MAS-4-HICKEY

IRL 521-10

CONTRACT REQUIREMENTS	CONTRACT ITEM	MODEL	CONTRACT NO.
Exhibit E, Para. 3.13	Work Package No. 712	LM-10	NAS 9-1100

Type II Document

LM-10 BPA TEST & CHECKOUT REQUIREMENTS DOCUMENT

REPORT NO. LPL 561-10

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SECTION 1.0 - INTRODUCTION

Section 1.0 - Introduction

1.0 Scope and Precedence.

1.1 Scope.

This Test and Checkout Requirements Document lists LM-10 Vehicle functions to be tested at the Grumman Bethpage facility from build-up to delivery to Cape Kennedy.

Precedence.

Reference (a); LSP 470-2; LM Master End Item Specification, Part II, Product Configuration and Acceptance Test Requirements.

Reference (b); SN8-R014 LM-4 and subsequent Test and Checkout Requirements Document (TCRD) for KSC.

Reference (a) shall govern for inconsistencies, if any, between the contract specification test requirements and those listed herein.

Reference (b) shall govern for inconsistencies, if any, between this document and the KSC TCRD.

1.2 Abstract.

The Test and Checkout Document is provided in accordance with the requirements of Apollo Directive 26. Changes to this document are to be made with replacement pages having an index to indicate change record. This document contains separate sections as follows:

1.3 Requirements Matrix (Section 2.0)

This section lists the test requirements by subsystem, and identifies in which Test Location requirements are satisfied. KSC Requirements are included as a general classification.

1.4 FEAT System Verification, Plugs-In (Section 3.0)

This section contains, in narrative form, a description of the plugs-in System Verification Test.

1.5 FEAT Mission Oriented, Plugs-Out (Section 4.0)

This section contains, in narrative form, a description of the plugs-out mission simulation test.

1.6 Retest Philosophy (Section 5.0)

This section contains the general ground rules to be followed for spacecraft or hardware verification in the event of test invalidation due to S/C equipment removal, cable disconnections, repair, etc.

1.7 General Requirements (Section 6.0)

General test requirements for vehicle testing are contained in this section.

1.8 Safety Requirements (Section 7.0)

Safety requirements for testing are contained in this section.

1.9 Subsystem Support Matrix (Section 8.0)

This section provides a matrix of systems required in support of vehicle subsystem testing.

SECTION 2.0 - TEST OBJECTIVES

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.1	STRUCTURAL MECHANICAL SUBSYSTEM.							
2.1.1	Landing Gear Installation & Functional Test							
	a. Verify Landing Gear Downlock Indicator circuit by observing the downlock indicator in cabin via simulated switch closure.				X			X
	b. Verify the overall functional capability of the Landing Gear System with regard to the uplock deployment, & downlock mechanism.				X			X
	c. Verify the time for deployment, from the up & locked to the full down and locked position as an indication of proper operation of components exercised during deployment and downlock.				X			X
	d. Verify circuitry and position of release of Lunar Surface Sensing Probe Uplock Mechanism.				X			X
	e. Verify Landing Gear "Down and Locked" switch operation.				X			X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
					MATED		
	A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
f. Verify probe "Surface Contact" switch operation.				X			X
g. Verify that the Landing Gear probes have been retracted and that the Lunar Surface Sensing Switches were reset.							X
2.1.2 A/S - Weight & Center of Gravity Test.							
a. To determine the dry weight of the LM Ascent Stage.			X				
b. To determine the horizontal (Y-Z) center of gravity of the LM Ascent Stage.			X				
2.1.3 D/S - Weight & Center of Gravity Check.							
a. To determine the dry weight of the Descent Stage.				X			
b. To determine the horizontal (Y-Z) center of gravity of the Descent Stage.				X			

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED NON-FEAT	MATED FEAT	
2.1.4	Mated LM Center of Gravity Determination.							
	a. To calculate the location of the center of gravity of the fully loaded mated LM from A/S and D/S measurements, and calculation of loading effects.				X			
2.1.5	Docking Test - LM A/S to C/M.							
	a. Verify pneumatic seal between LM docking ring surface and CM docking ring seal.							X
	(For BPA LM A/S only)	X						
	b. Verify mechanical mating of LM/CM umbilical connectors.							X
	c. Verify Crew Optical Alignment Sight (COAS) and Docking Target alignment, using NAR test tool.			X				X
	d. Verify that A/S can be pressurized from the CM.							X
2.1.6	LM to SLA Mate.							
	a. Perform a LM/SLA optical azimuth transfer.							X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.1.7	Thermal Emissivity & Solar Absorptance Test.							
	a. Verify that the thermal emissivities of LM panels, thermal insulating blankets, and critical vehicle surfaces are within tolerance.			X	X			X
	b. Verify that the solar absorptance values of LM panels, thermal insulating blankets, and critical vehicle surfaces are within tolerance.			X	X			X
2.2	ELECTRICAL POWER SUBSYSTEM.							
2.2.1	Ascent Stage EPS Power Distribution Verification.							
	a. Verify continuity of main DC feeders from ECA's up to DC buses.			X		X		
	b. Verify isolation between Commander's and LM Mission Pilot's DC buses.			X		X	X	
	c. Verify continuity between Commander's DC bus and LM Mission Pilot's DC bus with bus crosstie circuit breakers closed.			X		X		

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
					MATED		
	A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
d. Verify single point grounding to vehicle structure of each negative bus.			X				
e. Verify isolation between positive & negative buses with load circuit breakers open.			X				
f. Verify isolation between positive and negative buses with all load circuit breakers closed (no loads connected).			X				
g. Verify voltage of correct polarity at proper connector pins (or at most feasible point closest to load) using current limited voltage, and closing circuit breakers one at a time.			X				
h. Measure resistance of AC feeder between each inverter output interface connector and AC bus.					X		
i. Verify isolation of translunar buses from LM vehicle ground system (no translunar loads connected).			X		X		X
j. Verify isolation of translunar bus from LM vehicle ground system (with translunar loads connected.)					X		X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.2.2	Descent Stage Power Distribution Verification.							
	a. Verify continuity of main DC feeders from ECA's up to DC buses.					X		
	b. Verify isolation between Commander's DC bus and LM Mission Pilot's DC bus.					X		
	c. Verify continuity between Commander's DC bus and LM Mission Pilot's DC bus with crosstie circuit breakers closed.					X		
	d. Verify isolation between positive and negative buses with load circuit breakers open.					X		
	e. Verify isolation between positive and negative buses with all D/S load circuit breakers closed (no loads connected).					X		
	f. Verify isolation of ED control circuitry.					X		
	g. Verify voltage of correct polarity at proper connector pins (or at most feasible point closest to load) using bus voltage and closing circuit breakers one at a time.					X		

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
h. Verify voltage of correct polarity at proper connector pins while operating cabin EPS and ED switches.					X		
i. Verify voltage at Scientific Equipment interface connector (Lunar Landing Vehicle only).					X		
2.2.3 EPS Functional Checkout and Malfunction Detection.							
a. Monitor bus voltage. (ECA, MSS connector).					X	X	X
b. Verify EPS readout on ACE and on LM cabin indicators.					X	X	X
c. Monitor load, no-load voltage and frequency of AC inverter or 400 Hz Isolation Transformer.					X		X
d. Verify reverse current readout capability.					X		X
e. Verify overcurrent readout capability.					X		X
f. Verify manual switchover capability.					X	X	X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
g. Check for any malfunctions during normal operation under load.					X		X
h. Verify Automatic Power switchover using the abort stage switch.					X	X	X
i. Reset of malfunction indication.					X		X
j. Verify descent battery deadface switch.					X	X	X
k. Verify hi/low voltage tap switches.					X		X
l. Verify redundant function line operation.					X		X
m. Verify operation of window heaters.					X	X	X
n. Verify operation of cabin ammeter and voltmeter.					X	X	X
2.2.4 Lighting Functional Test.							
a. Verify display numerics operation, integral lighting and annunciator lights self-test (using GSE Lighting Test Set).			X		X		X
b. Verify display numerics integral lighting and annunciator lights operation, dimmer control response, and dimmer override (using Lighting Control Assembly).					X	X	X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
c. Verify docking light operation. Verify LM/SLA switch circuit operation.					X	X	X
d. Verify tracking light operation.					X	X	X
e. Verify portable utility light operation.					X		X
f. Verify power failure indicator lights.					X		X
g. Verify flood lighting and dimming controls operation. (LEOS)					X	X	X
h. Verify C&W annunciator and component caution lights operation.					X	X	X
i. Verify master alarm lights operation.					X		X
j. Verify voltage at COAS and sequence camera interfaces.					X		X
2.2.5 LM/CM Interface Checkout.							
a. Verify ED subsystem turn-on.							X
b. Verify electrical continuity.							X
c. Verify electrical isolation.							X
d. Verify ED subsystem turn-off.							X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
e. Verify CSM Interface Unit turn-on.							X
f. Verify activation of EPS buses with CSM Interface Stimuli Unit.					X	X	X
g. Verify activation of EPS logic for internal power operation.					X		X
h. Verify CSM Interface Unit turn-off.							X
2.2.6 LM/CM Umbilical EPS Functional Checkout.							
a. Verify activation of CSM subsystems.							X
b. Verify LM/SLA separation functionally.							X
c. Verify activation of LM EPS buses with CM Stimuli.					X	X	X
d. Verify activation of LM EPS logic for battery power operation.					X	X	X
e. Verify Umbilical redundancy.					X		X
2.2.7 LM/SLA/LUT Umbilical EPS Functional Checkout.							
a. Verify LUT power transfer interface for relay junction box LUT power contactor operation.					X	X	X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
	b. Verify activation of EPS buses with GSE power.					X	X	X
	c. Verify activation of EPS logic for internal power operation.					X	X	X
	d. Emergency shutdown capability verification.							X
2.2.8	EPS Flight Battery Activation							
	a. Perform activation procedure.							X
	b. Perform loading tests.							X
2.3	ENVIRONMENTAL CONTROL SUBSYSTEM.							
2.3.1	Heat Transport Section (HTS).							
2.3.1.1	To Verify Structural Integrity.							
	a. Proof pressure test A/S primary loop D/S primary loop and secondary loop.			X	X			
	b. Proof pressure test interstage QDs in mated configuration.					X		

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
					MATED		
	A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
2.3.1.2 To Verify External Leakage.							
a. Leak check A/S primary loop, D/S primary loop and secondary loop using He probe method.			X	X			
b. Leak check A/S and D/S primary loop using GN_2 pressure decay method.			X	X			
c. Leak check A/S interstage QD/s.			X				X
d. Leak check mated interstage QD's.					X		X
2.3.1.3 To Verify Internal Leakage.							
a. Verify inter-coolant loop leakage using GHe probe method.			X				
2.3.1.4 To Service HTS.							
a. Flush primary and secondary loops with water.					X		
b. Flush loops (excluding W/G accumulator) with isopropyl alcohol, purge and evacuate to dry.					X		
c. Evacuate and fill mated HTS primary loop, and secondary loop with W/G.					X		

