULES

A 3-67 THE UNMANNED APS BURN WILL BE INHIBITED FOR CONDITIONS REQUIRING ASCENT STAGE SYSTEMS FOR LIFE SUPPORT OR COMMUNICATIONS AS A RESULT OF CSM PROBLEMS (REFERENCE RULE 3-41) AND THE FOLLOWING LM CONDITIONS:

A. EPS

LOSS OF EITHER BUS
LOSS OF BOTH ASCENT BATTERIES

B. GUIDANCE AND CONTROL

LOSS OF PGNCS AND AGS
LOSS OF APS ARM-DEARM/ON-OFF CONTROL
LOSS OF 3-AXIS ATTITUDE CONTROL

C. INTERFACE CONDITIONS

1. COMMUNICATIONS

LOSS OF ALL TM
LOSS OF CMD UPLINK

A

RULE NUMBERS 3-68 THROUGH 3-75 ARE RESERVED.

REV	ITEM	ALL MANEUVERS	RULES
	3-76	A CRITICAL SPS MANEUVER WILL BE INHIBITED FOR THE FOLLOWING CSM PROBLEMS (OTHER PROPULSION SYSTEMS WILL BE USED IF AVAILABLE): A. G&C LOSS OF TWO TVC SERVO LOOPS LOSS OF THREE TVC CONTROL MODES (G&N, SCS AUTO, AND MTVC) B. SPS PRESSURE IN EITHER FUEL OR OXIDIZER TANK <115 PSI LOSS OF BOTH GN_2 BOTTLES (<400 PSI) FUEL OR OXIDIZER FEEDLINE TEMP <27°F FLANGE TEMP >480°F ON PREVIOUS BURN CHAMBER PRESSURE <70 PSI ON PREVIOUS BURN FUEL/OXIDIZER P >20 PSI FIRST BURN SUBSEQUENT TO DOCKED DPS WAS <40 SEC, CONTINUOUS C. DOCKING SYSTEM FOR DOCKED BURNS LESS THAN NINE GOOD DOCKING RING LATCHES	
A	3-77	A DPS MANEUVER WILL BE INHIBITED FOR THE FOLLOWING LM PROBLEMS: A. EPS LOSS OF EITHER BUS B. G&C LOSS OF ULLAGE NO GDA CONTROL AND GIMBAL FAILED HARDOVER C. DPS PROPELLANT TEMP NOT WITHIN 40 TO 75°F LIMITS DELTA PRESS BETWEEN FUEL AND OXIDIZER >TBD PSID AT FTP FUEL INLET PRESS <120 PSI FOR <65 PERCENT THROTTLE AND <150 PSI FOR >65 PERCENT THROTTLE LOSS OF SUPERCRITICAL He OR INSUFFICIENT He PRESS TO GAIN 310 FPS ΔV PROPELLANT LEAKS MORE THAN 100 SEC WILL BE ACCUMULATED IN DPS NON-THROTTABLE RANGE D. DOCKING SYSTEM FOR DOCKED BURNS LESS THAN NINE GOOD DOCKING RING LATCHES	
A	3-78	AN APS MANEUVER WILL BE INHIBITED FOR THE FOLLOWING LM PROBLEMS: A. G&C LOSS OF ULLAGE LOSS OF 3-AXIS ATTITUDE CONTROL LOSS OF PGNS AND AGS B. APS DELTA PRESS BETWEEN FUEL AND OXIDIZER >20 PSIA DELTA TEMP BETWEEN FUEL AND OXIDIZER >10°F PROPELLANT TEMP NOT WITHIN 40 TO 100°F LIMITS INLET PRESS <115 PSI PROPELLANT LEAKS	

REV	ITEM		
	3-79	LM RCS MANEUVERS WILL BE INHIBITED FOR THE FOLLOWING LM PROBLEMS:	RULES

A. G&C

LOSS OF PGNS AND AGS
LOSS OF 3-AXIS ATTITUDE CONTROL
LOSS OF BOTH ACA'S
LOSS OF 3-AXIS TRANSLATION

B. RCS

PROPELLANT TEMP NOT WITHIN 40 TO 100°F LIMITS
DELTA PRESS BETWEEN FUEL AND OXIDIZER >80 PSID
MANIFOLD PRESSURE <100 PSI
PROPELLANT LEAKS
QUAD TEMPS <119°F

C. DOCKING SYSTEM

THREE GOOD DOCKING RING LATCHES 120° APART ARE REQUIRED

4 GROUND INSTRUMENTATION REQUIREMENTS

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

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.
C. COMMAND TO THE LAUNCH VEHICLE IS MANDATORY FROM S-IVB CUTOFF TO S-IVB CUTOFF + 60 SEC AND POST S/C SEPARATION.

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	4-2	TELEMETRY			
		A. CONSOLE DISPLAY (D/TV, EVENTS, ANALOGS)	PRELAUNCH	MANDATORY	A. FOR DISPLAY OF MANDATORY S/V PARAMETERS.
		B. PCM GROUND STATIONS (4)	PRELAUNCH	1 OF 4 MANDATORY , 1 HIGHLY DESIRABLE	B. FOR DISPLAY OF MANDATORY S/V EVENTS AND ANALOGS.
		C. RECORDING AND PLAYBACK			
		ALDS MSFN	PRELAUNCH	BOTH DESIRABLE	
		D. FM - GROUND STATION	PRELAUNCH	1 OF 2 MANDATORY	D. TO PROVIDE MANDATORY DISPLAY DATA FOR THE MCC SURGEON.
A	4-3	COMMAND			
		A. MOCR TOGGLE SWITCHES (BOTH A AND B)			
		1. BSE ABORT REQUEST	PRELAUNCH	HIGHLY DESIRABLE	A. FOR LAUNCH PHASE ABORT REQUEST
		2. FIDO ABORT REQUEST	PRELAUNCH	HIGHLY DESIRABLE	
		3. FD ABORT REQUEST	PRELAUNCH	HIGHLY DESIRABLE	
		B. COMMAND PANELS:			
		EECOM, GUIDO, BSE, TELCOM, CONTROL, CCATS	PRELAUNCH	1 OF 6 MANDATORY	B. FOR BULKHEAD ΔP AFTER S/C INSERTION AND SEP
		C. MOCR CONSOLE/SITE SELECT CAPABILITY			
		1. RTC CONSOLE (CCATS) 2. CCATS CMD CONSOLE MED	PRELAUNCH	1 OF 2 MANDATORY	C. FOR BULKHEAD ΔP AFTER S/C INSERTION AND SEP
		D. FC/M&O SWITCHING CAPABILITY			
		1. FLIGHT DIRECTOR 2. CCATS CMD MED	PRELAUNCH	1 OF 2 MANDATORY	D. FOR BULKHEAD ΔP AFTER S/C INSERTION AND SEP

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	4-4	TRAJECTORY			
		A. TRAJECTORY DATA PROCESSING			A. THE TRAJECTORY DATA SOURCES ARE UTILIZED AS FOLLOWS:
		1. AVAILABILITY OF ONE INDIPENDENT TRACKING SOURCE (IP_R, USB) FROM LIFTOFF TO T + 10 MINUTES.	PRELAUNCH	1 MANDATORY	1.(A) INDEPENDENT VERIFICATION OF L/V NAVIGATION. (B) PROTECTION AGAINST VIOLATION OF LAUNCH ENVELOPE.
		2. IU AND CMC TM VECTORS FROM LIFTOFF TO INSERTION PLUS 60 SECONDS.	PRELAUNCH	BOTH MANDATORY	A.2. REQUIRED FOR ORBIT GO/NO-GO
		B. RTCC - DATA SELECT CAPABILITY	PRELAUNCH	MANDATORY	B. TO SELECT BEST AVAILABLE DATA SOURCE.
	4-5	COMMUNICATIONS			
		A. MOCR:			
		FD LOOP AFD CONF LOOP	PRELAUNCH	1 OF 2 MANDATORY	FOR MISSION CONTROL
		MOCR SYS 1 & 2 MOCR DYN A/G 1 LOOP A/G 2 LOOP	PRELAUNCH	ALL HIGHLY DESIRABLE	
		B. MCC/LAUNCH COMPLEX:			
		121 CLTC 111 CVTS 212 MSTC	PRELAUNCH	1 OF 3 MANDATORY	FOR TERMINAL COUNT COORDINATION OF MCC-PAD ACTIVITIES
		C. MCC/RSO:			
		FD LINE TO RSO RSO PRIVATE LINE CAPE 111 RSO LOOP	PRELAUNCH	1 OF 3 MANDATORY	FOR TRAJECTORY VERIFICATION AND BOOSTER SAFING
		D. MISCELLANEOUS:			
		BSE TM MONITOR LOOP CIF/USB LOOP	PRELAUNCH	DESIRABLE	USED FOR MONITORING SPACE VEHICLES SUBSYSTEM CHECKOUT
		E. MCC/REMOTED SITES:			
		ONE A/G PATH VIA GSFC	PRELAUNCH	MANDATORY	USED FOR COMMUNICATION WITH CREW

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	4-6	COMPUTER			
		A. MOC (IBM 360/75)	PRELAUNCH	MANDATORY	TO PROCESS MANDATORY S/V PARAMETERS AND TRAJECTORY DATA.
		B. DSC (IBM 360/75)	PRELAUNCH	HIGHLY DESIRABLE	AN SSC (IBM 360/75) IS AVAIL-ABLE AS BACKUP TO THE MOC OR DSC.
		C. CCATS (UNIVAC 494) - ONLINE D. CCATS (UNIVAC 494) - STANDBY	PRELAUNCH	I MANDATORY AND 1 HIGHLY DESIRABLE	TO THROUGH PROCESS TO MOC MANDATORY S/V PARAMETERS
		E. RTACF - 2	PRELAUNCH	1 HIGHLY DESIRABLE	PRELAUNCH IP PREDICTIONS FOR MODE 1 ABORTS.
	4-7	TIMING			
		MITE (2)	PRELAUNCH	1 MANDATORY	MCC TIMING STANDARD TO SUPPORT MANDATORY RTCC/CCATS COMPUTERS
	4-8	MCC POWER			
		A. BUS A_1	PRELAUNCH	MANDATORY	UNINTERRUPTABLE POWER FOR WIDE BAND CROSS BAR SWITCH
		B. BUS A_2	PRELAUNCH	MANDATORY	UNINTERRUPTABLE POWER FOR D/TV DATA DISTRIBUTORS
		C. BUS B_1	PRELAUNCH	MANDATORY	20 SECONDS INTERRUPTABLE POWER FOR PLOTBOARDS (POWER)
		D. BUS B_2	PRELAUNCH	MANDATORY	20 SECONDS INTERRUPTABLE POWER FOR VSM

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	4-9	DISPLAY			
		A. MOCR D/TV CHANNELS	PRELAUNCH	10 OF 36 MANDATORY	
		POSITION / NO. OF CHANNELS RETRO 1 FIDO 1 GUIDO 1 EECOM 1 GNC 1 RTCC 1 BOOSTER 4			
		B. TRAJECTORY DISPLAY			
		1. FDO LAUNCH DIGITALS	PRELAUNCH	MANDATORY ON D/TV	FOR CONTINGENCY ORBIT INSERTION MANEUVER DATA AND T_{FF} LIMITS.
		2. γ VS V	PRELAUNCH	MANDATORY ON 1 OF 4: (A) 10 X 20 SCRIBER PLOTTER (B) D/TV (C) RTCC PLOTBOARD (D) SSR PLOTBOARD	FROM SELECTED TRACKING DATA SOURCE.
		3. RFO LAUNCH DIGITALS	PRELAUNCH	MANDATORY ON D/TV	MONITOR FOR MODES III AND IB MANEUVER DATA.
		4. γ_{EI} VS V_{EI}	PRELAUNCH	MANDATORY ON 1 OF 2: (A) D/TV (B) SSR PLOTBOARD	MONITOR FOR G-LIMIT VIOLATION.
		5. ϕ VS λ	PRELAUNCH	H/D ON 1 OF 2: (A) RTCC PLOTBOARD (B) SSR PLOTBOARD	MONITOR FOR CROSS-RANGE LIMITS
		6. T_{FF} VS R_{IP}	PRELAUNCH	HIGHLY DESIRABLE ON 1 OF 2: (A) D/TV (B) SSR PLOTBOARD	MONITOR FOR ABORT MODES II, III, AND IB.
		7. h VS d	PRELAUNCH	H/D ON 10 X 20 SCRIBER PLOTTER	
		8. γi VS Vi (CMC DYNAMIC STATUS)	PRELAUNCH	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	PRELAUNCH	HIGHLY DESIRABLE ON D/TV	MONITOR FOR L/V AND S/C NAVIGATION PERFORMANCE
		10. GUIDO ANALOG CHART RECORDERS ONE AND TWO	PRELAUNCH	HIGHLY DESIRABLE ON TV	
		11. INSERTION/ INJECTION DIGITALS	PRELAUNCH	MANDATORY ON D/TV	FOR G&N GO/NO-GO
		C. ADEG CHANNELS 90-93	PRELAUNCH	HIGHLY DESIRABLE	FOR DSC DISPLAYS
		D. VSM	PRELAUNCH	MANDATORY	FOR D/TV
		E. AUX VSM	PRELAUNCH	HIGHLY DESIRABLE	
		F. EIDOPHORS (3)	PRELAUNCH	2 HIGHLY DESIRABLE	
		NOTE: INDIVIDUAL FLIGHT CONTROLLERS WILL BE RESPONSIBLE FOR REPORTING LOSS OF DISPLAY CAPABILITY OF MANDATORY PARAMETERS TO THE FLIGHT DIRECTOR.			

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	4-10	GSFC			
		A. GSFC UNIVAC - 494 (2) COMMUNICATIONS PROCESSOR	PRELAUNCH	1 MANDATORY	A. ONE UNIVAC - 494 CAN PERFORM ALL NECESSARY FUNCTIONS, THE SECOND ONE IS BACKUP.
		B. WBD (50.0 KBPS) LINES (2) BETWEEN MCC AND GSFC	PRELAUNCH	I MANDATORY	B. EITHER LINE CAN BE SWITCHED TO EITHER UNIVAC - 494.
		C. TTY CIRCUITS BETWEEN MCC AND GSFC	PRELAUNCH		C. ONE CIRCUIT IS (M) TO REC LOW SPEED RADAR DATA. ONE CIRCUIT IS (HD) TO SEND ACQ MESSAGES.
		1. VOICE FREQUENCY TTY GROUP LINES (2) 2. LOW-SPEED TTY CIRCUITS (2)		1 OF 4 MANDATORY	
	4-11	KSC			
		TELEMETRY:			
		A. VHF TM FROM THE FOLLOWING FOR S-II, S-IVB, AND IU:			A. THESE ANTENNAS CAN BE SWITCHED TO MILA OR CIF FACILITIES.
		1. CIF ANTENNA 2. MILA VHF ANTENNA	PRELAUNCH	1 MANDATORY	
		B. USB TM FROM THE FOLLOWING:			B. USB IS THE CSM'S ONLY SOURCE OF DATA.
		1. MILA USB 2. CIF USB	PRELAUNCH	1 MANDATORY	

COMMAND:

THIS CAPABILITY IS DEFINED UNDER GSFC/KSC/MSFN COMMAND RULE 4-12 FOR LAUNCH COVERAGE.

TRACKING:

THAT CAPABILITY REQUIRED TO SATISFY RULE 4-4 (TRAJECTORY) IS MANDATORY.

VOICE COMMUNICATIONS:

THIS KSC CAPABILITY IS DEFINED UNDER MCC RULE 4-5 (COMMUNICATIONS).

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	4-12	LAUNCH COVERAGE			
		KSC/MSFN SITES (SITES NOT LISTED DUE TO VARIABLE LAUNCH AZIMUTH) MUST PROVIDE THE FOLLOWING CAPABILITIES FROM LIFTOFF THROUGH S-IVB CUTOFF PLUS 60 SECONDS. REFER TO DECISION MATRIX (RULE 4-16 AND FIGURES 4-1 THROUGH 4-5) TO DETERMINE CAPABILITY.			
		A. CMD			
		CCS	PRELAUNCH	MANDATORY FROM S-IVB C/O TO S-IVB C/O + 60 SECS.	
		USB CSM	PRELAUNCH	HIGHLY DESIRABLE	
		B. TELEMETRY			
		S-IC (VHF)	PRELAUNCH	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)	PRELAUNCH	HIGHLY DESIRABLE FROM LIFTOFF TO S-II CUTOFF (APPROX. 8 + 36 SEC)	FOR ABORT CUES FROM MCC
		S-IVB VHF (CP-1)	PRELAUNCH	HIGHLY DESIRABLE	
		IU CCS (DP-1B) IU VHF (DP-1)	PRELAUNCH	1 OF 2 MANDATORY FROM LIFTOFF TO S-IVB CUTOFF PLUS 60 SEC	FOR ABORT CUES FROM MCC
		CSM (USB)	PRELAUNCH	MANDATORY FROM LIFTOFF THROUGH S-IVB CUTOFF PLUS 60 SEC.	FOR ABORT CUES FROM MCC
		C. TRACKING			
		THAT CAPABILITY REQUIRED TO SATISFY RULE 4-4 (TRAJECTORY) IS MANDATORY			
		D. A/G COMMUNICATIONS			
		1. MILA			
		VHF	PRELAUNCH	HIGHLY DESIRABLE	
		USB	PRELAUNCH	MANDATORY	
		2. MSFN			
		VHF USB	PRELAUNCH	1 OF 2 MANDATORY	
A	4-13	GENERAL ORBITAL COVERAGE (FROM S-IVB C/O + 60 SEC TO TLI C/O)			
		IT IS REQUIRED THE MSFN HAVE THE CAPABILITY OF PROVIDING THE MCC THE MINIMUM MISSION CONTROL SUPPORT LISTED BELOW OF TWO MSFN USB SITES PER REVOLUTION THROUGH REVOLUTION 3.			
		A. CMD			
		CCS	PRELAUNCH	HIGHLY DESIRABLE	
		CSM USB	PRELAUNCH	HIGHLY DESIRABLE	
		B. TELEMETRY			
		S-IVB VHF (CP-1)	PRELAUNCH	HIGHLY DESIRABLE	
		IU CCS (DP-1B) IU VHF (DP-1)	PRELAUNCH	1 OF 2 MANDATORY	DOWNLINKS REQUIRED TO RECOVER S-IVB DATA.
		CSM USB	PRELAUNCH	MANDATORY	
		C. TRACK			
		C-BAND	PRELAUNCH	HIGHLY DESIRABLE	
		USB	PRELAUNCH	MANDATORY	
		D. A/G COMMUNICATIONS			
		VHF	PRELAUNCH	HIGHLY DESIRABLE	
		USB	PRELAUNCH	MANDATORY	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	4-14	POST S/C SEPARATION			
		IT IS MANDATORY THAT 1 SITE PROVIDE THE FOLLOWING CAPABILITIES:			
		A. TLM - CCS	PRELAUNCH	MANDATORY	A. TO PROVIDE TM FOR DETERMINING S-IVB STATUS BEYOND VHF RANGE.
		B. CMD - CCS	PRELAUNCH	MANDATORY	B. TO PROVIDE CORRECTIVE COMMAND CAPABILITY FOR S-IVB BULKHEAD DELTA PROBLEMS.
					C. BOTH OF THE ABOVE ARE REQUIRED TO INSURE CREW SAFETY AND LM EXTRACTION.
A	4-15	HSK, GDS, MAD			
		IT IS MANDATORY 2 OF 3 OF THESE SITES PROVIDE THE FOLLOWING CAPABILITIES:			
		A. TM USB	PRELAUNCH	MANDATORY	A. TO COVER TRANSLUNAR COAST AND LPO.
		B. TRACK USB	PRELAUNCH	MANDATORY	
		C. VOICE USB	PRELAUNCH	MANDATORY	
		D. CMD USB	PRELAUNCH	HIGHLY DESIRABLE	
A	4-16	RIOMETER NETWORK SITES	PRELAUNCH		
		A. LIMA		HIGHLY DESIRABLE	
		B. CRO CYI		1 OF 2 HIGHLY DESIRABLE	

REV	ITEM	
	4-16	INTRODUCTION TO SITE FAILURE DECISION MATRICES (FIGURES 4-1 THROUGH 4-5) THESE DECISION MATRICES APPLY THE GROUND INSTRUMENTATION REQUIREMENTS TO THE POSSIBLE FAILURES OF SITE CAPABILITIES DURING LAUNCH PHASE. THESE MATRICES POINT OUT TIMES DURING LAUNCH WHEN A FAILURE WILL CAUSE A LOSS OF CONTINUOUS COVERAGE BETWEEN LIFTOFF AND INSERTION PLUS 60 SECONDS. TO USE THE MATRIX A. LOOK FOR AN X UNDER THE COLUMN FOR THE SITE WHERE THE FAILURE OCCURRED. B. GO ACROSS TO THE COLUMN FOR THE CAPABILITY THAT WAS LOST AND READ THE DECISION. C. THE COVERAGE THAT WAS LOST IS IN THE COLUMN LABELED "MANDATORY COVERAGE LOST." D. MORE THAN ONE X IN A ROW SPECIFIES A FAILURE OF THE SAME CAPABILITY AT MORE THAN ONE SITE.

REV	ITEM
A	

	SITES FAILED					MANDATORY COVERAGE LOST	CAPABILITY LOST				
	ALDS TM 0:00 8:49	MIL/CAPE 0:08 8:49	GBM 1:07 9:13	BDA 4:11 12:42	VAN 9:30 15:32		TELEMETRY USB OR VHF	CMD	TRACK BOTH S AND C BAND	A/G USB	A/G USB AND VHF
SINGLE FAILURE	X					NONE SEE NOTE 4	GO	N/A	N/A	N/A	N/A
SINGLE FAILURE		X				00:00 TO 01:07	GO	GO	NO-GO	NO-GO	NO-GO
SINGLE FAILURE			X			S-IC/S-II SEP SEE NOTE 1	GO	GO	GO	GO	GO
SINGLE FAILURE				X		NONE	GO	GO	GO	GO	GO
SINGLE FAILURE					X	NONE	GO	GO	GO	GO	GO
MULTIPLE FAILURES	X	X				00:00 TO 01:07	NO-GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES		X	X			00:00 04:11	GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES	X	X	X				NO-GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES		X		X		00:00 TO 01:07	GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES	X	X		X		9:13 TO 9:30	NO-GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES		X			X	00:00 TO 01:07	GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES	X	X			X		NO-GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES			X	X		08:49 TO 9:30 SEE NOTES 1 AND 3	GO	GO	GO	GO	GO
MULTIPLE FAILURES			X		X	S-IC/S-II SEP	GO	GO	GO	GO	GO
MULTIPLE FAILURES				X	X	9:13 TO INSR + 60	NO-GO	NO-GO	NO-GO	GO	NO-GO

NOTES:

1. FLAME ATTENUATION WILL CAUSE LOSS OF USB LOCK AT MIL DURING S-IC/S-II SEPARATION.
2. INSR + 60 SECONDS IS APPROXIMATELY 12:21.
3. LOSS OF COVERAGE IS NOT SEVERE ENOUGH FOR A NO-GO CONDITION.
4. LOSS OF ALDS RESULTS IN LOSS OF S-IC TM; HOWEVER, IT IS NOT MANDATORY FOR LAUNCH.

FIGURE 4-1.- 72° LAUNCH AZIMUTH SITE FAILURE DECISION MATRIX.

REV	ITEM
A	

	SITES FAILED					MANDATORY COVERAGE LOST	CAPABILITY LOST				
	ALDS TM 0:00 8:49	MIL/CAPE 0:00 8:49	GBM 1:07 9:20	BDA 4:12 12:33	VAN 9:11 16:12		TELEMETRY USB OR VHF	CMD	TRACK BOTH S AND C BAND	A/G USB	A/G USB AND VHF
SINGLE FAILURE	X					NONE SEE NOTE 4	GO	N/A	N/A	N/A	N/A
		X				00:00 TO 01:07	GO	GO	NO-GO	NO-GO	NO-GO
			X			S-IC/S-II SEP SEE NOTE 2	GO	GO	GO	GO	GO
				X		NONE	GO	GO	GO	GO	GO
					X	NONE	GO	GO	GO	GO	GO
MULTIPLE FAILURES	X	X				00:00 TO 01:07	NO-GO	GO	NO-GO	NO-GO	NO-GO
		X	X			00:00 TO 4:12	GO	GO	NO-GO	NO-GO	NO-GO
	X	X	X			00:00 TO 4:12	NO-GO	GO	NO-GO	NO-GO	NO-GO
		X		X		00:00 TO 01:07	GO	GO	NO-GO	NO-GO	NO-GO
	X	X		X		00:00 TO 01:07	NO-GO	GO	NO-GO	NO-GO	NO-GO
		X			X	00:00 TO 01:07	GO	GO	NO-GO	NO-GO	NO-GO
	X	X			X	00:00 TO 01:07	NO-GO	GO	NO-GO	NO-GO	NO-GO
			X	X		S-IC/S-II SEP	GO	GO	GO	GO	GO
			X		X	S-IC/S-II SEP	GO	GO	GO	GO	GO
				X	X	09:20 TO INSR + 60	NO-GO	NO-GO	NO-GO	GO	NO-GO

NOTES:

1. ANG HAS ACQUISITION FROM 07:48 TO 11:20; HOWEVER, MAXIMUM ELEVATION IS 1.6 DEGREES.
2. FLAME ATTENUATION WILL CAUSE LOSS OF USB LOCK AT MIL DURING S-IC/S-II SEPARATION.
3. INSR + 60 SECONDS IS APPROXIMATELY 12:21.
4. LOSS OF ALDS RESULTS IN LOSS OF S-IC TM; HOWEVER, IT IS NOT MANDATORY FOR LAUNCH.

FIGURE 4-2.- 81° LAUNCH AZIMUTH SITE FAILURE DECISION MATRIX.

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM
A	

	SITES FAILED						MANDATORY COVERAGE LOST	CAPABILITY LOST				
	ALDS TM 0:00 8:48	MIL/CAPE 0:00 8:48	GBM 1:06 9:26	BDA 4:15 12:13	ANG 7:23 12:48	VAN 9:07 16:19		TELEMETRY USB OR VHF	CMD	TRACK BOTH S AND C BAND	A/G USB	A/G USB AND VHF
SINGLE FAILURE	X						NONE SEE NOTE 4	GO	N/A	N/A	N/A	N/A
		X					00:00 TO 01:06	GO	GO	NO-GO	NO-GO	NO-GO
			X				S-IC/S-II SEP SEE NOTE 2	GO	GO	GO	GO	GO
				X			NONE	GO	GO	GO	GO	GO
					X		NONE	GO	GO	GO	GO	GO
						X	NONE	GO	GO	GO	GO	GO
MULTIPLE FAILURES	X	X					00:00 TO 01:06	NO-GO	GO	NO-GO	NO-GO	NO-GO
		X	X				00:00 TO 04:15	GO	GO	NO-GO	NO-GO	NO-GO
	X	X	X					NO-GO	GO	NO-GO	NO-GO	NO-GO
		X		X			00:00 TO 01:06	GO	GO	NO-GO	NO-GO	NO-GO
	X	X		X				NO-GO	GO	NO-GO	NO-GO	NO-GO
		X				X	00:00 TO 01:06	GO	GO	NO-GO	NO-GO	NO-GO
	X	X				X		NO-GO	GO	NO-GO	NO-GO	NO-GO
			X	X			S-IC/S-II SEP	GO	GO	GO	GO	GO
			X			X	S-IC/S-II SEP	GO	GO	GO	GO	GO
				X		X	NONE	GO	GO	GO	GO	GO
					X	X	12:13 TO INSR + 60	NO-GO	NO-GO	NO-GO	GO	NO-GO

NOTES:

1. ANG HAS MAXIMUM ELEVATION OF 5 DEGREES.
2. FLAME ATTENUATION WILL CAUSE LOSS OF USB LOCK AT MIL DURING S-IC/S-II SEPARATION.
3. INSR + 60 SECONDS IS APPROXIMATELY 12:21.
4. LOSS OF ALDS RESULTS IN LOSS OF S-IC TM; HOWEVER, IT IS NOT MANDATORY FOR LAUNCH.

FIGURE 4-3.- 90° LAUNCH AZIMUTH SITE FAILURE DECISION MATRIX.

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM
A	

	SITES FAILED						MANDATORY COVERAGE LOST	CAPABILITY LOST				
	ALDS TM 0:00 8:48	MIL/CAPE 0:00 8:48	GBM 1:06 9:31	BDA 4:21 11:43	ANG 7:00 13:40	VAN 9:16 15:57		TELEMETRY USB OR VHF	CMD	TRACK BOTH C AND S BAND	A/G USB	A/G USB AND VHF
SINGLE FAILURE	X						NONE SEE NOTE 3	GO	N/A	N/A	N/A	N/A
SINGLE FAILURE		X					00:00 TO 01:06	GO	GO	NO-GO	NO-GO	NO-GO
SINGLE FAILURE			X				S-IC/S-II SEP SEE NOTE 1	GO	GO	GO	GO	GO
SINGLE FAILURE				X			NONE	GO	GO	GO	GO	GO
SINGLE FAILURE					X		NONE	GO	GO	GO	GO	GO
SINGLE FAILURE						X	NONE	GO	GO	GO	GO	GO
MULTIPLE FAILURES	X	X					00:00 TO 01:06	NO-GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES		X	X				00:00 TO 04:21	GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES	X	X	X					NO-GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES		X		X			00:00 TO 01:06	GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES	X	X		X				NO-GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES		X				X	00:00 TO 01:06	GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES	X	X				X		NO-GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES			X	X			S-IC/S-II SEP	GO	GO	GO	GO	GO
MULTIPLE FAILURES			X			X	S-IC/S-II SEP	GO	GO	GO	GO	GO
MULTIPLE FAILURES				X		X	NONE	GO	GO	GO	GO	GO
MULTIPLE FAILURES				X	X		NONE	GO	GO	GO	GO	GO
MULTIPLE FAILURES					X	X	11:43 TO INSR + 60	NO-GO	NO-GO	GO	GO	NO-GO
MULTIPLE FAILURES		X			X		00:00 TO 01:06	GO	GO	NO-GO	NO-GO	NO-GO
MULTIPLE FAILURES	X	X			X			NO-GO	GO	NO-GO	NO-GO	NO-GO

NOTES:

1. FLAME ATTENUATION WILL CAUSE LOSS OF USB LOCK AT MIL DURING S-IC/S-II SEPARATION.
2. INSR + 60 SECONDS IS APPROXIMATELY 12:21.
3. LOSS OF ALDS RESULTS IN LOSS OF S-IC TM; HOWEVER, IT IS NOT MANDATORY FOR LAUNCH.

FIGURE 4-4.- 99° LAUNCH AZIMUTH SITE FAILURE DECISION MATRIX.

REV	ITEM
A	

	SITES FAILED						MANDATORY COVERAGE LOST	CAPABILITY LOST				
	ALDS TM 0:00 8:48	MIL/CAPE 0:00 8:48	GBM 1:06 9:35	BDA 4:29 11:03	ANG 6:48 14:10	VAN 9:42 14:59		TELEMETRY USB OR VHF	CMD	TRACK BOTH C AND S BAND	A/G USB	A/G USB AND VHF
SINGLE FAILURE	X						NOTE SEE NOTE 3	GO	N/A	N/A	N/A	N/A
		X					00:00 TO 01:02	GO	GO	NO-GO	NO-GO	NO-GO
			X				S-IC/S-II SEP SEE NOTE 1	GO	GO	GO	GO	GO
				X			NONE	GO	GO	GO	GO	GO
					X		NONE	GO	GO	GO	GO	GO
						X	NONE	GO	GO	GO	GO	GO
MULTIPLE FAILURES	X	X					00:00 TO 01:02	NO-GO	GO	NO-GO	NO-GO	NO-GO
		X	X				00:00 TO 04:11	GO	GO	NO-GO	NO-GO	NO-GO
	X	X	X					NO-GO	GO	NO-GO	NO-GO	NO-GO
		X			X		00:00 TO 01:02	GO	GO	NO-GO	NO-GO	NO-GO
	X	X			X			NO-GO	GO	NO-GO	NO-GO	NO-GO
		X				X	00:00 TO 01:02	GO	GO	NO-GO	NO-GO	NO-GO
	X	X				X		NO-GO	GO	NO-GO	NO-GO	NO-GO
			X		X		S-IC/S-II SEP	GO	GO	GO	GO	GO
			X			X	S-IC/S-II SEP	GO	GO	GO	GO	GO
					X	X	11:01 TO INSR + 60	NO-GO	NO-GO	GO	GO	NO-GO
				X	X		NONE	GO	GO	GO	GO	GO

NOTES:

1. FLAME ATTENUATION WILL CAUSE LOSS OF USB LOCK AT MIL DURING S-IC/S-II SEPARATION.
2. INSR + 60 SECONDS IS APPROXIMATELY 12:21.
3. LOSS OF ALDS RESULTS IN LOSS OF S-IC TM; HOWEVER, IT IS NOT MANDATORY FOR LAUNCH.

FIGURE 4-5.- 108° LAUNCH AZIMUTH SITE FAILURE DECISION MATRIX.

5 TRAJECTORY AND GUIDANCE

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
	5-1	THE LAUNCH PHASE WILL BE TERMINATED FOR ANY OF THE FOLLOWING CONDITIONS: A. VIOLATION OF THE VEHICLE BREAKUP LINE. B. $T_{FF} \leq 1 + 40$ AND DECREASING AFTER TOWER JETTISON. C. VIOLATION OF ENTRY "G" LIMIT. D. VS INCREASING. E. OVERSPEED CONDITIONS AT INSERTION. F. VIOLATION OF EXIT HEATING LINE.
	5-2	THE LES WILL NOT BE JETTISONED UNTIL MODE II CAPABILITY IS ESTABLISHED BY $T_{FF} \geq 1 + 20$ AND INCREASING.
	5-3	MODE II, III, IV, AND APOGEE KICK. A. THE GROUND IS PRIME FOR ABORT MODE DETERMINATION AND MODE III MANEUVER COMPUTATIONS. B. MANEUVERS WILL BE INTERRUPTED WHEN $T_{FF} = 1 + 40$ AND DECREASING. C. MODE IV MANEUVERS WILL BE INTERRUPTED IF THE CURRENT ALTITUDE IS 75 NM, DECREASING AND h_p <300K FT. D. IF ENTERING, UTILIZE LIFT OF AVOID LAND. UNAVOIDABLE LAND LANDING USE RL 90 DEG. E. MAXIMUM NUMBER OF SPS START ATTEMPTS IS TWO. F. IF NO SLA SEP OR IF SPS FAILS: 1. $h_p < 40$ - EXECUTE CM/SM SEP BY $T_{FF} = 1 + 40$. 2. $40 < h_p < 75$ - GROUND WILL DECIDE TO USE SM RCS ASAP OR AT APOGEE TO REDUCE h_p TO 40 NM.
A	5-4	MODE III ABORTS. A. PREDICTED T_{FF} AFTER SPS C/O <1 + 40. 1. FULL LIFT IP ON WATER - DO NOT BURN. 2. G&N GO AND FULL LIFT IP ON LAND - BURN TO $T_{FF} = 1 + 40$, RL 90 DEG. 3. G&N NO-GO AND FULL LIFT IP ON LAND - BURN A REDUCED ΔV TO MAINTAIN T_{FF} AFTER C/O AND RL 90 DEG.
|		B. IF $\Delta T_B \leq 2$ SEC, DO NOT BURN. C. IF IGNITION OCCURS AFTER GETI +10 SEC, BU N UNTIL G&N $\Delta R = 0$, RL 55 DEG. (IF UNABLE TO BURN $\Delta R = 0$, RL 90 DEG.)

REV	ITEM	
	5-5	THE S/C CMC WILL BE NO-GO FOR ABORT MANEUVER DETE MINATION AND MONITORING FOR ANY OF THE FOLLOWING: A. CMC PROGRAM FAILURE. B. RTCC AND CMC T_{FF} DIFFERENCE OF >40 SEC. C. CONFI MED ERROR IN S/C PLATFO M VELOCITY COMPONENTS OF >50 FPS IN X OR 100 FPS IN Z. D. CMC TRAJECTORY SOURCE INDICATES "GO' OR "NO-GO" INCONSISTENT WITH BEST TRAJECTORY SOURCE(S) INDICATION.
A	5-6	THE ORBIT IS "GO" IF $h_p \geq 75$ NM.
		RULES 5-7 THROUGH 5-19 ARE RESERVED.

REV	ITEM	
	5-20	EARTH ORBITAL ALTITUDE CONSTRAINTS: A. REAL-TIME MISSION PLANNING PERIGEE - 85 NM MINIMUM. MAXIMUM, h_p IS DETERMINED BY SM RCS AVAILABLE FOR HYBRID DEORBIT. B. CONTINGENCY PERIGEE - 75 NM MINIMUM (VIOLATIONS WILL BE CORRECTED ASAP) IF h_p <75 NM AND MANEUVER TO RAISE h_p IS NOT POSSIBLE: 1. 40 < h_p <75 - EXECUTE SPS RETROGRADE ASAP UNTIL h_p <40. IF NO SPS, USE SM-RCS. 2. h_p <40 - CM/SM SEP - RETRO WILL RECOMMEND ENTRY PROFILE.
A	5-21	THE CONTINGENCY SEPARATION MANEUVERS FOR THE CSM ARE: A. IMPENDING S-IVB OR UNMANNED LM EXPLOSION - <u>55</u> FPS SPS ASAP (<u>7000</u> FT SEPARATION REQUIRED IN <u>200</u> SEC). B. S-IVB ATTITUDE RATES ≥<u>5</u> DEG/SEC - <u>5</u> FPS RCS ASAP. C. S-IVB YAW ATTITUDE >45 DEG - <u>5</u> FPS RCS ASAP. D. CSM RETROFIRE REQUIRED WHILE ATTACHED TO THE S-IVB OR LM - SEPARATION 20 MINUTES PRIOR TO RETRO, 5 FPS RCS RETROGRADE WITH LINE ON HORIZON.
A	5-22	S/C COMPUTER TIMING UPDATES ARE REQUIRED FOR SET ERRORS AS FOLLOWS: A. CMC OR LGC >.5 SEC. B. AGS >2 SEC. C. S/C L/O TIME (GRR) WILL BE UPDATED WITH SRO L/O TIME IF THE TWO ARE DIFFERENT BY 10 SEC.
A	5-23	TIME BETWEEN EPO RETROFIRE GETI AND 400K MUST BE >9 MIN. IF NOT, RETARGET FOR NEXT PTP.
A	5-24	IF SPS RETROFIRE ΔT_B <7 SEC, USE SCS AUTO TVC.
	5-25	PLANNED G&N AND SCS RETROFIRE MANEUVERS WILL BE UPDATED IF: A. THE COMPUTED RETROFIRE POSITION CHANGES BY >0.5 DEG LONGITUDE PRIOR TO GETI -30 MIN. B. THE COMPUTED RETROFIRE POSITION CHANGES BY >2 DEG LONGITUDE AFTER GETI -30 MIN.
	5-26	IF A G&N FAILURE IS DETECTED PRIOR TO RETROFIRE, CREW USES SCS ΔV MODE WITH AN EMS ENTRY.

REV	ITEM	
A	5-27	IF SPS FAILS AFTER EPO RETROFIRE IGNITION OR NO SLA SEP: A. h_p >75 NM - RETARGET FOR NEXT BEST PTP USING RCS. B. 40 < h_p <75 - PITCH UP TO LOCAL HORIZONTAL ATTITUDE AND BURN SM RCS USING FOLLOWING PRIORITIES: 1. BURN h_p TO PAD VALUE 2. BURN MAXIMUM SM RCS ΔV AVAILABLE 3. BURN CM RCS TO h_p = 40 NM IF SM RCS ΔV NOT SUFFICIENT TO OBTAIN h_p = 40 NM IF h_p ≤40 NM TERMINATE ALL THRUSTING AT T_{FF} = 7 MIN. C. h_p <40 NM - REMAIN IN RETRO ATTITUDE AND BURN SM RCS USING THE FOLLOWING PRIORITY: 1. BURN ΔV RESIDUALS. 2. BURN MAXIMUM SM ΔV AVAILABLE. NOTE THE S-IVB LOX DUMP CAPABILITY MAY BE USED TO SHAPE THE ORBIT FOR RETROFIRE MANEUVER OR TO REDUCE THE S-IVB WEIGHT TO OBTAIN MORE SM RCS ΔV.
	5-28	THE G&N IS NO-GO FOR ENTRY IF: A. THE 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. B. V AND γ AT 400K ARE OUTSIDE THE CORRIDOR. GROUND WILL PROVIDE ENTRY PROFILE.
A	5-29	IU TARGET AND NAVIGATION UPDATES: A. THERE WILL BE NO IU TARGET UPDATE FOR EITHER TLI OPPORTUNITY. B. AN IU NAVIGATION UPDATE WILL BE PERFORMED FOR TLI OPPORTUNITIES WHEN S-IVB GUIDANCE REFERENCE FAILURE OCCURRED PRIOR TO EARTH ORBIT INSERTION.
	5-30	THE CMC STATE VECTOR WILL BE UPDATED PRIOR TO TLI WITH THE BEST MSFN VECTOR.
A	5-31	A PROPERLY OPERATING G&N (CMC + ISS + OSS) IS MANDATORY FOR TLI.
	5-32	THE MAXIMUM ALLOWABLE MISALIGNMENT RATES BETWEEN THE IU AND IMU ARE 0.6 DEG/HR (IU) AND 1.5 DEG/HR (IMU).
	5-33	THE S/C L/O RESFMMAT WILL BE USED FOR BOTH TLI OPPORTUNITIES.

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
A	5-34	DISPERSED TLI C/O:

A. PREDICTED END OF MISSION FUEL RESERVES (EOMFR) >500 FPS - CONTINUE MISSION AND EXECUTE MCC CONSISTENT WITH LUNAR ORBIT MISSION. (EOMFR INCLUDES T&D, BAP MCC_1, LOI_1, LOI_2, RENDEZVOUS RESCUE, AND TEI.)

B. PREDICTED EOMFR <500 FPS AND:

1. PREDICTED FUEL RESERVES AFTER T&D, BAP MCC_1, LOI_1, LOI_2, AND TEI (NO RENDEZVOUS RESCUE) >500 FPS - CONTINUE MISSION, EXEUCTE MCC CONSISTENT WITH LUNAR ORBIT MISSION. (DPS LOI MAY BE CONSIDERED TO IMPROVE SPS ΔV CAPABILITY.)

2. PREDICTED FUEL RESERVES AFTER T&D, BAP MCC_1, LOI_1 (DPS), LOI_2, AND TEI (NO RENDEZVOUS RESCUE) <500 FPS, AND:

   (A) EOMFR AFTER LUNAR FLYBY (CSM AND LM) >5500 FPS (CSM ONLY), EXECUTE MCC FOR FLYBY MISSION.
   (B) EOMFR AFTER LUNAR FLYBY <5500 FPS, EXECUTE ALTERNATE MISSION CONSISTENT WITH FINAL MISSION PLANNING.

5-35 DIFFERENCE IN CMC AND IU PLATFORM VELOCITY COMPONENTS OR TOTAL VELOCITY AT INSERTION:

A. VIOLATION OF ANY OF THE FOLLOWING MEANS TLI IS NO-GO:

$\Delta V\dot{X} > \underline{35}$ FPS

$\Delta V\dot{Y} > \underline{66}$ FPS

$\Delta V\dot{Z} > \underline{87}$ FPS

$\Delta V_T > \underline{33}$ FPS

B. VIOLATION OF ANY OF THE FOLLOWING MEANS TLI IS TEMPORARILY NO-GO:

$\underline{7.4} < \Delta\dot{X} < \underline{35}$ FPS

$\underline{45} < \Delta\dot{Y} < \underline{66}$ FPS

$\underline{27} < \Delta\dot{Z} < \underline{87}$ FPS

$\underline{13} < \Delta_T < \underline{33}$ FPS

TLI IS NO-GO UNTIL PARTS C AND 5-36 ARE DETERMINED (ORBITAL PARAMETER DECISIONS).

C. VIOLATION OF ANY OF TH FOLLOWING ORBITAL DECISION PARAMETERS AT GET = 1 HR 45 MIN MEANS TLI IS NO-GO. PARAMETERS ARE IU VERSUS MSFN.

$\Delta\alpha > \underline{19,300}$ FT

$\Delta\omega_{MAX} > \underline{32}$ FPS

A 5-36 DIFFERENCE IN MSFN AND IU DOWNRANGE POSITION (ΔR_V) >105,000 FT AT GET = 56 MIN MEANS TLI IS NO-GO.

RULES 5-37 THROUGH 5-45
ARE RESERVED.

REV	ITEM	
	5-46	THE CMC OR LGC WILL BE TEMPORARILY NO-GO FOR MANEUVER CONTROL FOR ANY OF THE FOLLOWING:

A. COMPUTER PROGRAM FAILURE.

B. CMC/IMU ALIGNMENT DISCREPANCY (FOR MANEUVER EXECUTION, MONITORING, AND ORBIT DETERMINATION).

1. SEXTANT STAR CHECK: AUTO OPTICS POSITIONING DOES NOT PLACE SELECTED STAR IN FIELD OF VISION OF SXT.
2. HORIZON CHECK ERROR >4 DEG FOR RETROFIRE FROM EPO.

