

CONTRACT REQUIREMENTS EXHIBIT E, PARA. 3.14	CONTRACT ITEM WORK PACKAGE NO. 712	MODEL LM-5	CONTRACT NO. NAS9-1100
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TYPE II DOCUMENT

LM-5 BPA FACTORY OPERATIONS TEST PLAN

LTP 561-5

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## 1.0 INTRODUCTION

### 1.1 Purpose

This document describes the Bethpage factory test program for the LM-5 vehicle. In order to verify that the vehicle and its subsystems satisfy the test program requirements and are in a condition for acceptance by NASA, a series of detailed tests are performed. These tests are identified as Operational Checkout Procedures (OCP's). Standard Manufacturing Procedures (SMP's) are included to identify their scope within the Test program.

### 1.2 Amendments

All amendments to this document shall be issued by S/CAT Test Engineering.

### 1.3 Precedence

This Factory Operations Test Plan shall have precedence over any other test plan pertaining to LM-5.

### 1.4 Applicable Documents

This Factory Operations Test Plan has been prepared in compliance with Contract NAS 9-1100, Exhibit E (Type II Documentation). Reference documents which are applicable are listed below.

LSP470-1	Contract Technical Specification for Lunar Module System
LSP470-2	LM-4 and Subsequent Master End Item Detail Specification, Product Configuration and Acceptance Test Requirements, Part II.
LSP470-7	LM-5 Contract End Item Detail Specification, Product Configuration and Acceptance Test Requirements, Part II
MIL-E-6051C	Electrical-Electronic System Compatibility and Interference Control
LED-360-7	LM-4 and Subsequent Measurement List
LPL567-5	LM-5 BPA Test and Checkout Requirements Document

## 2.0 TEST PROGRAM

### 2.1 Description

The LM ascent stage and descent stage flight structures individually go through a manufacturing buildup phase in Plant 2 in which secondary structure and bracketry, complete fluid systems (except for engines) and electrical harnesses are installed. This is followed by low pressure gross leak checks of the fluid systems and DITMCO checks of the electrical harnesses. Preliminary ambient checks of fluid system transducers are conducted. The RCS helium tankage modules are checked prior to installation in the ascent stage. The RCS system is flushed and leak checks made of the RCS isolation valves. A preliminary LM cabin leak check is made before the ascent stage leaves Plant 2.

## 2.0 TEST PROGRAM (Cont)

The descent stage is transferred to the Cold Flow Facility for high pressure fluids systems testing and propellant orifice sizing. The ascent stage is transferred to Plant 5 test area where it is rotated and cleaned and then placed in an integrated workstand. Portions of the electronics subsystems are installed. The ascent stage is then transferred to the Cold Flow Facility for high pressure fluids systems testing and orifice sizing.

Upon completion of cold flow testing, both stages are transferred to Plant 5 Final Assembly Area and installed in an integrated workstand. The remaining electronic components and engines are installed and flight connectors mated. The ELECTRICAL/ELECTRONIC Combined Subsystem PRE-FEAT tests (62000) are performed in preparation for FEAT (Formal Engineering Acceptance Tests).

Upon completion of FEAT, the stages are transferred to the Cold Flow Facility for a series of fluids systems confidence tests (Cold Flow II). They are then returned to the Final Assembly Area for installation of additional thermal shielding and installation and checkout of the landing gear. The ascent stage is rotated and cleaned, followed by a weight and center of gravity check and preparation for shipment. A descent stage weight and center of gravity check is performed, the landing gear removed, and the stage is rotated and cleaned and prepared for shipment.

## 2.2 Objective

The objective of the test program is to verify satisfactory performance of the vehicle.

## 2.3 Prerequisites

The following items are prerequisites on the IM-5 test program:

- a. Availability of the factory facilities
- b. Availability of the vehicle hardware (structure, electrical and fluids lines, functionally verified subsystem assemblies).
- c. Availability of GSE, ACE-S/C complex, and manufacturing hardware
- d. Availability of all required software (OCP's, SMP's, ACE-S/C programs, manufacturing procedures)
- e. Availability of data acquisition processing and reduction hardware and software

## 2.4 Limitations

The following limitations are imposed on the IM-5 test program:

- a. All operations must be capable of being performed under factory ambient conditions of temperature, humidity, pressure and cleanliness (no environmental testing).

## 2.0 TEST PROGRAM (Cont)

- b. Pyrotechnic operations are limited to the use of initiator simulators only.
- c. Live propellants are not used in any phase of the program.

## 2.5 Electromagnetic Compatibility (EMC) Testing

Electromagnetic interference will be monitored during some special EMC tests performed on the vehicle throughout FEAT testing.

## 2.6 Constraint Logic

- a. Module and subassembly tests must be completed prior to Combined Subsystem Pre-FEAT Tests (62000).
- b. Combined Subsystem Pre-FEAT Tests (62000) must be completed prior to FEAT, Plugs-In (61015).
- c. FEAT, Plugs-In (61015) must be completed prior to FEAT, Plugs-Out (61018).
- d. Full-up ascent stage prior to Weight and Center of Gravity Test (32001).
- e. Full-up descent stage prior to Weight and Center of Gravity Test (32003).

## 2.7 Vehicle/Test - Flow Chart

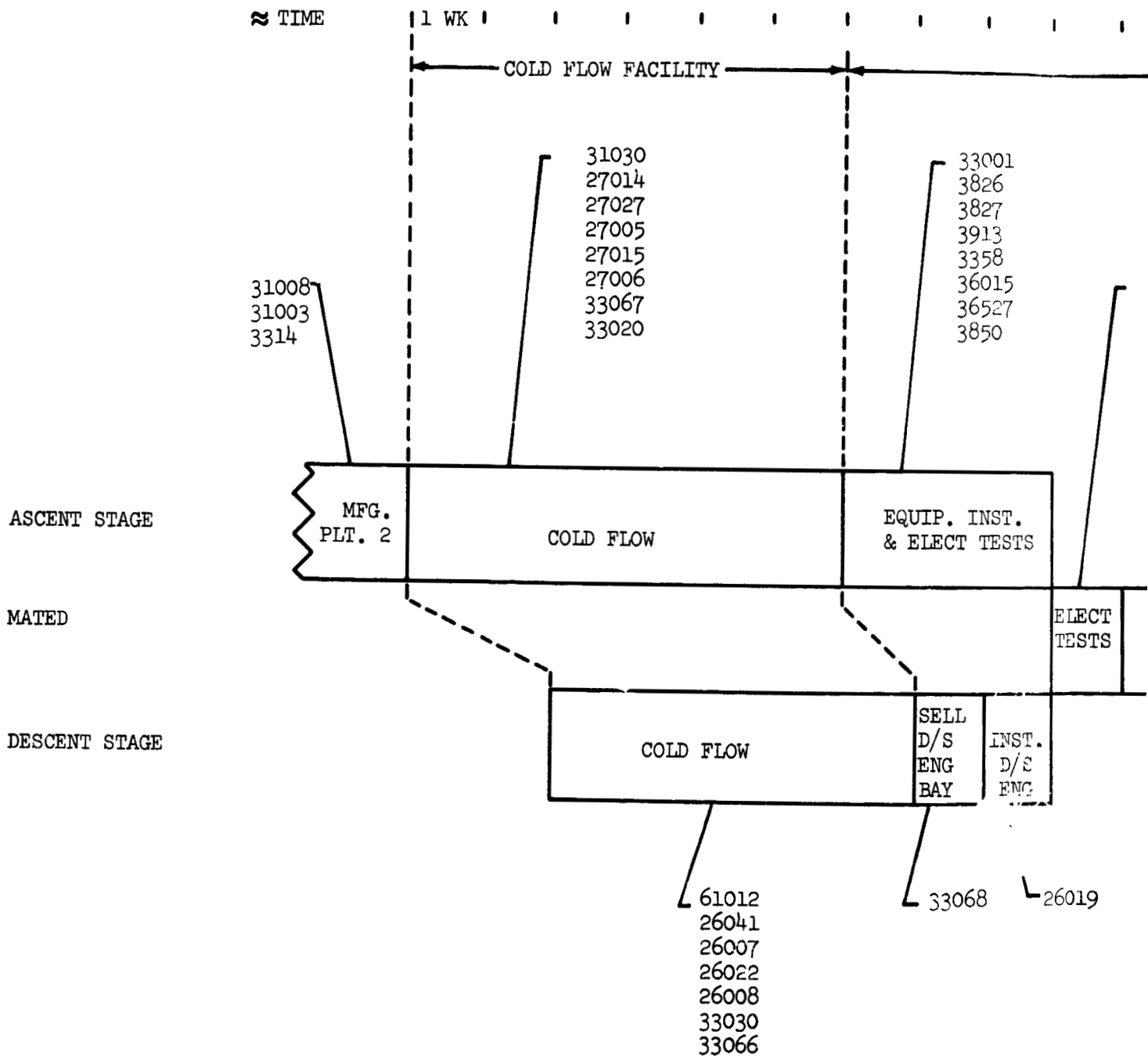
(See figure 1.)

## 3.0 OCP and SMP OUTLINES

In this section arranged in numerical order is an outline of each Operational Checkout Procedure (OCP) and Standard Manufacturing Procedure (SMP) to be performed on the LM-5 vehicle at GAEC, Bethpage.

### NOTE

Paragraphs referenced in the OCP Outlines refer to LSP470-2, Part II.



**BOLDOUT FRAME**

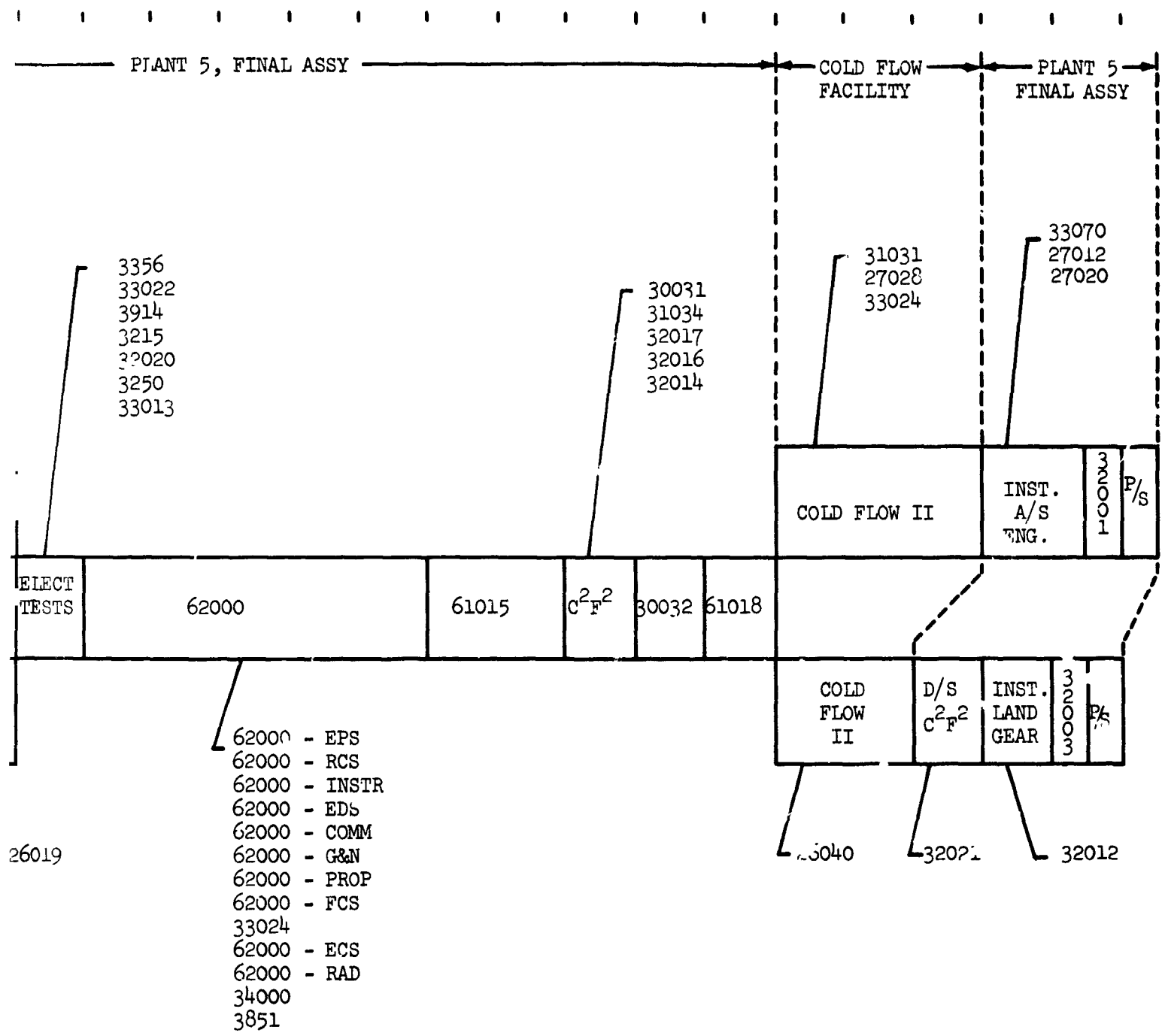


Figure 1. Vehicle/Test Flow Chart

SMP OUTLINE

SMP 3215

Test Title:

Inert Explosive Devices Clearance and Fit Check

Subsystem:

Ascent and Descent Explosive Devices

Test Objectives:

- a. To verify that no structural and/or plumbing interferences are present to hinder the installation of Explosive Devices and the torquing of Inert Cartridges in the LM Vehicle.
- b. To insure proper fit, correct routing and length of the Umbilical and Pyro Electrical Lines.

Vehicle Configuration:

Mated Stages

Location:

LM Final Assembly Area

Hazardous Operations:

Not Applicable

Components Under Test:

All areas in which explosive devices are installed.

Test Description:

Seq. 01: Interstage Umbilical Combing and Wrapping Procedure.

- a. Combing and wrapping Umbilical Lines (Electrical and Fluid), so as to allow the Guillotine Cutter Assembly to be fitted.

Seq. 02: Circuit Interrupter Cartridge Installations (inert).

- a. Installation of Explosive Cartridges in the dead face connectors and checking proper fit of Pyro Connectors to these Explosive Devices.

Seq. 03: Booster Cartridge Installation (inert).

- a. Installation of explosive cartridges in all Helium Valves and checking proper fit of Pyro Connectors to these explosive devices.

Seq. 04: RCS Cartridge Installation (inert)

- a. Installation of Explosive Cartridges in the RCS Valve and checking proper fit of Pyro Connectors to these Explosive Devices.

SMP OUTLINE

SMP 3215

Test Description: (Cont)

- Seq. 05: Inert Explosive Nut, Bolt and Cartridge Sub-Assembly Installations.
- a. Installation of Explosive Devices in all four (4) interstage fittings and checking proper fit of Pyro Connectors to these devices. Also fitting associated blast covers.
- Seq. 06: Pyro Line length check to Explosive Devices relay boxes (Ascent and Descent).
- a. Installation of ED Relay Boxes and mating all Pyro Connectors to insure proper fit and length.

SMP OUTLINE

SMP 3250

Test Title:

Explosive Devices Subsystem Resistance Measurement Test

Subsystem:

Explosive Devices

Test Objective:

To measure and establish limits for resistance of System "A" and System "B"  
Explosive Devices Firing Circuitry.

Vehicle Configuration:

Mated Stages

Location:

Plant #5 Final Assembly Area

Hazardous Operations:

Not Applicable

Components Under Test:

ED Relay Boxes  
Vehicle Wiring (Pyro Lines)

Test Description:

Seq. 01: Call to Station and EPS Activation

Seq. 02: Firing Circuit Resistance Measurements



## SMP OUTLINE

### Test Title:

SMP 3314

Proof Pressure and Interface Leak Check of Suit Circuit Assembly and Oxygen Control Module

### Subsystem:

ECS

### Test Objectives:

- a. Verification of the structural integrity of the interface between the LSC 330-190 Suit Circuit Assembly and the LSC 330-390 Oxygen Control Module by applying a proof pressure.
- b. Verification that the leakage at the interface between the LSC 330-190 Suit Circuit Assembly and the LSC 330-390 Oxygen Module is within allowable limits.

### Vehicle Configuration:

Not Applicable

### Location:

Plant #2 - Clean Room

### Hazardous Operations:

Proof pressure to 1465 psig.

### Components Under Test:

Interfaces between LSC 330-190 Suit Circuit Assembly and LSC 330-390 Oxygen Module

### Test Description

Seq. 01: Call to station

Seq. 02: LSC 330-390/190 Interface Proof Pressure & Leak Test

- a. Pressurize the following interfaces to a proof pressure of 1465 PSIG. Reduce pressure to operating pressure ( $1100 \pm 25$  psig) and perform a leakage test using a Mass Spectrometer Leak detector.
  1. Line between the LSC 330-190 and the Asc GOX No. 1 304 valve.
  2. Line between the LSC 330-190 and the Asc GOX No. 2 304 valve.
  3. Line between the LSC 330-190 and the PLSS 304 valve.
- b. Pressurize, the LSC 330-306 Sense lines and the interface between the outlet of the LSC 330-306 Reg and the inlet to the LSC 330-190 SCA, to a proof pressure of  $6.4 \pm .1$  psig. Reduce pressure to operating pressure ( $4.9 \pm .2$ ) psig and perform a leakage test using a Mass Spectrometer Leak detector.

Seq. 03: Securing after Test

## SMP OUTLINE

SMP 3356

### Test Title:

Flush, Purge, Fill and Gas Entrapment Test of Heat Transport Section, Primary Ascent Stage

### Subsystem:

ECS

### Test Objectives:

- a. To verify system leak free with a 1 hr GN<sub>2</sub> pressure decay.
- b. To clean the primary ascent stage HTS with flushing fluids to acceptable cleanliness level.
- c. To verify results within Specification limits of LSP14-0020.
- d. To dry HTS with a GN2 Purge and Vacuum.
- e. To perform vacuum decay verifying system dry.
- f. To fill the primary A/S Coolant Loop with certified water/glycol.
- g. To determine the amount of entrapped gas in the primary ascent stage.
- h. To circulate chilled W/G with the trim control unit through HTS - Primary A/S.
- i. To verify the HTS - Primary Ascent Stage Circulation.

### Vehicle Configuration:

Ascent Stage

### Location:

Plant #5 - Final Assembly

### Hazardous Operations:

Alcohol Flush of HTS

### Components Under Test:

A/S HTS

### Test Description:

- Seq. 01: Call to Stations.
- Seq. 02: HTS - GSE Power Activation

SMP OUTLINE

SMP 3356

Test Description: (Cont)

- Seq. 03: HTS Primary Coolant Loop Evacuation and Flush-Ascent Stage only.
- Seq. 04: HTS - Primary Coolant Evacuation and W/G Fill.
- Seq. 05: Gas Entrapment Test (Vehicle Only) (Para. 4.2.2.3.6.5)
- Seq. 06: Gas Entrapment Test (Vehicle and GSE)
- Seq. 07: Water/Glycol Circulation
- Seq. 08: Securing after Test - A/S

SMP OUTLINE

SMP 3358

Test Title:

Flush, Purge, Evacuation, Fill and Gas Entrapment Test of Heat Transport Section, Secondary

Subsystem:

ECS

Test Objectives:

- a. To verify system leak free with a 1 hr  $\text{GN}_2$  pressure decay.
- b. To clean the secondary HTS with Flushing Fluids to acceptable cleanliness level.
- c. To verify results are within Specification limits of LSP14-0020.
- d. To dry the HTS with a  $\text{GN}_2$  purge and vacuum.
- e. To perform vacuum decay verifying system dry.
- f. To fill the secondary coolant loop with certified water glycol.
- g. To determine the amount of entrapped gas in the secondary coolant loop.
- h. To circulate chilled W/G with the trim control unit through HTS Secondary.
- i. To verify the HTS - Secondary Circulation.

Vehicle Configuration:

Ascent Stage

Location:

Plant #5 - Final Assembly

Hazardous Operations:

Alcohol Flush

Components Under Test:

Secondary HTS

Test Description:

- Seq. 01: Call to Stations
- Seq. 02: HTS - GSE Power Activation
- Seq. 03: HTS - Secondary Coolant Loop Evacuation and Flush - A/S only
- Seq. 04: HTS - Secondary Coolant Evacuation and W/G Fill

SMP OUTLINE

SMP 3358

Test Description: (Cont)

- Seq. 05: Gas Entrapment Test (Vehicle Only) (Para. 4.2.2.3.6.5)
- Seq. 06: Gas Entrapment Test (Vehicle and GSE)
- Seq. 07: Water/Glycol Circulation
- Seq. 08: Securing after test - secondary HTS

SMP OUTLINE

SMP 3826

Test Title:

Operational VHF Section Insertion Loss and Voltage Standing Wave Ratio Test.

Subsystem:

Communications

Test Objectives:

The Verification of the VHF Communication RF Signal Paths

Vehicle Configuration:

Ascent Stage

Location:

Plant #5 Final Assembly

Hazardous Operations:

Not Applicable

Components Under Test:

RF Signal Paths

- a. Coax Lines
- b. Coax Connectors

Test Description:

Seq. 01: Call to Stations

Seq. 02: Insertion Loss Measurements

- a. Verify operation of GSE

Seq. 03: VSWR Measurements

- a. Verify operation of GSE

SMP OUTLINE

SMP 3827

Test Title:

"S" Band Section Insertion Loss and Voltage Standing Wave Ratio Test

Subsystem:

Communications

Test Objective:

The Verification of "S" Band Communication RF Signal Paths

Vehicle Configuration:

Mated Stages

Location:

Plant #5 Final Assembly

Hazardous Operations:

Not Applicable

Components Under Test:

RF Signal Path

- a. Coax Lines
- b. Coax Connectors

Test Description:

Seq. 01: Call to Stations

Seq. 02: Insertion Loss Measurements "S" Band Ascent Stage

Seq. 03: Insertion Loss Measurements "S" Band Descent Stage

Seq. 04: VSWR Measurements

Seq. 05: Securing after Test

SMP OUTLINE

SMP 3850

Test Title:

Audio Insertion Loss

Subsystem:

Communications

Test Objective:

To establish the insertion loss which will be incurred in the Vehicle and GSE Lines.

Vehicle Configuration:

Ascent

Location:

Plant #5 Final Assembly - Integrated Work Stand

Hazardous Operations:

Not Applicable

Components Under Test:

Microphone and Headset Lines including GSE

Test Description:

Seq. 01: Vehicle and GSE Insertion Loss of Microphone Lines.

Seq. 02: Vehicle and GSE Insertion Loss of Headset Lines.

Seq. 03: GSE Insertion Loss Microphone Lines.

Seq. 04: GSE Insertion Loss Headset Lines.

Seq. 05 Securing after Test.

- a. Computation of Sequence 01, 02, 03, and 04 to obtain Vehicle Insertion Loss of both Microphones and Headset Lines.



SMP OUTLINE

SMP 3851

Test Title:

In-flight Antenna and Coupler Insertion Loss Verification

Subsystem:

Communications

Test Objectives:

- a. To establish and record the insertion loss of the In-flight Antennas while mounted in their Antenna Coupler Hats.
- b. To establish and record the insertion loss of the GSE Attenuators in their test configuration.
- c. To record insertion loss and S/N's of each configuration to be used in OCP 61015 testing.

Vehicle Configuration:

Not Applicable

Location:

Plant No. 5 1st Mezz.

Hazardous Operations:

Not Applicable

Components Under Test:

LSC 380-21002 VHF In-flight Antenna  
LSC 380-28004 A-Band In-flight Antenna

Test Description:

- Seq. 01: Insertion Loss A-Band  
Seq. 02: Insertion Loss VHF

SMP OUTLINE

SMP 3913

Test Title:

Ascent Stage Power Verification

Subsystems:

Electrical Power

Test Objectives:

Verify the integrity of the Ascent EPS Subsystem Buses

Vehicle Configuration:

Ascent Stage

Location:

Plant #5 Final Assembly

Hazardous Operations:

Not Applicable

Components Under Test:

Panel 11  
Panel 14 and 16  
Vehicle Wiring

Test Description:

- Seq. 01: Call to Stations
- Seq. 02: Bus Isolation and Continuity Verification
- Seq. 03: Connector Voltage Measurements
- Seq. 04: Trans-Lunar Bus Verification
- Seq. 05: Securing after Test

SMP OUTLINE

SMP 3914

Test Title:

Descent EPS Power Checkout

Subsystems:

Electrical Power

Test Objectives:

Verifies the integrity of the Descent Stage  
EPS Main Feeders and Subsystem Buses

Vehicle Configuration:

Mated Stages

Location:

Plant #5 Final Assembly

Hazardous Operations:

Not Applicable

Components Under Test:

Panel 11  
Panels 14 and 16  
Panel 1  
Panel 8  
Descent ECA's No. 1 and 2  
Vehicle Wiring

Test Description:

- Seq. 01: Call to Stations
- Seq. 02: Continuity verification of the Vehicle Descent Stage Buses
- Seq. 03: Load Connector Voltage Verification
- Seq. 04: Comm. TV Voltage Verification
- Seq. 05: Securing after Test

OCP OUTLINE

OCP-GF-26007-IM-5

Test Title:

Descent Stage Substitute Propellant Cold Flow Test

Subsystem:

Descent Propulsion

Test Objectives:

To hydraulically balance the Descent Stage Propellant Feed System. To demonstrate the performance characteristics of the vehicle helium regulators at a pre-determined inlet pressure. (Paragraph 4.2.2.8.3.4)

Vehicle Configuration:

Descent Stage.

Location:

Cold Flow Facility

Hazardous Condition:

Pneumatic Pressures up to 1000 psig.

Equipment Under Test:

Pressurization and Propellant Feed Section.

- a. Pressure reducers (regulators)
- b. Orifice Plates

Test Description:

Seq. 01: Call To Stations

Seq. 02: Substitute Propellant Fill

- a. Fill of fuel and oxidizer tanks with substitute propellants to provide liquid media for flowing through the feed system for orifice sizing.

Seq. 03: Pre-Run Operation Helium Section

- a. Verification of facility gaseous helium status.
- b. Verification of a safe start condition prior to pressurization.

Seq. 04: Pre-Run Preparation of Instrumentation Module

- a. Assurance of instrumentation module bleed in.

## OCP OUTLINE

OCP-GF-26007-IM-5

### Test Description: (Cont)

#### Seq. 05: Pre-Run Fluid System Bleed

- a. Verification of a proper bleed in from the propellant tanks to the engine simulator.
- b. Verification that the oxid and fuel weigh tank catch unit is in a "GO" condition.
- c. Obtaining of initial fuel and oxidizer sight glass readings. (Actual level of propellants in respective tanks).

#### Seq. 06: Test Operations-Flowmeter Calibration

- a. Performance of a flowmeter calibration run during which the substitute propellants are flowed from the vehicle tanks into their respective fuel and oxidizer catch tanks and weighed.
- b. Indication by TC of his choice of continuing in sequential order through Seq. 09 or to perform Seq. 10. The option is to repeat the run from the partially filled tanks.

#### Seq. 07: Post Test Operation

- a. Unloading of weigh catch tank unit. (Return substitute propellants to storage and transfer carts.)

#### Seq. 08: Pre-Run Operations

- a. Bleed of Fluid System refer to Sequence 05.

#### Seq. 09: Test Operations

- a. Calibration of flowmeters. Refer to Sequence 06.

#### Seq. 10: Vent of Pressurization and Propellant Section

- a. Vent of propellant tanks to ambient.
- b. Vent of upstream of solenoid latch valves to ambient.
- c. Final sight glass readings are obtained.
- d. Performance of Post Test calibration procedures.

#### Seq. 11: Post Test Operation

- a. Return of substitute propellants to the storage and transfer carts.

#### Seq. 12: Pre-Run Operations Ambient Helium Propellant Utilization

- a. Load of substitute propellants (ox and fuel).

OCP OUTLINE

OCP-GF-26007-LM-5

Test Description: (Cont)

- Seq. 13: Pre-Run Operations Helium Section refer to Sequence 03.
- Seq. 14: Pre-Run Operation of Preparation of Instrumentation Module
- a. Refer to Sequence 04.
- Seq. 15: Test Operations-Propellant Utilization
- a. Verification of propellant initial levels in their respective tanks.
  - b. Flow of substitute propellants from their tanks through the engine simulator into the storage and transfer carts at a predetermined flow rate.
- Seq. 16: Secure From Test.

OCP OUTLINE

OCP-GF-26008-IM-5

Test Title:

Descent Stage Propellant Feed Section, Dry and Sample

Subsystem:

D/S Propulsion

Test Objective:

Verification of dryness in DPS at the conclusion of Cold Flow Testing

Vehicle Configuration:

Descent Stage

Location:

Cold Flow Facility

Hazardous Operations:

Pneumatic Pressure to 50 PSIG

Components Under Test:

Propellant tanks and lines

Test Description:

Seq. 01: Call to Stations

Seq. 02: First Flush Fluid Fill (low level)

- a. Filling of fuel tank to about 5 inches with freon TF, to float away any water in the bottom of the fuel tank.

Seq. 03: First Flush Fluid Drain

- a. Draining fuel tank of all freon.

Seq. 04: Second Flush Fluid Fill

- a. Filling of fuel tank with freon TF to float away any remaining water.

Seq. 05: Second Flush Fluid Drain

- a. Draining of fuel tank level to 5-7 inches as freon is returned to the storage cart.
- b. Checking of cleanliness by taking samples
- c. Draining and discarding of remaining freon.

## OCP OUTLINE

OCP-GF-26008-IM-5

### Test Description: (Cont)

#### Seq. 06: GN2 Warm Up and Purge

##### a. Drying of the System:

1. Purge the oxid and fuel tanks with warm GN2 for 4 hours at 50 PSIG.

##### b. Checking for DPS dryness after a 15 minute dwell:

1. Samples from the oxidizer and fuel systems will be checked for freon and moisture content.

#### Seq. 07: Simultaneous Purge of Fuel and Oxidizer Systems

- a. Sequence 07 will be performed only in the event that the samples taken in sequence 06 fail. This sequence is essentially a duplicate of sequence 06 pertaining to both the fuel and oxidizer systems.

#### Seq. 08: Repurge of Oxidizer System

- a. This sequence is performed only in the event that the fuel system samples met specifications and one or both oxidizer samples failed. This sequence is essentially a duplicate of sequence 06 pertaining to the oxidizer system.

#### Seq. 09: Repurge of Fuel System

- a. This sequence is performed only in the event that oxidizer system samples met specifications and one or both fuel samples failed. This sequence is essentially a duplicate of sequence 06 pertaining to the fuel system.

#### Seq. 10: System Sampling After 8 Hours

- a. Verification that the freon and/or moisture content does not exceed 200 ppm.
  1. Allow system to dwell 8 hours; at the end of 8 hours take new freon and water samples.
- b. If the samples exceed 200 ppm then repeat sequence 07, 08, or 09 as necessary, then repeat sequence 10.

#### Seq. 11: Securing After Test

- a. Application of GN2 blanket pressure of 10-20 PSIG to fuel and oxidizer tanks through GP9440 and GP9441.  
(Paragraph 4.2.2.8.4.)