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
d. Flush primary and secondary W/G accumulators with water.			X				
e. Check for gas entrapment in primary and secondary loops.					X		X
f. Fill mated interstage QD's.							X
2.3.1.5 Functionally Check HTS.							
a. Establish system head curves for primary and secondary loops.					X		
b. Turn on and verify primary loop pumps operation.					X	X	X
c. Turn on and verify secondary loop pump.					X	X	X
d. Verify water glycol accumulators low level C&W.					X	X	X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
e. Verify primary glycol ΔP low level C&W.					X	X	X
f. Verify primary glycol high temperature C&W.					X	X	X
g. Verify coolant regenerative heat exchanger & cabin temperature control valve operation.					X		X
h. Verify HTS Operational Flight Instrumentation.					X	X	X
i. Verify primary & secondary loop operation at altitude under total heat loads with cooling provided by water boiler.							X
2.3.2 Water Management Section (WMS).							
2.3.2.1 To Verify Structural Integrity.							
a. Proof pressure test A/S high and low pressure network.	X						
b. Proof pressure test D/S high pressure network.		X					
2.3.2.2 To Verify External Leakage.							
a. Leak check A/S and D/S high and low pressure networks using GHe probe method.	X	X			X		

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
b. Leak check A/S high & low pressure network using GN_2 pressure decay method.					X		X
c. Leak check D/S WMS usir g GN_2 pressure decay method.					X		X
d. Leak check mated WMS high & low press networks up to shut off valves using GN_2 pressure decay method.					X		X
2.3.2.3 Verify Internal Leakage of WMS.							
a. Leak check A/S and D/S tank bladders from water to gas and gas to water side using GN_2 volumeter displacement method.					X		X
b. Leak check A/S water tank check valves using GN_2 volumeter displacement method.					X		
c. Check leakage to reference pressure side (suit circuit ass'y) of water pressure regulators using fluid displacement method.					X		
d. Leak check water separator check valves in water control module using fluid displacement method.					X		

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
					MATED		
	A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
e. Leak check water tank select valve in ASC and DES positions using volumeter displacement method.					X		
f. Leak check ASC H_2O, DES H_2O, primary evaporator flow, and secondary evaporator flow valves using volumeter displacement method.					X		
2.3.2.4 Servicing of WMS.							
a. Evacuate and flush with water to meet cleanliness requirements.					X		
b. Evacuate and flush with bacteriacide to meet sterilization requirements.							X
c. Fill with water containing flight concentration of bacteriacide.							X
d. Purge and evacuate to dry.					X		X
e. Maintain blanket pressure on W/B's during non-test periods.			X		X		X
f. Maintain ΔP across A/S and D/S tank bladders during non-use periods.	X	X	X	X	X		X
2.3.2.5 Calibration of WQMD.							
a. Perform calibration using GN_2.					X		X
b. Perform calibration verification using H_2O.							X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.3.2.6	Functionally Test the WMS using GN_2.							
	a. Verify D/S tank low level C&W.					X	X	X
	b. Verify A/S tanks low level and differential C&W.					X	X	X
	c. Conduct gaseous flow tests to verify continuity of WMS paths and water regulator functions in Cabin and Egress modes.					X		X
	d. Verify WMS Operational Flight Instrumentation.					X	X	X
2.3.2.7	Functionally Test the WMS using Water.							
	a. Verify A/S tanks low level C&W.							X
	b. Verify primary & secondary W/B operation.							X
	c. Verify primary & secondary water reg's function in cabin mode & egress mode.							X
	d. Verify primary & secondary water reg's function in simulated cabin & egress mode.							X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
	e. Verify WMS Operational Flight Instrumentation.							X
	f. Dryout & restart of primary, secondary & suit W/B.							X
	g. Verify water supply through water dispenser (KSC), and through flex line (BPA).					X		X
	h. Recharge PLSS with water.							X
	i. Collect condensate from PLSS.							X
	j. Dryout secondary and suit W/B.							X
2.3.3	Oxygen Cabin Pressure Section (OCPS).							
2.3.3.1	To Verify Structural Integrity.							
	a. Proof pressure test A/S OCPS (GOX tanks)*							
	b. Proof pressure test D/S OCPS (GOX tanks)*							
	c. Proof pressure test mated interstage QD.					X		
	*Done Off Vehicle							

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
2.3.3.2 Verify External Leakage of OCPS.							
a. Leak check A/S OCPS using GHe probe.	X						
b. Leak check D/S OCPS using GHe probe method.		X					
c. Leak check mated interstage QD at operating pressure using GHe probe method.					X		X
d. Leak check A/S OCPS using GOX make up method.	X						
e. Leak check A/S GOX QD using GHe probe method.							X
f. Leak check mated OCPS at operating pressure with GOX using pressure decay.							X
2.3.3.3 Verify Internal Leakage.							
a. Leak check DESC and ASC oxygen shutoff valves at maximum operating pressure using fluid displacement method.	X						

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
b. Leak check oxygen demand regulators A and B in closed, cabin and egress positions using fluid displacement method.	X						
c. Leak check PLSS O_2 valve at operational pressure using fluid displacement method.	X						
2.3.3.4 Functionally Test D/S OCPS O_2 Control Assembly.							
a. D/S press. reg. lockup.		X					X
b. Overboard relief valve crack and reseat.		X					X
2.3.3.5 Oxygen Compatibility Verification.							
a. Pressurize A/S OCPS to operating pressure using gaseous oxygen.	X						
b. Pressurize D/S OCPS, to operating pressure using gaseous oxygen.		X					
2.3.3.6 Service OCPS.							
a. Evacuate and fill D/S & A/S GOX tank with gaseous oxygen.							X
b. Verify oxygen quantity display at various levels of fill.					X	X	X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
2.3.3.7 Functionally Check OCPS.							
a. Verify performance of A/S O_2 regulators in Cabin & Egress modes.	X						X
b. Verify performance of Cabin Repressurization & Emergency O_2 valve.	X						X
c. Verify electrical controls of Cabin Repressurization & Emergency O_2 valve.					X	X	X
d. Verify A/S GOX tanks low level C/W.					X	X	X
e. Verify D/S GOX tank low level C&W.					X	X	X
f. Verify A/S #1 & #2 tank less than full C/W.							X
g. Recharge PLSS with Oxygen.							X
h. Verify OCPS Operational Instrumentation.					X	X	X
i. Demonstrate the operation of the mechanical interlock.					X		X
2.3.4 Atmosphere Revitalization Section. (ARS)							
2.3.4.1 To Verify Structural Integrity.							
a. Proof pressure test ARS/SCA.	X						

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
2.3.4.2 To Verify External Leakage of ARS/SCA.							
a. Leak check ARS/SCA using flow meter make-up method.	X						X
2.3.4.3 ARS Functional.							
a. Evacuate suit loop, and turn-on and verify suit fans and water separators at cabin & egress pressures and at various back pressures.					X	X	X
b. Simulate suit fan & water separator failures and verify component lights and C&W.					X	X	X
c. Introduce water vapor to evacuated suit loop and verify water separator removal capabilities. Dryout suit loop.					X		
d. Introduce CO_2 to evacuated sensor & verify CO_2 partial pressure component light & CO_2 display.					X	X	X
e. Evacuate suit loop and verify performance of suit isolation valves and C&W.					X	X	X
f. Turn-on and verify cabin fans at reduced GSE voltage.					X	X	X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
g. Verify electrical interface between cabin fans, and oxygen regulators.					X	X	X
h. Verify operation of cabin temperature control.					X		X
i. Verify operation of suit temperature control & suit circuit regenerative heat exchanger.					X		X
j. Turn-on and verify suit fans and water separators, (at altitude).							X
k. Turn-on and verify cabin fans, (at altitude).							X
l. Verify performance of LiOH cartridges, (at altitude).							X
m. Verify water removal performance of water separators, (at altitude).							X
n. Replace and remove LiOH cartridges in suit circuit assembly and PLSS, (at altitude).							X
o. Install and remove LiOH cartridges in suit circuit assembly.					X		X
p. Verify operation of suit circuit diverter valve as a function of O_2 regulator positions.					X	X	X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
	q. Verify operation of cabin gas return valve.	X				X		X
	r. Verify ARS Operational Flight Instrumentation.					X	X	X
	s. Verify tensile strength of CDR's and LMP's O_2 umbilical by performing a post installation pull test.							X
2.3.5	LM Cabin.							
2.3.5.1	To Verify Structural Integrity.							
	a. Proof pressure test cabin.	X						
	b. Fit check NA drogue.	X						X
2.3.5.2	Verify External Leakage of Cabin.							
	a. Leak check cabin using GN_2 flow meter make-up method.	X						X
2.3.5.3	Functional Test.							
	a. Functionally test cabin pressure relief and dump valves.	X						X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
	b. Verify cabin pressure and temperature displays.	X				X	X	X
2.3.5.4	Servicing.							
	a. Purge cabin to obtain required O_2 concentration, at altitude.							X
	b. Turn on suit fan during cabin purge to ensure oxygen purge of suit loop.							X
2.3.5.5	Hatch Test.							
	a. Verify proper operation of upper docking hatch, relief valves and locking torque.	X						X
	b. Verify proper operation of forward ingress/egress hatch, relief valves and locking torque.	X						X
2.4	GUIDANCE AND NAVIGATION.							
2.4.1	General Turn-On.							
	a. Energize IMU standby, LGC operate & self-test.					X	X	X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.4.2	Standby Power On Test.							
	a. Verify DSKY generates power commands to electroluminescent elements.					X	X	X
	b. Verify that the LGC correctly performs arithmetic functional and parity checks.					X		X
2.4.3	Alarms and Interrupts Test.							
	a. Alarm and interrupt conditions are checked in conjunction with DSKY or K-start commands.					X		X
2.4.4	IMU Operate Power-On Test.					X		X
2.4.5	Temperature Control Verification.							
	a. Verify that all G&N power supplies and temperature controls turn on.					X	X	X
	b. Verify IMU temperature control.					X	X	X
2.4.6	PGNCS Power Supply Tests.							
	a. Verify 28, 14 & 4VDC at each respective G&N power supply.					X	X	X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
	b. Verify G&N 800 and 3200 CPS power supplies.					X	X	X
2.4.7	IMU Operational Test.							
	a. Verify CDU ZERO - coarse align and fine align modes.					X	X	X
	b. Verify PIPA loop operation by means of LGC computation of local gravity. (Gross PIPA verification.)					X	X	X
	c. Verify IRIG's ability to maintain inertial reference.					X	X	X
2.4.8	PGNCS Operational Test.							
	a. Verify CDU/IMU performance.					X	X	X
	b. Verify CDU command rate and accuracy.					X	X	X
	c. Verify FDAI and GASTA command.					X	X	X
2.4.9	IRIG Scale Factor Test.							
	a. Utilizing the LGC denote the torque pulse relationship to a specified gimbal movement.					X		X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.4.10	IMU Performance Test.							
	a. Verify PIPA loop operation by means of LGC computation of local gravity (Fine PIPA verification).					X		X
	b. Utilizing the LGC determine the three IRIG non-acceleration sensitive drift coefficient and six IRIG acceleration sensitive drive coefficients 30 to 60 day intervals.					X		X
2.4.11	LGC Voltage Margin Test.							
	a. Verify voltage operating range of +4 and +14 VDC.					X		X
	b. Verify operation of LGC self check program.					X		X
2.4.12	LGC Clock Frequency Test.							
	a. Verify frequency of 2V 3200HZ PSA power supply.					X		X
2.4.13	Gimbal Friction Test.							
	a. Verify IGA, MGA, OGA friction.					X		X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.4.14	Stabilization Loop Response Test.							
	a. Monitor IGA, MGA, OGA servo error and torque drive signals.					X		X
2.4.15	G&N Fine Alignment Test.							
	a. Align IMU to LGC commanded orientations.					X	X	
	b. Monitor PIPA outputs to determine accuracy of alignment.					X	X	
2.4.16	AOT Functional Accuracy Test.							
	a. Provide inputs from AOT sightings of known earth references in each of its 3 detent positions.					X		X
	b. Measure AOT shaft and trunnion angle for each sighting.					X		X
	c. Calculate AOT line of sight angles. (X1 and X2)					X		X
	d. Using AOT Shaft and trunnion angle measurements and manufacturer's calibration data, have LGC compute AOT line of sight angles.					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
e. Compare calculated and computed sight angles.					X		X
f. Verify AOT MARK X&Y and reject discretes to LGC.					X		X
g. Verify AOT heater.					X		X
2.4.17 Memory Bank Sum Check & Retention.							
a. Verify that the fill & retraction of data from the erasable memory is correct via ACE-S/C.					X		X
b. Cycle power on and off and check effect on E-memory retention.					X		X
2.4.18 G&N/Vehicle Interface Checks.							
a. Verify LGC/CWEA interface.					X	X	X
b. Verify LGC/CES interface.					X	X	X
c. Verify LGC/RCS control.					X	X	X
d. Verify PGNS cabin displays interfaces.					X	X	X
e. Verify mode control switch.					X	X	X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
	f. Verify guidance control switch function PGNS to AGS.					X	X	X
	g. Verify LGC/Manual controller interface.					X	X	X
2.4.19	LGC Clock Align.					X		X
2.4.20	PGNS Shutdown.							
	a. Verify gimbal parking.					X	X	X
	b. Remove IMU operate, LGC/DSKY and IMU standby power.					X	X	X
	c. Verify Transfer of control of IMU heater power to PTC.					X	X	X
2.5	RENDEZVOUS RADAR.							
2.5.1	RR Turn-On and Self Test.							
	a. Turn on RR.					X	X	X
	b. Activate RR self test.					X	X	X
	c. Monitor transmitter output power.					X	X	X
	d. Monitor AGC loop signal strength.					X	X	X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
	e. Monitor shaft and trunnion error signals.					X	X	X
	f. Monitor range and range rate signals.					X	X	X
	g. Verify mechanical unstowing of RRAA. (Alt. Chamber).							X
	h. Monitor shaft and trunnion axis motion.					X	X	X
2.5.2	RR Antenna Angular Coverage and Slew Test.							
	a. Verify antenna shaft and trunnion angular limits.					X		X
	b. Verify antenna slew rates, and antenna slew polarity.					X		X
2.5.3	RR RF Transmitter and Receiver Test.							
	a. Verify transmitter power output.					X		X
	b. Determine output frequency.					X		X
	c. Monitor transmitter output for spurious content.					X		X
	d. Calculate tone mod. indices.					X		X
	e. Verify 6.8 MC out of freq. sync.					X		