C. LGC/IMU ALIGNMENT DISCREPANCY INDICATE BY >2 DEG FROM PREDICTED COAS COORDINATES.

D. DIFFERENCE BETWEEN CMC/LGC GROUND NAV CHECK AFTER A NAV UPDATE FROM GROUND IS:

1. ϕ >.02 DEG.
2. λ >.02 DEG.
3. h >.2 NM.

REV	ITEM	
A	5-47	MODE III, APOGEE KICK OR EPO RETROFIRE WILL BE COMPLETED BY MANUAL TAKEOVER FOR ATTITUDE EXCURSIONS OF ≥5 DEG.
A	5-48	CRITICAL MANEUVERS WILL BE COMPLETED BY SCS (MTVC OR AUTO) OR AGS TAKEOVER FOR ANY OF THE FOLLOWING:

A. CSM OR STAGED LM

1. ATTITUDE EXCURSION ≥ 10 DEGREES
2. ATTITUDE RATES ≥ 10°/SEC
3. ATTITUDE ERRORS ≥ 10 DEGREES

B. UNSTAGED LM

1. ATTITUDE EXCURSIONS > 5 DEGREES
2. ATTITUDE RATES ≥ 5°/SEC
3. ATTITUDE ERRORS ≥ 5 DEGREES

REV	ITEM	
	5-49	NON-CRITICAL MANEUVERS WILL BE TERMINATED AFTER MANUAL TAKEOVER FOR:

A. ATTITUDE EXCURSIONS ≥ 10 DEG.

B. ATTITUDE RATES ≥ 10 DEG/SEC.

C. ATTITUDE ERRORS ≥ 10 DEG.

REV	ITEM	
A	5-50	GENERALLY, THE FOLLOWING MANEUVER RESIDUAL TRIMMING CRITERIA WILL APPLY:

A. DOCKED SPS - TRIMMED TO 1 FPS IN X-AXIS ONLY (MCC_1, MCC_2, AND LOI_1 ARE NOT TRIMMED).

B. DOCKED DPS WILL NOT BE TRIMMED.

C. ALL UNDOCKED MANEUVERS (BY EITHER VEHICLE) WILL BE TRIMMED TO WITHIN 0.2 FPS IN X-AXIS. Y AND Z-AXIS RESIDUALS WILL NOT BE TRIMMED.

REV	ITEM	
A	5-51	THE FOLLOWING MANEUVERS WILL BE MANUALLY TERMINATED AFTER VIOLATION OF THESE OVERBURN CRITERIA:
		A. TLI - 6 SEC
		B.1. LOI_1 - 10 SEC (SPS)
		2. LOI_1 - TBD SEC (DPS)
		C. LOI_2 - 1 SEC
		D. DOI - 2 SEC AND ΔV_{AGS} = 2 FPS
		E.1. TEI - 2 SEC AND ΔV_C > 40 FPS OVERBURN (SPS)
		2. TEI - 10 SEC AND ΔV_{AGS} > 10 FPS OVERBURN (DPS)

REV	ITEM	
	5-56	MIDCOURSE CORRECTION NOMINAL EXECUTION POINTS WILL BE AT THE FOLLOWING: A. TLI C/O +9 HRS (EARLIEST PLANNED MCC AT TLI C/O +4 HRS). B. TLI C/O +25 HRS. C. LOI -22 HRS. D. LOI_1 -5 HRS.
	5-57	TRANSLUNAR MCC EXECUTION CRITERIA A. MCC_1 AND MCC_2 WILL NOT BE EXECUTED AS LONG AS MCC_3 REMAINS LESS THAN 25 EPS. NOTE: MCC_3 ΔV >3 EPS ENABLES UTILIZATION OF SPS. B. MCC_3 WILL BE EXECUTED ONLY IF LOI, CANNOT BE TARGETED (WITHIN ALTITUDE AND APSIDAL SHIFT CONSTRAINTS) TO CORRECT THE TLC DISPERSIONS. C. MCC_4 WILL BE EXECUTED ONLY IF LOI_1 CANNOT BE TARGETED (WITHIN ALTITUDE CONSTRAINTS) TO CORRECT TLI DISPERSIONS.
	5-58	THE G&N WILL BE THE PRIMARY MODE OF EXECUTING TRANSLUNAR MCC.
	5-59	THE RESIDUALS OF MCC_3 WILL BE TRIMMED TO 0.5 FPS IN ALL AXES. IF MCC_4 IS EXECUTED, THE X-AXIS RESIDUAL WILL BE TRIMMED TO WITHIN 1.0 FPS.
A	5-60	LOI SHALL BE TARGETED WITHIN THESE CONSTRAINTS: A. 60 > h_p >50 (LUNAR PARKING ORBIT). B. THE PERICYNTHION OF THE APPROACH HYPERBOLA WILL BE MAINTAINED WITHIN 50 AND 70 NM. C. THE ALTITUDE OF THE NODE (BETWEEN THE APPROACH HYPERBOLA AND THE DESIRED LPO) WILL BE MAINTAINED BETWEEN 50 AND 75 NM.
A	5-61	A "GO" FOR LOI REQUIRES THE FOLLOWING: A. COMMITMENT TO AT LEAST 4 HRS IN LPO - (PROVIDES ONE REV OF TRACK AFTER LOI_1 FOR CALCULATION OF TEI). B. ADEQUATE FUEL REMAINING FOR SUBSEQUENT LUNAR ORBIT OPERATIONS (MINIMUM WOULD BE LOI_2 AND TEI). C. h_p >50 NM.
A	5-62	PREMATURE LOI SHUTDOWN A. ΔV_M <735 FPS (100 SEC) - EXECUTE AN SPS 15 MIN DIRECT ABORT OR A DPS 2 HR DIRECT ABORT. B. 735 <ΔV_M <1280 (100 TO 170 SEC) - EXECUTE AN SPS 15 MIN DIRECT ABORT OR A DPS TWO-IMPULSE CIRCUMLUNAR ABORT. C. ΔV_M >1280 FPS (>170 SEC TO END OF BURN) - EXECUTE TEI (SPS OR DPS) AT NEXT PERICYNTHION OR INITIATE AN ALTERNATE MISSION.

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
A	5-63	THE MAX ALLOWABLE MISS DISTANCE OVER THE LLS IS .5 OUT-OF-PLANE AND .5 DEG IN AZIMUTH. (NOTE: THE ALLOWABLE MISS DISTANCE IS AZIMUTH IS A FUNCTION OF THE LLS AND LAUNCH DAY.)
	5-64	IF THE SPS FAILS AT IGNITION: A. MCC - RESCHEDULE MCC FOR FLYBY TRAJECTORY WITH DPS/SM-RCS EXECUTION. B. LOI_1 - EXECUTE MCC_5 ABORT MANEUVER WITH DPS/SM-RCS. C. LOI_2 - EXECUTE GROUND COMPUTED TEI WITH DPS AS SOON AS PRACTICAL.

RULES 5-65 THROUGH
5-75 ARE RESERVED.

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
	5-76	THE LOI_2 MANEUVER WILL BE TARGETED TO MINIMIZE THE LLS MISS DISTANCE.
	5-77	A "GO" FOR LOI_2 REQUIRES COMMITMENT TO AT LEAST 4 HRS IN LUNAR ORBIT. (NOTE: THIS PROVIDES ONE FULL REV OF TRACK AFTER LOI_2 FOR CALCULATION OF TEI.)
A	5-78	ALL LUNAR ORBIT OPERATIONS WILL PRESERVE h_p NO LESS THAN 8 NM. VIOLATIONS WILL BE CORRECTED ASAP.
		RULES 5-79 THROUGH 5-85 ARE RESERVED.

REV	ITEM	
A	5-86	THE PGNCS IS PRIME FOR CSI, CDH, AND TPI MANEUVER COMPUTATION/EXECUTION WITH THE AGS AS BACKUP UTILIZING THE ACCEPTED SOLUTION (EXCEPTION: CDH IS AGS CONTROLLED):

A. THE AVAILABLE SOLUTIONS FOR CSI ARE: PGNCS, CHARTS, AND GROUND. THE ORDER OF PRIORITY WILL BE:

1. USE LARGEST SOLUTION (ΔV) IF NO GREATER THAN 2 FPS DIFFERENT FROM MIDDLE SOLUTION.
2. IF "1" ABOVE IS VIOLATED, USE MIDDLE SOLUTION +2 FPS.

B. THE AVAILABLE SOLUTIONS FOR CDH ARE: PGNCS, CHARTS, CMC. THE ORDER OF PRIORITY WILL BE:

1. COMPARE PGNCS AND CMC. IF NO DIFFERENT THAN 2 FPS IN $\dot{X}$ AND 6 FPS IN $\dot{Z}$, USE PGNCS SOLUTION.
2. IF "1" ABOVE IS VIOLATED, COMPARE PGNCS AND CHARTS WITH SAME CRITERIA. IF COMPARISON PASSES, USE PGNCS SOLUTION.
3. IF "1" AND "2" ABOVE ARE VIOLATED, COMPARE CHARTS AND CMC USING THE SAME CRITERIA. IF COMPARISON PASSES, USE CHART SOLUTION.
4. IF "1", "2", AND "3" ABOVE ARE VIOLATED, USE THE CMC SOLUTION.

C. THE AVAILABLE SOLUTIONS FOR TPI ARE: PGNCS, CHARTS, AND CMC. THE ORDER OF PRIORITY WILL BE:

1. COMPARE PGNCS AND CMC. IF NO DIFFERENT THAN 2 FPS IN $\dot{X}$, 5 FPS IN $\dot{Y}$, OR 6 FPS IN $\dot{Z}$, USE THE PGNCS SOLUTION.
2. IF "1" FAILS, COMPARE THE PGNCS AND CHARTS, WITH SAME CRITERIA. IF COMPARISON PASSES, USE THE PGNCS SOLUTION.
3. IF "1" AND "2" FAIL, COMPARE THE CHARTS AND THE CMC SOLUTIONS, USING THE SAME CRITERIA. IF COMPARISON PASSES, USE THE CHART SOLUTION.
4. IF "1", "2", AND "3" FAIL, USE THE CMC SOLUTION.

5-87 THE ORDER OF PRIORITY FOR THE TPI SOLUTION IS PGNCS, LM ONBOARD CHARTS, CSM, AND GROUND. THE ONBOARD SOLUTION WILL NOT BE USED IF DIFFERENT FROM THE CSM BY:

A. $\Delta V_{GX} > 2$ FPS

B. $\Delta V_{GY} > 5$ FPS

C. $\Delta V_{GZ} > 6$ FPS

D. ΔTIG TPI > 2 MIN

5-88 RENDEZVOUS PLANS SHALL, WHERE POSSIBLE, SATISFY THE FOLLOWING CONSTRAINTS:

A. RENDEZVOUS MANEUVERS MUST BE AT LEAST 25 MIN APART.

B. THE ALLOWABLE SLIP TIME FOR TPI IS ±15 MIN FROM MPD.

C. THE ΔH FOR TPI WILL BE 15 ±5 NM.

5-89 THE GROUND WILL BE RESPONSIBLE FOR ALL MANEUVERS PRIOR TO CSI.

(NOTE: GROUND WILL COMPUTE CSI, CDH, AND TPI BUT WILL NOT PASS THESE MANEUVERS UNLESS REQUESTED.)

5-90 PHASING AND INSERTION WILL BE TARGETED TO PRESERVE THE NOMINAL RENDEZVOUS.

5-91 ALL MANEUVERS WILL BE TRIMMED TO 0.2 FPS IN THE X-AXIS. Y AND Z-AXIS RESIDUALS WILL NOT BE TRIMMED.

(NOTE: THIS INCLUDES NOMINAL AND/OR RESCUE MANEUVERS.)

REV	ITEM	
A	5-92	THE FOLLOWING RENDEZVOUS OPTIONS AND RESCUE MODES WILL BE UTILIZED AS NECESSARY FOR FAILURES REQUIRING TERMINATION OF THE NOMINAL RENDEZVOUS:

A. DOI FAILURES

1. UNDERBURN

(A) ATTEMPT TO COMPLETE
(B) DPS FAILURE - PDI ABORT AT PC (APS ONLY PROFILE)
(C) PGNCS FAILURE - DIRECT RETURN

2. OVERBURN

(A) OVERBURN $\leq$ 12 FPS, NULL RESIDUALS
(B) OVERBURN $\geq$ 12 FPS, DIRECT RETURN
(C) PGNCS FAILURE - DIRECT RETURN

NOTE

THE PGNCS, AGS, OR RR IS "GO" IF AGREEMENT WITH EITHER OF THE OTHER SOURCES IS WITHIN $\underline{2}$ FPS.

PGNCS FAIL - DIRECT RETURN
AGS FAIL - CONTINUE MISSION
RR FAIL - CONTINUE MISSION

B. FOR FAILURES FROM DOI + 10 MIN TO PERICYNTHION THAT REQUIRE DEVIATION FROM THE NOMINAL, THE FIVE-IMPULSE PDI ABORT SEQUENCE WILL BE INITIATED. DOCKING WILL OCCUR 2 HOURS EARLIER THAN NOMINAL.

C. FOR DPS FAILURES FROM DOI C/O UNTIL THE V_{GO} OF THE PHASING MANEUVER IS 25 FPS, THE LM WILL STAGE AND COMPLETE THE BURN WITH THE APS. IF V_{GO} IS LESS THAN 25 FPS, THE LM WILL STAGE AND COMPLETE THE BURN WITH THE RCS. (NOTE: IF V_{GO} <5 FPS, LM WILL COMPLETE BURN VIA RCS - NO STAGING.)

D. FOR DPS FAILURES FOLLOWED BY APS FAILURES DURING PHASING, THE LM WILL TAKE NO FURTHER ACTION UNLESS V_M OF PHASING <40 FPS. IF V_M IS LESS THAN 40, THE LM WILL UTILIZE RCS TO ACHIEVE 40 FPS. THE CSM WILL INITIATE A FIVE-IMPULSE RESCUE WITH DOCKING OCCURRING AT THE NOMINAL TIME.

E. FOR COMPLETE LM FAILURES FOLLOWING DOI BUT PRIOR TO PHASING IGNITION, THE CSM WILL INITIATE THE FIVE-IMPULSE (R2) RESCUE SEQUENCE WITH DOCKING OCCURRING 2 HOURS LATE.

F. FOR CASES WHICH MAKE THE LM NO-GO FOR INSERTION, FOR NO APS IGNITION AT INSERTION, OR FOR V_M < 45 AND APS FAILURE, THE CSM WILL EXECUTE THE "ZERO INSERTION" BACKUP MANEUVER. THE CSM WILL ALSO EXECUTE CSI AND CDH WHILE EITHER VEHICLE MAY EXECUTE TERMINAL PHASE. (IF THE APS FAILS WITH V_M < 45 FPS, THE LM WILL UTILIZE THE RCS TO TRIM THE MANEUVER BACK TO ZERO.) DOCKING OCCURS AT THE NOMINAL TIME.

G. FOR APS FAILURES DURING INSERTION WHERE V_M > 45 AND V_{GO} > 80, THE CSM WILL INITIATE A FIVE-IMPULSE RESCUE. DOCKING WILL OCCUR 2 HOURS LATE WITH EITHER VEHICLE EXECUTING TERMINAL PHASE. (IF V_G < 80 FPS, THE LM WILL UTILIZE THE RCS TO COMPLETE THE MANEUVER.)

H. FOR LM FAILURES FOLLOWING INSERTION, THE CSM WILL EXECUTE ANY OR ALL OF THE CFP SEQUENCE UTILIZING THE MIRROR IMAGE TARGETING.

RULES 5-93 THROUGH 5-99 ARE RESERVED.

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
	5-100	TRANSEARTH MCC WILL BE TARGETED TO ACHIEVE ENTRY CONDITIONS AS FOLLOWS: A. IF V_{EI} >30000 FPS USE STEEP TARGET LINE. B. IF V_{EI} <30000 FPS AND G&N GO, USE SHALLOW TARGET LINE.
	5-101	TRANSEARTH MCC PHILOSOPHY. A. TEC MCC WILL NOT USE LANDING POINT CONTROL UNLESS THE LANDING POINT IS UNACCEPTABLE. B. IF γ_{EI} IS OUTSIDE THE ENTRY CORRIDOR, EXECUTE MCC ASAP (EXCEPTION: MCC_5 ONLY). C. THE LAST MCC WILL BE SCHEDULED NO LATER THAN EI-3 HOURS. D. THE G&N WILL BE THE PRIMARY MODE OF EXECUTION FOR ALL TEC MCC. E. MCC $\geq$10 FPS WILL USE THE SPS IF PRACTICAL. F. THE RESIDUALS FOR MCC'S WILL BE TRIMMED TO WITHIN 0.2 FPS IN EACH AXIS.
	5-102	TEC MCC FOR LANDING AREA CONTROL: A. PRIOR TO EI-24 HRS: WILL BE EXECUTED FOR RECOVERY ACCESS VIOLATIONS, UNACCEPTABLE WEATHER AT IP, OR IF ANY PART OF THE OPERATIONAL FOOTPRINT IS ON LAND. B. ATER EI-24 HRS: WILL NOT BE EXECUTED
	5-103	ENTRY CONDITIONS WILL BE CONTROLLED TO AVOID HEAT SHIELD LIMITATIONS.
	5-104	BACKUP ENTRY IS CONSTRAINED AS FOLLOWS: A. THE CONSTANT G ENTRY MUST FALL BETWEEN 3 AND 5 G'S. B. EMS RANGING WILL NOT BE ATTEMPTED UNTIL V $\leq$25500 FPS
	5-105	WEATHER AVOIDANCE WITH AERODYNAMIC LIFT WILL NOT BE ATTEMPTED UNLESS THE G&N IS OPERATIONAL, OR EMS-INDICATED VELOCITY <25500 FPS.
	5-106	PREDICTED ENTRY CORRIDOR VIOLATION AFTER THE LAST MCC OPPORTUNITY: A. UNDERSHOOT LINE EXCEEDED: GROUND ADVISE CREW TO FLY FULL LIFT UNTIL PEAK G IS PASSED, THEN FLY G&N. B. OVERSHOOT LINE EXCEEDED: GROUND ADVISE CREW TO FLY NEGATIVE LIFT TO 2 G'S FOLLOWED BY 4 G CONSTANT ENTRY.

REV	ITEM	
	5-107	IF THE EMS INDICATES A SKIP CONDITION, NEGATIVE LIFT SHOULD BE ACHIEVED PRIOR TO VERIFYING THE EMS WITH CROSS CHECKS.
	5-108	IF THE EMS INDICATES AN UNDERSHOOT CONDITION EXISTS, FULL LIFT SHOULD BE ACHIEVED PRIOR TO VERIFYING THE EMS WITH CROSS CHECKS.
A	5-109	THE G&N IS NO-GO DURING ENTRY IF: A. P65 VALUE OF V_L AND D_L ARE OUTSIDE THE TOLERANCE SPECIFIED BY GROUND DERIVED VALUES. B. CAUSES TRAJECTORY TO VIOLATE THE OFFSET LIMITS (SKIP) ON EMS SCROLL. C. CAUSES TRAJECTORY TO VIOLATE THE ONSET LIMITS (G) ON EMS SCROLL. D. IF THE G&N TRIM ATTITUDES AT CM/SM SEP DIFFER FROM THE HORIZON MONITOR ATTITUDE BY >5 DEG. E. IF THE G&N TRIM ATTITUDES AT .05 G DIFFERS FROM THE GROUND VALUES BY >5 DEG. F. IF THE CMC FAILS TO SEQUENCE FROM P63 TO P64 AT RET .05 G ±5 SEC.
		RULE NUMBERS 5-110 THROUGH 5-120 ARE RESERVED.

REV	ITEM	
		GENERAL:
	5-121	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.
	5-122	THE RSO WILL ACCOMPLISH THE PAD EMERGENCY RANGE CUTOFF PROCEDURE IF THE SPACE VEHICLE WILL NOT LIFT OFF AFTER IGNITION 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 CLTC-RSO DIRECT LINE TO TRANSMIT THIS REQUEST. THE RSO WILL NOT EXECUTE THIS PROCEDURE IF HE HAS A LIFTOFF INDICATION.
	5-123	THE FLIGHT DIRECTOR (FD) WILL INITIATE ABORT 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.
	5-124	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 BEEN 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.
	5-125	THE FD WILL INFORM THE RSO WHEN THE NO. 3 OR NO. 4 ENGINE HAS SHUT DOWN BY STATING "RSO, NO. 3 OUT (NO. 4 OUT)" AND/OR ACTIVATE THE ENGINE OUT LIGHT ON THE RSO CONSOLE.
	5-126	IF RANGE SAFETY DESTRUCT LINES ARE VIOLATED, THE RSO WILL SEND "ARM/MFCO" AND NOTIFY THE FD/FIDO. NO SPS THRUSTING WILL BE INITIATED FOLLOWING SUCH RANGE SAFETY ACTION.
	5-127	IF AN ESTABLISHED IMPACT PREDICTION (IP) POINT IS ON THE CAPE KENNEDY LAND AREA, "DESTRUCT/PD" WILL BE TRANSMITTED.
	5-128	IF AN ATTEMPT TO TERMINATE THRUST BY "ARM/MFCO" IS UNSUCCESSFUL WHILE THE IP IS ON THE CAPE KENNEDY LAND AREA, "DESTRUCT/PD" WILL BE SENT.
	5-129	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 ONLY AFTER FD/FIDO CONFIRMATION OF SATISFACTORY SPACECRAFT SEPARATION, AND ONLY IF FUEL DISPERSION IS NECESSARY.

REV	ITEM	
	5-130	IF AN IP POINT IS ESTABLISHED AND "DESTRUCT/PD" IS DEEMED UNNECESSARY, THE RSO WILL NOTIFY FD/FIDO AND SEND "SAFE" UPON FD/FIDO'S REQUEST.
	5-131	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.
	5-132	AN ETR RANGE SAFETY OFFICER (BRSO) IS REQUIRED AT BERMUDA TO MONITOR PRESENT POSITION AND IMPACT PREDICTION CHARTS, TO OBSERVE TELEMETRY DISPLAYS, AND TO TRANSMIT THE RANGE SAFETY FUNCTIONS WHEN COMMANDED TO DO SO BY THE RSO. FOR FLIGHT AZIMUTHS LESS THAN 90 DEGREES, THE BRSO WILL ASSUME RANGE SAFETY RESPONSIBILITY IN THE EVENT OF LOSS OF COMMUNICATIONS BETWEEN THE BRSO AND THE RSO.
	5-133	SAFING BY THE RSO WILL BE TRANSMITTED AFTER GATE PENETRATION 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."
	5-134	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."
		<u>TRACKING SOURCES</u>:
	5-135	AT LEAST TWO 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.
	5-136	DATA FROM TWO OF THE FOLLOWING THREE RADARS ARE <u>MANDATORY</u> BEFORE LAUNCH (<u>OTHER HIGHLY DESIRABLE</u>): BERMUDA FPS-16, BERMUDA FPQ-6, AND GRAND TURK TPQ-18.
	5-137	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.
	5-138	,DOP 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	
		AIRBORNE SYSTEMS:
	5-139	TWO 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.
	5-140	ONE OF TWO IU C-BAND BEACONS IS MANDATORY FOR LAUNCH FOR FLIGHT AZIMUTHS 72 TO 90 DEGREES (OTHER HIGHLY DESIRABLE). BEACON NO. 1 IS MANDATORY FOR LAUNCH FOR FLIGHT AZIMUTHS GREATER THAN 90 DEGREES.
		COMMAND/CONTROL:
	5-141	WHEN BERMUDA COMMAND COVERAGE IS REQUIRED, THE NASA BERMUDA DRS COMMAND/CONTROL SYSTEM IS MANDATORY FOR LAUNCH.
	5-142	RANGE SAFETY COMMANDS ("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."
		COMMUNICATIONS:
	5-143	TWO PRIVATE, INDEPENDENT, GEOGRAPHICALLY DIVERSIFIED COMMUNICATIONS LINKS BETWEEN THE RSO AND BRSO ARE REQUIRED. ONE OF TWO COMM LINKS IS MANDATORY.
	5-144	TWO OF THE FOLLOWING THREE COMMUNICATIONS LINKS ARE MANDATORY BETWEEN THE RSO AND FD/FIDO: A. RSO LOOP (CAPE 111) B. RSO PRIVATE LINE C. FLIGHT DIRECTOR LOOP
	5-145	A COMMUNICATIONS LINK BETWEEN THE RSO AND THE RANGE SAFETY SUPERVISOR (CRSS) AT THE LAUNCH CONTROL CENTER IS MANDATORY.
	5-146	A DIRECT LINE COMMUNICATIONS LINK BETWEEN THE RSO AND THE LAUNCH VEHICLE TEST CONDUCTOR (CLTC) IS HIGHLY DESIRABLE.
		TELEMETRY:
	5-147	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.

REV	ITEM	
		TELEMETRY:
	5-148	TELEMETRY REQUIREMENTS TO BE DISPLAYED FOR THE RSO AND THE BRSO ARE HIGHLY DESIRABLE.
		A. FOR RSO DISPLAY: SEE ATCH NO. 1
		B. FOR BRSO DISPLAY: SEE ATCH NO. 2
		RANGE SAFETY WEATHER RESTRICTIONS:
	5-149	WIND RESTRICTIONS:
		AN ANNUAL PROFILE WIND RESTRICTION OF 1.25 SIGMA (11%) WILL BE IN EFFECT FOR THE LAUNCH AREA.
	5-150	CEILING AND VISIBILITY RESTRICTIONS:
		PAD 39A: 2000 FEET/11.5 MILES FROM RADAR 19.18
		PAD 39B: 2000 FEET/12.5 MILES FROM RADAR 19.18

6 SLV - TB1 THROUGH TB4/TB4A (LAUNCH)

REV	ITEM	

BSE GENERAL RULES (THESE RULES SUPPLEMENT ALL BSE RULES)

A. BSE GENERALIZED SWITCH SELECTOR COMMAND CAPABILITY EXISTS:

1. WHEN CREW ENABLES IU COMMAND SYSTEM (EXCEPT AS NOTED BELOW IN ITEM D)

2. AFTER TB7 + 20 MIN.

B. BSE MANEUVER UPDATE AND INHIBIT CAPABILITY FOR TB7 MANEUVERS ONLY.

C. BSE HAS NAVIGATION UPDATE CAPABILITY.

D. BSE HAS NO COMMAND CAPABILITY DURING POWERED BURN PHASES.

E. A SAFE DISTANCE BETWEEN THE SPACECRAFT AND S-IVB/IU IS DEFINED AS 7000 FT.

F. BSE WILL RECOMMEND NO S-IVB RESTART FOR ANY CONFIRMED MALFUNCTION IN THE LAUNCH VEHICLE WHICH RESULTS IN:

1. A CATASTROPHIC HAZARD

2. INSUFFICIENT CONSUMABLES TO ASSURE A 1 SIGMA PROBABILITY OF GUIDANCE CUTOFF, OR

3. ANY CONDITION/MALFUNCTION(S) FOR WHICH A GUIDANCE CUTOFF WILL DEFINITELY NOT BE ACHIEVED. CONDITIONS LEADING ONLY TO A FAILURE TO RESTART WILL NOT BE CONSIDERED.

G. IN THE EVENT OF NO S-IVB IGNITION AT RESTART OR AN EARLY S-IVB SECOND BURN CUTOFF, THE SPACECRAFT SHOULD REMAIN ATTACHED TO THE S-IVB/IU AND MONITOR LH_2 AND LOX ULLAGE PRESSURES UNTIL THE STAGE STATUS CAN BE ASSESSED BY GROUND. IF EMERGENCY SEPARATION IS REQUIRED IMMEDIATELY AFTER S-IVB CUTOFF, THE SPACECRAFT SHOULD IMMEDIATELY GO TO A SAFE DIST NCE (7000 FT) FROM THE S-IVB/IU.

H. ABORT DURING LAUNCH PHASE WILL BE RECOMMENDED FOR THE FOLLOWING:

6-1 S-IC LOSS OF THRUST

6-7 S-II LOSS OF THRUST
6-8 S-II GIMBAL SYSTEM FAILURE - ACTUATOR HARDOVER INBOARD
6-9 S-II SECOND PLANE SEPARATION FAILS TO OCCUR AT TB3 + 31 SEC
6-10 S-IVB LOSS OF HYDRAULIC FLUID
6-11 S-IVB LOSS OF THRUST

I. SPACECRAFT GUIDANCE TAKEOVER WILL BE RECOMMENDED FOR THE FOLLOWING:

6-4 LAUNCH VEHICLE INERTIAL PLATFORM FAILURE-ATTITUDE REFERENCE
7-8 LOSS OF ATTITUDE CONTROL

J. S-II/S-IVB EARLY STAGING WILL BE RECOMMENDED FOR THE FOLLOWING:

6-7 S-II LOSS OF THRUST (AFTER S-IVB TO ORBIT CAPABILITY)

K. SPACECRAFT SEPARATION OR TLI INHIBIT PRIOR TO RESTART WILL BE RECOMMENDED FOR THE FOLLOWING:

7-1 INSUFFICIENT PROPELLANTS REMAIN FOR TLI GUIDANCE CUTOFF
*7-11 TIME BASE 5 OR TIME BASE 7 FAILS TO INITIATE AT S-IVB CUTOFF
7-8 LOSS OF ATTITUDE CONTROL
7-16 J-2 ENGINE CONTROL BOTTLE PRESSURE LESS THAN 400 PSIA
8-1 INERTIAL PLATFORM FAILURE - ACCELEROMETER
8-6 S-IVB ACTUATOR CONFIRMED HARDOVER PRIOR TO RESTART
7-22 S-IVB LOSS OF ENGINE HYDRAULIC FLUID
8-8 LOSS OF ATTITUDE CONTROL DURING SECOND BURN
8-5 S-IVB LH_2 TANK ULLAGE PRESSURE LESS THAN 25 PSIA PRIOR TO SECOND BURN

REV	ITEM	

L. SPACECRAFT SEPARATION OR TLI INHIBIT PRIOR TO RESTART WILL BE RECOMMENDED UNLESS COMMAND ACTION IS SUCCESSFUL FOR THE FOLLOWING:

- 7-4 J-2 ENGINE MAIN OXIDIZER VALVE FAILS TO CLOSE AT S-IVB CUTOFF
- 7-5 FAILURE OF THE RANGE SAFETY SYSTEM AFTER INSERTION
- *7-6 S-IVB COLD HELIUM SHUTOFF VALVES FAIL TO CLOSE
- 7-9 S-IVB CONTINUOUS VENT SYSTEM (CVS) REGULATOR FAILS TO OPEN IN TB5
- *7-14 S-IVB STAGE COMMON BULKHEAD DELTA PRESSURE REACHES OR EXCEEDS +36 OR -26 PSID
- 7-18 S-IVB COLD HELIUM SPHERE PRESSURE LOW
- 7-20 J-2 ENGINE START BOTTLE PRESSURE OUTSIDE RESTART LIMITS
- 8-7 S-IVB CONTINUOUS VENT SYSTEM (CVS) REGULATOR FAILS TO CLOSE DURING RESTART SEQUENCE
- 7-19 LOW LOX TANK ULLAGE PRESSURE

M. FOR EARLY SPACECRAFT SEPARATION THE CREW SHOULD ENABLE THE IU COMMAND SYSTEM AND THE BSE SHOULD GROUND COMMAND TO LOCK OPEN THE IU COMMAND SYSTEM, PRIOR TO SPACECRAFT SEPARATION IF AT ALL POSSIBLE.

*EMERGENCY SEPARATION REQUIRED.

REV	ITEM

SUMMARY OF LAUNCH PHASE RULES

THE FOLLOWING MISSION RULES ALSO APPLY TO THIS SECTION:

NONE

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	6-1	S-IC STAGE LOSS OF THRUST			A&B. CUES:
		A. ANY SINGLE ENGINE PRIOR TO TB3	LAUNCH	A. CONTINUE MISSION BSE INFORM FLIGHT AND FIDO.	1. THRUST OK SWITCHES OFF (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	B. CONTINUE MISSION BSE INFORM FLIGHT.	
		1. PRIOR TO DEACTIVATION OF TWO ENGINES AUTO ABORT		1. ABORT BSE INFORM FLIGHT AND TRANSMIT ABORT REQUEST.	
		2. AFTER DEACTIVATION OF TWO ENGINES AUTO ABORT		2. CONTINUE MISSION BSE INFORM FLIGHT AND FIDO. CAPCOM ADVISE CREW OF POTENTIAL OVERRATE CONDITION.	2. THRUST CHAMBER PRESSURE <500 PSIA (D8-101 THROUGH D8-105). 3. LONGITUDINAL ACCELERATION - ZERO (A2-603). 4. FINAL THRUST OK CUTOFF - ON (K52-115 THROUGH K56-115). A&B. NOTE: CREW MAY DEACTIVATE AUTOMATIC ABORT AFTER TB1 + 120 SEC.
		C. LOSS OF THRUST - ENGINE 3 OR 4 (THIS RULE APPLIES ONLY FOR THE UNIQUE CASE OF ENGINE 3 OR 4 THRUST LOSS BETWEEN 0 TO 45 SEC)	LAUNCH	C. CONTINUE MISSION BSE INFORM FLIGHT AND FIDO. FLIGHT INFORM RSO.	C. CUES: 1. THRUST CHAMBER PRESSURE LESS THAN 500 PSIA (D8-103, D8-104). 2. ENGINE 3 THRUST OK SWITCHES OFF (K39-115, K40-115, K41-115, K42-115, K43-115, K44-115).
		1. VOICE COMM WITH RSO		1.(A) FLIGHT CONFIRM ENGINE 3 OR 4 OUT VIA RSO PRIVATE LINE. (B) FLIGHT CONFIRM NO OTHER KNOWN ANOMALIES BY LITE ACTIVATION AND VOICE REPORT.	3. ENGINE 3 OR 4 FINAL THRUST OK CUTOFF (K54-115, K55-115). C. NOTES: 1. RSO LOOP 111 OR FD LOOP BACKUP TO PL.
		2. NO VOICE COMM WITH RSO		2. FLIGHT CONFIRM ENGINE 3 OR 4 OUT AND NO OTHER KNOWN ANOMALIES BY LITE ACTIVATION.	2. CONFIRMATION OF NO OTHER KNOWN ANOMALIES WILL BE BASED ON: (A) ENGINE CHAMBER PRESSURE ABOVE 500 PSIA AND HOLDING (B) THRUST OK SWITCHES ON.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	6-2	LOSS OF ATTITUDE CONTROL A. S-IC BURN	LAUNCH	A. <u>LAUNCH VEHICLE ABORT</u> BSE INFORM FLIGHT AND FIDO. CAPCOM INFORM CREW OF LOSS OF ATTITUDE CONTROL. CREW WILL ABORT ON LIMITS (NOTE A.1.).	A. <u>CUES</u>: 1. ANGULAR RATES - PITCH (R4-602, R13-602) OR YAW (R5-602, R8-602) GREATER THAN 2 DEG/SEC AND NOT DECREASING. ROLL (R6-602, R12-602) GREATER THAN 5 DEG/SEC AND NOT DECREASING. 2. PLATFORM GIMBAL ANGLES - PITCH, YAW, OR ROLL (H60-603) CHANGING AT THE RATES GIVEN IN CUE A.1. 3. LOSS OF ATTITUDE CONTROL ALERT (SEE NOTE A.2). A. <u>NOTES</u>: 1. CREW ABORT LIMITS: (A) PITCH AND YAW RATE ±4 DEG/SEC (B) ROLL RATE ±20 DEG/SEC (C) PITCH, YAW, OR ROLL ERROR ±5 DEG AND Q-BALL ΔP ±3.2 PSID 2. LOSS OF ATTITUDE CONTROL ALERT WILL BE GIVEN FOR THE FOLLOWING CONDITIONS: (A) LVDC/LVDA COMPUTATIONAL FAILURE (B) ATTITUDE ERROR SIGNALS $>\pm5$ DEG (C) FAILURE TO INITIATE PROPER GUIDANCE SEQUENCE (D) S-IC ENGINE ACTUATOR HARDOVER $>\pm5$ DEG

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	6-2 (CONT'D)	B. S-II BURN	LAUNCH	B. LAUNCH VEHICLE ABORT BSE INFORM FLIGHT AND FIDO. CAPCOM INFORM CREW OF LOSS OF ATTITUDE CONTROL. CREW WILL ABORT ON LIMITS (NOTE B.1).	B. CUES: 1. ANGULAR RATES - PITCH (R4-602, R13-602), YAW (R5-602, R8-602), OR ROLL (R6-602, R12-602) GREATER THAN 5 DEG/SEC AND NOT DECREASING. 2. PLATFORM GIMBAL ANGLES - PITCH, YAW OR ROLL (H60-603) CHANGING AT THE RATES GIVEN IN CUE B.1. 3. LOSS OF ATTITUDE CONTROL ALERT (SEE NOTE B.2). B. NOTES: 1. CREW ABORT LIMITS: (A) PITCH AND YAW RATE ±10 DEG/SEC (B) ROLL RATE ±20 DEG/SEC 2. LOSS OF ATTITUDE CONTROL ALERT WILL BE GIVEN FOR THE FOLLOWING CONDITIONS: (A) LVDC/LVDA COMPUTATIONAL FAILURE (B) ATTITUDE ERROR SIGNALS >±5 DEG (C) FAILURE TO INITIATE PROPER GUIDANCE SEQUENCE 3. LOSS OF ATTITUDE CONTROL ALERT WILL BE GIVEN DURING S-II BURN FOR S-IVB ENGINE ACTUATOR HARDOVER ±5 DEG

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	6-2 (CONT'D)	C. S-IVB BURN	LAUNCH	C. LAUNCH VEHICLE ABORT BSE INFORM FLIGHT AND FIDO. CAPCOM INFORM CREW OF LOSS OF ATTITUDE CONTROL. CREW WILL ABORT ON LIMITS (NOTE C.1):	C. CUES: 1. ANGULAR RATES - PITCH (R4-602, R13-602); YAW (R5-602, R8-602); OR ROLL (R6-602, R12-602) GREATER THAN 5 DEG/SEC AND NOT DECREASING. 2. PLATFORM GIMBAL ANGLES - PITCH, YAW, OR ROLL (H60-603) CHANGING AT THE RATES GIVEN IN CUE C.1. 3. LOSS OF ATTITUDE CONTROL ALERT (SEE NOTE C.2). C. NOTES: 1. CREW ABORT LIMITS: (A) PITCH AND YAW RATE ±10 DEG/SEC (B) ROLL RATE ±20 DEG/SEC 2. LOSS OF ATTITUDE CONTROL ALERT WILL BE GIVEN FOR THE FOLLOWING CONDITIONS: (A) LVDC/LVDA COMPUTATIONAL FAILURE (B) ATTITUDE ERROR SIGNALS: ROLL >±3.5 DEG, PITCH AND YAW >±5 DEG. (C) FAILURE TO INITIATE PROPER GUIDANCE SEQUENCE

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	6-3	INERTIAL PLATFORM FAILURE - ACCELEROMETER	LAUNCH	CONTINUE MISSION BSE INFORM FLIGHT AND FIDO. CAPCOM ADVISE CREW OF PROBABLE DEGRADED ORBIT.	CUES: 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" 2. ACCELEROMETER PICKOFFS (X, Y, OR Z) INDICATE IN EXCESS OF 3 DEG AND NOT DECREASING (H10-603, H11-603, H12-603) NOTES: 1. NO EFFECT ON VEHICLE TRAJECTORY DURING S-IC STAGE BURN. 2. LVDC SWITCHES TO A BACKUP MODE AND UTILIZES A PRE-COMPUTED F/M PROFILE FOR FAILED AXIS DURING THE S-IC, S-II, AND S-IVB BURNS.
	6-4	LAUNCH VEHICLE INERTIAL PLATFORM FAILURE - ATTITUDE REFERENCE RULE NUMBERS 6-5 THROUGH 6-6 ARE RESERVED.	LAUNCH	CONTINUE MISSION BSE INFORM FLIGHT AND RECOMMEND SPACECRAFT GUIDANCE TAKEOVER.	CUES: 1. GUIDANCE REFERENCE FAILURE (D04 OR D06) MODE CODE 26 BIT D8 SET TO "ONE" (H60-603). 2. GUIDANCE STATUS WORD - (MODE CODE 24) (H60-603) BITS D20 AND D19 FOR Z GIMBAL SET TO "ONE" BITS D18 AND D17 FOR X GIMBAL SET TO "ONE" BITS D16 AND D15 FOR Y GIMBAL SET TO "ONE" 3. LADDER OUTPUTS CONSTANT FOR FAILED AXES (H54-603, H55-603, H56-603). 4. ATTITUDE ERROR CONSTANT FOR FAILED AXES (H69-602, H70-602, H71-602). NOTES: 1. CUE 1 AND ANY OTHER CUE ARE NECESSARY TO CALL PLATFORM FAILURE

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	6-7	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 BSE INFORM FLIGHT AND FIDO.	A.1. THRUST OK SWITCHES OFF (K285-201 THROUGH 205, K286-201 THROUGH 205); 2. THRUST CHAMBER PRESSURE ZERO (D13-201 THROUGH 205); 3. LONGITUDINAL ACCELERATION (A2-603);
		B. ANY TWO ENGINES-FAILURE TO ATTAIN THRUST OR LOSS OF THRUST:			B.1. TWO ENGINES OUT (CUES A.1, A.2, A.3); 2. ANGULAR RATES PITCH OR YAW EXCEED 9.5 DEG/SEC (R4-602, R13-602, R5-602, R8-602); 3. COMMANDED ANGLES AND GIMBAL ANGLES (H60-603) CHANGING AT THE RATES GIVEN IN CUE B.2.
		1. VEHICLE CONTROLLING		B.1. CONTINUE MISSION BSE INFORM FLIGHT AND FIDO.	
		2. IF ANGULAR RATES EXCEED 9.5 DEG/SEC OR THE DIFFERENCE IN COMMANDED ANGLES AND GIMBAL ANGLES EXCEEDS 40 DEG IN PITCH OR YAW		2. ABORT BSE INFORM FLIGHT AND FIDO AND TRANSMIT ABORT REQUEST.	
		C. THREE OR MORE ENGINES OUT		C. ABORT/EARLY STAGE/CONTINUE MISSION	C.1. THREE OR MORE ENGINES OUT (CUES A.1, A.2, A.3);
		1. PRIOR TO S-IVB TO ORBIT CAPABILITY		1. ABORT BSE INFORM FLIGHT AND TRANSMIT ABORT REOUEST.	
		2. AFTER S-IVB TO ORBIT CAPABILITY BUT PRIOR TO LOW LEVEL SENSE ARM		2. EARLY STAGE BSE INFORM FLIGHT AND RECOMMEND EARLY STAGING.	
		3. AFTER LOW LEVEL SENSE ARM		3. BSE INFORM FLIGHT AND FIDO.	
		(A) THREE OR FOUR ENGINES OUT		(A) EARLY STAGE BSE RECOMMEND EARLY STAGE.	
		(B) ALL ENGINES OUT		(B) CONTINUE MISSION	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	6-8	S-II STAGE GIMBAL SYSTEM FAILURE ANY SINGLE ACTUATOR HARDOVER (INBOARD)	LAUNCH	ABORT BSE INFORM FLIGHT AND TRANSMIT ABORT REQUEST.	CUES: 1. YAW ACTUATOR POSITION EXCEEDS + 6 DEG (G8-201 THROUGH 204) (G30-201 THROUGH 204). 2. PITCH ACTUATOR POSITION EXCEEDS + 6 DEG (G9-201 THROUGH 204) (G31-201 THROUGH 204). 3. ADJACENT CONTROL ENGINE ACTUATOR IN SAME PLANE MOVES 4-1/2 DEG INBOARD (SAME MEASUREMENTS AS CUES 1 AND 2). NOTE: CREW SHOULD ABORT AS SOON AS POSSIBLE AFTER MALFUNCTION OCCURS TO PRECLUDE EXCESSIVE THERMAL PROBLEMS IN THE AFT INTERSTAGE.
	6-9	S-II SECOND PLANE SEPARATION FAILS TO OCCUR AT TB3 + 31 SEC	LAUNCH	ABORT BSE INFORM FLIGHT AND TRANSMIT ABORT REQUEST. CREW ABORT PRIOR TO TB3 + 52 SEC.	CUES: 1. SECOND PLANE SEPARATION INDICATION SHOWS NO SEPARATION (M86-206, M87-206) 2. GUIDANCE MODE WORD 1 MODE CODE 25 BIT D15 REMAINS ZERO (H60-603). 3. IGNITION BUS VOLTAGE REMAINS AT APPROXIMATELY 28 VOLTS (M125-207). 4. RECIRCULATION BUS VOLTAGE REMAINS AT APPROXIMATELY 56 VOLTS (M111-207). NOTES: 1. MANUAL ABORT BY CREW WITH ONBOARD INDICATION. 2. PROBABLE SUBSEQUENT LOSS OF VEHICLE DUE TO EXCESSIVE TEMPERATURE.