## OCP OUTLINE

OCP-GF-26019-LM-5

### Test Title:

Low Pressure Descent Engine Interface Leakage Check

### Subsystems:

D/S Propulsion

### Test Objectives:

- a. To establish the leakage integrity of the D/S engine interfaces at low pressure.
- b. To leak check all mechanical connections and all new brazes not previously leak checked.

### Vehicle Configuration:

Descent Stage

### Location:

LM Final Assembly Area

### Hazardous Operations:

Pneumatic pressures to 50 psig.

### Components Under Test:

D/S Propellant Feed Section Vehicle/Engine Interfaces. Propellant line quick disconnects.

### Test Description:

Seq. 01: Call To Stations

Seq. 02: Low Pressure Leak Check (Paragraph 4.2.2.8.3.6)

- a. Pressurization and venting of the D/S propellant tanks with GHe (3 cycles) to ensure a GHe environment throughout the system.
- b. Pressurization of the D/S propellant tanks and engine feed lines to 50 psig GHe.
- c. Leak check of the D/S engine interfaces and feed lines using a mass spectrometer leak detector.
- d. Leak check of the D/S propellant line quick disconnects using a volumetric leak detection meter (LDM).

OCP OUTLINE

OCP-GF-26019-LM-5

Test Description: (Cont)

- e. Leak check of the D/S engine solenoid vent valves using a mass spectrometer leak detector.
- f. Venting of GHe from propellant tanks.

Seq. 03: GN<sub>2</sub> Blanket Pressure Application

- a. Pressurization and venting of the D/S propellant tanks with GN<sub>2</sub> (3 cycles) to clear them of GHe.
- b. Pressurization of the propellant tanks to 15 psig with GN<sub>2</sub>.

Seq. 04: Securing After Test

## OCP OUTLINE

OCP-GF-26022-LM-5

### Test Title:

Descent Stage Internal Component Leak Checks.

### Subsystem:

D/S Propulsion.

### Test Objectives:

To establish that the leakage integrity of the D/S propulsion subsystem was not degraded during the Cold Flow Tests.

### Vehicle Configuration:

Descent Stage.

### Location:

Cold Flow Facility

### Hazardous Operations:

Pneumatic pressures up to 1000 psig.

### Components Under Test:

Solenoid Valves, Helium regulators, burst disc, lunar dump squib valves and quad check valves.

### Test Description:

Seq. 01: Call to Station

Seq. 02: Substitute Propellant Fill, Fuel (Para. 4.2.2.8.3.4(c))

- a. Fill tank with substitute propellant to reduce pneumatic pressure energy stored in tank during Sequence 04.

Seq. 03: Substitute Propellant Fill, Oxidizer (Para. 4.2.2.8.3.4(c))

Typical to Sequence 02.

Seq. 04: Primary and Secondary Solenoid Valves, Regulator Creep, Propellant Burst Discs, and Lunar Dump Squib Valves Leak Test

Primary and Secondary Solenoid Valves (Para. 4.2.2.8.3.3(d))

- a. Apply an upstream pressure of 950 psig GHe through GQ 9405 with latching valves closed.
- b. Using an LDM at port GQ 9425 collect, for a specific period of time, the quantity of helium leaking past the valves.
- c. Vent high pressure manifold through GQ 9405 to atmosphere.

## OCP OUTLINE

OCP-GF-26022-IM-5

### Test Description: (Cont)

#### Seq. 04-022: Regulator Creep Test (Para. 4.2.2.8.3.3(d), (e))

- a. Apply vacuum on reference ports of primary and secondary regulators.
- b. Pressurize high pressure manifold to 950 psig GHe through port GQ 9405 with latching valves open.
- c. Close primary and secondary latching valves after checking that the regulators have locked up and are maintaining a maximum of 255 psig outlet pressure.
- d. Vent the low pressure manifold through GQ 9425 to 212 psig.
- e. Open primary solenoid valve.
- f. Monitor primary regulator creep by observing for a specified period of time the pressure rise in the low pressure manifold at port GQ 9425.
- g. Repeat above steps for secondary regulator.

#### Seq. 04-066: Fuel and Oxidizer Burst Disc and Lunar Dump Valve Leak Check (Para. 4.2.2.8.3.3(f))

- a. Vent low pressure manifold through GQ 9425 to ambient.
- b. Maintain a pressure of 240 psig downstream of the quad check valves.
- c. Using an LDM at ports GQ 9445 and GQ 9444 collect, for a specified period of time, the quantity of helium leaking past the fuel and oxid burst discs.
- d. Using an LDM at ports GQ 9448 and GQ 9449, respectively, collect, for a specified period of time, the quantity of helium leaking past the lunar dump squib valves.
- e. Vent propellant system to 8-10 psig through GQ 9442 and GQ 9443.

#### Seq. 05: Quad Check Valve Leak Check (Para. 4.2.2.8.3.3(f))

- a. Vent low pressure manifold upstream of check valves through GQ 9425 to atmosphere.

#### Seq. 05-004: Leak Check Downstream Check Valves

- a. With LDM at GQ 9432, collect, for a specified period of time, the quantity of helium leaking past the check valve.
- b. Repeat previous step for GQ 9433, GQ 9430 and GQ 9431.

OCP OUTLINE

OCP-GF-26082-LM-5

Test Description: (Cont)

Seq. 05-020: Leak Check Upstream Check

- a. Pressurize GQ 9431 to 10 psig GHe.
- b. With LDM at GQ 9425, collect, for a specified period of time, the quantity of helium leaking past check valve upstream of GQ 9431.
- c. Repeat similar steps for check valves upstream of GQ 9430, GQ 9432 and GQ 9433.

Seq. 05-043: Leak Check Whole Check Valves Assemblies

- a. Close GQ 9432 and GQ 9433.
- b. With LDM at GQ 9425 collect, for a specified period of time, the quantity of helium leaking past fuel check valve assembly.
- c. Repeat similar steps for oxidizer check valve assembly.

Seq. 06: Substitute Propellant Offloading

- a. Pressurize propellant tanks with GHe through GQ 9404 to 50 psig.
- b. Open GQ 9452 and GQ 9453 to offload propellants.
- c. When propellants are offloaded, close GQ 9452 and GQ 9453.
- d. Close helium supply at GQ 9404.
- e. Vent propellant tanks to 15 psig through GQ 9442 and GQ 9443.

OCP OUTLINE

OCP-GF-26040-LM-5

Test Title:

D/S Propulsion System Verification.

Subsystem:

D/S Propulsion.

Test Objectives:

To verify that the Descent Stage Propulsion System is ready for shipment to Kennedy Space Center by performing functional and pressure integrity tests.

Vehicle Configuration:

Descent Stage.

Location:

Cold Flow Facility.

Hazardous Operations:

High pneumatic pressures.

Equipment Under Test:

- a. Supercritical Helium Tank.
- b. Helium Explosive Valves.
- c. Latching Helium Solenoid Valve.
- d. Helium Regulators.
- e. Quad Check Valves.
- f. Compatibility Squib Valves.
- g. Pressure Relief Valves and Burst Discs.
- h. Engine Pre-Valves.
- i. Engine Ball Valves.
- j. New Brazes.
- k. Mechanical fittings.

Test Description:

Seq. 01: Call to Station

Seq. 02: SHe Tank Purge and Sample

OCP OUTLINE

OCT-GF-26040-IM-5

Test Description: (Cont)

- Seq. 03: SHe Tank Cold Gas Flow, LHe Fill and Cold Soak (Para. 4.2.2.8.3.3)
- Seq. 04: SHe Tank Heat Leak Test (Para. 4.2.2.8.3.3(b))
- Seq. 05: SHe Tank Leak Test, Latching Helium Solenoid Valve Leak Check, and High Pressure Manifold Proof and Leak Check (Para. 4.2.2.8.3.3)
- Seq. 06: Helium Regulator Functional Check and Leak Test (Para. 4.2.2.8.3.3)
- Seq. 07: Leak Check of Braze Bypass Caps, Relief Valve Functional Check, Quad Check Valve Functional and Leakage Check, Engine Ball Valve Leak Check, and Pre-Valve Leak Check, and Thermo Relief Check (Para. 4.2.2.8.3.3, 4.2.2.8.3.7)
- Seq. 08: Engine Ball Valve Leakage Check, using GN<sub>2</sub> (Para. 4.2.2.8.3.7)
- Seq. 09: Quad Check Valve Low Pressure Leakage Test on Factory Floor Only (Para. 4.2.2.8.3.6)
- Seq. 10: Pressure Purge D/S Propulsion and SHe Tank Blanket Pressure (GN<sub>2</sub>) Reapplication (Para. 4.2.2.8.4)

OCP OUTLINE

OCP-GF-26041-IM-5

Test Title:

D/S Propulsion Subsystem Proof Pressure, Leak Check and SHe Tank Heat Leak Test and Mission Simulation Run

Subsystem:

D/S Propulsion

Test Objective:

- a. Verification of Quad Check Valve Leakage Characteristics.
- b. Verification of Structural Integrity of Plumbing Lines and Pressurization Modules at Proof Pressure Levels.
- c. Verification of Structural Integrity of SHe and He Tanks and Associated Lines at Proof Pressure.
- d. Verification of Relief Valve Functional Operation and Structural Integrity at Proof Pressure.
- e. Verification of Brazing Integrity of Propellant System Down to Quad Check Valves by Leak Check
- f. Mission Simulation Performance Utilizing the SHe Tank.

Vehicle Configuration:

Descent Stage

Location:

Cold Flow Facility

Hazardous Operation:

- a. Pneumatic Pressures Up to 2274 PSIG
- b. Liquid Helium Stored at -450°F and at Pressures up to 2274 PSIG

Equipment Under Test:

Quad Check Valves  
Plumbing Lines  
Pressurization Modules  
Relief Valves  
Propellant System  
Check Valves

Test Description:

- Seq. 01: Call To Station  
Seq. 02: Quad Check Valve Leak Check (Para. 4.2.2.8.3.3)



OCP OUTLINE

OCP-GF-26041-IM-5

Test Description: (Cont)

- Seq. 03: Substitute Propellant Fill (Fuel Side) (Para. 4.2.2.8.3.4(c))
- Seq. 04: Substitute Propellant Fill (Oxidizer Side) (Para. 4.2.2.8.3.4(c))
- Seq. 05: Proof Pressure and Leak Check of Propellant Feed Section and Low Pressure Helium Manifold, Relief Valve Functional and Lunar Dump Valve Functional Tests. (Paras. 4.2.2.8.3.1, 4.2.2.8.3.2, 4.2.2.8.3.3)
- Seq. 06: Substitute Fuel and Oxidizer Propellant Off Loading (Para. 4.2.2.8.3.4(c))
- Seq. 07: SHe Tank Purge and Sample
- Seq. 08: SHe Tank Cold Gas Flow, LHe Fill and Cold Soak (Para. 4.2.2.8.3.3)
- Seq. 09: SHe Tank LHe Refill
- Seq. 10: Safety Precautions for Emergency SHe Tank Venting
- Seq. 11: High Pressure Manifold Proof and Leak Test and SHe Tank Proof and Leak Test. Ambient Helium Start Tank Proof and Leak Test. (Para. 4.2.2.8.3.1, 4.2.2.8.3.2)
- Seq. 12: LHe Fill and Cold Soak (Para. 4.2.2.8.3)
- Seq. 13: SHe Tank LHe Refill and SHe Pressurization (Para. 4.2.2.8.3.3)
- Seq. 14: SHe Tank Heat Leak Test (Para. 4.2.2.8.3.4)
- Seq. 15: Mission Simulation Profile Run (Para. 4.2.2.8.3.5)
- Seq. 16: Securing After Test Vent Procedure
- Seq. 17: Substitute Fuel Propellant Off Loading
- Seq. 18: SHe Tank Venting (To be done only if required.)
- Seq. 19: Securing SHe Tank (To be done only if required.)
- Seq. 20: Securing After Test (To be done only if required.)

## OCP OUTLINE

OCP-GF-27005-LM5

### Test Title:

Ascent Stage Substitute Propellant Cold Flow Test.

### Subsystem:

Ascent Stage Propulsion.

### Test Objectives:

To hydraulically balance the ascent stage propellant feed system.

To demonstrate the performance characteristics of the pressurization and propellant feed system with the four pressure regulators operating individually and in combination.

To demonstrate the performance characteristics of the pressure regulators under decaying inlet pressure and low temperature conditions, and to demonstrate the performance characteristics of the solenoid latching valves at low temperature.

### Vehicle Configuration:

Ascent stage.

### Location:

Cold Flow Facility.

### Hazardous Operations:

Pneumatic pressures up to 3500 psig.

### Components Under Test:

Set of matched orifices in the fuel and oxidizer feed lines.  
Pressure reducers (regulators).  
Solenoid latching valves.

### Test Description:

(Para. 4.2.2.8.2.4.)

Seq. 01: Call to Stations.

Seq. 02: Substitute Propellant Fill, Fuel.

- a. Filling of fuel tank with substitute propellant (water) to reduce pneumatic energy stored in tank.

Seq. 03: Substitute Propellant Fill, Oxidizer.

- a. Filling of oxidizer tank with substitute propellant (freon) to reduce pneumatic energy stored in tank.

## OCP OUTLINE

OCP-GF-27005-LM5

### Test Description: (Cont)

#### Seq. 04: Helium Pressurization Preparation.

- a. Seq. 04-002: Check of helium storage to ascertain that it is at 4500 psig minimum.
- b. Seq. 04-004: Setting of pneumatic control station into start-safe condition.
- c. Seq. 04-005: Setting of ascent stage control station into 'GO' condition.

#### Seq. 05: Preparation of Instrumentation Module.

- a. Seq. 05-002: Application of vacuum to reference port of one helium regulator.
- b. Seq. 05-006: Isolation of instrumentation module from vehicle.
- c. Seq. 05-012: Purge of instrumentation module of fluid.
- d. Seq. 05-015: Recordation of ambient and pressurized zero readings of the delta P transducers on instrumentation module.
- e. Seq. 05-031: Bleed of the fluid lines after opening of the instrumentation module to vehicle propellants.
- f. Seq. 05-044: Recordation of ambient bled-in zeros with instrumentation module in 'isolate mode' and 'test mode'.
- g. Seq. 05-046: Recordation of fluid level in propellant tanks.

#### Seq. 06: Test Operation (Flowmeter Calibration).

- a. Seq. 06-002: Setting of fuel and oxidizer Weigh Tank Calibration Units (WTCU) to receive substitute propellants flowing through the propulsion system.
- b. Seq. 06-005: Verification of facility valves configuration to route substitute propellants to WTCU's.
- c. Seq. 06-011: Pressurization of ullage in propellant tanks.
- d. Seq. 06-014: Recordation of pre-run pressurized bled-in zeros with instrumentation module in 'test mode' and 'isolate mode'.
- e. Seq. 06-026: Flow of substitute propellants through Engine Simulator Unit (ESU) to WTCU's as follows:
  - 1. Turn on of all instrumentation recorders.
  - 2. Start of flow.

OCP OUTLINE

OCP-GF-27005-LM5

Test Description: (Cont)

3. Adjustment of flow to 33 GPM.
4. Set of instrumentation module in 'test mode'.
5. When fuel WTCU collected 2000 lbs of fuel approximately, set of instrumentation module to 'isolate mode' and termination of flow.
- f. Seq. 06-028: Recordation of post-run pressurized bled-in zeros with instrumentation module in 'test mode' and 'isolate mode'.

Seq. 07: Vent and Pressurization of Propellant Section.

- a. Seq. 07-002: Closing of 'He Pri Shutoff' and 'He Sec Shutoff' valves.
- b. Seq. 07-003: Venting of cell pressurization system to ambient.
- c. Seq. 07-005: Depressurization of propellant tanks to 10-20 psig.
- d. Seq. 07-009: Isolation of instrumentation module from vehicle.
- e. Seq. 07-013: Purge of instrumentation module of fluid.
- f. Seq. 07-018: Recordation of ambient zero readings of the delta P transducers on instrumentation module.
- g. Seq. 07-028: Recordation of fluid level in the propellant tanks.
- h. Seq. 07-031: Turn off of all instrumentation recorders.

Seq. 08: Post Run Operations.

- a. Seq. 08-003: Recordation of post run weight pressure and fluid level of the WTCU's.
- b. Seq. 08-005: Configuration of the WTCU's and facility valves to enable the return of the substitute propellants to the storage carts.
- c. Seq. 08-008: Return of the substitute propellants from WTCU's to the fuel and oxidizer storage carts.

Seq. 09: Substitute Propellant Fill, Fuel.

Typical to Sequence 02.

Seq. 10: Substitute Propellant Fill, Oxidizer.

Typical to Sequence 03.

Seq. 11: Helium Pressurization Preparation.

Typical to Sequence 04.

OCP OUTLINE

OCP-GF-27005-LM5

Test Description: (Cont)

Seq. 12: Preparation of Instrumentation Module.

Typical to Sequence 05.

Seq. 13: Test Operations (Propellant Utilization).

- a. Seq. 13-002: Configuration of the facility valves to route substitute propellants from vehicle to the fuel and oxidizer storage carts.
- b. Seq. 13-007: Pressurization of the ullage of the propellant tanks.
- c. Seq. 13-011: Recordation of pre-run pressurized bled-in zeros with instrumentation module in 'test mode' and 'isolate mode'.
- d. Seq. 13-015: Flowing of substitute propellants from vehicle through ESU to the fuel and oxidizer storage carts as follows:
  1. Turn on of all instrumentation recorders.
  2. Start of flow.
  3. Adjustment of flow to 33 GPM.
  4. Setting of instrumentation module in 'test mode'.
  5. 120 seconds from initiation of flow, setting of instrumentation module in 'isolate mode' and terminate flow.
- e. Seq. 13-016: Recordation of post run pressurized bled-in zeros with instrumentation module in 'test mode' and 'isolate mode'.
- f. Seq. 13-021: Isolation of vehicle from pressurization system.
- g. Seq. 13-023: Partial depressurization of vehicle.
- h. Seq. 13-025: Switch of vacuum to the reference port of an alternate helium regulator.
- i. Seq. 13-028: Repressurization of ullage of propellant tanks.
- j. Repeat steps (c), (d), and (e).
- k. Repeat steps (f) through (j).

Seq. 14: Vent and Pressurization of Propellant Section.

Typical to Sequence 07.

Seq. 15: Substitute Propellant Fill, Fuel.

Typical to Sequence 02.

OCP OUTLINE

OCP-GF-27005-LM5

Test Description: (Cont)

- Seq. 16: Substitute Propellant Fill, Oxidizer.  
Typical to Sequence 03.
- Seq. 17: Helium Pressurization Preparation.  
Typical to Sequence 04.
- Seq. 18: Preparation of Instrumentation Module.  
Typical to Sequence 05.
- Seq. 19: Test Operations (Propellant Utilization).  
Typical to Sequence 13.
- Seq. 20: Vent and Pressurization of Propellant Section.  
Typical to Sequence 07.
- Seq. 21: Substitute Propellant Fill, Fuel.  
Typical to Sequence 02.
- Seq. 22: Substitute Propellant Fill, Oxidizer.  
Typical to Sequence 03.
- Seq. 23: Helium Pressurization Preparation.  
Typical to Sequence 04.
- Seq. 24: Preparation of Instrumentation Module.  
Typical to Sequence 05.
- Seq. 25: Test Operations (Propellant Utilization).  
Typical to Sequence 13.
- Seq. 26: Vent and Pressurization of Propellant Section.  
Typical to Sequence 07.
- Seq. 27: Substitute Propellant Fill, Fuel.  
Typical to Sequence 02.
- Seq. 28: Substitute Propellant Fill, Oxidizer.  
Typical to Sequence 03.

OCP OUTLINE

OCP-GF-27005-LM5

Test Description: (Cont)

Seq. 29: Helium Pressurization Preparation.

Typical to Sequence 04.

Seq. 30: Preparation of Instrumentation Module.

Typical to Sequence 05.

Seq. 31: Test Operations (Propellant Utilization).

Typical to Sequence 13.

Seq. 32: Vent and Pressurization of Propellant Section.

Typical to Sequence 07.

Seq. 33: Substitute Propellant Fill, Fuel.

Typical to Sequence 02.

Seq. 34: Substitute Propellant Fill, Oxidizer.

Typical to Sequence 03.

Seq. 35: Helium Pressurization Preparation.

- a. Sequence 35-002: Assure helium storage is at 4500 psig minimum.
- b. Seq. 35-004: Set of pneumatic control station to start-safe condition.
- c. Seq. 35-005: Set of ascent stage control station to 'GO' condition.
- d. Seq. 35-006: Interconnection of one helium tank with the high pressure manifold and the pressurization system.

Seq. 36: Preparation of Instrumentation Module.

Typical to Sequence 05.

Seq. 37: Test Operations (Blowdown).

- a. Seq. 37-002: Verification that facility valves are configured to route substitute propellants from vehicle to the fuel and oxidizer storage carts.
- b. Seq. 37-007: Pressurization of ullage of the propellant tanks and one helium tank to regulator lockup pressure (203 psia maximum).
- c. Seq. 37-009: Closing of 'He Pri Shutoff' and 'He Sec Shutoff' valves.

## OCP OUTLINE

OCP-GF-27005-LM5

### Test Description: (Cont)

- d. Seq. 37-010: Continuation of pressurization of the helium tank until approximately six pounds (mass) of helium are contained within the tank.
  - e. Seq. 37-012: Isolation of vehicle from facility pressurization system.
  - f. Seq. 37-013: Opening of 'He Pri Shutoff' and 'He Sec Shutoff' valves.
  - g. Seq. 37-017: Recordation of pre-run pressurized bled-in zeros with instrumentation module in 'test mode' and 'isolate mode'.
  - h. Seq. 37-020: Flow of substitute propellants from vehicle through ESU to the fuel and oxidizer storage carts as follows:
    - 1. Turn on of all instrumentation recorders.
    - 2. Start of flow.
    - 3. Adjusting of flow to 34.5 GPM.
    - 4. Set of instrumentat\_on module into 'test mode'.
    - 5. 360 to 390 seconds from initiation of flow set of instrumentation module into 'isolate mode' and terminate flow by closing of 'He Pri Shutoff' and 'He Sec Shutoff' valves, followed by switching of 'Fuel Shutoff' and 'Oxid Shutoff' to 'ALL CLOSED' position.
  - i. Seq. 37-021: Recordation of post-run pressurized bled-in zeros with instrumentation module in 'test mode' and 'isolate mode'.
- Seq. 38: Vent and Pressurization of Propellant Section and Helium Tank.
- a. Seq. 38-003: Verification that 'He Pri Shutoff' and 'He Sec Shutoff' valves are closed.
  - b. Seq. 38-004: Depressurization of helium tank to 10-30 psig.
  - c. Seq. 38-005B: Depressurization of propellant tanks to 10-20 psig.
  - d. Seq. 38-005D: Isolation of instrumentation module from vehicle.
  - e. Seq. 38-009: Purge of instrumentation module of fluid.
  - f. Seq. 38-022: Recordation of ambient zero readings of the delta P transducers on instrumentation module.



OCP OUTLINE

OCP-GF-27005-LM5

Test Description: (Cont)

- g. Seq. 38-024: Recordation of fluid level in the propellant tanks.
- h. Seq. 38-027: Turn off of all instrumentation recorders.

OCP OUTLINE

OCP-GF-2700-IM-5

Test Title:

Ascent Stage Propellant Feed Section - Dry and Sample.

Subsystem:

A/S Propulsion

Test Objective:

Verification of dryness in the APS at the conclusion of Cold Flow Testing.

Vehicle Configuration:

Ascent Stage

Location:

Cold Flow Facility

Hazardous Operations:

Pneumatic pressure to 50 psig.

Components Under Test:

Propellant tanks and lines.

Test Description:

Seq. 01: Call to Stations

Seq. 02: First Flush Fluid Fill (low level)

- a. Filling of fuel tank to about 5 inches with freon TF, to float away any water in the bottom of the fuel tank.

Seq. 03: First Flush Fluid Drain

- a. Draining fuel tank of all freon.

Seq. 04: Second Flush Fluid Fill.

- a. Filling of fuel tank with freon TF to float away any remaining water.

Seq. 05: Second Flush Fluid Drain.

- a. Draining of fuel tank level to 5-7 inches as freon is returned to the storage cart.
- b. Checking of cleanliness by taking samples.
- c. Draining and discarding of remaining freon.

OCP OUTLINE

OCP-GF-27006-IM-5

Test Description: (Cont)

Seq. 06: GN2 Warm Up and Purge.

a. Drying of the system:

1. Purge the oxid and fuel tanks with warm GN2 for 4 hours at 50 PSIG.

b. Checking for APS Dryness after a 15 minute dwell:

1. Samples from the oxidizer and fuel systems will be checked for freon and moisture content.

Seq. 07: Simultaneous Purge of Fuel and Oxidizer Systems.

- a. Sequence 07 will be performed only in the event that the samples taken in Sequence 06 fail. This sequence is essentially a duplicate of Sequence 06 pertaining to both the fuel and oxidizer systems.

Seq. 08: Repurge of Oxidizer System

- a. This sequence is performed only in the event that the fuel system samples met specifications and one or both oxidizer samples failed. This sequence is essentially a duplicate of Sequence 06 pertaining to the oxidizer system.

Seq. 09: Repurge of Fuel System

- a. This sequence is performed only in the event that oxidizer system samples met specifications and one or both fuel samples failed. This sequence is essentially a duplicate of sequence 06 pertaining to the fuel system.

Seq. 10: System Sampling After 8 Hours

- a. Verification that the freon and/or moisture content does not exceed 200 ppm.
1. Allow system to dwell 8 hours. At the end of 8 hours take new freon and water samples.
- b. If the samples exceed 200 ppm then repeat sequence 07, 08, or 09 as necessary, then repeat sequence 10.

Seq. 11: Securing After Test

- a. Application of GN2 blanket pressure of 10-20 psig to fuel and oxidizer tanks through GP9440 and GP9441. (Para. 4.2.2.8.4.)

## OCP OUTLINE

OCP-GF-27012-LM5

### Test Title:

Low Pressure Ascent Engine Interface Leakage Check.

### Subsystem:

Ascent Stage Propulsion.

### Test Objectives:

To establish the leakage integrity of the ascent stage engine interfaces at low pressure.

### Vehicle Configuration:

Ascent stage.

### Location:

LM Final Assembly Area.

### Hazardous Operations:

Pneumatic pressures up to 50 psig.

### Components Under Test:

A/S propellant feed section vehicle/engine interfaces. Propellant line quick disconnects.

### Test Description:

Seq. 01: Call to Stations.

Seq. 02: Ascent Engine Interface Leak Check of Oxidizer Propellant Lines.

- a. Pressurization of the oxidizer propellant feed section with GHe to 50 psig.
- b. Seq. 02-014: Leak check of all new braze joints and mechanical connections in the oxidizer propellant feed section. (Para. 4.2.2.8.2.5)

Seq. 03: Ascent Engine Interface Leak Check of Fuel Propellant Lines.

- a. Pressurization of the fuel propellant feed section with GHe to 50 psig.
- b. Seq. 03-017: Leak check of all new braze joints and mechanical connections in the fuel propellant feed section. (Para. 4.2.2.8.2.5)

OCP OUTLINE

OCP-GF-27012-LM5

Test Description: (Cont)

- c. Seq. 03-047: Leak check of all new joints and mechanical connections in the overboard vent line (Para. 4.2.2.8.2.5)

Seq. 04: Securing After Test.

OCP OUTLINE

OCP-GF-27014-IM-5

Test Title:

Ascent Stage Propulsion Subsystem Dry Leak Check.

Subsystem:

A/S Propulsion

Test Objectives:

Establishment of leakage integrity of the A/S Propellant Pressurization and Feed Subsystem Components.

Vehicle Configuration:

Ascent Stage

Location:

Cold Flow Facility

Hazardous Operations:

Pneumatic Pressures up to 1000 psig

Components Under Test:

Low Pressure Manifold  
Fuel and Oxidizer Propellant Tanks  
Propellant Pressurization and Feed Lines  
APS/RCS Interconnect Valves  
Harness Check of Transducers GPO018P, GPO025P, GPO501P, GP1001P, GPO718T, and GP1218T.

Test Description:

Seq. 01: Call To Stations

Seq. 02: Ascent Stage Low Pressure Manifolds, Propellant Feed Section and RCS Interconnect Valve Leak Test. Partial APS Harness Check

- a. External leak check at 175-190 psig of pressurization and propellant section downstream of the pressure regulators. (Para. 4.2.2.8.2.2. (b) (4).)
- b. APS/RCS Interconnect Valves Internal Leakage Test (Para. 4.2.2.7.6(g))
- c. Partial APS Transducer Harness Check. (Para. 4.2.2.12.3.1)

Seq. 03: Securing After Test

OCP OUTLINE

OCP-GF-27015-LM-5

Test Title:

Ascent Stage Internal Component Leak Checks

Subsystems:

A/S Propulsion

Test Objectives:

Establishment of Leakage Integrity of the A/S Propulsion Subsystems Components.

Vehicle Configuration:

A/S Stage

Location:

Cold Flow Facility

Hazardous Operations:

Pneumatic Pressures Up to 3500 psig.

Components Under Test:

He Solenoid Shut Off Valves.  
Pressure Reducing Valves (Regulator)  
Burst Discs  
Quad Check Valves  
Propellant Low Level Sensors

Test Description:

Seq. 01: Call To Station

Seq. 02: Substitute Propellant Fill, Fuel

- a. Filling of fuel tank with substitute propellant (water) to reduce pneumatic energy stored in tank.

Seq. 03: Substitute Propellant Fill, Oxidizer

- a. Filling of oxidizer tank with substitute propellant (freon).

Seq. 04: Helium Solenoid Latching Valve Leak Check

- a. Leak Check of Primary and Secondary Solenoid Latching Valves.
  - 1. Pressurization of primary and secondary solenoid latching valves with GHe to 3500 psig.
  - 2. Seq. 04-017: Leak check of primary and secondary solenoid latching valves (Para. 4.2.2.8.2.3.(b)).

OCP OUTLINE

OCP-GF-27015-LM

Test Description: (Cont)

Seq. 05: Regulator Creep Test (Paragraph 4.2.2.8.2.3 (b))

- a. Regulator Creep Test, Class 1 secondary.
  - 1. Pressurization of Propellant Tanks with GHe
  - 2. Pressurization of High Pressure Manifold with GHe.
  - 3. Flow of GHe through Class 1 regulator then lockup.
  - 4. Seq. 05-031: Creep Test of Class 1 secondary regulator.
- b. Regulator Creep Test, Class 1 Primary
  - 1. Flow of GHe through Class 1 regulator then lockup.
  - 2. Seq. 05-041. Creep Test of Class 1 primary regulator.
- c. Regulator Creep Test, Class 2 Secondary
  - 1. Flow of GHe through Class 2 secondary regulator then lockup.
  - 2. Seq. 05-050. Creep Test of Class 2 secondary regulator.
- d. Regulator Creep Test, Class 2 Primary
  - 1. Flow of GHe through Class 2 primary regulator then lockup.
  - 2. Seq. 05-059. Creep Test of Class 2 primary regulator.