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
	f. Verify 1.7 MC received.							X
	g. Monitor AGC response.					X		X
	h. Monitor no track indication.					X	X	X
	i. Measure RR acquisition time.					X		X
	j. Measure static and dynamic range rates.					X		X
	k. Measure MDS.					X		X
	l. Monitor preamplifier AGC response					X		
2.5.4	LGC Interface Test.							
	a. Verify RR range & range rate signals.					X	X	X
	b. Monitor LGC for range and range rate outputs.					X	X	X
	c. Verify lo scale factor switching.					X		X
	d. Verify RR CDU fail.					X		
	e. Verify that the LGC designate signals drive the RRAA in trunnion and in shaft.					X		X
	f. Monitor angle readouts.					X		X
	g. Verify R-04 self-test routine.					X		X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.5.5	RR Power Supply Tests.							
	a. Measure Prime LGC 800 Hz Signal.					X		X
	b. Measure ϕ_A & ϕ_B 800 Hz signal.					X		X
	c. Measure DC signals.					X		X
2.5.6	RR Gyro Torquing Test.							
	a. Monitor Gyro compensated outputs.					X		X
	b. Repeat test for redundant pair of Gyros.					X		X
2.5.7	RR Pointing Accuracy.							
	a. Verify RR self test.							X
	b. Optically align RR to range signal source.							X
	c. Verify X-Band source transmitted signal.							X
	d. Verify RR lock on.							X
	e. Pointing error, bias error, random error, and delta bias error will be monitored.							X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.5.8	RR Angle Tracking Test.							
	a. Verify initial acquisition and lock on.						X	X
	b. Slew positioner off boresight.							X
	c. Verify radar re-acquisition.						X	X
	d. Monitor and evaluate error signals (due to boresight position).						X	X
	e. Monitor and evaluate shaft and trunnion angle tracking errors at ranges of 400 NM, 100 NM, and minimum GSE range.					X		
	f. Verify RR acquisition and re-acquisition.						X	X
2.5.9	RR Closed Loop Servo Test.							
	a. Mechanically torque RRAA on LM mockup.							X
	b. Verify ability of RRAA to stabilize itself.							X
2.5.10	RR System Drift Test.							
	a. Measure RR System Drift rate.					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED NON-FEAT	MATED FEAT	
2.5.11 RR Range Measurement.							
a. Verify RR lock on (acquisition time), and Monitor RR range.					X		X
b. Compare with surveyed range.							X
2.5.12 Transponder RF Test.							
a. Monitor transmitter power output.							X
b. Monitor transmitter frequency.							X
c. Monitor tone modulation index.							X
d. Monitor RF sweep range.							X
e. Measure system sensitivity. (MDS)							X
f. Measure acquisition time.							X
g. Check AGC curve.							X
h. Transponder - self test check, monitor transmitter power, AGC voltage, frequency tracker lock up.							X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.5.13	RR/T Compatibility Test.							
	a. Initiate Transponder acquisition by RR.							X
	b. Measure range and range rate.							X
	c. Monitor system acquisition time.							X
	d. Monitor system acquisition threshold level.							X
2.5.14	RR Auto Ascent Profile.							
	a. Verify LGC designates via K-Start-Monitor shaft and trunnion angle readings.					X	X	
	b. Verify range rate in discrete steps (-4900 to 4900fps) - Monitor RR and LGC range output.					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
c. Verify closing range, at -1000 fps closing Rates At 3 Starting Ranges & Power Levels, NM: 350 / 150 / 60 — PWR Levels: 400 NM / 150 NM / 60 NM							
-Monitor RR range output (via LGC).					X		
d. Verify acquisition time, and acquisition threshold.					X		X
2.5.15 Verify Mechanical Alignment of RR Base to NAV Base.					X		X
2.5.16 RR Antenna Heater Check.							
a. Monitor antenna temperature.					X	X	
b. Monitor heater operation under environmental stimulus.							X
2.5.17 RR Shut-Down.							
a. Turn off all CB's associated with the RR.					X	X	X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.6	LANDING RADAR.							
2.6.1	LR Turn-On and Self-Test.							
	a. Turn-on and activate LR self-test.					X	X	X
	b. Monitor transmitter power output.					X	X	X
	c. Monitor altitude & altitude rate.					X	X	X
	d. Monitor forward and lateral velocities					X	X	X
2.6.2	LR Antenna Heater Check.							
	a. Monitor antenna temperature.					X	X	X
	b. Monitor Heater operation.					X		X
2.6.3	LR Internal Power Check.							
	a. Verify proper operation of LR power supplies.					X	X	X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
						MATED		
		A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
2.6.4	RF Power Measurement.							
	a. Measure velocity transmitted power output.					X		X
	b. Measure altimeter transmitted power output.					X		X
	c. Monitor altitude and velocity transmitter detected power in LM cabin and at GSE.					X		X
	d. Measure velocity and altimeter transmitter frequencies.					X		X
2.6.5	Self-Test Frequencies.							
	a. Monitor LR self-test frequencies.					X		X
2.6.6	Altimeter Modulation.							
	a. Measure modulation frequency.					X		X
	b. Measure average modulation rate.					X		X
	c. Measure modulation linearity.					X		
2.6.7	Gain State Switching.							
	a. Monitor beam attenuation.					X		X
	b. Observe gain state switching.					X		X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.6.8	Acquisition Time and Threshold.							
	a. Measure Acquisition threshold.					X		X
	b. Determine Acquisition probability.					X		X
2.6.9	LR Display Accuracy Test.							
	a. Monitor RDNG and VDNG discretes.					X		X
	b. Verify LR response to simulated altitude and velocity conditions as indicated by cabin displays readouts.					X		X
	c. Monitor RDG and VDG discretes.					X		X
2.6.10	Forced Tracker Search.							
	a. Verify forced loss of tracker lock.					X		X
	b. Measure time of VDNG-RDNG to VDG-RDG sequence.					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
2.6.11 Maximum Tracking Rate and Track Through Zero Doppler.							
a. Measure maximum doppler frequency change rates to maintain tracker lock.					X		
b. Measure loss of lock frequency during zero doppler track.					X		
2.6.12 Antenna Tilt Verification.							
a. Switch antennas via ACE K-start, or DSKY.					X	X	X
b. Switch antenna manually.					X		X
c. Monitor antenna position at ACE.					X	X	X
d. Verify tilt timing.					X		
2.6.13 Preamp Scan and Cross Talk Check.							
a. Scan preamps for spurious noise.					X		
b. Measure preamp signal leakage.					X		