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	6-10	S-IVB LOSS OF ENGINE HYDRAULIC FLUID PRIOR TO FIRST S-IVB BURN	LAUNCH	SPACECRAFT SEPARATION BSE INFORM FLIGHT AND FIDO AND RECOMMEND NO S-IVB START. FIDO WILL ADVISE FLT OF COI CAPABILITY	CUES: 1. HYDRAULIC RESERVOIR OIL LEVEL APPROX ZERO PERCENT (L7-403). 2. HYDRAULIC SYSTEM PRESSURE LESS THAN 1700 PSIA (D41-403). 3. HYDRAULIC RESERVOIR PRESSURE APPROX ZERO PSIA (D42-403). NOTE: 1. L7-403 (CUE 1) PLUS ONE OF THE OTHER CUES ARE REQUIRED FOR IMPLEMENTATION OF THIS RULE. 2. COI CAPABILITY NOMINALLY EXISTS AT S-II CUTOFF
	6-11	S-IVB STAGE LOSS OF THRUST			CUES: 1. THRUST CHAMBER PRESSURE - ZERO (D0001-401). 2. THRUST OK SWITHCHES - OFF (K0014-401, K0157-401). 3. LONGITUDINAL ACCELERATION - ZERO (A2-603). 4. TB5 IS INITIATED. MODE CODE 25, BIT D2 SET TO ONE (H60-603). 5. TB7 IS INITIATED. MODE CODE 26, BIT D20 SET TO ONE (H60-603).
		A. FAILS TO ATTAIN THRUST OR PREMATURE SHUTDOWN PRIOR TO OBTAINING PARKING ORBIT	LAUNCH	A. SPACECRAFT SEPARATION BSE INFORM FLIGHT AND FIDO. FIDO WILL ADVISE FLT OF COI CAPABILITY.	
		B. FAILS TO ATTAIN THRUST OR PREMATURE SHUTDOWN PRIOR TO VELOCITY CUT-OFF FOR SECOND BURN	EARTH ORBIT	B. CONTINUE MISSION BSE INFORM FLIGHT AND FIDO. THE SPACECRAFT SHOULD REMAIN ATTACHED TO THE S-IVB/IU AND MONITOR LH2 AND LOX TANK ULLAGE PRESSURES. IF SEPARATION IS REQUIRED, THE SPACECRAFT SHOULD IMMEDIATELY GO TO A SAFE DISTANCE (7000 FT) FROM THE S-IVB/IU.	NOTE: SEPARATION WILL BE REQUIRED FOR VIOLATION OF FMR 7-6 OR FMR 7-14.

7 SLV - TB5 AND TB7 (COAST)

REV	ITEM

SUMMARY OF COAST PHASE RULES

7-1 INSUFFICIENT PROPELLANT

7-2 RESERVED

7-3 AIN FUEL VALVE FAILS TO CLOSE

7-4 AIN OXIDIZER VALVE FAILS TO CLOSE

7-5 RANGE SAFETY SYSTEM NOT SAFED AFTER INSERTION

7-6 COLD HELIUM SHUTOFF VALVE FAILS OPEN

7-7 AUXILIARY HYDRAULIC PUMP FAILS

7-8 LOSS OF ATTITUDE CONTROL

7-9 CONTINUOUS VENT REGULATOR FAILS TO OPEN

7-10 APS ULLAGE ENGINE FAILS ON

7-11 TB5 OR TB7 FAILS TO INITIATE

7-12 RESERVED

7-13 IU ENVIRONMENTAL CONTROL SYSTEM FAILS

7-14 COMMON BULKHEAD ΔP

7-15 LOSS OF S-IVB STAGE PNEUMATICS

7-16 LOSS OF ENGINE CONTROL BOTTLE PRESSURE

7-17 LH_2 TANK VENT FAILURE OR LEAK

7-18 LOW COLD HELIUM SUPPLY

7-19 LOX TANK ULLAGE PRESSURE <31 PSIA

7-20 J-2 ENGINE START BOTTLE PRESSURE OUTSIDE RESTART LIMITS

7-21 PU VALVE FAILURE

7-22 S-IVB LOSS OF HYDRAULIC FLUID

7-23 RESERVED

7-24 RESERVED

7-25 LOX NON-PROPULSIVE VENT FAILS TO OPEN

7-26 LH_2 LATCHING VENT VALVE FAILS TO OPEN

7-27 GH_2 START BOTTLE DU P FAILS TO OCCUR

7-28 COLD HELIUM DUMP FAILS TO OCCUR

7-29 RESERVED

7-30 RESERVED

THE FOLLOWING MISSION RULES ALSO APPLY TO THIS SECTION:

NONE

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-1	PRIOR TO RESTART, INSUFFICIENT PROPELLANT REMAINS FOR ACHIEVEMENT OF TLI GUIDANCE CUTOFF	COAST	NO S-IVB RESTART BSE INFORM FLIGHT AND RECOMMEND NO S-IVB RESTART.	CUE: PROPELLANT REMAINING AS ASCERTAINED DURING REAL-TIME MONITORING EVALUATIONS.
		RULE NUMBER 7-2 IS RESERVED.			

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-3	J-2 ENGINE MAIN FUEL VALVE (MFV) FAILS TO CLOSE AT: A. FIRST S-IVB CUTOFF	COAST	A. <u>CONTINUE MISSION</u> BSE INFORM FLIGHT AND COMMAND (ASAP): 1. PREVALVES AND RECIRC SHUTOFF VALVES CLOSED (SEE NOTE 1) 2. ATTEMPT TO CLOSE MFV IF SUCCESSFUL, BSE COMMAND: 3. ENGINE MFV CLOSE 4. PREVALVE AND RECIRC SHUT-OFF VALVES OPEN	<u>CUES</u>: 1. MAIN FUEL VALVE POSITION (G004-401). 2. MAIN FUEL VALVE OPEN (K118-401). 3. FUEL RECIRC FLOWRATE (F5-401). 4. FUEL FLOWMETER FLOWRATE (F2-401). <u>NOTES</u>: 1. IF THE MFV IS OPEN, THE LH_2 PUMP INLET PRESSURE WILL GO TO ZERO PSIA AFTER COMMAND ACTION (A.1). 2. THIS FAILURE WILL REQUIRE EVALUATION OF LH_2 RESI-DUALS TO DETERMINE ADEQUACY FOR TLI VELOCITY CUTOFF (REF FMR 7-1).
		B. SECOND S-IVB CUTOFF	COAST SLINGSHOT	B. <u>CONTINUE MISSION</u> BSE INFORM FLIGHT AND COMMAND: 1. PREVALVES AND RECIRC SHUTOFF VALVES CLOSE 2. ATTEMPT TO CLOSE MFV WHEN S-IVB IS AT PROPER DUMP ATTITUDE, BSE COMMAND: 3. PREVALVES AND RECIRC SHUTOFF VALVES OPEN	
	7-4	J-2 ENGINE MAIN OXIDIZER VALVE (MOV) FAILS TO CLOSE AT: A. FIRST S-IVB CUTOFF	COAST	A. <u>CONTINUE MISSION/NO S-IVB RESTART</u> BSE INFORM FLIGHT AND COMMAND (ASAP): 1. PREVALVES AND RECIRC SHUTOFF VALVES CLOSED 2. ATTEMPT TO CLOSE MOV IF SUCCESSFUL, BSE COMMAND: 3. ENGINE MOV CLOSED 4. PREVALVE AND RECIRC SHUTOFF VALVES OPEN IF MOV CANNOT BE CLOSED, RECOMMEND NO S-IVB RESTART	<u>CUES</u>: 1. MAIN OXIDIZER VALVE POSI-TION (G3-401). 2. MAIN OXIDIZER VALVE OPEN (K120-401). 3. LOX FLOWMETER FLOWRATE (F1-401). <u>NOTES</u>: 1. MANNED RESTART WILL BE ATTEMPTED IF THE MOV CAN BE CLOSED. 2. THIS FAILURE WILL REQUIRE EVALUATION OF LOX RESI-DUALS TO DETERMINE ADEQUACY FOR TLI VELOCITY CUTOFF (REF FMR 7-1).
		B. SECOND BURN CUTOFF	COAST SLINGSHOT	B. <u>CONTINUE MISSION</u> BSE INFORM FLIGHT AND COMMAND: 1. PREVALVES AND RECIRC SHUTOFF VALVES CLOSED 2. ATTEMPT TO CLOSE MOV AT INITIATION OF LOX DUMP, BSE COMMAND: 3. PREVALVES AND RECIRC SHUTOFF VALVES OPEN	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-5	RANGE SAFETY SYSTEM NOT SAFED AFTER INSERTION A. PROPELLANT DISPERSION SYSTEM NOT ARMED B. PROPELLANT DISPERSION SYSTEM ARMED AND RSO HAS NOT SENT MFCO	COAST	A. CONTINUE MISSION BSE INFORM FLIGHT AND RECOMMEND RSO SEND SAFE COMMAND B. SPACECRAFT SEPARATION BSE INFORM FLIGHT AND: 1. RECOMMEND SPACECRAFT SEPARATION TO A SAFE DISTANCE (7000 FT). 2. WHEN SPACECRAFT HAS REACHED A SAFE DISTANCE, RECOMMEND RSO SEND SAFE COMMAND.	CUES: 1. FIRING UNIT 1 RS EBW ≥1.6 VOLTS (M30-411). 2. FIRING UNIT 2 RS EBW ≥1.6 VOLTS (M31-411). 3. RANGE SAFETY RECEIVER #1 ENABLE (N057-411) BETWEEN 2.4 AND 4.5 VOLTS. 4. RANGE SAFETY RECEIVER #2 ENABLE (N062-411) BETWEEN 2.4 AND 4.5 VOLTS. 5. RSO DISPLAY AND COMMAND SYSTEM STATUS. NOTES: 1. RSO SHOULD NOT ATTEMPT TO SAFE THE RANGE SAFETY RECEIVERS ON REVS 2 AND 3 UNTIL MCC CONFIRMS THE PROPELLANT DISPERSION SYSTEM IS NOT ARMED (CONDITION A ONLY). 2. EITHER CUE 1 OR CUE 2 IS SUFFICIENT FOR IMPLEMENTING THIS RULE.
	7-6	S-IVB STAGE COLD HELIUM SHUTOFF VALVES FAIL TO CLOSE AT: A. TB5 + 1.4 SEC B. TB7 + 1.1 SEC	COAST	A. CONTINUE MISSION/SPACECRAFT SEPARATION BSE INFORM FLIGHT AND COMMAND: 1. LOX NPV VALVE OPEN 2. ATTEMPT TO CLOSE STAGE COLD HELIUM SHUTOFF VALVES IF 2 SUCCESSFUL, BSE COMMAND IMMEDIATELY: 3. LOX NPV VALVE CLOSE IF 3 IS UNSUCCESSFUL, BSE INFORM FLIGHT AND RECOMMEND SPACECRAFT SEP IF LOX ULLAGE PRESSURE AT 50 PSIA OR SATURATED B. CONTINUE MISSION AFTER TB7 + 2 MIN 30 SEC, BSE INFORM FLIGHT AND COMMAND: 1. LOX NPV VALVE OPEN AT TB7 + 15 MIN BSE SEND: 2. LOX NPV VALVE CLOSE	CUES: 1. COLD HELIUM REGULATOR DISCHARGE PRESSURE GREATER THAN 200 PSIA (D0105-403). 2. COLD HELIUM BOTTLE PRESSURE DECAYING (D0016-425, D0263-403). 3. LOX TANK ULLAGE PRESSURES (D0179-406, D0180-406). NOTES: 1. FAILURE TO CLOSE THE SHUTOFF VALVES WILL RESULT IN THE DEPLETION OF THE COLD HELIUM. 2. ACTION REQUIRED TO AVOID EXCEEDING LOX TANK OVERPRESSURE OR BULKHEAD POSITIVE DELTA PRESSURE LIMITS (FMR 7-14). 3. SEE FMR 7-18 FOR RESTART CRITERIA FOR OFF-NOMINAL COLD HELIUM PRESSURE.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-7	S-IVB AUXILIARY HYDRAULIC PUMP FAILS			
		A. TO TURN OFF AS SEQUENCED	COAST	A. CONTINUE MISSION BSE INFORM FLIGHT AND ATTEMPT TO TURN OFF AUXILIARY HYDRAULIC PUMP AS SOON AS POSSIBLE	A. CUES: 1. SYSTEM PRESSURE ABOVE 1700 PSIA (D41-403). 2. RESERVOIR LEVEL BELOW 50 PERCENT (L7-403). 3. AFT BUS NO. 2 CURRENT ABOVE 20 AMPS (M22-404). 4. HYDRAULIC RESERVOIR OIL PRESSURE GREATER THAN 137 PSIA (D42-403). A. NOTES: FAILURE TO TURN OFF HYDRAULIC PUMP DEPLETES AFT NO. 2 BATTERY IN APPROXIMATELY 90 MIN AND OVERHEATS HYDRAULIC SYSTEM IN APPROXIMATELY 70 MIN
		B. TO TURN ON		B. CONTINUE MISSION	B. CUES:
		1. AS SEQUENCED AND THE HYDRAULIC FLUID TEMP IS BELOW OR PREDICTED TO DROP BELOW 10°F BEFORE NEXT STATION AOS	COAST	1. BSE INFORM FLIGHT AND ATTEMPT TO TURN ON AUXILIARY HYDRAULIC PUMP 2. BSE INFORM FLIGHT AND ATTEMPT TO TURN OFF AUXILIARY HYDRAULIC PUMP	1. SYSTEM PRESSURE BELOW 1700 PSIA (D41-403). 2. RESERVOIR OIL LEVEL ABOVE 50 PERCENT (L7-403).
		2. AT TB6 + 3 MIN 39 SEC	RESTART		3. AFTER BUS NO. 2 CURRENT AT ZERO AMPS (M22-404). 4. RESERVOIR PRESSURE LESS THAN 89 PSI (D42-403). 5. HYDRAULIC PUMP INLET OIL TEMP (C50-401). 6. RESERVOIR OIL TEMP (C51-403).

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-8	LOSS OF ATTITUDE CONTROL DURING			CUES:
		A. TB5 AND TB7 TO TB7 + 15 MIN	COAST	A. SPACECRAFT GUIDANCE TAKEOVER BSE INFORM FLIGHT AND RECOMMEND SPACECRAFT GUIDANCE TAKEOVER IF UNSUCCESSFUL, BSE RECOMMEND SPACECRAFT SEPARATION	A.1. ANGULAR RATES - PITCH (R4-602; R13-602) OR YAW (R5-602; R8-602), GREATER THAN 0.3 DEG/SEC AND NOT DECREASING, AND ROLL (R6-602; R12-602) GREATER THAN 0.5 DEG/SEC AND NOT DECREASING 2. PLATFORM GIMBAL ANGLES - PITCH, YAW, OR ROLL (H60-603) CHANGING AT RATES CORRESPONDING TO THOSE IN CUE 1 3. LOSS OF ATTITUDE CONTROL ALERT (SEE NOTE 2)
		B. TB6 TO TB6 + 9 MIN 20 SEC	RESTART	B. TLI INHIBIT BSE INFORM FLIGHT AND RECOMMEND TLI INHIBIT	B.1. ANGULAR RATES - PITCH (R4-602; R13-602) OR YAW (R5-602; R8-602) GREATER THAN 0.5 DEG/SEC AND NOT DECREASING, AND ROLL (R6-602, R12-602) GREATER THAN 0.5 DEG/SEC AND NOT DECREASING 2. SAME AS CUE A.2 3. SAME AS CUE A.3
		C. AFTER TB7 + 15 MIN	SLINGSHOT	C. CREW DISCRETION BSE INFORM FLIGHT AND FIDO	C.1. ANGULAR RATES PITCH (R4-602; R13-602), YAW (R5-602; R8-602), AND ROLL (R6-602; R12-602) GREATER THAN 1.0 DEG/SEC AND NOT DECREASING 2. SAME AS CUE A.2 3. SAME AS CUE A.1
		D. AFTER TB8 INITIATE	SLINGSHOT	D. CONTINUE MISSION BSE INFORM FLIGHT AND FIDO AND TERMINATE: 1. PROPELLANT DUMP 2. ULLAGE ENGINE BURNS	D. SAME AS CUES C.1, C.2, AND C.3 NOTES: 1. AFTER S-IVB CUTOFF AND DURING PROGRAMED MANEUVERS THE ABOVE RATE LIMITS ARE NOT APPLICABLE 2. LOSS OF ATTITUDE CONTROL ALERT WILL BE GIVEN FOR THE FOLLOWING CONDITIONS: (A) LVDC/LVDA COMPUTATIONAL FAILURE (B) ABNORMAL ATTITUDE ERROR SIGNALS (C) FAILURE TO INITIATE PROPER GUIDANCE SEQUENCE (D) ATTITUDE REFERENCE FAILURE

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-9	CONTINUOUS VENT SYSTEM (CVS) REGULATOR FAILS TO OPEN IN TB5 (TB5 + 59 SEC)	COAST	CONTINUE MISSION/NO S-IVB RESTART BSE INFORM FLIGHT AND 1. ATTEMPT TO OPEN CVS RELIEF OVERRIDE SHUTOFF VALVE IF UNSUCCESSFUL, BSE: 2. VENT THE LH_2 TANK PRIOR TO TB6 TO A VALUE BELOW THE PRESSURE REQUIRED FOR TB6 INITIATE IF THE LH_2 BLOWDOWN IS COMPLETED WITHIN 30 MINUTES PRIOR TO TB6 INITIATE, COMMAND: 3. ULLAGE ENGINES ON AFTER 90 SEC OF ULLAGING SEND: 4. ULLAGE ENGINES OFF ULLAGING SHOULD BE COMPLETED PRIOR TO THE AMBIENT REPRESSURIZATION.	CUES: 1. LH_2 ULLAGE PRESSURE (D177-410, D178-410). 2. CVS NOZZLE PRESSURE (D181-409, D182-409). 3. CVS REGULATOR CLOSED (K154-411). NOTES: 1. IF THE CVS REGULATOR FAILS TO OPEN, THE LH_2 SATURATION TEMPERATURE WILL INCREASE ABOVE RESTART LIMITS. 2. COMMAND ACTION WILL REQUIRE EVALUATION OF LH_2 RESIDUALS TO DETERMINE ADEQUACY FOR TLI VELOCITY CUTOFF. APPROXIMATELY 150 POUNDS OF LH_2 WILL BE LOST FOR EACH PSI THE LH_2 TANK IS VENTED BELOW 19.5 PSIA
			RESTART	IF NEITHER COMMAND ACTION 1 NOR 2 IS SUCCESSFUL PRIOR TO TB6 + 8 MIN 40 SEC, BSE RECOMMEND NO S-IVB RESTART	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-10	APS ULLAGE ENGINE(S) THRUST FAILS TO TERMINATE AT SEQUENCED TIMES	COAST	CONTINUE MISSION BSE INFORM FLIGHT AND ATTEMPT TO TERMINATE ULLAGE ENGINE THRUST. IF UNSUCCESSFUL, BSE INFORM FLIGHT OF IMPENDING LOSS OF ATTITUDE CONTROL.	CUES: 1. ULLAGE ENGINE THRUST CHAMBER PRESSURE GREATER THAN 90 PSIA (D220-414, D221-415). 2. APS HELIUM SPHERE PRESSURE DECREASING (D35-414, D036-415, D250-414, D251-415).
	7-11	TIME BASE 5 OR TIME BASE 7 FAILS TO INITIATE AT S-IVB CUTOFF RULE NUMBER 7-12 IS RESERVED.	COAST	SPACECRAFT SEPARATION BSE INFORM FLIGHT AND RECOMMEND IMMEDIATE SEPARATION TO A SAFE DISTANCE	CUE: LVDC FAILURE NOTE: THIS CONDITION WILL RESULT IN LOSS OF SEQUENCING AND PITCH AND YAW ATTITUDE CONTROL.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-13	IU ECS WATER VALVE FAILS TO CYCLE OPEN AND CLOSED A. WATER VALVE CLOSED AND COOLANT INLET CONTROL TEMPERATURE IS 64°F OR HIGHER, AND THE INERTIAL GIMBAL TEMPERATURE IS PREDICTED TO BE EQUAL TO OR GREATER THAN 115°F BEFORE THE NEXT SITE AOS OR, THE LVDC MEMORY TEMPERATURE IS PREDICTED TO BE EQUAL TO OR GREATER THAN 124°F BEFORE THE NEXT SITE AOS. B. WATER VALVE OPEN AND COOLANT INLET CONTROL TEMP IS 55°F OR LESS, AND THE INERTIAL GIMBAL TEMPERATURE IS PREDICTED TO BE 104°F OR LESS BEFORE THE NEXT SITE AOS OR, THE LVDC MEMORY TEMPERATURE IS PREDICTED TO BE 32°F OR LESS BEFORE THE NEXT SITE AOS.	ALL	CONTINUE MISSION A. BSE INFORM FLIGHT AND SEND: 1. ECS LOGIC INHIBIT COMMAND 2. WATER VALVE OPEN B. BSE INFORM FLIGHT AND SEND: 1. ECS LOGIC INHIBIT COMMAND 2. WATER VALVE CLOSED	CUES: 1. WATER VALVE CLOSED/OPEN (G5-601, G6-601). 2. ME/H_2O TEMP (C15-601). 3. OMW MODE CODE 27 BIT D8 SET TO "O" (H60-603). 4. ST-124 INERTIAL GIMBAL TEMP (C34-603). 5. SUBLIMATOR INLET TEMP (C11-601). 6. LVDC MEMORY TEMP (C54-603). 7. LVDA TEMP #1 (C55-603). 8. LVDA TEMP #2 (C56-603).
	7-14	S-IVB STAGE COMMON BULKHEAD DELTA PRESSURE REACHES OR EXCEEDS: A. MINUS 20 PSID OR PLUS 30 PSID B. MINUS 26 PSID OR PLUS 36 PSID	COAST RESTART	A. CONTINUE MISSION BSE INFORM FLIGHT AND COMMAND: LH_2 AND/OR LOX VENT VALVES OPEN OR CLOSED TO PRECLUDE REACHING SEPARATION LIMITS B. SPACECRAFT SEPARATION BSE INFORM FLIGHT AND FIDO AND RECOMMEND SPACECRAFT SEPARATION TO A SAFE DISTANCE	CUES: 1. LH_2 TANK ULLAGE PRESSURE (D0177-410, D0178-410). 2. LH_2 PUMP INLET PRESSURE (D0002-403). 3. LOX TANK ULLAGE PRESSURE (D0180-406, D0179-406). 4. LOX PUMP INLET PRESSURE (D0003-403). NOTES: 1. MINUS DELTA PRESSURE IS DEFINED AS A FUEL TANK ULLAGE PRESSURE GREATER THAN THE LOX TANK ULLAGE PRESSURE. 2. PLUS DELTA PRESSURE IS DEFINED AS A LOX TANK ULLAGE PRESSURE GREATER THAN THE FUEL TANK ULLAGE PRESSURE. 3. THE MINIMUM RECOMMENDED DISTANCE BETWEEN THE S-IVB AND THE SPACECRAFT IS 7,000 FT. 4. THE BULKHEAD WILL STRUCTURALLY FAIL AT THE ULTIMATE LIMITS OF MINUS 32.5 PSID OR PLUS 42.0 PSID.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-15	LOSS OR IMPENDING LOSS OF S-IVB STAGE PNEUMATICS PRESSURE	COAST		<u>CUES</u>:
		A. ENGINE PUMP PURGE FAILS (TB5 + 10 MIN 3 SEC)		A. <u>CONTINUE MISSION</u> BSE INFORM FLIGHT AND 1. ATTEMPT TO TERMINATE PURGE IF UNSUCCESSFUL, COMMAND: 2. AMBIENT HELIUM SUPPLY SHUTOFF VALVE CLOSED 3. REOPEN AMBIENT HELIUM SUPPLY SHUTOFF VALVE AS REQUIRED	A.1. ENGINE PUMP PURGE REGULATOR PRESSURE (D0050-403) FAILS TO DECREASE FROM ABOUT 100 PSIA TO ABOUT 10 PSIA. 2. AMBIENT HELIUM PNEUMATIC SPHERE PRESSURE (D0236-403, D0256-403) DECREASING AT 8 PSI/MIN.
		B. STAGE PNEUMATIC PRESSURE LEAKING AT GREATER THAN 6 PSI/MIN IN TB5 OR EXCESSIVE LEAKAGE DURING TB7		B. <u>CONTINUE MISSION</u> BSE INFORM FLIGHT AND COMMAND: 1. AMBIENT HELIUM SHUTOFF VALVE CLOSED 2. REOPEN AMBIENT HELIUM SHUTOFF VALVE AS REQUIRED	B.1. STAGE PNEUMATIC SUPPLY PRESSURE (D0236-403, D025-403).
	7-16	S-IVB ENGINE CONTROL BOTTLE PRESSURE LESS THAN 400 PSIA	COAST RESTART	<u>NO S-IVB RESTART (TB5)/TLI INHIBIT (TB6)</u> BSE INFORM FLIGHT AND RECOMMEND NO S-IVB RESTART	<u>CUES</u>: 1. ENGINE CONTROL BOTTLE PRESSURE (D019-401, D242-401). 2. REPRESSURIZATION BOTTLE PRESSURE (D20-403, D88-403, D249-403, D254-403).
	7-17	LH_2 TANK VENT FAILURE OR LEAK DURING ORBITAL COAST	COAST RESTART	<u>CONTINUE MISSION</u> IF LH_2 ULLAGE PRESSURE DROPS BELOW 17 PSIA, BSE COMMAND: 1. BOOST LH_2 VENT VALVES CLOSED AND CVS REGULATOR CLOSED (ORIFICE OPEN) IF THE SITUATION CANNOT BE CORRECTED, AFTER INITIATION OF BURNER REPRESS, BSE COMMAND: 2. SECOND BURN RELAY OFF	<u>CUES</u>: 1. LH_2 ULLAGE PRESSURE (D177-410, D178-410). 2. LH_2 PUMP INLET PRESSURE (D002-403). 3. LH_2 VENT CLOSED DISCRETES (K001-424, K210-410). <u>NOTES</u>: 1. IF THE ULLAGE PRESSURE RISES ABOVE 21 PSIA AFTER THE REGULATOR HAS BEEN CLOSED, THE REGULATOR SHOULD BE CYCLED TO MAINTAIN A 17 TO 21 PSIA ULLAGE PRESSURE IN LH_2 TANK. 2. EXISTENCE OF A SERIOUS LEAK WILL BE VERIFIED BY LITTLE OR NO PRESSURE RISE DURING BURNER REPRESS.

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-17 (CONT'D)		COAST RESTART		3. REPRESS REQUIREMENTS ARE BASED ON LH_2 TANK ULLAGE PRESSURE OF 21 PSIA AT INITIATION OF RESTART SEQUENCE. 4. IF LH_2 TANK ULLAGE PRESSURE DROPS BELOW 19.5 PSIA DURING TB5, RESULTING PROPELLANT LOSSES SHOULD BE INCLUDED IN THE EVALUATION OF CAPABILITY TO ACHIEVE TLI GUIDANCE CUTOFF PER FMR 7-1.
	7-18	LOW COLD HELIUM SUPPLY PRESSURE			CUE: COLD HELIUM SPHERE PRESSURE (D0016-425, D0263-403).
		A. LESS THAN 1000 PSIA DURING TB5	COAST	A. CONTINUE MISSION BSE INFORM FLIGHT AND COMMAND FROM LAST STATION PRIOR TO TB6: BURNER LOX SHUTDOWN VALVE CLOSE ON	
		B. LESS THAN 450 PSIA DURING BURNER REPRESSURIZATION	RESTART	B. CONTINUE MISSION BSE INFORM FLIGHT AND COMMAND: 1. BURNER LOX SHUTDOWN VALVE CLOSE ON 2. BURNER LOX SHUTDOWN VALVE CLOSE OFF	
		C. LESS THAN 350 PSIA PRIOR TO RESTART	COAST RESTART	C. NO S-IVB RESTART (TB5)/TLI INHIBIT (TB6) BSE INFORM FLIGHT AND RECOMMEND NO S-IVB RESTART.	
	7-19	LOW LOX TANK ULLAGE PRESSURE	COAST		CUES:
		A. LOX ULLAGE PRESSURE <31 PSIA IN TB5		A. CONTINUE MISSION BSE INFORM FLIGHT AND COMMAND: 1. BURNER LOX SHUTDOWN VALVE CLOSE 2. LOX VENT VALVES BOOST CLOSE AS CLOSE AS POSSIBLE TO TB6 + 7 MIN 30 SEC, BSE COMMAND: 3. LOX REPRESS ON	A.1. LOX ULLAGE PRESSURES (D179-406, D180-406). 2. LOX PUMP INLET PRESSURE (D0003-403).
		B. THE AMBIENT REPRESS SYSTEM DOES NOT INCREASE THE ULLAGE PRESSURE TO AT LEAST 20 PSIA FOR FIRST OPPORTUNITY RESTART OR 23 PSIA FOR SECOND OPPORTUNITY RESTART BY TB6 + 9 MIN 10 SEC		B. TLI INHIBIT BSE INFORM FLIGHT AND RECOMMEND TLI INHIBIT	B. LOX ULLAGE PRESSURE (D0179-406, D0180-406).

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-20	J-2 ENGINE START BOTTLE PRESSURE OUTSIDE RESTART LIMITS	COAST		CUES: 1. START BOTTLE PRESSURE (D17-401; D241-401)
		A. ABOVE 1400 PSIA DURING ORBITAL COAST FOR FIRST OPPORTUNITY RESTART OR ABOVE 1500 PSIA FOR SECOND OPPORTUNITY RESTART		A. CONTINUE MISSION BSE INFORM FLIGHT AND SEND: 1. START BOTTLE VENT OPEN FOR 3 SEC 2. REPEAT COMMAND AS NECESSARY TO ENSURE A PRESSURE OF LESS THAN 1400 PSIA FOR FIRST OPPORTUNITY RESTART OR 1500 PSIA FOR SECOND OPPORTUNITY RESTART	
		B. ABOVE 1800 PSIA PRIOR TO RESTART		B. SPACECRAFT SEPARATION BSE INFORM FLIGHT AND FIDO AND RECOMMEND SPACECRAFT SEPARATION	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-21	PU VALVE FAILURE FAILS TO A HIGH MIXTURE RATIO GREATER THAN 5.0 TO 1 AND ANY TIME PRIOR TO RESTART	COAST	CONTINUE MISSION BSE INFORM FLIGHT AND COMMAND: 1. PU VALVE HARDOVER POSITION ON (LOW EMR 4.5 TO 1) (SEE NOTE 1) IF 1 IS UNSUCCESSFUL, BSE INFORM FLIGHT AND: 2. VENT START BOTTLE TO ACCEPTABLE LIMITS	CUES: 1. PU VALVE POSITION (G010-401) 2. PU FEEDBACK VOLTAGE (M061-411) NOTES: 1. THIS FAILURE WILL REQUIRE EVALUATION OF RESIDUALS TO DETERMINE ADEQUACY FOR TLI VELOCITY CUTOFF (REF FMR 7-1). 2. PU FEEDBACK VOLTAGE M061, IS ONLY VALID WHEN PU SYSTEM POWER IS ON
	7-22	S-IVB LOSS OF ENGINE HYDRAULIC FLUID RULE NUMBERS 7-23 AND 7-24 ARE RESERVED.	COAST RESTART	NO S-IVB RESTART (TB5)/TLI INHIBIT (TB6) BSE INFORM FLIGHT AND RECOMMEND NO S-IVB RESTART	CUES: 1. HYDRAULIC RESERVOIR OIL LEVEL APPROX ZERO PERCENT (L7-403). 2. HYDRAULIC SYSTEM PRESSURE LESS THAN 1700 PSIA (D41-403). 3. HYDRAULIC RESERVOIR PRESSURE APPROXIMATELY ZERO PSIA (D42-403). NOTES: 1. L7-403 PLUS ONE OF THE OTHER CUES ARE REQUIRED FOR IMPLEMENTATION OF THIS RULE. 2. IF ALL THREE CUES ARE FUNCTIONING PROPERLY, THEY ARE REQUIRED FOR IMPLEMENTATION OF THIS RULE.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-25	S-IVB STAGE LOX NON-PROPULSIVE VENT (NPV) FAILS TO OPEN AT:			CUES: 1. LOX NPV NOZZLE PRESSURES (D0243-404, D0244-404). 2. LOX NPV OPEN DISCRETE (K0198-424). 3. LOX NPV CLOSE DISCRETE (K0199-424). 4. LOX TANK ULLAGE PRESSURE (D0179-406, D0180-406).
		A. TB7 + 0.7 SEC	COAST	A. CONTINUE MISSION BSE INFORM FLIGHT AND 1. ATTEMPT TO OPEN THE LOX NPV VALVE IF SUCCESSFUL, 2. VENT THE LOX TANK FOR 2 MIN 30 SEC THROUGH THE NPV IF UNSUCCESSFUL, BSE COMMAND: 3. LOX NPV VALVE CLOSE 4. LOX VENT VALVE OPEN FOR 40 SEC	
		B. TO LATCH OPEN AT TB8 + 17 MIN 3 SEC	SLINGSHOT	B. CONTINUE MISSION BSE INFORM FLIGHT AND 1. ATTEMPT TO LATCH OPEN THE LOX LATCHING VENT VALVE IF UNSUCCESSFUL, BSE COMMAND: 2. LOX NPV OPEN IF B2 UNSUCCESSFUL, BSE COMMAND: 3. LOX VENT OPEN	
	7-26	LH_2 LATCHING VENT VALVE FAILS TO LATCH OPEN AS PROGRAMED	COAST SLINGSHOT	CONTINUE MISSION BSE INFORM FLIGHT AND 1. ATTEMPT TO OPEN THE LH_2 LATCHING VENT VALVE IF UNSUCCESSFUL, BSE COMMAND: 2. LH_2 LATCHING VENT VALVE CLOSED 3. LH_2 VENT VALVE OPEN AT TB7 + 15 MIN OR TB7 + 1 HR 15 MIN COMMAND: 4. LH_2 VENT VALVE CLOSE	CUES: 1. LH_2 NPV NOZZLE PRESSURES (D183-409, D184-409). 2. LH_2 ULLAGE PRESSURE (D177-410, D178-410). 3. LH_2 LATCHING VENT VALVE DISCRETES (K210-410, K211-410).
	7-27	ENGINE START BOTTLE DUMP FAILS TO INITIATE	COAST	CONTINUE MISSION BSE INFORM FLIGHT AND ATTEMPT TO OPEN THE START BOTTLE VENT CONTROL VALVE	CUES: 1. GH_2 START BOTTLE PRESSURE (D017-401, D241-410).

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	7-28	S-IVB STAGE COLD HELIUM DUMP FAILS TO INITIATE	COAST SLINGSHOT	CONTINUE MISSION BSE INFORM FLIGHT AND 1. ATTEMPT TO OPEN THE LH_2 CRYOGENIC REPRESSURIZATION SUPPLY VALVES IF UNSUCCESSFUL, BSE INFORM FLIGHT AND AT TB8 + 17 MIN 30 SEC SEND: 2. LOX PRESSURIZATION SHUTOFF VALVES OPEN	CUES: 1. COLD HELIUM BOTTLE PRESSURE (D0016-425, D0263-403).
		RULE NUMBERS 7-29 AND 7-30 ARE RESERVED.			

8 SLV - TB6
(RESTART)

REV	ITEM	

SUMMARY OF RESTART PHASE RULES

8-1 ACCELEROMETER FAILURE

8-2 O_2/H_2 BURNER LH_2 VALVE FAILS

8-3 LH_2 CHILLDOWN SYSTEM FAILS

8-4 LOX CHILLDOWN SYSTEM FAILS

8-5 LH_2 TANK ULLAGE PRESSURE LOW

8-6 S-IVB ACTUATOR HARDOVER

8-7 CONTINUOUS VENT REGULATOR FAILS TO CLOSE

8-8 LOSS OF ATTITUDE CONTROL DURING SECOND BURN

THE FOLLOWING MISSION RULES ALSO APPLY TO THIS SECTION:

6-11 S-IVB STAGE LOSS OF THRUST

7-7 S-IVB AUXILIARY HYDRAULIC PUMP FAILS

7-8 LOSS OF ATTITUDE CONTROL DURING TB5 AND TB7 TO SPACECRAFT SEPARATION, TB6 TO TB6 + 9 MIN 20 SEC

7-9 CONTINUOUS VENT SYSTEM (CVS) REGULATOR FAILS TO OPEN IN TB5 (TB5 + 59 SEC)

7-13 IU ECS WATER VALVE FAILS TO CYCLE OPEN AND CLOSED

7-14 S-IVB STAGE COMMON BULKHEAD DELTA PRESSURE REACHES OR EXCEEDS MINUS 20 PSID OR PLUS 30 PSID, MINUS 26 PSID OR PLUS 36 PSID

7-16 S-IVB ENGINE CONTROL BOTTLE PRESSURE LESS THAN 400 PSIA

7-17 LH_2 TANK VENT FAILURE OR LEAK DURING ORBITAL COAST

7-18 LOW COLD HELIUM SUPPLY PRESSURE

7-19 LOX TANK ULLAGE PRESSURE LESS THAN 31 PSIA IN TB5

7-22 S-IVB LOSS OF ENGINE HYDRAULIC FLUID

7-21 PU VALVE FAILS TO A MIXTURE RATIO GREATER THAN 5.0 TO 1 ANY TIME AFTER RESTART

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	8-1	INERTIAL PLATFORM FAILURE-ACCELEROMETER A. AFTER TB6 INITIATED BUT PRIOR TO TB6 + 9 MIN 10 SEC B. AFTER TB6 + 9 MIN 10 SEC	RESTART	A. TLI INHIBIT BSE INFORM FLIGHT AND FIDO AND RECOMMEND TLI INHIBIT PRIOR TO TB6 + 9 MIN 10 SEC. B. CONTINUE MISSION BSE INFORM FLIGHT AND FIDO.	CUES: 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" 2. ACCELEROMETER PICKOFFS (X, Y, OR Z) INDICATE IN EXCESS OF 0.5 DEG AND NOT DECREASING (H10-603, H11-603, H12-603). NOTES: 1. LVDC SWITCHES TO A BACKUP MODE AND UTILIZES A PRE-COMPUTED F/M PROFILE FOR FAILED AXIS DURING S-IVB BURN. 2. ACCELEROMETER FAILURE OCCURRING DURING TB5 WILL NOT BE RECOGNIZED UNTIL TB6 INITIATED.
	8-2	S-IVB STAGE O_2/H_2 BURNER FUEL PROPELLANT VALVE FAILS CLOSED	RESTART	CONTINUE MISSION BSE INFORM FLIGHT AND COMMAND: A. BURNER SHUTDOWN B. CONTINUOUS VENT SYSTEM ORIFICE OPEN C. CRYOGENIC REPRESSURIZATION OFF	CUES: 1. BURNER CHAMBER DOME TEMPERATURE INDICATES 460°R OR LESS (C0382-403). 2. BURNER NOZZLE TEMPERATURE (C0380-403) OFF SCALE LOW. 3. BURNER GH_2 INJECTOR TEMPERATURE (C0383-403). 4. AMBIENT REPRESSURIZATION MODE SELECT (K0195-404). 5. BURNER PROPELLANT VALVE POSITIONS (K0180-404, K0192-403). NOTES: 1. 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.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	8-3	LH_2 CHILLDOWN SYSTEM FAILS DURING RESTART PREPARATIONS	RESTART	CONTINUE MISSION A. BSE INFORM FLIGHT AND ATTEMPT TO CORRECT SITUATION SPECIFIED IN NOTE 1(A), 1(B), 1(D) B. IF UNSUCCESSFUL, BSE INFORM FLIGHT AND AT TB6 + 8 MIN 45 SEC COMMAND FUEL LEAD	CUES: 1. LH_2 PREVALVE OPEN (K111-404). 2. LH_2 PREVALVE CLOSE (K112-404). 3. LH_2 BLEED VALVE CLOSE (K127-401). 4. LH_2 RECIRC VALVE CLOSE (K136-409). 5. LH_2 RECIRC FLOW (F005-404). 6. LH_2 PUMP INLET PRESS (D002-403). 7. LH_2 ULLAGE PRESS (D177-409, D178-409). 8. LH_2 PUMP INLET TEMP (C003-403). NOTES: 1. LH_2 CHILLDOWN WILL NOT BE SATISFACTORY IF: (A) PREVALVE IS OPEN (B) RECIRCULATION VALVE IS CLOSED (C) BLEED VALVE IS CLOSED (D) CHILLDOWN PUMP IS NOT ON 2. THIS FAILURE AND THE FUEL LEAD WILL REQUIRE EVALUATION OF RESIDUALS TO DETERMINE ADEQUACY FOR TLI VELOCITY CUTOFF (REF FMR 7-1).

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	8-4	S-IVB STAGE LOX CHILLDOWN SYSTEM FAILS DURING RESTART PREPARATIONS	RESTART	<u>CONTINUE MISSION</u> BSE INFORM FLIGHT AND ATTEMPT TO CORRECT SITUATION SPECIFIED IN NOTE 1(A), 1(B), 1(D)	CUES: 1. LOX PUMP INLET PRESSURE (D0003-403) AND LOX TANK ULLAGE PRESSURE (D0179-406; D0180-406). 2. LOX CHILLDOWN FLOWRATE (F0004-424). 3. LOX PUMP INLET TEMPERATURE (C0004-403). 4. LOX PREVALVE OPEN POSITION (K0109-403). 5. LOX PREVALVE CLOSED POSITION (K0110-403). 6. LOX BLEED VALVE POSITION (K0126-401). 7. LOX RECIRCULATION VALVE POSITION (K0139-424). <u>NOTES</u>: 1. LOX CHILLDOWN WILL NOT BE SATISFACTORY IF: (A) PREVALVE IS OPEN (B) RECIRCULATION VALVE IS CLOSED (C) BLEED VALVE IS CLOSED (D) CHILLDOWN PUMP IS NOT ON
	8-5	LOW LH_2 TANK ULLAGE PRESSURE AT TB6 + 9 MIN 10 SEC (SEE NOTES 1 AND 2)	RESTART	<u>TLI INHIBIT</u> BSE INFORM FLIGHT AND RECOMMEND TLI INHIBIT.	<u>CUES</u>: 1. LH_2 TANK ULLAGE PRESSURE (D177-410, D178-410). 2. LH_2 PUMP INLET PRESSURE (D002-403). <u>NOTES</u>: 1. THIS RULE IS NOT VALID WITH ANY INDICATION OF AN LH_2 VENT VALVE PROBLEM (I.E., LEAKAGE OR FAILURE TO CLOSE). (SEE FMR 7-17 AND 8-7.) 2. AT TB6 + 9 MIN 10 SEC, THE LH_2 TANK ULLAGE PRESSURE SHOULD BE <u>4</u> PSIA HIGHER THAN ULLAGE PRESSURE DURING ORBITAL COAST TO MEET RESTART REQUIREMENTS.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	8-6	S-IVB ACTUATOR CONFIRMED HARDOVER PRIOR TO TB6 + 9 MIN 10 SEC	RESTART	<u>TLI INHIBIT</u> BSE INFORM FLIGHT AND RECOMMEND TLI INHIBIT	<u>CUES</u>: 1. ACTUATOR POSITIONS $\pm$ 5 DEG OR GREATER (G1-400, G1-403, G2-400, G2-403). <u>NOTE</u>: BOTH INDIVIDUAL ACTUATOR POSITIONS MUST CONFIRM MALFUNCTION PRIOR TO RECOMMENDING S/C SEPARATION OR TLI INHIBIT.
	8-7	S-IVB STAGE CONTINUOUS VENT SYSTEM (CVS) REGULATOR FAILS TO CLOSE DURING RESTART SEQUENCE	RESTART	<u>CONTINUE MISSION/TLI INHIBIT</u> BSE INFORM FLIGHT AND COMMAND: 1. SECOND BURN RELAY OFF 2. ATTEMPT TO CLOSE THE CVS REGULATOR IF NEITHER 1 NOR 2 IS SUCCESSFUL, BSE INFORM FLIGHT AND RECOMMEND TLI INHIBIT.	<u>CUES</u>: 1. CVS REGULATOR CLOSED (K154-411). 2. CVS NOZZLE PRESSURE REMAINS GREATER THAN 3 PSIA (D181-409, D182-409) 3. LH_2 TANK ULLAGE PRESSURE (D177-410, D178-410).

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	8-8	LOSS OF ATTITUDE CONTROL DURING S-IVB SECOND BURN	RESTART	SPACECRAFT SEPARATION BSE INFORM FLIGHT AND FIDO. CAPCOM INFORM CREW OF LOSS OF ATTITUDE CONTROL. CREW WILL ABORT ON LIMITS.	CUES: 1. ANGULAR RATES - PITCH (R4-602, R13-602), YAW (R5-602, R8-602), OR ROLL (R6-602, R12-602) GREATER THAN 5 DEG/SEC AND NOT DECREASING. 2. PLATFORM GIMBAL ANGLES PITCH, YAW, OR ROLL (H60-603), CHANGING AT RATES GIVEN IN CUE 1. 3. LOSS OF ATTITUDE CONTROL ALERT (SEE NOTE 2). NOTES: 1. THE SLV YAW GIMBAL (2-AXIS) IS CRITICAL BEYOND $\pm$ 45 DEG. 2. LOSS OF ATTITUDE CONTROL ALERT WILL BE GIVEN FOR THE FOLLOWING CONDITIONS: (A) LVDC/LVDA COMPUTATIONAL FAILURE. (B) ATTITUDE ERROR SIGNALS ROLL $>\pm 3.5$ DEG, PITCH AND YAW $>\pm 5$ DEG (C) FAILURE TO INITIATE PROPER GUIDANCE SEQUENCE. (D) FAILURE OF S-IVB ENGINE HYDRAULICS. (E) ATTITUDE REFERENCE FAILURE.