Seq. 06: Relief Valve Burst Disc Leak Check

- a. With Propellant Tanks pressurized to operating pressure leak check of fuel and oxidizer burst discs. (Para. 4.2.2.8.2.3 (f))
  - 1. Seq. 06-006: Leak check of fuel burst disc.
  - 2. Seq. 06-011: Leak check of oxidizer burst disc.

Seq. 07: Quad Check Valve Low Pressure Internal Leak Check.  
(Para. 4.2.2.8.2.3. (e))

- a. Leak check of downstream fuel check valves.
  - 1. Venting of low pressure manifold.
  - 2. Seq. 07-004 and 07-006: Leak check of fuel downstream check valves.



OCP OUTLINE

OCP-GF-27015-IM-5

Test Description: (Cont)

- b. Seq. 07-010 and 07-013. Leak check of downstream oxidizer check valves.
- c. Leak check of upstream oxidizer check valves.
  - 1. Pressurization of downstream side of upstream check valves to 8-10 psig.
  - 2. Seq. 07-025 and 07-030: Leak check of upstream check valves, oxidizer side.
- d. Seq. 07-035 and 07-040: Leak check of upstream check valve, fuel side.
- e. Seq. 07-045 and Seq. 07-049: Leak check of total check valve assembly.

Seq. 08: Securing After Test and Low Level Sensor Check

- a. Pressurization of Propellant Tanks to 50 psig.
- b. Verification of low level sensors on fuel and oxidizer tanks.  
(Paragraph 4.2.2.8.2.3. (j))
- c. Drain fuel and oxidizer tanks of propellant.

OCP OUTLINE

OCP-GF-27020-IM5

Test Title:

Ascent Engine Functional and Gaseous Blowdown Check.

Subsystem:

Ascent Stage Propulsion.

Test Objectives:

Verification of the Functional Operation and Pressure Integrity of the Ascent Stage Engine.

Vehicle Configuration:

Ascent Stage.

Location:

LM Final Assembly Area.

Hazardous Operations:

Pneumatic pressures up to 190 psig.  
Gaseous blowdown of the feed section and engine.

Components Under Test:

Engine solenoid valves.  
Engine pre-valves.  
Engine fuel actuators.  
Engine isolation and bi-propellant valves.  
Thrust chamber pressure transducer.  
Fuel pressure transducer, isolation valve inlet.  
Oxidizer pressure transducer, isolation valve inlet.  
Isolation/bipropellant valve mismatch.

Test Description:

Seq. 01: Call to Stations.

Seq. 02: Support System and Vehicle Status Verification.

- a. Functional verification of ACE, heat transport section, electrical power section and instrumentation.

Seq. 03: Engine Solenoid Valve Leakage Check and Pre-Valve Thermal Relief Check.

- a. Leak check of the four engine solenoid valves.
  - 1. Pressurization of the fuel line between the pre-valves and the engine solenoid valves with GN<sub>2</sub> to 190 psig.

## OCP OUTLINE

OCP-GF-27020-LM5

### Test Description: (Cont)

2. Seq. 03-010: Leak check of the isolation solenoid valve 'A'.  
(Paragraph 4.2.2.8.2.6(d))
  3. Seq. 03-014: Leak check of the bi-propellant solenoid valve 'A'.  
(Paragraph 4.2.2.8.2.6(d))
  4. Seq. 03-018: Leak check of the isolation solenoid valve 'B'.  
(Paragraph 4.2.2.8.2.6(d))
  5. Seq. 03-021: Leak check of the bi-propellant solenoid valve 'B'.  
(Paragraph 4.2.2.8.2.6(d))
- b. Prevalve thermal relief check.
1. Seq. 03-026: Pressurization of the fuel line with GN<sub>2</sub> until the prevalve relieve. (Paragraph 4.2.2.8.2.6(c))
- Seq. 04: Engine Fuel Actuator Functional Checks.
- a. Determination of the start-to-open and full-open pressures required to activate the isolation and propellant valves and verification of the operation of the valve position indication switches.  
(Paragraph 4.2.2.8.2.5(e))
- Seq. 05: Engine Prevalve and Engine Solenoid Valves Functional Checkout.
- a. Activation of the prevalves and engine solenoid valves from the IM cabin controls.
    1. Seq. 05-010: Operation of the valves from the IM cabin controls.  
(Paragraph 4.2.2.8.2.5(e))
- Seq. 06: Prevalve Leak Test and Gaseous Blowdown.
- a. Leak test of the prevalves.
    1. Pressurization of the propellant tanks with GN<sub>2</sub>.
    2. Seq. 06-008: Leak check of the prevalves.  
(Paragraph 4.2.2.8.2.6(d))
  - b. Gaseous blowdown through leg 'B' of the propellant feed section.
    1. Seq. 06-015: Gaseous blowdown through leg 'B' of the propellant feed system. (Paragraph 4.2.2.8.2.5(d)).
  - c. Gaseous blowdown through leg 'A' of the propellant feed section.
    1. Pressurization of the propellant tanks with GN<sub>2</sub>.
    2. Seq. 06-029: Gaseous blowdown through leg 'A' of the propellant feed system. (Paragraph 4.2.2.8.2.5(d))

O.P. OUTLINE

OCP-GF-27020-LM5

Test Description: (Cont)

Seq. 07: Ascent Engine Ball Valve and Shaft Seal Leakage and Checkout of Thrust Chamber Pressure Transducer.

- a. Thrust chamber pressure transducer functional.
  - 1. Pressurization of the propellant tanks with GN<sub>2</sub>.
  - 2. Pressurization of the thrust chamber with GN<sub>2</sub>.
  - 3. Seq. 07-010: ACE-S/C verification of the thrust chamber pressure transducer indication. (Paragraph 4.2.2.8.2.6)
- b. Seq. 07-018: Gross fuel shaft seal leakage check and leakage check of isolation valves A and B actuator. (Paragraph 4.2.2.8.2.6)
- c. Seq. 07-020: Leakage check of fuel and oxidizer propellant valves A and B. (Paragraph 4.2.2.8.2.6)
- d. Seq. 07-022: Leakage check of oxidizer shaft seal. (Paragraph 4.2.2.8.2.6)
- e. Seq. 07-025: Leakage check of oxidizer propellant valves A and B. (Paragraph 4.2.2.8.2.6)
- f. Seq. 07-027: Leakage check of fuel propellant valves A and B. (Paragraph 4.2.2.8.2.6)
- g. Seq. 07-028: Leakage check of isolation valves A and B actuators. (Paragraph 4.2.2.8.2.6)
- h. Seq. 07-031: Leakage check of isolation valve B actuator. (Paragraph 4.2.2.8.2.6)
- i. Seq. 07-033: Check of isolation valve A actuator leak rate and gross fuel shaft seal leak rate. (Paragraph 4.2.2.8.2.6)
- j. Seq. 07-040: Leakage check of propellant valves A and B actuators and isolation valves A and B. (Paragraph 4.2.2.8.2.6)
- k. Seq. 07-042: Leakage check of fuel and oxidizer isolation valves A and B. (Paragraph 4.2.2.8.2.6)
- l. Seq. 07-044: Leakage check of isolation valves A and B oxidizer shaft seal. (Paragraph 4.2.2.8.2.6)
- m. Seq. 07-046: Leakage check of propellant valves A and B oxidizer shaft seal.
- n. Seq. 07-048: Leakage check of isolation valves A and B oxidizer. (Paragraph 4.2.2.8.2.6)

OCP OUTLINE

OCP-GF-27020-LM5

Test Description: (Cont)

- o. Seq. 07-050: Leakage rate of isolation valves A and B fuel.  
(Paragraph 4.2.2.8.2.6)
  - p. Seq. 07-051: Leakage check of propellant valves A and B actuators.  
(Paragraph 4.2.2.8.2.6)
  - q. Seq. 07-054: Leakage check of propellant valve B actuator.  
(Paragraph 4.2.2.8.2.6)
  - r. Seq. 07-056: Leakage check of propellant valve A actuator.  
(Paragraph 4.2.2.8.2.6)
  - s. Seq. 07-059, 07-060: Venting of propellant tanks to 15 psig.
- Seq. 08: Securing After Test.

## OCP OUTLINE

OCP-GF-27027-LM-5

### Test Title:

A/S Pressurization and Propellant Feed Sections Proof, Leak and Functional

### Subsystem:

A/S Propulsion

### Test Objectives:

- a. Verification of the structural integrity of the A/S Pressurization Section, A/S Propellant Feed Section when subjected to proof pressure.
- b. Verification of the regulator lock-up capability.
- c. Verification of the relief valve functional operation.
- d. Verification that the internal leakage across regulators, explosive valves, quad check valves, relief valves and relief valve burst discs is within allowable limits.
- e. Verification that the external leakage in the pressurization section of the propulsion subsystem above the quad check valves are within allowable limits at full operating pressure.
- f. Verification of the responses of subsystem instrumentation at ambient and other conditions.

### Vehicle Configuration:

Ascent Stage

### Location:

Cold Flow Facility, Plt. 5

### Hazardous Operation:

High Pressure Gas

### Equipment Under Test:

Tank He, Ascent Prop. No. 1 and 2.  
Tank Assy, Prop. A/S - Fuel & Oxid.  
Helium Explosive Valves, Quad check  
Valves, Relief Valves, Burst discs, regulator

### Test Description:

Seq. 01: Call To Station

Seq. 02: Proof Pressurization of Helium Tanks (Para. 4.2.2.8.2.1)

OCP OUTLINE

OCP-GF-27027-IM-5

Test Description: (Cont)

- Seq. 03: Leak Check of Helium Tank Explosive Valve at Operating Pressure
- Seq. 04: Installing Blanket Press on A/S He Tanks
- Seq. 05: Substitute Propellant Fill Procedure Fuel Tank
- Seq. 06: Substitute Propellant Fill Procedure Oxidizer Tank
- Seq. 07: Proof Pressure of High and Low Pressure Helium Manifolds and Propellant Feed Sections, Relief Valve Functional Test
- Seq. 09: Pressurization Section External Leak Check and Internal Leakage Check of Solenoid Latching Valve
- Seq. 10: Relief Valve Burst Disc and Quad Check Valve Leak Check
- Seq. 11: Dumping of Oxidizer Tank and Refill with Freon

OCP OUTLINE

OCP-GF-27028-IM-5

Test Title:

Ascent Stage Propulsion System Verification.

Subsystem:

A/S Propulsion.

Test Objectives:

Verification of component function and system pressure integrity.

Vehicle Configuration:

Ascent Stage.

Location:

Cold Flow Facility.

Hazardous Operations:

Pneumatic pressures up to 4025 psig.

Equipment Under Test:

- a. Helium Explosive Valves.
- b. Solenoid Latching Valves.
- c. Pressure Regulators.
- d. Quad Check Valves.
- e. Compatibility Explosive Valves.
- f. Pressure Relief Valves.
- g. Burst Discs
- h. Engine Pre-Valves.
- i. Engine Ball Valves, Actuators and Seals.
- j. All new brazes.
- k. All mechanical joints.
- l. Quick Disconnects



## OCP OUTLINE

OCP-GF-27028-IM-5

### Test Description:

- Seq. 01: Call to Station (Plant 5 Final Assembly Area)
- Seq. 02: Quad Check Valve Low Pressure Leakage Test, Low Pressure Manifold External Leak Check and Cumulative Leak Check of Q. D.'s. During this sequence the internal leakage of each poppet assembly of the check valve and the gross leakage of each quad check valve assembly is determined. A leak check of the helium low pressure manifold is also performed.
- a. Pressurize fuel side of propellant feed system to 8-10 psig He through port GP9441.
  - b. Vent fuel downstream poppet assemblies to ambient through port GP9432 and GP9433.
  - c. Vent low pressure manifold to ambient through port GP9425.
  - d. With LDM at port GP9432, collect, for a specified period of time the quantity of helium leaking past the GP9432 downstream poppet assembly. (Para. 4.2.2.8.2.3)
  - e. Repeat preceding step at port GP9433 for the GP9433 downstream poppet assembly. (Para. 4.2.2.8.2.3).
  - f. Close ports GP9432 and GP9433.
  - g. With LDM at port GP9425, collect, for a specified period of time, the quantity of helium leaking past the fuel quad check valve assembly. (Para. 4.2.2.8.2.3)
  - h. Pressurize port GP9433 to 8-10 psig He.
  - i. Vent the GP9432 downstream and upstream poppet assembly through port GP9432.
  - j. With LDM at port GP9425, collect for a specified period of time, the quantity of helium leaking past the GP9433 upstream poppet assembly.
  - k. Pressurize port GP9432 to 8-10 psig He.
  - l. Vent the GP9433 upstream and downstream poppet assembly through port GP9433.
  - m. Repeat step J for the GP9432 upstream poppet assembly.
  - n. Pressurize oxidizer side of propellant feed system to 8-10 psig He through port GP9440.
  - o. Repeat steps similar to b through l for oxidizer side check valves. (Para. 4.2.2.8.2.3.)

## OCP OUTLINE

OCP-GF-27028-IM-5

### Test Description: (Cont)

- p. Verify primary and secondary latch valves open.
- q. Pressurize vehicle through GP9406 to 180-190 psig.
- r. Using LDM and QD Leak Check Adapters collect, for a specified period of time, the helium leaking past the following QD's.  
(Para. 4.2.2.8.2.2.)  
GP9430  
GP9431  
GP9440  
GP9432  
GP9433  
GP9425  
GP9441
- s. Using a mass spectrometer, check for leakage of all new brazes and all mechanical joints between the helium regulators and the compatibility explosive valves. (Leak check pressure 180-190 psig.)  
(Para. 4.2.2.8.2.2).
- t. Vent vehicle to 5-15 psig through ports GP9440 and GP9441.

Seq. 03: Call to Stations (Cold Flow Facility)

Seq. 04: Regulator Flow Test

During this sequence, the temperature and pressure upstream and downstream of each regulator is determined under flow conditions.

- a. Apply vacuum to reference ports of Class I primary and Class II primary regulators.
- b. Open primary latching solenoid, and close secondary latching solenoid.
- c. Pressurize the high pressure manifold to 3400-3500 psig He through port GP9406.
- d. Open GP9425 and establish flow rate of 1.45 lbs/min minimum for 30 seconds.
- e. Record upstream and downstream pressure and temperature for Class I primary regulator. (Para. 4.2.2.8.2.3.)
- f. Close GP9425 and primary latching valve.
- g. Open secondary latching valve.
- h. Repeat steps d and e above for Class II primary regulator.  
(Para. 4.2.2.8.2.3.)
- i. Close GP9425 and secondary latching valve.

OCP OUTLINE

OCP-GF-27028-IM-5

Test Description: (Cont)

- j. Connect vacuum lines to reference ports of Class I secondary and Class II secondary regulators and disconnect from reference ports of Class I primary and Class II primary regulators.
- k. Pressurize Pri Reg sense ports JP9410 and JP9412 to 50-60 psig He.
- l. Open primary latching valve.
- m. Repeat steps d, e, and f above for Class I secondary regulators. (Para. 4.2.2.8.2.3.)
- n. Close primary latching valve and open secondary latching valve.
- o. Repeat steps d and e above for Class II secondary regulator. (Para. 4.2.2.8.2.3.)
- p. Close GP9425 and open primary and secondary latching valves.
- q. Vent primary regulator sense ports JP9410 and JP9412 to ambient.

Seq. 05: External Leak Check of Helium Pressurization Section

During this sequence the internal leakage of the solenoid latching valves is measured. The high pressure and low pressure manifolds are brought to operating pressures and external leakage of all new brazes and all mechanical joints between the helium explosive valves and the compatibility explosive valves is determined.

- a. Through port GP9406, increase pressure in high pressure manifold to 4000-4025 psig. (1.15 MDOP)
- b. Record high pressure manifold pressure (4000-4025 psig) and low pressure manifold pressure (180-203 psig.)
- c. Vent high pressure manifold through ports GP9440 and GP9441 to 3400-3500 psig.
- d. Repeat step b.
- e. Using LDM and QD leak check adapter collect, for a specified period of time, the helium leaking past QD GP9406.
- f. Using a mass spectrometer check for leakage of all new brazes and all mechanical joints between the helium explosive valves and the compatibility explosive valves. (System pressures: 3400-3500 psig above the regulators and 180-203 psig below the regulators.)
- g. Close primary and secondary solenoid latching valves.
- h. Vent low pressure manifold to ambient through port GP9425, GP9440, and GP9441.

OCP OUTLINE

OCP-GF-27028-IM-5

Test Description: (Cont)

Seq. 05-030: Low Pressure Manifold Proof

- a. Apply vacuum to reference ports of four regulators.
- b. Open primary and secondary latching valves and allow system to come to lockup.
- c. Pressurize low pressure manifold to 240-250 psig through port GP9425. Hold pressure for fifteen (15) seconds maximum.
- d. Vent low pressure manifold to lockup pressure through GP9425.

Seq. 05-036: Cumulative Leak Check of QD's and External Leak Check

- a. Record high pressure manifold and low pressure manifold pressures.
- b. With LDM at port GP9430 collect, for a specified period of time, the quantity of helium leaking past QD GP9430.
- c. Repeat Step b at ports GP9431, GP9440, GP9406, GP9432, GP9433, GP9425 and GP9441 to measure leakage past these QD's.
- d. Using a mass spectrometer check for leakage of all new brazes and all mechanical joints between the helium explosive valves and the compatibility explosive valves. (System pressures: 3400-3500 psig above the regulators and 180-203 psig below the regulators.)
- e. Close primary and secondary solenoid latching valves.
- f. Vent low pressure manifold to ambient through ports GP9425, GP9440, and GP9441.

Seq. 06: Regulator Creep Test

During this sequence the internal leakage (creep) of each regulator is determined.

- a. Apply vacuum to reference port of Class I secondary regulator.
- b. Open primary latching valve (secondary latching valve remains closed).
- c. Pressurize reference port of Class I primary regulator to 50-60 psig He.
- d. Allow pressure and temperature to stabilize then record lockup pressure.
- e. Allow regulator to flow for twenty to thirty seconds through port GP9425, then stop flow at port GP9425.

OCP OUTLINE

OCP-GF-27028-IM-5

Test Description: (Cont)

- f. Allow pressure and temperature to stabilize, then record start time and lockup pressure.
- g. Monitor lockup pressure for twenty minutes, then record end time and final pressure. Verify that leak rate of Class I secondary regulator is within allowable limits. (Paragraph 4.2.2.8.2.3)
- h. Close Primary latching solenoid.
- i. Vent reference port of Class I primary regulator to ambient.
- j. Attach vacuum hose to Class I primary regulator and remove from Class I secondary regulator.
- k. Open primary latching solenoid.
- l. Repeat steps e through h above for Class I primary regulator. (Paragraph 4.2.2.8.2.3)
- m. Attach vacuum hose to Class II secondary regulator and remove from Class I primary regulator.
- n. Pressurize reference port of Class II primary regulator to 50-60 psig He.
- o. Open secondary solenoid latching valve.
- p. Allow regulator to flow for twenty to thirty seconds through port GP9425, then stop flow at port GP9425.
- q. Allow pressure and temperature to stabilize, then record start time lockup pressure.
- r. Monitor lockup pressure for twenty minutes, then record end time and final pressure. Verify that leak rate of Class II secondary regulator is within allowable limits. (Paragraph 4.2.2.8.2.3. (d))
- s. Close secondary solenoid latching valve.
- t. Vent reference port of Class II primary regulator to ambient.
- u. Attach vacuum hose to Class II primary regulator and remove from Class II secondary regulator.
- v. Repeat steps o through r above for Class II primary regulator. (Paragraph 4.2.2.8.2.3 (d))
- w. Vent vehicle to 5-15 psig through ports GP9440 and GP9441.
- x. Close secondary latching valve.

## OCF OUTLINE

OCF-GF-27028-LM-5

### Test Description: (Cont)

#### Seq. 07: Quad Check Valve Flow and Low Pressure Leakage Test

During this sequence the flow and internal leakage of each poppet assembly quad check valve will be determined. The Gross Leakage of each quad check valve assembly will also be determined.

- a. Pressurize port 9425 to 8-10 psig He.
- b. Monitor for a flow of helium past the upstream poppet assembly. Quad check valves at each of the following Q. D.'s, GP9433, GP9432, GP9431, and GP9430.
- c. Close port GP9425.
- d. Pressurize port GP9430 to 8-10 psig He.
- e. Monitor for a flow of helium past the GP9430 downstream poppet valves at Q.D. GP9440.
- f. Pressurize port GP9431 to 8-10 psig He.
- g. Monitor for a flow of helium past the GP9431 downstream poppet valve at Q.D. GP9440.
- h. Pressurize port GP9432 to 8-10 psig He.
- i. Monitor for a flow of helium past the GP9432 downstream poppet valve at Q.D. GP9441.
- j. Pressurize port GP9433 to 8-10 psig He.
- k. Monitor for a flow of helium past the GP9433 downstream poppet valve at Q.D. 9441.
- l. Pressurize fuel side of propellant feed system to 8-10 psig He, through port GP9441.
- m. Vent low pressure manifold to ambient through port GP9425.
- n. With LDM at port GP9432, collect for a specified period of time the quantity of the helium leaking past the GP9432 downstream poppet assembly. (Para. 4.2.2.8.2.3)
- o. Repeat preceding step at port GP9433 for the GP9433 downstream poppet assembly. (Para. 4.2.2.8.2.3.)
- p. Close ports GP9432 and GP9433.
- q. With LDM at port GP9425, collect for a specified period of time, the quantity of helium leaking past the fuel quad check valve assembly. (Para. 4.2.2.8.2.3.)

OCP OUTLINE

OCP-GF-27028-LM-5

Test Description: (Cont)

- r. Pressurize port GP9433 to 8-10 psig He.
- s. Vent the GP9432 downstream and upstream poppet assembly through port GP9432.
- t. With LDM at port GP9425, collect for a specified period of time, the quantity of helium leaking past the GP9433 upstream poppet assembly.
- u. Pressurize port GP9432 to 8-10 psig He.
- v. Vent the GP9433 downstream and upstream poppet assembly through port GP9433.
- w. Repeat step t for the GP9432 upstream poppet assembly.
- x. Pressurize oxidizer side of propellant feed system to 8-10 psig He through port GP9440.
- y. Repeat steps similar to m through w for oxidizer side check valves. (Para. 4.2 2.8.2.3)

Seq. 08: Helium Relief Valve Functional Internal Leak Check of Compatibility Explosive Valves, Engine Pre-valve and Ball Valves, RCS Interconnect Valves, Cumulative Leak Check of QD's and External Leak Check.

The following tests are performed during this sequence:

Application of relief valve cracking pressure to propellant system (245 psig max).

Determination of relief valve cracking and reseal pressures.

Measurement of relief valve and burst disc internal leakages.

Function of relief valve vent valves.

External leak check of all new brazes and all mechanical joints between the compatibility explosive valves and the engine shut off valves.

Internal leak check of the compatibility explosive valves, engine pre-valve, RCS interconnect valves and engine ball valves.

Thermal relief function of engine pre-valve with fuel tank at operating pressure.

- a. Simultaneously pressurize propellant tanks and burst disc cavities to 50-60 psig with He through ports GP9452 and GP9453.
- b. Check vehicle, GSE, and connecting lines for audible leakage.

## OCP OUTLINE

OCP-GF-27028-IM-5

### Test Description: (Cont)

- c. Increase propellant tanks and burst disc cavities pressure to 90-100 psig.
- d. Open propellant ball valve "A" and isolation ball valve "A" by pressurizing GP9471 and GP9473 with 180-190 psig helium.
- e. Verify throat plug seal integrity by monitoring pressure at throat plug port for thirty minutes.
- f. Close propellant ball valve "A" and isolation ball valve "A" by venting to ambient at GP9471 and GP9473.
- g. Simultaneously increase pressure in propellant tanks and burst disc cavities to 190-210 psig.
- h. Simultaneously increase pressure in oxid tank and burst disc cavity until oxid relief valve cracks.
- i. Block pressure to oxid tank and burst disc cavity so oxid relief valve reseats.
- j. Repeat steps f and g above for second cracking and reseat pressure determination. Record valves. (Para. 4.2.2.8.2.3)
- k. Decrease pressure in oxid tank and burst disc cavity to 180-190 psig.
- l. Record oxid tank pressure.
- m. Repeat steps, similar to f through j above, for fuel side of vehicle. (Para. 4.2.2.8.2.3)
- n. Visually inspect fuel and oxid lines, tanks, and fittings for structural damage.

### Relief Valve Internal Leak Check

- a. With LDM at the thrust neutralizer tee, GP9447, collect, for a specified period of time, the quantity of helium leaking past the fuel relief valve. (Paragraph 4.2.2.8.2.3)
- b. Repeat step, similar to preceding step, for oxidizer relief valve.

### External Leak Check Downstream of Burst Discs and Cumulative Leak Check of QD's.

- a. Using mass spectrometer, check all new brazes and all mechanical joints between ports GP9444, and GP9445 and their respective burst disc cavities. (Para. 4.2.2.8.2.3)



## OCP OUTLINE

OCP-GF-27028-IM-5

### Test Description: (Cont)

- b. Using LDM and QD Leak Check Adapters collect, for a specified period of time, the quantity of helium leaking past the following QD's:  
GP9444  
GP9443  
GP9445  
GP9458  
GP9442  
GP9452  
GP9463  
GP9453  
GP9459  
GP9464
- c. Vent oxid and fuel burst disc cavities to ambient through ports GP9444 and GP9445.
- d. Using the mass spectrometer, check for leakage (180-190 psig) of all new brazes and all mechanical joints between the compatibility, explosive valves and engine shutoff valves.

### R.V. Vent Valve Functional

- a. Pressurize fuel burst disc cavity to 30-40 psig with He, through port GP9445.
- b. Verify R.V. vent valve is closed. (Para. 4.2.2.8.2.3.) Vent valve closing pressure (100 psig max.)
- c. Vent fuel burst disc cavity until vent valve opens. (Para. 4.2.2.8.2.3.)
- d. Repeat steps, similar to a, b, and c above, for oxidizer R.V. vent valve. (Para. 4.2.2.8.2.3)

### Relief Valve Burst Disc Internal Leak Check

- a. Seal off oxidizer thrust neutralizer tee GP9446.
- b. With LDM at port GP9444, collect, for a specified period of time, the quantity of helium leaking past the oxidizer R.V. burst disc. (Para. 4.2.2.8.2.3.)
- c. Repeat steps, similar to a and b above, for the fuel burst disc.

### Thermal Relief Test of Pre-Valves, Cumulative Leak Check of QD's, External Leak Check Downstream of Pre-Valves

- a. With LDM at port GP9445 collect, for a specified period of time, the quantity of helium leaking past QD GP9455. (Paragraph 4.2.2.8.2.6 (c)).
- b. Pressurize downstream side of pre-valves to 290-300 psig, with He through port GP9455.

## OCP OUTLINE

OCP-GF-27028-IM-5

### Test Description: (Cont)

- c. Continue pressurization pre-valve in 10 psig increments until pre-valve opens. Record cracking pressure.
- d. Vent through port GP9455 to 170-180 psig then repressurize to 180-190 psig.
- e. Using mass spectrometer check for leakage (180-190 psig) of all new brazes and all mechanical joints downstream of pre-valve outlet to engine shutoff valve. (Para. 4.2.2.8.2.6).
- f. Vent downstream side of pre-valves to ambient through port GP9455.

### Leak Test of Compatibility Explosive Valves

- a. Verify pressure downstream of compatibility squibs is 180-190 psig.
- b. Close pressurization ports GP9442 and GP9443.
- c. Vent lines upstream of compatibility explosive valves to ambient through ports GP9425, GP9440, GP9441, GP9430, GP9431, GP9432, and GP9433.
- d. With LDM at port GP9440, collect, for a specified period of time, the quantity of helium leaking past the oxidizer explosive valves. (Para. 4.2.2.8.2.6.)
- e. Repeat preceding step with LDM at port GP9441 for fuel explosive valve.

### Leak Test of Engine Interface Primary Seals

- a. Remove screw from primary seal leak test port GP9480.
- b. With LDM at port GP9480, collect for a specified period the quantity of helium leaking past the primary seal of GP9480.
- c. Repeat preceding steps (a and b) with LDM at port GP9482.

### Internal Leak Check of RCS Interconnect Valves

- a. Open fuel and oxidizer "A" secondary interconnect valves.
- b. Vent RCS manifolds to ambient through ports GR6321, GR6322, GR6323 and GR6324.
- c. With LDM at GR6322 collect, for a specified period of time, the quantity of helium leaking past the oxidizer "A" primary interconnect valve.
- d. With LDM at GR6321 collect, for a specified period of time, the quantity of helium leaking past the fuel "A" primary interconnect valve.

## OCP OUTLINE

OCP-GF-27028-LM-5

### Test Description: (Cont)

- e. Close fuel and oxidizer "A" secondary interconnect valves.
- f. Open fuel and oxidizer "A" primary interconnect valves.
- g. Repeat Step d for fuel "A" secondary interconnect valve leakage.
- h. Repeat Step C for oxid "A" secondary interconnect valve.
- i. Close fuel and oxidizer "A" primary interconnect valves.
- j. Open fuel and oxidizer "B" secondary interconnect valves.
- k. Repeat steps similar to c through i above for leakage of fuel and oxidizer "B" primary and fuel and oxidizer "B" secondary interconnect valves.

### Gross Leakage Check of Engine Ball Valves

- a. Open propellant "A" and "B" ball valves by pressurizing to 180-190 psig helium at GP9473 and GP9474.
- b. With LDM at engine throat plug leakage port collect, for a specified period of time, the quantity of helium leaking past the isolation "A" and "B" ball valves.
- c. Close propellant "A" and "B" ball valves by venting to ambient at ports GP9473 and GP9474.
- d. Open isolation "A" and "B" ball valves by pressurizing to 180-190 psig helium at GP9471 and GP9472.
- e. Repeat Step b for leakage of propellant "A" and "B" ball valves.
- f. Vent propellant tanks to 5-15 psig through ports GP9452 and GP9453.
- g. Close isolation "A" and "B" ball valves by venting to ambient through ports GP9471 and GP9472.

### Seq. 09: Leak Check of Helium Tanks and Helium Explosive Valves

During this sequence the external leakage of all new brazes and all mechanical joints between the helium tanks and the helium explosive valves is determined. Also, the internal leakage of the helium explosive valves is measured.

- a. Pressurize helium tanks to reproof pressure (1.15 MDOP) of 4000-4025 psig with He through ports GP9401 and GP9402.
- b. Decrease helium tank pressure to 3400-3500 psig.
- c. Visually inspect helium tanks and lines for structural damage.