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
2.6.14 LR Portion of PGNS Auto Descent Profiles.							
a. Monitor LR and LGC velocity outputs.					X	X	X
b. Monitor LR and LGC range outputs.					X	X	X
2.6.15 Verify Mechanical Alignment of LR A.A. to NAV Base.					X		X
2.6.16 LR Shut Down.							
a. Turn off all CB's associated with LR.					X	X	X
2.7 STABILIZATION AND CONTROL.							
2.7.1 Control Power Turn-On and Verification.							
a. Verify power turn-on before commencing checkout of stabilization and control subsystem.					X	X	X
2.7.1.1 AGS Turn-On.							
a. Monitor and record ASA block temperature.					X	X	X
b. Monitor and record ASA gyro run-up time.					X	X	X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
c. Verify "Operate Mode" ASA, DEDA and AEA clock outputs.					X	X	X
d. Verify DEDA voltages.					X	X	X
e. Verify presence of ASA accelerometer and gyro pulse counts.					X	X	X
f. Verify presence of ASA gyro SMRD pulses.					X	X	X
g. Verify AGS Status via down link.					X	X	X
h. Monitor & record ASA gyro run-down time.					X	X	X
i. Verify ASA pulses received by AEA.					X	X	X
2.7.1.2 CES Turn-On.							
a. Verify voltages (ATCA) via power failure indicators.					X	X	X
b. Verify RGA SMRD pulses.					X	X	X
c. Verify RGA run-up time.					X	X	X
d. Perform self-test.					X	X	X
e. Record RGA run-down time.					X	X	X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.7.2	Verify DEDA Functions.							
	a. Verify DEDA keyboard functions.					X	X	X
	b. Verify operator error and clear functions.					X	X	X
	c. Verify DEDA lighting and EL segments.					X	X	X
	d. Verify DEDA/AEA communications.					X	X	X
2.7.3	Verify AEA Computer Self Checks.							
	a. Logic and instruction self-test.					X	X	X
	b. Memory address test.					X	X	X
	c. Memory noise self-test.					X	X	X
	d. Sum Check					X	X	X
	e. AGS Accelerometer & gyro drift input register check.					X	X	X
	f. AGS Memory dump.					X	X	X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
2.7.4 Check Operation of AGS Align Modes.							
2.7.4.1 IMU Align Submode.							
a. Verify that AGS alignment to PGNCS alignment data transferred is within specified limits by means of AGS and PGNCS downlink data.					X	X	X
2.7.4.2 State Vector Transfer.							
a. Verify state vector initialization of AGS by PGNS using flight representative hardware.					X	X	X
b. Verify state vector transfer from PGNCS to AGS using flight program.					X	X	X
c. Verify state vector transfer from PGNCS to AGS during PGNCS Sim-flight.							X
d. Verify alignment transfer during PGNCS Sim-flight.							X
2.7.4.3 Body Axis Align Submode (Orbital Align).							
a. Monitor AGS downlink to verify that AGS Body Axis alignment submode is functioning properly.					X	X	X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED NON-FEAT	MATED FEAT	
2.7.4.4	Lunar Align Submode.							
	a. Monitor AGS downlink to verify that AGS Lunar alignment submode is functioning properly.					X	X	X
2.7.4.5	a. Perform an AGS lunar surface calibration.					X	X	X
2.7.5	Verify ASA/IMU Alignment.							
	a. Verify that the difference between the inertial measurements of ASA and IMU level is within specified limits.					X		X
2.7.6	AEA Flight Program Entry and Verification.							
	a. By means of the EPC program, determine the ASA gyro drift readings.					X		X
	b. Enter the flight program into the AEA erasable memory.					X	X	X
	c. Verify the flight program entry.					X	X	X
	d. AGS sim. flight.						X	X
	e. AEA digital downlink verification.					X	X	X
	f. Perform AGS Earth pre-launch calibrate check.					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
g. Compare AEA memory dump Vs TRW binary and card decks, AEA ACE file tapes and ACE master tapes.							X
h. Verify AEA memory integrity during simulated staging.						X	
2.7.7 ASA Parameter Verification.							
a. The ASA inertial parameters cannot be determined in the vehicle; during the shipping and waiting time preceding the tests noted, the ASA shall be removed from the vehicle and returned to the MSOB inertial test facility for parameter evaluation. It is desired that this process be repeated at approximately 30-day intervals during the test cycles preceding launch.					X		X
b. In-vehicle accelerometer & gyro measurements.					X		
c. ASA to AEA digital continuity.					X		
2.7.8 AGS/CES Threshold Verification.							
a. Verify proper AGS/CES functional operation by monitoring AGS/CES response to earth's rate input.					X		X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
	b. Verify AGS firing of RCS jets in response to earth rate with AGS in attitude hold.					X	X	X
2.7.9	AGS/Display Interface Verification.							
	a. Verify AGS/FDAI total attitude display interface.					X	X	X
	b. Verify AGS/FDAI steering error display interface.					X	X	X
	c. Verify AGS/Altitude and altitude rate display meter interface.					X	X	X
	d. Verify AGS/Lateral velocity interface.					X	X	X
	e. Verify AGS/cross pointer display.					X	X	X
	f. Verify AGS input/output discretes.					X	X	X
2.7.10	CES Functional Verification							
2.7.10.1	Verify the following CES Parameters or Functions.							
	a. Attitude signal limiting (Ascent and Descent).					X		X
	b. Attitude control deadband (narrow and wide deadband).					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
c. Attitude control loop offset.					X		X
d. Attitude rate gain.					X		X
e. PRM characteristics.					X		X
f. Pulse mode characteristics.					X		X
g. Gimbal trim threshold.					X		X
h. Gimbal trim rate.							X
i. Manual throttle control.					X		X
j. Attitude gain.					X		X
k. Verify TVA and thrust meter response to throttle commands.					X		X
2.7.10.2 Verify the following CES Logic and Switching Functions.							
a. RCS jet logic with AEA steering error inputs.					X	X	X
b. RCS jet logic with ACA rate command inputs.					X	X	X
c. RCS jet logic with T/TCA translation inputs.					X	X	X
d. RCS jet logic with RGA rate inputs.							X
e. RCS jet logic with 4-Jet select switch inputs.					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
f. RCS jet logic with balanced couple switch inputs.					X		X
g. Gimbal trim malfunction logic.					X	X	X
h. ACA/Secondary solenoid direct and hard-over interface in 2-Jet and 4-Jet control.					X		X
2.7.10.3 Verify CES Descent Engine Control Functions.							
a. Verify automatic engine on/off control.					X	X	X
b. Verify engine arm, start, stop, abort, abort stage (Manual).					X	X	X
c. Verify Descent Engine Override.					X		X
d. Lunar contact logic.					X		X
2.7.10.4 Verify Ascent Engine Control Functions.							
a. Verify engine automatic engine on/off and abort stage control.					X	X	X
b. Verify engine arm, start, stop (Manual).					X	X	X
2.7.10.5 Verify CES/Display Interfaces.							
a. Attitude rate display interface.					X	X	X
b. Manual thrust display interface.					X	X	X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
2.7.10.6 Verify the following CES Discretes.							
a. ACA out-of-detent to AEA.					X	X	X
b. ACA out-of-detent to LGC.					X	X	X
c. Ascent and Descent Engine on to AEA.					X	X	X
d. Start Abort Stage Program to AEA & LGC.					X	X	X
e. Start Abort Program to AEA and LGC.					X	X	X
f. Ascent and Descent Engine armed to LGC.					X	X	X
g. Auto, discrete to AEA.					X	X	X
h. Guidance select switch discrete to AEA (follow-up).					X	X	X
i. Auto stabilization and attitude hold discretes to LGC.					X	X	X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
2.7.10.7 Verify RGA & ASA Polarity.							
a. Verify the RGA polarity by rotating the vehicle and verifying proper RCS thruster response to RGA sensed rate inputs.					X		
b. Verify the ASA polarity by rotating vehicle & verifying proper RCS response.					X		
2.7.11 Ordeal.							
a. Verify Functional Performance.					X		X
b. Verify crew interface.					X		X
2.7.12 PGNCS Functional Interface Tests.							
a. LGC/Descent Engine on/off Auto.					X	X	X
b. LGC/Descent Engine Throttle.					X	X	X
c. LGC/Descent Engine Gimbal Trim.					X	X	X
d. LGC/Ascent Engine on/off (auto).					X	X	X
e. LGC-ACA and T/TCA interface.					X	X	X
f. PGNCS-RCS Timing Command input.					X	X	X
g. PGNCS/display interface.					X	X	X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.8	REACTION CONTROL SUBSYSTEM.							
2.8.1	RCS Liquid Flush.							
	a. Verify the cleanliness level of RCS propellant manifolds by flushing with Freon TF.	X_1*						
	b. Dry manifolds subsequent to Freon flush.	X_1*						
	c. Verify cleanliness of RCS propellant tanks by flushing with Freon TF.	X_1*						
	d. Dry propellant tanks subsequent to Freon flush.	X_1*						
2.8.2	RCS Proof Test.							
	a. Proof pressurization of He Module and Propellant tanks.	X_1*						
	b. Proof pressurization of propellant manifolds and lines.	X						
2.8.3	RCS Valve Response.							
	a. Obtain oscillograph records of voltage transients occurring across the 32 fuel and oxidizer thruster solenoid secondaries during ATCA, PGNS and ACA excitation.	X						X

*X_1 - MFG. PLANT 2

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
b. Measure absolute and skew time delays of RCS thruster response to commands.					X		
c. Verify, electrically, the operation of the RCS propellant valves and their position signals to the cabin flags and via TM to ACE-S/C displays.					X	X	X
2.8.4 RCS Thrusters Heaters Functional Test.							
a. Verify operation of the primary and secondary thruster cluster heater assemblies, check operation of heaters by current measurements.					X		X
b. Correlate thruster cluster temperature readings using GSE thermocouples versus cabin display readouts and ACE readouts.					X		
c. Verify auto & manual modes.					X	X	X
2.8.5 RCS - Fluid Systems Test, Harness Electrical Check & Dry Structural Integrity Test.							
a. Verify vehicle GSE interface compatibility of electrical wiring harness.	X						

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
b. Verify response of components to electrical control signals.	X						
c. Verify structural integrity of system.	X						
2.8.6 RCS Pressurization and Feed System Functional and Leak Check.							
a. Perform an external leak check of He tanks, pressurization system and propellant system to main shut off valves. Check internal leakage of initiating valves.	XX_1*						X
b. Check leakage past burst disc & overall quad check valve internal leakage. (Leak check individual quad check valve elements BPA only.)	XX_1*						X
c. Leak check propellant tank bladders.	XX_1*						X
d. (Perform relief valve functional (cracking & reset pressures) - BPA only.) Check valve functional (cracking pressure of each individual valve including bleed valves) and regulator functional tests.	XX_1*						X
e. Check internal leakage of main shut off valves.	XX_1*						X

*X_1 - MFG. PLANT 2

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
f. Check internal leakage of RCS-Ascent Interconnect valves.	XX_1*						X
g. Perform an external leak check of the propellant feed section.	X						X
h. Functionally operate and leak check cross-feed valves and isolation valves.	X						X
i. Check pressure & temperature instrumentation.	X_1*					X	X
j. Check operation of RCS - Ascent interconnect valves.	XX_1*				X		X
k. Leak check TCA injector valves.	XX_1*						X
l. Parker valves latch force test.	XX_1*						
m. Verify operation and internal leakage of RCS Helium Regulator.	XX_1*						X
n. Leak check RCS - Helium explosive valves.	X						
o. Functionally check the PQMD's and high pressure transducer.	XX_1*						X
p. After leakage tests, maintain proper blanket pressure.	X				X		X

*X_1 - MFG. PLANT 2

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.8.7	RCS Subsystem Pressure Decay Test.							
	a. Verify pressure integrity of complete reaction control subsystem (RCS) by pressure decay.	X						X
2.8.8	RCS Engine Functional Tests.							
	a. Verify TCA injector valve flow rates are within limits.					X		X
	b. Perform a flow test of the TCA injector orifices.					X		X
	c. Verify valve signatures.					X		X
	d. Check operation of chamber pressure switches.	X				X		X
	e. TCA alignment check.			X				X
2.8.9	RCS Subsystem & FCS Integrated Checkout.							
	a. Verify FCS/RCS operation all modes. Both guidance systems.							X
	b. Verify TCA injector valve sequencing and response times (primary & secondary coils).							X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.8.10	Hypergolic Servicing.							
	a. Service RCS propulsion system including the propellant manifolds up to isolation valves.							X
	b. Interconnect valve leak check.							X
2.8.11	RCS Quick Disconnect Leak Checks.							
	a. Leak check QD's - caps on and off.							X
2.8.12	Helium Servicing RCS.							
	a. Load RCS He tanks.							X
2.8.13	Tank Pressure Cycling Limitations (See TSCD).							X
2.9	PROPULSION SUBSYSTEM.							
2.9 1	D/S Fluid System Test, Harness Electrical Check & Propulsion Dry Structural Integrity Test.							
	a. Verify vehicle - GSE interface compatibility of electrical wiring harnesses.		X			X	X	

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED NON-FEAT	MATED FEAT	
b. Verify response of fluid control & monitoring devices in D/S prop. & subsystems to known stimuli, and identify sensor output channels at A/S - D/S interface.		X			X	X	
c. Pressurize propellant section, high and low pressure, helium manifold and SHe storage section, to establish confidence level in the structural pressure integrity, of the D/S fluid lines and tanks prior to performing subsequent cold flow OCP's.		X					
2.9.2 Lo. Pressure D/E Interface Leak Check.							
a. Leak check the descent engine/feed section fluid line interfaces.		X		X			X
b. Leak check all fluid line connections and all new brazes not previously leak checked.		X		X			X
2.9.3 D/S Propulsion Subsystem External, leak Tests.							