9 SLV - TB8 (SAFING AND SLINGSHOT)

REV	ITEM	

SUMMARY OF SAFING AND SLINGSHOT RULES

9-1 STAGE PNEUMATIC DUMP FAILS

9-2 LOX DUMP FAILS

9-3 ENGINE CONTROL BOTTLE DUMP FAILS

9-4 RESERVED

9-5 LOSS OF APS FOR DUMP

THE FOLLOWING REFERENCED FLIGHT MISSION RULES ARE ALSO APPLICABLE DURING TIME BASE EIGHT (TB8)

7-3 J-2 ENGINE MAIN FUEL VALVE (MFV) FAILS TO CLOSE AT FIRST S-IVB CUTOFF, SECOND S-IVB CUTOFF

7-4 J-2 ENGINE MAIN OXIDIZER VALVE FAILS TO CLOSE AT FIRST S-IVB CUTOFF, SECOND BURN CUTOFF

7-8 LOSS OF ATTITUDE CONTROL DURING TB5 AND TB7 TO SPACECRAFT SEPARATION, TB6 TO TB6 + 9 MIN 20 SEC AFTER SPACECRAFT SEPARATION, AFTER TB8 INITIATE

7-13 IU ECS VALVE FAILS TO CYCLE OPEN AND CLOSED

7-14 S-IVB STAGE COMMON BULKHEAD DELTA PRESSURE REACHES OR EXCEEDS MINUS 20 PSID OR PLUS 30 PSID, MINUS 26 PSID OR PLUS 36 PSID

7-25 S-IVB STAGE LOX NON-PROPULSIVE VENT (NPV) FAILS TO OPEN AT TB7 + 0.7 SEC, TO LATCH OPEN AT TB8 + 17 MIN 3 SEC

7-26 LH_2 LATCHING VENT VALVE FAILS TO LATCH OPEN AS PROGRAMED

7-28 S-IVB STAGE COLD HELIUM DUMP FAILS TO INITIATE

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	9-1	S-IVB STAGE PNEUMATIC DUMP FAILS TO INITIATE	SLINGSHOT	CONTINUE MISSION BSE INFORM FLIGHT AND ATTEMPT TO OPEN THE ENGINE PUMP PURGE CONTROL VALVE	CUES: 1. ENGINE PUMP PURGE PRESSURE (D050-403). 2. AMBIENT HELIUM SUPPLY PRESSURE (D236-403, D256-403).
	9-2	S-IVB LOX DUMP FAILS TO INITIATE AT TB8 + 12 MIN 2.8 SEC	SLINGSHOT	CONTINUE MISSION BSE INFORM FLIGHT AND ATTEMPT TO INITIATE LOX DUMP BY OPENING THE MAIN OXIDIZER VALVE	CUES: 1. MAIN OXIDIZER VALVE POSITION (G0003-401). 2. MAIN OXIDIZER VALVE OPEN DISCRETE (K0120-401). 3. LOX PUMP INLET TEMPERATURE (C0004-403). 4. LOX RECIRCULATION FLOWRATE (F0004-424).
	9-3	ENGINE CONTROL BOTTLE DUMP FAILS TO INITIATE	SLINGSHOT	CONTINUE MISSION BSE INFORM FLIGHT AND ATTEMPT TO OPEN THE ENGINE HELIUM CONTROL VALVE	CUE: ENGINE CONTROL HELIUM SPHERE PRESSURE (D019-401, D242-401).
	9-4	RESERVED			
	9-5	LOSS OF EITHER OR BOTH APS MODULES PRIOR TO OR DURING PROPELLANT DUMP RULE NUMBERS 9-6 THROUGH 9-9 ARE RESERVED.	SLINGSHOT	CONTINUE MISSION BSE INFORM FLIGHT AND COMMAND S-IVB BURN MODE ON	CUES: 1. MANIFOLD PRESSURE MOD 1 LESS THAN 160 PSIA (OXID-FUEL) (D70-414, D71-414). 2. MANIFOLD PRESSURE MOD 2 LESS THAN 160 PSIA (OXID-FUEL) (D72-415, D73-415). 3. ATTITUDE CONTROL HELIUM CONTROL PRESSURE TANK 1 APPROXIMATELY 1100 PSIA (D35-414, D250-414). 4. ATTITUDE CONTROL HELIUM CONTROL PRESSURE TANK 2 APPROXIMATELY 1100 PSIA (D36-415, D251-415).

REV	ITEM
	9-10

PRELAUNCH INSTRUMENTATION

MEASUREMENT DESCRIPTION	MEAS NUMBER	ONBOARD	TRANS-DUCERS	CATE-GORY	EFFEC-TIVITY	MISSION RULE REFERENCE
STAGE COMMUNICATIONS SYSTEMS AND FLIGHT CONTROL MEASUREMENT CATEGORIZATION						
STAGE COMMUNICATIONS SYSTEMS						
S-IC STAGE-NONE						
S-II STAGE-NONE						
S-IVB STAGE						
MUX DP1B0 (VIA IU)				M		
INSTRUMENT UNIT						
LINK DP1B				M		
EMERGENCY DETECTION SYSTEM (EDS)				M		
COMMAND COMMUNICATIONS SYSTEM (CCS) UPLINK				M		
FLIGHT CONTROL MEASUREMENTS						
S-IC STAGE-NONE						
S-II STAGE						
POSITION YAW ACTUATOR	G8-201			HD		6-8, 8-6
POSITION YAW ACTUATOR	G8-202			HD		6-8
POSITION YAW ACTUATOR	G8-203			HD		6-8
POSITION YAW ACTUATOR	G8-204			HD		6-8
POSITION PITCH ACTUATOR	G9-201			HD		6-8, 8-6
POSITION PITCH ACTUATOR	G9-202			HD		6-8
POSITION PITCH ACTUATOR	G9-203			HD		6-8
POSITION PITCH ACTUATOR	G9-204			HD		6-8
E1 YAW ACTUATOR PIST POS	G30-201			HD		6-8
E2 YAW ACTUATOR PIST POS	G30-202			HD		6-8
E3 YAW ACTUATOR PIST POS	G30-203			HD		6-8
E4 YAW ACTUATOR PIST POS	G30-204			HD		6-8
E1 PITCH ACTUATOR PIST POS	G31-201			HD		6-8
E2 PITCH ACTUATOR PIST POS	G31-202			HD		6-8
E3 PITCH ACTUATOR PIST POS	G31-203			HD		6-8
E4 PITCH ACTUATOR PIST POS	G31-204			HD		6-8
VOLT, IGNITION DC BUS	M125-207			HD		6-9
S-IVB STAGE						
PRESS, FUEL PUMP INLET	D2-403					7-14
PRESS, FUEL TANK ULLAGE EDS 1	D177-410	METER*	COMMON	2 OF 3		7-14
PRESS, FUEL TANK ULLAGE EDS 2	D178-410	METER*	COMMON	M		7-14
PRESS, OXID PUMP INLET	D3-403					7-14/19,
PRESS, OXID TANK ULLAGE EDS 1	D179-406	METER*	COMMON	2 OF 3		7-14/19, 8-5
PRESS, OXID TANK ULLAGE EDS 2	D180-406	METER*	COMMON	M		7-14/19, 8-5
PRESS, COLD HELIUM SPHERE	D16-425			HD		7-18
PRESS, GH_2 START BOTTLE	D17-401			HD		7-20
PRESS, ENG CONTROL He SPHERE	D19-401			HD		7-16
PRESS, HYDRAULIC SYSTEM	D41-403			HD		6-10, 7-22
PRESS, RESERVOIR OIL	D42-403			HD		6-10, 7-22
PRESS, AMBIENT He PNEU SPHERE	D236-403			HD		7-15
PRESS, GH_2 START BOTTLE BKUP MEAS	D241-401			HD		7-20
PRESS, ENG CONT He SPHERE BKUP MEAS	D242-401			HD		7-16
PRESS, AMB He PNEU SPHERE	D256-403			HD		7-15
PRESS, COLD He SPHERE	D263-403			HD		7-18
FLOWMETER, OXIDIZER	F1-401			HD		7-4
POSITION, PITCH ACTUATOR	G1-403			HD		8-6
POSITION, YAW ACTUATOR	G2-403			HD		8-6
POSITION, MAIN OXIDIZER VALVE	G3-401			HD		7-4
POSITION, PU SYSTEM RATIO VALVE	G10-401			HD		7-21
VOLT, F/U 1 EBW RANGE SAFETY	M30-411			HD		7-5
VOLT, F/U 2 EBW RANGE SAFETY	M31-411			HD		7-5
VOLT, PU VALVE POSITION FEEDBACK	M61-411			HD		7-21
NETWORK				MAND		

REV	ITEM	MEASUREMENT DESCRIPTION	MEAS NUMBER	ONBOARD	TRANS-DUCERS	CATE-GORY	EFFEC-TIVITY	MISSION RULE REFERENCE
	9-10 (CONT'D)	MISC, SEC R/S RCVR 1 L/L SIG STR	N57-411			HD		7-5
		MISC, SEC R/S RCVR 2 L/L SIG STR	N62-411			HD		7-5
		LEVEL, RESERVOIR OIL	L7-403			HD		6-10, 7-22
		INSTRUMENT UNIT						
		GUIDANCE COMPUTER OPERATION	H60-603			M		6-1/4/7/9, 7-8/11, 8-1/8
		COMPUTER RESET PULSE NO. 1- GUIDANCE DECODER	J71-603			1 OF 2		REQUIRED TO COMPLETE MULTIPLE WORD GROUND COMMANDS
		COMPUTER RESET PULSE NO. 2- GUIDANCE DECODER	J72-603			M		
		ANG VEL PITCH CONTROL	R4-602			HD		6-1/7, 7-8, 8-8
		ANG VEL YAW CONTROL	R5-602			HD		6-1/7, 7-8, 8-8
		ANG VEL ROLL CONTROL	R6-602			HD		6-1/7, 7-8, 8-8
		ANG VEL YAW EDS GROUP 1 (REF)	R8-602			HD		6-1/7, 7-8, 8-8
		ANG VEL ROLL EDS GROUP 2 (REF)	R12-602			HD		6-1/7, 7-8, 8-8
		ANG VEL PITCH EDS GROUP 3 (REF)	R13-602			HD		6-1/7, 7-8, 8-8

**ONBOARD DISPLAY

10 CSM ENVIRONMENTAL CONTROL

REV	ITEM	
		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. TLC & TEC WATER EVAPORATION WILL BE LIMITED TO COMPONENT TESTING. ALL PHASES A. BACKUP SYSTEMS AND BACKUP COMPONENTS WILL BE USED FOR THE MOST RAPID PRACTICAL RETURN TO EARTH, NOT FOR MISSION CONTINUTATION. B. LM SYSTEMS WILL BE USED AS REQUIRED FOR CSM SYSTEMS BACKUP. IF CSM SYSTEMS REQUIRE LM BACKUP THE DESCENT STAGE WILL BE RETAINED WHERE POSSIBLE. C. TO CONTINUE, WATER QUANTITY PREDICTIONS MUST REFLECT ADEQUATE QUANTITIES TO MEET NORMAL MISSION REQUIREMENTS.
	10-2	DEFINITIONS LOSS OF CABIN INTEGRITY: CM PRESSURE VESSEL LEAKAGE SUCH THAT CABIN PRESSURE CANNOT BE MAINTAINED $\geq$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/OF CO_2 REMOVAL WITHOUT USING DIRECT O_2. LOSS OF O_2 MANIFOLD: AN O_2 MAINFOLD 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 RADIATORS 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 ASSOCIATED ISOLATABLE PLUMBING FAILURES WHICH REQUIRE ISOLATION OF THE SURGE TANK AND/OR REPRESS PACK. RULE NUMBERS 10-3 THROUGH 10-9 ARE RESERVED.

REV	ITEM	
		SYSTEMS MANAGEMENT
A	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 ALL PHASES EXCEPT LAUNCH AND TUNNEL/LM PRESSURIZATION AND RECHARGE.

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. LIOH CANISTER WILL BE REPLACED EVERY 12 HOURS OR 7.6 MM HG OF PCO_2 WHICHEVER COMES FIRST.

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

1. INABILITY TO MAINTAIN CABIN PRESSURE ABOVE 4.5 PSIA
2. ALL UNDOCKED 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

L. CABIN FANS WILL NORMALLY BE OFF FOR MISSION DURATION.

COOLANT MANAGEMENT

A. FOR SIMULTANEOUS 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 PERCENT.

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 DEG.

REV	ITEM	

WATER SYSTEM

A. WASTE WATER WILL BE DUMPED OVERBOARD AS REQUIRED TO MAINTAIN INDICATED QUANTITY <85-90 PERCENT. WASTE WATER WILL NORMALLY BE DUMPED TO 25 PERCENT; 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:

1. AT LOI, THE WASTE TANK WILL CONTAIN >75 PERCENT.

2. AT CM-SM SEPARATION, THE POTABLE TANK WILL BE FULL AND THE WASTE TANK WILL BE 90 PERCENT FULL.

C. GENERAL DUMPING CONSIDERATIONS TO REDUCE TRAJECTORY CALCULATION PERTURBATIONS:

1. DUMPS WILL BE PERFORMED (IF REQUIRED) WITHIN 2 HOURS PRECEDING MCC MANEUVERS.

2. IF DUMPS ARE REQUIRED IN LUNAR ORBIT THE OPTIMUM DUMP TIME IS IMMEDIATELY PRECEDING SLEEP PERIODS.

SYSTEM BACKUP

LM STSTEMS WILL BE USED AS REQUIRED FOR CSM SYSTEMS BACKUP. DESCENT STAGE WILL BE RETAINED IF POSSIBLE.

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

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
				SPECIFIC MISSION RULES	
	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:			• CREW OPTION TO USE LM ENVIRONMENT FOR EARTH RETURN IN LIEU OF SUITED RETURN.
		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 CIRCULATION	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	
A	10-22	LOSS OF SUIT CIRCULATION CABIN STABLE, AND >4.5 PSIA			• LM SYSTEMS (IF AVAILABLE) WILL BE USED FOR CO_2 AND H_2O REMOVAL.
			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)
			EO	B. ENTER NEXT BEST PTP WITHIN 4 HOURS	
				1. DOFF SUITS.	
				2. OPEN WASTE OVERBOARD DRAIN VALVE TO OBTAIN CABIN BLEED FLOW.	B.2. WASTE OVERBOARD BLEED = 1.00 LB O_2/HR
				3. DON FACE MASKS AFTER 1 HOUR	3. TIME REQUIRED FOR CM CO_2 PARTIAL PRESSURE TO INCREASE TO 7.6 MM HG 1 CREWMAN: 4 HR. 3 CREWMAN: 80 MIN.
			ALL	C. ENTER NEXT BEST PTP	
	10-23	LOSS OF SURGE TANK OR REPRESS PACK			FOR LEAK IN SURGE TANK, ISOLATE SURGE TANK AND PLACE PLSS VALVE TO FILL.
			LAUNCH	A. CONTINUE MISSION	
			ALL	B. CONTINUE MISSION	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	10-24	LOSS OF SURGE TANK AND REPRESS PACK			
			LAUNCH	A. CONTINUE MISSION	
			ALL	B. CONTINUE MISSION PLAN TO RESTORE ENTRY O_2 BY STORING OPS IN CM AT FINAL LM EGRESS.	B. OPS O_2 QTY 2 TANKS -2 LB/TANK
			TEC	C. CONTINUE MISSION DOFF SUITS FOR ENTRY.	
	10-25	FIRE OR SMOKE IN COMMAND MODULE	LAUNCH	A. ABORT 1. DECOMPRESS CABIN 2. TROUBLESHOOT ELECTRICAL SYSTEM PER FLIGHT CREW CHECKLIST BOOST FIRE PROCEDURES.	
			ALL	B.1. TROUBLESHOOT/COMBAT FIRE PER FLIGHT CREW CHECKLIST EMERGENCY PROCEDURES. 2. ASSESS DAMAGE AND REMOVE POWER FROM AFFECTED SYSTEMS 3. ENTER NEXT BEST PTP	
	10-26	CONTAMINATION IN CABIN	ALL	CREW MAY ELECT TO DECOMPRESS	IF UNABLE TO CLEAR CONTAMINATION, MISSION MAY BE TERMINATED EARLY.
	10-27	LOSS OF SUIT INTEGRITY			CONTINUE MISSION EXCEPT FOR MAJOR CSM PRESSURE VESSEL CONFIGURATION CHANGES
			LAUNCH	A. CONTINUE MISSION	
			EO	B. CONTINUE MISSION	
			TEC	C. INHIBIT TD&E	
			TD&E	D. TERMINATE PHASE CONTINUE LM EJECTION IF LM IS PRESSURIZED AND TUNNEL WORK IS COMPLETE. NO-GO FOR UNDOCK	
			ALL	E. CONTINUE MISSION NO-GO FOR UNDOCK	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	10-28	LOSS OF O_2 MANIFOLD			
		A. O_2 MANIFOLD LEAKS >4 LB/HR AND CABIN PRESSURE >4.5 PSIA	LAUNCH	A.1. CONTINUE MISSION	
			ALL	2. ENTER NEXT BEST PTP	A.2. APPROXIMATELY 5 HOURS ARE REQUIRED TO DEPLETE CABIN O_2 FROM 4.8 TO 3.5 PSIA, WITH 0.456 LB/HR USAGE RATE (CREW + CABIN LEAK + TANK PRESS BLEED)
				(A) VERIFY SURGE TANK AND REPRESS PACK ISOLATED UNTIL ENTRY.	
				(B) RETRIEVE OPS FROM LM.	A.2.(B) CREW OPTION TO USE LM ENVIRONMENT FOR EARTH RETURN IN LIEU OF MANUAL CABIN PRESSURE REGULATION.
		B. O_2 MANIFOLD LEAKS >4 LB/HR AND CABIN PRESSURE <4.5	LAUNCH	B.1. ABORT ASAP	
			ALL	2. ENTER ASAP USE OPS IN SUITED MODE FOR ENTRY	LM O_2 (IF AVAILABLE) MAY BE USED TO SUPPLEMENT CSM SUPPLY.
	10-29	LOSS OF ONE MAIN REGULATOR	LAUNCH	A. CONTINUE MISSION	
			EO	B. NO-GO FOR TLI	
			TLC	C. ENTER NEXT BEST PTP	
			ALL	D. CONTINUE MISSION CONSIDER TEI AT NEXT BEST OPPORTUNITY AFTER RNDZ	
	10-30	BOTH MAIN REGULATORS FAILED CLOSED			LM SYSTEMS (IF AVAILABLE) MAY BE USED IN LIEU OF CSM SYSTEMS
			LAUNCH	A. CONTINUE MISSION	
			ALL	B. ENTER NEXT BEST PTP	
	10-31	LOSS OF ONE SUIT COMPRESSOR	LAUNCH	A. CONTINUE MISSION	
			EO	B. NO-GO FOR TLI	
			ALL	C. CONTINUE MISSION CONSIDER RETAINING LM ASCENT STAGE AND DOING EARLY TEI AT NEXT OPPORTUNITY AFTER RNDZ	
		RULE NUMBERS 10-32 10-39 ARE RESERVED.			

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	10-40	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 <80°F OR AS REQUIRED FOR CREW COMFORT.	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 80°F.
		B. LOSS OF RADIATORS	LAUNCH	B.1. CONTINUE MISSION	B.1. REF MALF PROC ____
			EO	2. NO-GO FOR TLI (A) ACTIVATE SECONDARY LOOP. (B) USE PRIMARY LOOP IN ADDITION TO SECONDARY LOOP FOR G&N OPERATIONS.	
			ALL	3. ENTER NEXT BEST PTP	
		C. TOTAL LOSS OF LOOP	LAUNCH	C.1. CONTINUE MISSION ACTIVATE SECONDARY LOOP	
			EO	2. NO-GO FOR TLI ACTIVATE SECONDARY LOOP	C.2. ALTERNATE MISSION MAY BE PERFORMED.
			ALL	3. ENTER NEXT BEST PTP ACTIVATE SECONDARY LOOP	
	10-41	SECONDARY LOOP MALFUNCTIONS			
		A. LOSS OF EVAPORATOR	ALL	A. CONTINUE MISSION	A. MALF ECS ____
		B. LOSS OF RADIATORS	EO	B.1. NO-GO FOR TLI LOOP IS STILL OPERATIONAL IN EVAPORATIVE MODE.	B.1. MALF ECS ____
			ALL	2. ENTER NEXT BEST PTP	
		C. TOTAL LOSS OF LOOP	EO	C.1. NO-GO FOR TLI	C.1. MALF ECS ____
			ALL	2. ENTER NEXT BEST PTP	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	10-42	LOSS OF PRIMARY AND SECONDARY EVAPORATORS	EO	A. CONTINUE MISSION NO-GO FOR TLI	
			TLC	B. CONTINUE MISSION NO-GO FOR LOI	
			ALL	C. ENTER NEXT BEST PTP	
	10-43	LOSS OF ALL COOLING, PRIMARY AND SECONDARY			LM SYSTEMS (IF AVAILABLE) WILL BE USED TO SUPPLEMENT CSM OPERATIONS.
			LAUNCH	A. CONTINUE MISSION	
			EO	B. ENTER NEXT BEST ATP OR PTP MAXIMUM ORBIT TIME: 4 HOURS EMERGENCY POWER DOWN FOLLOWED BY 1.5 HOURS OF POWER UP FOR ENTRY.	
			ALL	C. ENTER ASAP	
	10-44	CONFIRMED LEAK OF GLYCOL COOLANT			LM ENVIRONMENT (IF AVAILABLE) MAY BE USED FOR EARTH RETURN IN LIEU OF CSM.
		A. IN COMMAND MODULE	LAUNCH	A.1. CONTINUE MISSION	
			EO	2. ENTER NEXT BEST PTP DON SUITS. PURGE SUIT LOOP WITH DIRECT O_2.	
			ALL	3. ENTER NEXT BEST PTP	
		B. IN SUIT CIRCUIT	LAUNCH	B.1. CONTINUE MISSION	
			EO	2. ENTER NEXT BEST PTP DOFF SUITS AND USE FACE MASKS IF REQUIRED.	
			ALL	3. ENTER NEXT BEST PTP	
		RULE NUMBERS 10-45 THROUGH 10-49 ARE RESERVED.			

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	10-50	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. 2. BLEED O_2 FROM WATER TANK THROUGH WASTE MANAGEMENT OVERBOARD DRAIN VALVE INTO CABIN.
		B. LOSS OF ALL OVERBOARD DUMP CAPABILITY	ALL	B. ENTER NEXT BEST PTP	B.1. IF POTABLE AND WASTE TANKS (OR WASTE TANKS ALONE) BECOME FULL, FORCED WATER BOILING WILL BE NECESSARY TO ALLOW FUEL CELL AND/OR CYCLIC ACCUMULATOR OPERATION. 2. LM URINE STORAGE BAGS (IF AVAILABLE) WILL BE USED.
	10-51	FAILURE OF BOTH WATER ACCUMULATORS OR UNCONTROL-LABLE HIGH HUMIDITY			LM SYSTEMS MAY BE USED FOR HUMIDITY CONTROL.
			LAUNCH	A. CONTINUE MISSION	
			ALL	B. ENTER NEXT BEST PTP	
	10-52	WASTE WATER TANK LEAK OR LOSS OF WASTE WATER STORAGE CAPABILITY			LM SYSTEMS (IF AVAILABLE) MAY BE USED TO SUPPLEMENT CSM. WHEN POTABLE WATER TANK BECOMES FULL, FUEL CELL WATER WILL BE DUMPED THROUGH OVER-BOARD PRESSURE RELIEF VALVES
			LAUNCH	A. CONTINUE MISSION	
			EO	B. CONTINUE MISSION NO-GO FOR TLI	
			ALL	C. ENTER NEXT BEST PTP	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	10-53	CONFIRMED LEAK IN POTABLE WATER TANK OR UNABLE TO TRANSFER FUEL CELL WATER TO POTABLE TANK.			LM SYSTEMS (IF AVAILABLE) MAY BE USED TO SUPPLEMENT CSM.
			LAUNCH	A. <u>CONTINUE MISSION</u>	
			EO	B. <u>CONTINUE MISSION</u> NO-GO FOR TLI ENTER NEXT BEST PTP AFTER TANK DEPLETED.	
			ALL	C. <u>ENTER NEXT BEST PTP</u>	
		RULE NUMBERS 10-54 THROUGH 10-59 ARE RESERVED.			

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
A	10-60	INSTRUMENTATION REQUIREMENTS

MEAS DESCRIPTION	PCM	ONBOARD	TRANSDUCER	CATEGORY	REFERENCE
CABIN PRESS	CF0001P	METER	COMMON	1 OF	10-20
SUIT PRESS	CF0012P	METER	COMMON	3 M	
TANK BLADDER PRESS	CF0120P	-----	------		
SUIT PRESS (CUFF GAGES)	-------	-----	------	MANDATORY (EACH CREWMAN)	10-21
SURGE TANK PRESS	CF0006P	METER	COMMON	1 OF	10-28
OXYGEN REPRESS PRESS	------	METER	------	2 M	
PRIM ACCUM QTY	CF0019Q	METER	COMMON	1 OF	10-40,
PRIM PUMP OUT PRESS	CF0016P	METER	COMMON	2 M	10-44
POTABLE H_2O QTY	CF0010Q	METER	COMMON	1 OF	10-53,
WASTE H_2O QTY	CF0009Q	METER	COMMON	2 M	10-52
SEC STEAM PRESS	CF0073P	METER	COMMON	1 OF	10-41
SEC EVAP OUT TEMP	CF0071T	METER	COMMON	2 M	
SEC ACCUM QTY	CF0072P	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	SF0263T	-----	------	HD	
SEC RAD OUT TEMP	SF0236T	METER	------	HD	

11 CSM CRYOGENICS

REV	ITEM	
		GENERAL
	11-1	LAUNCH 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	ALL PHASES 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 AFTER LOSS OF RECHARGE CAPABILITY FROM THE CRYO SYSTEM WILL REDUCE SUPPLY AVAILABLE FOR ENTRY, LANDING, AND POSTLANDING.
A	11-3	LOSS OF CRYOGENIC TANK IS DEFINED AS: PRESSURE CANNOT BE MAINTAINED ABOVE 150 PSIA FOR O_2 AND 100 PSIA FOR H_2.
A	11-4	LUNAR MISSION WILL BE CONTINUED AS LONG AS ENOUGH CRYO (O_2, H_2) IS MAINTAINED IN LOWEST TANK TO PERFORM AN EARTH RETURN FROM ANY POINT WITH AT LEAST A POWER LEVEL OF 50 AMPS AVERAGE. EARTH ORBIT MISSION WILL BE CONTINUED AS LONG AS ENOUGH TOTAL CRYO (O_2, H_2) IS AVAILABLE TO PERFORM AN ENTRY INTO THE NEXT DAILY GO/NO-GO AREA.
		RULE NUMBERS 11-5 THROUGH 11-9 ARE RESERVED.

REV	ITEM	SYSTEMS MANAGEMENT
A	11-10	CRYO MANAGEMENT
		A. MANUAL PRESSURE CONTROL WILL BE USED AS REQUIRED TO MAINTAIN:
		1. TANK PRESSURES GREATER THAN 750 PSIA O_2 AND 200 PSIA FOR H_2
		2. QUANTITY BALANCE WITHIN 4 PERCENT O_2 AND 3 PERCENT FOR H_2
|		B. IT IS PREFERABLE TO EITHER PURGE F/C OR POWER UP TO PRECLUDE VENTING.
		C. O_2 TANK FANS AND H_2 TANK FANS WILL NOT BE OPERATED IN THE AUTO MODE.
		D. MANUAL FAN CYCLE CRITERIA: O_2 AND H_2 FANS WILL BE CYCLED BOTH PRE AND POST SLEEP.
	11-11	CRYO GAGING
		A. ONBOARD CRYOGENIC QUANTITY GAGING IS PRIME. ACCURACY IS ±2.65 PERCENT (±8.48 LB O_2, ±0.72 LB H_2) PER TANK.
		B. MCC CALCULATED QUANTITY USING PRESSURE VERSUS TEMPERATURE IS BACKUP.
		RULE NUMBERS 11-12 THROUGH 11-19 ARE RESERVED.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
				SPECIFIC MISSION RULES	
	11-20	LOSS OF ONE O_2 AND/OR H_2 CRYO TANK (TANK PRESSURE <150 O_2, <100 H_2, RESPECTIVELY).	LAUNCH	A. CONTINUE MISSION	LM, PLSS, AND OPS O_2 WILL BE USED AS REQUIRED TO SUPPLEMENT CSM O_2.
			EO	B. CONTINUE MISSION NO-GO FOR TLI	
			TD&E	C. CONTINUE MISSION	
			ALL	D. ENTER NEXT BEST PTP	
	11-21	LOSS OF BOTH O_2 AND/OR H_2 CRYO TANK (TANK PRESSURE <150 O_2, <100 H_2, RESPECTIVELY)	LAUNCH	A. CONTINUE MISSION ISOLATE SURGE TANK PRIOR TO 800 PSIA.	
			EO	B. ENTER NEXT BEST ATP OR PTP MAXIMUM ORBIT TIME IS 4.75 HOURS FOR LOSS OF THREE FUEL CELLS.	B. IF THREE FUEL CELLS ARE LOST PRIOR TO CM/SM SEP, SMJC'S WILL BE INOPERATIVE.
		RULE NUMBERS 11-22 THROUGH 11-49 ARE RESERVED.			

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	11-20
O_2 TANK 2 QTY	SC0033Q	METER	COMMON	MANDATORY	
O_2 TANK 1 TEMP	SC0041T	-----	------	HIGHLY DESIRABLE	11-20
O_2 TANK 2 TEMP	SC0042T	-----	------	HIGHLY DESIRABLE	
H_2 TANK 1 QTY	SC0030Q	METER	COMMON	1 OF 2	11-20
H_2 TANK 2 QTY	SC0031Q	METER	COMMON	MANDATORY	
H_2 TANK 1 TEMP	SC0043T	-----	------	HIGHLY DESIRABLE	11-20
H_2 TANK 2 TEMP	SC0044T	-----	------	HIGHLY DESIRABLE	
O_2 TANK 1 PRESS	SC0037P	METER	COMMON	1 OF 2	11-20
O_2 TANK 2 PRESS	SC0038P	METER	COMMON	MANDATORY	
H_2 TANK 1 PRESS	SC0039P	METER	COMMON	1 OF 2	11-20
H_2 TANK 2 PRESS	SC0040P	METER	COMMON	MANDATORY	

12 CSM ELECTRICAL
POWER SYSTEM

REV	ITEM	
		GENERAL
	12-1	LAUNCH 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.
	12-3	ALL PHASES THE MISSION WILL BE CONTINUED AS LONG AS THE REQUIRED NUMBER OF FUEL CELLS ARE AVAILABLE AND ARE CAPABLE OF SUPPORTING MISSION REQUIREMENTS OF 75 TO 90 AMPS (WITHOUT BATTERY SUPPLEMENT EXCEPT DURING SPS ΔV'S) AND THREE GOOD ENTRY BATTERIES REMAIN.
	12-4	BATTERY IS CONSIDERED FAILED IF: A. OUTPUT <3 AMPS WHEN CONNECTED TO A MAIN BUS DURING SPS MANEUVERS (NOMINAL TOTAL BATTERY CURRENT FOR SPS MANEUVERS IS 20 ± 2 AMPS). 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: A. OUTPUT VOLTAGE ON ANY PHASE >130 VAC. B. OUTPUT VOLTAGE ON ANY TWO PHASES <95 VAC.
	12-7	FUEL CELL IS CONSIDERED FAILED FOR MISSION PLANNING IF: A. FUEL CELL CANNOT SUPPLY SUFFICIENT POWER TO MEET ITS OWN PARASITIC LOADS (5 AMPS PLUS INLINE HEATER POWER AS REQUIRED). B. FUEL CELL H_2 LOOP IS CONTAMINATED WITH KOH. C. REGULATED H_2 PRESSURE <36.7 PSIA (CORRESPONDS TO N_2 PRESSURE SHIFT DOWN TO 28.2 PSIA FOR CRITICAL OPERATION; LOWER N_2 PRESSURE CAN BE MANAGED BY TURNING OFF H_2O TANK PRESSURE).
	12-8	TLI MINIMUM PURGE CAPABILITY IS BOTH OXYGEN AND HYDROGEN ON ONE FUEL CELL AND AT LEAST OXYGEN ON ANY OTHER FUEL CELL.
		RULE NUMBERS 12-9 THROUGH 12-19 ARE RESERVED.

REV	ITEM	

SYSTEMS MANAGEMENT

12-20 BUS MANAGEMENT

A. ONE AND ONLY ONE FUEL CELL WILL BE TIED TO BOTH MAIN BUSES.

B. INVERTERS WILL BE CONFIGURED SUCH THAT MAIN BUS A WILL SUPPLY AC BUS 1 AND MAIN BUS B WILL SUPPLY AC BUS 2.

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.

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.

E. MINIMUM MAIN BUS VOLTAGE WILL BE MAINTAINED TO BE COMPATABLE WITH ONLINE OPERATION EQUIPMENT.

1. SPS 24.5
2. PGNS 25.0
3. AUTO SM-RCS 22.0
4. AUTO CM-RCS 21.0
5. DIRECT SM-RCS 21.0
6. DIRECT CM-RCS 17.0
7. INVERTERS 19.0

12-21 BATTERY MANAGEMENT

A. BATTERIES A AND B WILL BE USED TO SUPPLEMENT MAIN BUS LOADS FROM T-75 SECONDS TO INSERTION.

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.

C. BATTERY CHARGING WILL BE TERMINATED FOR ONE OF THE FOLLOWING, WHICHEVER OCCURS FIRST:

1. INTEGRATED AMP-HOURS INTO BATTERY BY CHARGER EQUALS INTEGRATED AMP-HOURS OUT OF BATTERY BY LOADS.
2. WHEN BATTERY CHARGER CURRENT DROPS TO 0.4 AMPS.

D. THREE BATTERIES WILL BE TIED TO THE MAIN BUSES FOR DEORBIT MANEUVER AND ENTRY.

E. BATTERIES ARE CONSIDERED TO HAVE 40 AMP-HR CAPABILITY INFLIGHT AND 45 AMP-HR CAPABILITY FOR POSTLANDING.

F. A SINGLE BATTERY THAT CANNOT BE RECHARGED WILL NOT BE USED EXCEPT DURING DEORBIT, ENTRY, AND POSTLANDING.

G. BATTERY VENT VALVE WILL REMAIN CLOSED UNLESS MANIFOLD PRESSURE IS GREATER THAN 6 PSIA. VENTING OPERATION WILL BE ALLOWED TO TROUBLESHOOT A SUSPECTED FROZEN DUMP.

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.

REV	ITEM	
A	12-22 (CONT)	B. FUEL CELL MAY BE "OPEN CIRCUITED" FOR THE FOLLOWING: 1. SKIN TEMP >475°F 2. TCE TEMP >215°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 FOR CONFIRMED HIGH PH INDICATION. F. EACH H_2 PURGE WILL NORMALLY BE PRECEDED BY 20 MIMUTES OF H_2 VENT HEATER OPERATION. G. FC INLINE HEATERS WILL NORMALLY OPERATE IN "AUTO" CONTINUOUSLY. H. REACTANT VALVES MUST REMAIN OPEN <u>AT ALL TIMES</u> 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.
A	12-23	<u>INVERTER MANAGEMENT</u> INVERTERS MAY BE REMOVED FROM LINE FOR ANY OF THE FOLLOWING REASONS: A. INVERTER TEMP >190°F B. SPACECRAFT LOAD MANAGEMENT
		RULE NUMBERS 12-24 THROUGH 12-29 ARE RESERVED

NASA — Manned Spacecraft Center

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	
			EO	B. NO-GO FOR TLI	
				1. OPEN CIRCUIT FUEL CELL.	B.1. REF MALF PROC EPS 5.
				2. RECONFIGURE REMAINING TWO FUEL CELLS TO ONE FUEL CELL PER MAIN BUS ONLY.	
				3. IF FUEL CELL CANNOT BE RESTORED, PERFORM SHUT-DOWN.	
			TLC	C. BASED ON THE FAILURE MODE, CONSIDERATION WILL BE GIVEN TO CONTINUING WITH LOI.	
			ALL	D. CONTINUE MISSION	
A	12-31	LOSS OF TWO FUEL CELLS (OUTPUT <5 AMPS EACH)			• LM SYSTEMS (IF AVAILABLE) MAY BE USED IN LIEU OF CSM SYSTEMS TO CONSERVE CSM POWER.
			LAUNCH	A. CONTINUE MISSION AFTER 2 + 00 GET PERFORM:	
				1. EDS AUTO/OFF TO OFF.	
				2. IF LOSS OF FC 1 AND 2, TIE BAT C TO MAIN A.	
				3. IF LOSS OF FC 2 AND 3, TIE BAT C TO MAIN B.	
				4. IF LOSS OF FC 1 AND 3, TIE BAT C TO BOTH MAIN BUSES.	
			ALL	B. ENTER NEXT BEST PTP	B. ONE ENTRY BATTERY MAY BE USED TO SUPPLEMENT REMAINING FC FOR G&N ALIGNMENT PRIOR TO DEORBIT.
				1. CONNECT REMAINING FUEL CELL TO BOTH MAIN BUSES.	
				2. PERFORM "LOSS OF TWO FC POWER DOWN."	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	12-32	LOSS OF THREE FUEL CELLS			LM SYSTEMS (IF AVAILABLE) MAY BE USED IN LIEU OF CSM SYSTEMS TO CONSERVE CSM POWER.
		A. OUTPUT <10 AMPS EACH	LAUNCH	A.1. CONTINUE MISSION	
				(A) AFTER 2 + 00 EDS AUTO/OFF TO OFF.	A.1.(A) IF TOTAL OUTPUT CAPABILITY LESS THAN 8 AMPS AT 22 VDC, SMJC WILL BE INOPERATIVE FOR CM/SM SEP.
				(B) TIE BAT C TO BOTH MAIN BUSES.	
				(C) POWER DOWN AT INSERTION ENTER 2-1 IF FUEL CELLS CANNOT BE RESTORED.	A.1.(C) 4.75 HOURS LEFT IN ORBIT BEFORE DEORBIT MANEUVER.
			ALL	2. ENTER NEXT BEST PTP	
		B. TOTAL OUTPUT CAPABILITY INSUFFICIENT TO SUPPORT DRIFTING FLIGHT LOADS	ALL	B.1. ENTER NEXT BEST PTP MANIPULATION OF CYCLIC LOADS WILL BE ATTEMPTED TO MAINTAIN VM >26.5 VDC	B.1. 95 AMPS REPRESENTS MAXIMUM DRIFTING FLIGHT REQUIREMENTS (66 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. 36 AMPS REPRESENTS MINIMUM POWER TO SUPPORT S/C SYSTEMS IN ORBIT.
			LAUNCH	2. NOT APPLICABLE	
	12-33	LOSS OF THREE FUEL CELLS PLUS ONE BATTERY CURRENT <50 PERCENT OF LOAD ON EITHER REMAINING BATTERY			USE LM SYSTEMS (IF AVAILABLE). RESERVE ENTRY BATTERIES FOR ENTRY.
			LAUNCH	A. ABORT	A. ASSUMES ALL THREE FUEL CELL CURRENTS ≤5 AMPS AND BATTERY C TIED TO BOTH MAINS.
			EO	B. ENTER NEXT BEST ATP OR PTP PERFORM EMERGENCY POWER DOWN	B. 2.4 HOURS LEFT IN ORBIT BEFORE SPS IGNITION
			ALL	C. ENTER NEXT BEST PTP PERFORM EMERGENCY POWER DOWN	
		RULE NUMBERS 12-34 THROUGH 12-39 ARE RESERVED			

NASA — Manned Spacecraft Center

MISSION RULES

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> 1. EDS AUTO/OFF TO OFF. 2. IF LOSS OF BAT A, TIE BAT C TO MAIN A. 3. IF LOSS OF BAT B, TIE BAT C TO MAIN B.	
			EO	B. <u>NO-GO FOR TLI</u>	B. IF LOST DURING SPS MANEUVER, CONTINUE ON REMAINING BATTERY.
			ALL	C. BASED ON FAILURE MODE, CONSIDERATION WILL BE GIVEN TO CONTINUING NOMINAL MISSION.	
	12-41	LOSS OF TWO ENTRY BATTERIES (OUTPUT <3 AMPS EACH WHEN CONNECTED TO MAIN BUS)	LAUNCH	A. <u>CONTINUE MISSION</u> 1. EDS AUTO/OFF TO OFF. 2. ENTER 2-1 POWERED DOWN.	
			ALL	B. <u>ENTER NEXT BEST PTP</u> USE ONE BATTERY ENTRY PROCEDURE.	B. IF LOSS DURING SPS MANEUVER, ATTEMPT TO TIE BATTERY C TO BOTH MAINS.
A	12-42	LOSS OF BATTERY CHARGER		BATTERY CHARGER WILL NOT BE CHECKED PRIOR TO TLI. ROTATE BATT C AS REQUIRED TO MAINTAIN BALANCED BATTERIES.	BATT ENERGY LEVELS ALLOW AN ADDITIONAL 5 AMP-HRS GAINED AT SPLASH. ALL REDLINES ALLOW FOR UPRIGHTING AND 18 HRS OF POSTLANDING.
			EO (AFTER TLI NO-GO)	A. <u>ENTER NEXT BEST PTP</u> IF REQUIRED DEORBIT CAPABILITY IS LOST AS FOLLOWS: 3 GOOD BATTS / 2 GOOD BATTS HYBRID: 68 AH / 73 AH SM-RCS: 52 AH / 57 AH	
			TLC	B. <u>NO-GO LOI</u> IF SUM OF TWO LOWEST BATTS <56 AH.	B. ENERGY LEVEL REFLECTS NO CSM RESCUE, NO PRE CM/SM SEP BATT CONDITIONING, AND REDUCED POWER G&N ENTRY WITH TWO BATTS.
			LO	C. <u>NO-GO FOR UNDOCK/RNDZ</u> IF SUM OF TWO LOWEST BATTS <52 AH. CONSIDERATION WILL BE GIVEN TO EARLY TEI AFTER RNDZ IF SUM OF TWO LOWEST ENTRY BATTS <49 AH.	C. ENERGY LEVEL REFLECTS CSM RESCUE WITH NO PRE CM/SM SEP BATT CONDITIONING AND A REDUCED POWER SCS ENTRY WITH TWO BATTS. 49 AH WILL ALLOW A TWO BATT POWERED DOWN G&N ENTRY WITHOUT PRE CM/SM SEP BATT CONDITIONING.
		RULE NUMBERS 12-43 THROUGH 12-49 ARE RESERVED			

FEC/TSC Form 291 (AUG 68)

NASA — Manned Spacecraft Center
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 (A) IF MOTOR SW A/C, TIE BAT C TO MAIN BUS A. (B) IF MOTOR SW B/C, TIE BAT C TO MAIN BUS B.	
			ALL	2. CONTINUE MISSION 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 CB CLOSED FOR CHARGING.
		B. ONE OR BOTH MOTOR SW FAILED CLOSED	ALL	B. CONTINUE MISSION USE CB'S AS MOTOR SWITCHES.	B. IF BOTH MOTOR SWITCHES FAIL CLOSED, BATTERIES CANNOT BE CHARGED.
	12-51	MAIN BUS SHORTED CAUSING FUEL CELL REVERSE CURRENT DISCONNECT			
		A. FUEL CELL 2 DISCONNECTS FROM MAIN A	LAUNCH	A.1. CONTINUE MISSION (A) PLACE EDS AUTO/OFF TO OFF. (B) F/C 2 TO BUS A ONLY. (C) TIE BAT C TO MAIN A. (D) INVERTER 3 TO AC BUS 2, MAIN A. (E) POWER DOWN MAIN BUS B.	A.1. >85 AMPS SHORT ON MAIN B WILL CAUSE REVERSE DISCONNECT DURING LAUNCH MALF EPS-3.
			ALL	A.2. ENTER NEXT BEST PTP IF BUS NOT RESTORED POWER DOWN MAIN BUS B.	A.2. REF MALF PROC EPS 5SR-1
		B. FUEL CELL 2 DISCONNECTS FROM MAIN B	LAUNCH	B.1. CONTINUE MISSION (A) PLACE EDS AUTO/OFF TO OFF. (B) FC 2 TO BUS B ONLY. (C) TIE BAT C TO MAIN BUS B. (D) INVERTER 3 TO AC BUS 1, MAIN B. (E) POWER DOWN MAIN BUS A. (F) TVC GIMBAL DRIVE (P,Y) -2. (G) GIMBAL MOTOR CONTROL (YAW 2, PITCH 2) BAT B OPEN FOLLOWING GIMBAL MOTOR TURN ON.	B.1. >79 AMPS SHORT ON MAIN A WILL CAUSE REVERSE DISCONNECT DURING LAUNCH
			ALL	B.2. ENTER NEXT BEST PTP IF BUS NOT RESTORED. POWER DOWN MAIN BUS A	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	12-51 (CONT)	C. MAIN BUS SHORTED >25 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.	2. IF FUEL CELL FEED CIRCUITRY SHORTED, CLOSE FC REACTANT VALVES.
	12-52	A. BATTERY BUS SHORTED >5 AMPS	LAUNCH	A.1. CONTINUE MISSION (A) PLACE EDS AUTO/OFF TO OFF. (B) OPEN ASSOCIATED MAIN BUS TO BAT BUS CB. (C) TIE BAT C TO ASSOCIATED MAIN BUS.	A.1. >22 AMPS WILL CAUSE BATTERY BUS VOLTAGE TO BE ≤ MAIN BUS VOLTAGE.
			ALL	2. ENTER NEXT BEST PTP IF BUS NOT RESTORED	A.2. REMOVE POWER FROM BUS, IF SHORTED ≤ 10 AMPS. POWER BUS JUST PRIOR TO ENTRY TO MAINTAIN SECS REDUNDANCY.
		B. BATTERY BUS SHORTED <5 AMPS	ALL	B. CONTINUE MISSION REMOVE POWER FROM BUS EXCEPT FOR MANEUVERS AND ENTRY	
	12-53	BATTERY RELAY BUS SHORTED			
		A. SHORT >2.0 AMPS	LAUNCH	A.1. CONTINUE MISSION	
			ALL	2. ENTER NEXT BEST PTP OPEN BATTERY BUS TO BATTERY RELAY BUS CB'S.	A.2. REF MALF PROC EPS-SSR-2
		B. SHORT <2.0 AMPS	ALL	B. CONTINUE MISSION	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 EPS SSR-2
	12-54	LOSS OF ONE BATTERY BUS, MAIN BUS, OR BATTERY RELAY BUS. (UNABLE TO POWER BUS)	LAUNCH	A. CONTINUE MISSION	
			ALL	B. ENTER NEXT BEST PTP	
		RULE NUMBERS 12-54 THROUGH 12-59 ARE RESERVED			