## OCP OUTLINE

OC -GF-27028-IM-5

### Test Description: (Cont)

- d. With LDM at port GP9401, collect, for a specified period of time, the quantity of helium leaking past QD GP9401. (Para. 4.2.2.8.2.2)
- e. With LDM at port GP9402, repeat step d for the leakage past QD GP9402.
- f. Using mass spectrometer, check for leakage (3400-3500 psig) of all new brazed and all mechanical joints between the helium tanks and the helium explosive valves. (Para. 4.2.2.8.2.3)

#### Seq. 09-032: Leak Check of Helium Explosive Valves

- a. Vent high pressure manifold downstream of helium explosive valve to ambient through port GP9406.
- b. With LDM at port GP9406, collect, for a specified period of time, the quantity of helium leaking past both helium explosive valves. (Para. 4.2.2.8.2.2.)
- c. Vent helium tanks to pad pressure (5-15 psig) through ports GP9401 and GP9402.

#### Seq. 10: Engine Ball Valve, Shaft Seal and Actuator Leakage and Pre-Valve Thermal Relief Check

During this sequence the leakage rate of the following valves, seals and actuators will be determined.

- Isolation and Propellant Ball Valves.
- Isolation and Propellant Valve Seals.
- Isolation and Propellant Valve Actuators.

Also, the thermal relief pressure of the pre-valves will be determined.

- a. Pressurize fuel and oxid tanks to 50-60 psig GN2 through port GP9452 and GP9453.
- b. Open propellant valve "A" and isolation valve "A" by pressurizing to 180-190 psig GN2 at ports GP9471 and GP9473.
- c. Verify combustion chamber pressure is within  $\pm 10$  psig of propellant tank pressure by observing pressure at throat plug leak port.
- d. Close propellant valve "A" and isolation valve "A" by venting to ambient at GP9471 and GP9473.
- e. Monitor combustion chamber pressure for thirty minutes.
- f. Pressurize fuel tank to 180-190 psig with GN2 through port GP9443.
- g. Pressurize oxidizer tank to 180-190 psig with GN2 through port GP9442.

## OCP OUTLINE

OCP-GF-27028-IM-5

### Test Description: (Cont)

- h. Activate Isolation Valve "A" by pressurizing to 180-190 psig with GN2 at port GP9472.
- i. Activate Isolation Valve "B" by pressurizing to 180-190 psig with GN2 at port GP9472.
- j. With LDM at port GP9477, collect for a specified period of time, the quantity of GN2 leaking past the Fuel Isolation Valves "A & B" shaft seals, Fuel Prop Valves "A & B" shaft seals and Fuel Isolation Valves "A & B" actuators.
- k. With LDM at throat plug leakage port, collect for a specified period of time, the quantity of GN2 leaking past the Fuel and Oxid Prop Valves "A & B". (Para. 4.2.2.8.2.6(2)).
- l. With LDM at port GP9476, collect for a specified period of time, the quantity of GN2 leaking past the Oxid Isolation Valves "A & B" shaft seals and the "Oxid" Prop Valves "A & B" shaft seals. (Para. 4.2.2.8.2.6 (3)).
- m. Deactivate Isolation Valve "A" by venting to ambient through port GP9471.
- n. Deactivate Isolation Valve "B" by venting to ambient through port GP9472.
- o. Activate Prop Valve "A" by pressurizing to 180-190 psig with GN2 through port GP9473.
- p. Activate Prop Valve "B" by pressurizing to 180-190 psig with GN2 through port GP9474.
- q. With LDM at port GP9477, collect for a specified period of time, the quantity of GN2 leaking past the Fuel Isolation Valves "A" & "B" shaft seals and the Prop Valves "A & B" shaft seals and the Prop Valves "A & B" actuators. (Para. 4.2.2.8.2.6. (3)).
- r. With LDM at throat plug, collect for a specified period of time, the quantity of GN2 leaking past the Fuel and Oxid Isolation Valves "A & B". (Para 4.2.2.8.2.6 (2)).
- s. With LDM at port GP9476, collect for a specified period of time, the quantity of GN2 leaking past Oxid Isolation Valves "A & B" shaft seals. (Para. 4.2.2.8.2.6 (3)).
- t. Subtract leakage rate obtained in Step s, from that in Step l to obtain leakage rate of Oxid Prop Valves "A & B" shaft seals.
- u. Deactivate Prop Valve "A" by venting to ambient through port GP9473.
- v. Deactivate Prop Valve "B" by venting to ambient through port GP9474.

OCP OUTLINE

OCP-GF-27028-LM-5

Test Description: (Cont)

- w. Depressurize Fuel tank by venting to pad pressure through port GP9442.
- x. Depressurize Oxid tank by venting to pad pressure through port GP9443.

NOTE

If excessive leakage is obtained in any of above steps, additional steps will be performed to determine leakage path.

Seq. 11: Securing After Test

- a. Vent helium tanks to ambient through port GP9401 and GP9402.
- b. Pressurize helium tanks to 5-15 psig with GN2.
- c. Repeat step a above.
- d. Pressurize helium tanks to 75-85 psig with GN2.
- e. Obtain gas samples at port GP9402 for particle count.
- f. Vent helium tanks to pad pressure.
- g. Open primary and secondary latching solenoid valves.
- h. Establish GN2 flow through helium pressurization system by pressurizing at port GP9406 and venting at port GP9425. Maintain flow at 5 psig minimum for a period of three (3) minutes.
- i. Obtain gas samples at port GP9425 for particle count.
- j. Secure helium pressurization system with GN2 pad pressure. (Para. 4.2.2.8.2.6.)
- k. Repeat steps, similar to h, i, and j above for oxidizer side of propellant system by pressurizing at port GP9442, and venting at port GP9463.
- l. Determine condition of oxidizer burst disc by monitoring oxidizer thrust neutralizer tee for audible leakage.
- m. Repeat steps, similar to h, i, j and l above for fuel side of propellant system by pressurizing at port GP9443 and venting at port GP9464.

## OCP OUTLINE

OCP-GF-30031-LM-5

### Test Title:

RCS Valve Response

### Subsystem:

Stabilization and Control (S&C)  
Reaction Control (RCS)

### Test Objectives:

Verification of proper timing of RCS thruster valve responses.

Verification of proper geometric position and proper primary to secondary coil identification.

### Vehicle Configuration:

Ascent stage

### Location:

Integrated workstand, Plant 5 CEF

### Hazardous Operations:

Not applicable

### Components Under Test:

Attitude and Translation Control Assembly (ATCA)

RCS Thrusters

Attitude Controller Assembly (ACA)

Thrust Translation Controller Assembly (T/TCA)

LM Guidance Computer (LGC)

### Test Description:

Seq. 01: Call to Stations

Seq. 02: Support System Status Verification

- a. Verification of power application to vehicle bus at 26.5 VDC
- b. Set and verification of vehicle cabin circuit breaker and switch configuration.

OCP OUTLINE

OCP-GF-30031-LM-5

Test Description: (Cont)

Seq. 03: RCS Jet Wiring and channel verification

- a. Verification of  $GN_2$  at 15 to 25 PSIG.
- b. Energize TCA Cb for a particular quad and RCS system. Activate T/TCA for single axis translation and observe specified thruster gas bag inflation. The T/TCA is returned to detent and the CB's and switches are opened and turned off respectively.
- c. Item b above is repeated 15 times to cover all RCS thrusters and systems individually.
- d. The data is checked for correct channel assignment.

Seq. 04: AGS Mode

- a. Valve signatures recorded
  1. T/TCA positioned to obtain single Axis responses from RCS thrusters for all Axis.
  2. Transient responses across secondary coil fuel and oxid solenoids due to primary coil fuel and oxid solenoid energization are recorded.
- b. Verification of data appearing on correct Instrumentation Recorder System channels.

Seq. 05: Hardover Mode

- a. Valve signatures recorded
  1. ACA positioned to obtain "Hardover" responses from RCS thrusters.
  2. Transient responses to hardover commands are recorded.
- b. Verification of data appearing on correct Instrumentation Recorder System channels.



OCP OUTLINE

OCP-GF-30031-LM-5

Test Description: (Cont)

Seq. 06: G&N Turn-On (G&N Stby Mode)

- a. Verification of nominal +28 VDC power application to vehicle bus, and G&N system.
- b. DSKY lighting turn-on.
  - 1. Verification of power applied to the DSKY
  - 2. Set cabin CB and switch configuration.
- c. LGC Self Check

Seq. 07: Valve Signature - PGNS Mode

- a. Insert RCS firing data into the LGC memory via tape.
- b. Verification of data appearing on correct Instrumentation Recorder System channels.

Seq. 08: Securing After Test

OCP OUTLINE

OCP-GF-30032-IM-5

Test Title:

Extended Polarity Tests

Subsystem:

Stabilization and Control Subsystem

Test Objectives:

- a. Verification of the end to end polarity of the attitude control loops for yaw, pitch and roll, exercised by rotation of the vehicle to verify polarity of RGA gyros in response to the physical rotation about X, Y and Z axes.
- b. Verification of the polarity of ASA gyros in response to the physical rotation about X, Y and Z axes.

Vehicle Configuration:

Mated Stages

Location:

Integrated Workstand, Plant 5

Hazardous Operation:

Suspension of vehicle:

Equipment Under Test:

- a. Rate Gyro Assembly (RGA)
- b. Attitude and Translation Control Assembly (ATCA)
- c. Abort Sensor Assembly (ASA)
- d. Abort Electronics Assembly (AEA)

Test Description:

- Seq. 01: Call to Station
- Seq. 02: Support System Status Verification
- Seq. 03: Configuration and CES Turn-On
- Seq. 04: Pitch Rotation
  - a. Verification of GSE guide and drive equipment for pitch rotation.
  - b. Activation of Control Switch Box.

OCP OUTLINE

OCP-GF-50032-IM-5

Test Description: (Cont)

- c. Rotation of the vehicle in positive and negative pitch to verify polarity of the RGA pitch gyro attitude control loop.

Seq. 05: Roll Rotation

- a. Verification of GSE guide and drive equipment for roll rotation.
- b. Activation of Control Switch Box.
- c. Activation of RGA.
- d. Rotation of the vehicle in positive and negative roll to verify polarity of the RGA roll gyro attitude control loop.

Seq. 06: Yaw Rotation

- a. Verification of GSE guide and drive equipment for yaw rotation.
- b. Activation of Control Switch Box.
- c. Activation of RGA.
- d. Rotation of the vehicle in positive and negative yaw to verify polarity of the RGA yaw gyro attitude control loop.

Seq. 07: Instrumentation, Caution and Warning Activation, and AGS Turn-On.  
(Para. 4.2.2.6.5.8 A5)

Seq. 08: Yaw Rotation  
(Para. 4.2.2.6.5.4. F1)

- a. Verification of GSE guide and drive equipment for yaw rotation.
- b. Selection of AGS attitude hold mode.
- c. Activation of Control Switch Box.
- d. Rotation of the vehicle in positive and negative yaw to verify polarity of the AGS attitude hold loop.

Seq. 09: Roll Rotation  
(Para 4.2.2.6.5.4 F1)

- a. Verification of GSE guide and drive equipment for roll rotation.
- b. AEA self test.
- c. Body axis align.
- d. Selection of AGS attitude hold mode.
- e. Activation of ATCA and RGA.

OCP OUTLINE

OCP-GF-30032-LM-5

Test Description: (Cont)

- f. Activation of Control Switch Box.
- g. Rotation of the vehicle in positive and negative roll to verify polarity of AGS attitude hold loop.
- h. Deactivation of ATCA and RGA, and verification of CES caution and warning.

Seq. 10: Pitch Rotation  
(Para. 4.2.2.6.5.4 Fl)

- a. Verification of GSE guide and drive equipment for pitch rotation.
- b. AEA self test.
- c. Body axis align.
- d. Selection of AGS attitude hold mode.
- e. Activation of ATCA and RGA.
- f. Activation of Control Switch Box.
- g. Rotation of the vehicle in positive and negative pitch to verify polarity of the AGS attitude hold loop.
- h. Deactivation of ATCA and RGA.
- i. Removal of earth rate compensation in X, Y, and Z axes.

Seq. 11: Recording Gyro Rundown Time and AGS Shut-down

OCP OUTLINE

OCP-GF-31003-LM5

Test Title:

RCS Liquid Flush.

Subsystem:

Reaction Control Subsystem (RCS).

Test Objectives:

- a. Verification of the cleanliness level of the RCS propellant manifolds by flushing with Freon TF.
- b. Drying of the manifolds subsequent to the freon flush.
- c. Verification of the dryness of the RCS propellant tank bladders after flushing the feed manifolds.
- d. Leak check of the solenoid valves in Systems 'A' and 'B'.
- e. Hydrostatic proof test of the manifold system.

Vehicle Configuration:

Ascent stage.

Location:

LM Test Area - Plant 2.

Hazardous Operations:

- a. Hydrostatic pressures up to 340 psig.
- b. Pneumatic pressures up to 210 psig.

Components Under Test:

Propellant manifolds.  
Propellant tank bladders.  
Isolation valves.  
Main shutoff valves.  
Crossfeed valves.

Test Description: (Paragraphs 4.2.2.7.5 and 4.2.2.7.6)

Seq. 01: Call to Stations.

## OCP OUTLINE

OCP-GF-31003-LM5

### Test Description: (Cont)

#### Seq. 02: First Flush and Sample - Oxidizer System.

- a. Freon sampling of LDW 430-6860-3, RCS Freon Flush Cart, prior to flushing vehicle propellant manifolds. Verification of cleanliness before proceeding.
- b. Circulation of freon throughout the 'A' and 'B' oxidizer system for fifteen (15) minutes, going through the service disconnects GR6322 and GR6324 respectively and out the quadrant feed manifolds (isolation valves and filters are not installed). Freon is routed through a common GSE manifold, and back to the flush cart.
- c. Circulation of freon through 'A' oxidizer system only for fifteen (15) minutes, going in through port GR6322, and out the 'A' quadrant feed manifolds.
- d. Circulation of freon through each quad individually (System 'A' only), and through the crossfeed line ('A' to 'B' direction) for five minutes each, while vibrating the oxidizer line that is open to circulation.
- e. Circulation of freon through the oxidizer crossfeed line ('A' to 'B' direction) for fifteen (15) minutes, going in through GR6322 'A', and out the quadrant feed manifolds of System 'B'.
- f. Circulation of freon through 'B' oxidizer system for fifteen (15) minutes, going in through GR6324 and out the 'B' quadrant feed manifolds.
- g. Circulation of freon through each quad individually (System 'B' only), and through the crossfeed line ('B' to 'A' direction) for five minutes each, while vibrating the oxidizer line that is open to circulation.
- h. Freon sampling of the eight GSE sample ports located on the individual quadrant feed manifolds.
- i. Stopping of freon pump, and draining of freon from propellant manifolds.

#### Seq. 03: First Purge and Dry - Oxidizer System.

- a. Establishment of a warm nitrogen pump (200°F) throughout the oxidizer system by going in through the service disconnects GR6322 (System 'A') and GR6324 (System 'B') and out the quadrant feed manifolds (5 to 20 psig).
- b. Purge of each quadrant feed manifold individually at 45-50 psig ( $\text{GN}_2$ ) until no fluid can be seen.
- c. Purge of oxidizer system for a minimum of four (4) hours at 45-50 psig ( $\text{GN}_2$ ).

OCP OUTLINE

OCP-GF-31003-LM5

Test Description: (Cont)

- d. Sample of each quadrant at GSE sample ports until moisture content is acceptable.
- e. Reduction of system pressure to 0 psig.

Seq. 04: First Flush and Sample - Fuel System.

Similar to Sequence 02, except using service disconnects GR6321 (System 'A') and GR6323 (System 'B') as inlet ports, and the quadrant feed manifolds as the exit ports.

Seq. 05: First Purge and Dry - Fuel System.

Similar to Sequence 03, except using service disconnects GR6321 (System 'A') and GR6323 (System 'B') as inlet ports, and the quadrant feed manifolds as the exit ports.

Seq. 06: Proof Pressure Test - Oxidizer System.

NOTE

Oxidizer inlet filters and isolation valves installed after first purge and dry. Also, quadrant manifolds are terminated with simulated RCS thrust engines for Sequences 06 through 15.

- a. Hydrostatically proof pressure oxidizer system through service disconnects GR6322 and GR6324 with freon to  $330 \pm 10$  psig. Maintain pressure for five (5) minutes.
- b. Reduce pressure to 0 psig by draining freon from manifolds.

Seq. 07: Final Flush and Sample - Oxidizer System.

- a. Taking of freon sample from LDW 430-6860-3, and verification of cleanliness.
- b. Circulation of freon in oxidizer system through service disconnects GR6322 and GR6324 and out the individual mockup engines for five minutes each, while vibrating the oxidizer line that is open to circulation.
- c. Taking of freon samples at the sixteen (16) GSE sample ports.
- d. Circulation of freon through individual mockup engines for two (2) minutes each.
- e. Circulation of freon for fifteen (15) additional minutes through entire oxidizer system, going in through service disconnects GR6322 (System 'A') and GR6324 (System 'B').
- f. Turn off freon pump and drain freon from system.

## OCP OUTLINE

OCP-GF-31003-LM5

### Test Description: (Cont)

#### Seq. 08: Final Purge and Dry - Oxidizer System.

- a. Establishment of warm nitrogen purge (200°F) throughout oxidizer system at 5 to 20 psig, going in through service ports GR6322 (System 'A') and GR6324 (System 'B') and out GSE sampling ports.
- b. Purging of all oxidizer lines at 45-50 psig (GN<sub>2</sub>) until no fluid is seen leaving sampling ports.
- c. Purging of oxidizer system for a minimum of four (4) hours at 45-50 psig (GN<sub>2</sub>).
- d. Maintenance of "locked up" sample in system at 45 to 50 psig (GN<sub>2</sub>) for one hour.
- e. Taking of moisture samples.
- f. Venting of system to 0 psig.

#### Seq. 09: Proof Pressure Test - Fuel System.

Similar to Sequence 06, except using service disconnects GR6321 (System 'A') and GR6323 (System 'B').

#### Seq. 10: Final Flush and Sample - Fuel Sample.

Similar to Sequence 07, except using service disconnects GR6321 (System 'A') and GR6323 (System 'B').

#### Seq. 11: Final Purge and Dry - Fuel System.

Similar to Sequence 08, except using service disconnects GR6321 (System 'A') and GR6323 (System 'B').

#### Seq. 12: RCS Fuel and Oxidizer Tank Dryness Verification - System 'A'

- a. Purging of propellant tank bladders with dry nitrogen at 10 ± 5 psig through bleed disconnects GR6301 and GR6302, and out fill disconnects GR6311 and GR6312.
- b. Taking of gaseous nitrogen samples at fill disconnects GR6311 and GR6312, and analyzation for acceptable moisture content.
- c. Reduction of pressure to 5 ± 2 psig after acceptable sampling and leaving tanks pressurized.

#### Seq. 13: RCS Fuel and Oxidizer Tank Dryness Verification - System 'B'

Similar to Sequence 12, except purging through bleed disconnects GR6303 and GR6304 and out fill disconnects GR6313 and GR6314.



OCP OUTLINE

OCP-GF-31003-LM5

Test Description: (Cont)

Seq. 14: Solenoid Valve Leak Check - System 'A'.

- a. Pressurization of oxidizer and fuel manifolds of System 'A' through service disconnects GR6321 and GR6322, to  $200 \pm 10$  psig, using gaseous helium.
- c. Leak check of isolation valves, main shutoff valves, and crossfeed valves ('A' to 'B' direction).
- c. Reduction of pressure to 0 psig.

Seq. 15: Solenoid Valve Leak Check - System 'B'

- a. Similar to Sequence 14 (a), except using service disconnects GR6321 (fuel) and GR6322 (oxidizer).
- b. Similar to Sequence 14 (b), 'B' to 'A' direction.
- c. Application of helium pad pressure of 8 to 10 psig throughout entire system (tanks and manifolds).

Seq. 16: Securing After Test.

OCP OUTLINE

OCP-GF-31008-IM5

Test Title:

RCS Module Proof, Leakage and Functional Tests.

Subsystem:

Reaction Control.

Test Objectives:

Establish the structural and leakage integrity and proper operation of components of the RCS module.

Vehicle Configuration:

Not applicable; tankage module assembly only.

Location:

Controlled Environment Facility, Plant 2.

Hazardous Operations:

Pneumatic pressures up to 4655 psig.

Components Under Test:

Quad Check Valves

Relief Valves

Main Shutoff Valves

Helium Regulators

Test Description:

Seq. 01: Call to Station

Seq. 02: Freon Flush of RCS Fuel and Oxidizer Tank Bladders, Followed by  
Purging and Drying with Warm GN<sub>2</sub>, System A

- a. Flush fuel and oxidizer tank bladders through bleed (GR6301, GR6302), fill (GR6311, GR6312), and service (GR6321, GR6322) QD's with PCA freon to meet cleanliness requirements.
- b. Purge and dry bladders with warm GN<sub>2</sub> through bleed, fill and service QD's to meet moisture and freon vapor requirements.

## OCP OUTLINE

OCP-GF-31008-IM5

### Test Description: (Cont)

Seq. 03: Proof Pressure Test of Helium Tank and Leakage Test of All Joints Between Helium Tank and Squib Valves, System A.

- a. Pressurize helium tank to 4560-4655 psig GHe through GR6201 helium fill port. Hold pressure for specified period of time. (Para. 4.2.2.7.2 (a)1)
- b. Reduce pressure in helium tank to  $3500 \pm 50$  psig GHe, inspect for damage and leak check tank fitting and all joints between tank and squib valves. Leak check squib valves. Leak check squib valves at GR6211 helium test port. (Para. 4.2.2.7.2 (a))
- c. Vent helium tank to 10-50 psig GHe through GR6201.
- d. Monitor tank temperatures while pressurizing and venting to maintain proper temperatures.
- e. Verify proper operation of PQMD (GR1085Q) and flight helium supply pressure transducer (GR1101P).

Seq. 04: Proof Pressure Test of RCS Propellant Tanks and Regulator Inlet Section. Leak Check of All Joints Between Squib Valves and Main Shutoff Valves, System A.

- a. Pressurize liquid and gas sides of propellant tanks simultaneously through fill and GHe vent QD's to 325 to 335 psig while, for a specified period of time, maintaining a positive delta P between inside and outside of the bladders. (Para. 4.2.2.7.2 (b) (1))
- b. Reduce pressure in tanks to 200 to 210 psig while maintaining positive delta P.
- c. Pressurize the helium regulator inlet section to 4560 to 4655 psig through the helium test QD (GR6211). Hold for five to ten minutes. Verify proper operation of regulator outlet transducer (GR1201P). (Para. 4.2.2.7.2 (a) (2))
- d. Reduce pressure to 3450 to 3550 psig, inspect module for visual evidence of damage and leak check all joints and fittings. (Para. 4.2.2.7.2. (a))
- e. Leak check all QD's. (Para. 4.2.2.7.2 (a) (3))
- f. Perform forward leakage check of main shutoff valves by measuring volumetric leakage out of propellant line tube stubs. (Para. 4.2.2.7.6 (e))
- g. Reduce pressure in propellant tanks to zero on gas side and 5-15 psig on liquid side while maintaining a positive delta P.

OCP OUTLINE

OCP-GF-31008-LM5

Test Description: (Cont)

Seq. 05: Leakage Test of Relief Valve Burst Discs. Reverse Leakage of Overall Quad Check Valve Assembly, System A

- a. Pressurize propellant tanks to 165 to 170 psig through fill (GR6311 and GR6312) and vent (GR6281 and GR6282) QD's simultaneously, while maintaining a 5-15 psig positive delta P on the bladder.
- b. Using a helium mass spectrometer at ports "G" (GR6262) and "N" (GR6261), measure burst disc leakage. (Para. 4.2.2.7.6 (d) (3) (b))
- c. Connect a VLD to port "D" (GR6233) and measure quad check valve assembly leakage. (Para. 4.2.2.7.6 (c) (1))
- d. Decrease pressure on propellant tanks to 5-15 psig pad pressure inside of bladders while maintaining a positive delta P.

Seq. 06: Verification of Cracking and Reseat Pressures of Relief Valves, System A

- a. Pressurize fuel tank with GHe to 224 to 240 psig through fuel fill, vent and port "H" (GR6261) simultaneously while maintaining 5-15 psig positive delta P on bladder.
- b. Determine relief valve cracking pressure while raising pressure in step (a) by monitoring for leakage from relief valve outlet. (Para. 4.2.2.7.6 (d)(1)).
- c. Lower pressure on tank to 212 psig and monitor relief valve reseating pressure. (Para. 4.2.2.7.6 (d) (1))
- d. Lower pressure to 200 psig. Connect VLD to relief valve outlet and monitor relief valve leakage. (Para. 4.2.2.7.6 (d) (3) (a))
- e. Reduce pressure to 5-15 psig pad pressure while maintaining 5-15 psig delta P on bladder.
- f. Repeat above steps for oxidizer relief valve, using oxidizer fill, vent and port "G" (GR6262) QD's.

Seq. 07: Verification of Cracking Pressures of Individual Quad Check Valve Elements, System A

- a. Pressurize inside of propellant tank bladders with GHe to 5-15 psig through fill QD's.
- b. Determine quad check valve elements cracking pressure by monitoring for leakage from oxidizer vent Q.D. (Para. 4.2.2.7.6 (c) (2))
- c. Pressurize ports "E" (GR6251) and "C" (GR6253) in turn from 0 to 5.0 psig and monitor VLD connected to oxidizer vent QD for indication of cracking pressure. (Para. 4.2.2.7.6 (c) (2))

## OCP OUTLINE

OCP-GF-31008-LM5

### Test Description: (Cont)

- d. Connect VLD to fuel vent QD and monitor for leakage to determine quad check valve elements cracking pressure. (Para. 4.2.2.7.6 (c) (2))
- e. Pressurize ports "F" (GR6241) and "D" (GR6242) in turn from 0-5 psig and monitor VLD connected to fuel vent QD for indication of cracking pressure. (Para. 4.2.2.7.6 (c) (2))
- f. Connect VLD to ports "E", "F", "C", and "D" in turn while pressurizing through port "B" (GR6233) from 0 to 4.0 psig and monitoring VLD for indication of cracking pressure in each case.

#### Seq. 08: Internal Leak Check of Individual Quad Check Valve Elements at 0.5 psig and 100 psig, Respectively

- a. Pressurize inside of propellant tank bladders to 5-15 psig through fill QD's GR6311 and GR6312.
- b. Pressurize through oxidizer vent QD, GR6282, to 0.5 to 0.8 psig and monitor leakage at ports "E" (GR6251) and "C" (GR6253) respectively, with VLD. (Para. 4.2.2.7.6 (c) (1))
- c. Pressurize through fuel vent QD, GR6281 to 0.5 to 0.8 psig and monitor leakage at ports "F" (GR6241) and "D" (GR6242) respectively, with VLD. (Para. 4.2.2.7.6 (c) (1))
- d. Connect VLD to port "B" (GR6233) and pressurize to 0.5 to 0.8 psig through ports "E", "F", "C" and "D" in turn while monitoring leakage at port "B". (Para. 4.2.2.7.6 (c) (1))
- e. Pressurize inside of bladders to 90 to 100 psig through fill QD's GR6311 and GR6312, and outside of bladders to 80 to 90 psig through vent QD's GR6281 and GR6282, simultaneously while maintaining positive delta P.
- f. Pressurize to 80 to 90 psig through ports "E" "C" "F", and "D" in turn while monitoring upstream poppet leakage at port "B" (GR6233) with VLD. (Para. 4.2.2.7.6 (c) (1))
- g. Connect VLD to ports "E", "C", "F" and "D" in turn to monitor downstream valve leakage. (Para. 4.2.2.7.6 (c) (1))
- h. Reduce pressure on tanks to 5-15 psig pad pressure inside bladders while maintaining a positive delta P.

#### Seq. 09: Functional Test of Primary and Secondary Helium Pressure Regulators at High Flow, Low Flow and Lockup Conditions, System A

- a. Pressurize propellant tanks to 205 to 215 psig through fill (GR6312 and GR6311), and vent (GR6281) and (GR6282) QD's and ports "G" (GR6262) and "H" (GR6261) simultaneously while maintaining 5-15 psig positive delta P on bladders. (Para. 4.2.2.7.6 (b) (1))

OCP OUTLINE

OCP-GF-31008-LM5

Test Description: (Cont.)

- b. Pressurize regulator inlet to 1450 to 1550 psig through port "A" (GR6211), (Para. 4.2.2.7.6 (b) (1))
- c. Flow through port "B" (GR6233), adjusting flow sequentially to 0.19 to 0.21 lbs/min, 0.036 to 0.040 lbs/min, and zero (lockup). (Para. 4.2.2.7.6 (b) (1)).
- d. Pressurize primary regulator sensing port (JR6231) to 50-55 psig to lockout primary regulator. (Para. 4.2.2.7.6 (b) (2))
- e. Flow through port "B" (GR6233) to flowmeter, adjusting flows to 0.19 to 0.21 lbs/min, 0.036 to 0.040 lbs/min and zero (lockup).
- f. Pressurize regulator inlet to 3450 to 3550 psig through port "A" (GR6211) and record regulator "creep" rate. (Para. 4.2.2.7.6 (b) (3))
- g. Reduce pressure on regulator inlet to 300 to 350 psig remove burst disc and reconnect flowmeter line to port "B" (GR6233).
- h. Remove line from primary regulator sensing port and connect to secondary regulator sensing port.
- i. Repeat steps (d), (e), (f) and (g), on primary regulator.
- j. Reduce pressure on tanks to 5-15 psig pad pressure inside bladders while maintaining a positive delta P.

Seq. 10: Verification Test of Fuel and Oxidizer Tank Bladder Leakage Rates, System A

- a. Pressurize inside of bladders to 9 to 10 psig through fill QD's.
- b. Connect VLD's to tank vent QD's and monitor bladder leakage. (Para. 4.2.2.7.6 (i)(1)).
- c. Close all QD's and remove all GSE equipment.

Seq. 11  
through

Seq. 19: Repeat above Sequences 2 through 10 for RCS System B Module.

## OCP OUTLINE

OCP-GF-31030 LM5

### Test Title:

Propellant Feed Section Proof, Leakage and Functional Test.

### Subsystem:

Reaction Control Subsystem (RCS).

### Test Objectives:

Establishment of the structural integrity and functional capability of RCS propellant manifold lines and components after assembly on the vehicle.

### Vehicle Configuration:

Ascent Stage.

### Location:

Cold Flow Facility.

### Hazardous Operations:

Pneumatic pressures up to 350 psig.

### Components Under Test:

Propellant manifold lines.  
Manifold flight transducers.  
Chamber pressure switches.  
Injector valves.  
Isolation valves.

Test Description: (Paragraphs 4.2.2.7, 4.2.2.7.3 (b) (c) (d) (e) (f) (Partial), 4.2.2.7.5 (Partial), 4.2.2.7.7 (c) and 4.2.2.7.8)

Seq. 01: Call to Stations

Seq. 02: Proof Pressure and External Leak Check of RCS Propellant Manifolds.

- a. Sequential venting of propellant tanks by first venting volume external to the bladders through GR6281, GR6282, GR6283, GR6284, and then volume inside the bladders through GF6311, GR6312, GR6313, and GR6314. Ports remain open and capped as a safety precaution.
- b. Verification of acceptable output from manifold pressure transducers at ambient pressure.