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
					MATED		
	A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
a. External leak test SHe tank, ambient helium tank, high and low pressure manifolds and associated quick disconnects down to the top of propellant tanks.		X					X
2.9.4 D/S Internal Component Leak Checks.							
a. Verify that internal leakages across latching solenoid valves are within allowable limits.		X					X
b. Verify that internal leakage across Quad check valves and burst disks, are within allowable limits.		X					X
c. Verify that internal leakage across all Squib valves are within allowable limits.		X					
d. Verify that internal leakage of the fuel He heat exchanger is within allowable limits.		X					X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED NON-FEAT	MATED FEAT	
2.9.5	D/S Propulsion Subsystem, Ambient He Purge & Dry Leak Check at Operating Pressures.							
	a. Remove GN_2 blanket from SHe tank and replace with GHe blanket.		X					X
	b. Remove GN_2 blanket from D/S propellant feed section and replace with GHe blanket.		X					X
	c. Verify external leakage integrity of hardware associated with SHe tank assembly.		X					X
	d. Verify external leakage integrity of high pressure He manifold and associated hardware.		X					X
	e. Verify external leakage integrity of propellant feed section and associated hardware.		X					X
2.9.6	D/S Substitute Propellant Cold Flow Test.							
	a. Hydraulically balance the D/S propellant feed system.		X					

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
					MATED		
	A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
b. Demonstrate performance characteristics of vehicle He regulators at a predetermined inlet pressure.		X					
c. Demonstrate performance characteristics of pressurization and propellant feed system with supercritical He.		X					
2.9.7 D/S Propellant Feed Section, Dry and Sample.							
a. Flush and dry propellant tanks and feed section upon completion of Cold Flow testing.		X					
b. System cleanliness will be verified by sampling fuel flush fluid effluent from propellant tanks.		X					
c. Ensure subsystem cleanliness by establishing a positive GN_2 blanket pressure within the LM descent propulsion subsystem.		X					
2.9.8 A/S Pressurization & Propellant Feed Systems Leak Checks at Operating Pressure.							

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
					MATED		
	A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
a. Internal leak check regulator.	X						X
b. Verify cracking and reseating of relief valves.	X						X
c. Verify that internal leakage across Squib valves, (BPA only) check valves, relief valves, and relief valve burst discs is within allowable limits.	X						X
d. Verify that external leakages in the helium high and low pressure section and propellant feed section are within allowable limits at full operating pressure.	X						
e. Verify that leakages of all quick disconnects are within allowable limits.	X						X
2.9.9 A/S - Internal Component Pneumatic Leak Test After Substitute Cold Flow Test.							
a. Verify that internal leakage across the solenoid valves, check valves, and burst discs are within allowable limits after completion of Cold Flow Test.	X						

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.9.10	A/S Propulsion Subsystem Dry Leak Check.							
	a. Check external leakage of brazed and mechanical propellant feed system joints downstream of propellant tanks.	X						X
2.9.11	A/S Substitute Propellant Cold Flow Test.							
	a. Hydraulically balance the LM A/S propellant feed system.	X						
	b. Demonstrate that the He gas system can perform satisfactorily using various modes of regulation.	X						
	c. Determine regulator starve out point, and decay mode characteristics.	X						
2.9.12	A/S Propellant Feed Section Dry and Sample.							
	a. Dry propellant tanks and feed section upon completion of cold flow testing.	X						
	b. System cleanliness will be verified by sampling fuel fluid from propellant tanks.	X						
	c. Ensure subsystem cleanliness by establishing a positive GN_2 blanket pressure within the ascent propulsion subsystem.	X						X

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
						MATED		
		A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
2.9.13	A/S Propellant Low Level Indication and D/S Propellant Quantity Gaging System Verification.							
	a. Verify performance of D/E propellant quantity gaging system control unit.					X	X	X
	b. Verify D/S PQGS control unit telemetry outputs and cabling interfaces with ACE-S/C					X	X	X
	c. Verify D/S PQGS sensor circuity.					X	X	X
	d. Verify operation of D/S PQGS cabin display.					X	X	X
	e. Verify operation of A/E & D/E propellant low level sensors under empty tank conditions via ACE-S/C telemetry downlink.					X	X	X
	f. Verify operation of A/S propellant low level sensors with liquid in the tanks.	X						
2.9.14	A/S Propulsion System Verification.							
	a. Verify relief valve functional operation.	X						X
	b. Verify functional operation of regulators.	X						X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED NON-FEAT	MATED FEAT	
c. Leak check engine ball valves and pre-valves.	X						X
d. Verify that internal leakage across S/O valves, squib valves (BPA only), He regulators, and quad check valves is within allowable limits.	X						X
e. Verify external leakages in all new brazes and mechanical joints in the high and low pressure sections and propellant feed section of the A/S are within allowable limits.	X						X
2.9.15 D/S Propulsion System Verification. Verify that the D/S propulsion system is ready for shipment to KSC by performing following tests.							
a. SHe tank heat leak check.		X					X
b. External leak tests SHe tank, ambient helium tank and new brazed fittings and mechanical fittings.		X					X
c. Internal leak check of relief valves, Squib valves (BPA only), quad check and solenoid latching valve.		X					X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
					MATED		
	A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
d. Helium regulator functional and creep test, and relief valve functional tests.		X					X
e. Leak check engine ball valves.		X			X		X
f. Engine pre-valves thermal relief and internal leak check.		X			X		X
2.9.16 A/S Propulsion Electrical Valve Functional Verification.							
a. Verify functional status of electrically controlled solenoid valves within the A/S propulsion fluid lines.			X			X	X
2.9.17 D/S Engine Functional and Gaseous Blow-down Check.			X			X	
a. Verify functional operation and leakage integrity of D/E.					X		X
b. Ascertain that propellant feed section & D/E propellant passages do not have restrictions.					X		X
c. Verify proper operation of thermal relief capability of engine pre-valves and check internal leakage of pre-valves.		X			X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
d. Verify proper operation of descent propulsion instrumentation.					X	X	X
e. Monitor ball valve full open positions pneumatically.					X		X
2.9.18 APS -- Low Pressure Leak Tests.							
a. External leak check all fluid line connections between vehicle and ascent engine.	X		X				X
b. External leak check brazed caps installed after cold flow tests.			X				X
c. External leak check compatibility Squib valves.			X				
2.9.19 Ascent Engine Functional and Gaseous Blowdown Check.							
a. Verify functional operational and leakage integrity of ascent engine.	X		X				X
b. Verify proper operation of thermal relief capability of engine pre-valves; check internal leakage of pre-valves.	X		X				X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
					MATED		
	A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
c. Ascertain that propellant feed section and ascent engine propellant passages do not have any restrictions.	X		X				X
d. Verify proper operation of applicable ascent propulsion instrumentation.	X		X		X		X
2.9.20 A/S Fluid Systems Test Harness Electrical Check.							
a. Demonstrate compatibility of the vehicle in facility electrical interface.					X		
b. Verify proper response of subsystem components to electrical control signals.					X		X
c. Verify response of subsystem instrumentation to ambient conditions.					X		
2.9.21 Servicing.							
a. A/S, D/S hypergolic loading.							X
b. SHe loading.							X
c. A/S, D/S helium tank loading.							X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED NON-FEAT	MATED FEAT	
2.9.22 Propulsion Related Displays.							
a. Verify indicator - thrust display.					X	X	X
b. Verify meter - thrust/wt ratio.					X	X	X
c. Verify indicator - eng. fuel and oxidizer temp.					X	X	X
d. Verify indicator - eng. fuel and oxidizer press.					X	X	X
2.10 EXPLOSIVE DEVICES SUBSYSTEM.							
2.10.1 ED Bridgewire and Installation Resistance Tests.							
a. To verify the electrical integrity of the bridge wire circuits of the end detonator, and cartridges by measuring the bridge-wire and insulation resistances.							X
2.10.2 Explosive Component Resistance Checks (After Installation).							X
2.10.3 ED Bus Verification · Explosive Device Battery Installation.					X	X	X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
					MATED		
	A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
2.10.4 End Detonator Performance Demonstration.*							
a. To verify that the end detonator will fire with minimum all fire current applied to bridgewire.							X
b. To verify that the end detonator will cause specified indentation of a standard test plate.							X
c. Verify the post fire circuit status.							X
2.10.5 LM Standard Cartridge Performance Demonstration.*							
a. To verify that the cartridge will fire with minimum all fire current applied to the bridgewire.							X
b. To verify the cartridge output pressure vs time.							X
c. To verify the post fire circuit status.							X

*Performed 30 days or less prior to launch - off line.

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED NON-FEAT	MATED FEAT	
2.10.6 Guillotine Cutter Performance Demonstration.*							
a. To verify that the guillotine cable cutter will cut a flight cable segment, with minimum all fire pulse applied to bridgewire in both end detonators.							X
2.10.7 ED Battery Performance Demonstration.							
a. To verify battery activation.							X
b. To verify formation discharge of battery.							X
c. To verify battery operational capability after charging.							X
2.10.8 Verification of Proper Circuit Isolation and Firing Circuit Resistances.					X	X	X
2.10.9 ED Circuitry Functional Test (Initiator Simulators are Used).							
a. To verify the functional check of both systems (A and B) separately and together, using ED firing circuits.					X	X	X

*Performed 30 days or less prior to launch - off line.