NASA — Manned Spacecraft Center

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	B. CONSIDERATION WILL BE GIVEN TO RETAINING LM FOR SYSTEM BACKUP.
	12-61	LOSS OF ONE AC BUS (WO PHASES CANNOT BE MAINTAINED >95 VAC)	LAUNCH	A. CONTINUE MISSION	
			ALL	B. ENTER NEXT BEST PTP	B. REF MALF PROC EPS-1
	12-62	LOSS OF BOTH AC BUSES	LAUNCH	A. ABORT MODE I OR MODE II 1. OPEN DIRECT O_2 FOR SUIT VENTILATION. 2. IF AFTER MODE II, ENTER 2-1 PTP.	A. REF MR____ A.2. INITIATE CONTINUOUS FC H_2 PURGE FOR COOLING.
			ALL	B. ENTER NEXT BEST PTP OR ATP IF SUITED, REMOVE HELMET AND GLOVES. IF TIME PERMITS, REMOVE SUITS. IF CABIN DEPRESSURIZED, USE DIRECT O_2 UNTIL CABIN IS REPRESSURIZED.	B.1. USE LM SYSTEMS (IF AVAILABLE) FOR AC POWERED FUNCTIONS TO ENTRY. 2. FOR CSM ONLY, ENTER WITHIN 1-1/2 HOURS. INITIATE CONTINUOUS FC H_2 PURGE FOR COOLING.
		RULE NUMBERS 12-63 THROUGH 12-69 ARE RESERVED			

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM
	12-70

INSTRUMENTATION REQUIREMENTS

MEAS DESCRIPTION	PCM	ONBOARD	TRANSDUCERS	CATEGORY	MISSION RULE REFERENCE
AC BUS 1 ϕA VAC	CC0200V	METER	SEPARATE	HIGHLY DESIRABLE	12-5,6,61
AC BUS 1 ϕB VAC	-------	METER	-----------	HIGHLY DESIRABLE	
AC BUS 1 ϕC VAC	-------	METER	-----------	HIGHLY DESIRABLE	
		COMMON METER			
AC BUS 2 ϕA VAC	CC0203V	METER	SEPARATE	HIGHLY DESIRABLE	12-5,6,61
AC BUS 2 ϕB VAC	-------	METER	-----------	HIGHLY DESIRABLE	
AC BUS 2 ϕC VAC	-------	METER	-----------	HIGHLY DESIRABLE	
MAIN BUS A VDC	CC0206V	METER	SEPARATE	1 OF 2 MANDATORY	12-32,52,20C 12-22
MAIN BUS B VDC	CC0207V	METER	SEPARATE		
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	2 OF 3 MANDATORY	12-4,33,40,41
BAT B CURRENT	CC0223C	METER	COMMON		
BAT C CURRENT	CC0224C	METER	COMMON		
FC 1 CURRENT	SC2113C	METER	COMMON	1 OF 3 MANDATORY	12-7,31,32,33, 22A
FC 1 O_2 FLO	SC2141R	METER	COMMON		
FC 1 H_2 FLO	SC2139R	METER	COMMON		
FC 2 CURRENT	SC2114C	METER	COMMON	1 OF 3 MANDATORY	12-7,31,32,33, 22A
FC 2 O_2 FLO	SC2142R	METER	COMMON		
FC 2 O_2 FLO	SC2140R	METER	COMMON		
FC 3 CURRENT	SC2115C	METER	COMMON	1 OF 3 MANDATORY	12-7,31,32,33, 22A
FC 3 O_2 FLO	SC2144R	METER	COMMON		
FC 3 H_2 FLO	SC2141R	METER	COMMON		
BAT CHARGER CURRENT	SC0215C	METER	COMMON	HIGHLY DESIRABLE	
FC 1 SKIN TEMP	SC2084T	METER	COMMON	HIGHLY DESIRABLE	12-22B
FC 2 SKIN TEMP	SC2085T	METER	COMMON	HIGHLY DESIRABLE	
FC 3 SKIN TEMP	SC2086T	METER	COMMON	HIGHLY DESIRABLE	
FC 1 COND TEMP	SC2081T	METER	COMMON	HIGHLY DESIRABLE	12-22B
FC 2 COND TEMP	SC2082T	METER	COMMON	HIGHLY DESIRABLE	
FC 3 COND TEMP	SC2083T	METER	COMMON	HIGHLY DESIRABLE	
FC 1 RAD OUT TEMP	SC2087T	METER	COMMON	HIGHLY DESIRABLE	12-22I
FC 2 RAD OUT TEMP	SC2088T	METER	COMMON	HIGHLY DESIRABLE	
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	12-22E
FC 2 PH	SC2161X	TALKBACK	COMMON	HIGHLY DESIRABLE	
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)

NASA — Manned Spacecraft Center

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	LAUNCH 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	ALL MISSION PHASES TO CONTINUE THE MISSION, BOTH PYRO BUSES AND BOTH LOGIC BUSES ARE REQUIRED.
	14-4	SEQUENTIAL LOGIC BUS IS CONSIDERED FAILED IF: 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) B. LOGIC BUS SHORTED >10 AMPS
	14-5	PYRO BUS IS CONSIDERED FAILED IF: A. SHORTED >10 AMPS B. FAILURE TO PERFORM ANY SEQUENTIAL FUNCTION WITH SUSPECTED FAILED PYRO SYSTEM
		RULE NUMBERS 14-6 THROUGH 14-9 ARE RESERVED

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

NASA — Manned Spacecraft Center

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 ENTER 3-1 IF BUS NOT RESTORED	
			ALL	B. TERMINATE OPERATIONS ENTER NEXT BEST PTP IF BUS NOT RESTORED	
	14-21	PYRO BUS A OR B ≤35 VDC			• SHORTS CAN ONLY BE DETECTED USING ENTRY BATTERY TIE
		A. SHORTED >10 AMPS	LAUNCH	A.1. CONTINUE MISSION	
			ALL	2. TERMINATE OPERATIONS 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 NOT SHORTED	LAUNCH	C.1. CONTINUE MISSION 2. ATTEMPT FUNCTION USING SUSPECTED FAILED BUS ONLY: (A) IF FUNCTION NORMAL, CONTINUE MISSION (B) IF FUNCTION DOES NOT WORK NORMALLY, ENTER NEXT BEST PTP	
	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 CB'S 1, 2, OR 3 CLOSED	
	14-23	LET JETTISON MOTOR DOES NOT FIRE	LAUNCH	CONTINUE MISSION ATTEMPT JETTISON PER CREW CHECKLIST EMERGENCY PROCEDURE	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	14-24	SMJC ACTIVATES PREMATURELY	ALL	ENTER NEXT BEST PTP A. TERMINATE OPERATIONS AND POWER DOWN AFFECTED MAIN BUS. DO NOT ARM AFFECTED PYRO BUS B. IF UNDOCKED, RETURN TO CSM AND PERFORM CSM/LM FINAL SEP 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. B. USE GOOD SEQUENTIAL SYSTEM
	14-25	ACTIVATED CM RCS PRESS LOGIC RELAYS.	ALL	CONTINUE MISSION A. PRIOR TO CM RCS PRESS: DO NOT ARM RESPECTIVE PYRO BUS (FOR BOTH INDICATIONS PERFORM SLA SEP WITH SECS ARM CB'S OPEN.) B. AT CM RCS PRESS: ARM RESPECTIVE PYRO BUS	CD0173X AND/OR CD0174X
	14-26	ACTIVATED SLA DEPLOY LOGIC RELAYS	ALL	CONTINUE MISSION A. PRIOR TO SLA SEP: DO NOT ARM RESPECTIVE PYRO BUS B. FOR SLA SEP: ARM RESPECTIVE PYRO BUS FIRST	CD0123X AND/OR CD0124X
	14-27	UNABLE TO PERFORM SLA SEPARATION	TLC	ENTER NEXT BEST PTP	REF MR ____
A	14-28	LOST GROUND TO RESISTER NETWORK FOR LOGIC OR PYRO BUS VOLTS MEASUREMENTS RULE NUMBERS 14-29 THROUGH 14-39 ARE RESERVED	ALL	CONTINUE MISSION DO NOT ARM AFFECTED SYSTEM UNTIL SEQ GO/NO-GO PRIOR TO ENTRY UNLESS OTHER SYSTEM FAILS.	ARMING SYSTEM WITH VOLTAGE >18 VDC WILL RESULT IN PERMANENT LOSS OF ALL ANALOG TELEMETRY PARAMETERS.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	14-40	ACTIVATED APEX JETTISON LOGIC RELAYS	ALL	ENTER NEXT BEST PTP 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	ENTER NEXT BEST PTP 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	TEC	ENTER NEXT BEST PTP 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) CB CLOSED
		RULE NUMBERS 14-43 THROUGH 14-49 ARE RESERVED			

NASA — Manned Spacecraft Center

MISSION RULES

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
SEQ LOGIC BUS B VOLTS	CD0201V	-------	-----------	HD	14-20
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	19-23
CSM-LM LOCK RING SEP RELAY B	CD1155X	-------	-----------	HD	19-23
LM CURRENT	SC2962C	METER	COMMON	HD	-----

15 CSM GUIDANCE AND CONTROL

REV	ITEM	GENERAL
	15-1	LAUNCH THERE ARE NO FAILURES OF THE CSM GUIDANCE AND CONTROL SYSTEM WHICH ARE CAUSE FOR ABORT.
	15-2	EARTH ORBIT PHASE A. IN ORDER TO CONTINUE THE MISSION PAST THE NEXT BEST PTP, THE GUIDANCE AND CONTROL SYSTEMS MUST PROVIDE SPS CRITICAL BURN CAPABILITY AND ONE BACKUP DEORBIT METHOD (SM OR HYBRID). THE FOLLOWING MINIMUM CAPABILITIES MUST BE AVAILABLE: 1. ATTITUDE CONTROL: DIRECT RCS AND RATE DAMPING IN EACH AXIS. 2. TVC (CRITICAL BURNS): ONE TVC SERVO LOOP IN EACH AXIS AND ONE TVC CONTROL MODE (ACCEL CMD EXCLUDED). 3. BACKUP DEORBIT: AS LONG AS ENOUGH PROPELLANT IS AVAILABLE FOR AN SM DEORBIT, THE G&C SYSTEMS MUST PROVIDE THAT CAPABILITY. IF SM DEORBIT IS NOT POSSIBLE DUE TO LACK OF PROPELLANT OR A SYSTEMS FAILURE, THE G&C SYSTEMS MUST PROVIDE CAPABILITY FOR A HYBRID DEORBIT. (A) SM DEORBIT REQUIREMENTS: - TRANSLATION CAPABILITY - ONE OPERATIONAL FDAI - RATE DAMPING IN ALL THREE AXES (DAP OR SCS) (B) HYBRID DEORBIT REQUIREMENTS: - ALL SM DEORBIT REQUIREMENTS (RATE DAMPING MUST BE SCS) - OPERATIONAL, IMU, CMC, AND MAIN DSKY - TWO OPERATIONAL RHC'S B. IN ORDER TO PERFORM A NON-CRITICAL BURN AFTER THE STORAGE TANKS ARE EMPTY, THE G&C SYSTEMS MUST PROVIDE THE CAPABILITY TO EXECUTE AN ULLAGE MANEUVER BY EITHER CMC AUTO (RCS DAP), SCS AUTO, OR DIRECT ULLAGE. C. IN ORDER TO COMMIT TO THE TRANSLUNAR COAST PHASE, THE GUIDANCE AND CONTROL SYSTEMS MUST PROVIDE SPS NON-CRITICAL BURN CAPABILITY. THE FOLLOWING MINIMUM CAPABILITIES MUST ALSO BE AVAILABLE TO BE GO FOR TLI: 1. ATTITUDE CONTROL: DIRECT RCS AND RATE DAMPING IN EACH AXIS. 2. TVC: TWO SERVO LOOPS AND BOTH G&N AND ONE SCS TVC CONTROL MODES (ACCEL CMD EXCLUDED) 3. G&N: CMC, IMU, AND MDC DSKY FULLY OPERATIONAL AND OPTICS CAPABLE OF ALIGNING PLATFORM. 4. DISPLAYS: ONE OPERATIONAL FDAI. 5. ATTITUDE REFERENCE: REDUNDANT ATTITUDE SOURCES ARE REQUIRED FOR ENTRY.
	15-3	TRANSLUNAR COAST IN ORDER TO CONTINUE THE MISSION PAST THE NEXT BEST PTP, THE GUIDANCE AND CONTROL SYSTEMS MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES: A. ATTITUDE CONTROL: DIRECT RCS AND RATE DAMPING IN EACH AXIS. B. RCS TRANSLATION: X-AXIS VIA AUTO COILS OR DIRECT ULLAGE PUSHBUTTON. C. ATTITUDE REFERENCE: REDUNDANT ATTITUDE REFERENCE SOURCES ARE REQUIRED FOR ENTRY.

REV	ITEM	
	15-4	LOI, LUNAR ORBIT PHASES:

LOI, LUNAR ORBIT PHASES:

A. LOI WILL BE INHIBITED OR LUNAR ORBIT TERMINATED EARLY IF EITHER REDUNDANT ATTITUDE CONTROL, REDUNDANT SPS CONTROL OR NON-CRITICAL SPS CAPABILITY IS LOST. IN ADDITION, THE FOLLOWING MINIMUM CAPABILITIES MUST BE AVAILABLE BEFORE COMMITTING TO OR CONTINUING LUNAR ORBIT.

1. ATTITUDE CONTROL: DIRECT RCS AND RATE DAMPING IN EACH AXIS.
2. TVC: BOTH SERVO LOOPS AND TWO TVC CONTROL MODES (ACCEL CMD EXCLUDED).
3. G&N: THE G&N MUST BE FULLY OPERATIONAL WITH THE EXCEPTION OF OPTICS AND NAV DSKY. OPTICS MUST BE CAPABLE OF ALIGNING PLATFORM.
4. RCS TRANSLATION: X-AXIS VIA AUTO COILS OR DIRECT ULLAGE PUSHBUTTON.

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.

15-5 DOCKED SPS MANEUVERS

THE GUIDANCE AND CONTROL SYSTEM MUST PROVIDE A MINIMUM OF ONE TVC SERVO LOOP IN EACH AXIS AND ONE TVC CONTROL MODE TO ALLOW DOCKED SPS MANEUVERS.

15-6 UNDOCKED

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, RATE DAMPING AND TRANSLATION CAPABILITY IN EACH AXIS FOR DOCKING/UNDOCKING CONTROL.

15-7 RENDEZVOUS

THE RENDEZVOUS PHASE WILL BE DELETED 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:

- OPERATIONAL OPTICS SUBSYSTEM
- ONE DSKY
- TRANSLATION CAPABILITY
- RATE DAMPING IN ALL THREE AXES
- OPERATIONAL IMU AND CMC
- ONE OPERATIONAL RHC
- ONE OPERATIONAL FDAI
- DIRECT RCS

RULES 15-8 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. LM IN ACTIVE RCS CONTROL; CSM WILL NOT BE IN ACTIVE ATTITUDE HOLD. 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 0.007 FT/SEC AND 0.075 DEG/HR RESPECTIVELY.
A	15-12	ΔV COUNTER DRIFT SHOULD THE ΔV 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 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. 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 VALUES BY 10.0 PERCENT.
		RULE NUMBERS 15-14 THROUGH 15-19 RESERVED.

NASA — Manned Spacecraft Center

MISSION RULES

SPECIFIC MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	15-20	LOSS OF EITHER BMAG 1 OR 2 IN EITHER PITCH OR YAW CHANNEL	ALL	<u>CONTINUE MISSION</u>	A. REF MALF PROC ____ B. NO SCS AUTO TVC C. IF IN YAW CHANNEL, AFTER .05G, RSI IS USABLE IF REMAINING GYRO IS SELECTED FOR RATE. RSI MUST BE REALIGNED IN ADDITION TO THE ABOVE, FOR YAW FAILURE AFTER .05G.
	15-21	LOSS OF BOTH BMAG 1 AND 2 IN EITHER PITCH OR YAW CHANNEL	LAUNCH	A. <u>CONTINUE MISSION</u>	A. MTVC ACCEL CMD IS ONLY MODE III OR MODE IV SPS CONTROL MODE.
			TLC	B. <u>NO-GO FOR LOI</u>	
			RNDZ	C. <u>CONTINUE MISSION</u>	
			ALL OTHERS	D. <u>TERMINATE PHASE AND ENTER NEXT BEST PTP</u>	D. IN EARTH ORBIT, 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
			ENTRY	E. <u>CONTINUE MISSION</u>	E. RSI AND SCS FDAI ROLL UNUSABLE WITH YAW CHANNEL FAILURES.
	15-22	LOSS OF ROLL BMAG A. NUMBER ONE	ALL	A. <u>CONTINUE MISSION</u>	A.1. MANUAL ROLL ATTITUDE CONTROL REQUIRED IN ALL SCS MODES. 2. NO SCS FDAI ROLL. RSI VALID.
		B. NUMBER TWO	ALL	B. <u>CONTINUE MISSION</u>	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. 2. SELECTION OF RATE 1 WILL PROVIDE BOTH RSI AND SCS FDAI ROLL FOR ENTRY. RSI MUST BE REALIGNED FOR ROLL FAILURE AFTER .05G.

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	15-23	LOSS OF BOTH ROLL BMAG'S	LAUNCH	A. CONTINUE MISSION	
			TLC	B. NO-GO FOR LOI	
			LO/UN-DOCKED	C. CONTINUE MISSION	
			RNDZ	D. CONTINUE MISSION	
			ALL OTHERS	E. TERMINATE PHASE AND ENTER NEXT BEST PTP	
			ENTRY	F. CONTINUE MISSION	F. NO SCS FDAI ROLL OR RSI AVAILABLE
	15-24	LOSS OF EITHER TVC SERVO LOOP IN EITHER PITCH OR YAW AXIS			• MAINTAIN 20 LBS/QUAD/AXIS FOR HARDOVER RECOVERY FOR UNDOCKED AND ____LBS/QUAD/AXIS FOR HARDOVER RECOVERY FOR DOCKED SPS MANEUVERS.
			LAUNCH/EO	A. CONTINUE ALTERNATE EO MISSION SELECT 1 OR 2 ON TVC GIMBAL DRIVE SWITCH IN APPROPRIATE AXIS	
			TLC	B. NO-GO FOR LOI	
			RNDZ	C. CONTINUE MISSION	C. DO NOT STAGE LM
			ALL OTHERS	D. TERMINATE PHASE AND ENTER NEXT BEST PTP	
	15-25	LOSS OF BOTH TVC SERVO LOOPS	LAUNCH	A. CONTINUE MISSION	A.1. REF MALF PROC SCS ____ 2. NO MODE III OR IV CAPABILITY. LIMITED LANDING POINT CONTROL IN MODE III OR IV WITH SM-RCS.
			EO	B. ENTER NEXT BEST PTP RCS DEORBIT	
			TLC	C. NO-GO FOR LOI	
			RNDZ	D. CONTINUE MISSION	D. DO NOT STAGE LM
			ALL OTHERS	E. TERMINATE PHASE AND ENTER NEXT BEST PTP	
	15-26	LOSS OF PROPORTIONAL CONTROL FROM:			
		A. EITHER RHC	ALL	A. CONTINUE MISSION USE REMAINING RHC	
		B. BOTH RHC'S	ALL	B. CONTINUE MISSION USE DIRECT RCS OR ACCEL CMD FOR MANUAL MANEUVERS	B. NO MTVC RATE OR MTVC ACCEL CMD CAPABILITY

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	15-27	LOSS OF DIRECT RCS CONTROL FROM:			• REF MALF PROC SCS ___
		A. EITHER RHC	ALL	A. CONTINUE MISSION	
		B. BOTH RHC'S	LAUNCH	B.1. CONTINUE MISSION	
			RNDZ	2. CONTINUE MISSION	
			ALL OTHERS	3. TERMINATE PHASE AND ENTER NEXT BEST PTP	B.3. FAILURE VIOLATES DIRECT RCS REQUIREMENT.
	15-28	COMPLETE LOSS OF AUTO ATTITUDE CONTROL IN PITCH AND YAW CHANNELS.			• REF MALF PROC SCS ___ SUSPECTED FAILURE WOULD BE AUTO INHIBIT CIRCUITRY.
		A. CONTROL IS REGAINED BY OPENING EMS CB'S.	ALL	A. CONTINUE MISSION AFTER SM JETTISON EMS MAY BE REENABLED WITHOUT LOSS OF AUTO RCS.	
		B. CONTROL IS REGAINED BY PLACING S/C CONTROL SWITCH TO CMC.	ALL	B. CONTINUE MISSION	B. NO SCS ATTITUDE OR TVC CONTROL
		C. CONTROL IS NOT REGAINED	RNDZ	C.1. CONTINUE MISSION	
			ALL OTHERS	2. TERMINATE PHASE AND ENTER NEXT BEST PTP USE DIRECT ULLAGE AND DIRECT RCS.	C.2. FAILURE VIOLATES RATE DAMPING REQUIREMENTS.
	15-29	LOSS OF FLIGHT DIRECTOR ATTITUDE INDICATORS			• REF MALF PROC SCS ___
		A. ONE	ALL	A. CONTINUE MISSION	
		B. BOTH	LAUNCH	B.1. CONTINUE MISSION	
			TLC	2. NO-GO FOR LOI	
			RNDZ	3. CONTINUE MISSION	
			ALL OTHERS	4. TERMINATE PHASE AND ENTER NEXT BEST PTP	4. USE WINDOW REF.

NASA — Manned Spacecraft Center

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: A. REDUNDANT SERVO LOOP POWER. BOTH SERVO LOOPS MUST BE POWERED BY THE SAME BUS. B. PROPORTIONAL ATTITUDE CONTROL FROM BOTH RHC'S. ALL PROPORTIONAL CONTROL FROM RHC #1. C. FDAI #1 D. GYRO ASSEMBLY #1 E. SCS TOTAL ATTITUDE ERROR F. SCS TOTAL ATTITUDE G. SCS AUTO TVC CAPABILITY H. SCS MINIMUM IMPULSE CAPABILITY I. SCS ATTITUDE CONTROL RATE DAMPING J. GPI P&Y DRIVE #1. • IN EARTH ORBIT, LOSS OF AC1 PRECLUDES HYBRID DEORBIT AND SUBJECTS BOTH REMAINING DEORBIT METHODS TO A SINGLE FAILURE (AC2 ϕA).
			LAUNCH	A. CONTINUE MISSION	
			TLC	B. NO-GO FOR LOI	
			RNDZ	C. CONTINUE MISSION	C. DO NOT STAGE LM.
			ALL OTHERS	D. TERMINATE PHASE AND ENTER NEXT BEST PTP	
	15-31	LOSS OF AC2 ϕA			• LOSS OF AC2 ϕA RESULTS IN THE LOSS OF: A. REDUNDANT SERVO LOOP POWER B. ALL PROPORTIONAL CONTROL C. FDAI #2 D. GYRO ASSEMBLY #2 E. SCS PITCH AND YAW TOTAL ATTITUDE F. ALL SCS TVC CAPABILITY (AUTO, RATE AND ACCEL CMD) G. RSI H. GPI P&Y DRIVE #2 • IN EARTH ORBIT, LOSS OF AC2 RESULTS IN ALL THREE DEORBIT METHODS BEING SUBJECTED TO A SINGLE FAILURE (AC1 ϕA).
			LAUNCH	A. CONTINUE MISSION	
			TLC	B. NO-GO FOR LOI	
			RNDZ	C. CONTINUE MISSION	C. DO NOT STAGE LM.
			ALL OTHERS	D. TERMINATE PHASE AND ENTER NEXT BEST PTP	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	15-32	LOSS OF ORBIT RATE DISPLAY (ORDEAL) EARTH AND LUNAR	ALL	CONTINUE MISSION	REF MALF PROC SCS ____
	15-33	LOSS OF ENTRY MONITOR SYSTEM	ALL	CONTINUE MISSION	REF MALF PROC SCS ____
	15-34	GROUND AT EITHER SPS SOL DRIVER OUTPUT AND UNABLE TO REMOVE.			• REF MALF PROC SCS ____
			LAUNCH	A. CONTINUE MISSION	
			EARTH ORBIT	B. CONTINUE ALTERNATE EO MISSION. USE OTHER SPS BANK FOR ENGINE OPERATION	
			TLC	C. NO-GO FOR LOI	
			RNDZ	D. CONTINUE MISSION	
			ALL OTHERS	E. TERMINATE PHASE AND ENTER NEXT BEST PTP	
	15-35	LOSS OF TRANSLATION HAND CONTROLLER	LAUNCH	A. CONTINUE MISSION	
			EARTH ORBIT	B. ENTER NEXT BEST PTP	B. VIOLATES BOTH SM AND HY-BRID DEORBIT MINIMUM REQUIREMENTS.
			TLC	C. CONTINUE MISSION	
			LO	D. NO-GO FOR UNDOCKING PERFORM ALTERNATE LO MISSION	D. VIOLATES LM RESCUE MINIMUM REQUIREMENTS.
			UNDOCKED	E. DOCK	
			RNDZ	F. CONTINUE MISSION	
		RULE NUMBERS 15-36 THROUGH 15-49 ARE RESERVED.			

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	15-50	LOSS OF COMMAND MODULE COMPUTER			• REF MALF PROC G&C ____
			LAUNCH	A. CONTINUE MISSION	
			EO	B. CONTINUE ALTERNATE EO MISSION IF BOTH SPS AND SM DEORBIT CAPABILITY AVAILABLE	B. VIOLATES HYBRID DEORBIT MINIMUM REQUIREMENTS.
			TLC	C. NO-GO FOR LOI	
			LO	D. NO-GO FOR UNDOCKING PERFORM ALTERNATE LO MISSION	D. VIOLATES LM RESCUE MINIMUM REQUIREMENTS
			UNDOCKED	E. DOCK	
			RNDZ	F. CONTINUE MISSION	
			ENTRY	G. PERFORM BACKUP ENTRY	
	15-51	LOSS OF DSKY			• REF MALF PROC G&C ______
		A. EITHER MDC OR LEB DSKY	ALL	A. CONTINUE MISSION	
		B. BOTH MDC AND LEB DSKY	EO	B.1. CONTINUE ALTERNATE EO MISSION IF BOTH SPS AND SM DEORBIT CAPABILITY AVAILABLE	B.1. VIOLATES HYBRID DEORBIT MINIMUM REQUIREMENTS
			TLC	2. NO-GO FOR LOI	
			LO	3. NO-GO FOR UNDOCKING PERFORM ALTERNATE LO MISSION	3. VIOLATES LM RESCUE MINIMUM REQUIREMENTS
			UNDOCKED	4. DOCK	
			RNDZ	5. CONTINUE MISSION	
			ENTRY	6. PERFORM BACKUP ENTRY	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	15-52	CSM WARNING RELAY IN NAV DSKY CLOSED			• CONSTITUTES LOSS OF PIPA'S G&N TVC, ENTRY GUIDANCE AND FINE ALIGN.
			LAUNCH	A. CONTINUE MISSION	
			EO	B. CONTINUE ALTERNATE EO MISSION IF BOTH SPS AND SM DEORBIT CAPABILITY AVAILABLE	B. PIPA'S ARE REQUIRED FOR ΔV SENSING IN HYPRID DEORBIT.
			TLC	C. NO-GO FOR LOI	
			LO	D. NO-GO FOR UNDOCKING PERFORM ALTERANATE LO MISSION	D. VIOLATES LM RESCUE MINIMUM REQUIREMENTS
			UNDOCKED	E. DOCK	
			RNDZ	F. CONTINUE MISSION	
			ENTRY	G. PERFORM BACKUP ENTRY	
	15-53	LOSS OF INERTIAL SUB-SYSTEM			• REF MALF PROC G&C ____
			LAUNCH	A. CONTINUE MISSION	
			EO	B. CONTINUE ALTERNATE EO MISSION IF BOTH SPS AND SM DEORBIT	B. VIOLATES HYBRID DEORBIT MINIMUM REQUIREMENTS
			TLC	C. NO-GO FOR LOI	
			LO	D. NO-GO FOR UNDOCKING PERFORM ALTERNATE LO MISSION	D. VIOLATES LM RESCUE MINIMUM REQUIREMENTS
			UNDOCKED	E. DOCK	
			RNDZ	F. CONTINUE MISSION	
			ENTRY	G. PERFORM BACKUP ENTRY	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	15-54	LOSS OF OPTICS SUBSYSTEM			• REF MALF PROC G&C _____
			LAUNCH	A. CONTINUE MISSION	
			EO	B. CONTINUE ALTERNATE EO MISSION USE BACKUP ALIGNMENT PROCEDURE (COAS)	
			TLC	C. NO-GO FOR LOI	
			LUNAR ORBIT	D. NO-GO FOR UNDOCKING PERFORM ALTERNATE LO MISSION	D. VIOLATES LM RESCUE MINIMUM REQUIREMENTS
			UNDOCKED	E. DOCK	
			RNDZ	F. CONTINUE MISSION	
	15-55	LOSS OF OPTICS SUBSYSTEM COUPLING DATA UNIT DIGITAL TO ANALOG CONVERTER			• REF MALF PROC G&C _____ • CONSTITUTES LOSS OF TVC DAP
			LAUNCH	A. CONTINUE MISSION	
			EO	B. CONTINUE ALTERNATE EO MISSION IF BOTH SPS AND SM DEORBIT CAPABILITY AVAILABLE	
			TLC	C. NO-GO FOR LOI	
			LO	D. NO-GO FOR UNDOCKING PERFORM ALTERNATE LO MISSION	
			UNDOCKED	E. DOCK	
			RNDZ	F. CONTINUE MISSION	
		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	15-50
SPS SOL DRIVER 1	CH3604X	EMS-SPS-ON	SEPARATE		HIGHLY DESIRABLE	15-34
SPS SOL DRIVER 2	CH3605X	EMS-SPS-ON	SEPARATE		HIGHLY DESIRABLE	15-34
PITCH GIMBAL POS 1 & 2	CH3517H	GPI	COMMON	1 OF 2	MANDATORY-OB/HD-PCM	15-24/25
YAW GIMBAL POS 1 & 2	CH3518H	GPI	COMMON	1 OF 2	MANDATORY-OB/HD-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	CH1513X	-	-		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	15-24/25
SCS TVC YAW AUTO CMD	CH3583V	-	-		HIGHLY DESIRABLE	15-24/25
MTVC PITCH CMD	CH3585H	-	-		HIGHLY DESIRABLE	15-24/25
MTVC YAW CMD	CH3586H	-	-		HIGHLY DESIRABLE	15-24/25
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	15-24/25
YAW DIFF CLUTCH CUR	CH3667C	-	-		HIGHLY DESIRABLE	15-24/25

16 CSM SERVICE PROPULSION SYSTEM

REV	ITEM	SYSTEMS MANAGEMENT
	16-10	PROPELLANT GAGING A. PRIME METHOD: ONBOARD GAGING SYSTEM (1%). B. BACKUP METHOD: FLOW RATE x BURN TIME (3%).
	16-11	PROPELLANT UTILIZATION VALVE 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 THE SPS WILL ALWAYS BE STARTED USING A SINGLE BANK. HOWEVER, THE OTHER BANK WILL BE OPEN 2 TO 5 SECONDS AFTER IGNITION FOR BURNS GREATER THAN 6 SEC. BANK A WILL BE USED FOR THE FIRST ENGINE IGNITION.
A	16-13	PROPELLANT MANAGEMENT A. THE SPS PROPELLANT REDLINE TO PROVIDE A GO CAPABILITY FOR LOI IS 92.6 PERCENT INDICATED PROPELLANT REMAINING AND INCLUDES LOI, TEI, AND TRANSEARTH MCC'S. B. THE SPS PROPELLANT REDLINE TO PROVIDE A GO CAPABILITY FOR RENDEZVOUS IS 32.2 PERCENT INDICATED PROPELLANT REMAINING AND INCLUDES CSM RESCUE, TEI, AND TRANSEARTH MCC'S.
A	16-14	PROPELLANT FEEDLINE TEMPERATURE MANAGEMENT SPS LINE HEATERS WILL BE MANUALLY CYCLED TO MAINTAIN FEEDLINE TEMPERATURES BETWEEN 45°F AND 75°F AND ENGINE VALVE TEMPERATURE ABOVE 40°F.
	16-15	ULLAGE MANAGEMENT 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.

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
				SPECIFIC MISSION RULES	
	16-20	SUSTAINED PRESSURE DECAY IN EITHER THE FUEL OR OXIDIZER TANK (COULD BE HELIUM OR FUEL OR OXIDIZER)	LAUNCH	CONTINUE MISSION • PLAN RCS DEORBIT AT NEXT BEST PTP • IF LAND IMPACT IS IMMINENT AFTER ABORTING, REPRESS MANUALLY AND PERFORM BURN TO AVOID LAND.	• MALF PROC: SPS ____ • MANUAL PRESSURIZATION OF THE TANKS SHOULD BE CONSIDERED PRIOR TO ANY REQUIRED SPS BURN.
			EO	ENTER NEXT BEST PTP RCS DEORBIT	
			TLC	NO-GO FOR LOI INHIBIT NON-CRITICAL SPS BURNS	
			LO	PLAN TEI ASAP USE LM DPS IF CAPABILITY EXISTS	
			UNDOCKED	DOCK ASAP	
			RNDZ	RETURN TO CSM OR ATTEMPT CSM RESCUE	DO NOT STAGE LM
			TEC	CONTINUE MISSION INHIBIT NON-CRITICAL BURNS	
		A. DURING NON-CRITICAL BURN	ALL	A. TERMINATE BURN	
		B. DURING CRITICAL BURN	ALL	B. CONTINUE BURN	
	16-21	LOSS OF ONE GN_2 TANK PRESSURE (<400 PSIA)	UNDOCKED	A. NO-GO FOR RNDZ	• MALF PROC: SPS ____ • TRANSDUCER INDICATION CANNOT BE VERIFIED WITHOUT ENGINE OPERATION.
			ALL OTHERS	B. CONTINUE MISSION	
	16-22	LOSS OF BOTH GN_2 TANK PRESSURES (<400 PSIA)	LAUNCH	A. CONTINUE MISSION	• MALF PROC: SPS ____ • TRANSDUCER INDICATION CANNOT BE VERIFIED WITHOUT ENGINE OPERATION.
			EO	B. ENTER NEXT BEST PTP RCS DEORBIT	
			TLC	C. NO-GO FOR LOI	
			LO	D. PLAN TEI ASAP WITH LM DPS	
			UNDOCKED	E. DOCK ASAP	
			RNDZ	F. CONTINUE MISSION	F. DO NOT STAGE LM
			TEC	G. CONTINUE MISSION	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	16-23	FUEL FEEDLINE AND/OR OXIDIZER FEEDLINE TEMP <40°F AND UNABLE TO INCREASE.			• MALF PROC: SPS _______ LIMITATION FOR CRITICAL BURNS IS 27°F.
			LAUNCH	A. CONTINUE MISSION	
			EO	B. CONTINUE ALTERNATE EO MISSION INHIBIT NON-CRITICAL BURNS	
			TLC	C. NO-GO FOR LOI	
			LO	D. PLAN TEI ASAP	
			UNDOCKED	E. DOCK ASAP	
			RNDZ	F. CONTINUE MISSION	
			TEC	G. CONTINUE MISSION	
	16-24	ENGINE FLANGE TEMP GOES HIGHER THAN 480°F DURING AN SPS BURN.			• MALF PROC: SPS _______
			LAUNCH	NOT APPLICABLE	
			EO	ENTER NEXT BEST PTP RCS DEORBIT	
		A. DURING NON-CRITICAL BURN	ALL	A. TERMINATE BURN INHIBIT FURTHER NON-CRITICAL BURNS	
		B. DURING CRITICAL BURN	ALL	B. CONTINUE BURN INHIBIT FURTHER NON-CRITICAL BURNS	
	16-25	UNABLE TO IGNITE SPS	LAUNCH	A. NOT APPLICABLE	
			EO	B. ENTER NEXT BEST PTP RCS DEORBIT	
			TLC	C. NO-GO FOR LOI	
			LO	D. PLAN TEI ASAP WITH LM DPS	
			UNDOCKED	E. N/A	
			RNDZ	F. RETURN TO CSM ASAP CONSERVING DPS IF POSSIBLE	
			TEC	G. CONTINUE MISSION	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	16-26	THRUST CHAMBER PRESSURE <70 PSI CONFIRMED BY OTHER INSTRUMENTATION	LAUNCH EO	NO APPLICABLE ENTER NEXT BEST PTP	• MALF PROC: SPS ______ • CONFIRMING INSTRUMENTATION INCLUDES ONBOARD P_c METER, CREW, DEGRADED THRUST, FU AND OX INTERFACE PRESSURES, F/O VALVE POSITIONS, FU AND OX TANK PRESSURES.
		A. DURING NON-CRITICAL BURN		A. TERMINATE BURN INHIBIT FURTHER NON-CRITICAL BURNS	
		B. DURING CRITICAL BURN		B. CONTINUE BURN INHIBIT FURTHER NON-CRITICAL BURNS	
	16-27	LACK OF ULLAGE CAPABILITY	LAUNCH EO TLC LO UNDOCKED RNDZ	A. NOT APPLICABLE B. NO-GO FOR TLI CONTINUE MISSION IN EO WITH SUITABLE ALTERNATE C. NO-GO FOR LOI D. PLAN TEI ASAP E. DOCK ASAP F. CONTINUE MISSION	MALF PROC: SM RCS ______
A	16-28	FIRST BURN SUBSEQUENT TO DOCKED DPS BURN WAS <40 SEC	ALL	INHIBIT ALL BURNS	IF BURN IS TERMINATED FOR ANY REASON: 1. BEFORE 4 SECONDS - REPEAT ENTIRE 40 SECOND BURN WITH ULLAGE. NO CONSTRAINT ON REIGNITION TIME. 2. AFTER 4 SECONDS, BUT BEFORE 40 SECONDS - IF REQUIRED TO COMPLETE A CRITICAL MANEUVER, REIGNITE ASAP WITH NO ULLAGE.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	16-29	ΔP BETWEEN FUEL AND TANK PRESSURES >20 PSI AND UNABLE TO DECREASE	LAUNCH	CONTINUE MISSION	MALF PROC: SPS ___
			EO	ENTER NEXT BEST PTP RCS DEORBIT	
			TLC	NO-GO FOR LOI	
			LO	PLAN TEI ASAP WITH LM DPS	
			UNDOCKED	DOCK ASAP	
			RNDZ	RETURN TO CSM OR ATTEMPT CSM RESCUE	DO NOT STAGE LM
			TEC	CONTINUE MISSION	
		A. DURING NON-CRITICAL BURN		A. TERMINATE BURN INHIBIT FURTHER NON-CRITICAL BURNS	
		B. DURING CRITICAL BURN		B. CONTINUE BURN INHIBIT FURTHER NON-CRITICAL BURNS	
A	16-30	LEAK OR COMPLETE LOSS OF HELIUM SUPPLY PRESSURE OR BOTH HELIUM VALVES FAIL CLOSED.			• BLOWDOWN ΔV CAPABILITY IS A FUNCTION OF ULLAGE VOLUME AT TIME OF FAILURE.
			LAUNCH	A. CONTINUE MISSION	
			EO	B. NO-GO FOR TLI CONTINUE MISSION IN EO IF SUFFICIENT ULLAGE BLOWDOWN ΔV CAPABILITY EXISTS	
			TLC	C. NO-GO FOR LOI	
			LO	D. CONTINUE MISSION IF SUFFICIENT ULLAGE BLOW-DOWN ΔV CAPABILITY EXISTS	
			UNDOCKED	E. CONTINUE MISSION IF SUFFICIENT ULLAGE BLOW-DOWN ΔV CAPABILITY EXISTS	
			RNDZ	F. CONTINUE MISSION	F. DO NOT STAGE LM
			TEC	G. CONTINUE MISSION	
		RULE NUMBERS 16-31 THROUGH 16-49 ARE RESERVED.			

NASA — Manned Spacecraft Center

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	M O/B	16-20, 29
OX SM/ENG INTERFACE P	SP0931P	-	-	HD	16-20, 29
FU TK PRESS	SP0006P	METER/C&W	COMMON	M O/B	16-20, 29
FU SM/ENG INTERFACE P	SP0939P	-	-	HD	16-20, 29
SPS VLV ACT PRESS-PRI	SP0600P	METER	COMMON	1 OF 2 M O/B	16-21, 22
SPS VLV ACT PRESS-SEC	SP0601P	METER	COMMON		16-21, 22
SPS FU FEEDLINE TEMP	SP0048T	METER	COMMON	1 OF 2 M	16-23
SPS OX FEEDLINE TEMP	SP0049T	SYS TEST	COMMON		
SPS INJ FLANGE TEMP 1	SP0061T	C&W	COMMON	1 OF 2 M O/B	16-24
SPS INJ FLANGE TEMP 2	SP0062T	C&W	COMMON		
ENG CHAMBER PRESS	SP0661P	METER	COMMON	M O/B	16-26
He TK PRESS	SP0001P	METER	SEPARATE	HD	16-30
FU/OX VLV 1 POS	SP0022H	DISPLAY	SEPARATE	M 1 OF 2 O/B	16-25, 26
FU/OX VLV 2 POS	SP0023H	DISPLAY	SEPARATE	M	16-25, 26
FU/OX VLV 3 POS	SP0024H	DISPLAY	SEPARATE	M 1 OF 2 O/B	16-25, 26
FU/OX VLV 4 POS	SP0025H	DISPLAY	SEPARATE	M	16-25, 26
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 THE LOSS OF ONE QUAD IS NOT CAUSE FOR ABORT AND THERE ARE NO SINGLE FAILURES NOR ANY REASONABLE REALISTIC COMBINATION OF FAILURES WHICH LEAD ONLY TO LOSS OF MULTIPLE QUADS. THERE ARE, THEREFORE, NO SM-RCS FAILURES WHICH ARE CONSIDERED CAUSE FOR ABORT.
	17-2	EARTH ORBIT PHASE 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 REQUIRE TLI BE INHIBITED AND MAY LEAD TO EARLY MISSION TERMINATION SINCE THE CAPABILITY TO PERFORM SM OR HYBRID DEORBIT WILL BE AFFECTED. B. LOSS OF TWO OR MORE QUADS IS CAUSE FOR ENTRY INTO THE NEXT BEST PTP. 1. LOSS OF TWO ADJACENT QUADS WILL DESTROY THE CAPABILITY TO PERFORM ULLAGE MANEUVERS AND WILL REQUIRE DELETION OF NON-CRITICAL SPS MANEUVERS. LOSS OF TWO ADJACENT QUADS PRECLUDES SM OR HYBRID DEORBIT. 2. LOSS OF TWO OPPOSITE QUADS WILL DESTROY THE CAPABILITY TO PERFORM PRECISE 3-AXIS ATTITUDE CONTROL AND PRECLUDES SM OR HYBRID DEORBIT.
	17-3	TRANSLUNAR COAST LOSS OF ONE QUAD IS NOT, IN ITSELF, CAUSE FOR TERMINATION OF THE MISSION. HOWEVER, DEPENDING ON LM RCS CAPABILITY, THE TRANSLUNAR COAST PHASE MAY BE TERMINATED BY ENTRY INTO THE NEXT BEST PTP.
	17-4	LOI LOSS OF ONE QUAD IS CAUSE FOR INHIBITING LOI_1, BECAUSE SUBSEQUENT FAILURE OF QUADS OR JETS IMPAIR ATTITUDE CONTROL OR ULLAGE.
	17-5	LUNAR ORBIT LOSS OF ONE QUAD IS CAUSE FOR EARLY TERMINATION OF LUNAR ORBIT PHASE AND FOR INHIBITING LOI_2 ANO RENDEZVOUS, BECAUSE SUBSEQUENT FAILURE OF QUADS OR JETS IMPAIR ATTITUDE CONTROL OR ULLAGE, CONSIDERATION MAY BE GIVEN TO A MANEUVER TO DECREASE THE REMAINING TIME OF FLIGHT.
		RULE NUMBERS 17-6 THROUGH 17-14 ARE RESERVED.