## OCP OUTLINE

OCP-GF-31030-LM5

### Test Description: (Cont)

- c. Pressurization of the propellant manifolds at 30 to 40 psig GHe through GR6321 and GR6322.
- d. Verification that main shutoff valves are closed, as indicated by no audible evidence of leakage at GR6311 and GR6312. Verification that interconnect valves are closed by monitoring of pressures indicated by gages connected to GP9459 and GP9458. An increase in pressure indicates a leaking interconnect valve.
- e. Pressure is increased in propellant manifolds to 320 to 340 psig GHe through GR6321 and GR6322. Proof pressure is held for a specified period of time.
- f. Venting of propellant manifolds through GR6321 and GR6322 to ambient, and visual inspection of the manifolds for physical damage.
- g. Pressurization of the propellant manifolds to 195 to 205 psig GHe through GR6321 and GR6322. Leak check of all brazed, weld and mechanical joints. Leak check of flight half Q.D. poppets GR6323, GR6324, GR6321 and GR6322.
- h. Verification of accuracy of propellant manifold pressure transducers with the propellant manifolds pressurized to 195 to 205 psig.
- i. Correlation of each propellant manifold pressure transducer output to its respective manifold by individually venting each manifold to ambient. Venting of System 'A' fuel manifold through GR6321, System 'A' oxid manifold through GR6322, System 'B' fuel manifold through GR6323 and System 'B' oxid manifold through GR6324.
- j. Verification of acceptable output from manifold pressure transducers at ambient pressure.

### Seq. 03: Engine Thrust Chamber Switch Leak Check and Functional Tests.

- a. Pressurization of the propellant manifolds to 195 to 205 psig GHe through GR6321 and GR6322.
- b. Installation of throat plug into the engine under test and pressurization of thrust chamber to 100 to 110 psig (GHe).
- c. Leak check of mechanical connections of pressure switch.
- d. Venting of thrust chamber pressure through throat plug to ambient.
- e. Slow evacuation of the thrust chamber to approximately 2 psia through the throat plug. Record of the pressure when the chamber pressure switch opens.



## OCP OUTLINE

OCP-GF-31030-LM5

### Test Description: (Cont)

- f. Slow increase of pressure in the thrust chamber to approximately 15 psia through the thrust plug. Observance and recording of the pressure when the pressure switch closes.
- g. Repeat of steps (e) and (f) two times.
- h. Venting of pressure in thrust chamber through the throat plug to ambient.
- i. Repeat of steps (b) through (h) for each remaining RCS engine.
- j. Venting of pressure in propellant manifolds through GR6321 and GR6322 to ambient.

### Seq. 04: Primary and Secondary Valve Signatures to Verify Electrical Wiring

- a. Pressurization of the propellant manifolds to 20 to 30 psig  $\text{GN}_2$  through GR6321 and GR6322.
- b. Verification of proper harness wiring to the fuel injector valves by actuating the valves individually and verifying gas flow through the respective engines.
- c. Verification of proper harness wiring to the oxidizer injector valves by actuating the valves individually and verifying gas flow through the respective engines.
- d. For each engine, one engine at a time, actuation of the fuel and oxidizer injector valves using secondary coil actuation while recording the respective valve signatures.
- e. For each engine, one engine at a time, actuation of the fuel and oxidizer injector valves using primary coil actuation (secondary coil sensing) while recording the respective valve signatures.
- f. Venting of pressure in the oxidizer and fuel manifolds through GR6321 and GR6322 to ambient.

### Seq. 05: Engine Gas Flow Check Using $\text{GN}_2$ through Fuel and Oxidizer Injector Valves

- a. Opening of If engines fuel injector valve and pressurization of fuel manifold with  $\text{GN}_2$  through an orifice flowmeter at GR6321. Establishment of flow with 24.95 to 25.05 psig in the fuel manifold. Pressurization of oxid manifold to approximately 160 psig through GR6322.
- b. Increase of input pressure to flowmeter (approximately 10 psig) and determination of stabilized fuel manifold pressure. Decrease of input pressure to flowmeter (approximately 20 psig) and determination of stabilized fuel manifold pressure. Increase of pressure to establish original flow conditions.

## OCP OUTLINE

OCP-GF-31030-LM5

### Test Description: (Cont)

- c. While maintaining initially established input pressure, the fuel injector valve in each engine is flowed individually. Stabilized flowmeter input pressure is recorded, as well as corresponding fuel manifold pressure for each engine.
- d. Decrease of manifold supply pressure to zero psig. The oxid manifold then vents through GR6322 and fuel manifold. Fuel injector valve is then closed.
- e. Repeat of steps (a) through (d) for the oxid injector valves, establishing a controlled GN<sub>2</sub> flow through the flowmeter orifice located on GR6321 and a backup pressure through GR6322.

### Seq. 06: RCS Engine Injector Orifice Flow Test.

- a. Pressurization of the fuel manifold to 98 to 102 psig GN<sub>2</sub> through port GR6321, and the oxidizer manifold to 3 to 5 psig GN<sub>2</sub> through port GR6322.
- b. Opening of the Is fuel and oxidizer injector valves and actuation of the injector flow sensor unit. Recording of sensor unit signals for Is fuel orifices.
- c. Closing of Is oxidizer and fuel injector valves.
- d. Venting of pressure in the oxidizer and fuel manifolds through GR6321 and GR6322 to ambient.
- e. Pressurization of the oxidizer manifold to 98 to 102 psig GN<sub>2</sub> through port GR6322, and the fuel manifold to 8 to 12 psig GN<sub>2</sub> through port GR6321.
- f. Repeat of step (c) for Is oxidizer orifice.
- g. Closing of Is oxidizer and fuel injector valves.
- h. Venting of pressure in the oxidizer and fuel manifolds through GR6321 and GR6322 to ambient.
- i. Repeat of steps (a) through (h) for remaining RCS engines.

### Seq 07: Injector Valve Forward Leakage Check Using GN<sub>2</sub>

- a. Pressurization of the fuel manifold to 95 to 105 psig GN<sub>2</sub> through port GR6321.
- b. With VLD's attached to throat plugs installed in the If and IIf engine thrust chambers, collection for a specified period of time of the nitrogen leaking through the fuel injector valves.

OCP OUTLINE

OCP-GF-31030-LM5

Test Description: (Cont)

- c. Venting of the fuel manifold through GR6321 to 10 to 20 PSIG.
- d. Pressurization of the oxidizer manifold to 95 to 105 psig  $\text{GN}_2$  through port GR6322.
- e. With VLD's attached to throat plugs installed in the If and IIf engine thrust chambers, collection for a specified period of time of the nitrogen leaking through the oxidizer injector valves.
- f. Venting of the oxidizer manifold through port GR6322 to 10-20 PSIG.

Seq. 08: Reapplication of Pad Pressure in RCS Tankage Modules.

- a. Pressurization of System 'A' fuel and oxidizer propellant tank bladders to 5 to 15 psig  $\text{GN}_2$  through GR6311 (fuel) and GR6312 (oxidizer), with GR6281 and GR6282 vented.
- b. Close GR6311, GR6312, GR6281 and GR6282.
- c. Pressurization of System 'B' fuel and oxidizer propellant tank bladders to 5 to 15 psig  $\text{GN}_2$  through GR6313 (fuel) and GR6314 (oxidizer) with GR6283 and GR6284 vented.
- d. Close GR6313, GR6314, GR6283, and GR6284

OCP OUTLINE

OCP-GF-31031-LM5

Test Title:

RCS Verification.

Subsystem:

Reaction Control Subsystem (RCS).

Test Objectives:

- a. Verification of helium high pressure section through proof pressurization and leak tests of braze and mechanical joints.
- b. Verification of normal functioning of PQMD.
- c. Verification of acceptance leakage rates for main shutoff valves, helium couplings, propellant quick disconnects, burst discs, and propellant tank bladders.
- d. Verification of normal functioning of helium pressure relief valves and helium pressure regulators.

Vehicle Configuration:

RCS/Ascent Stage.

Location:

Plant 5, Cold Flow Facility.

Hazardous Operations:

Pneumatic pressures up to 4000 psig.

Components Under Test:

RCS tankage module.

RCS helium tank.

Helium module components (PQMD's, relief valves, burst disc, regulators and squib valve, etc.).

Test Description:

Seq. 01: Call to Stations.

The following tests are accomplished on both RCS 'A' and 'B' Systems.

Seq. 02: Helium Module Pressure Tests.

- a. Proof pressure tests of helium tanks and lines, upstream of the explosive valves, are made at 4000 psig.

OCP OUTLINE

OCP-GF-31031-LM5

Test Description: (Cont)

- b. External leak check at 3500 psig of joints and fittings upstream of the explosive valves.
- c. Leak checks of explosive valves and helium fill and vent quick disconnects at 3500 psig.
- d. Functional tests were made at various measures on the PQMD's and the high pressure transducer.

(Paragraphs 4.2.2.7.2, 4.2.2.7.6)

Seq. 03  
and

Seq. 04: Propellant Tank System.

- a. Verification of burst disc integrity at 20-30 psig (verification of no gas flow through the burst disc port).
- b. The propellant tanks and lines between the quad check valves and the main shutoff valves pressurized to operating pressure (195-205 psig) and leak checks made on all mechanical joints. Leakage through the main shutoff valves is determined. Leak checks made on the poppets of the helium and propellant flight half QD's.

(Paragraph 4.2.2.7.6)

Seq. 05  
and

Seq. 06: Relief Valve Functional Tests.

- a. Verification is made on relief valve cracking and reseating pressures.
- b. Leak check of relief valve test ports.
- c. Verification of bleed valve opening and closing pressures.

(Paragraph 4.2.2.7.6.)

Seq. 07  
and

Seq 08: Regulator Functional Checks.

- a. Checks of both the primary and secondary regulator outlet pressures is made at high flow (20 SCFM) and low flow (3.6 SCFM). Inlet pressures are 1000 psig. Regulator creep rate at lockup conditions is also checked.
- b. Internal leakage of both the primary and secondary regulators is made with an inlet pressure of 3500 psig.

(Paragraph 4.2.2.7.6)

OCP OUTLINE

OCP-GF-31031-LM5

Test Description: (Cont)

Seq. 09

and

Seq. 10: Burst Disc Leak Check.

- a. The leak rate of the burst disc of each helium pressure relief valve is determined.

(Paragraph 4.2.2.7.6)

Seq. 11

and

Seq. 12: Bladder Leak Check.

- a. Leakage through the bladders is determined using an internal pressure of 10 psig.

(Paragraph 4.2.2.7.6)

Seq. 13: Reapplication of Pad Pressure.

- a. A blanket pressure of  $\text{GN}_2$  is restored to the propellant tanks and manifolds of both the 'A' and 'B' systems.

(Paragraph 4.2.2.7.5)

OCP OUTLINE

OCP-GF-31034-LM5

Test Title:

RCS Functional.

Subsystem:

Reaction Control Subsystem (RCS).

Test Objectives:

- a. Verification that the helium leak rates of all isolation valves (Systems 'A' and 'B'), the fuel and oxidizer crossfeed valves (both directions), and mechanical joints are within specification requirements.
- b. Verification that the gas flow distribution in the RCS engine combustion chambers are within allowable limits.
- c. Verification of isolation valve channel identification.
- d. Verification that the forward leakage rates of the engine injector valves are within allowable limits.
- e. Verification of main shutoff valve channel identification.
- f. Verification that the cracking pressure and internal leakage of each of the individual check valves of the quad check valve assemblies are within specification requirements. (Systems 'A' and 'B'.)

Vehicle Configuration:

Ascent Stage.

Location:

CEF, Plant 5.

Hazardous Operations:

Pneumatic pressures to 205 psig.

Components Under Test:

Isolation and crossfeed valves.

Engine orifices and injector valves.

Quad check valves.

Test Description:

Seq. 01: Call to Stations.

OCP OUTLINE

OCP-GF-31034-LM5

Test Description: (Cont)

Seq. 02: Leak Check of Isolation Valves, Crossfeed Valves and Service Q.D.'s and Channel ID.

(Paragraphs 4.2.2.7.3(b)5(e) & (f), 4.2.2.7.6(f) and (h))

- a. Pressurization of Systems 'A' and 'B' propellant manifolds to 195 to 205 psig GHe through service ports GR6323 and GR6324.
- b. Determination of external leakage of the mechanical connectors of the propellant manifold pressure transducers, engine dyna-tube mechanical joints, and the manifold service Q.D.'s (capped and uncapped).
- c. Determination of isolation valve forward leakage by opening the engine injector valves and collecting leakage using a volumetric leak detector.
- d. Determination of crossfeed valve internal leakage (both directions) by first pressurizing the 'A' system through service ports GR6321 and GR6322, to 195 to 205 psig GHe, and collecting leakage at ports GR6323 and GR6324. System 'B' is then pressurized through GR6323 and GR6324, with leakage collected at GR6321 and GR6322.
- e. Determination of crossfeed valve channel identification by opening the valves and verifying gas flow through GR6321 and GR6322.

Seq. 03: Injector Valve Forward Leakage, Main Shutoff Valve Channel I.D. and Reapplication of Pad Pressure.

(Paragraph 4.2.2.7.3(e)(f))

- a. Leak check of engine injector valves using throat plugs and volumetric leak detectors. Four valves are done simultaneously. The four throat plugs and volumetric leak detectors are first configured to the quad I engines. The fuel manifolds are pressurized to 95 to 105 psig nitrogen through service ports GR6321 and GR6323, and the leakage from the fuel injector valves in Quad I, is collected for fifteen (15) minutes.
- b. The fuel manifolds are vented, and the oxidizer manifolds are pressurized to 95 to 105 psig nitrogen through service ports GR6322 and GR6324. Leakage through the oxidizer injector valves in Quad I is collected for fifteen (15) minutes.
- c. Repeat (a) and (b) for Quads II, III, and IV.
- d. Verification of main shutoff valve vehicle wiring by cycling the valves from the cabin, and observing nitrogen gas flow going into port GR6322 and out GR6312 (oxidizer 'A'), in GR6321 and out GR6311 (fuel 'A'), in GR6324 and out GR6314 (oxidizer 'B'), and in GR6323 and out GR6313 (fuel 'B').



OCP OUTLINEOCP-GR-31034-LM5Test Description: (Cont)

- e. Disconnect GSE, leaving a 10 to 20 psig nitrogen pad pressure in the propellant manifolds.

Seq. 04: Quad Check Valve - Cracking and Internal Leakage - System 'A'  
(Paragraph 4.2.2.7.6(c))

- a. Pressurization of propellant tank bladders to 10 to 15 psig helium through fill disconnects GR6312 (oxidizer) and GR6311 (fuel).
- b. Determination of the cracking pressures of the individual quad check valves by pressurization of the upstream side with helium until the valve poppet is unseated. The pressure at which the valve cracks, is determined by observing a container of water placed on the downstream side of the valve. Three readings for each valve are taken. The following table lists the service ports that are pressurized, and the ports at which the water container is placed, for each of the valves.

<u>Propellant</u>	<u>Check Valve</u>	<u>Pressure</u>	<u>Water Container</u>
Oxidizer	V1 (Pri)	GR 6233	GR 6251
Oxidizer	V2 (Pri)	GR 6233	GR 6252
Oxidizer	V3 (Sec)	GR 6251	GR 6282
Oxidizer	V4 (Sec)	GR 6252	GR 6282
Fuel	V1 (Pri)	GR 6233	GR 6241
Fuel	V2 (Pri)	GR 6233	GR 6242
Fuel	V3 (Sec)	GR 6241	GR 6281
Fuel	V4 (Sec)	GR 6242	GR 6281

Determination of the leak rates of each of the individual quad check valves by pressurization of the downstream side of the valve to 0.5 to 0.8 psig helium, and collecting leakage on the upstream side with a volumetric leak detector. The following table lists the service ports that are pressurized, and the ports at which the volumetric leak detector is placed for each of the valves.

<u>Propellant</u>	<u>Check Valve</u>	<u>Pressure</u>	<u>VLD</u>
Oxidizer	V1 (Pri)	GR 6251	GR 6233
Oxidizer	V2 (Pri)	GR 6252	GR 6233
Oxidizer	V3 (Sec)	GR 6282	GR 6251
Oxidizer	V4 (Sec)	GR 6282	GR 6252
Fuel	V1 (Pri)	GR 6241	GR 6233
Fuel	V2 (Pri)	GR 6242	GR 6233
Fuel	V3 (Sec)	GR 6281	GR 6241
Fuel	V4 (Sec)	GR 6281	GR 6242

Seq. 05: Propellant Tank Pad Pressure - System "A"

- a. Connect GSE lines to System "A" oxidizer tanks fill port (GR6312) and fuel tank fill port (GR6311).

OCP OUTLINEOCP-Gr-31034-IM5Test Description: (Cont)

- b. Establish a 10-15 PSIG GHe pad pressure in the propellant tanks, System "A".

Seq. 06: Quad Check Valve - Cracking and Internal Leakage - System 'B'  
(Paragraph 4.2.2.7.6(c))

- a. Typical to Sequence 04 (a) using ports GR6314 (oxidizer) and GR6313 (fuel).
- b. Typical to Sequence 04 (b) using the following service ports.

<u>Propellant</u>	<u>Check Valve</u>	<u>Pressure</u>	<u>Water Container</u>
Oxidizer	V1 (Pri)	GR 6234	GR 6253
Oxidizer	V2 (Pri)	GR 6234	GR 6254
Oxidizer	V3 (Sec)	GR 6253	GR 6284
Oxidizer	V4 (Sec)	GR 6254	GR 6284
Fuel	V1 (Pri)	GR 6234	GR 6243
Fuel	V2 (Pri)	GR 6234	GR 6244
Fuel	V3 (Sec)	GR 6243	GR 6283
Fuel	V4 (Sec)	GR 6244	GR 6283

<u>Propellant</u>	<u>Check Valve</u>	<u>Pressure</u>	<u>VLD</u>
Oxidizer	V1 (Pri)	GR 6253	GR 6234
Oxidizer	V2 (Pri)	GR 6254	GR 6234
Oxidizer	V3 (Sec)	GR 6284	GR 6253
Oxidizer	V4 (Sec)	GR 6284	GR 6254
Fuel	V1 (Pri)	GR 6243	GR 6234
Fuel	V2 (Pri)	GR 6244	GR 6234
Fuel	V3 (Sec)	GR 6283	GR 6243
Fuel	V4 (Sec)	GR 6283	GR 6244

Seq. 07: Propellant Tank Pad Pressure - System "B"

- a. Connect GSE lines to System "B" oxidizer tank fill port (GR6314) and fuel tank fill port (GR6313).
- b. Establish a 10-15 PSIG GHe pad pressure in the propellant tanks, System "B".

OCP OUTLINE

OCP-GT-32001-JME

Test Title:

A/S Weight and Center of Gravity Test

Subsystem:

Structure

Test Objective:

To determine the dry weight and the horizontal (Y-Z) center of gravity of the Ascent Stage

Vehicle Configuration:

Ascent Stage

Location:

Plant 5, Weight and Balance Fixture

Hazardous Operation:

Not Applicable

Equipment Under Test:

Ascent Stage

Test Description:

Seq. 01: Call to Stations

Seq. 02: A/S Weight and Center of Gravity Test

- a. Positioning and leveling of Ascent Stage.
- b. Adjustment of load cell digital readout unit.
- c. Zeroing of load cells
- d. Preloading of load cells
- e. Transfer of total load to load cells
- f. Verification that Ascent Stage has remained level.
- g. First Weighing
- h. Repeat of above for second and third weighings
- i. The data from this OCP will be used as the basis for a weight report giving actual weight and horizontal center of gravity.  
(Paragraph 4.2.2.1.1)

OCP OUTLINE

OCP-GF-32003-LM5

Test Title:

Landing Gear Functional Test

Subsystem:

Mechanical

Test Objective:

To verify the overall functional ability of the landing gear system with regard to the deployment and downlock mechanisms.

Vehicle Configuration:

Descent

Location:

Plant 5, Landing Gear Test Fixture

Hazardous Operation:

Not Applicable

Equipment Under Test:

Landing Gear Mechanism

Test Description:

Seq. 01: Call to Stations

Seq. 02: Continuity Check of Lunar Surface Sensing Probe Switches

Seq. 03

to

Seq. 06: Landing Gear Functional Test

- a. Continuity check of landing gear deployed switches in deployed and stowed positions.
- b. Measurement of gear travel (distance between bolt centers of uplock mechanism) at probe release during deployment.
- c. Measurement of time to fully extend and lock gear down.
- d. Above procedures are performed individually for each gear.  
(Paragraph 4.2.2.1.3)

OCP OUTLINE

OCP-GF-32012-LM5

Test Title:

D/S Weight and Center of Gravity Test

Subsystem:

Structure

Test Objectives:

To determine the dry weight and the horizontal (Y-Z) center of gravity of the descent stage.

Vehicle Configuration:

Descent Stage

Location:

Plant 5, Weight and Balance Fixture

Hazardous Operation:

Not Applicable

Equipment Under Test:

Descent Stage

Test Description:

Seq. 01: Call to Stations

Seq. 02: D/S Weight, and Center of Gravity Test

- a. Position and level of descent stage
- b. Adjustment of Load Cell Digital Readout Unit
- c. Zeroing of load cells
- d. Preloading of load cells
- e. Transfer of total load to load cells
- f. Verification that descent stage had remained level
- g. First weighing
- h. Repeat of above for second and third weighings.
- i. The data from this OCP will be used as the basis for a weight report giving actual weight and horizontal center of gravity.  
(Paragraph 4.2.2.1.2)

OCP OUTLINE

OCP-GF-32014-LM5

Test Title:

Crew Compartment Fit and Functional Test

Subsystem:

Crew Provisions

Test Objective:

To demonstrate that each crew equipment item is functionally and physically compatible with the spacecraft, the mission sequence and crew flight requirements, by simulating the LM-5 mission.

Vehicle Configuration:

Mated Stages

Location:

Integrated Work Stand Plant 5

Hazardous Operation:

Not Applicable

Equipment Under Test:

Crew equipment within the crew compartment listed on official LM-5 stowage list.

Test Description:

Seq. 01: Call to Stations

Seq. 02: Support System Status Verification

- a. Power-up and verification of EPS.
- b. Power-up and verification of Veh. Comm.

Seq. 03: Lunar Television Transmission

Seq. 04: Flight Crew Readiness

- a. Verification of Crew Suiting and Cabin Ingress per OCP-GR-32015-LM5
- b. Evaluation of reach capability and mobility utilizing transfer umbilical.

Seq. 05: Ingress and Checkout

- a. Demonstration of change-over, transfer umbilical to LM ECS.
- b. Preparation of Cabin for habitation.

## OCP OUTLINE

OCP-GF-32014-LM5

### Test Description: (Cont)

- c. Verification of communication capability.
- d. Demonstration of Equipment Transfer
- e. Demonstration of Post Ingress Operation
- f. Demonstration of waste management capability
- g. Alignmer' of IMU
- h. Utilization of food packs

### Seq. 06: EVA

- a. Demonstration of EVA preparation
- b. Demonstration of PLSS/OPS Preparation for Checkout
- c. Demonstration of Post EVA Configuration
- d. Verification of PLSS recharge fit check
- e. Evaluation of Sequence Camera Operation
- f. Demonstration of EVA Equipment Stowage
- g. Evaluation of Hard Suit Operations in Cabin

### Seq. 07: Rendezvous Egress

- a. Demonstration of LiOH cartridge replacement
- b. Demonstration of preparation for docking
- c. Installation of COAS in Forward and Docking Windows and changing of COAS light bulb.
- d. Demonstration of Rendezvous Radar Antenna Deployment
- e. Preparation of Equipment for Transfer
- f. Stowage of Droque and Probe
- g. Verification of cabin egress per OCP-GF-32016-LM5.  
(Paragraph 4.2.2.4.5(b))

### Seq. 08: Egress/Ingress Procedure for Lunch Break

### Seq. 09: Droque Installation & Removal Fit Check

### Seq. 10: Securing After Test

OCP OUTLINE

OCP-GF-32016-LM5

Test Title:

Crew Suiting, Vehicle Ingress/Egress and Suit - Vehicle Checkout.

Subsystem:

Crew Provisions

Test Objective:

To control the crew suiting and their ingress and egress of the LM spacecraft.

Vehicle Configuration:

Ascent Stage

Location:

Final Assembly Area, Integrated Work Stand

Hazardous Operation:

Not Applicable.

Equipment Under Test:

Spacesuits and associated support equipment.

Test Description:

Seq. 01: Call to Stations

Seq. 02: PGA Preparation to Donning

Preparation of the pressure garment assembly for donning. Verification of the liquid cooling garment and urine collection transfer assembly acceptability

Seq. 03: PGA Donning

Suiting of the crew, and donning of associated equipment.

Seq. 04: Crew LM Ingress

Ingress of the LM Crew to the Vehicle

Seq. 05: Crew LM Egress

Egress of the LM Crew from the Vehicle.



OCP OUTLINE

OCP-GF-32017-LM5

Test Title:

Crew Compartment Stowable Equipment Installation and Removal.

Subsystem:

Crew Provisions

Test Objectives:

To control packaging, installation and removal of all stowable equipment.

Vehicle Configuration:

Mated Stages

Location:

Final Assembly Area, Integrated Work Stand.

Hazardous Operations:

None

Equipment Under Test:

All equipment listed in LM5 Stowage List, List B plus TV camera and associated equipment.

Test Description:

Seq. 01: Call to Stations

Seq. 02: Stowage in Crew Compartment

- a. Transferral of packages to vehicle from the bond and packaging area.
- b. Removal of each item from its package and stowage in the vehicle as stated in Stowable Item Verification Checkout Data Sheet.

Seq. 03: Re-stowage of Vehicle after Run I of OCP-32014.

- a. Verification and/or restowing of all stowable equipment as stated in Stowable Item Verification Checkout Data Sheet.

Seq. 04: Removal from Vehicle

- a. Removal of each stowable item from vehicle, and placement in their respective package containers.

Seq. 05: Return to Bond and Packaging Area

- a. Transferral of all packages from vehicle to bond and packaging area.

OCP OUTLINE

OCP-GF-32020-LM5

Test Title:

Electrical Circuit Interrupter Operational Test

Subsystem:

Explosive Devices

Test Objective:

Verification of the cycling operation of the electrical circuit interrupters.

Vehicle Configuration:

Ascent and Descent Stages, electrically mated.

Location:

Integrated Workstand, Plant 5

Hazardous Operations:

Pressurization and X-Ray of Electrical Circuit Interrupters.

Components Under Test:

Electrical Circuit Interrupters

Test Description:

Seq. 01: Call to Stations.

Seq. 02: Electrical Circuit Interrupter Operation. (NASA TWX EP4/13-6-BG 54-67-T321 Dated 23 Mar 67, and LTE 10-38 Dated 4 March 1967)

- a. P/J173 ECI Cycling
- b. P/J174 ECI Cycling
- c. X-RAY of ECI Connectors
- d. P/J173 ECI Reset
- e. P/J174 ECI Reset
- f. X-Ray of ECI Connectors for verification of resetting

OCP OUTLINE

OCP-GF-32021-LM5

Test Title:

D/S Equipment Fit and Functional

Subsystem:

Crew Provisions

Test Objective:

To demonstrate that each crew equipment item stowed within the D/S is functionally and physically compatible with the spacecraft.

Vehicle Configuration:

D/S

Location:

Final Assembly Area, Weight and Balance Fixture

Hazardous Operations:

None

Equipment Under Test:

D/S stowable equipment as listed in Stowage Test

Test Description: (Reference: CCA 857 Ammend, 1)

Seq. 01: Call to Stations

Seq. 02: D/S Equipment Fit and Functional Test

- a. Activate ME3A release mechanism and adjust height of pallet.
- b. Deploy and position work table and lunar transfer bag.
- c. Stow and unstow LiOH canisters and PLSS batteries in transfer bag.
- d. Unstow and simulate use of T.V. Camera and accessories.
- e. Unstow and simulate use of Sample Return Container.

OCP OUTLINE

OCP-GF-33001-LM5

Test Title:

Ascent Stage Environmental Control Subsystem Proof Pressure and Leakage Checks.

Subsystem:

Environmental Control System HTS A/S

Test Objectives:

To verify the structural integrity of the HTS A/S with a proof pressure and leakage test.

Vehicle Configuration:

Ascent Stage

Location:

Integrated Workstand, Plant 5.

Hazardous Operations:

Pneumatic pressures up to 60 psig.

Components Under Test.

A/S HTS Including:

Coolant Recirculation Assembly.

Secondary Filter

ARS H/X s

Suit Temperature Control Valve

Coolant Regenerative H/X

Cabin Air Recirculation Assembly

Cabin Temperature Control Valve

DSE Cold Plate

PSA Cold Plate

CDU Cold Plate

LGC Cold Plate

LCA Cold Plate

OCP OUTLINE

OCP-GF-33001-LM5

Components Under Test: (Cont)

GASTA Cold Plate

Coolant Accumulator

Aft Equipment Bay Cold Plates 1 through 11

TLE Cold Plate

ASA Cold Plate

PTA Cold Plate

RGA Cold Plate

Interstage Disconnects

Test Description:

Seq. 01: Call to Stations

Seq. 02: HTS Proof Pressure and Pressure Decay Test

- a. Proof Pressure Test of the Primary and Secondary HTS A/S at 60 psig with helium. (Para. 4.2.2.3.6.)
- b. Pressure Decay Test of the Primary and Secondary A/S at 45 psig with helium. (Para. 4.2.2.3.6.)

Seq. 03: WMS Secondary HTS Interloop Test

- a. Leakage test of the LSC 330-410 Isolation Valve (Para. 4.2.2.3.6).

Seq. 04: Leakage Test of the Primary and Secondary HTS A/S with a Mass Spectrometer Using Helium at 45 PSIG. (Para. 4.2.2.3.6.)

Seq. 05: HTS Inter-Coolant Loop Leak Test (Para. 4.2.2.3.6).

- a. Purge of the secondary loop for 15 minutes with GN<sub>2</sub>.
- b. Probe of the HTS secondary effluent gas continuously for 4 minutes.

Seq. 06: Secondary HTS Pressure Decay Test (Para. 4.2.2.3.6)

- a. Pressurization of the secondary HTS to 45 PSIG with GN<sub>2</sub>.
- b. Performance of a one hour pressure decay test on the secondary HTS.

Seq. 07: Primary HTS A/S Pressure Decay Test (Para. 4.2.2.3.6)

- a. Pressurization of the Primary HTS A/S to 45 PSIG with GN<sub>2</sub>.

OCP OUTLINE

OCP-GF-33001-LM5

Test Description: (Cont)

- b. Performance of a 4.6 hour Pressure Decay Test of the Primary HTS A/S with the accumulator LSC330-210 disconnected from the system.
- c. Performance of a volumetric leakage test of the accumulator LSC 330-210 in accordance with the following:
  - 1. Accumulator LSC 330-210 connected to the Primary HTS A/S.
  - 2. Displacement Leak Meter connected to port JF 9137 of the Accumulator
  - 3. The Primary HTS A/S pressurized with GN<sub>2</sub> at 45 PSIG.
- d. Performance of a 1 hour Pressure Decay Test of the Primary HTS A/S with GN<sub>2</sub> at 45 PSIG, with the accumulator LSC 330-210 connected to the system.