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
b. To verify via ACE-S/C the firing of initiator simulators and the closing of associated relays upon command of							
- Manual Cabin ED Control					X	X	X
- DECA Engine ON Command					X	X	X
- AELD Engine START Command					X	X	X
- ABORT STAGE Command					X	X	X
c. Monitor staging timing operations.					X		X
d. Monitor transient responses.					X	X	X
2.10.10 Stray Voltage Check.							
a. To verify no stray voltage is present in each firing circuit immediately prior to physical connection to the individual device.							X
2.10.11 Demonstration of ECI Operation.							
a. LM ECI are to be pneumatically operated and mechanically reset once to establish proper operations after potting and installation on the LM vehicle.					X		
b. LM ECI connectors are X-ray verified after cycling and resetting.					X		

PLANNED TEST OBJECTIVES		BPA						KSC
		COLD FLOW		FINAL ASSEMBLY				
		A/S	D/S	A/S	D/S	MATED		
						NON-FEAT	FEAT	
2.10.12	To verify performance of special ED tooling a dummy booster cartridge installation will be performed to verify minimum clearances between ED explosive valves and plumbing and/or surrounding structure, circuit interrupter and surrounding structure, L.G. uplock and surrounding structure; Guillotine and surrounding structure, and interstage nuts and bolts and surrounding structure.					X		
2.11	COMMUNICATIONS.							
2.11.1	ICS Tests.							
	a. MIC & BIO-Med Voltage.					X		X
	b. CDR to LMP, LMP to CDR levels.					X	X	X
	c. Master & ICS Volume Dynamic Range-CDR & LMP.					X		X
	d. Sidetone-CDR & LMP.					X	X	X
	e. VOX Sensitivity-CDR & LMP.					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
f. ICS Qualitative Test.						X	X
g. Verify no output at headsets with T/R off.					X		
2.11.2 VHF Tests.							
a. Sensitivity-VHF A&B RCVRS CDR & LMP HDST.					X	X	X
b. Squelch-VHF A&B RCVRS CDR & LMP HDST.					X	X	X
c. AVC-VHF A&B RCVRS CDR & LMP HDST.					X		X
d. Doppler-VHF A&B RCVRS.					X		X
e. Fidelity-VHF A&B RCVRS/CDR & LMP HDST.					X		X
f. Transmitted S+N/N, VHF A&B XMTRS/ CDR & LMP MIC.					X		X
g. Carrier Freq-VHF A&B XMTRS.						X	X
h. Carrier Power-VHF A&B XMTRS.						X	X
i. Noise Suppression OSC Effectiveness VHF A&B.					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
j. Insertion loss & V.S.W.R. of R.F. paths.			X				
k. Uplink down link verification.					X	X	X
l. PLSS Compatibility VHF voice and data high and low power.					X	X	X
m. VHF/PLSS/suit compatbility.							X
n. VHF bit rate BIT error count with & without voice.					X		X
o. LM/CM/PLSS compatibility voice and data.							X
p. Tone ranging (qualification test).					X		X
q. VHF voice qualitative test.					X	X	X
r. VHF A-B volume control dynamic range.					X	X	X
s. Functional performance of mission modes.					X	X	X
t. Verify no output at headset when T/R off.					X	X	
u. When T/R off verify UHF "A"/"B" turnoff.					X	X	
v. PLSS insertion loss test.					X		

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
					MATED		
	A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
2.11.3 S-Band Tests.							
a. Carrier Power-PRIM & SEC XMTR/PA.					X	X	X
b. Carrier Freq-PRIM & SEC XMTR/PA (Incl. SPE).					X	X	X
c. Threshold-PRIM & SEC RCVR (incl. AGC Curves).					X	X	X
d. Acquisition & Track-PRIM RCVR.					X		X
e. Quieting Sensitivity-PRIM & SEC XCVR/ CDR & LMP HDST.					X		X
f. S-Band Compatibility.					X	X	X
g. Fidelity-PRIM & SEC RCVR/CDR & LMP HDST.					X		X
h. Ranging Delay-PRIM XCVR/PA.					X	X	X
i. Margin Test-PRIM & SEC Power Amplifier.					X		X
j. S-Band Steerable Antenna Mechanical & Electrical Tracking. (Acquisition)					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
k. Television transmission capabilities.					X		X
l. Functional Performance of Mission Modes.							
a. S-Band Downlink Deviation Tests							
1. ST-2 (SR-6)					X		
2. ST-4 (SR-2)					X		
3. ST-6 (SR-2)					X		
4. ST-8A					X		
5. ST-10 (SR-2)					X		
b. ST-3 S-Band Low Bit Error Rate							
c. ST-10 S-Band Hi Bit Error Rate.							
m. Insertion loss and VSWR of R. F. paths.					X		
n. S-band voice qual test.					X	X	X
o. Verify EKG presence.					X		X
p. S-band volume control dynamic range (CDR and LMP).					X		X
q. S-band squelch dynamic range.					X		X
r. Functional check of steerable antenna heaters.					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED NON-FEAT	MATED FEAT	
s. Verify transmitted S+N/N, PRIM & SEC XCVR.					X		
t. Verify no output at HDST with T/R off.						X	
2.11.4 D.U.A. TESTS.							
a. D.U.A. Decoder test.					X	X	X
b. D.U.A./LGC interface.					X	X	X
c. D.U.A./S-band interface.					X	X	X
d. Redundant S-band uplink voice and squelch.					X	X	X
e. D.U.A. -70 KHZ uplink back up voice test and level.					X	X	X
2.11.5 DSEA Tests.							
a. Time correlation data input.							X
b. 1 KHZ tone input (Voice Annotative).					X		X
c. Recorder tape display flag.					X		X
d. Record command VOX voltage					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
e. Voice recording on tape.					X		X
f. Time correlation data inputs on tape.							X
g. Internal reference frequency on tape.					X		X
h. DSEA control via cabin communication panel switches.					X		X
i. Verify avoid-S/N ratio.							X
j. Verify harmonic distortion is within spec.							X
2.11.6 TLM Verification.							
a. Verify S-band TLM AGC.					X		
b. Verify S-band TLM static phase error.					X		
c. Verify S-band transmitter TLM power output.					X		
d. Verify S-band power amplifier forward power out.					X		

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED NON-FEAT	MATED FEAT	
2.12 INSTRUMENTATION.							
2.12.1 Pulse Code Modulation & Timing Electronics Assembly (PCMTEA).							
a. Verify turn-on of the PCMTEA, related vehicle subsystem & GSE.			X		X	X	X
b. Verify mission elapsed time is resettable to zero and updates at one second intervals.			X		X	X	X
c. Verify PCMTEA provides timing signals at GSE connector and ACE.			X				X
d. Verify switchover of High/Low bit rate.			X		X	X	X
e. Verify analog 15% & 85% calibration voltage for High & Low bit rates.			X		X	X	X
f. Verify PCM Downlink ambient status check.			X		X	X	X
g. Verify 2048KHZ oscillator failure is detectable.			X				X
h. Verify PCMTEA/ACE S/C synchronization.			X		X	X	X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
i. Verify PCMTEA/LGC timing interface.					X		X
j. Verify ID format.			X		X	X	X
k. Verify indicator event timer and mission elapsed timer.					X	X	X
l. LM LBR-CSM - DSE interface.							X
m. Verify the redundant gate status check.							X
2.12.2 Signal Conditioning Electronics Assembly (SCEA).							
a. Verify SCEA turn-on.			X		X	X	X
b. Simulate vehicle sensors and signal sources and verify:							
- Cabin display response only - ACE S/C readout only - Simultaneous cabin display and ACE S/C readout.			X		X		
c. Simulate analog signals and verify:							
- DC analog channels - AC analog channels - Resistance temperature channels.			X		X		

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
					MATED		
	A/S	D/S	A/S	D/S	NON-FEAT	FEAT	
d. Verify discrete responses to relay and switch contact closures as well as to solid state equivalent switch closures.					X		
e. Verify that vehicle sensors provide inputs to the SCEA's.					X	X	
2.12.3 Caution & Warning Electronics Assembly (CWEA).							
a. Verify CWEA turn-on.			X		X	X	X
b. Simulate caution & warning inputs & verify:			X		X		X
- Caution annunicator alarm functions - Warning annunciator alarm functions - Master alarm light functions - Alarm indication reset functions - Component caution alarm functions.							
c. Verify discrete alarm parameters when alarm state inputs are applied.			X		X	X	X
d. Verify analog alarm functions when alarm level inputs are supplied.			X		X	X	X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED NON-FEAT	MATED FEAT	
e. Verify proper functioning of "multiple input alarms" to application of "Inhibits" and "Enables".			X		X	X	X
f. Verify caution & warning inputs under ambient conditions.			X		X	X	X
g. Perform the jet logic checkout.					X	X	X
2.13 CREW PROVISIONS.							
2.13.1 Waste Management Section (WMS), to Verify Structural Integrity and External Leakage.							
a. Leak check WMS using helium probe method.					X		X
b. Leak check waste fluid transfer assembly.					X		X
c. Leak check PLSS condensate collector assembly.					X		
d. Verify PLSS pressure relief valve (note cracking pressure of valve).					X		X
2.13.2 To Verify Internal Leakage of WMS.							
a. Leak check flow control valve internally using fluid displacement method.					X		

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED NON-FEAT	MATED FEAT	
2.13.3 To Functionally Test the WMS.							
a. Functionally test the WMS at altitude using distilled water.							X
b. Purge WMS to dry.							X
2.13.4 Fit and Functional Test.							
a. Verification of accessibility and operational suitability of all stowed and crew station equipment as applicable.					X		X
b. Top off PLSS O_2 and H_2O.							X
2.13.5 Servicing.							
a. Stow all provisions required for mission.					X		X
2.13.6 Crew Suiting Test.							
a. Verify liquid cooling garment and urine collection transfer acceptability.					X		X

PLANNED TEST OBJECTIVES	BPA						KSC
	COLD FLOW		FINAL ASSEMBLY				
	A/S	D/S	A/S	D/S	MATED		
					NON-FEAT	FEAT	
b. Ingress of LM crew to vehicle.					X		X
c. Egress of LM crew from vehicle.					X		X

SECTION 3.0 - FEAT, SYSTEM VERIFICATION, PLUGS-IN TEST

FEAT, LM SYSTEM VERIFICATION PLUGS-IN (OCP-GF-62500-PLG)

This test will be performed to verify quantitatively the total LM system EMC performance in typical mission modes, under static and dynamic conditions.

Major Mode I - Consists of vehicle power application and subsystem turn-on and self test. This turn on mode consists of ten major sub-sections and are as follows:

1. Activation of ECS, EPS and Instrumentation. This consists of application of water-glycol cooling, DC power via MSS & (J167) connector to CDR and LMP buses, instrumentation, PCM high bit rate telemetry. Power switching from MSS to LUT, then to LM batteries low voltage taps.

2. The LM/CSM Interface checkout comprises the activation of the L. R., R. R. and S-band Antenna Heaters. IMU and ASA Heater Switchover to LM power. Power switching of LM batteries to CSM power and back to LM batteries.

   PCM telemetry turn-on via, vehicle CB's and inverter simulator turn-on. Ending with window heater C/O and pyro simulator reset.

3. A communication checkout (S-Band and VHF), including S-Band ranging and bit error check, ending with activation of DUA.

4. A lighting check, including C&WEA turn-on and self test, and a AC/DC bus C&WEA trip level check.

5. The test continues with an ECS checkout which checks the caution and warning of the water glycol primary loop, suit fan water separator and carbon dioxide sensor, and cabin repressurization valve. It continues with a checkout of the descent water tank, ascent water tank and oxygen tank controls and their associated displays and caution and warning.