REV	ITEM	SYSTEMS MANAGEMENT
	17-15	PROPELLANT GAGING A. PRIME METHOD: RTCC EQUATION (6%) B. BACKUP METHOD: HELIUM PRESSURE/TEMPERATURE (11%) (ONBOARD)
	17-16	QUAD PROPELLANT BALANCE 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.
	17-17	SECONDARY PROPELLANT FUEL PRESSURE VALVE THE RCS SECONDARY FUEL PRESSURIZATION VALVE WILL BE OPENED WHEN THE PRIMARY FUEL MANIFOLD PRESSURE REACHES 150 PSIA.
		RULE NUMBERS 17-18 THROUGH 17-19 ARE RESERVED.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
				SPECIFIC MISSION RULES	
	17-20	SUSTAINED LEAK IN HELIUM TANK			• MALF PROC: RCS _______
		A. ONE OR MORE QUADS	LAUNCH	A. CONTINUE MISSION	• QUAD WILL REMAIN USABLE UNTI He MANIFOLD PRESSURE REACHES 75 PSI
		B. ONE QUAD (ALL OTHER QUADS NORMAL)	EO	B.1. NO-GO FOR TLI	
			TLC	2. ENTER NEXT BEST PTP	
			LO	3. PLAN TEI FOR NEXT OPPORTUNITY	
			UNDOCKED	4. DOCK ASAP	
			RNDZ	5. CONTINUE MISSION	
		C. MORE THAN ONE QUAD	EO	C.1. CONTINUE MISSION ENTER PRIOR TO LOSS OF HYBRID DEORBIT CAPABILITY	
			ALL OTHER	2. REF RULING B	C.2. RETAIN LM ASCENT STAGE FOR TEI
	17-21	SUSTAINED LEAK BELOW He ISOLATION VALVE (COULD BE HELIUM OR FUEL OR OXIDIZER)			• MALF PROF: RCS _______ • QUAD WILL REMAIN USABLE UNTIL He MANIFOLD PRESSURE REACHES 75 PSI.
		A. ONE OR MORE QUADS	LAUNCH	A. CONTINUE MISSION	
		B. ONE QUAD (ALL OTHER QUADS NORMAL)	EO	B.1. NO-GO FOR TLI	
			TLC	2. ENTER NEXT BEST PTP	
			LO	3. PLAN TEI FOR NEXT OPPORTUNITY	
			UNDOCKED	4. DOCK ASAP	
			RNDZ	5. CONTINUE MISSION	
		C. MORE THAN ONE QUAD	EO	C.1. ENTER NEXT BEST PTP	
			ALL OTHER	2. REF RULING B	C.2. RETAIN LM ASCENT STAGE FOR TEI
	17-22	PACKAGE TEMP <55°F AND UNABLE TO INCREASE	LAUNCH	NOT APPLICABLE	• MALF PROC: RCS _______
		A. ONE QUAD (ALL OTHER QUADS NORMAL	EO	A.1. NO-GO FOR TLI	
			TLC	2. ENTER NEXT BEST PTP	
			LO	3. PLAN TEI FOR NEXT OPPORTUNITY	
			UNDOCKED	4. DOCK ASAP	
			RNDZ	5. CONTINUE MISSION	
		B. MORE THAN ONE QUAD	EO	B.1. ENTER NEXT BEST PTP	
			ALL OTHER	2. REF RULING A	B.2. RETAIN LM ASCENT STAGE FOR TEI

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	17-23	LOSS OF INDIVIDUAL THRUSTERS OR THRUSTER COMBINATIONS AS A RESULT OF CLOGGING, FREEZING, BURNOUT, OR CONTROL SYSTEM MALFUNCTION	LAUNCH	NOT APPLICABLE	CONTROL SYSTEM MALFUNCTION WILL CAUSE LOSS OF AUTO COILS OF THRUSTER ALTHOUGH DIRECT COILS ARE STILL AVAILABLE.
|		A. LOSS OF ANY ROLL THRUSTER	LO	A.1. NO-GO FOR UNDOCKING	
			UNDOCKED	2. DOCK ASAP	
			ALL OTHERS	3. CONTINUE MISSION	
		B. LOSS OF FOLLOWING THRUSTER COMBINATIONS: 2 PITCH OR 2 YAW 1 PITCH AND 1 YAW 1 PITCH AND 2 ROLL IN SAME DIRECTION 1 YAW AND 2 ROLL IN SAME DIRECTION 3 ROLL IN SAME DIRECTION	EO	B.1. CONTINUE ALTERNATE EO MISSION IF BOTH SPS AND SM RCS DEORBIT CAPABILITY AND ALL AXIS ATTITUDE CONTROL AVAILABLE	
			TLC	2. NO-GO FOR LOI	
			LO	3. PLAN TEI FOR NEXT OPPORTUNITY	
			UNDOCKED	4. DOCK ASAP	
			RNDZ	5. CONTINUE MISSION	B.5. RETAIN LM ASCENT STAGE FOR TEI IF LOSS OF ALL THRUSTERS IN ONE DIRECTION IN SAME AXIS
			TEC	6. CONSIDER MANEUVER TO DECREASE FLIGHT TIME	
		C. LOSS OF +X THRUSTERS ON ADJACENT QUADS.	ALL	C. INHIBIT NON-CRITICAL SPS BURNS	C. REF SPS RULE 16-27, LACK OF ULLAGE CAPABILITY

REV	ITEM

INSTRUMENTATION REQUIREMENTS

17-50

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

18 CSM CM-RCS

REV	ITEM	GENERAL
A	18-1	LAUNCH
		A. A SUSTAINED LEAK IN OR THE LOSS OF HELIUM SUPPLY PRESSURE OR HELIUM MANIFOLD PRESSURE IN <u>ONE CM RCS RING</u> 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 NO LONGER REDUNDANT.
		B. A SUSTAINED LEAK IN OR THE LOSS OF HELIUM SUPPLY PRESSURE OR HELIUM MANIFOLD PRESSURE IN <u>BOTH CM RCS RINGS</u> 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 SPIN UP 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 PUT THE SPACECRAFT AND CREW INTO AN UNSAFE ENVIRONMENT.
	18-2	ALL OTHER PHASES
		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.
		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.
		RULE NUMBERS 18-3 THROUGH 18-9 ARE RESERVED.

REV	ITEM	
		SYSTEMS MANAGEMENT
A	18-10	THRUSTER TEMP CONTROL 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 ENTRY. MALF PROC RCS ____.
	18-11	HELIUM INTERCONNECT AS A LAST RESORT, IF THE HELIUM IN ONE RING IS DEPLETED DUE TO A LEAK AND THE 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. MALF PROC RCS ____.
		RULE NUMBERS 18-12 THROUGH 18-19 ARE RESERVED.

NASA — Manned Spacecraft Center
MISSION RULES

SPECIFIC MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	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	
			RNDZ	2. CONTINUE MISSION	
			ALL OTHERS	3. TERMINATE PHASE AND ENTER NEXT BEST PTP	A.3. 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	
			RNDZ	2. CONTINUE MISSION	
			ALL OTHERS	3. TERMINATE PHASE AND ENTER NEXT BEST PTP	B.3. CONTINGENCY SM RCS SPIN-UP PRIOR TO CM/SM SEP
A	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	
			RNDZ	2. CONTINUE MISSION	
			ALL OTHERS	3. 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.	
			RNDZ	2. CONTINUE MISSION	
			ALL OTHERS	3. TERMINATE PHASE AND ENTER NEXT BEST PTP	B.3. CONTINGENCY SM RCS SPIN-UP PRIOR TO CM/SM SEP
	18-22	CM RCS IS ARMED FOR ANY REASON	RNDZ	CONTINUE MISSION	
			ALL OTHERS	TERMINATE PHASE AND ENTER NEXT BEST PTP	
		RULE NUMBERS 18-23 THROUGH 18-49 ARE RESERVED.			

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
		INSTRUMENTATION REQUIREMENTS
	18-50	

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 TK A TEMP	CR0003P	METER	COMMON	M	18-20
CM TK B TEMP	CR0004P	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
A	19-1	THREE GOOD DOCKING RING LATCHES 120 DEGREES APART ARE REQUIRED FOR AN IVT.
A	19-2	THREE GOOD DOCKING RING LATCHES 120 DEGREES APART ARE REQUIRED FOR A D CKED RCS MANEUVER.
	19-3	DOCKED SPS OR DPS BURNS REQUIRE AT LEAST NINE DOCKING RING LATCHES.
	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.
	19-5	THE SECONDARY FORWARD HATCH MECHANISM MAY BE USED AS THE SOLE METHOD OF LOCKING OR UNLOCKING THE FORWARD HATCH.
	19-6	LOSS OF VISUAL DOCKING AIDS (COAS AND TARGETS) WILL NOT INHIBIT DOCKING AND UNDOCKING.
	19-7	TD&E WILL BE ATTEMPTED WITH A NON-EXTENDED DOCKING PROBE.
		NOTE: THE ONLY DOCKING PROBE INSTRUMENTATION CONSISTS OF TWO TALK BACK INDICATORS IN THE CSM.
A	19-8	LOW PROBE TEMPERATURE WILL NOT INHIBIT DOCKING ATTEMPTS.
A		RULE NUMBERS 19-9 AND 19-10 ARE RESERVED.

REV	ITEM	MANAGEMENT
	19-11	TWO NITROGEN BOTTLES ARE REQUIRED FOR UNDOCKING. FOR SYSTEM RETRACT FAILURE, USE THE SECOND BOTTLE IN THE SAME SYSTEM BEFORE UTILIZING BOTTLES IN THE REDUNDANT 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.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
				SPECIFIC MISSION RULES	
A	19-20	FAILURE TO ACHIEVE OR MAINTAIN POWER TO X-LUNAR BUS LOADS FROM CSM	DOCKED	CONTINUE MISSION 1. INSURE LM DESCENT BATTERY LOW VOLTAGE TAPS ON 2. OPEN CB (11) AND CB (16) EPS: DES ECA CB WITHIN 6 HRS OF TD&E 3. CLOSE CB (11) AND CB (16) EPS: DES ECA CB'S AT FIRST PLANNED MANNING	• NOMINAL MISSION MAY BE PERFORMED BECAUSE ECA THERMAL CONSTRAINTS WILL NOT BE VIOLATED WITH DESCENT ECA CB OPEN. OVERCURRENT PROTECTION, HOWEVER, IS LOST UNTIL THESE CB'S ARE CLOSED.
	19-21	FAILURE TO ACHIEVE S-IVB/LM SEPARATION OR FAILURE TO MATE LM UMBILICALS (P23 AND P24)	TD&E	PERFORM CSM/LM FINAL SEP	S-IVB/LM SEP CANNOT BE ACHIEVED WITHOUT MATING AT LEAST ONE UMBILICAL. POWER CAN BE SWITCHED AND MAINTAINED WITH EITHER PLUG.
	19-22	FAILURE TO ACHIEVE CSM/LM FINAL SEPARATION	DOCKED	MUST PERFORM NORMAL UNDOCKING A. RETRIEVE PROBE AND DROGUE AND INSTALL. B. AFTER UNDOCKING, DEPRESS CSM AND JETTISON PROBE OVERBOARD.	LM MASS MAY HAVE TO BE MODIFIED FOR APS BURN
	19-23	FAILURE TO INDICATE DOCKING PROBE EXTEND OR BOTH TALK BACK INDICATORS ARE BARBER POLE.	TD&E UNDOCKED	A. CONTINUE MISSION ATTEMPT TD&E B. CONTINUE MISSION ATTEMPT DOCKING	DOCKING RING/TUNNEL STRUCTURE DAMAGE MAY OCCUR TO THE EXTENT THAT TUNNEL PRESSURE CAN NOT BE MAINTAINED.
	19-24	CANNOT REMOVE CSM FORWARD HATCH	TD&E DOCKED	A. PERFORM CSM/LM FINAL SEP B. PERFORM CSM/LM FINAL SEP IF LM MANNED, PERFORM EVT TO CSM.	
	19-25	CANNOT REMOVE DOCKING PROBE, LM DROGUE, AND/OR LM UPPER HATCH.	DOCKED	CONTINUE MISSION PERFORM EVT IF LM MANNED	SPS AND SM RCS MANEUVERS MAY BE PERFORMED
	19-26	FAILURE TO RELEASE CAPTURE LATCHES	DOCKED	REDOCK PERFORM RETRACTION	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	19-27	PRIMARY FORWARD HATCH LOCK/UNLOCK MECHANISM INOPERATIVE	ALL	CONTINUE MISSION	
	19-28	FAILURE TO REINSTALL CSM FORWARD HATCH	ALL	CONTINUE MISSION	REF BACKUP PROCEDURES
	19-29	FAILURE TO REINSTALL PROBE AND/OR DROGUE OR FAILURE TO CLOSE LM UPPER HATCH	DOCKED	NO UNDOCKING	RETAIN DESCENT STAGE FOR TBI
	19-30	LOSS OF PRIMARY OR SECONDARY DOCKING SYSTEM	ALL	CONTINUE MISSION TWO RETRACT BOTTLES ARE REQUIRED IN REMAINING SYSTEM.	TUNNEL INGRESS MAY HAVE TO BE PERFORMED TO INTERCHANGE PROBE UMBILICALS.

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: A. DOCKED (TUNNEL HARDWARE INSTALLED) TWO LIFE SUPPORT UNITS (PLSS AND OPS OR 2 OPS) PROVIDING SUFFICIENT CONSUMABLES TO SUPPORT A 30 MINUTE CONTINGENCY TRANSFER. B. UNDOCKED/RNDZ TWO LIFE SUPPORT UNITS (PLSS AND OPS OR 2 OPS) PROVIDING SUFFICIENT CONSUMABLES TO SUPPORT A CONTINGENCY TRANSFER.
		MANAGEMENT
A	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.
A	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.
A	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.
	20-5	THE OPS IS CONSIDERED TO HAVE A MINIMUM SOURCE PRESSURE OF 5380 PSIA. THIS CONSUMABLE IS MONITORED BY A PRESSURE GAGE LOCATED ON THE OPS.
		RULE NUMBERS 20-6 THROUGH 20-19 ARE RESERVED.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
				SPECIFIC	
A	20-20	LOSS OF PRESSURE INTEGRITY	CEVT		
		A. PGA PRESS <3.75 PSIA (TM) AND DECREASING OR PGA PRESS GAGE OF <3.7 PSIA AND DECREASING		A. <u>CONTINUE</u> ACTIVATE OPS	A. GT8168P PGA PRESS PGA PRESS GAGE LOW PGA PRESS TONE (3.0 KHZ)
		B. PGA PRESS >4.05 PSIA (TM) AND INCREASING OR PGA PRESS GAGE OF >4.0 PSIA AND INCREASING		B. <u>CONTINUE</u> 1. ACTIVATE OPS 2. CLOSE POS SHUTOFF VALVE	B. GT8168P PGA PRESS PGA PRESS GAGE CREW SENSIBLE DETECTION
A	20-21	LOSS OF OXYGEN VENTILATION			
		A. FAN FAILURE	CEVT	A. <u>CONTINUE</u> 1. ACTIVATE OPS 2. OPEN PGA PURGE VALVE	A. GT8140C PLSS BAT CUR GT8141V PLSS BAT VOLT LOW VENT FLOW TONE (3.0 KHZ)
		B. NOXIOUS ODOR	CEVT	B. <u>CONTINUE</u> 1. ACTIVATE OPS 2. OPEN PGA PURGE VALVE	B. CREW SENSIBLE DETECTION
	20-22	HUMIDITY CONTROL MALFUNCTION TOTAL LOSS OF WATER SEPARATOR	CEVT	<u>CONTINUE</u> IF DEHUMIDIFICATION IS REQUIRED, ACTIVATE OPS IN PURGE MODE	CREW SENSIBLE DETECTION GT8110P FEED H_2O PRESS GT8140C PLSS BAT CUR GT8196T LCG H_2O ΔT LOW FEED H_2O PRESS TONE (1.5 KHZ)
		RULES 20-23 THROUGH 20-29 ARE RESERVED.			

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	20-30	LOSS OF LIQUID TRANSPORT LOOP THERMAL CONTROL LOSS OF COOLING	CEVT	CONTINUE IF ADDITIONAL COOLING IS REQUIRED, ACTIVATE OPS IN PURGE MODE	GT8154T LCG H_2O TEMP GT8196T LCG H_2O ΔT GT8140C PLSS BAT CUR CREW SENSIBLE DETECTION LOW FEED H_2O PRESS TONE (1.5 KHZ)
	20-31	FAILURE OF OPS TO CHECK OUT A. OPS SOURCE PRESSURE <5380 PSIA B. OPS REG PRESSURE >4.0 PSID OR <3.4 PSID C. LOSS OF BOTH GREEN HEATER STATUS LIGHTS	CEVT	A. CHECK OUT PLSS USE DEGRADED OPS WITH THE PLSS FOR CEVT B. CHECK OUT PLSS USE DEGRADED OPS WITH THE PLSS FOR CEVT C. CHECK OUT PLSS USE DEGRADED OPS WITH THE PLSS FOR CEVT	A. PRESSURE GAGE ON OPS B. PRESSURE GAGE ON CHECKOUT FIXTURE C. CREW DETECTION
	20-32	DEPLETION OF POS POS PRESS <130 PSIA	CEVT	ACTIVATE OPS	GT8182P PLSS O2 PRESS GT8168P PGA PRESS PGA PRESS GAUGE LOW PGA PRESS TONE (3.0 KHZ) PLSS O_2 QTY IND
	20-33	LOSS OF MAIN POWER SUPPLY	CEVT	CONTINUE ACTIVATE OPS IN A PURGE MODE	
	20-34	DEGRADED POWER PROFILE CUR <2.0 AMP OR CUR >3.0 AMP	CEVT	CONTINUE VERIFY PERFORMANCE OF FAN, PUMP, AND SSC	GT8140C PLSS BAT CUR LOW VENT FLOW TONE (3 KHZ)

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	20-35	LOSS OF TM	CEVT	CONTINUE	
	20-36	LOSS OF ANY CRITICAL INSTRUMENTATION	CEVT	CONTINUE ACTIVATE OPS	REF MR 20-42
		RULES 20-37 THROUGH 20-40 ARE RESERVED.			

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
		INSTRUMENTATION REQUIREMENTS

20-41

MEAS DESCRIPTION	FM/FM	ONBOARD	TRANSDUCERS	CATEGORY	MISSION RULE REFERENCE
FEED H_2O PRESS	GT8110P			HD	
LOW FEED H_2O PRESS		WARNING TONE (1.5 KHZ)	COMMON	M	
PLSS EKG	GT8124J			*	
PLSS BAT CUR	GT8140C			HD	
PLSS BAT VOLT	GT8141V			HD	
LCG H_2O TEMP	GT8154T			HD	
PGA PRESS	GT8168P			HD	
PLSS O_2 PRESS	GT8182P	METER	COMMON	HD	
PLSS O_2 QTY IND				M	
LCG H_2O ΔT	GT8196T			HD	
LOW VENT FLOW		WARNING TONE (3.0 KHZ)		M	
PGA PRESS GAGE		METER		M	
LOW PGA PRESS		WARNING TONE (3.0 KHZ)		M	
OPS PRESS GAGE		METER		M	
OPS REG PRESS GAGE		METER		**M	
HEATER STATUS CHECK		GREEN LIGHTS		1 OF 2 M	

*AEROMEDICAL PARAMETER REFERENCE SECTION 31.

**NOTE: 1 OF 2 OPS REG PRESS GAGES 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 GAGE		METER	
LOW VENT FLOW		WARNING TONE (3.0 KHZ)	

21 LM SEQUENTIAL AND PYROTECHNIC

NASA — Manned Spacecraft Center

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: A. DOCKED, UNDOCK RNDZ ONE OPERATIONAL PYRO SYSTEM B. NORMAL STAGING TWO OPERATIONAL PYRO SYSTEMS
	21-2	A PYRO SYSTEM IS CONSIDERED LOST IF: A. PYRO BATTERY OPEN CIRCUIT VOLTAGE <35 VDC B. UNABLE TO ARM SYSTEM
A	21-3	A PYRO SYSTEM WILL BE DISABLED IF: A. ANY RELAY K2 THROUGH K6 INADVERTANTLY CLOSES (REF MR 21-13) B. ANY RELAY K7 THROUGH K15 INADVERTANTLY CLOSES A PYRO SYSTEM IS DISABLED BY OPENING THE APPROPRIATE "LOGIC POWER" CIRCUIT BREAKER. SYSTEM WILL BE USED FOR APS PRESSURIZATION AND STAGING.
	21-4	THE ASCENT AND DESCENT STAGES ARE CONSIDERED RIGIDLY ATTACHED WITH TWO DIAGONALLY OPPOSITE BOLT/NUT PAIRS INTACT.
A	21-5	THE ASCENT AND DESCENT STAGES ARE CONSIDERED NON-RIDIGLY ATTACHED IF ALL STAGING FUNCTIONS OCCUR EXCEPT THE GUILLOTINE FAILS TO SEVER THE INTERSTAGE UMBILICALS.
		RULE NUMBERS 21-6 THROUGH 21-9 ARE RESERVED.
		MANAGEMENT MISSION RULES
	21-10	APS WILL BE PRESSURIZED PRIOR TO 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.
	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.
	21-12	UNDOCKED STAGING WITH ONE PYRO SYSTEM WILL BE PERFORMED ONLY IF ABSOLUTELY NECESSARY TO MAINTAIN CREW SAFETY.
	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.
		RULE NUMBERS 21-14 THROUGH 21-19 ARE RESERVED.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
				SPECIFIC MISSION RULES	
A	21-20	PYRO BATTERY VOLTAGE <35 VDC			• REF MR 21-12, 3-58
		A. ONE SYSTEM	ALL	A. CONTINUE MISSION DELAY STAGING	
		B. TWO SYSTEMS	ALL	B.1. DO NOT STAGE	
			DOCKED	2. CONTINUE MISSION DO NOT UNDOCK	
			UNDOCKED	3. DOCK ASAP DO NOT PERFORM SEPARATION	
			RNDZ	4. DOCK ASAP SEP - DO NOT PERFORM DOI DOI - CONTINUE MISSION PHASING - CONTINUE MISSION	
A	21-21	UNABLE TO ARM PYRO SYSTEM(S)			• REF MR 21-12, 3-58
		A. ONE SYSTEM	ALL	A. CONTINUE MISSION DELAY STAGING	
		B. BOTH SYSTEMS PRIOR TO:			
		1. UNDOCKING	DOCKED	B.1. CONTINUE MISSION DO NOT UNDOCK	B.1. STAGING CANNOT BE ACCOMPLISHED
		2. DPS SHE PRESSUR-IZATION	RNDZ	2. DOCK ASAP SEPARATION - DO NOT PERFORM DOI	
		3. APS PRESSURIZATION/ STAGING	RNDZ	3. DOCK ASAP	3. CSM RESCUE MAY BE REQUIRED DUE TO RCS REDLINES

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	21-22	UNABLE TO DISARM PYRO SYSTEM(S)	DOCKED UNDOCKED	A. CONTINUE MISSION	REF MALF PROC ED 1 K1 = MASTER ARM RELAY
			RNDZ	B. CONTINUE MISSION STAGE NORMALLY	• EPS WILL BE CONFIGURED TO INSURE ASCENT POWER.
	21-23	RELAY K2 THROUGH K6 (OR K1 THROUGH K6 AFTER APS PRESS) INADVERTANTLY CLOSED AND CANNOT BE RESET	DOCKED	CONTINUE MISSION	RELAYS K2 = STAGE K3 = STAGE SEQUENCE K4 = 1 GUILLOTINE K5 = 2 BOLTS (SYS A) AND 2 NUTS (SYS B) K5A = 2 BOLTS (SYS A) AND 2 NUTS (SYS B) K6 = 2 ELECTRICAL CIRCUIT INTERRUPTERS
		A. SYSTEM A (DESCENT STAGE)	ALL	A. CONTINUE MISSION OPEN LOGIC POWER A CB UNTIL TIME TO PRESSURIZE APS, THEN: 1. ASC He SEL SW - BOTH 2. MSTR ARM SW - ON 3. ASC He PRESS SW - FIRE 4. MSTR ARM SW - OFF 5. LOGIC PWR A CB - CLOSE 6. ASC He PRESS SW - FIRE (HOLD) 7. STAGE SW - FIRE 8. MSTR ARM SW - ON 9. ASC He PRESS SW - SAFE	A. ALL PYRO FUNCTIONS EXCEPT APS PRESSURIZATION AND STAGING WILL BE PERFORMED ON SYSTEM B.
		B. SYSTEM B (ASCENT STAGE)	ALL	B. CONTINUE MISSION OPEN LOGIC PWR B CB UNTIL TIME TO PRESSURIZE APS, THEN: 1. ASC He SEL SW - BOTH 2. MSTR ARM SW - ON 3. ASC He PRESS SW - FIRE 4. STAGE SW - FIRE 5. LOGIC PWR B CB - CLOSE 6. ASC He PRESS SW - FIRE	B. ALL PYRO FUNCTIONS EXCEPT APS PRESSURIZATION AND STAGING WILL BE PERFORMED ON SYSTEM A.
		C. BOTH SYSTEMS	ALL	C. CONTINUE MISSION OPEN BOTH LOGIC POWER A AND B CB'S UNTIL TIME TO PRESSURIZE APS, THEN: 1. ASC He SEL SW - BOTH 2. LOGIC PWR A CB - CLOSE 3. ASC He PRESS SW - FIRE (HOLD) 4. STAGE SW - FIRE 5. MSTR ARM SW - ON 6. ASC He PRESS SW - SAFE 7. LOGIC PWR B CB - CLOSE 8. ASC He PRESS SW - FIRE	C. NO PYRO FUNCTION CAN BE PERFORMED EXCEPT APS PRESSURIZATION/STAGING. FOR THIS EVENT SYSTEM B WILL BE BACKUP TO SYSTEM A.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	21-24	A RELAY K7 THROUGH K15 INADVERTANTLY CLOSES	ALL		RELAYS K7 = RCS PRESS K8 = LAND GEAR DEPLOY K8A = LAND GEAR DEPLOY K9 = DPS CRYO He PRESS K10 = ASC He TANK 1 K11 = ASC He TANK 2 K12 = ASC FUEL & OX COMP VALVE K12A = ASC FUEL & OX COMP VALVES (SYSTEM A ONLY) K13 = DPS FU & OX VENT K14 = DPS AMBIENT He K15 = DPS FU & OX COMP VALVES
		A. SYSTEM A		A. CONTINUE MISSION OPEN LOGIC POWER A C/B UNTIL DPS CRYO He PRESSURIZATION ACCOMPLISHED	A. ALL PYRO FUNCTIONS EXCEPT STAGING WILL BE PERFORMED ON SYSTEM B
		B. SYSTEM B		B. CONTINUE MISSION 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 2. OPEN LOGIC POWER A&B C/B'S UNTIL NEXT PYRO FUNCTION 3. CLOSE LOGIC POWER A&B C/B'S 4. CLOSE DES He REG 1 AND VERIFY DES He REG 2 CLOSED 5. MASTER ARM SW ON 6. PERFORM PYRO FUNCTION 7. MASTER ARM SW OFF 8. OPEN DES He REG 1 AFTER SUCCESSFUL DPS AMBIENT He PRESS.	C. BOTH PYRO SYSTEMS MAY BE USED TO ACCOMPLISH STAGING
	21-25	UNABLE TO STAGE			
		A. ASCENT AND DESCENT STAGE STILL RIGIDLY TIED TOGETHER	RNDZ	A.1. CONTINUE MISSION 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 2. GO TO DRIFTING FLIGHT	B. EVT MAY BE REQUIRED
		RULE NUMBERS 21-26 THROUGH 21-49 ARE RESERVED.			

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	

INSTRUMENTATION REQUIREMENTS

21-50

MEAS DESCRIPTION	PCM	ONBOARD		CATEGORY	MISSION RULE REFERENCE
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 CAUTION		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

REV	ITEM	
		GENERAL
A	22-1	TO INITIATE THE FOLLOWING MISSION EVENTS, THE ELECTRICAL POWER SYSTEM MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES:
		A. DOCKED WITH HATCH CLOSED
		1. CDR AND LMP BUSES
		2. TWO DESCENT BATTERIES PLUS ONE ASCENT BATTERY
		3. BOTH ASCENT FEEDERS PLUS ONE DESCENT FEEDER
		4. SUFFICIENT AVAILABLE ELECTRICAL ENERGY TO POWER THE LM FOR 2 HRS BEYOND THE PLANNED LM TO CSM CREW TRANSFER
|		B. DOCKED WITH HATCH OPEN AND TUNNEL CLEAR (NOTE: DOCKED DPS BURN FOR TEI IS NO-GO FOR ITEM 1)
		1. CDR OR LMP BUS
		2. TWO DESCENT BATTERIES WITH ASSOCIATED FEEDER OR ONE ASCENT BATTERY WITH ASSOCIATED FEE ER
|		C. UNDOCKING, SEPARATION
		1. CDR AND MP BUSES
		2. TWO DESCENT BATTERIES PLUS ONE ASCENT BATTERY
		3. BOTH ASCENT FEEDERS PLUS ONE DESCENT FEEDER
|		4. SUFFICIENT AVAILABLE ELECTRICAL ENERGY TO POWER THE LM FOR 2 HOURS BEYOND THE PLANNED LM TO CSM CREW TRANSFER

REV	ITEM	
A	22-1 CONT'D	D. DOI
		1. CDR AND LMP BUSES
		2. TWO DESCENT BATTERIES PLUS TWO ASCENT BATTERIES OR FOUR DESCENT BATTERIES PLUS ONE ASCENT BATTERY
		3. BOTH ASCENT FEEDERS PLUS ONE DESCENT FEEDER.
		4. ONE INVERTER AND BOTH AC BUSES
		5. SUFFICIENT AVAILABLE ELECTRICAL ENERGY TO POWER THE LM FOR 2 HOURS BEYOND THE PLANNED LM TO CSM CREW TRANSFER
		E. PHASING (FIVE IMPULSE RNDZ WILL BE SELECTED IF THESE CONDITIONS ARE VIOLATED)
		1. CDR AND LMP BUSES
		2. TWO DESCENT BATTERIES PLUS TWO ASCENT BATTERIES OR FOUR DESCENT BATTERIES PLUS ONE ASCENT BATTERY
		3. BOTH ASCENT FEEDERS PLUS ONE DESCENT FEEDER UNLESS DESCENT FEEDER LOST DUE TO HARD SHORT
		4. SUFFICIENT AVAILABLE ELECTRICAL ENERGY TO POWER THE LM FOR 2 HOURS BEYOND THE PLANNED LM TO CSM CREW TRANSFER
		F. STAGING (NORMAL)
		1. CDR AND LMP BUSES
		2. BOTH ASCENT BATTERIES OR ONE ASCENT BATTERY IF NO DESCENT ENERGY REMAINS AND DESCENT O_2 TANK IS DEPLETED
		3. EITHER ASCENT FEEDER
		4. ASCENT BATTERY OVERCURRENT PROTECTION
		5. SUFFICIENT AVAILABLE ASCENT ELECTRICAL ENERGY TO POWER THE LM FOR 2 HOURS BEYOND THE PLANNED LM TO CSM CREW TRANSFER
		G. STAGING (DOCKED, HATCH OPEN AND TUNNEL CLEAR, OR DELAYED)
		1. CDR OR LMP BUS
		2. ONE ASCENT BATTERY
		3. ONE ASCENT FEEDER
		4. SUFFICIENT AVAILABLE ASCENT ELECTRICAL ENERGY TO POWER THE LM FOR 2 HOURS BEYOND THE PLANNED LM TO CSM CREW TRANSFER
		H. UNMANNED APS BURN
		1. CDR AND LMP BUSES
		2. ONE ASCENT BATTERY
		3. ONE ASCENT FEEDER
	22-2	THE CDR OR LMP BUS IS CONSIDERED LOST IF:
		A. BUS VOLTAGE CANNOT BE MAINTAINED ABOVE 26.5 VDC
		B. BUS CURRENT $\geq$90 AMPS

REV	ITEM	
	22-3	A BATTERY IS CONSIDERED LOST IF: A. OUTPUT ≤2 AMPS WHEN CONNECTED TO THE BUS B. TEMPERATURE IS ≥145°F C. CANNOT MEET VOLTAGE REGULATION AT REQUIRED LOAD D. CANNOT BE CONNECTED TO A FEEDER DUE TO A MALFUNCTIONING ECA E. BATTERY OPEN CIRCUIT VOLTAGE BELOW 31.8 VDC STEADY STATE
	22-4	A DC BUS FEEDER IS CONSIDERED LOST IF: CANNOT BE USED AS A POWER PATH
	22-5	AN INVERTER AND/OR ASSOCIATED AC DISTRIBUTION SYSTEM IS CONSIDERED LOST IF: A. AC BUS VOLTAGE ≤110.5 OR ≥120 VAC B. AC BUS FREQUENCY ≤390 OR ≥410 HZ C. POWER CANNOT BE SUPPLIED TO AN AC BUS
	22-6	A. ECA OVERCURRENT PROTECTION IS <u>DEFINITELY</u> LOST IF: 1. BOTH CIRCUIT BREAKERS POWERING THE ECA'S FAIL OPEN (ALL DESCENT OR ALL ASCENT ECA'S, WHICHEVER IS APPLICABLE) 2. ASCENT BATTERY BACKUP FEED IS USED B. ECA OVERCURRENT PROTECTION IS <u>PROBABLY</u> LOST IF: 1. UNABLE TO MEASURE A BATTERY CURRENT BOTH ONBOARD AND ON TELEMETRY 2. UNABLE TO TAKE THE BATTERY OFF LINE
		RULE NUMBERS 22-7 THROUGH 22-9 ARE RESERVED.

REV	ITEM	MANAGEMENT
	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.
A	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 PHASING MANEUVER. IN THE EVENT THAT A BATTERY IS LOST AT, OR SUBSEQUENT TO STAGING, SINGLE BUS OPERATION WILL BE CONTINUED UNTIL 20 AMP-HOURS HAVE BEEN REMOVED FROM THE REMAINING ASCENT BATTERY.
	22-13	DELETED
		RULE NUMBERS 22-14 THROUGH 22-19 ARE RESERVED.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
				SPECIFIC MISSION RULES	
A	22-20	LOSS OF EITHER DC BUS			• REF MALF PROC EPS:
			DOCKED	A. CONTINUE MISSION	1. UNSTAGED DC BUS
				1. DO NOT UNDOCK	2. STAGED DC BUS
				2. CREWMAN OPERATE WITH CONNECTING HATCHES OPEN AND TUNNEL CLEAR	3. UNSTAGED C&W PWR 4. STAGED C&W PWR
				3. PERFORM LIMITED SYSTEMS EVALUATION	• LOSS OF DC BUS RESULTS IN LOSS OF ONE PYRO SYSTEM
			UNDOCKED RNDZ	B. DOCK ASAP DELAY STAGING	• REF MR 21-12, 3-58
A	22-21	SHORTED DC BUS FEEDER			
		A. DESCENT	ALL	A. CONTINUE MISSION	
				1. PUT BOTH ASCENT BATTERIES ON NORMAL FEED WITH SHORT ISOLATED VIA DEADFACE RELAY	• 1. UNSTAGED DC BUS 2. STAGED DC BUS 3. UNSTAGED C&W PWR
			DOCKED UNDOCKED	2. CONTINUE MISSION	4. STAGED C&W PWR
			RNDZ	3. SEP - CONTINUE MISSION DOI - PERFORM FIVE IMPULSE RNDZ PHASING - CONTINUE MISSION	
		B. ASCENT	ALL	B.1. SET UP FOR UNMANNED APS BURN	
			DOCKED	2. CONTINUE MISSION (A) DO NOT UNDOCK (B) POWER AFFECTED BUS FROM OTHER BUS VIA 100 AMP CROSSTIE C/B'S (C) CREWMEN OPERATE WITH CONNECTING HATCHES OPEN AND TUNNEL CLEAR (D) PERFORM SYSTEMS EVALUATION	
			UNDOCKED RNDZ	3. DOCK ASAP	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	22-22	DEFINITE LOSS OF OVER-CURRENT PROTECTION			• NO APPLICABLE MALF PROC REF MR 22-6, 21-12, 3-58
		A. DESCENT BATTERIES	ALL	A. CONTINUE MISSION	
		B. ASCENT BATTERIES	ALL	B. CONTINUE MISSION DELAY STAGING	
A	22-23	LOSS OF ASCENT BATTERIES:			• REF MALF PROC EPS: 2 STAGED DC BUS 4 STAGED C&W POWER 5 BATTERY
		A. LOSS OF ONE ASCENT BATTERY	ALL	A.1. CONTINUE MISSION DO NOT STAGE UNLESS DESCENT BATTERIES ARE DEPLETED AND DESCENT O2 TANK DEPLETED.	
		B. LOSS OF TWO ASCENT BATTERIES	ALL	B.1. DO NOT STAGE	
			DOCKED	2. CONTINUE MISSION (A) DO NOT UNDOCK (B) CREWMEN OPERATE WITH CONNECTING HATCHES OPEN AND TUNNEL CLEAR (C) PERFORM SYSTEMS EVALUATION	
			UNDOCKED RNDZ	3. DOCK ASAP	

NASA — Manned Spacecraft Center

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 OR TWO DESCENT BATTERIES	ALL	A. CONTINUE MISSION	1 UNSTAGED DC BUS
		B. LOSS OF THREE DESCENT BATTERIES	DOCKED	B.1. CONTINUE MISSION	3 UNSTAGED C&W POWER
			UNDOCKED	2. CONTINUE MISSION	5 BATTERY
			RNDZ	3. SEP - DO NOT PERFORM DOI	
				4. DOI - PERFORM FIVE IMPULSE RNDZ	
				5. PHASING - CONTINUE MISSION	
		C. LOSS OF FOUR DES BATTERIES	ALL	C.1. SET UP FOR UNMANNED APS BURN	
			DOCKED	2. CONTINUE MISSION (A) DO NOT UNDOCK (B) CREWMAN OPERATE WITH CONNECTING HATCHES OPEN AND TUNNEL CLEAR (C) PERFORM SYSTEMS EVALUATION	
A	22-25	LOSS OF INVERTERS			● REF MALF PROC EPS:
		A. LOSS OF ONE INVERTER	ALL	A. CONTINUE MISSION	7 INVERTER
		B. LOSS OF BOTH INVERTERS	DOCKED UNDOCKED	B.1. CONTINUE MISSION	
			RNDZ	2. SEP - DO NOT PERFORM DOI	● LOSS OF AC BUS A RESULTS IN LOSS OF DPS GIMBAL CONTROL AND RR.
				3. DOI - CONTINUE MISSION	● LOSS OF AC BUS B RESULTS IN LOSS OF S-BAND STEERABLE ANTENNA (HBR TM).
				4. PHASING - CONTINUE MISSION	● LOSS OF BOTH AC BUSES RESULTS IN THE ABOVE PLUS LOSS OF BOTH FDAI SPHERES.

NASA — Manned Spacecraft Center
MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	22-26	LOSS OF AC BUSES A. LOSS OF BUS A, BUS B, OR BOTH BUSES	DOCKED UNDOCKED RNDZ	A.1. CONTINUE MISSION 2. SEPARATION - CONTINUE MISSION DO NOT PERFORM DOI 3. DOI - CONTINUE MISSION 4. PHASING - CONTINUE MISSION	• REF MALF PROC EPS: 7 INVERTER • LOSS OF AC BUS A RESULTS IN LOSS OF DPS GIMBAL CONTROL AND RR. • LOSS OF AC BUS B RESULTS IN LOSS OF S-BAND STEERABLE ANTENNA (HBR TM). • LOSS OF BOTH AC BUSES RESULTS IN THE ABOVE PLUS LOSS OF BOTH FDAI SPHERES.

REV	ITEM
	22-50

INSTRUMENTATION REQUIREMENTS

MEAS DESCRIPTION	PCM	ONBOARD		CATEGORY	MISSION RULE REFERENCE
AC BUS FREQ	GC0155F	CAUTION	COMMON	M	22-1,5,25,26
AC BUS VOLTS	GC0071V	METER/CAUTION	LIGHT	M	
BAT 1 VOLTS	GC0201V	METER		HD	
BAT 2 VOLTS	GC0202V	METER		HD	22-1,2,3,10,
BAT 3 VOLTS	GC0203V	METER	COMMON	HD	20,21,22,24
BAT 4 VOLTS	GC0204V	METER	METER	HD	
BAT 5 VOLTS	GC0205V	METER		M	22-1,2,3,10,
BAT 6 VOLTS	GC0206V	METER		M	20,21,22,23
CDR BUS VOLTS	GC0301V	METER/WARNING	COMMON	1 OF 2	22-1,2,3,20,
LMP BUS VOLTS	GC0302V	METER/WARNING	LIGHT	M	21,22,23,24
BAT 1 CUR	GC1201C	METER		M PCM	
BAT 2 CUR	GC1202C	METER		M PCM	22-1,2,3,10
BAT 3 CUR	GC1203C	METER	COMMON	M PCM	20,21,22,24
BAT 4 CUR	GC1204C	METER	METER	M PCM	
BAT 5 CUR	GC1205C	METER		M PCM	22-1,2,3,10
BAT 6 CUR	GC1206C	METER		M PCM	20,21,22,23
BAT 1 MAL	GC9961U	CAUTION/COMP		M ONBOARD	
BAT 2 MAL	GC9962U	CAUTION/COMP		M ONBOARD	22-1,2,3,
BAT 3 MAL	GC9963U	CAUTION/COMP	COMMON	M ONBOARD	10,22,24
BAT 4 MAL	GC9964U	CAUTION/COMP	LIGHTS	M ONBOARD	
BAT 5 MAL	GC9965U	CAUTION/COMP		M ONBOARD	22-1,2,3,10,22,23
BAT 6 MAL	GC9966U	CAUTION/COMP		M ONBOARD	
BATTERY MAL	GC4047X			HD	22-1,2,3,10,22,23,2
BAT 1 LOW TAP	GC4362X	FLAG		HD	
BAT 2 LOW TAP	GC4364X	FLAG		HD	22-1,2,3,10,20,22,2
BAT 3 LOW TAP	GC4366X	FLAG		HD	
BAT 4 LOW TAP	GC4368X	FLAG		HD	
BAT 5 B/U CDR	GC4369X	FLAG		HD	
BAT 6 NORM CDR	GC4370X	FLAG		HD	22-1,2,3,10,20,
BAT 5 NORM LMP	GC4371X	FLAG		HD	21,22,23
BAT 6 B/U LMP	GC4372X	FLAG		HD	

NASA — Manned Spacecraft Center

MISSION RULES

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

A. DOCKED WITH HATCH OPEN

1. COMBINED VEHICLE PRESSURE INTEGRITY
2. ONE LM COOLANT LOOP

B. DOCKED WITH HATCH CLOSED

1. CABIN PRESSURE INTEGRITY
2. SUIT CIRCUIT INTEGRITY
3. ONE SUIT FAN
4. ONE DEMAND REGULATOR
5. ONE COOLANT LOOP
6. SUFFICIENT O_2, H_2O, AND LiOH CONSUMABLES TO COMPLETE THE SPECIFIED ACTIVITY PERIOD

C. UNDOCKING

1. CABIN PRESSURE INTEGRITY
2. SUIT CIRCUIT INTEGRITY
3. ONE SUIT FAN
4. ONE DEMAND REGULATOR
5. ONE COOLANT LOOP
6. SUFFICIENT O_2, H_2O, AND LiOH CONSUMABLES TO COMPLETE THE SPECIFIED ACTIVITY PERIOD PLUS 2 HOURS
7. SUFFICIENT ASCENT CONSUMABLES TO EFFECT A CONTINGENCY RETURN AND TRANSFER TO CSM FROM ANY POINT PLUS 2 HOURS

D. SEPARATION

1. CABIN PRESSURE INTEGRITY
2. SUIT CIRCUIT INTEGRITY
3. ONE SUIT FAN
4. ONE DEMAND REGULATOR
5. ONE COOLANT LOOP
6. SUFFICIENT O_2, H_2O, AND LiOH CONSUMABLES TO COMPLETE START OF EVENT THROUGH DOCKING AND CONTINGENCY TRANSFER TO CSM PLUS 2 HOURS
7. THE O_2 AND H_2O CONSUMABLES ARE TO BE CONTAINED IN AT LEAST TWO ASCENT O_2 TANKS AND ONE ASCENT H_2O TANK

REV	ITEM	
A	23-1 (CONT'D)	E. DOI

E. DOI

1. CABIN PRESSURE INTEGRITY
2. SUIT CIRCUIT INTEGRITY
3. ONE SUIT FAN
4. ONE DEMAND REGULATOR
5. ONE H_2O SEPARATOR
6. BOTH COOLANT LOOPS
7. PRIMARY H_2O FEEDPATH CAPABILITY
8. SUFFICIENT O_2, H_2O, AND LiOH CONSUMABLES TO COMPLETE A CONTINGENCY RETURN AND TRANSFER IF PHASING IS NOT PERFORMED PLUS 2 HOURS
9. THE O_2 AND H_2O CONSUMABLES ARE TO BE CONTAINED IN AT LEAST TWO OF THREE O_2 TANKS AND IN TWO OF THREE H_2O TANKS.

F. PHASING

1. CABIN PRESSURE INTEGRITY
2. SUIT LOOP INTEGRITY
3. ONE SUIT FAN
4. ONE DEMAND REGULATOR
5. ONE H_2O SEPARATOR
6. BOTH COOLANT LOOPS
7. SUFFICIENT O_2, ASCENT H_2O, AND LiOH CONSUMABLES TO COMPLETE THE SPECIFIED ACTIVITY PERIOD. THROUGH DOCKING PLUS 2 HOURS
8. THE O_2 AND H_2O CONSUMABLES REQUIRED ARE TO BE CONTAINED IN AT LEAST TWO OF THREE O_2 TANKS AND TWO OF THREE H_2O TANKS.