Seq. 06: Securing After Test

- a. Venting of the Primary HTS A/S to ambient pressure.

OCP OUTLINE

OCP-GF-33013-LM5

Test Title:

ECS Interstage Disconnects Proof Pressure and Leakage Test

Subsystem:

ECS HTS and OCPS

Test Objectives:

To verify the mechanical integrity of the HTS and OCPS Interstage Disconnects with a proof pressure and leakage test.

Vehicle Configuration:

Ascent and Descent Stage mated.

Location:

Integrated workstand, Plant 5.

Hazardous Operations:

Pneumatic pressures up to 1340 PSIG.

Equipment Under Test:

HTS and OCPS Interstage Disconnects

Test Description:

Seq. 01: Call to Station

Seq. 02: HTS Interstage Disconnects Proof Pressure and Leak Check.

- a. Pressure Decay Test of the HTS Interstage Disconnects with helium at 29 PSIG for 5 minutes.
- b. Proof Pressure Test of the HTS Interstage Disconnects with helium at 60 PSIG for 5 minutes, (paragraph 4.2.2.3.6).
- c. Leakage test of the HTS Interstage Disconnects with a Mass Spectrometer using helium at 45 PSIG, (paragraph 4.2.2.3.6).

Seq. 03: GOX Interstage Disconnect Proof Pressure and Leak Check

- a. Proof Pressure Test of the GOX Interstage Disconnect with helium at 1340 PSIG for 5 minutes, (paragraph 4.2.2.3.5.1(b)).
- b. Leakage Test of the GOX Interstage Disconnect with a Mass Spectrometer using helium at 950 PSIG, (paragraph 4.2.2.3.5.1(c)(2)).

Seq. 04: Securing After Test

OCF OUTLINE

OCF-GF-33020-LMS

Test Title:

A/S Oxygen Cabin Pressure Section Proof Pressure, External Leak and Flow Checks

Subsystem:

A/S Environmental Control

Test Objectives:

- a. Perform a proof pressure test and helium leak test to verify the mechanical and pressure integrity of the Oxygen Cabin Pressure Section (OCPS), and Atmosphere Revitalization Section (ARS).
- b. To verify mechanical operation and control of regulators and valves at operating pressure and flow conditions.

Vehicle Configuration:

Ascent Stage

Location:

Cold Flow Facility

Hazardous Operation:

- a. Application of gaseous helium pressures up to 1350 PSIG.
- b. Application of gaseous oxygen pressures up to 980 PSIG.
- c. Application of gaseous nitrogen pressures up to 980 PSIG.

Components Under Test:

- a. A/S GOX Tanks
- b. A/S Interstage QD
- c. Oxygen Control Module
- d. Suit Circuit Assembly
- e. PLSS O<sub>2</sub> Fill QD

Test Description:

eq. 01: Call to Stations



OCP OUTLINE

OCP-GF-33020-LM5

Test Description: (Cont)

Seq. 02: OCPS Low Pressure Leak Test

- a. Fill A/S OCPS with gaseous Helium through JF9555 to 300 PSIG.
- b. Probe each possible source of leakage with a Helium Leak Detector.

Seq. 03: OCPS Proof Pressure Test

- a. Increase pressure of OCPS through JF9555 to Proof Pressure of 1340 PSIG GHe.
- b. Hold Proof Pressure for 5 minutes (paragraph 4.2.2.3.5.1(B)).
- c. Reduce pressure of OCPS through JF9555 to 980 PSIG GHe.

Seq. 04: OCPS Gross Leak Test

- a. Disconnect GH QD from JF9555.
- b. Perform fifteen minute Pressure Decay Test of OCPS.

Seq. 05: OCPS Helium Leakage Test

- a. Probe each possible source of leakage with a Helium Leak Detector. (Paragraph 4.2.2.3.5.1.1(a)).
- b. Connect GSE QD to JF9555.
- c. Reduce OCPS pressure to ambient through JF9555.

Seq. 06: ARS and ARS/WMS Proof Pressure Test

- a. Isolate ARS from Cabin and OCPS.
- b. Isolate Oxygen Control Module from Cabin and GOX Tanks.
- c. Pressurize ARS through JF9112 and GF9114 and oxygen Control Module through JF9555 to 6.4 PSIG GHe.
- d. Hold Proof Pressure for five minutes (paragraph 4.2.2.3.3(c)).
- e. Vent ARS through JF9112 and GF9114 and oxygen Control Module through JF9555 to 4.1 PSIG GHe.

Seq. 07: ARS and ARS/WMS Interface Helium Leak Test

- a. Probe each possible source of leakage with a Helium Leak Detector.
- b. Vent ARS through JF9112 and GF9114 and Oxygen Control Module through JF9555 to ambient pressure.

OCP OUTLINE

OCP-GF-33020-LM5

Test Description: (Cont)

Seq. 08: ARS and ARS/WMS Interface External Leakage Test

- a. Pressure purge ARS and OCPS to 3.9 PSIG with GOX through JF9112, GF9114 and JF9555 to expel Helium.
- b. With the Oxygen Demand Regulators closed and the CO<sub>2</sub> Canister Select Valve in the Mid-Position, measure the oxygen make-up flow through GF9114 and JF9112 required to compensate for ARS oxygen external leakages (Paragraph 4.2.2.3.3(c)).
- c. With the Oxygen Demand Regulators closed, the CO<sub>2</sub> Canister Select Valve in Primary and the secondary CO<sub>2</sub> Canister Cover removed, measure the oxygen make-up flow through GF9114 and JF9112 required to compensate for ARS oxygen external leakage.
- d. With the Oxygen Demand Regulators closed, the CO<sub>2</sub> Canister Select Valve in Secondary and the Primary CO<sub>2</sub> Canister Cover removed, measure the oxygen make-up flow through GF9114 and JF9112 required to compensate for ARS oxygen external leakage.
- e. Vent ARS through JF9112 and GF9114 and Oxygen Control Module through JF9555 to ambient pressures.

Seq. 09: Cabin Repressurization Valve Functional Test

- a. Pressurize OCPS through JF9555 to 935 PSIG with GOX.
- b. Electrically open the LSC-330-309 Cabin Repressurization Valve for two seconds. Allow valve to slam reseal at high pressure.
- c. Pressurize the OCPS through JF9555 to 935 PSIG.
- d. Electrically open the LSC-330-309 Cabin Repressurization Valve for Ten seconds. Record pressure and temperature decay of OCPS GOX Tanks.
- e. Pressurize OCPS through JF9555 to 935 PSIG with GOX.

Seq. 10: Oxygen Demand Regulator Functional Test - Cabin Mode

- a. Evacuate ARS through JF9112 and GF9114 to 4.8 PSIA.
- b. With Oxygen Demand Regulator "A" in "Cabin" and Oxygen Demand Regulator "B" in "Closed", withdraw oxygen through JF9111 and GF9113 to simulate metabolic demand. (Paragraph 4.2.2.3.5.2(c))
- c. With Oxygen Demand Regulator "A" in "Closed" and Oxygen Demand Regulator "B" in "Cabin", withdraw oxygen through JF9111 and GF9113 to simulate metabolic demand. (Paragraph 4.2.2.3.5.2(c))

OCP OUTLINE

OCP-GF-33020-LM5

Test Description: (Cont)

Seq. 11: Oxygen Demand Regulator Functional Test-E<sub>1</sub> Mode

- a. Evacuate ARS through JF9112 and GF9114 to 3.8 PSIA.
- b. With Oxygen Demand Regulator "A" in "Egress" and Oxygen Demand Regulator "B" in "Closed", withdraw oxygen through JF9111 and GF9113 to simulate metabolic demand. (Paragraph 4.2.2.3.5.2(c))
- c. With Oxygen Demand Regulator "A" in "Closed" and Oxygen Demand Regulator "B" in "Egress", withdraw oxygen through JF9111 and GF9113 to simulate metabolic demand. (Paragraph 4.2.2.3.5.2(c))
- d. Vent the ARS to ambient through GF9113 and JF9111.

Seq. 12: OCPS External Leakage Test

- a. With both "Reg A" and "Reg B" closed measure the make-up leakage flow through JF9555 required to maintain 935 PSIG GOX in the OCPS. (Paragraph 4.2.2.3.5.1.1(A))
- b. With "Reg A" in "Egress" and "Reg B" closed measure the make-up flow through JF9555 required to maintain 935 PSIG GOX in the OCPS (Paragraph 4.2.2.3.5.1.1(A)).
- c. With "Reg A" in "Cabin" and "Reg B" closed measure the make-up flow through JF9555 required to maintain 935 PSIG GOX in the OCPS. (Paragraph 4.2.2.3.5.1.1(A)).
- d. With "Reg A" closed and "Reg B" in "Egress measure the make-up flow through JF9555 required to maintain 935 PSIG GOX in the OCPS. (Paragraph 4.2.2.3.5.1.1(A)).
- e. With "Reg A" closed and "Reg B" in "Cabin" measure the make-up flow through JF9555 required to maintain 935 PSIG GOX in the OCPS (Paragraph 4.2.2.3.5.1.1(a)).
- f. Vent the OCPS to ambient through JF9555.

Seq. 13: Oxygen Shut-off Valve Internal Leakage Test

- a. Descent O<sub>2</sub> Valve Positive Direction Leakage Test.
  1. Pressurize upstream side of Descent O<sub>2</sub> Valve through GF9117 to 940 PSIG GN<sub>2</sub>.
  2. Measure leakage at JF9555 with a VLD.

OCP OUTLINE

OCP-GF-33020-LM5

Test Description: (Cont)

- b. PLSS O<sub>2</sub> Fill Valve Test
  - 1. Pressurize upstream side of PLSS Fill Valve through GF9117 to 940 PSIG with GN<sub>2</sub>.
  - 2. Measure leakage at JF9555 with a VLD.
- c. No. 1 Ascent O<sub>2</sub> Valve Test
  - 1. Pressurize GOX Tank #1 through GF9117 to 940 PSIG GN<sub>2</sub>.
  - 2. With No. 1 Asc O<sub>2</sub> Valve closed vent Oxygen Control Module to ambient through GF9117.
  - 3. With the Descent O<sub>2</sub> Valve closed measure leakage at JF9555 with a VLD.
  - 4. Vent GOX Tank #1 to ambient through GF9117.
- d. No. 2 Ascent O<sub>2</sub> Valve Test
  - 1. Pressurize GOX Tank #2 through GF9117 to 940 PSIG with GN<sub>2</sub>.
  - 2. With No. 2 Asc O<sub>2</sub> Valve closed, vent Oxygen Control Module to ambient through GF9117.
  - 3. With Descent O<sub>2</sub> Valve closed measure leakage at JF9555.
- e. Descent O<sub>2</sub> Valve - Negative Direction Test.
  - 1. With PLSS Valve closed, pressurize Descent O<sub>2</sub> Valve at 940 PSIG with GN<sub>2</sub> from GOX Tank #2.
  - 2. Measure leakage at GF9117.

Seq. 14: Emergency Ventilation Mode Test

- a. Press. Reg. A Test
  - 1. With Press. Reg. A in "Direct O<sub>2</sub>" measure pressure decay of GOX Tank #2 for 5 minutes.
  - 2. During pressure decay, perform a Tactile Flow Test from suit circuit diverter valve and cabin gas return valve.
  - 3. Repressurize GOX Tank #2 and Oxygen Control Module through GF9117 to 940 PSIG with GN<sub>2</sub>.

OCP OUTLINE

OCP-GF-33020-LM5

Test Description: (Cont.)

b. Press Reg B Test

1. With Press Reg B in "Direct O<sub>2</sub>" measure pressure decay of COX Tank #2 for five minutes.
2. During decay perform a Tactile Flow Test from Suit Circuit Diverter Valve and Cabin Gas Return.

Seq. 15: Securing After Test

- a. Attach Alnor Dew Point Indicator to GSE downstream fo GF9117, take two Dew Point readings from GOX Tank #2 through GF9117.
- b. Vent GOX Tank #2 to Ambient through GF9117.
- c. Remove and Stow GSE.
- d. Configure Vehicle for storage.

OCP OUTLINE

OCP-GF-33022-LM5

Test Title:

Water Management Section Leak and Functional Test

Subsystem:

Environmental Control

Test Objectives:

- a. Verification of the structural and Leakage integrity of the WMS.
- b. Verification that the WMS exhibits satisfactory flow characteristics with  $H_2O$ .
- c. To verify leakage rate through WMS bladders is within specifications.
- d. To check internal leakage of water tank select valve, check valves (except descent tank check valve), manual valves, delta P transducers and regulators.
- e. The functional check of the delta P transducer and water regulators.
- f. To flush the water tanks and WCM to verify cleanliness level that will meet requirements of LSP 14-0020 Table II.

Vehicle Configuration:

Mated Stages

Location:

Integrated Workstand, Plant 5

Hazardous Operations:

Proof pressure with GHe to 10.6 psig. Gas pressure to 50 psig.

Equipment Under Test:

Water Control Module  
Ascent Water Tanks  
Descent Water Tank

Test Description:

- Seq. 01: Call to Stations
- Seq. 02: WMS Low Pressure Network Proof Pressure and Helium Leak Test
- a. Pressurization of the ASC tanks to 15 psig with GHe
  - b. Proof pressure test of the low pressure network with GHe at 10.6 psig (excluding 209 & 224 W/B's). (Para. 4.2.2.3.7)

Test Description: (Cont)

- c. Helium leak check of the WMS low pressure network at 9 psig (Para. 4.2.2.3.7).

Seq. 03: Leak Check of Tank Bladder and WCM

- a. Leakages of the water tank bladders from water side to gas side (bladder inflated) as well as from gas side to water side (bladder deflated) at 5 psig GN<sub>2</sub>.
- b. Internal leakage of water tank check valves (except the des. tank check valve due to impracticability), of des. H<sub>2</sub>O check valve, of des. H<sub>2</sub>O valve, of ASC. H<sub>2</sub>O valve, and of tank selector valve from D/S to A/S and A/S to D/S at 50 psig with GN<sub>2</sub>.
- c. Internal leakage of water separator check valves, of prim. evap. flow #1 valve, or sec. evap. flow valve, and of prim. evap. flow #2 valve at 9 psid with GN<sub>2</sub>. (Para. 4.2.2.3.7 and 4.2.2.3.7.1)

Seq. 04: Ascent Tanks and Descent Tank Water Side - 5 Hour Pressure Decay Test

- a. Fill of the water tanks with GN<sub>2</sub> to 50 psig.
- b. Pressurization of the low pressure network (excluding water boiler) to 9 psig.

Seq. 05: WMS Tank Gas Side Pressure Decay; Regulator Redundancy and Flow Check with Water

- a. Evacuation of the water side WMS and fill with water to 50 psig for a 5 hour pressure decay on the gas side of the tanks.
- b. Cycling of regulators and measuring water outlet pressure and flow rates (para. 4.2.2.3.7.1).

Seq. 06: WMS Flush, Purge, Evacuation, and Blanket Pressure

- a. Flush of WMS with water according to cleanliness spec.
- b. Hot N<sub>2</sub> purge of WMS
- c. Evacuation of WMS to 500 microns.
- d. N<sub>2</sub> fill and dew point verification.
- e. N<sub>2</sub> blanket pressure
- f. Securing After Test

OCP OUTLINE

OCP-GF-33024-LM5

Test Title:

Cabin Proof Pressure Test, Cabin Leak Test, and Cabin Dump/Relief Valve Functional Test.

Subsystem:

Environmental Control.

Test Objectives:

Verification of structural integrity of the LM cabin and its pressure regulating characteristics.

Vehicle Configuration:

Ascent Stage

Location:

Cold Flow Facility

Hazardous Operation:

Cabin proof pressure to 7.7 PSIG.

Components Under Test:

Cabin Structure, cabin dump/relief valves.

Test Description:

Seq. 01: Call to Stations

Seq. 02: Cabin and Docking Tunnel Proof Pressure Test (paragraph 4.2.2.3.5.7).

- a. Proof Pressure cabin with nitrogen to 7.7 PSIG.
- b. Determine cracking pressure of Upper Hatch.

Seq. 03: Cabin and Docking Tunnel Leak Test and Cabin Relief/Dump Valve Functional Test (FWD) (paragraph 4.2.2.3.5.1).

- a. Pressurize Cabin and Docking Tunnel to 5.0 PSIG with GN<sub>2</sub>.
- b. Determine Cabin and Docking Tunnel Leakage Rate.
- c. Perform Functional Test of FWD Hatch Dump/Relief Valve
- d. Determine leakage rate of AR3 Steam Duct.
- e. Vent Cabin and Docking Tunnel to Ambient Pressure.
- f. Prepare Vehicle for Upper Hatch Dump/Relief Valve Functional Test.



OCP OUTLINE

OCP-GF-33024-LM5

Test Description: (Cont)

- Seq. 04: Cabin Leak Test and N.A.A. Droque Fit Test (paragraph 4.2.2.3.5.7)
- a. Pressurize cabin to 5 PSIG with GN<sub>2</sub>.
  - b. Determine Cabin Leakage Rate.
  - c. Conduct N.A.A. Droque Fit Test at 5 PSIG.
- Seq. 05: Cabin Relief/Dump Valves Functional Test (paragraph 4.2.3.5.7)
- a. Increase Cabin pressure to perform Functional Test of Upper Hatch Dump Relief Valve.
  - b. Vent cabin to Ambient Pressure.
  - c. Conduct N.A.A. Droque Fit Test at Ambient Pressure.
- Seq. 06: Securing After Test

OCP OUTLINE

OCP-GF-33030-LM5

Test Title:

Descent Stage Oxygen Cabin Pressure Section Proof Pressure, External Leakage and Flow Check.

Subsystem:

Descent stage ECS OCPS

Test Objectives:

- a. To verify the mechanical integrity of the D/S ECS OCPS
- b. To verify the proper functional operation of the regulators and relief valves of the high pressure oxygen control module, part number LSC 330-392.

Vehicle Configuration:

Descent Stage

Location:

Cold Flow Facility

Hazardous Operations:

- a. Pneumatic pressures up to 4000 PSIG.
- b. Oxygen Flow at 2800 PSIG.

Components Under Test:

D/S GOX Tank  
D/S High Pressure Oxygen Control Assembly.  
D/S Oxygen Interstage Disconnect.

Test Description:

Seq. 01: Call to Stations

Seq. 02: D/S OCPS Proof Pressure (Para. 4.2.2.3.5.1)

- a. Pressurize the D/S GOX tank to 4000 PSIG with helium and maintain pressure for 5 minutes.

Seq. 02-011: Bypass Relief Valve Series Functional Test (Para. 4.2.2.3.5.5)

- a. At approximately 2875 PSIG during the above pressurization cycle, observe change in discharge pressure being emitted through GF9118, which is indicative to either relief valve cracking.

OCP OUTLINE

OCP-GF-33030-LM5

Test Description: (Cont)

- b. Depressurize system through GF9150 to 3100 PSIG. Then permit normal venting to continue through overboard relief valve port while observing for indication of valve reseating at approximately 2850 PSIG. Reseat determined by observing change in discharge pressure being emitted through GF9118.

Seq. 03: Primary Bypass Valve Cracking and Reseating Test (Paragraph 4.2.2.3.5.5)

- a. With secondary relief valve overridden, repressurize the D/S GOX tank to 3100 PSIG with helium through GF9150 while observing for indication of primary relief valve cracking at approximately 2875 PSIG. Cracking is determined by noting change in discharge pressure being emitted through GF9118.
- b. Permit normal relief valve action to vent through overboard relief valve port until reseating occurs at approximately 2850 PSIG. Reseat is determined by observing change in discharge pressure being emitted through GF9118.

Seq. 04: Secondary Bypass Relief Valve Cracking and Reseating Test (Paragraph 4.2.2.3.5.5)

- a. With primary relief valve overridden, repressurize the descent stage GOX tank to 3100 PSIG with helium through GF9150 while observing for indication of secondary relief valve cracking at approximately 2875 PSIG. Cracking is determined by observing change in discharge pressure being emitted through GF9118.
- b. Permit normal relief valve action to vent through overboard relief valve port until reseating occurs at approximately 2850 PSIG. Reseat is determined by observing change in discharge pressure being emitted through GF9118.

Seq. 05: Downstream Proof Pressure and Seals Overboard Vent Relief Valve Functional Test (Para. 4.2.2.3.5.5)

- a. Pressure downstream of regulators is increased using GN<sub>2</sub> and pressurizing through port GF9118 to 1090 PSIG while observing for indication of either relief valve cracking at approximately 1020 PSIG.
- b. Downstream Proof Pressure (1090 PSIG) is held for five (5) minutes.
- c. The system upstream of regulators is vented through port GF9150 to 1150 PSIG.
- d. The system downstream of regulators is vented thru port of GF9118 to ambient.

OCP OUTLINE

OCP-GF-33030-IM5

Test Description: (Cont)

Seq. 06: OCPS D/S GOX System Helium Leak Check (Para. 4.2.2.3.5.1.1)

- a. Pressurize D/S GOX Tank to 2800 PSIG with helium through GF9150.
- b. Disengage GOX Tank fill disconnect and install flight cap. Close downstream isolation valve and disconnect line.
- c. Probe all joints with helium leak detector.
- d. After a two hour period elapses, for a pressure decay check, reconnect fill disconnect and downstream line.
- e. Vent system through GF9150 to 1200 PSIG.
- f. Vent system through GF9118 to atmosphere.

Seq. 07: OCPS Simulated GOX Tank Fill (Paragraph 4.2.2.3.5.6)

- a. Helium is evacuated from system through port GF9118.
- b. System is pressurized with GOX through GF9150 in 2 steps, first to 1400 PSIG, then to 2800 PSIG.

Seq. 08: Cabin Repressurization Simulation (Series Regs.) (Para. 4.2.2.3.5.2)

GOX flow through GF9118 is established and maintained for twenty (20) seconds.

Seq. 09: Simulated Metabolic O<sub>2</sub> Consumption (Series Regs) (Para. 4.2.2.3.5.2)

The simulated metabolic flow rates are introduced and the resultant effects on discharge pressure are observed.

Seq. 10: Cabin Repressurization Simulation (Secondary Reg. Operating) (Para. 4.2.2.3.5.2)

GOX flow through GF9118 is established and maintained for twenty (20) seconds.

Seq. 11: Simulated Metabolic O<sub>2</sub> Consumption Secondary Regulator Operating (Para. 4.2.2.3.5.2)

Simulated metabolic flowrates are introduced and resultant effects on discharge pressure are observed.

Seq. 12: Simulated Cabin Repressurization - Primary Reg. Operating (Para. 4.2.2.3.5.2)

After tank pressure is re-established at 2700 PSIA (GOX), flow through GF9118 is established and maintained for twenty (20) seconds.

OCP OUTLINE

OCP-GF-33030-LM5

Test Description: (Cont)

Seq. 13: Simulated Metabolic O<sub>2</sub> Consumption - Primary Reg. Operating  
(Paragraph 4.2.2.3.5.2)

Simulated metabolic flowrates are introduced and resultant effects on discharge pressure are observed.

Seq. 14: Secondary Overboard Vent Relief Valve Test (Para. 4.2.2.3.5.5)

- a. With primary relief valve overridden, the GOX tank pressure level is reestablished through GF9150 to approximately 2400 PSIG.
- b. Pressure downstream of regulators is increased to 1090 PSIG through port GF9118 while observing for indication of secondary relief valve cracking at approximately 1020 PSIG.
- c. Permit normal relief valve action to vent while observing for valve reseal to occur.

Seq. 15: Primary Overboard Vent Relief Valve Test (Para. 4.2.2.3.5.5)

- a. With secondary relief valve overridden, the pressure downstream of regulators is increased through port GF9118 to 1090 PSIG while observing for indication of primary relief valve cracking at approximately 1020 PSIG.
- b. Permit normal relief valve action to vent while observing for valve reseal to occur.

Seq. 16: D/S OCPS GN<sub>2</sub> Pressure Purge (Para. 4.2.2.3.5.1)

- a. Vent system through GF9118 to ambient.
- b. Pressurize Descent Stage GOX Tank to 900 PSIG with GN<sub>2</sub> through GF9150.
- c. Vent system through GF9118 to ambient.
- d. Pressurize Descent Stage GOX Tank to 900 PSIG with GN<sub>2</sub> through GF9150.
- e. Vent system through GF9118 to ambient.

Seq. 17: Securing After Test

OCP OUTLINE

OCP-GF-33066-LM5

Test Title:

D/S Water Management Section Proof and Leak Check.

Subsystem:

Environmental Control - WMS.

Test Objectives:

- a. Verification of the structural integrity of the D/S water tank and associated lines.
- b. Verification of maximum indicated leak rate at any single point of  $2 \times 10^{-7}$  SCC/SEC.

Vehicle Configuration:

Descent Stage.

Location:

Cold Flow Test Facility.

Hazardous Operation:

Large Tank Volume at 65 PSIG - GHe.

Components Under Test:

D/S Water Tank

WQMD Instrumentation Port

QD's Water and Gas GF9108, GF9109

Lines and Fittings

Test Description:

Seq. 01: Call to Stations

Seq. 02: D/S WMS Proof Pressure Test and Decay Check (Para. 4.2.2.3.7)

- a. Pressurization of inside and outside of tank bladder simultaneously to 65 PSIG, with helium
- b. Pressurization of the system from 49 to 51 PSIG for a two (2) minute decay check with a maximum allowable decay of 1 PSI.

Seq. 03: D/S WMS GHe Leak Test (Para. 4.2.2.3.7)

- a. External leak check of D/S water tank, lines, and fittings.

OCP OUTLINE

OCP-GF-33066-LM5

Test Description: (Cont)

- b. Repair or replacement of any item where leak rate exceeds  $2 \times 10^{-7}$  SCC/SEC, indicated.
- c. Venting of the system to a pressure of 5 PSIG.

Seq. 04: Securing After Test

OCP OUTLINE

OCP-GF-33067-LM5

Test Title:

A/S Water Management Section Proof and Leak Check

Subsystem:

Environmental Control - WMS

Test Objectives:

- a. Verification of the structural integrity of the A/S water tanks and the valves, lines, and fittings in the high pressure network, including the PLSS hose.
- b. Verification of maximum indicated leak rate at any single point from the tanks to the primary and secondary regulators of  $4 \times 10^{-8}$  SCC/SEC.

Vehicle Configuration:

Ascent Stage

Location:

Cold Flow Test Facility

Hazardous Operation:

Large Tank Volume at 65 psi - GHe

Components Under Test:

A/S Water Tank (2)

WQMD Instrumentation Ports

Water Control Module

PLSS Hose & QD

QD's - Water & Gas GF9106, GF9107, GF9105, GF9104

Lines and Fittings

Test Description:

Seq. 01: Call to Stations

Seq. 02: A/S WMS Proof Pressure Test (paragraph 4.2.2.3.7)

- a. Pressurization of inside and outside of tank bladders simultaneously to 65 PSIG, with helium.



OCP OUTLINE

OCP-GF-33067-LM5

Test Description: (Cont)

Seq. 03: Pressure Decay Check (paragraph 4.2.2.3.7)

- a. Pressurization of system from 49 to 51 PSIG for a two (2) minute decay check with a maximum allowable pressure decay of 1 PSI.

Seq. 04: A/S WMS GHe Leak Test (paragraph 4.2.2.3.7)

- a. External leak check of all components, lines, and fittings in the high pressure system.
- b. Repair or replacement of any item where leak rate exceeds  $4 \times 10^{-8}$  SCC/SEC indicated.

Seq. 05: Venting

- a. Venting of the system to a pressure of 5 PSIG.

Seq. 06: Securing After Test

OCP OUTLINE

OCP-GF-33068-LM5

Test Title:

D/S HTS Proof and Leak Check

Subsystem:

ECS - D/S HTS

Test Objectives:

To verify the structural integrity of the D/S HTS.

Vehicle Configuration:

Descent Stage

Location:

Integrated workstand, Plant 5.

Hazardous Operations:

Pneumatic Pressures up to 60 PSIG.

Components Under Test:

D/S W/G Supply and Return Interstage Disconnects.

D/S W/G Supply and Return Flex Lines

D/S HTS Gamah TEE's, Unions, and Bulkhead fittings.

D/S HTS Cold Plate Assemblies

Test Description:

Seq. 01: Call to Stations

Seq. 02: D/S HTS Proof Pressure and Leak Check

- a. Pressurization of D/S HTS with helium at 60 PSIG for 5 minutes (Proof Pressure Test) (paragraph 3.1.3.2.3).
- b. Pressure Decay Test of the D/S HTS with helium at 45 PSIG for 15 minutes.
- c. Leakage Test of the D/S HTS W/G Supply and Return Interstage Disconnects (paragraph 4.2.2.3.6).
- d. Leakage Test of the D/S HTS W/G Supply and Return Flex Lines. (Paragraph 4.2.2.3.6).

OCP OUTLINE

OCP-GF-33068-LM5

Test Description: (Cont)

- e. Leakage Test of the D/S HTS Gamah unions, TEE's and bulkhead fittings. (paragraph 4.2.2.3.6)
- f. Leakage Test of the D/S HTS Cold Plate Assemblies (paragraph 4.2.2.3.6).

Seq. 03: D/S Primary HTS Pressure Decay Test

- a. Pressure Decay Test of the D/S HTS with nitrogen at 45 PSIG for two hours.

Seq. 04: Securing After Test

OCP OUTLINE

OCP-GF-3070-LM5

Test Title:

Installation of Water Boilers and Verification Test of Water Glycol Fill

Subsystem:

Heat Transport Section - ECS

Test Objectives:

Verification of the W/G Fill of the Heat Transport Section and installation of Water Boilers for safe shipment of LM vehicle.

Vehicle Configuration:

Ascent and Descent Stages

Location:

Integrated Work Stand Plant 5

Hazardous Operations:

Water-Glycol Mixture - Possibility of Spillage

Components Under Test:

W/G Fluid Lines and Accessories

Coolant Accumulator

W/G Pump Discharge Pressure Transducer

Water Boiler Outlet Temperature Transducer

W/G Quick Disconnects

Primary Water Boiler

Secondary Water Boiler

Test Description:

Seq. 01: Call to Stations

Seq. 02:

and

Seq. 03: Installation of Primary Water Boiler

Seq. 04

and

Seq. 05: Installation of Secondary Water Boiler

OCP OUTLINE

OCP-GF-33070-LM5

Test Description: (Cont)

Seq. 06: GSE Power Activation and W/G Circulation Secondary Loop  
(Paragraph 4.2.2.3.6.5(b))

- a. Activation of GSE for functional check
- b. Circulation of rated amount of W/G through the secondary loop
- c. Heating of W/G in the secondary loop to an average temperature of 120°F.
- d. De-Activation of GSE at rated pressure and temperature. Disconnection of vehicle secondary loop lines from GSE.
- e. Monitoring of W/G pressure and temperature.