6. Major Mode I continues with CES turn-on. Including FCS displays turn-on; ATCA and DECA turn-on; cabin controls set-up including T/TCA's. A verification is then made of the RGA run-up followed by a set-up of the Start and Stop buttons, and circuits controlling the engines.

7. The Landing Radar and Rendezvous Radar are then activated and self tested.

8. An RCS functional checkout commences with a Helium Caution Reset and Propellant pressure and temperature checkout. The valve status is then checked along with the main SOV functions. This is followed by a checkout of manifold pressure.

9. A Propulsion Functional Checkout follows with a check of descent helium regulators, propulsion displays and controls, and propulsion caution and warning. This is followed by manual descent engine start/stop, and manual ascent engine start/stop.

10. Major Mode I ends with the verification and initialization of the AEA memory noise-test load.

Major Mode II - Consists of employing an Automatic Descent profile generated by the LGC comprising an automatic engine ON-OFF, gimbaling and throttling and LGC pulse commands to the RCS jets. During the "profile," various functions are tested such as DC voltage switching (Hi-Lo), radars commanded and radar data fed to the LGC and the communications. There are three individual tests which are enumerated below:

1. Test 1 consists of the following performed concurrently with the descent profile, rendezvous radar antenna slewing under manual control, landing radar antenna switching under LGC control. Also included are the switching ON and OFF of docking lights.

   A. D. C. switchover is made from Lo to Hi taps, and the Ascent Battery #5 32. 5 normal feed and backup feed are switched ON and OFF.

   A communication check is run and the antenna slew is performed. Cabin instrumentation is monitored during the test.

2. Test 2 consists of the following performed concurrently with the descent profile, rendezvous radar antenna slewing under manual control, landing radar antenna switching under LGC control. The tracking lights are exercized. D. C. power switches (Lo to Hi) is performed, the Ascent Battery #5 normal and backup feeds are turned on and the descent batteries are (deadfaced). A glycol pump 1 to pump 2 switchover is performed. A communication check is run and the S Band antenna slew is performed. Cabin instrumentation is monitored during the test.

3. Test 3 consists again of operating the profile. Concurrently with it the rendezvous radar antenna is slewed, the landing radar antenna is switched and the window heaters (LMP & CDR) are turned on and off. Both the docking and tracking lights are cycled on and off. A glycol pump switchover is performed. DC power switchover (Lo to Hi) is performed, then Ascent Battery #6 normal and backup feeds to bus and the descent batteries are deadfaced. Both suit fans are exercized and the He regulator valves are cycled.

   The communication check is run and the S-Band antenna slew is performed. Cabin instrumentation is monitored during the profile.

4. Test 4 again the profile is run with the radar antennas exercized. The docking and tracking lights are exercized. The glycol pump switchover and descent helium regulator valve cycling are performed. Engine gimbaling is disabled/enabled, manned throttle commands given and manual overrides of descent engine stop is exercized. PGNS ATT hold and AGS auto functions are checked. The DC power switchover, Battery #5 and #6 backup feed to bus and descent batteries to deadfaced is performed.

   The communications test and slewing of the S-Band antenna cabin instrumentation is monitored during the profile. Using the GSE inverter simulator for AC, the voltage is varied and monitored.

5. Test 5 is a repeat of Test 4 with the exception of the following:

   The Ascent batteries normal feed to bus is used instead of the backup feed, and the GSE inverter voltage is constant, with the frequency varied.

Major Mode III - Consists of an abort and abort stage in the AGS mode using, a program generated by the AEA comprising automatic engine ON-OFF, and steering errors. The AEA memory noise test is terminated and the LGC memory test initiated. The two tests are enumerated below:

1. The Abort/Abort Stage program is run concurrently with an S-Band antenna slew, manual throttle control glycol pump switchover, inverter switchover and activation of docking and tracking lights.

2. The Abort/Abort Stage program with S-Band antenna slew, manual throttle commands by CDR who also activates his audio-control back-up. The docking lights are turned ON-OFF and the DECA is turned off during program.

Major Mode IV - Consists of a vehicle turn-off electrically demated and turn-on for PGNS Auto Ascent profile. The program consists of ascent engine ON-OFF and an RCS jet profile. The RR, Communications, ECS and Lighting Systems are exercized. RCS valves are cycled and cabin instrumentation is monitored during test.

SECTION 4.0 - FEAT, MISSION ORIENTED PLUGS-OUT TEST

FEAT MISSION-ORIENTED, PLUGS-OUT (OCP-GF-62500-SIM)

This test will be performed to verify all functions which are planned for the Lunar Mission. The eight phases are:

1. Pre-Launch Checkout
2. Earth Orbit - Translunar - Pre-Separation
3. Separation and First DPS Burn
4. Lunar Descent and Landing
5. Lunar Stay
6. Pre-Launch
7. Powered Ascent
8. AGS Abort and Rendezvous

1. Pre-Launch checkout commences with an EPS verification, PCM turn-on via LUT, installation of ED devices and a closeout check. The ASA, IMU, LR and RR heaters are activated by vehicle power.

2. Earth Orbit-Translunar - Pre-Separation commences with a CSM/LM interface verification. The PCM telemetry is turned on via vehicle CB's.

   The cabin lighting is switched on and the following systems are activated and self checked; Instrumentation, Caution and Warning, ECS, Communications, Propulsion, RCS, Primary Guidance, and Abort Guidance. In addition, the PGNS is fine aligned and the AGS aligned to it, and the state vector is loaded into the LGC and transferred to AEA.

   The Landing Gear Deployment, DUA turn-on and Ordeal Checkout finish this section.

3. Separation and First DPS Burn commences with a simulated minus X translation initiated at the DSKY. Cabin switches are set for a short descent burn, an ullage maneuver is performed, and the descent engine is stated via DSKY command. (This simulates orbit insertion). Verification is made that helium pressurization fuses are blown, EPS modes are set for powered descent, and the tracking light is turned on.

   Propellant, Gases and Fluids Checkout are performed.

4. Lunar Descent and Landing the LGC is loaded with the burn profile via the DUA. Suit fan #1 and glycol pump #1 are turned on and the second profile is initiated. The gimbaling, throttling and RCS commands are stored on the FR 1400 tapes. The suit fan and glycol pump are then turned off.

   The LR is activated and self tested. Manual functions associated with Hover are performed.

5. Lunar Stay commences with a subsystem deactivation and EPS checkout. The AGS Lunar Align, PGNS deactivation and communications checkout including a PLSS test are performed.

6. Pre-Launch reactivation includes PGNS alignment checks and propellants status checks. EPS is configured for ascent burn, AGS and RR are self tested and the RCS/ASC interconnect valves opened.

7. Powered Ascent commences with ascent helium pressurization. A profile is loaded into the LGC via the DUA. Suit fan #2 and glycol pump #2 are turned off and the Ascent Engine is switched off for coast.

   A VHF ranging test, manual ACA ascent burns exercise to simulate docking and PGNS shutdown.

8. AGS Abort and Rendezvous - The modified AEA FP3 flight program is run and an Analog Autopilot Rendezvous performed.

SECTION 5.0 - RETEST PHILOSOPHY

Section 5.0 - Retest Philosophy

Because of possible retrofits, failures, troubleshooting, etc., a certain amount of previously accomplished testing may be invalidated and therefore must be reverified. Specific retest requirements shall be established for each situation, based upon the following general ground rules:

A. GENERAL

1. Re-verification may require delta testing or may utilize downstream testing but must be accomplished prior to the start of the FEAT System Verification, Plugs-In. However, if troubleshooting or a replacement is required during the FEAT, Plugs-In Test, the re-verification must be accomplished before the completion of the FEAT Plugs-In Test by re-running the appropriate test procedure sequences.

2. The documentation that identifies and authorizes the operation resulting in invalidation of previous testing must include the specific retest requirements for re-verification of the vehicle or test constraints, and must be approved by the Resident Assistant Manager, Apollo Spacecraft Program Office.

B. ELECTRICAL

1. All electronic replaceable assemblies must be pre-installation tested in accordance with existing specification and time limitations to verify that the assembly, by itself, meets the required performance criteria.

2. Any suspected or failed assembly removed from the spacecraft must be recycled through a pre-installation test, plus any bench level delta testing that may be required to isolate malfunctions. Units which have exhibited intermittent failures must not be reinstalled into the spacecraft until the cause of the failure has been determined and corrected.

3. If an electronic assembly is replaced in the spacecraft with a different unit, all functional modes and all functional paths to and through the replacement assembly must be re-verified.

4. When assemblies are removed from the spacecraft solely for access to other equipment, only an interface integrity test will be performed.

5. All electrical connectors which are demated or replaced must have all functional paths re-verified after remating.

C. FLUID AND MECHANICAL SYSTEMS

1. Functional verification in the spacecraft is required on replacement of components or the breaking of any fluid system.

2. Mechanical assemblies that have been functionally tested in the spacecraft and subsequently invalidated because of removal and/or replacement are to be re-verified for fit and function.

SECTION 6.0 - GENERAL REQUIREMENTS

Section 6.0 - General Requirements

1. Positive pressure is to be maintained on all tanks at all times for atmospheric pressure changes and for maintaining system cleanliness.

2. The IMU temperature controller PTC is to be activated and monitored at all times except when on internal power.

3. The Abort Sensor Assembly temperature controller PTMU is to be activated and monitored at all times except when on internal power.

4. G&N parameter verification tests are to be conducted on the PIPA scale factor and bias and on the IRIG scale factor and drift coefficient on a periodic basis normally not to exceed 60 days between tests.

5. Cabin air to be provided during all test operation in order to maintain cleanliness and provide cooling.

6. Provide cooling to electrical subsystems utilizing GSE circulated water glycol.

7. Prior to the introduction of any fluids into spacecraft systems, spec requirements of the fluids must be verified.

8. Abort and simulated mission sequences are to conform to the AOH as closely as possible within test configuration and facility constraints.

9. AGS Parameter verification is performed every 30 to 60 days.

	CATEGORY	
	MANDATORY	OPTIONAL
Unsuited Crew participation is required during the following tests:		
OCP 36527 DATA CHANNEL VERIFICATION (C&W ONLY)		X
OCP 62000 COMBINED SUBSYSTEM TESTS, PRE-FEAT		
ECS		X
G&N		X
COMM		X
RADAR		X
FCS		X

	CATEGORY	
	MANDATORY	OPTIONAL
OCP 62500 - PLG LM COMBINED FEAT TEST - SYSTEMS VERIFICATION, PLUGS-IN.		X
OCP 62500 - SIM LM COMBINED FEAT, TEST - MISSION ORIENTED, PLUGS-OUT.	X	

Suited Crew participation is required during the following tests:

OCP 32016 CREW SUITING, VEHICLE INGRESS/EGRESS AND SUIT - VEHICLE CHECKOUT	X
OCP 32014 A/S CREW COMPARTMENT FIT AND FUNCTIONAL	X
OCP 32022 CREW SUITING (FOR D/S, LMP ONLY)	X
OCP 32021 D/S CREW COMPARTMENT FIT AND FUNCTIONAL	X

MANDATORY: One or more of the Prime or Backup Flight Crew will man the spacecraft for the test.

OPTIONAL: One or more GAEC Consulting Pilots will man the spacecraft for the test. Flight crew manning will be at the option of the Crew Commander.