G. NOMINAL STAGING

1. CABIN PRESSURE INTEGRITY
2. SUIT LOOP INTEGRITY
3. TWO SUIT FANS
4. ONE DEMAND REGULATOR
5. ONE H_2O SEPARATOR
6. ONE COOLANT LOOP
7. SUFFICIENT O_2 ASCENT H_2O, AND LiOH CONSUMABLES TO COMPLETE THE SPECIFIED ACTIVITY PERIOD THROUGH DOCKING PLUS 2 HOURS
8. THE O_2 AND H_2O CONSUMABLES REQUIRED THROUGH DOCKING ARE TO BE IN AT LEAST TWO ASCENT O_2 TANKS AND TWO ASCENT H_2O TANKS.

H. NON-NOMINAL STAGING (DELAYED)

1. CABIN PRESSURE INTEGRITY
2. SUIT LOOP INTEGRITY
3. ONE SUIT FAN

REV	ITEM	
	23-1 (CONTD)	4. ONE COOLANT LOOP 5. SUFFICIENT ASCENT CONSUMABLES TO COMPLETE DOCKING IN TWO ASCENT O_2 TANKS AND ONE ASCENT H_2O TANK
A	23-2	DEFINITIONS: 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 .68 LBS/HR. FOR DOCKED ACTIVITIES, THIS WILL BE RELAXED TO A FLOW RATE OF 6 LBS/HR. LOSS OF SUIT INTEGRITY — TOTAL PGA/SUIT LOOP LEAKAGE $\geq$0.2 PSI/MIN (0.6 LB/HR) DURING SUIT LOOP PRESSURE CHECK OR A VISIBLE TEAR IN THE PGA. 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). GLYCOL COOLANT LEAK — OBSERVED FLUID IN CABIN CONFIRMED BY TASTE OR PRESENCE OF GLYCOL LOW INDICATION CONFIRMED BY STATIC PRESSURE DROP. LOSS OF DESCENT O_2 TANK — INABILITY TO TRANSFER O_2 FROM DESCENT TANK OR MSFN CONFIRMATION OF DESCENT TANK PRESSURE WITH O_2 MANIFOLD PRESSURE (WITHIN LIMITS). LOSS OF ASCENT O_2 TANK — (1) MSFN CONFIRMATION OF LOSS OF ASCENT TANK PRESSURE WITH O_2 MANIFOLD PRESSURE; OR (2) IF UNSTAGED AND DESCNET TANK >35 PERCENT, CREW CONFIRM LOSS BY BALANCING ONE TANK AGAINST THE OTHER; OR (3) IF STAGED OR IF DESCENT O_2 <35 PERCENT, LOSS OF ONBOARD AND MSFN READOUT. 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 ΔP (MSFN ONLY). 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.
	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.
	23-4	IF A SUBLIMATOR IS LOST DUE TO BREAKTHROUGH, NO RESTART ATTEMPT WILL BE MADE.
A	23-5	DELETED
	23-6	OXYGEN PURGE SYSTEM AND PLSS CONSUMABLES WILL BE RESERVED FOR POSSIBLE EVT AND WILL NOT BE CONSIDERED FOR NOMINAL REDLINE USAGE.
		RULE NUMBERS 23-7 THROUGH 23-9 ARE RESERVED

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	SYSTEMS MANAGEMENT
	23-10	PRIMARY GLYCOL LOOP CIRCULATION WILL BE DISCONTINUED AT START OF THE SECONDARY LOOP BUT MAY BE INITIATED FOLLOWING SEC LOOP STABILIZATION IF DEEMED NECESSARY.
	23-11	IF EITHER ASCENT O_2 TANK IS $\leq$95 PERCENT, IT WILL BE REPLENISHED FROM THE DESCENT O_2 WHEN THE DESCENT TANK QUANTITY $\geq$35 PERCENT AND AS CLOSE TO STAGING AS POSSIBLE.
	23-12	PLSS FILL VALVE WILL BE CLOSED, EXCEPT FOR REPRESSURIZING THE PLSS AND FOR MSFN REQUESTED READOUTS OF O_2 MANIFOLD PRESSURE.
	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.
		RULE NUMBERS 23-14 THROUGH 23-19 ARE RESERVED.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
				SPECIFIC MISSION RULES	
	23-20	LOSS OF CABIN PRESSURE INTEGRITY			
			ALL	A. SET UP FOR UNMANNED APS BURN	A. REF MALF PROC ECS CABIN
			DOCKED	B.1. PERFORM SYSTEMS EVALUATION WITHIN CONSUMABLES LIFE-TIME CONSTRAINTS WITH ONE CREWMAN ON BOTH THE CSM AND LM UMBILICALS.	
				2. NO-GO FOR UNDOCKING	
			UNDOCKED	C.1. DOCK ASAP	
				2. DO NOT STAGE WHILE UNDOCKED	
				3. NO-GO FOR RNDZ	
			RNDZ	D.1. DOCK ASAP	
				2. DO NOT STAGE WHILE UNDOCKED	
	23-21	LOSS OF SUIT LOOP INTEGRITY	ALL	A. SET UP FOR UNMANNED APS BURN	
			DOCKED	B.1. PERFORM SYSTEMS EVALUATION	
				2. NO-GO FOR UNDOCKING	
			UNDOCKED	C.1. DOCK ASAP	
				2. DO NOT STAGE WHILE UNDOCKED	
				3. NO-GO FOR RNDZ	
			RNDZ	D.1. DOCK ASAP	
				2. DO NOT STAGE WHILE UNDOCKED	
	23-22	SUIT FAN(S) FAILURE			REF MALF PROC ECS SUIT/FAN
		A. ONE SUIT FAN	ALL	A. CONTINUE MISSION	
		B. TWO SUIT FANS	DOCKED	B.1. CONTINUE MISSION ON CSM TRANSFER UMBILICAL	B.1.(A) OTHER CREWMAN RETURN TO CSM
				NO-GO FOR UNDOCKING	(B) REMOVE HELMET AND GLOVES
			UNDOCKED	2. DOCK ASAP	
				NO-GO FOR RNDZ	
				DO NOT STAGE WHILE DOCKING	
			RNDZ	3. DOCK ASAP	
				DO NOT STAGE WHILE UNDOCKED	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	23-23	LOSS OF H_2O SEPARATOR(S)			REF MALF PROC ECS ECS
		A. ONE SEPARATOR	ALL	A. CONTINUE MISSION	
		B. TWO SEPARATORS	DOCKED	B.1. CONTINUE MISSION	
			UNDOCKED	2.(A) CONTINUE MISSION AT CREW OPTION (B) NO-GO FOR RNDZ (C) DELAY STAGING	
			RNDZ	3. DOCK ASAP DELAY STAGING	
	23-24	DEMAND REGULATOR(S) FAIL OPEN OR CLOSED			
		A. ONE REGULATOR	ALL	A. CONTINUE MISSION	
		B. TWO REGULATORS	DOCKED	B.1.(A) SET UP FOR UNMANNED APS BURN (B) PERFORM SYSTEMS EVALUATION WITHIN CONSUMABLES LIFETIME CONSTRAINTS WITH ONE CREWMAN ON BOTH THE CSM AND LM UMBILICALS (C) NO-GO FOR UNDOCKING	
			UNDOCKED RNDZ	B.2.(A) DOCK ASAP (B) NO-GO FOR SEP, DOI, PHASING (C) DELAY STAGING	
	23-25	LOSS OF COOLANT LOOP(S)			REF MALF PROC ECS ECS
		A. PRIMARY LOOP	DOCKED UNDOCKED	A.1. CONTINUE MISSION ON SECONDARY LOOP NO-GO FOR DOI	
			RNDZ	2. RETURN TO CSM VICINITY ASAP ON SECONDARY LOOP	
		B. BOTH LOOPS (ANY COMBINATION OF LOSS OF CIRCULATION, SUBLIMATION CAPABILITY, OR H_2O FEED FOR BOTH LOOPS)	DOCKED	B.1. INGRESS CSM ASAP NO-GO FOR UNDOCKING	
			UNDOCKED	2. DOCK ASAP NO-GO FOR SEPARATION	
			RNDZ	3. DOCK ASAP (A) CONTINUE GLYCOL CIRCULATION IF POSSIBLE (B) POWER DOWN S/C FOR LIFE SUPPORT ONLY (C) AWAIT CSM RESCUE	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	23-26	LOSS OF PRIMARY H_2O FEEDPATH			REF MALF PROC ECS GLYCOL
			DOCKED UNDOCKED	A. CONTINUE MISSION NO-GO FOR DOI	
			RNDZ	B. RETURN TO VICINITY OF CSM ASAP	
	23-27	FIRE OR SMOKE IN CABIN OR SUIT			REF AOH PROC 5.3.2
			ALL	A. TROUBLESHOOT/COMBAT FIRE	
				B. ASSESS DAMAGE AND TRANSFER TO CSM IF NECESSARY	
	23-28	CONTAMINATION IN CABIN	ALL	CREW MAY ELECT TO DECOMPRESS	IF UNABLE TO CLEAR CONTAMINATION, MISSION MAY BE TERMINATED EARLY.
	23-29	GLYCOL COOLANT LEAK	ALL	TRANSFER TO CSM SET UP FOR UNMANNED APS BURN	
		A. CABIN	ALL	A. PURGE SUIT WITH DIRECT O_2	
		B. SUIT	ALL	B. DISCONNECT FROM SUIT LOOP	

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM
A	23-50

INSTRUCTIONS REQUIREMENTS

MEAS DESCRIPTION	PCM	ONBOARD	CATEGORY
SUIT PRESS	GF1301P	METER	MANDATORY
		WARNING	MANDATORY
CABIN PRESS	GF3571P	METER	MANDATORY
REPR ELEC OPEN	GF3572X	WARNING	HIGHLY DESIRABLE
CO_2 PART PRESS	GF1521P	METER, CAUTION COMP	HIGHLY DESIRABLE
H_2O SEP RATE	GF9999U	CAUTION, COMP	HIGHLY DESIRABLE
DES O_2 PRESS	GF3584P	METER, CAUTION	MANDATORY
ASC 1 O_2 PRESS	GF3582P	METER, CAUTION	1 OF 2
ASC 2 O_2 PRESS	GF3583P	METER, CAUTION	MANDATORY
O_2 MANIFOLD PRESS	GF3589P	------	MANDATORY
GLYCOL PUMP ΔP	GF2021P	------	MANDATORY
GLYCOL PUMP SW/O	GF2936X	COMP	HIGHLY DESIRABLE
GLYCOL PUMP P	GF9997U	METER	MANDATORY
GLYCOL LEVEL LOW	GF2041X	CAUTION	MANDATORY
GLYCOL TEMP	GF9998U	METER, CAUTION	MANDATORY PCM
DES H_2O QTY	GF4581Q	METER, CAUTION	MANDATORY
ASC 1 H_2O QTY			
ASC 2 H_2O QTY			
	GF4582Q, GF4583Q (1 OF 2)	METER	MANDATORY BOTH (1 OF 2)
	GF4582Q, GF4583Q (BOTH)	CAUTION	MANDATORY BOTH (1 OF 2)
PRI H_2O REG ΔP	GF4101P	------	MANDATORY
SUIT DIV EGRESS	GF1221X	------	HIGHLY DESIRABLE
SUIT TEMP	GF1281T	METER	HIGHLY DESIRABLE
CABIN TEMP	GF1651T	METER	HIGHLY DESIRABLE

REV	ITEM

THIS
SECTION
HAS BEEN
DELETED

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

REV	ITEM	GENERAL
	25-1	DOCKED NO MINIMUM G&C SYSTEM CAPABILITIES ARE REQUIRED TO CONTINUE THE DOCKED PHASE.
	25-2	UNDOCKED IN ORDER TO INITIATE AND CONTINUE THE UNDOCKED PHASE, THE G&C SYSTEMS MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES: A. REDUNDANT 3-AXIS ATTITUDE CONTROL, INCLUDING ONE MANUAL CAPABILITY AND ONE AUTO ATT HOLD CAPABILITY. B. 3-AXIS TRANSLATION CAPABILITY, DEFINED AS HAVING A MINIMUM OF: 1. ONE TTCA 2. PGNS OR AGS TRANSLATION CAPABILITY
A	25-3	RENDEZVOUS IN ORDER TO INITIATE AND CONTINUE THE RENDEZVOUS PHASE, THE G&C SYSTEMS MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES: A. SEPARATION 1. REDUNDANT 3-AXIS ATTITUDE CONTROL CAPABILITY 2. 3-AXIS TRANSLATION CAPABILITY B. DOI THE SAME MINIMUM G&C SYSTEMS CAPABILITIES FOR SEPARATION ARE REQUIRED TO INITIATE DOI PLUS THE FOLLOWING MINIMUM CAPABILITIES: 1. OPERATIONAL PGNS, DEFINED AS: (A) NO LGC FAILURE (B) NO ISS FAILURE (C) 3-AXIS ATTITUDE CONTROL CAPABILITY (D) OPERATIONAL DSKY 2. ENG ON/OFF CAPABILITY 3. NO MORE THAN 100 SECONDS MAXIMUM DPS OPERATION IN NON-THROTTLEABLE RANGE 4. EITHER AN OPERATIONAL AOT OR COAS 5. ONE OPERATIONAL FDAI 6. OPERATIONAL RENDEZVOUS RADAR AND RR TRANSPONDER COMBINATION, DEFINED AS: A VALID LOCK-ON DURING THE SEPARATION PHASE

REV	ITEM	
	25-3 (CONT)	C. STAGING IN ORDER TO STAGE THE LM, THE G&C SYSTEMS MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES: 1. 3-AXIS ATTITUDE CONTROL 2. +X TRANSLATION CAPABILITY
	25-4	UNMANNED 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 A S BURN: A. APS ENG ARM-DEARM/ON-OFF CONTROL B. OPERATIONAL PGNS OR AGS
		RULE NUMBERS 25-5 THROUGH 25-9 ARE RESERVED

REV	ITEM	
		SYSTEMS MANAGEMENT

SYSTEMS MANAGEMENT

REV A — ITEM 25-10 — IMU

A. THE IRIG BIASES WILL BE UPDATED WHEN THE GYRO DRIFT IS ≥ ±.225°/HR (15 MERU)

B. THE PGNS WILL BE CONSIDERED NO-GO WITH A GYRO DRIFT > ±1.5°/HR (100 MERU) OR AN IRIG BIAS ≥ ±1.93°/HR (128 MERU), THE MAXIMUM ALLOWABLE VALUE WITHIN THE LGC.

C. THE PIPA BIAS WILL BE UPDATED WHENEVER THE Δ BIAS (LGC VALUE OF BIAS - MEASURED BIAS) IS ≥ ±.200 CM/SEC^2 (.0066 FT/SEC^2).

D. THE PGNS WILL BE CONSIDERED NO-GO IF THE PIPA BIAS EXCEEDS ±3.125 CM/SEC^2, THE MAXIMUM ALLOWABLE VALUE WITHIN THE LGC.

REV A — ITEM 25-11 — LGC

A. A MASS UPDATE IS REQUIRED IF A MASS Δ OF ±10% (DIFFERENCE BETWEEN GROUND CALCULATION AND LGC VALUE) EXISTS WHEN IN THE DPS CONFIGURATION OR ±5% IN APS CONFIGURATION.

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.

C. ULLAGE FOR ALL APS BURNS MAY BE FOUR JET OR TWO JET SYSTEM "A" OR "B".

D. ALL ± (U-V) JETS WILL BE INHIBITED VIA V65 DURING DOCKED DPS BURNS.

E. DURING DOCKED MANEUVERS, ALL DPS GIMBAL TRIMMING MUST BE DONE AT >35% THROTTLE. THE RECOMMENDED SETTING IS 40% THROTTLE.

REV A — ITEM 25-12 — RENDEZVOUS RADAR

A. THE RR MUST NOT BE OPERATED UNTIL THE ANTENNA TEMPERATURE (HPM) IS ≥10°F AND THE GYRO PACKAGE IS ESTIMATED TO BE ≥15°F.

B. THE RR SHOULD NOT BE OPERATED AT AN ANTENNA TEMPERATURE ≥145°F AND/OR A GYRO PACKAGE TEMP (ESTIMATED) OF ≥200°F.

C. IF THE RR ANTENNA TEMP EXCEEDS THE NOMINAL TEMPERATURE PROFILE BY +10°F, THE RR SHOULD BE TURNED OFF IF IT IS NOT NEEDED.

D. IF THE ESTIMATED GYRO PACKAGE TEMP SHOULD EXCEED 200°F (HPM≈ 125°F) ANYTIME DURING THE RENDEZVOUS PHASE, THE AC POWER TO THE RR SHOULD NOT BE TURNED OFF.

E. IF IT IS ESTIMATED THAT THE RR GYRO PACKAGE WILL EXCEED 200°F (HPM≈125°F) PRIOR TO COMPLETION OF THE BRAKING PHASE, THE RR SHOULD BE TURNED OFF UNTIL REQUIRED FOR TPI AND BRAKING.

REV A — ITEM 25-13 — AGS

A. THE AGS IS DECLARED NO-GO WITH AN ASA TEMPERATURE OF < +90°F OR > +150°F.

B. THE AGS IS DECLARED NO-GO DURING A GYRO AND ACCELEROMETER CALIBRATION IF THE GYRO DRIFT CHANGE IS GREATER THAN 2.50°/HR AND IF THE ACCELEROMETER BIAS CHANGE IS GREATER THAN 0.049 FT/SEC^2 FROM THE VALUE AT THE START OF THE CALIBRATION.

C. THE AGS SHOULD BE UPDATED WITHIN 7 MINUTES OF A BURN.

D. THE AGS CAN BE USED TO PERFORM DOCKED ATTITUDE HOLD CONTROL.

E. THE AGS IN PULSED MODE, USING ONLY TTCA CONTROL, CAN BE USED TO PERFORM A DOCKED DPS BURN.

REV	ITEM	
A	25-14	LANDING RADAR A. THE LR SHOULD NOT BE OPE ATED AT AN ANTENNA TEMP OF <50°F. B. THE LR SHOULD NOT BE OPE ATED AT AN ANTENNA TEMP OF >145°F.
		RULES 24-15 THROUGH 25-19 ARE RESERVED.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
				SPECIFIC MISSION RULES	
A	25-20	LOSS OF AN OPERATIONAL PGNS	DOCKED/ UNDOCKED	A.1. CONTINUE THRU SEPARATION 2. SELECT AGS 3. DOI NO-GO 4. START APS UNMANNED BURN IN AGS	
			RNDZ	B.1. PRIOR TO DOI: (A) SELECT AGS (B) DOI NO-GO	
				2. WITHIN 10 MIN AFTER DOI: PERFORM DIRECT RETURN	REF MR 3-52
				3. AFTER DOI +10 MIN (A) SELECT AGS (B) PERFORM 5-IMPULSE	
			UNMANNED	C. CONTINUE BURN IN AGS	
	25-21	LOSS OF FDAI			
		A. ONE	ALL	A. CONTINUE MISSION	
		B. BOTH	DOCKED	B.1. CONTINUE MISSION	
			UNDOCKED	2. CONTINUE MISSION DOI NO-GO	
			RNDZ	3.(A) PRIOR TO DOI DOI NO-GO (B) AFTER DOI CONTINUE MISSION	
			UNMANNED	4. CONTINUE MISSION	
	25-22	LOSS OF AOT AND/OR COAS			
		A. EITHER	ALL	A. CONTINUE MISSION	
		B. BOTH	DOCKED/ UNDOCKED	B.1. CONTINUE MISSION DOI NO-GO	
			RNDZ	2.(A) PRIOR TO DOI DOI NO-GO (B) AFTER DOI CONTINUE MISSION	
			UNMANNED	3. CONTINUE MISSION	
	25-23	LOSS OF RENDEZVOUS RADAR AND/OR TRANSPONDER	DOCKED/ UNDOCKED	A. CONTINUE MISSION	
			RNDZ	B.1. PRIOR TO DOI DOI NO-GO 2. AFTER DOI CONTINUE MISSION	
			UNMANNED	C. CONTINUE MISSION	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	25-24	LOSS OF REDUNDANT 3-AXIS ATTITUDE CONTROL			
		A. ONLY AUTO ATT HOLD CAPABILITY REMAINING	DOCKED	A.1.(A) DO NOT UNDOCK (B) PERFORM APS UNMANNED BURN IN PGNS	
			UNDOCKED	2. RETURN TO CSM AND DOCK ASAP	
			RNDZ	3.(A) PRIOR TO DOI DOI NO-GO (B) AFTER DOI CONTINUE MISSION	
			UNMANNED	4. CONTINUE MISSION	
		B. ONLY MANUAL CAPABILITY REMAINING	DOCKED	B.1.(A) DO NOT UNDOCK (B) APS UNMANNED BURN NO-GO	
			UNDOCKED	2. RETURN TO CSM AND DOCK ASAP	
			RNDZ	3.(A) PRIOR TO DOI DOI NO-GO RETURN TO CSM AND DOCK ASAP (B) AFTER DOI CSM RESCUE	
			UNMANNED	4. STOP BURN ASAP	
	25-25	LOSS OF TRANSLATION CAPABILITY			
		A. ULLAGE (+X)	DOCKED	A.1.(A) DO NOT UNDOCK (B) PERFORM APS UNMANNED BURN WITHOUT ULLAGE	
			UNDOCKED	2. RETURN TO CSM AND DOCK ASAP CSM ACTIVE DOCKING	
			RNDZ	3.(A) PRIOR TO DOI RETURN TO CSM AND DOCK ASAP CSM ACTIVE DOCKING (B) AFTER DOI CSM RESCUE LM STAGING NO-GO	
			UNMANNED	4. CONTINUE MISSION	
		B. EITHER ±Y, ±Z, -X TRANSLATION	DOCKED	B.1. DO NOT UNDOCK	
			UNDOCK/ RNDZ	2. RETURN TO CSM AND DOCK ASAP CSM PERFORM BRAKING MANEUVER AND DOCKING	
			UNMANNED	3. CONTINUE MISSION	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	25-26	LOSS OF THRUST VECTOR CONTROL			
		A. RCS IMPINGEMENT CONSTRAINTS WILL NOT BE VIOLATED	ALL	A. CONTINUE MISSION	
		B. RCS IMPINGEMENT CONSTRAINTS WILL BE VIOLATED	ALL	B.1. INHIBIT DPS BURNS 2. STAGE LM 3. CONTINUE MISSION USING APS	B. RCS IMPINGEMENT CONSTRAINTS MAY BE VIOLATED BECAUSE OF RCS OPPOSING THRUST VECTOR OFFSET.
	25-27	LOSS OF AUTO ENG ON/OFF CAPABILITY	RNDZ	A.1. DEPRESS START PB IMMEDIATELY 2. CONTINUE MISSION USING MANUAL ON/OFF CONTROL	
			UNMANNED	B. APS UNMANNED BURN NO-GO	B. NO FURTHER APS START CAPABILITY EXISTS
	25-28	ENG DOES NOT IGNITE AFTER START PB DEPRESSION	RNDZ	A.1. DOI (A) SET STOP PB (B) DEARM DPS (C) MSFN EVALUATE FOR APS ON/OFF CONTROL 2. PHASING: (A) START DPS VIA DES ENG CMD OVRD SW (B) STOP BURN VIA STOP PB 3. INSERTION (A) SET STOP PB (B) DEARM APS (C) CSM PERFORM INSERTION (D) APS UNMANNED BURN NO-GO	A.1. STOP PB MUST BE SET TO RESET THE LATCHING RELAYS ENERGIZED BY START PB DEPRESSION 3. NO FURTHER APS START CAPABILITY EXISTS

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	25-29	LOSS OF OPERATIONAL AGS	ALL	A. 1. CONTINUE MISSION IN PGNS 2. PERFORM UNMANNED APS BURN IN PGNS	
			UNMANNED	B. CONTINUE BURN SWITCH TO PGNS	
	25-30	DPS BURN IN NON-THROTTLEABLE RANGE	RNDZ	CONTINUE BURN CONTINUE MISSION	NO LONGER THAN 100 SEC IN NON-THROTTLEABLE RANGE CAN BE ACCUMULATED
A	25-31	LOSS OF MANUAL THRUST CONTROL			
		A. ZERO OUTPUT	RNDZ	A. CONTINUE MISSION USE LOW STOP POINT FOR DPS BURN STARTS	A.1. THE THROTTLE WILL GO TO APPROXIMATELY 10% WITH ZERO MANUAL INPUT TO VARIABLE THROTTLE ACTUATOR ELECTRONIC CONTROLS. 2. DURING PHASING BURN, AUTO THROTTLE TO MAX WILL CAUSE THRUST TO INCREASE TO THE NON-THROTTLEABLE RANGE, BUT FOR AN ACCEPTABLE DURATION.
		B. MAXIMUM OUTPUT	RNDZ	B.1. PRIOR TO DOI (A) CONTINUE MISSION (B) START AT MAX THRUST (C) CONTINUE MISSION USING APS 2. DURING DOI (A) CONTINUE BURNING UNTIL COMMAND SHUTDOWN (B) CONTINUE MISSION 3. PRIOR TO PHASING (A) CONTINUE MISSION (B) START AT MAX THRUST 4. DURING PHASING (A) CONTINUE BURNING UNTIL COMMAND SHUTDOWN (B) CONTINUE MISSION	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	25-32	LOSS OF ACA			
		A. ONE	ALL	A. CONTINUE MISSION	
		B. BOTH	DOCKED	B.1. DO NOT UNDOCK	
			UNDOCKED	2. RETURN TO CSM ASAP CSM ACTIVE DOCKING	
			RNDZ	3.(A) PRIOR TO DOI DOI NO-GO CSM ACTIVE DOCKING (B) AFTER DOI CONTINUE LM ACTIVE UNTIL TERMINAL PHASE CSM ACTIVE DOCKING	
			UNMANNED	4. CONTINUE MISSION	
	25-33	LOSS OF TTCA			
		A. ONE	ALL	A. CONTINUE MISSION	
		B. BOTH	DOCKED	B.1. DO NOT UNDOCK	
			UNDOCKED	2. RETURN TO CSM ASAP CSM ACTIVE DOCKING	
			RNDZ	3.(A) PRIOR TO DOI DOI NO-GO CSM ACTIVE DOCKING (B) AFTER DOI CONTINUE LM ACTIVE UNTIL TERMINAL PHASE CSM ACTIVE DOCKING	
			UNMANNED	4. CONTINUE MISSION	
		RULE NUMBERS 25-34 THROUGH 25-39 ARE RESERVED.			

REV	ITEM	
		PRELAUNCH INSTUMENTATION
	25-40	

MEAS DESCRIPTION	PCM	ONBOARD	TRANSDUCERS	CATEGORY	MISSION RULE REFERENCE
LGC DOWNLINK	GG0001U	-	-	M	25-20
PLS TORO 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	25-20
IG IX RSVR OUT SIN	GG2112V	FDAI	COMMON	M-PCM	25-20
IG IX RXVR OUT COS	GG2113V	FDAI	COMMON	M-PCM	25-20
MG SVO ERR IN ϕ	GG2137V	-	-	HD	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	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
RR SHFT SIN	GG3304V	FDAI	COMMON	HD - PCM	25-23
RR SHFT COS	GG3305V	FDAI	COMMON	HD - PCM	25-23
RR TRUN SIN	GG3324V	FDAI	COMMON	HD - PCM	25-23
RR TRUN COS	GG3325V	FDAI	COMMON	HD - PCM	25-23
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	25-23
RR ANT TEMP	GN7723T	TEMP MONITOR	COMMON	M-PCM	25-23
YAW ERR CMD	GH1247V	-	-	M	25-24
PITCH ERR CMD	GH1248V	-	-	M	25-24
ROLL ERR CMD	GH1249V	-	-	M	25-24
JD A4D OUTPUT	GH1419V	-	-	HD	25-24,25-25
RCS TCP A4D	GR5032X	-	-	HD	25-24,25-25
JD B3D OUTPUT	GH1423V	-	-	HD	25-24,25-25
RCS TCP B3D	GR5036X	-	-	HD	25-24,25-25
JD A2D OUTPUT	GH1427V	-	-	HD	25-24,25-25
RCS TCP A2D	GR5040X	-	-	HD	25-24,25-25
JD B1D OUTPUT	GH1431V	-	-	HD	25-24,25-25
RCS TCP B1D	GR5044X	-	-	HD	25-24,25-25
JD B4U OUTPUT	GH1418V	-	-	HD	25-24,25-25
JD B4F OUTPUT	GH1420V	-	-	HD	25-24,25-25
JD A4R OUTPUT	GH1421V	-	-	HD	25-24,25-25
JD A3U OUTPUT	GH1422V	-	-	HD	25-24,25-25
JD B3A OUTPUT	GH1424V	-	-	HD	25-24,25-25
JD A3R OUTPUT	GH1425V	-	-	HD	25-24,25-25
JD B2U OUTPUT	GH1426V	-	-	HD	25-24,25-25
JD A2A OUTPUT	GH1428V	-	-	HD	25-24,25-25
JD B2L OUTPUT	GH1429V	-	-	HD	25-24,25-25
JD A1U OUTPUT	GH1430V	-	-	HD	25-24,25-25
JD A1F OUTPUT	GH1432V	-	-	HD	25-24,25-25
JD B1L OUTPUT	GH1433V	-	-	HD	25-24,25-25
RCS TCP B4U	GR5031X	-	-	HD	25-24,25-25
RCS TCP B4F	GR5033X	-	-	HD	25-24,25-25
RCS TCO A4R	GR5034X	-	-	HD	25-24,25-25
RCS TCP A3U	GR5035X	-	-	HD	25-24,25-25
RCS TCP B3A	GR5037X	-	-	HD	25-24,25-25
RCS TCP A3R	GR5038X	-	-	HD	25-24,25-25
RCS TCP B2U	GR5039X	-	-	HD	25-24,25-25
RCS TCP A2A	GR5041X	-	-	HD	25-24,25-25
RCS TCP B2L	GR5042X	-	-	HD	25-24,25-25
RCS TCP A1U	GR5043X	-	-	HD	25-24,25-25
RCS TCP A1F	GR5045X	-	-	HD	25-24,25-25
RCS TCP B1L	GR5046X	-	-	HD	25-24,25-25
YAW ATT ERR	GH1455V	FDAI	COMMON	HD	25-24
PITCH ATT ERR	GH1456V	FDAI	COMMON	HD	25-24

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	

GENERAL

26-1 DOCKED

IN ORDER TO INITIATE AND CONTINUE THE DOCKED PHASE, THE DPS SUBSYSTEM MUST PROVIDE THE FOLLOWING CONDITION:

NO DPS PROPELLANT LEAK

26-2 UNDOCKED/SEPARATION

IN ORDER TO INITIATE AND CONTINUE THE UNDOCKED PHASE, THE DPS SUBSYSTEM MUST PROVIDE THE FOLLOWING MINIMUM CONDITION:

NO DPS PROPELLANT LEAK

A 26-3 DOI/RENDEZVOUS

IN ORDER TO INITIATE AND CONTINUE THE RENDEZVOUS PHASE, THE DPS SUBSYSTEM MUST PROVIDE A SAFE BURN CAPABILITY, DEFINED AS FOLLOWS:

A. NO DPS PROPELLANT LEAKS

B. AN OPERATIONAL DPS DEFINED AS FOLLOWS:

1. FUEL AND OXID ENGINE INLET PRESSURE $\geq$100 PSI AT BURN INITIATION.
2. DURING BURN, OXID AND FUEL ENGINE INLET PRESS $\geq$120 PSI (THROTTLE SETTING <65%) OR >150 PSI (THROTTLE SETTING >65%).
3. DPS PROPELLANT TEMPS <75°F OR $\geq$50°F ONLY TO INITIATE A BURN.
4. ΔT BETWEEN FUEL AND OXID TEMP $\leq$25°F ONLY TO INITIATE A BURN.
5. ΔP BETWEEN FUEL AND OXIDIZER ENGINE INLET PRESSURE <TBD PSID AT <65% THROTTLE, OR <TBD PSID AT >65% THROTTLE FOR BURNS <TBD SEC.

C. SUFFICIENT ΔV CAPABILITY TO ACCOMPLISH DOI AND PHASING.

RULES 26-4 THROUGH
26-10 ARE RESERVED.

FEC/TSG Form 292 (AUG 66)

REV	ITEM	SYSTEMS MANAGEMENT
A	26-11	THE LOW THROTTLE POINT IS THE MINIMUM THROTTLE POSITION THAT THE THROTTLE ACTUATOR WILL ASSUME WITH MINIMUM MANUAL THROTTLE COMMAND VOLTAGE (12.4% FOR LM-4)
	26-12	DPS USABLE PROPELLANT IS 17627.0 LBS. TOTAL LOADED 18229.5 LBS TRAPPED 367.5 LBS TM ERROR 235.0 LBS 17627.0 LBS
	26-13	THE TOTAL CONTINUOUS BURN TIME OF THE DESCENT ENGINE SHALL NOT EXCEED 910 SECONDS OF OPERATION INDEPENDENT OF THRUST LEVEL.
A	26-14	THE DPS ENGINE MINIMUM BURN TIME IS 3.5 SECONDS. THE MINIMUM COAST TIME BETWEEN DPS ENGINE BURNS IS 2 SECONDS.
	26-15	ALL DPS STARTS MUST BE NOMINALLY PLANNED AT THE LOW THROTTLE POINT.
	26-16	THE DPS ENGINE MUST NOT BE OPERATED IN THE NON-THROTTLING RANGE (65% TO FTP) FOR MORE THAN 100 SEC.
	26-17	SUPERCRITICAL HELIUM BURST DISC RUPTURE DURING MANNED OPERATION IS AN ALLOWABLE EVENT.
A	26-18	ALL DESCENT ENGINE STARTS MUST NOMINALLY BE PRECEDED BY A PROPELLANT SETTLING MANEUVER.
A		RULE 26-19 IS RESERVED.

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. 3.5 SEC TO TBD SEC	2 SECONDS	NO CONSTRAINT
B. TBD TO 190 SECS	2 SECONDS	400 SECS
C. 190 SECS TO 600 SECS	REFERENCE (SEE FIGURE BELOW)	100 SECS
D. 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.

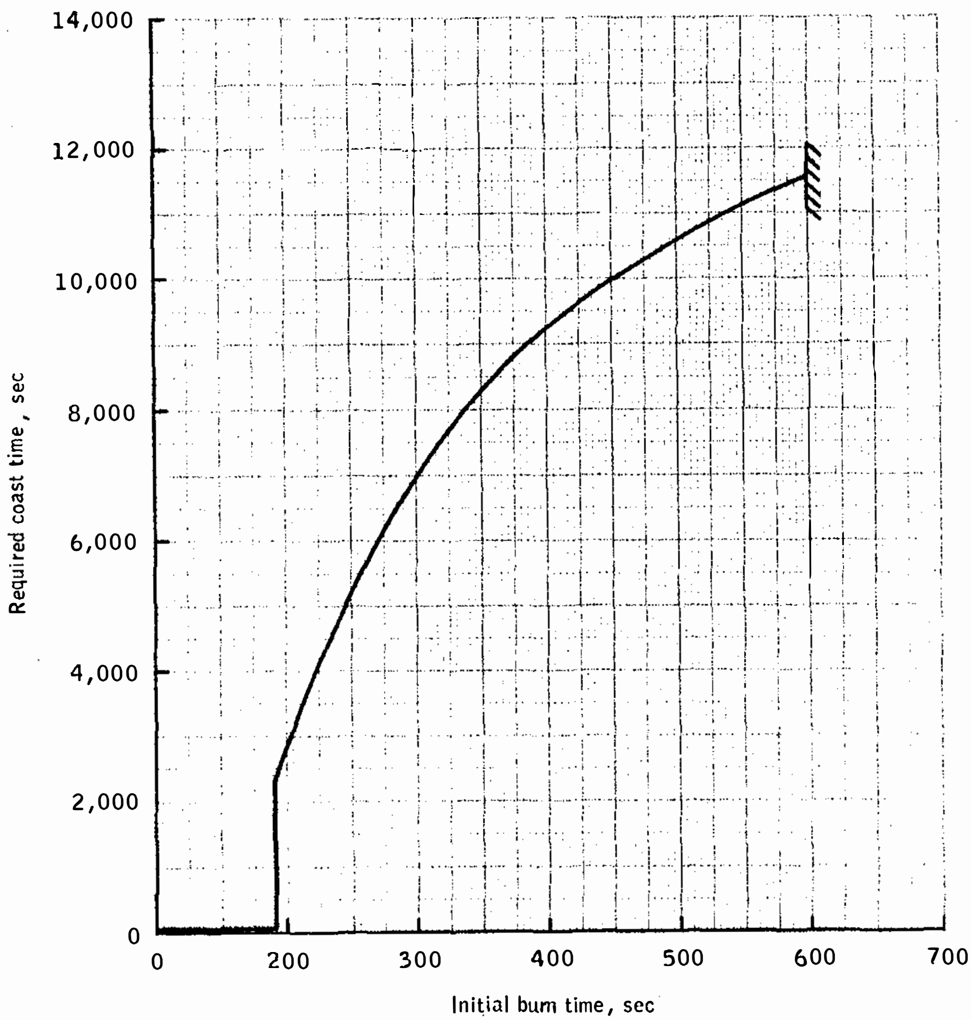

Figure 26-1 .- LMDE required coast time vs initial burn time for engine chamber heating limitations.

REV	ITEM	
	26-20	ONLY PREMISSION APPROVED ALTERNATE DPS/MULTIBURN PROFILES WILL BE EXECUTED, SINCE NO DATA EXISTS TO ALLOW REAL-TIME SUPPORT FOR EXAMINING DPS FREEZING, CHARRING, BACKWALL TEMPERATURE CONSTRAINTS FOR MULTIBURN PROFILES.
A	26-21	PROPELLANT GAGING A. PRIME METHOD: GROUND MASS CALCULATION (1.5%) B. BACKUP METHOD: PQGS (TM, ONBOARD) (1.3%)
		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 MISSION RULES	
A	26-30	LOSS OF ALL OPERATIONAL DPS	ALL	A. CONTINUE MISSION 1. DOI NO-GO 2. FOR FURTHER MAIN ENGINE BURNS USE APS B. PRIOR TO PHASING 1. INHIBIT BURN 2. STAGE AND USE APS FOR FURTHER MAIN ENGINE BURNS C. DURING PHASING 1. STOP BURN 2. COMPLETE BURN PER MR 3-53	AN OPERATIONAL APS AND RCS IS REQUIRED
	26-31	START TANK LEAK PRIOR TO PRESS A. FU AND OXID ENGINE INLET PRESS $\geq$100 PSIA AT IGNITION B. FU AND/OR OXID ENGINE INLET <100 PSIA	ALL	A. CONTINUE MISSION INHIBIT FIRING DPS START TANK SQUIB B. CONTINUE MISSION FIRE SQUIB TO START TANK	REF MAL PROC DPS #1 NOTE: PRESSURIZATION SYSTEM MAY BE OPENED TO START TANK LEAK; CLOSE PRIMARY He REG SOV AFTER EACH BURN AND REOPEN AT INITIATION OF EACH SUBSEQUENT BURN.
	26-32	DPS FAILS TO PRESSURE A. VIA START TANK 1. INLET PRESS <100 PSIA 2. INLET PRESS >100 PSIA B. VIA SUPERCRITICAL HELIUM	ALL	A.1. INHIBIT ALL DPS BURNS REF ALT MISSION ___ AND APS UNMANNED BURN 2. CONTINUE MISSION B. CUT OFF BURN ON INLET PRESS 1. DO NOT GO TO FTP 2. IF AT FTP, THROTTLE TO 40%	
	26-33	OFF NOMINAL SUPERCRITICAL He PRESS <500 PSI	RNDZ	A. CONTINUE MISSION REMAIN AT 10% UNTIL SHe PRESS $\geq$500 PSIA	REF MAL PROC DPS #1

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	26-34	LEAK BETWEEN He REG SHUTOFF AND QUAD CHECK VALVES	ALL	CONTINUE MISSION A. CLOSE He REG SHUTOFF VALVES B. OPEN He SHUTOFF VALVES PRIOR TO EACH BURN	REF MAL PROC DPS #1 & 2.
A	26-35	DPS PROPELLANT LEAK	ALL	STAGE ASAP	REF MAL PROC DPS ______

REV	ITEM	
	27-1	DOCKED, UNDOCKING, SEPARATION

IN ORDER TO INITIATE THE ABOVE PHASES, THE APS MUST EXHIBIT THE FOLLOWING CAPABILITY:

NO PROPELLANT LEAK

REV	ITEM	
A	27-2	DOI/RENDEZVOUS

IN ORDER TO INITIATE THE RENDEZVOUS PHASE OF THE MISSION, THE APS SUBSYSTEM MUST PROVIDE A SAFE BURN CAPABILITY DEFINED AS FOLLOWS:

A. NO APS PROPELLANT LEAKS

B. AN OPERATIONAL APS, DEFINED AS FOLLOWS:

MANNED	START BURN	CONTINUE BURN
1. APS BULK TEMP	>30°F < 120°F	N/A
2. OX-FUEL ΔT	<60°F*	N/A
3. INLET PRESS	>115 < 250 PSI*	>115 < 250 PSI, NO PRESS OSCILLATIONS
4. INLET PRESS ΔP	20 PSID*	<12 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	<250 PSI	<250 PSI, NO PRESS OSCILLATIONS
4. INLET PRESS ΔP	<90 PSID	<20 PSID
5. TCP	N/A	<150, NO PRESS OSCILLATIONS
6. PROPELLANT LEAK	N/A	NONE

*VALUES SHOWN ARE FOR BURNS <100 SEC LONG.

C. SUFFICIENT ΔV CAPABILITY TO DO INSERTION BURN.

REV	ITEM	
	27-3	STAGING/INSERTION

IN ORDER TO STAGE THE LM PRIOR TO THE INSERTION BURN, THE APS SUBSYSTEM MUST PROVIDE A SAFE BURN CAPABILITY FOR THE INSERTION BURN

RULES 27-4 THROUGH 27-9 ARE RESERVED.

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
	26-40	DPS - PRELAUNCH INSTRUMENTATION

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	QG3719T	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 LM APS

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
		GENERAL
	27-1	DOCKED, UNDOCKING, SEPARATION IN ORDER TO INITIATE THE ABOVE PHASES, THE APS MUST EXHIBIT THE FOLLOWING CAPABILITY: NO PROPELLANT LEAK
	27-2	DOI/RENDEZVOUS IN ORDER TO INITIATE THE RENDEZVOUS PHASE OF THE MISSION, THE APS SUBSYSTEM MUST PROVIDE A SAFE BURN CAPABILITY DEFINED AS FOLLOWS: A. NO APS PROPEL ANT LEAKS B. AN OPERATIONAL APS, DEFINED AS FOLLOWS: 1. ΔP BETWEEN APS FUEL AND OXIDIZER ENGINE INLET PRESSURE <TBD PSID. 2. ΔT BETWEEN APS FUEL AND OXIDIZER TEMP <10°F. ONLY TO INITIATE A BURN. 3. APS FUEL AND/OR OXIDIZER TEMP >40°F AND <85°F. ONLY TO INITIATE A BURN. 4. APS FUEL AND/OR OXIDIZER INLET PRESSURE >115 PSI AND <220 PSI C. SUFFICIENT ΔV CAPABILITY TO DO INSERTION BURN.
	27-3	STAGING/INSERTION IN ORDER TO STAGE THE LM PRIOR TO THE INSERTION BURN, THE APS SUBSYSTEM MUST PROVIDE A SAFE BURN CAPABILITY FOR THE INSERTION BURN
		RULES 27-4 THROUGH 27-9 ARE RESERVED.

REV	ITEM	SYSTEMS MANAGEMENT
A	27-10	APS MANNED ENGINE STARTS WILL BE PRECEDED BY A PROPELLANT SETTLING MANEUVER.
	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.
	27-12	THE USABLE PROPELLANT FOR APS IS 2465.6 LBS. TOTAL LOADED 2631.7 LBS TRAPPED 53.1 LBS TM ERROR 113.0 LBS USABLE 2465.6 LBS
A	27-13	THE MINIMUM IMPULSE OF THE APS ENGINE IS 1200 LBS/SEC, WHICH CORRESPONDS TO A BURN TIME OF 0.5 SEC.
	27-14	ONLY PREMISSION APPROVED APS MULTIBURN PROFILES WILL BE EXECUTED, SINCE NO DATA EXISTS TO ALLOW REAL-TIME SUPPORT FOR EXAMINING APS FREEZING, CHARRING, BACKWALL TEMPERATURE CONSTRAINTS FOR MULTIBURN PROFILES.
	27-15	PROPELLANT GAGING (NO ONBOARD READOUT): A. PRIME METHOD: FLOWRATE X TIME (5%) B. BACKUP METHOD: GROUND MASS CALCULATION (5%)
A	27-16	THE APS ENGINE MAY BE RESTARTED WITH COAST TIMES A. <10 SEC OR >200 SEC, WITH PROPELLANT TEMP <65°F B. <10 SEC OR >90 SEC, WITH PROPELLANT TEMP >65°F
A		RULES 27-17 THROUGH 27-19 ARE RESERVED.