Seq. 07: Activation of Vehicle Power and W/G Level Adjustment - Primary Loop

- a. Activation of W/G transducers for functional check
- b. Adjustment and setting of accumulator level with reference to W/G temperature
- c. Disconnection of vehicle primary loop lines from GSE.

Seq. 08: Gas Entrapment Test - Primary Loop (Paragraph 4.2.2.3.6.5(a))

Seq. 09: Connection of A/S and D/S Interstage Supply and Return Lines

Seq. 10: Securing After Test

OCP OUTLINE

OCP-GF-34000-LM5

Test Title:

Waste Managment Section - External Leakage Test

Subsystem:

Crew Provisions

Test Objectives:

Establishment of Leakage Integrity of the Waste Management Section

Vehicle Configuration:

Ascent Stage or Mated Vehicle

Location:

Integrated Workstand, Plant 5

Hazardous Operations:

Not Applicable

Components Under Test:

Hose Assemblies

Valve Assembly

Quick Disconnects

Flow Indicator

Test Description:

Seq. 01: Call to Stations

Seq. 02: Condensate Collector Assembly Relief Valve Operating Pressure Test  
(paragraph 4.2.2.4.3)

- a. Record cracking and seating pressure of relief valve. (Paragraph 4.2.2.4.3(c))

Seq. 03: Condensate Transfer Assembly External Leakage Test (paragraph 4.2.2.4.3)

- a. Pressurization of Condensate Transfer Assembly to 3.9 psig. (Paragraph 4.2.2.4.3)
- b. Leakage test of the Condensate Transfer Assembly with a Helium Leak Detector. (Paragraph 4.2.2.4.3)

OCP OUTLINE

OCP-GF-34000-LM5

Test Description: (Cont)

Seq. 04: Waste Managment Section Helium External Leakage Test (paragraph 4.2.2.4.3)

- a. Pressurization of the hose assemblies and valve assembly of the Waste Management Section to 3.9 psig with helium. (Paragraph 4.2.2.4.3)
- b. Leakage Test of the Hose assemblies and Valve assembly of the Waste Managment Section. (Paragraph 4.2.2.4.3)

Seq. 05: Valve Assembly Internal Leakage Test (paragraph 4.2.2.4.3)

- a. Pressurization of Valve Assembly to 3.8 PSIG with nitrogen.
- b. Internal Leakage Test of the Valve Assembly with a Displacement Leak Meter (paragraph 4.2.2.4.3)

Seq. 06: Securing After Test

## OCP OUTLINE

OCP-GF-36015-LM5

### Test Title:

Pulse Code Modulation and Timing Electronics Assembly Turn-On and Verification

### Subsystem:

Instrumentation

### Test Objectives:

- a. Verification of the functional operation of the Pulse Code Modulation and Timing Electronics Assembly.
- b. Verification of the synchronization of the acceptance checkout equipment with the Airborne Pulse Code Modulation and timing electronics.
- c. Verification of data transmission and pulse code modulation of:
  1. Calibration Voltages
  2. Mission Elapsed Time
  3. Format words in assigned time slots

### Vehicle Configuration:

Ascent Stage

### Location:

Integrated work stand, Plant 5 CEF

### Hazardous Operation:

Not applicable

### Component Under Test:

LSC 360-2-5-8 PCMTEA

### Test Description:

- Seq. 01-000: Call to Stations
- Seq. 02-000: Verification of GPS and ACE-S/C activation.
- Seq. 03-000: Verification of Pulse Code Modulation and Timing Electronics Assembly and signal verification (Paragraph 4.2.2.12.2(c))
- Seq. 03-005: Verification of PCMTEA timing signals as measured at the GSE connector. (Paragraph 4.2.2.12.2.1(a))



OCP OUTLINE

OCP-GF-36015-LM5

Test Description: (Cont)

- Seq. 04-000: Verification of PCMTEA/GSE umbilical interface high-bit rate (paragraph 4.2.2.12.2.1.1)
- 04-003: Verification of 85 PCT hi calibration voltage
- 04-004: Verification of 15 PCT hi calibration voltage
- 04-005: Verification of format identification word 00011011
- Seq. 05-000: Verification of PCMTEA mission elapsed time reset. (Paragraph 4.2.2.12.2.1.1)
- 05-006: Verification that mission elapsed time is updating from zero at one second intervals after reset.
- Seq. 06-000: PCMTEA Hi-Bit to Lo-Bit Rate Verification
- 06-002: Verification of prime frame synch (Para. 4.2.2.12.2.1.1)
- 06-006: Verification of PCMTEA hi bit to low bit rate switchover (Paragraph 4.2.2.12.2.1.1)
- Seq. 07-000: Verification of PCMTEA umbilical interface lo bit rate (Paragraph 4.2.2.12.2.1.2)
- 07-002: Verification of 85 PCT HL calibration voltage.
- 07-003: Verification of 15 PCT HL calibration voltage.
- 07-004: Verification of format identification work 11100100.
- Seq. 08-000: Verification of PCMTEA lo bit to hi bit rate switchover (Paragraph 4.2.2.12.2.1.2)
- 08-002: Verification of prime frame synch (Para. 4.2.2.12.2.1.2)
- Seq. 09-000: Verification of 204.8 KHZ crystal oscillator failure detector circuit (Paragraph 4.2.2.12.2.1.2 & 4.2.2.12.2.1.1)
- a. Verification of internal osc failure detector discrete signal
- b. Verification of internal osc failure detector analog signals with the LGC off
- Seq. 10-000: Securing After Test

OCP OUTLINE

OCP-GF-36527-LM5

Test Title:

Data Channel Verification

Subsystem:

Instrumentation

Test Objectives:

- a. Verification of the operational instrumentation data channels which go through either of the two signal conditioner electronics assemblies (SCEA) by simulating transducer and signal sensors at the SCEA input connectors.
- b. Verification of measurements are monitored at their normal points of readouts as applicable.
  1. Cabin display only
  2. ACE-S/C only (via PCMTEA at high bit rate)
  3. Cabin displays and ACE-S/C
- c. Verification of CWEA data logic channels by simulated signals at the SCEA input connectors.

Vehicle Configuration:

Ascent stage

Location:

Integrated work stand, Plant 5, CEF

Hazardous Operation:

Not applicable

Components Under Test:

LSC 360-5-1010-1 SCEA #1

LSC 360-5-1020-1 SCEA #2

LSC 360-8-9 CWEA

LSC 360-2-5-8 PCMTEA

The following components are partially verified.

LDW 390-54101-3 Panel 1

LDW 390-54102-3 Panel 2

OCP OUTLINE

OCP-GF-36527-LM5

Components Under Test: (Cont)

LDW 390-54103-3 Panel 3  
LDW 390-54108-3 Panel 8  
LDW 390-54110-1 Panel 11  
LDW 390-54112-1 Panel 12  
LDW 390-54114-1 Panel 14  
LDW 390-54114-1 Panel 16

Test Description:

Seq. 01: Call to Stations  
Seq. 02: Verification of support system status  
Seq. 03: Verification of displays turn-on  
Seq. 04: Verification of 0-5 VDC analog channel  
Seq. 05: Verification of 0-40 VDC analog channel  
Seq. 06: Verification of 0-12 VDC analog channel  
Seq. 07: Verification of 0-14.6 VDC analog channel  
Seq. 08: Verification of -10 VDC to +10 VDC analog channel  
Seq. 09: Verification of -13 to +13 VDC analog channel  
Seq. 10: Verification of +/-3.5 VRMS 800 HZ analog channel  
Seq. 11: Verification of 15 VRMS 400 HZ channel  
Seq. 12: Verification of 115 VRMS 400 HZ analog channel  
Seq. 13: Verification of resistance channel 1364 Ohms-1671 Ohms  
Seq. 14: Verification of resistance channel 1364 Ohms-1793 Ohms  
Seq. 15: Verification of resistance channel 1363 Ohms-1913 Ohms  
Seq. 16: Verification of resistance channel 665 Ohms-2795 Ohms  
Seq. 17: Verification of resistance channel 665 Ohms-1913 Ohms  
Seq. 18: Verification of discrete channel contact closures  
Seq. 19: Verification of discrete channel solid state closures

OCP OUTLINE

OCP-GF-36527-LM5

Test Description: (Cont)

- Seq. 20: Verification of high bit rate/low bit rate dump
- Seq. 21: Verification of ISG CWEA test preparation
- Seq. 22: Verification of Bat. 1, ECA 1 (Para. 4.2.2.12.4)
- Seq. 23: Verification of Bat. 2, ECA 1 (Para. 4.2.2.12.4)
- Seq. 24: Verification of Bat. 3, ECA 2 (Para. 4.2.2.12.4)
- Seq. 25: Verification of Bat. 4, ECA 2 (Para. 4.2.2.12.4)
- Seq. 26: Verification of Bat. 5, ECA 3 (Para. 4.2.2.12.4)
- Seq. 27: Verification of Bat. 6, ECA 4 (Para. 4.2.2.12.4)
- Seq. 28: Verification of Prim. Suit comp fail (Para. 4.2.2.12.4)
- Seq. 29: Verification of spare suit comp fail (Para. 4.2.2.12.4)
- Seq. 30: Verification of coolant accum. (Para. 4.2.2.12.4)
- Seq. 31: Verification of Sel. coolant pump fail (Para. 4.2.2.12.4)
- Seq. 32: Verification of emer O2 vlv elec/VPI open (Para. 4.2.2.12.4)
- Seq. 33: Verification of LGC Warning (Para. 4.2.2.12.4)
- Seq. 34: Verification of ISS Warning (Para. 4.2.2.12.4)
- Seq. 35: Verification of pitch trim fail (Para. 4.2.2.12.4)
- Seq. 36: Verification of roll trim fail (Para. 4.2.2.12.4)
- Seq. 37: Verification of L/R data vel/rng NG (Para. 4.2.2.12.4)
- Seq. 38: Verification of R/R no track ind (Para. 4.2.2.12.4)
- Seq. 39: Verification of Prop tank lvl low (Para. 4.2.2.12.4)
- Seq. 40: Verification of fuel tank level low (Para. 4.2.2.12.4)
- Seq. 41: Verification of O<sub>2</sub> tank level low (Para. 4.2.2.12.4)
- Seq. 42: Verification of AEA test cond fail (Para. 4.2.2.12.4)
- Seq. 43: Verification of jet drivers (Para. 4.2.2.12.4)
- Seq. 44: Verification of ED system 'A' relay transfer (Para. 4.2.2.12.4)
- Seq. 45: Verification of ED system 'B' relay transfer (Para. 4.2.2.12.4)

OCP OUTLINE

OCP-GF-36527-LM5

Test Description:

- Seq. 46: Verification of volt select S-band receiver AGC (Para. 4.2.2.12.4)
- Seq. 47: Verification of commanders bus voltage (Para. 4.2.2.12.4)
- Seq. 48: Verification of system eng'r bus voltage (Para. 4.2.2.12.4)
- Seq. 49: Verification of suit outlet press (Para. 4.2.2.12.4)
- Seq. 50: Verification of CO<sub>2</sub> part pressure (Para. 4.2.2.12.4)
- Seq. 51: Verification of H<sub>2</sub>O sep rate (Para. 4.2.2.12.4)
- Seq. 52: Verification of manifold pres reg. (Para. 4.2.2.12.4)
- Seq. 53: Verification of pres. He tank No. 1 (Para. 4.2.2.12.4)
- Seq. 54: Verification of pres. He tank No. 2 (Para. 4.2.2.12.4)
- Seq. 55: Verification of pres fuel/isol valve(Para. 4.2.2.12.4)
- Seq. 56: Verification of pres O<sub>2</sub>/isol valve(Para. 4.2.2.12.4)
- Seq. 57: Verification of des eng arm press He reg. (Para. 4.2.2.12.4)
- Seq. 58: Verification of +28VDC ASA (Para. 4.2.2.12.4)
- Seq. 59: Verification of +12VDC ASA (Para. 4.2.2.12.4)
- Seq. 60: Verification of press He tank A (Para. 4.2.2.12.4)
- Seq. 61: Verification of press He tank B (Para. 4.2.2.12.4)
- Seq. 62: Verification of press He reg A (Para. 4.2.2.12.4)
- Seq. 63: Verification of press He reg B (Para. 4.2.2.12.4)
- Seq. 64: Verification of Des O<sub>2</sub> Press (Para. 4.2.2.12.4)
- Seq. 65: Verification of ASC O<sub>2</sub> Press 1 and 2 (Para. 4.2.2.12.4)
- Seq. 66: Verification of Des H<sub>2</sub>O qty (Para. 4.2.2.12.4)
- Seq. 67: Verification of Asc H<sub>2</sub>O qty 1 and 2 (Para. 4.2.2.12.4)
- Seq. 68: Verification of +15VDC supply (Para. 4.2.2.12.4)
- Seq. 69: Verification of +4.3VDC supply (Para. 4.2.2.12.4)
- Seq. 70: Verification of +6VDC supply (Para. 4.2.2.12.4)
- Seq. 71: Verification of -15VDC supply (Para. 4.2.2.12.4)

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Test Description: (Cont)

- Seq. 72: Verification of -6VDC supply (Para. 4.2.2.12.4)
- Seq. 73: Verification of -4.7VDC supply (Para. 4.2.2.12.4)
- Seq. 74: Verification of -4.7VDC back up supply (Para. 4.2.2.12.4)
- Seq. 75: Verification of freq. ASA, 29V, 400 HZ (Para. 4.2.2.12.4)
- Seq. 76: Verification of RGA IPH pickoff, 0.8 KHZ (Para. 4.2.2.12.4)
- Seq. 77: Verification of inv. bus volt and freq (Para. 4.2.2.12.4)
- Seq. 78: Verification of phase A, B, C, RGA spinmotor (Para. 4.2.2.12.4)
- Seq. 79: Verification of temp, upstream of crit elec (Para. 4.2.2.12.4)
- Seq. 80: Verification of temp, quad cluster No. 4 (Para. 4.2.2.12.4)
- Seq. 81: Verification of temp, quad cluster No. 3 (Para. 4.2.2.12.4)
- Seq. 82: Verification of temp, quad cluster No. 2 (Para. 4.2.2.12.4)
- Seq. 83: Verification of temp, quad cluster No. 1 (Para. 4.2.2.12.4)
- Seq. 84: Verification of L/R ant. temp. (Para. 4.2.2.12.4)
- Seq. 85: Verification of R/R ant. loop (Para. 4.2.2.12.4)
- Seq. 86: Verification of temp S-band ster. ant. (Para. 4.2.2.12.4)
- Seq. 87: Verification of master alarm relay driver redundancy (Para. 4.2.2.12.4)
- Seq. 88: Deleted
- Seq. 89: Verification of CWEA Pwr Caution (Para. 4.2.2.12.4)
- Seq. 90: Securing after test

## OCP OUTLINE

OCP-GF-61012-LM5

### Test Title:

D/S - Fluid System Test Harness Electrical Check and Preliminary Dry Structural Integrity Check.

### Subsystem:

Descent Stage ECS.

Descent Stage Propulsion.

### Test Objectives:

- a. The verification of vehicle/CFF compatibility of the electrical interface harnesses.
- b. Verification of responses of the fluid control and monitoring devices in the descent stage propulsion and ECS subsystems to known stimuli, and to identify the sensor output channels at the A/S - D/S interface.
- c. To establish a confidence level in the structural integrity of the descent stage fluid lines and tanks prior to performing other Cold Flow OCP's.
- d. Verification of the preliminary external leakage integrity of the propellant feed section and associated hardware.
- e. Verification of the preliminary external leakage integrity of the descent stage ECS oxygen cabin pressurization section.

### Vehicle Configuration:

Descent Stage.

### Location:

Cold Flow Facility.

### Hazardous Conditions:

ECS Oxygen Cabin Pressure Section up to 1200 psig. Propellant Feed Sections up to 1000 psig.

### Equipment Under Test:

Pressure Transducers and Associated Harness (DPS and OCPs).

Temperature Transducers and Associated Harness (DPS and OCPs).

Solenoid Latching Valves and Associated Harness (DPS).

Propellant Feed Section (DPS).

Engine Bleed Lines.

OCP OUTLINE

OCP-GF-61012-LM5

Equipment Under Test: (Cont)

Ambient Helium Tank.

Supercritical Helium Tank

D/S Ox Cabin Pressure Section

Test Description:

Seq. 01: Call to Stations.

Seq. 02: D/S OCPS Harness Check.  
(Paragraph 4.2.2.12.3.1)

- a. Comparison of descent stage GOX tank pressure and temperature transducer outputs (GF3584P and GF3587T) to expected indications under ambient conditions.
- b. Pressurization of the descent stage GOX tank through port GF9150 of approximately 600 psig and 1200 psig.
- c. Comparison of descent stage GOX tank pressure and temperature transducer outputs (GF3584P and GF3587T) to expected indications.
- d. Vent GOX tank to approximately 500 psig through port GF9118 and isolate vehicle from pressure source at port GF9150.

Seq. 03: D/S OCPS Preliminary Dry Leak Check.

- a. Pressurization of GOX tank through port GF9150 to 500 psig.
- b. External leak check of descent stage OCPS (helium) at following points:
  1. Descent stage GOX tank connector.
  2. GOX tank pressure transducer.
  3. Descent stage GOX tank fill Q.D.
  4. Descent stage GOX module inlet.
  5. Descent stage GOX module outlet.
  6. Descent stage GOX module.
  7. Gamah union.
  8. Flex hose outlet.
  9. Interstage disc.
  10. Interstage disc cap.
  11. Isolation valve stub cap.



OCP OUTLINE

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Test Description: (Cont)

- c. Vent GOX tank to ambient through port GF9118; read GOX tank pressure transducer GF3584P and compare its output to expected indication.

Seq. 04: DPS Pressurization and Propellant Feed Sections Harness/Dry Structural Integrity Check.

- a. Vent descent stage propulsion subsystem to ambient pressure.
- b. Comparison of following transducer outputs to expected indications under ambient conditions:  
(Paragraph 4.2.2.12.3.1)

1. Press He Reg Outlet Manifold	GQ3018P
2. Press He Reg Outlet Manifold Redundant	GQ3025P
3. Press No. 1 Fuel Tank Ullage	GQ3501P
4. Temp No. 1 Fuel Tank Bulk	GQ3718T
5. Temp No. 2 Fuel Tank Bulk	GQ3719T
6. Press No. 1 Oxid Tank Ullage	GQ4001P
7. Temp No. 1 Oxid Tank Bulk	GQ4218T
8. Temp No. 2 Oxid Tank Bulk	GQ4219T
9. Press Eng Interface Fuel	GQ3611P
10. Press Eng Interface Oxid	GQ4111P

- c. Pressurization of the fuel feed section to approximately 55 psig through port GQ9441; comparison of outputs of transducers in (b) above to expected indications.
- d. Pressurization of the oxid feed section to approximately 55 psig through port GQ9440; comparison of outputs of transducers in (b) above to expected indications.
- e. Pressurization of the entire propellant feed section to approximately 125 psig through ports GQ9440 and GQ9441; comparison of following transducer outputs to expected indications:

1. Press No. 1 Fuel Tank Ullage	GQ3501P
2. Press No. 1 Oxid Tank Ullage	GQ4001P
3. Press Eng Interface Fuel	GQ3611P

## OCP OUTLINE

OCP-GF-61012-IM5

### Test Description: (Cont)

- |    |  |         |
|----|--|---------|
| 4. | Press Eng Interface Oxid               | GQ4111P |
| 5. | Press He Reg Outlet Manifold           | GQ3018P |
| 6. | Press He Reg Outlet Manifold Redundant | GQ3025P |
- f. Pressurization of the propellant feed section to approximately 205 psig through port GQ9440 and GQ9441.
- g. Helium secondary regulator disabled by closing helium secondary solenoid valve and opening helium primary solenoid valve.
- h. Pressurization of the helium high pressure manifold to approximately 100 psig through port GQ9404; comparison of the following transducer outputs to expected indications:
- |    |  |         |
|----|--|---------|
| 1. | Press He Reg Outlet Manifold           | GQ3018P |
| 2. | Press He Reg Outlet Manifold Redundant | GQ3025P |
- i. Pressurization of the helium high pressure manifold to approximately 520 psig through port GQ9404 and propellant tanks to primary helium regulator lockup pressure; comparison of the following transducer outputs to expected indications:
- |    |  |         |
|----|--|---------|
| 1. | Press He Reg Outlet Manifold           | GQ3018P |
| 2. | Press He Reg Outlet Manifold Redundant | GQ3025P |
| 3. | Press No. 1 Fuel Tank Ullage           | GQ3501P |
| 4. | Press No. 1 Oxid Tank Ullage           | GQ4001P |
| 5. | Press Eng Interface Fuel               | GQ3611P |
| 6. | Press Eng Interface Oxid               | GQ4111P |
- j. Vent propellant tank ullage pressures to approximately 205 psig.
- k. Helium primary regulator disabled by closing helium primary solenoid valve and opening helium secondary solenoid valve.
- l. Repressurization of the helium high pressure manifold to approximately 520 psig and propellant tanks to secondary helium regulator lockup pressure through port GQ9404.
- m. Pressurization of helium high pressure manifold to approximately 1000 psig and keep stable at 1000 to 1020 psig.
- n. Pressure at end of sequence 1000 psig above regulators and lockup pressure below regulators.

OCP OUTLINE

OCP-GF-61012-IM5

Test Description: (Cont)

Seq. 05: Propellant Feed Section Dry Leak Check.

- a. Vent propellant tank pressure to 195 to 210 psig.
- b. Leak check of DPS propellant feed section (from check valves to engine interface).  
(Paragraph 4.2.2.8.3.2(b)(5))

Seq. 06: Supercritical Helium Section Harness Check.  
(Paragraph 4.2.2.12.3.1)

- a. SHe tank is vented to zero psig through port GQ9409; comparison of SHe tank pressure transducer outputs (GQ3435P and GQ3436P) to expected indications under ambient conditions.
- b. Pressurization of SHe tank to 250 psig through port GQ94094; comparison of SHe tank pressure transducer outputs (GQ3435P and GQ3436P) to expected indications.
- c. Pressurization of SHe tank to 470 psig through port GQ9409; comparison of SHe tank pressure transducer outputs (GQ3435P and GQ3436P) to expected indications.
- d. Vent SHe tank to blanket pressure.

Seq. 07: Propulsion Transducer Blanket Pressure Readout.  
(Paragraph 4.2.2.12.3.1)

- a. Comparison of following DPS transducer outputs with expected indications.
  1. SHe Supply Tank Press GQ3435P
  2. SHe Supply Tank Redundant Press GQ3436P
  3. Helium Reg Outlet Manifold Press GQ3018P
  4. Helium Reg Outlet Manifold Redundant Press GQ3025P
  5. No. 1 Fuel Tank Ullage Press GQ3501P
  6. Engine Interface Fuel Press GQ3611P
  7. No. 1 Oxidizer Tank Ullage Press GQ4001P
  8. Eng Interface Oxid Press GQ4111P

OCP OUTLINE

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Test Description: (Cont)

Seq. 08: Ambient Helium Pre-Pressurization Bottle Harness Check.  
(Paragraph 4.2.2.12.3.1)

- a. Vent ambient helium bottle to zero psig through port GQ9415; comparison of ambient helium pre-pressure bottle pressure transducer output (GQ3015P) with expected indication.
- b. Pressurization of ambient helium pre-pressurization bottle to 300 psig through port GQ9415; comparison of ambient helium pre-pressurization bottle pressure transducer output (GQ3015P) with expected indication.
- c. Pressurization of ambient helium pre-pressurization bottle to 470 psig through port GQ9415; comparison of ambient helium pre-pressurization bottle pressure transducer output (GQ3015P) with expected indication.
- d. Vent ambient helium pre-pressurization bottle to blanket pressure (20-40 psig); comparison of ambient helium pre-pressurization bottle pressure transducer output (GQ3015P) with expected indication.
- e. Inspection of helium tanks, propellant tanks, and all other portions of pressurization and feed sections for visible structural damage.

Seq. 09: Solenoid Latching Valve Channel Identification.  
(Paragraph 4.2.2.12.3.1)

- a. Apply regulated blanket pressure upstream of lunar dump valves. The following valves will be cycled and their mechanical actuation and proper electrical response verified as follows:

1. Fuel Vent Solenoid Valve Open	GQ3500X
2. Oxid Vent Solenoid Valve Open	GQ4000X
3. He Pri Sol Valve Closed	GQ3309X
4. He Sec Sol Valve Open	GQ3310X

Seq. 10: Leak Check of Engine Bleed Lines.

- a. External helium leak check of following line at 250 psig.
  1. Oxid Low Point Drain Line.
  2. Oxid High Point Bleed Line.
  3. Fuel Low Point Drain Line.
  4. Fuel High Point Bleed Line.
  5. Pre-Valve Test Shutoff Valve Line.

OCP OUTLINE

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Test Description: (Cont)

- b. Above lines vented to zero (0) psig after respective leak checks.

Seq. 11: Propellant Tank Temperature Transducer Partial Channel Identification.  
(Paragraph 4.2.2.12.3.1)

- a. Comparison of following DPS temperature transducer outputs to expected indications (at ambient temperature).

1. Temp No. 1 Fuel Tank Bulk	GQ3718T
2. Temp No. 2 Fuel Tank Bulk	GQ3719T
3. Temp No. 1 Oxid Tank Bulk	GQ4218T
4. Temp No. 2 Oxid Tank Bulk	GQ4219T

- b. Sequential application of stimulus to above temperature transducers and verification of increase in output.

Seq. 12: Pressure Transducer Partial Channel Identification.

- a. Comparison of following DPS pressure transducer outputs to expected indications (with pad pressure applied to DPS).

1. Press No. 1 Fuel Tank Ullage	GQ3501P
2. Press Eng Interface Fuel	GQ3611P
3. Press No. 1 Oxid Tank Ullage	GQ4001P
4. Press Eng Interface Oxid	GQ4111P
5. Press He Reg Outlet Manifold	GQ3018P
6. Press He Reg Outlet Manifold Redundant	GQ3025P

- b. Sequential removal of power from above transducers and verification of loss of transducer outputs.

Seq. 13: Securing After Test.

OCP OUTLINE

OCP-GF-61015-LM5

Test Title:

Feat/EMC Systems Verification (Plugs In)

Subsystem:

Alt Subsystems - Integrated Vehicle

Test Objectives:

To verify the total LM System EMC performance in typical mission modes.

Vehicle Configuration:

- a. Ascent and Descent stages electrically mated for Descent, Abort and Abort Stage phases of mission.
- b. Ascent stage de-mated for Ascent phase of mission.

Location:

Integrated Test Stand

Hazardous Conditions:

Not Applicable.

Equipment Under Test:

All flight equipment except for:

- a. Test units substituted for RCS Quads
- b. GSE Power Supplies in place of LM batteries

Test Description:

Seq. 001: Call to Stations

- a. Verification of the intercom voice communication between the test conductor and all test personnel.
- b. Verify decoms setting.
- c. Annotation of all recorders.
- d. Load basic ACE file structure.
- e. Activate voltage monitoring recorder.

Seq. 002: Activation of EPS and Instrumentation

- a. Verification of GSE water-glycol cooling of the LM vehicle (4.2.2.3.6.5)
- b. GSE DC power to CDR BUS, via MSS (J167) (4.2.2.2.2(C2))
- c. MSS DC power to LMP BUS, via BUS cross-ties (4.2.2.2.2(C2))
- d. RCS SYS (A&B) Quads & TCA CB Turn-on

## OCP OUTLINE

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### Test Description: (Cont)

- e. INSTR. PCM Telemetry Turn-On, Hi Rate, controlled externally via LUT umbilical path. (4.2.2.2.2(D2))

#### Seq. 003: EPS, DC Power Switchover.

- a. Preparation for LUT-ON, MSS-OFF switchover. (4.2.2.2.2(D))
- b. LUT power-On (4.2.2.2.2(D))
- c. MSS power-off
- d. Preparation for LM LVT-On.
- e. Descent batteries LVT power-On.
- f. LUT power-Off.
- g. Separation of CDR and LMP Buses.
- h. Monitoring of EPS status.

#### Seq. 004: LM/CSM Interface checkout (Pre Launch Set-Up)

- a. S-Band and radar heaters turn-on.
- b. IMU switchover to IM power.
- c. ASA temp switchover to LM power.
- d. DC power switchover from the descent batteries LVT to CSM power.
- e. DC power switchover from CSM power to the descent batteries LVT.
- f. ASA power switchover to PTMU.
- g. PCM telemetry turn-on via vehicle CB'S.
- h. Inverter simulator turn-on.
- i. Window heater C/O
  - 1. SE window heater
  - 2. CDR window heater
- j. Resetting of pyro simulator.
- k. ED transient check SYS (A AND B).

#### Seq. 005: Verification of Ambient Readouts of Temperature, Pressures, and Quantity of Expendables Throughout the LM Subsystems.

#### Seq. 006: COMM, VHF XMTR Power Verification and S-Band Power Measurements

- a. Activation & C/O of PRI & SEC S-Band (4.2.2.11.1.5.2)
- b. Activation & C/O of VHF (4.2.2.11.1.4.1)

#### Seq. 007: COMM, Voice Link Checkout

- a. Turn-on of CDR audio communication (4.2.2.11.1.1.1)
- b. Turn-on of LMP audio communication (4.2.2.11.1.1.1)

OCP OUTLINE

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Test Description: (Cont)

- c. Turn-on of PM S-Band primary transceiver and primary power amplifier (4.2.2.11.1.5.2)
- d. Checkout of S-Band uplink. (4.2.2.11.1.5.1)
- e. Turn-on of VHF-A, and downlink checkout. (4.2.2.11.1.4)
- f. Turn-on of CTS VHF-A, and uplink checkout. (4.2.2.11.1.7.4.1(c))

Seq. 008: S-Band Ranging Test (continuous) and BEC Test

- a. Preparation for ranging test.
- b. S-BD ranging test.
- c. Bit error comparison check (continuous).
- d. Determination of ranging delay.
- e. Flight headset C/O CDR and LMP.
- f. DUA 70KC S-Band backup voice check.
- g. VHF A voice check.
- h. VHF A/Intercom intelligibility test.
- i. VHF B voice check.
- j. VHF B/Intercom intelligibility test.
- k. S-Band voice check.
- l. S-Band/Intercom voice intelligibility test.
- m. VHF ranging.

Seq. 009: Activation of DUA

- a. Verification of DUA off.
- b. Turn-on of DUA.
- c. Clearing CRT DUA counts. (and continuous monitoring)

Seq. 010: Lighting Checkout

- a. Verification of flood lights. (4.2.2.2.5(B)(1))
- b. Verification of integral lights. (4.2.2.2.5(B)(3))
- c. Verification of numeric lights. (4.2.2.2.5(B)(2))
- d. Mission timer ON/RESET (4.2.2.9.3)
- e. Event timer ON/STOP/RESET (4.2.2.9.2)
- f. Propulsion alphanumeric lights C/O
- g. CDR X-PNTR numeric lights C/O
- h. Range/ALT numeric lights C/O
- i. RCS numeric lights C/O
- j. SE X-PNTR numeric lights C/O
- k. Numeric lights dimmer C/O
- l. Verification of docking lights via cabin controls. (4.2.2.2.5(A))
- m. Verification of docking lights via LM/SLA SW. (4.2.2.2.5(A))
- n. Verification of tracking lights. (4.2.2.2.5 (A))



OCP OUTLINE

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Test Description: (Cont)

Seq. 011: C&WEA Displays Turn-On, and Self-Test.