10. An accounting of limitated life or limited cycle items will be maintained.

11. LM configuration will be verified to be compatible with each test and GSE prior to any test.

12. Flight Instrumentation used for spacecraft evaluation shall be verified/calibrated prior to use.

13. The current Apollo Operations Handbook (AOH) procedures will be utilized where applicable to the LM Manned Flight Vehicles to accomplish corresponding OCP sequences for OCP 62500 SIM at Bethpage as well as all tests at KSC involving the flight crew. These OCP's shall deviate for the AOH procedures only when required to meet approved test objectives or test constraints.

SECTION 7.0 - SAFETY REQUIREMENTS

Section 7.0 - Safety Requirements

BPA operations are to be in accordance or conformance with the following considerations or conditions:

Identification of all hazardous operations.

The planning operations to minimize the exposure of personnel to hazardous conditions.

Verification that all inputs to the spacecraft systems are correct before connection or insertion is made.

All nonflight equipment introduced for testing must be nonhazardous.

All hardware and associated software must meet required configurations and must have received proper controlled handling.

Supporting personnel must have been trained in the respective operations for achieving satisfactory test data while maintaining the safety of the space vehicle, equipment, crew and other support personnel.

A planned method for restoring the vehicle to a safe configuration following an interruption of the test.

A plan for the escape and rescue of the crew and supporting personnel during all hazardous tests.

Pretest verification of the test readiness of all facilities employed in checkout operations.

The protection of the spacecraft and its systems from exposure to harmful environments or contaminants.

The providing of maximum protection against damage to the spacecraft or space vehicle as a result of accidental fluid leakage or spillage.

Operational checkout procedures and safety program documents must be evaluated and reviewed to assure that they:

Will not create destructive damage to any spacecraft system or to the crew.

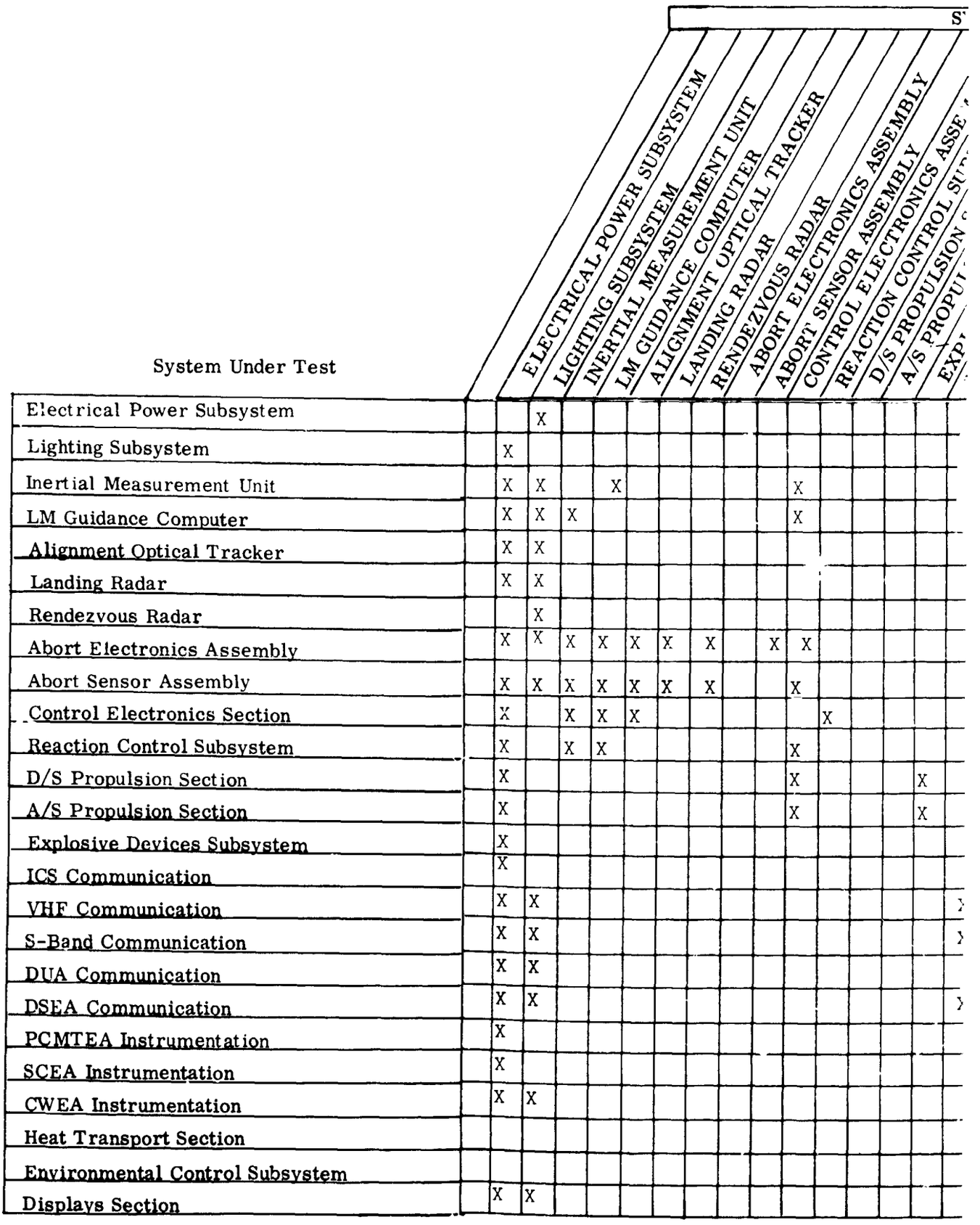
Are applicable for the hardware configuration.

Contain the proper safety requirements, warning, and caution notes to insure maximum personnel identification of and awareness of all hazards involved.

Have back-out (emergency) capability.

Do not initiate unscheduled or out-of-sequence events.

SECTION 8.0 - SUBSYSTEM SUPPORT MATRIX



System Under Test	ELECTRICAL POWER SUBSYSTEM	LIGHTING SUBSYSTEM	INERTIAL MEASUREMENT UNIT	LM GUIDANCE COMPUTER	ALIGNMENT OPTICAL TRACKER	LANDING RADAR	RENDEZVOUS RADAR	ABORT ELECTRONICS ASSEMBLY	ABORT SENSOR ASSEMBLY	CONTROL ELECTRONICS ASSEMBLY	REACTION CONTROL SUBSYSTEM	D/S PROPULSION	A/S PROPU	EXPL	S
Electrical Power Subsystem		X													
Lighting Subsystem	X														
Inertial Measurement Unit	X	X		X						X					
LM Guidance Computer	X	X	X							X					
Alignment Optical Tracker	X	X													
Landing Radar	X	X													
Rendezvous Radar		X													
Abort Electronics Assembly	X	X	X	X	X	X	X		X	X					
Abort Sensor Assembly	X	X	X	X	X	X	X			X					
Control Electronics Section	X		X	X	X						X				
Reaction Control Subsystem	X		X	X						X					
D/S Propulsion Section	X									X			X		
A/S Propulsion Section	X									X			X		
Explosive Devices Subsystem	X														
ICS Communication	X														
VHF Communication	X	X													X
S-Band Communication	X	X													X
DUA Communication	X	X													
DSEA Communication	X	X													X
PCMTEA Instrumentation	X														
SCEA Instrumentation	X														
CWEA Instrumentation	X	X													
Heat Transport Section															
Environmental Control Subsystem															
Displays Section	X	X													

FOLDOUT FRAME

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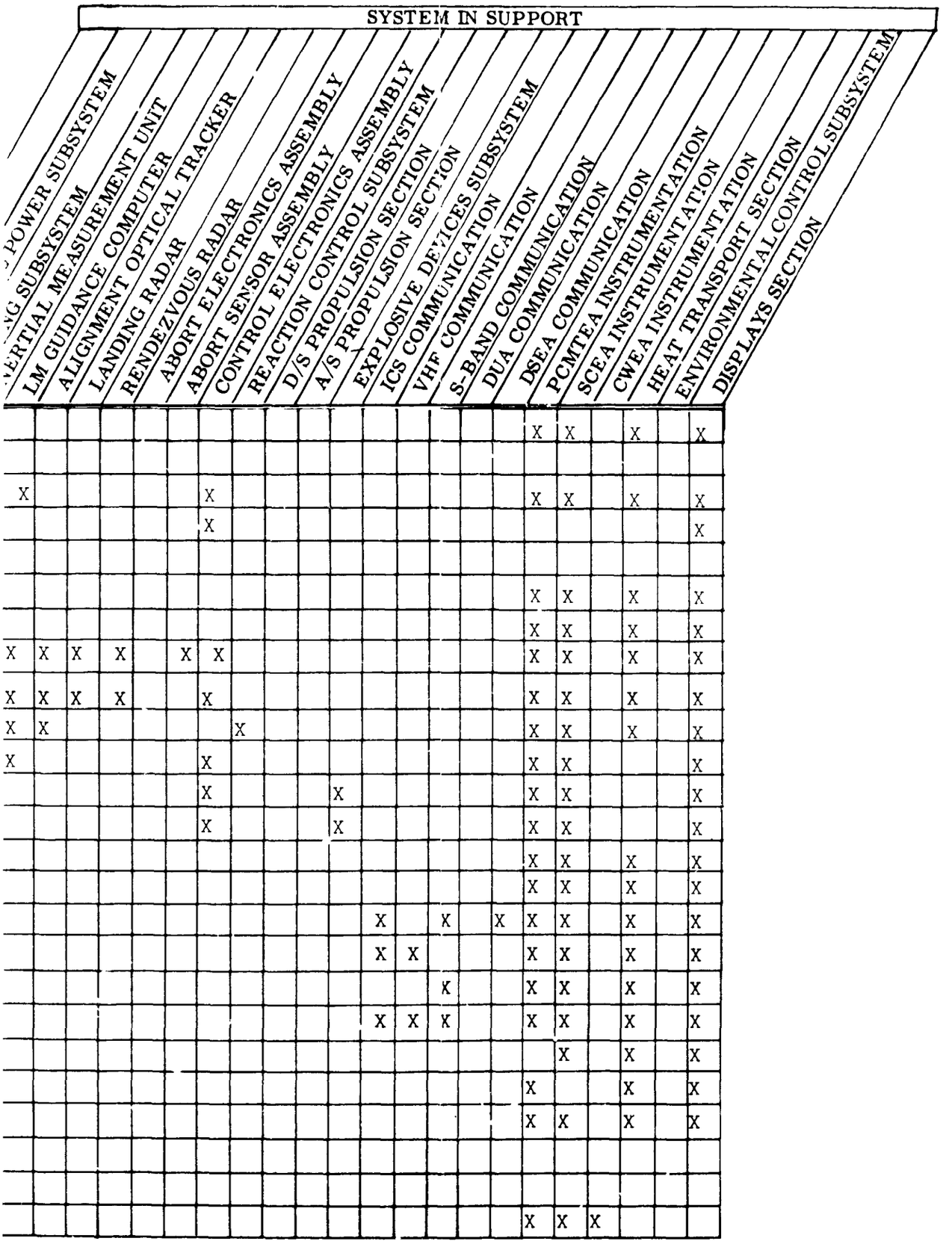

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