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
				SPECIFIC MISSION RULES	
A	27-20	LOSS OF AN OPERATIONAL APS	RNDZ	A.1. PRIOR TO STAGING (A) DO NOT STAGE (B) PERFORM INSERTION USING DPS 2. AFTER STAGING (A) INHIBIT APS BURNS (B) INSERTION NO-GO (C) CSM PERFORM INSERTION 3. INSERTION (A) STOP BURN IF IN PROGRESS (B) COMPLETE ΔV REQUIREMENTS IN ACCORDANCE WITH MR 3-54	
			UNMANNED	B.1. STOP BURN IF IN PROGRESS 2. INHIBIT FURTHER APS BURNS	
A	27-21	DELETED			
	27-22	APS He SOURCE PRESSURE			REF MAL PROC APS #1
		A. LEAK PRIOR TO PRESSURIZATION	ALL	A. CONTINUE MISSION INHIBIT USE OF EFFECTED TANK	
		B. PRESS >3500 PSI PRIOR TO PRESSURIZATION	ALL	B. PRESSURIZE APS	
		C. SOURCE PRESSURE LESS THAN ENGINE INLET PRESSURE	ALL	C.1. CONTINUE MISSION CLOSE He REG SHUTOFF VALVES	
			RNDZ	2. CONTINUE MISSION (A) CLOSE He REG SHUTOFF VALVES (B) OPERATE IN BLOWDOWN MODE	
	27-23	APS He LEAK BETWEEN QUAD CHECK VALVES AND He SHUTOFF VALVES	ALL	CONTINUE MISSION A. CLOSE He REG SHUTOFF VALVES B. OPEN He REG SHUTOFF VALVES PRIOR TO EACH BURN	REF MAL PROC APS #2

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	27-24	APS PROPELLANT LEAK	DOCKED	A. EGRESS TO CSM ASAP 1. JETTISON LM 2. APS UNMANNED BURN NO-GO	REF MAL PROC APS #1 & 4
			UNDOCKED	B.1. DOCK ASAP 2. CSM ACTIVE DOCKING	
			RNDZ	C. CSM RESCUE	
			UNMANNED	D. CONTINUE BURN	
	27-25	APS PROP VALVE MISMATCH (ΔPOS)	RNDZ	A. CONTINUE BURN IN PROGRESS INHIBIT FURTHER MANNED APS BURNS	THIS INDICATION PRIOR TO FIRST APS ENGINE ON WILL BE CONSIDERED A TM FAILURE.
			UNMANNED	B. CONTINUE MISSION	

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	

APS - PRELAUNCH INSTRUMENTATION

27-30

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

28 LM REACTION CONTROL SYSTEM

REV	ITEM	
	28-1	<u>DOCKED</u> IN ORDER TO INITIATE AND CONTINUE THE DOCKED PHASE OF THE MISSION, THE RCS SUBSYSTEM MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITY: NO PROPELLANT LEAKS
A	28-2	A. <u>UNDOCKED</u> 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: 1. REDUNDANT CAPABILITY TO SUPPLY PROPELLANT FOR MAINTAINING RCS 3-AXIS ATTITUDE CONTROL VIA ONE OF THE FOLLOWING: (A) OPERATIONAL SYSTEM A AND B (B) OPERATIONAL SYSTEM A OR B, PLUS CROSSFEED CAPABILITY AND ASC FEED CAPABILITY 2. NO THRUSTER PAIRS ISOLATED OR ANY SINGLE VERTICAL JET FAILED 3. NO PROPELLANT LEAKS B. <u>SEPARATION/DOI/PHASING</u> 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: 1. RCS SYSTEM A AND B OPERATIONAL 2. NO THRUSTER PAIRS ISOLATED OR ANY SINGLE VERTICAL JET FAILED 3. NO LEAKS C. <u>STAGING</u> IN ORDER TO INITIATE STAGING, THE FOLLOWING MINIMUM CAPABILITIES ARE REQUIRED: 1. 3-AXIS RCS ATTITUDE CONTROL 2. 3-AXIS RCS TRANSLATION D. <u>INSERTION</u> 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. 1. SAME AS SEPARATION/PHASING
A	28-3	DELETED
	28-4	<u>UNMANNED</u> IN ORDER TO INITIATE AND CONTINUE THE UNMANNED PHASE OF THE MISSION, THE RCS SUBSYSTEM MUST PROVIDE THIS MINIMUM CAPABILITY: 3-AXIS ATTITUDE CONTROL RULE NUMBERS 28-5 THROUGH 28-8 ARE RESERVED.

REV	ITEM	SYSTEMS MANAGEMENT
A	28-9	AN OPERATIONAL RCS SYSTEM IS DEFINED AS MAINTAINING: A. PROPELLANT TEMPERATURE >40°F AND <100°F B. ΔP BETWEEN OXID AND FUEL <80 PSI C. PROPELLANT MANIFOLD PRESSURE >100 PSI D. CAPABILITY TO EXPEL REQUIRED RCS PROPELLANT FROM TANKS TO SUPPORT PLANNED GO/NO-GO'S
A	28-10	THRUSTER TEMP THE RCS QUAD TEMP MUST BE BROUGHT UP TO OPERATING TEMP VIA THE RCS HEATERS PRIOR TO ANY RCS FIRINGS. THRUSTER QUAD TEMP MUST BE ABOVE 119°F AND LESS THEN 190°F, EXCEPT DURING PERIODS OF HEAVY DUTY CYCLE WITH EXPECTED TEMP RISES SUCH AS DOCKING.
	28-11	USABLE RCS PROPELLANT IS 530 LBS. TOTAL LOADED 630 LBS TRAPPED 40 LBS TM ERROR* 63 LBS USABLE 530 LBS *TO BE UPDATED TO REFLECT GROUND COMPUTATIONAL ACCURACY
A	28-12	PROPELLANT GAGING A. PRIME METHOD: RCS GROUND PROGRAM (6%) B. BACKUP METHOD: PQMD TM (10%) ONBOARD (13%)
	28-13	PRIOR TO UNDOCKING, THE LM SHOULD BE IN WIDE DEADBAND ATTITUDE HOLD AND THE CSM IN NARROW DEADBAND ATTITUDE HOLD.
	28-14	ASCENT FEED OPERATION IS NOMINALLY PLANNED FOR THE UNMANNED APS DEPLETION BURN. HOWEVER, IF ONE RCS SYSTEM HAS >30 PERCENT TOTAL PROPELLANT REMAINING PRIOR TO THE UNMANNED APS BURN, THAT SYSTEM WILL REMAIN WITH THE MAINS OPEN AND ASCENT FEED VALVES CLOSED. IF BOTH SYSTEMS HAVE >30 PERCENT TOTAL PROPELLANT REMAINING, THEN THE SYSTEM WITH THE GREATER AMOUNT OF PROPELLANT WILL REMAIN IN THE ABOVE CONFIGURATION WHILE THE OTHER USES ASCENT FEED OPERATION AND THE SYSTEM WITH ASCENT FEED WILL BE USED FOR ULLAGE.

REV	ITEM	
A	28-15	RCS PLUME IMPINGEMENT ON THE LM

MAXIMUM ALLOWABLE CONTINUOUS FIRING OF RCS JETS:

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.

B. LM, +X (DOWN FIRING ENGINE): 55 SEC STAGED.

C. UNDOCKED 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 OVERPRESSURE DUE TO PLUME.

D. DOCKED LM, -X: 15 SEC FIRING EXCEEDING -X IMPINGEMENT TIME COULD RESULT IN DAMAGE TO CSM THERMAL COATINGS.

A

RULE NUMBERS 28-16 THROUGH 28-19 ARE RESERVED.

NASA — Manned Spacecraft Center
MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
			SPECIFIC MISSION RULES		
A	28-20	LOSS OF RCS SYSTEM A OR B	ALL	A.1. ISOLATE EFFECTED SYSTEM 2. UTILIZE GOOD SYSTEM	REF MAL PROC RCS #1 AND MR 28-2
			DOCKED	B. DO NOT UNDOCK REFER TO ALT MISSION	
			UNDOCKED/ RNDZ	C. CSM RESCUE LM IN FREE DRIFT UNTIL DOCKING	
			UNMANNED	D. CONTINUE MISSION	
	28-21	RCS THRUSTER PAIR			REF MAL PROC RCS #3
		A. ONE PAIR ISOLATED	DOCKED	A.1. DO NOT UNDOCK REFER TO ALT MISSION _____	
			UNDOCKED/ RNDZ	2. RETURN TO CSM AND DOCK ASAP	
			UNMANNED	3. CONTINUE MISSION	
		B. COMBINATION ISOLATED RESULTING IN LOSS OF ATTITUDE CONTROL	DOCKED	B.1. DO NOT UNDOCK UNMANNED APS BURN NO-GO	
			UNDOCK	2. CSM ACTIVE DOCK ASAP	
			RNDZ	3. CSM RESCUE	
			UNMANNED	4. STOP UNMANNED APS BURN	
	28-22	DECREASING OR LOSS OF RCS He PRESSURE			REF MAL PROC RCS #1 AND 2
			ALL	A. CONTINUE MISSION 1. CONTINUE USING BOTH SYSTEMS UNTIL MFLD PRESS IN BAD SYSTEM $\leq$100 PSI. THEN ISOLATE BAD SYSTEM. 2. CROSSFEED FROM GOOD SYSTEM	
			DOCKED	B. DO NOT UNDOCK	WHEN MFLD PRESS DROPS BELOW 100 PSI, THE SYSTEM IS CONSIDERED NON-OPERATIONAL REF 28-20
			UNDOCKED	C. DOCK ASAP	
			RNDZ	D. RETURN TO CSM AND DOCK ASAP	
			UNMANNED	E. CONTINUE MISSION	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	28-23	RCS PROPELLANT LEAK	DOCKED	A. CREW EVACUATE SPACECRAFT 1. UNDOCK 2. CSM SEPARATE FROM LM 3. INHIBIT FURTHER MANNING OF LM	REF MAL PROC RCS #5
			UNDOCKED/ RNDZ	B. RETURN TO CSM ASAP CSM RESCUE REQUIRED	
			UNMANNED	C. CONTINUE MISSION	
A	28-24	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 28-21	REF MAL PROC RCS #3 QUAD TEMP <119°F INDICATE THE POSSIBILITY OF INCOMPLETE COMBUSTION, WHICH COULD CAUSE HARD STARTS AND POSSIBLE EXPLOSIONS. QUAD TEMPS >190°F INDICATE PREMATURE OXID VAPORIZATION AND ALSO POSSIBILITY OF VALVE SEAT DAMAGE.
		RULE NUMBERS 28-26 THROUGH 28-29 ARE RESERVED.			

REV	ITEM

PRELAUNCH INSTRUMENTATION

28-30

MEAS DESCRIPTION	PCM	ONBOARD	TRANSDUCER	CATEGORY	MISSION RULE REFERENCE
RCS "A" PROP QTY	GR1085Q	QUANTITY	COMMON	M	28-23,22
RCS "B" PROP QTY	GR1095Q	QUANTITY	COMMON	M	28-23,22
RCS "A" REG PRESS	GR1201P	PRESS MON C&W	COMMON	M-PCM	28-20,22,23
RCS "B" REG PRESS	GR1202P	PRESS MON C&W	COMMON	M-PCM	28-20,22,23
RCS "A" HE PRESS	GR1101P	PRESS MON C&W	COMMON	M-PCM	28-23,24
RCS "B" HE PRESS	GR1102P	PRESS MON C&W	COMMON	M-PCM	28-23,24
RCS "A" FUEL TEMP	GR2121T	TEMP MON	COMMON	M-PCM	28-20
RCS "B" FUEL TEMP	GR2122T	TEMP MON	COMMON	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	28-20,24,23
RCS "B" FUEL MFLD PRESS	GR2202P	PRESS MON	COMMON	M	28-20,24,23
RCS "A" OX MFLD PRESS	GR3201P	PRESS MON	COMMON	M	28-20,24,23
RCS "B" OX MFLD PRESS	GR3202P	PRESS MON	COMMON	M	28-20,24,23
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	28-25
QUAD 2 TEMP	GR6003T	TEMP MON C&W	COMMON	M	28-25
QUAD 3 TEMP	GR6002T	TEMP MON C&W	COMMON	M	28-25
QUAD 4 TEMP	GR6001T	TEMP MON C&W	COMMON	M	28-25
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: 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 AN/OR A DEPTH (GASTROINTESTINAL) DOSE OF 50 RAD. 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 RADS. C. THESE DOSES REPRESENT THE CUTOFF POINT WHERE A DECISION MUST BE MADE WHETHER TO CONTINUE OR TERMINATE THE MISSION. D. THE RADIATION ABSORBED DOSE (RAD) IS A UNIT OF ABSORBED DOSE WHICH IS EQUAL TO AN ENERGY DEPOSITION OF 100 ERGS/GRAM. E. THE RELATIVE BIOLOGICAL EFFECTIVENESS (RBE) EXPRESSES THE EFFECTIVENESS OF PARTICULAR TYPES OF RADIATION IN PRODUCING THE SAME BIOLOGICAL RESPONSE. THE AVERAGE RBE THAT WILL BE USED FOR SOLAR PARTICLE EVENT RADIATION FROM PROTONS IS 1.2. F. THE ROENTGEN EQUIVALENT MAN (REM) IS THE PRODUCT OF THE RAD AND THE RBE (REM = RAD X RBE). G. A CONFIRMED EVENT IS DEFINED AS AN EVENT THAT HAS BEEN MEASURED BY TWO OR MORE RELIABLE SOURCES. H. A SIGNIFICANT INCREASE OF THE MOD IS DEFINED AS A PARTICLE EVENT THAT WILL PRODUCE A FLUX OF 10^{10} AND A SKIN DOSE OF 575 RADS AND/OR A DEPTH DOSE OF 140 RADS.

(CONTINUED)

NASA — Manned Spacecraft Center

MISSION RULES

INSTRUMENTATION REQUIREMENTS

REV	ITEM	MEAS DESCRIPTION		PCM	ONBOARD	TRANSDUCERS	CATEGORY	MISSION RULE REF
A	29-15	RADIATION DOSIMETER 1 (CM DEPTH DOSE RATE)	VABD	CK1051K	-	-	HD	29-12
		RADIATION DOSIMETER 2 (CM SKIN DOSE RATE)	VABD	CK1052K	-	-	HD	29-12
		DOSIMETER RATE CHANGE	VABD	CK1053R	-	-	HD	29-12
		PROTON COUNT RATE CHAN 1	NPDS	ST0820K	-	-	HD	29-14
		PROTON COUNT RATE CHAN 2	NPDS	ST0821K	-	-	HD	29-14
		PROTON COUNT RATE CHAN 3	NPDS	ST0822K	-	-	HD	29-14
		PROTON COUNT RATE CHAN 4	NPDS	ST0823K	-	-	HD	29-14
		ALPHA COUNT RATE CHAN 1	NPDS	ST0830K	-	-	HD	29-14
		ALPHA COUNT RATE CHAN 2	NPDS	ST0831K	-	-	HD	29-14
		ALPHA COUNT RATE CHAN 3	NPDS	ST0832K	-	-	HD	29-14
		PROTON INTEGER COUNT RATE	NPDS	ST0838K	-	-	HD	29-14
		TEMP NUCLEAR PART. DET	NPDS	ST0840T	-	-	HD	29-14
		TEMP NUCLEAR PART. ANAL	NPDS	ST0841T	-	-	HD	29-14
		PERSONAL RADIATION DOSIMETER (PRD)		-	3 - ONBOARD	-	MANDATORY TO BE ONBOARD	29-14
|		RATE SURVEY METER (RSM)		-	1 - ONBOARD	-	MANDATORY TO BE ONBOARD	29-14

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
			SPECIFIC MISSION RULES		
A	30-1	ACCEPTABLE WEATHER CONDITIONS AND RECOVERY CAPABILITY* IN THE LAUNCH SITE AREA	PRELAUNCH	MANDATORY	
A	30-2	ACCEPTABLE WEATHER CONDITIONS AND RECOVERY CAPABILITY* IN THE LAUNCH ABORT AREA TO 1000 NM DOWNRANGE AND IN THE MID-PACIFIC RECOVERY ZONE	PRELAUNCH	HIGHLY DESIRABLE	
A	30-3	MINIMUM OF 65 AMP-HOURS OF CM POSTLANDING POWER AVAILABLE AT LANDING		HIGHLY DESIRABLE	TO PROVIDE FOR 40 HOURS OF CM POSTLANDING POWER PLUS ONE UPRIGHTING
A	30-4	UNTIL ENTRY -24 HOURS, RETAIN ΔV CAPABILITY TO MOVE ENTRY POINT ±500 NM		HIGHLY DESIRABLE	TO PROVIDE WEATHER AVOIDANCE CAPABILITY

A

*RECOVERY CAPABILITY WILL BE BASED PRIMARILY UPON THE LOCAL RECOVERY UNIT COMMANDER'S EVALUATION OF HIS CAPABILITY TO PERFORM THE RECOVERY OPERATION. WEATHER CONDITIONS AT THE TIME OF THE CM LANDING AFFECT BOTH RECOVERY CAPABILITY AND STRUCTURAL INTEGRITY OF THE CM. THE FOLLOWING GUIDELINES ARE USED TO INDICATE WHEN IT MAY BE NECESSARY TO RE-EVALUATE:

SURFACE WINDS	25 KNOTS
CEILING	1500 FT
VISIBILITY	3 NM
WAVE HEIGHT	8 FT

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	30-5	TARGET POINTS WILL BE LOCATED SUCH THAT THE FOLLOWING AREAS WILL BE CLEAR OF ALL LAND: A. AN ELLIPSE 163 NM UPRANGE, 152 NM DOWN-RANGE, AND 50 NM EITHER SIDE OF 55°/55° TARGET POINT. B. AN ELLIPSE 105 NM UPRANGE, 105 NM DOWN-RANGE, AND 40 NM EITHER SIDE OF ROLL RIGHT 90° (DELAYED) LANDING POINT.	EARTH ORBITAL	MANDATORY	
A	30-6	TARGET POINTS WILL BE LOCATED SUCH THAT THE FOLLOWING AREAS WILL BE CLEAR OF LARGE LAND MASSES: A. AN ELLIPSE 109 NM UPRANGE, 109 NM DOWN-RANGE, AND 40 NM EITHER SIDE OF 90°/90° LANDING POINT. B. AN ELLIPSE 105 NM UPRANGE AND DOWNRANGE AND 40 NM EITHER SIDE OF ROLL RIGHT 90° LAND-ING POINT.	EARTH ORBITAL	HIGHLY DESIRABLE	
A	30-7	TARGET POINTS WILL BE LOCATED SUCH THAT THE FOLLOWING AREAS WILL BE CLEAR OF ALL LAND: A. AN ELLIPSE 5 NM UPRANGE, 5 NM DOWNRANGE, AND 3 NM TO EITHER SIDE OF THE GNCS TARGET POINT. B. AN ELLIPSE 18 NM UPRANGE, 18 NM DOWN-RANGE, AND 45 NM TO EITHER SIDE OF EMS LANDING POINT.	POST-TLI	MANDATORY	

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
A	30-8	TARGET POINTS WILL BE LOCATED SUCH THAT THE FOLLOWING AREAS WILL BE CLEAR OF LARGE LAND MASSES A. REMAINDER OF OPERATIONAL FOOTPRINT. B. AN ELLIPSE 130 NM UPRANGE, 270 NM DOWN-RANGE, AND 35 NM TO EITHER SIDE OF THE CONSTANT "G" LANDING POINT.	POST-TLI	HIGHLY DESIRABLE	

31 AEROMEDICAL

REV	ITEM	GENERAL
	31-1	PRELAUNCH PRIOR TO COMMITTING TO LAUNCH, THE FOLLOWING CONDITIONS MUST BE MET: A. SATISFACTORY FLIGHT CREW PHYSIOLOGICAL STATUS. B. THE MINIMUM CABIN OXYGEN CONCENTRATION FOR LAUNCH IS 60 PERCENT. 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	THE MAXIMUM ALLOWABLE CONCENTRATION OF PCO_2 IS 5 MM HG.
	31-5	LAUNCH THERE ARE NO MEDICAL REASONS FOR ABORTING DURING THE LAUNCH PHASE OTHER THAN THOSE CONDITIONS INTOLERABLE TO THE CREW.
	31-6	ORBIT EARLY MISSION TERMINATION FOR MEDICAL FALL INTO TWO CATEGORIES: A. ONSET OF CONDITIONS WHICH ADVERSELY AFFECT CREW SAFETY, HEALTH, OR FUNCTION AND PERFORMANCE. B. FAILURE OF SPACECRAFT SYSTEMS TO MAINTAIN A PHYSIOLOGICALLY SATISFACTORY ENVIRONMENT.
	31-7	WATER PALATABILITY CREW EVALUATION OF THE DRINKING WATER TASTE WILL BE THE BASIS FOR DETERMINING WATER PALATABILITY, EVEN FOR KOH CONTAMINATION.
		RULE NUMBERS 31-8 THROUGH 31-14 ARE RESERVED

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	31-19	DYSBARISM IN ANY CREWMAN	LAUNCH	A. CONTINUE MISSION CREW MAY ELECT TO ABORT IF CONDITION IS INTOLERABLE	A.1. CHECK SUIT INTEGRITY. 2. IF CONDITIONS PERMIT CREW MAY ELECT TO OVER-PRESSURIZE. (A) ALL THREE SUITS CONNECTED TO SUIT CIRCUIT. (B) SUIT DEMAND REG TO PRESS POSITION (C) MONITOR SUIT PRESS (SHOULD REACH 9 PSIA IN 75 SEC). (D) SELECT SUIT DEMAND REG INLET SEL VALVE TO OFF WHEN SUIT PRESS REACHES 9.0 PSIA. (E) MAINTAIN SUIT OVER-PRESSURE BY OPENING INLET SELECTOR VALVE AS NECESSARY. NOTE: RELIEF FUNCTION OF DEMAND REGULATOR IS ISOLATED WHEN USING THIS PROCEDURE.
			ALL	B. TERMINATE PHASE ENTER NEXT BEST PTP	B. MCC SURGEON WILL EVALUATE AND MAY RECOMMEND EARLY MISSION TERMINATION IF CORRECTIVE ACTION IS NOT EFFECTIVE.
	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 ENTER NEXT BEST PTP	
		B. IF RESULTANT FROM THERMAL OVERLOAD	LAUNCH	B.1. NOT APPLICABLE	
			ALL	2. TERMINATE PHASE ENTER NEXT BEST PTP	
		RULE NUMBERS 31-21 THROUGH 31-24 ARE RESERVED			

REV	ITEM
	31-35

INSTRUMENTATION REQUIREMENTS

CSM

MEAS DESCRIPTION	PCM	ONBOARD	TRANSDUCERS	CATEGORY	MISSION RULE REFERENCE
ELECTROCARDIOGRAM	CJ0060J	NOT DISPLAYED		M*	31-15/16
ELECTROCARDIOGRAM	CJ0061J	NOT DISPLAYED		M*	31-15/16
ELECTROCARDIOGRAM	CJ0062J	NOT DISPLAYED		M*	31-15/16
CO_2 PARTIAL PRESSURE	CF0005P	METER	COMMON	HD	31-2/27/28
SUIT CABIN DELTA PRESS	CF0003P	NOT DISPLAYED		HD	31-3/19
ORAL TEMPERATURE		CLINICAL THERMOMETER		M*	31-20
PNEUMOGRAM	CJ0200R	NOT DISPLAYED		HD	31-17
PNEUMOGRAM	CJ0201R	NOT DISPLAYED		HD	31-17
PNEUMOGRAM	CJ0202R	NOT DISPLAYED		HD	31-17

LM

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

PLSS

MEAS DESCRIPTION	PCM	ONBOARD	TRANSDUCERS	CATEGORY	MISSION RULE REFERENCE
PLSS ELECTROCARDIOGRAM	GT8124J			M	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 AND LM COMMUNICATIONS AND INSTRUMENTATION SYSTEMS MUST PROVIDE THE FOLLOWING MINIMUM CAPABILITIES: A. LAUNCH THERE ARE NO COMMUNICATIONS/INSTRUMENTATION FAILURES FOR WHICH THE LAUNCH/INSERTION PHASE WILL BE TERMINATED. B. ALL PHASES EXCEPT LAUNCH AND RNDZ 1. CRITICAL INSTRUMENTATION (CRITICAL INSTRUMENTATION IS THAT INSTRUMENTATION, ONBOARD OR TM, REQUIRED TO VERIFY GO/NO-GO CRITERIA) 2. TWO-WAY VOICE COMM BETWEEN SPACECRAFT. NOTE: THIS MAY BE SATISFIED BY UMBILICAL INTERCOM DURING DOCKED PHASES. 3. TWO-WAY VOICE COMM BETWEEN CSM OR LM AND MSFN DURING ALL DOCKED ACTIVITIES ND BETWEEN BOTH SPACECRAFT AND MSFN DURING UNDOCKED ACTIVITIES. C. RENDEZVOUS 1. CRITICAL ONBOARD DISPLAYS 2. TWO-WAY VOICE COMM BETWEEN CSM AND LM 3. LM LBR AND CSM OPERATIONAL TELEMETRY 4. DIRECT TWO-WAY VOICE COMM BETWEEN CSM/LM AND MSFN
	32-2	THE MISSION WILL BE CONTINUED WITH THE LOSS OF: A. EITHER OR BOTH THE CSM AND THE LM UPDATA LINK B. EITHER OR BOTH THE CSM AND THE LM CAUTION AND WARNING SYSTEM C. THE CSM DATA STORAGE EQUIPMENT D. THE CSM OR LM HIGH GAIN ANTENNA
A	32-3	VOICE CONFIGURATION A. LM/CSM/MSFN 1. VHF DUPLEX B AND USB WILL BE TRANSMITTED/RECEIVED SIMULTANEOUSLY FOR LAUNCH. VHF SIMPLEX A AND USB WILL BE TRANSMITTED/RECEIVED SIMULTANEOUSLY FOR EARTH ORBIT. (THE BEST QUALITY DOWNLINK WILL BE REMOTED TO HOUSTON.) 2. VHF A SIMPLEX 296.8 MHZ IS PRIME VOICE COMM BETWEEN VEHICLES EXCEPT DURING RANGING WHEN DUPLEX B (CSM) AND DUPLEX A (LM) WILL BE USED. 3. VHF B SIMPLEX 259.7 MHZ IS BACKUP TO VHF A, BUT WILL BE USED ONLY IF REQUIRED. 4. USB IS PRIME VOICE COMM BETWEEN MSFN AND CSM/LM. 5. USB/VHF RELAY IS VOICE COMM BACKUP TO USB BETWEEN MSFN AND MALFUNCTIONED S/C. 6. NORMAL VOICE COMM WILL USE SIMULTANEOUS MSFN UPLINK TO BOTH VEHICLES. HOWEVER, IF REQUIREMENT SHOULD EXIST, SIMULTANEOUS INDEPENDENT MSFN/CSM AND MSFN/LM COMM MODES WILL BE INITIATED. 7. CSM AND LM WILL TRANSMIT SIMULTANEOUSLY ON VHF AND USB. RULE NUMBERS 32-4 THROUGH 32-9 ARE RESERVED.

REV	ITEM	
		MANAGEMENT
	32-10	CSM VHF/USB MANAGEMENT
		A. FOR CREW REST PERIODS, CSM S-BAND ANTENNAS WILL BE SELECTED BY GROUND COMMANDS.
		B. NORMAL CONTROL OF THE S-BAND MODES WILL BE BY GROUND COMMAND. CSM COMMUNICATIONS SWITCH POSITION WILL REFLECT OUT-OF-SITE CONTACT CONFIGURATION.
	32-11	DSE MANAGEMENT
		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 IN LUNAR ORBIT.
		B. CM HIGH BIT RATE DSE RECORDINGS WILL BE MADE DURING THE FOLLOWING OPERATIONS: 1. LAUNCH 2. S-IVB/CSM SEPARATION 3. ALL SPS MANEUVERS 4. CM/LM SEPARATION AND ENTRY 5. DTO REQUIREMENTS (TBD)
		C. DATA DUMP LOGS WILL BE MAINTAINED AND MSFN DATA RECORDING STORAGE WILL BE MANAGED IN ORDER TO ALLOW IMMEDIATE REPLAY OF ANY DATA RECORDED WITHIN THE PREVIOUS 24 HOURS.
		D. DURING SLEEP PERIODS 1. USING HIGH GAIN ANTENNAS, DSE RECORDING AND DUMPING WILL BE MANAGED PER (A) ABOVE. 2. USING OMNI'S, LM AND CSM LOW BIT RATE TELEMETRY WILL BE RECORDED CONTINUOUSLY WHEN NOT IN CONTACT WITH GROUND TELEMETRY SITES. DATA WILL NOT BE DUMPED UNLESS A MALFUNCTION SO DICTATES. IN THIS CASE THE HGA WILL BE ACTIVATED FOR THE DUMP.
	32-12	CTE AND MISSION TIMER MANAGEMENT
		A. CTE AND THE MISSION TIMER WILL BE CONFIGURED TO CLOCK IN GET FOR FLIGHT; HOWEVER, IF A HOLD OCCURS AFTER T-20 MINUTES, CTE WILL NOT BE CORRECTED UNTIL COMPLETION OF POWERED FLIGHT.
		B. CTE AND THE MISSION TIMER WILL BE ALLOWED TO DRIFT ± 5 SEC BEFORE BEING UPDATED AFTER ORBIT INSERTION.
	32-13	LM USB/TM MANAGEMENT
		A. FOR NORMAL LM POWERED UP PHASES, THE LM STEERABLE ANTENNA WILL BE USED.
		B. DURING PERIODS OF LM OUT-OF-STATION CONTACT (LUNAR FAR SIDE), THE TM BIT RATE WILL BE SWITCHED FROM HBR TO LBR AND TRANSMITTED TO THE CSM OVER VHF B EXCEPT DURING VHF RANGING.

REV	ITEM	
	32-14	SYSTEMS MONITORING DURING SLEEP PERIODS TBD CREWMEN WILL SLEEP WITH HEADSETS TO MONITOR FOR MC&W AND/OR GROUND ALERT SIGNAL.
A	32-15	LM STEERABLE ANTENNA MANAGEMENT A. CSM THRUSTERS B3 AND C4 MUST BE DISABLED WHEN THE LM STEERABLE ANTENNA IS UNSTOWED DURING DOCKED PHASES. B. DURING ALL PHASES, THE STEERABLE ANTENNA TEMPERATURE SHOULD BE MAINTAINED BETWEEN -65°F AND 185°F.
A		RULE NUMBERS 32-16 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 CSM AND LM	DOCKED	A. CONTINUE MISSION DO NOT UNDOCK	REF MALF PROC ____
			UNDOCKED	B. DOCK WITH TWO VEHICLE MSFN COVERAGE NO-GO FOR RNDZ	
			RNDZ	C. CONTINUE MISSION	
	32-21	LOSS OF TWO-WAY VOICE COMM WITH MSFN			CONFIGURE FOR CSM OR LM VOICE RELAY AS REQUIRED.
		A. LM ONLY	DOCKED	A.1. CONTINUE MISSION UNDOCKING OK	
			UNDOCKED	2. NO-GO FOR RNDZ	
			RNDZ	3. CONTINUE MISSION	
		B. CSM ONLY	LAUNCH	B.1. CONTINUE MISSION	
			ORBIT	2. ENTER NEXT BLOCK DATA POINT	
			ALL	C. ENTER NEXT BEST PTP	
	32-22	LOSS OF CSM TM			
		A. HBR OR LBR	ALL	A. CONTINUE MISSION	
		B. ALL TM	LAUNCH	B.1. CONTINUE MISSION	
			ALL	2. ENTER NEXT BEST PTP	
	32-23	LOSS OF LM TM			
		A. LBR	ALL	A. CONTINUE MISSION	
		B. ALL TM	DOCKED	B.1. CONTINUE MISSION	
			UNDOCKED	2. NO-GO FOR RNDZ	
			RNDZ	3. CONTINUE MISSION	
	32-24	LOSS OF USB RANGING (CSM OR LM)	ALL	CONTINUE MISSION	

NASA — Manned Spacecraft Center

MISSION RULES

REV	RULE	CONDITION/MALFUNCTION	PHASE	RULING	CUES/NOTES/COMMENTS
	32-25	LOSS OF ONE CSM PMP POWER SUPPLY	ALL	CONTINUE MISSION	
	32-26	LOSS OF FM DOWNLINK (CSM OR LM)	ALL	CONTINUE MISSION	
	32-27	LOSS OF THE UPDATA LINK (CSM AND/OR LM)	ALL	CONTINUE MISSION	
	32-28	LOSS OF BOTH CSM POWER AMPLIFIERS	EPO	NO-GO FOR TLI	
	32-29	LOSS OF THE SCE	EPO	A. NO-GO FOR TLI	
			TLC	B. ENTER NEXT BEST PTP NO-GO FOR LOI	
	32-30	LOSS OF TWO CSM AUDIO CENTERS	EPO	NO-GO FOR TLI	
	32-31	LOSS OF CRITICAL INSTRUMENTATION			
		A. ONBOARD	LAUNCH	CONTINUE MISSSION	
			EO	NO-GO FOR TLI	
			TLC	CONTINUE MISSION NO-GO FOR LOI	
			ALL	NO-GO FOR RNDZ	
		B. ONBOARD AND TM	ALL	ENTER NEXT BEST PTP	
A		RULE NUMBERS 32-32 THROUGH 32-39 ARE RESERVED.			

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM	
		COMM/INST INSTRUMENTATION
A	32-40	LM

MEAS DESCRIPTION	PCM	ONBOARD	CATEGORY
PCM OSC FAIL 2 }	GL0422V		1 OF 2
PCM OSC FAIL 3 }	GL0423V		HIGHLY DESIRABLE
CAL 85 PCT	GL0401V		HIGHLY DESIRABLE
CAL 15 PCT	GL0402V		HIGHLY DESIRABLE
MET	GL0501W		HIGHLY DESIRABLE
C&W PWR FAIL	GL4054X	CAUTION	HIGHLY DESIRABLE
MASTER ALARM	GL4069X	MASTER ALARM	HIGHLY DESIRABLE
DUA STATUS	GT0441X		HIGHLY DESIRABLE
S-BND ST PH ERR	GT0992B		HIGHLY DESIRABLE
S-BND XMTR PO	GT0993E		HIGHLY DESIRABLE
S-BND RCVR SIG	GT0994V	METER	HIGHLY DESIRABLE
DSE TAPE MOTION MONITOR	CT0012X		HIGHLY DESIRABLE
SIG COND POS SUPPLY VOLTS	CT0015V		HIGHLY DESIRABLE
SIG COND NEG SUPPLY VOLTS	CT0016V		HIGHLY DESIRABLE
SENSOR EXCITATION 5 VOLTS	CT0017V		HIGHLY DESIRABLE
SENSOR EXCITATION 10 VOLTS	CT0018V		HIGHLY DESIRABLE
CTE TIME FROM LAUNCH	CT0145F		HIGHLY DESIRABLE
UDL SYS VALIDITY SIG	CT0262V		HIGHLY DESIRABLE
USB REC AGS VOLTS	CT0620E		HIGHLY DESIRABLE
USB REC STATIC PH ERR	CT0640F		HIGHLY DESIRABLE

APPENDICES

A ACRONYMS AND SYMBOLS

NASA — Manned Spacecraft Center

MISSION RULES

REV	ITEM		
A		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
		BAP	BEST ADOPTIVE PATH
		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
		BTD	BURN TO DEPLETION
		BTU	BRITISH THERMAL UNIT
		CAL	CALIBRATE
		CASTS	COUNTDOWN AND STATUS TRANSMISSION SYSTEM
		CB	CIRCUIT-BREAKER
		CCATS	COMMAND, COMMUNICATIONS, AND TELEMETRY SYSTEM
		CCW	COUNTERCLOCKWISE
		CDDT	COUNTDOWN DEMONSTRATION TEST
		CDH	CONSTANT DELTA HEIGHT
		CDP	COMMAND DATA PROCESSOR
		CDR	COMMANDER
		CDU	COUPLING DATA UNIT
		CES	CONTROL ELECTRONICS SYSTEM
		CEVT	CONTINGENCY EXTRA VEHICULAR TRANSFER
		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
		EOMFR	END OF MISSION FUEL RESERVE
		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

MISSION	REV	DATE	SECTION	GROUP	PAGE
APOLLO 10	A	4/23/69	ACRONYMS AND SYMBOLS		A-1

FEC/TSG Form 292 (AUG 68)

REV	ITEM
A	

FL	FULL LIFT
FM	FREQUENCY MODULATION
FPS	FEET PER SECOND
FQR	FLIGHT QUALIFICATION RECORDER
FTP	FIXED THROTTLE POINT
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
H2O	WATER
Ha	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
LMRD	LAUNCH MISSION RULE DOCUMENT
L/O	LIFTOFF
LOI	LUNAR ORBIT INSERTION
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
MCC	MIDCOURSE CORRECTION
MC&W	MASTER CAUTION AND WARNING
MDAS	MEDICAL DATA ACQUISITION SYSTEM
MED	MANUAL ENTRY DEVICE
MERU	MILLI EARTH RATE UNIT
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
PC	PERICYNTHION
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)

REV	ITEM		
		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	PRELAUNCH
		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
		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	REFERENCE 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
		SECO	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
		Tig	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
		VEI	INERTIAL VELOCITY AT ENTRY INTERFACE
		Vgx	VELOCITY TO BE GAINED X-AXIS
		Vgy	VELOCITY TO BE GAINED Y-AXIS
		Vgy	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
		XMTR	TRANSMITTER
		Y	YAW OR Y-AXIS
		YTV	YAW THRUST VECTOR

REV	ITEM	

Z	Z-AXIS

SYMBOLS

h	ALTITUDE
Δ	DIFFERENCE
γ	FLIGHT PATH ANGLE
ϕ	LATITUDE 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
λ	LONGITUDE
γi	INERTIAL FLIGHT PATH ANGLE
γEI	INERTIAL FLIGHT PATH ANGLE AT ENTRY
ΔV_{IN}	DELTA VELOCITY IN INSERTION
ΔT_B	DELTA BURN TIME
ΔH	DELTA ALTITUDE

B DISTRIBUTION LIST

REV	ITEM
A	

DISTRIBUTION LIST

DIRECTOR OF FLIGHT OPERATIONS

FA/KRAFT, C.C., JR. (2)
SJOBERG, S.A.
ROSE, R.G.
KOONS, W.E.

FLIGHT CONTROL DIVISION

FC/KRANZ, E.F.
LUNNEY, G.S.
CHARLESWORTH, C.E.
GRIFFIN, G.D.
WINDLER, M.L.
FRANK, M.P.
ROACH, J.W.
BROOKS, M.F.
MILLER, H.G.

FLIGHT CONTROL OPERATIONS BRANCH

FC2/HARLAN, C.S.
LEWIS, C.R.
FENDELL, E.I. (3)
EALICK, P.L. (9)
PLATT, W.E. (3)
MOLNAR, W.M. (4)

CSM SYSTEMS BRANCH

FC3/ALDRICH, A.D.
HUTCHINSON, N.B.
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

SYSTEMS ENGINEERING BRANCH

FS2/SATTERFIELD, J.M.

OPERATIONS SUPPORT BRANCH

FS4/FRERE, J.A.
SANBORN, S.D. (15)
MONKVIC, J.A. (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.
OWEN, D.H.

FLIGHT ANALYSIS BRANCH

FM3/ALLEN, C.F. (14)

LANDING ANALYSIS BRANCH

FM2/BENNETT, F.V.
BOLT, W.M.
GRAVES, C.A.
HARPOLD, J.C.
ALPHIN, J.
DUPNICK, E.
HANSSEN, V.

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)

APOLLO TRAJECTORY SUPPORT OFFICE

FM13/PARTEN, R.
COLLINS, M.
BENNET, W.J.

LANDING AND RECOVERY DIVISION

FL/HAMMACK, J.B. (8)

DIRECTOR OF FLIGHT CREW OPERATIONS

CA/SLAYTON, D.K. (2)

ASTRONAUT OFFICE

CB/SHEPARD, A.B. (20)
DUKE, C.P. (2)

FLIGHT CREW SUPPORT DIVISION

CF/NORTH, W.J.
GRIMM, D.F.
BILODEAU, J.W.

FLIGHT CREW SUPPORT DIVISION (CONTINUED)

DEMENT, M.E. (4)
ALLEN, L.D. (4)
KRAMER, P.C. (5)
WARREN, D.K. (3)
ANDERSON, W.M.
WOODLING, C.H.
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.

DIRECTOR OF MEDICAL RESEARCH AND OPERATIONS DA

BERRY, C.A., M.D.
CATTERSON, A.D., M.D.
ZIEGLSCHMID, J.F., M.D. (6)

PUBLIC AFFAIRS OFFICE

AP/HANEY, P.
AP8/GREEN, D.J. (5)

APOLLO SPACECRAFT PROGRAM OFFICE

PA/LOW, G.M.
BOLENDER, C.H., BRIG. GEN.
PA2/APOLLO FILES
PD/BATTEY, R.V.
DENNETT, A.

PD5/GOREE, J.
PD7/KOHRS, R.
SILVER, M. (40)

PD9/CRAIG, J.
PD12/PERRINE, C.H.
TOMBERLIN, J.L.
WARD, R.J. (2)
PD14/BYINGTON, H.W.
PP/MCCLINTOCK, J.
PP32/TASH, H.L.
NA/BLAND, W.M. (2)
PT/ARABIAN, D.O.
PT3/GOLDENBEUM, D. (10)
PT4/LOBB, J. (3)
BM86 MISSION DATA PACK (15)
PD13/WESTMORELAND, P.
NA3/SEIGLER, J.P. (2)

DIRECTOR OF ENGINEERING AND DEVELOPMENT

EA/FAGET, M.A.
GARDINER, R.A.
CHAMBERLIN, J.A.
BOND, A.C.
EA2/LEE, J.B.
EA4/BURT, R.P.
EA5/DEANS, P.M.
EB/KYLE, H.
EB3/TRAVIS, D.
STOKER, C.
EB5/NEWLIN, R.
EC/SMYLIE, R.E.

REV	ITEM
A	

DIRECTOR OF ENGINEERING AND DEVELOPMENT (CONTINUED)

EC3/GILLEN, R.J.
TUCKER, E.M.
EC9/STUTESMAN, H.L.

EE/SAWYER, R.S.
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.
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.
EX2/REDD, B.

FLIGHT SAFETY OFFICE

MSC/SA FRENCH, J.C.
SF/GREENWELL, D.
KSC/HY VAUGHN, N.B.

RELIABILITY AND CERTIFICATION OFFICE

NB2/WILLIAMS, H.L. (2)

DIRECTOR OF SCIENCE AND APPLICATIONS

TG5/LILL, J.C.
TA/CALIO, A.J.

TRW-HOUSTON

ROBERTSON, R.L. (3)
TRW TECHNICAL INFORMATION CENTER, HOUSTON OPERATIONS (2)

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 OFF (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.
LP-PLN-2/KNIGHT, G.W. (2)
LV/GRUENE, H.
LV-ENG/RIGELL, I.A.
LV-TOM-1/HART, J.J.
LV-TOM-4/YOUMANS, R.E.
LV-GDC/LEALMAN, R.E.
LV-INS/EDWARDS, M.D.
LV-MEC/FANNIN, L.E.
LS/WILLIAMS, J.J.
LS-ENG-1/GASKINS, R.B. (4)
MARS, C.B. (4)
TBC, 3L15/PARK, J.E. (2)
NAR, 2M16/WEAVER, R.A. (2)
MDC, 27B12/SHAFFER, J.R. (2)
IBM, 3N1/GROVIER, P.M. (2)
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

MUELLER, G.E., DR.
PHILLIPS, S.C., MAJ. GEN.
HAGE, G.H.
ALLER, R.O. (12)
STOUT, F.E. (2)
DRAPER, C.N., TC (5)
SCHULHERR, R.M., MOP

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)
DOMS-H, COLOPY, R.E., CDR

MIT LABORATORIES BOSTON, MASS.

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

REV	ITEM	
A		NORTH AMERICAN ROCKWELL, DOWNEY, CALIF.
		POTTS, J.R. CODE AB70 (1)
		GRUMMAN AIRCRAFT ENGINEERING CORP., BETHPAGE, NEW YORK
		PRATT, R. (35)
		BOEING, HOUSTON, TEXAS
		BOEING DATA MANAGEMENT, N/S HA-04 (2)
		BOEING COMPANY SPACE DIVISION (955 L "ENFANT PLAZA," N, SW, WASHINGTON, D.C. 20024)
|		CAMPBELL, R.L. (3)
		NASA, DAYTONA BEACH OPER, P.O. BOX 2500, DAYTONA BEACH, FLA. 32015
|		CAHALAN, P.F., MA-2D

C CHANGE CONTROL

REV	ITEM

CHANGE CONTROL

1.0 INTRODUCTION

1.1 PURPOSE

THE PURPOSE OF THIS APPENDIX IS TO DELINEATE CHANGE CONTROL PROCEDURES FOR THE AS-505/106/LM-4 MISSION RULES. THIS WILL INSURE THE PROPER COORDINATION OF CHANGES, PROVIDE A RECORD OF 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

FEBRUARY 24, 1969

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 FORMAT

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 COORDINATION

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 SIGNOFF/DISAPPROVAL

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 DISAPPROVED CHANGES

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

2.3 PUBLICATION AND DISTRIBUTION OF INTERIM CHANGES

INTERIM CHANGES WILL BE DISTRIBUTED VIA 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.

REV	ITEM	

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.

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 CHANGE REQUEST FORM.

APOLLO

FMR

FINAL FLIGHT MISSION RULES

APOLLO 10
(AS-505/106/LM-4)

FCD
MSC
NASA