- a. Turn-on of C&WEA displays. (4.2.2.12.2)
- b. C&WEA self-test.
- c. Master alarm C/O.

Seq. 012: AC/DC BUS C/W Trip Level Checkout

- a. DC BUS trip level check.
- b. AC BUS trip level check.

Seq. 013: ECS, Heat Transport Section (HTS) Caution and Warning Checkout  
(4.2.2.3.6)

- a. Verification of caution and warning of the primary glycol loop.
- b. Glycol pump Auto switchover check
- c. Verification of caution and warning of the secondary glycol loop.

Seq. 014: ECS, Atmosphere Revitalization Section (ARS) Caution and Warning Checkout

- a. The caution and warning is verified as operated by the following ARS components.
  1. Suit fans.
  2. Water separators.
  3. Glycol low delta pressure.
  4. CO<sub>2</sub> sensor. (4.2.2.3.2)
  5. Torn suit protection.
  6. Cabin suit repress C/O.

Seq. 015: ECS, Cabin Repressurization Checkout. (4.2.2.3.5.2)

Functional operation of cabin repressurization system is verified in the normal and backup modes as follows:

- a. Operation under the decompressed cabin condition (simulated) in the following configurations:
  1. Oxygen regulators A and B in cabin mode.
  2. Manual override of repress valve.
  3. Oxygen regulator A failed.

OCP OUTLINE

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Test Description: (Cont)

4. Oxygen regulator B failed.
  5. Oxygen regulators A and B failed.
  - b. Operation under the decompressed cabin condition (simulated) in the egress mode, in the following configuration:
    1. Oxygen regulator A in egress, and regulator B failed.
    2. Oxygen regulator B in egress, and regulator A failed.
    3. Oxygen regulators A and B in egress.
  - c. Operation under the pressurized cabin condition in the following configurations:
    1. Oxygen regulators A and B failed.
    2. Oxygen regulator A in egress, and regulator B failed.
    3. Oxygen regulator B in egress, and regulator A failed.
  - d. Operation of manual override of oxygen regulators A and B under the decompressed cabin condition (simulated).
- Seq. 016: ECS, Descent Water Tank Checkout and ASC Tank(s) Zero Point Checkout (Para. 4.2.2.3.7.2)
- a. Pressurization of descent water tank by GSE.
  - b. Verification of caution and warning at the low level (simulated).
- Seq. 017: ECS, Ascent Water Tank Checkout
- a. Pressurization of ascent water tank by GSE.
  - b. Verification of caution and warning at the following water levels (simulated).
    1. Tank 2 less than full.
    2. Tank 2 less than tank 1.
    3. Tank 1 less than full.
    4. Tank 1 less than tank 2.
- Seq. 018: ECS, Oxygen Tanks Functional Checkout (Para. 4.2.2.3.5.6)
- a. Pressurization of the descent and ascent oxygen tanks.

OCP OUTLINE

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Test Description: (Cont)

Seq. 019: ECS, Oxygen Tank C/W Checkout

- a. Verification of caution and warning at ascent and descent tank low levels (simulated).

Seq. 020: Activation of CES.

- a. FCS displays turn-on.
- b. CES turn-on.
- c. Selection of cabin controls.
- d. Setting ACE-S/C control room recorders.
- e. RGA SMRD verification.
- f. Verification of start stop buttons are off.
- g. Activation of engine control circuits.
- h. Monitoring of critical parameter via PCM.

Seq. 021: Descent Engine Override

- Arming of Des Eng
- a. Verification start and stop buttons are off.
- b. Des. Eng Gimbaling
- Activation of the engine control circuits.

Seq. 022: G & N/AGS Abbreviated Turn-On.

- a. LGC/DSKY power turn-on.
- b. LGC self check.
- c. AGS turn-on (4.2.2.6.5.1(A))
- d. DEDA EL checkout.
- e. AEA self-test.
- f. AEA error volt verification.
- g. Application of IMU operate power. (4.2.2.5.4(B))
- h. IMU operational test.

Seq. 023: Activation of Radars

- a. Landing radar activation.
- b. Landing radar self-test. (4.2.2.5.8.1)
- c. LRAA to hover.

OCP OUTLINE

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Test Description: (Cont)

- d. LRRA to descent.
- e. RNDZ radar activation.
- f. RNDZ radar self-test. (4.2.2.5.7.1)

Seq. 024: RCS Heater Activation (4.2.2.7.4)

- a. Activation heaters and monitor temperature.

Seq. 025: RCS Functional Test

- a. RCS activation.
- b. RCS fuel tanks temp and press displays check.
- c. RCS displays check.
- d. RCS main sov and ascent feed valves display check.
- e. RCS thruster pair displays check.
- f. RCS SYS A, main sov check.
- g. RCS SYS B, main sov check.
- h. RCS fuel manifolds, pressure display check.
- i. RCS oxid manifolds, pressure display check.
- j. RCS pressurization check, simulated.
- k. RCS pressurization reset.
- l. RCS system A, main sov close.
- m. RCS system B, main sov close.

Seq. 026: ED Checkout

- a. LDG Gear functional check.
- b. DES pressure vent.

Seq. 027: Propulsion S/S Functional Test

- a. Descent He Regulators and flags C/O.
- b. Propulsion displays and controls C/O.

OCP OUTLINE

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Test Description: (Cont)

- c. PQGS sensor test dry.
- d. PQGS control unit checkout.
- e. Propulsion transducers ambient C/O. (4.2.2.12.3.1)
  - 1. Ascent transducers.
  - 2. Descent Transducers.
  - 3. Descent 2 transducers.
  - 4. Descent supercritical press transducers.
  - 5. Ascent temp 1 transducers
  - 6. Ascent press 1 transducers.
  - 7. Ascent temp 2 transducers.
  - 8. Ascent press 2 transducers.
  - 9. Descent ambient press transducers.
  - 10. Descent engine thrust transducers.

Seq. 028: Propulsion Ascent He Regulators Selection, and Pressurization C/O.

- a. Ascent He solenoid valve open, pri and sec.
- b. Ascent He reg 1, open, He reg 2 close.
- c. Ascent He reg 1, close.
- d. Ascent He reg 2, open.
- e. Ascent He reg 1, open.
- f. Ascent He tanks ED arm.
- g. Ascent He tanks reset.
- h. Ascent He tank 1, ED actuation.
- i. Ascent He tank 1, ED reset.
- j. Ascent He tank 2, ED actuation.
- k. Ascent He tank 2, ED reset.

## OCP OUTLINE

OCP-GF-61015-LM5

### Test Description: (Cont)

1. Ascent He both tanks, ED actuation.
- m. Ascent He both tanks, ED reset.

Seq. 029: Descent Engine Manual Start/Stop Functional Checkout

Seq. 030: Ascent Engine Manual Start/Stop Functional C/O

Seq. 031: AEA Load Memory Noise Test.

Seq. 032: AEA Memory Noise Test.

Seq. 033: Major Mode Two - Test One - PGNG Auto Descent Profile

- a. Static test - LM subsystem check for normal performance, set proper configuration and confidence check for individual subsystems.
  1. Inverter simulator shutdown.
  2. Inverter 1 turn-on.
  3. Static test/EPS.
    - a. Adjustment of DES BAT LV taps.
      1. Power supplies 4 and 3 at 0.2 VDC below trip level.
      2. Power supplies 1 and 2 at 0.2 VDC below trip level.
    - b. Adjustment of ASC batteries
      1. BAT 5 and 6 normal feed.
    - c. Adjustment of DES BAT HV taps.
    - d. DC and AC voltage verification.
    - e. HV tap to LV tap switchover.
  4. Static test/PR.
  5. Static test/PSH, OBS tape recorder check.
  6. Static test/communication.
  7. Static test/LR.
    - a. Preamp baseline for STC-7 setup.
    - b. Initialization of strobe program.

## OCP OUTLINE

OCP-GF-61015-LM5

### Test Description: (Cont)

- c. LR altitude monitoring (DES POS).
- d. LR VEL X, Y, Z monitoring (DES POS).
- 8. Static test/LM cabin.
- 9. Static test/S and C verification.
  - a. Status verification via ACE-S/C.
  - b. Jet counter activation.
- 10. Static test/G and N verification.
  - a. K-Start tape load.
- b. Test 1 - Dynamic test.
  - 1. Instructions
  - 2. IMU fine align - inertial mode.
  - 3. CES, ED and PQGS cabin control configuration.
  - 4. Arming Descent engine.
  - 5. Dynamic test run (4.2.2.13.1.2)
    - a. PGNS auto descent profile, fine align mode.
    - b. RK manual slew.
    - c. LR STC-7, LGC strobing and antenna auto tilt.
    - d. Docking lights cycling.
    - e. Communications audio VHF and S-Band, DSEA operation and S-Band antenna slew.
    - f. Stimulation of PQGS.
    - g. EPS switching of HV/LV taps and ascent batteries.
  - 6. Securing after dynamic test.
  - 7. Verification of dynamic test

OCP OUTLINE

OCP-GF-61015-LM5

Test Description: (Cont)

Seq. 034: Major Mode 2 - Test Two

- a. Static test of subsystems and configuration set.
  1. EPS test
    - a. ASC BATS to BUS.
    - b. Adjustment of ASC BATS.
    - c. ASC BATT off BUS.
    - d. Adjustment of DES BAT HV taps.
    - e. HV/LV Switchover.
    - f. Adjustment of LV power supplies.
  2. Static test/RR
    - a. Power to ATCA.
    - b. RR power supply activation (AC).
  3. Static test/communications.
  4. Static test/LR.
    - a. Preamp baseline for STC-7.
    - b. Initiation of strobe program.
    - c. LR altitude monitoring (DES POS).
    - d. LR VEL X, Z monitoring (DES POS).
  5. Static test/LM cabin.
  6. Static test/S and C verification.
    - a. Status verification via ACE-S/C
    - b. Jet counter activation.
  7. Static test/G and N verification.
    - a. K-Start tape loading.
- b. Test 2 - Dynamic Test.
  1. Instructions.



OCP OUTLINE

OCP-GF-61015-LM5

Test Description: (Cont)

2. IMU fine align - inertial mode.
3. CES, lighting cabin control configuration.
4. Arming descent engine.
5. Dynamic test run. (4.2.2.13.1.2)
  - a. Re-performance of dynamic tests of test 1.
  - b. EPS simulation of an AC failure - INV 1 to INV 2 switchover.
  - c. Tracking lights cycling.
  - d. Simulation of glycol pump failure - pump 1 to pump 2 switchover.
6. Securing after test.
7. Verification of dynamic test.

Seq. 035: Major Mode 2 - Test 3

- a. Static test of subsystems and configuration setup
  1. Static test/EPS
    - a. ASC BATT 6 to CDR/LMP BUS.
    - b. Adjustment of ASC BATS.
    - c. ASC BAT 6 off CDR/LMP BUS.
    - d. Adjustment of DES BAT HV taps.
    - e. HV/LV switchover.
    - f. Adjustment of LV power supplies.
  2. Static test/RR.
  3. Static test/communications
  4. Static test/LR.
    - a. Preamp baseline for STC-7 setup.
    - b. Initiation of strobe program.
    - c. LR altitude monitoring (DES POS).
    - d. LR VEL X, Y, Z monitoring (DES POS).

OCP OUTLINE

OCP-GF-61015-LM5

Test Description: (Cont)

5. Static test/prop.
6. Static test/S and C verification.
  - a. Status verification via ACE-S/C.
  - b. Jet counter activation.
7. Static test/G and N verification.
  - a. K-Start tape load.
- b. Test 3 - Dynamic test
  1. Instructions.
  2. IMU align - inertial mode.
  3. Gain controls configuration.
  4. Arming descent engine.
  5. Dynamic test run. (4.2.2.13.1.2)
    - a. Re-performance of dynamic tests of test 2
    - b. Cycling of DES He reg valves 1 and 2.
  6. Securing After Test.
  7. Verification of dynamic test.

Seq. 036: Major Mode 2 - Test 4

- a. Static test of subsystems and configuration setup.
  1. Static test/EPS.
    - a. ASC BAT 5 and 6 backup feed to bus.
    - b. Adjustment of ASC BATS.
    - c. ASC BAT 5 and 6 off CDR/LMP BUS.
    - d. Adjustment of DES HV taps.
    - e. HV to LV switchover.
    - f. Adjustment of LV power supplies.

OCP OUTLINE

OCP-GF-61015-LM5

Test Description: (Cont)

- g. Inverter shutdown.
- h. AC volts to bus with inverter simulator.
- 2. Static test/RR.
- 3. Static test/COMMUNICATIONS.
- 4. Static test/LR
  - a. Preamp baseline for STC-7 setup.
  - b. Initiation of strobe program.
  - c. LR altitude monitoring (DES POS).
  - d. LR VEL X, Y, Z monitoring (DES POS).
- 5. Static test/LM cabin.
- 6. Static test/S and C verification.
  - a. Status verification via ACE-S/C.
  - b. Jet counter activation.
- 7. Static test/G and N verification.
  - a. K-Start tape load.
- b. Test 4 - dynamic test.
  - 1. Instructions.
  - 2. IMU fine align - inertial mode.
  - 3. Cabin controls configuration.
  - 4. Arming descent engine.
  - 5. Dynamic test row (4.2.2.13.1.2)
    - a. Re-performance of dynamic tests of test 1.
    - b. ECS switchover of glycol pumps.
    - c. EPS adjustment of AC bus voltage from low to high limit.
    - d. Cycling of tracking lights.

OCP OUTLINE

OCP-GF-61015-LM5

Test Description: (Cont)

- e. ECS switchover of glycol pumps.
- f. Propulsion check of.
  - 1. PQGS stimulation.
  - 2. Descent reg switchover.
  - 3. Descent engine manual start/stop.
  - 4. Manual throttle override.
- 6. Securing after dynamic tests.
- 7. Verification after dynamic tests.

Seq. 037: Major Mode 2 - Test 5

- a. Static test of subsystems and configuration setup.
  - 1. Static test/EPS
    - a. ASC BATT 5 and 6 normal feed to bus.
    - b. Adjustment of ASC BATS.
    - c. ASC BATS of BUS.
    - d. Adjustment of DES BAT HV taps.
    - e. HV to LV switchover.
    - f. Adjustment of LV power supplies.
    - g. Adjustment of AC BUS frequency.
  - 2. Static test/RR.
  - 3. Static test/communications.
  - 4. Static test/LR.
    - a. Preamp baseline for STC-7 setup.
    - b. Initiation of strobe program.
    - c. LR altitude monitoring (DES POS).
    - d. LR VEL X, Y, Z monitoring (DES POS).

OCP OUTLINE

OCP-GF-61015-IM5

Test Description: (Cont)

5. Static test/S and C verification.
  - a. Status verification via ACE-S/C.
  - b. Jet counter activation.
6. Static test/G and N verification.
  - a. K-Start tape load.
- b. Test 5 - Dynamic Test.
  1. Instructions.
  2. IMU fine align, inertial mode.
  3. Cabin controls configuration.
  4. Arming descent engine.
  5. Dynamic test run (4.2.2.13.1.2).
    - a. Re-performance of dynamic tests of test 1.
    - b. ECS switchover of glycol pumps.
    - c. EPS adjustment of AC BUS frequency from low to high limit.
    - d. Removal of BATS 1 and 3 from bus prior to LV/HV switchover.
    - e. Cycling of tracking lights.
    - f. ECS switchover of glycol pumps.
    - g. Propulsion check of.
      1. PQGS stimulation.
      2. Desc. reg switchover.
      3. Desc. eng. manual start/stop.
      4. Manual throttle override.
  6. Securing after dynamic tests.
  7. Verification of dynamic tests.

OCP OUTLINE

OCP-GF-61015-LM5

Test Description: (Cont)

Seq. 038: Major Mode Three (FCS) - AGS Aborts

- a. Stopping AEA memory, noise, test.
- b. Interruption of PGNS/AEA interface.
- c. Dumping AEA memory.
- d. Loading abort/abort stage program.

Seq. 039: MM3 - Test 1, AGS abort/abort Stage

- a. Static test - LM subsystem check for normal performance and setting proper configuration.
  1. Testing LGC memory load.
  2. Centering descent engine.
  3. Static test/EPS.
    - a. ASC BATS 5 and 6 normal feed to bus.
    - b. Removal of DES BATS from bus via DFR.
    - c. Adjustment of ASC BATS.
    - d. Removal of ASC BATS from bus.
    - e. HV to LV switchover.
    - f. Adjustment of LV power supplies.
    - g. Shutdown of inverter simulator.
    - h. Turn-on of inverter 1.
  4. Static test/RR.
    - a. Activation of ATCA.
    - b. Activation of RR.
  5. Static test/communication.
  6. Static test/LR.
    - a. Setup of preamp baseline for STC-7.
    - b. Initialization of cabin controls.

OCP OUTLINE

OCP-GF-61015-LM5

Test Description: (Cont)

- c. Verification of cabin controls via ACE-S/C.
- d. Check of forward and lateral velocity and altitude and altitude rate via cabin meters.
- 7. Static test/ED
  - a. Resetting pyro simulators.
- b. Dynamic Test - Test 1.
  - 1. Instructions.
  - 2. Activation of LGC self check.
  - 3. Activation of Glycol pump 1.
  - 4. Activation of DECA and engine arm power.
  - 5. Dynamic test run (4.2.2.13.1.2).
    - a. Initiation of AGS test profile by abort button.
    - b. Initiation of abort stage during test profile.
    - c. Monitoring of cycling of docking lights.
    - d. Monitoring of cycling of tracking lights.
    - e. Check of DSEA operation.
    - f. Check of S-Band ranging.
    - g. Switchover from DESC to ASC BATS.
    - h. Inverter 1 to inverter 2 switchover.
    - i. Auto switchover from glycol pump 1 to pump 2.
    - j. Manual throttling of descent engine.
  - 6. Securing after dynamic test.
  - 7. Verification of dynamic test.

Seq. 040: PGNS Shutdown.

Seq. 041: MM3 - Test 2 Abort/Abort Stage

- a. Static tests of subsystems and configuration setup.

OCP OUTLINE

OCP-GF-61015-LM5

Test Description: (Cont)

1. Static test/EPS.
  - a. ASC BAT 5 and 6 normal feed to bus.
  - b. Removal of DES BATS from bus via DFR.
  - c. Adjustment of ASC BATS.
  - d. Removal of ASC BATS from bus.
  - e. Adjustment of LV power supplies.
  - f. Turn-on of inverter 2.
2. Static test/RR.
  - a. Activation of ATCA.
  - b. Activation of RR.
3. Static Test/Communications.
4. Static Test/LR.
  - a. Setup of preamp baseline for STC-7.
  - b. Initialization of cabin controls.
  - c. Check of forward/lateral velocities and alt/alt rate via cabin meters.
  - d. Verification of cabin control via ACE-S/C.
5. Static Test/ED
  - a. Resetting pyro simulators.
- b. Dynamic Test - Test 2
  1. Instructions
  2. Dynamic test run (4.2.2.13.1.2)
    - a. Re-performance of dynamic tests of test 1.
    - b. Simulation of loss of CDR bus.
    - c. Shutdown of PGNS.
  3. Securing after dynamic test.



OCP OUTLINE

OCP-GP-61015-1M5

Test Description: (Cont)

4. Verification of dynamic test.

5. CDR bus shutdown.

Seq. 042: Vehicle Turn-Off From MM3

- a. AGS shutdown.
- b. Displays shutdown.
- c. RCS shutdown.
- d. Prop shutdown.
- e. CES shutdown.
- f. COMM shutdown.
- g. ECS shutdown.
- h. DC bus power via J167 turn-on.
- i. Instrumentation shutdown.
- j. DC bus power via J167 turn-off.
- k. DC bus power via J166 turn-off.
- l. EPS shutdown.
- m. Demating of interstage connectors.
- n. Major mode 4 turn-on.
  - 1. ECA turn-on.
  - 2. PCM turn-on.
  - 3. EPS status check.
  - 4. Inverter 1 turn-on.
  - 5. C/W displays turn-on.
  - 6. Heater activation.
  - 7. Mission timer activation.
  - 8. Evatn timer activation.

OCP OUTLINE

OCP-GF-61015-LM5

Test Description: (Cont)

9. ECS turn-on.
10. DUA turn-on.
11. PGNS turn-on.
  - a. IMU standby power turn-on.
  - b. LGC/DSKY power turn-on.
  - c. LGC self check.
  - d. IMU operate power turn-on.
  - e. IMU coarse align to zero.
  - f. IMU operational test.
  - g. AGS turn-on, warmup, standby, operate.
  - h. DEDA el checkout.
  - i. AEA self test.
  - j. AEA error volts verification.
  - k. AEA memory noise test.
  - l. Counter activation for monitoring GSE-5.
  - m. Loading of load and verify routine.
  - n. Monitoring GSE-5.
  - p. Loading and verification of memory noise test program.
  - q. Activation of PGNS/AGS interface.
  - r. RCS turn-on system A/S quad power.
  - s. RCS heater turn-on and temperature monitoring.
  - t. CES activation and status verification via ACE-S/C.

Seq. 042-279: Major Mode 4 Test 1 - PGNS Auto Ascent

- a. Static test of subsystems and configuration set-up.
  1. Activation of RR cabin controls.
  2. Activation of lighting and RCS cabin controls.

OCP OUTLINE

OCP-GF-61015-LM5

Test Description: (Cont)

3. Configuration of RCS system.
  - a. Interconnect valves.
  - b. Cross feed valves.
  - c. Main shut-off valves.
4. Activation of cabin controls/displays for ASC He reg.
5. Loading of K-Start tape.
6. Static test/communications.
7. Static test/RR.
8. Activation of lighting and ordeal cabin controls.
- b. Dynamic Test - Test 1.
  1. Instructions
  2. Activation of IMU fine align, inertial mode.
  3. Activation of glycol pump 1 and auto transfer power.
  4. Dynamic test run (4.2.2.13.1.2).
    - a. Performance of PGNS auto ascent profile.
    - b. Exercising RR IU track mode.
    - c. Cycling of docking/tracking lights.
    - d. Exercising following EPS functions:
      1. BATS 5 and 6 in normal and backup modes.
      2. CDR/LMP bus cross-tie on and off
      3. Inverter 1/inverter 2 switchover.
    - e. Exercising following communications functions using S-Band primary transceiver and amplifier via omni antenna 1.
      1. CDR voice communications.
      2. CDR biomed data.
      3. PCM data at high bit rate.

OCP OUTLINE

OCP-GT-61015-LM5

Test Description: (Cont)

4. Switchover from omni antenna 1 to antenna 2.
5. Slewing steerable antenna.
6. LMP voice communications via VHF antenna 2.
7. Switchover from VHF antenna 2 to antenna 1.
- f. Exercising the following RCS functions:
  1. Ordeal Checkout.
  2. Cycling isolation valves.
  3. Opening main shutoff valves.
  4. Closing interconnect valves.
  5. Closing crossfeed valves.
  6. Cycling quad heaters.
- g. Exercising following propulsion functions:
  1. Repeated cycling of ASC He reg valve.
  2. Ascent engine manual start/stop.
5. Securing after dynamic test.
6. Verification of dynamic test.
7. Terminating AEA memory noise test.
8. Interruption of PGNS D/L data.
9. Dump and verification of AEA memory.

Seq. 043: Shutdown of Subsystems

- a. PGNS
- b. AGS
- c. RR
- d. RR GSE
- e. RCS
- f. PROP

OCP OUTLINE

OCP-GF-61015-LM5

Test Description: (Cont)

- g. CES
- h. COMM
- i. DC BUS POWER VIA J166, J167
- j. DC BUS POWER VIA GSE

OCP OUTLINE

OCP-GF-61018-LM5

Test Title:

FEAT/EMC Mission Oriented Plugs-Out Test

Subsystem:

All LM Subsystems

Test Objectives:

Verification of all LM subsystems to perform : . functions as planned for a manned LM mission, with the following functional objectives:

- a. Pre-Launch Checkout.
- b. Earth Orbit-Translunar-Pre-Separation.
- c. Separation and First DPS Burn.
- d. Lunar Descent and Landing.
- e. Lunar Stay.
- f. Pre-Launch Checkout.
- g. Powered Ascent
- h. AGS Abort & Rendezvous.

Vehicle Configuration:

Mated Ascent & Descent Stages.

Location:

Integrated Test Area, Plt 5.

Hazardous Operations:

Not Applicable.

Equipment Under Test:

Integrated flight-all LM panels and components used throughout a manned lunar mission.

Test Description: (Para. 4.2.13.1.3)

A. Pre-Launch Checkout

Seq. 01: Call to Station

- a. Verification of the Intercom voice communication between the test conductor and all test personnel participating in this OCP.

OCP OUTLINE

OCP-GF-61018-LM5

Test Description: (Cont)

Seq. 02: Bus Power On via J167 (Para. 4.2.2.2 (c2))

- A. GSE D.C. power supplied via MSS connector J167.
- B. Closure of all pertinent EPS circuit breakers needed for pre-launch checkout.
- C. Turn-on 5 Volt R.C.S. stimuli.
  - 1. Verify each channel on (stimuli) recorder.

Seq. 03: PCM Turn-On via LUT and Interface Unit. (Para. 4.2.2.2(c3) and 4.2.2.1.2.2.1.1)

- A. PCM turn on controlled externally via LUT umbilical path.
- B. Verification of PCM lock on with ACE.
  - 1. Verification of PCM calibration voltages and bus voltages.

Seq. 04: Installation of ED Devices (Para. 4.2.2.10.3)

- A. ED devices are installed in place of all flight fuses
- B. Resistance measuring check.

Seq. 05: Closeout Check

- A. Checkout of RCS valves, landing gear deploy, ascent and descent He regulator valves, RCS and propulsion valve power (pre-separation)
- B. Verification of associated flags

Seq. 06: DC power to Bus via LUT (GSE umbilical) (Para. 4.2.2.2.2 (d))

- A. LUT Power On
- B. J167 bus power turn off
- C. Verify GSE power supplied via LUT umbilical

Seq. 07: Descent LV Turn-On/LUT Reset (Para. 4.2.2.2.2 (d))

- A. LV turn on via EPS interface unit.
- B. Reset LUT and GSE umbilical power.
- C. ASA switchover to vehicle power.

Test Description: (Cont)

- D. IMU switchover to vehicle power.
- E. Activate 0025 program to verify battery pwr  
dissipation in amp Hrs.
- B. Earth Orbit - Translunar - Pre-Separation
  - Seq. 08: SIA Separation and CSM/LM Power Transfer (Para. 4.2.2.2.e)
    - A. SIA separation
    - B. Verification of GSE power to bus via CSM/LM interface  
(J9 & J10)
    - C. Transfer CSM power to LM (via CSM/LM interface)
  - Seq. 09: PCM Turn-On (Para. 4.2.2.2.13.1.3 & 4.2.2.12.2)
    - A. PCM telemetry turn-on via vehicles CB's.
    - B. Turn on S-Band (LMP) XMITR and RCVR
    - C. Verification of PCM lock-up with ACE
    - D. EPS monitoring of Descent Batteries voltage and current
  - Seq. 10: Ingress and LM Lighting Checkout (Para. 4.2.2.2.5)
    - A. AC power turn on
    - B. Verify flood lights via docking hatch switch
    - C. Switchover to Inverter #2
    - D. Verify operation of integral lights
    - E. Verify operation of numeric lights
  - Seq. 11: Activate and Checkout Caution and Warning System  
(Para. 4.2.2.1.2.4)
    - A. Turn on C&WEA displays
    - B. C&WEA Self-Test
    - C. Lighting control override check
    - D. Verification of flood lights



OCP OUTLINE

OCP-GF-61018-IM5

Test Description: (Cont)

Seq. 12: Activate and Checkout Heat Transport Section  
(Para. 4.2.2.3.6.1 & 4.2.2.3.6.2)

- A. Verification of C&WEA of the Primary and Secondary loops
- B. Verification of Glycol pump auto switchover
- C. Checkout of accumulator (low level)
- D. Zero PT. C/O
- E. Descent H<sub>2</sub>O Tank Low Level C/O
- F. 100% PT C/O and regulator check

Seq. 13: Activate & C/O WMS (Para. 4.2.2.3.7.1 & 4.2.2.3.7.2)

- A. Pressurized Ascent Water tank C/O
  - 1. Checkout of Ascent tank #2 less than full
  - 2. Checkout of Ascent tank #2 less than tank #1
  - 3. Checkout of Ascent tank #1 less than full
  - 4. Checkout of Ascent tank #1 less than tank #2

Seq. 14: Activate & C/O ARS (Para. 4.2.2.3.6.1)

A checkout of the following ARS components

- 1. suit fan
- 2. water separator
- 3. suit gas diverter C/O

Seq. 15: ARS redundant mode C/O (Para. 4.2.2.3.5.1.1 & 4.2.2.3.2)

- A. Checkout of ARS components and associated C&WEA
  - 1. Suit Fans
  - 2. Water Separator
  - 3. Glycol low delta pressure
  - 4. CO<sub>2</sub> Sensor
  - 5. Torn Suit protection System Checkout

Test Description: (Cont)

B. Activate Ascent and Descent O<sub>2</sub> Tanks

1. Pressurization of the descent and ascent O<sub>2</sub> tanks. Verification of C&WEA at low level, as well as, meter readings.

Seq. 16: Activate RCS Heaters and Check Quad Temperatures  
(Para. 4.2.2.7.1 (h))

- A. Cabin verification of Quad Cluster Heaters by monitoring temperature circuitry.

Seq. 17: Activate VHF Voice Communication

- A. Demonstrate Voice Communications uplink and downlink between CTS and LMP via VHFA.

Seq. 18: S-Band Checkout (Para. 4.2.2.11.1.7.1)

A. Checkout S-Band Omni Fwd.

1. Verify voice communications via S-Band secondary system and omni antenna #1.
2. Verify LMP lock-up voice communication via CDR S-Band link.
3. Verify voice communications via S-Band Primary system and Omni antenna #2.

B. Ranging Function Checkout

1. Ranging delay check

C. FM Modulation Checkout

D. Checkout of S-Band Aft Antenna

E. VHF-A Checkout of CDR Voice Communications

Seq. 19: Activate Subsystems

A. Activate subsystems circuit breakers

B. DES LV/HV Switchover (if not previously performed)

Seq. 20: Ascent Batteries Checkout (Para. 4.2.2.2.4)

A. Checkout Ascent Batteries on open circuit

1. Turn on Inverter #1 and Inverter #2 turn off.

OCP OUTLINE

OCP-GF-61018-LM5

Test Description: (Cont)

- B. Checkout Ascent Batteries connected to either bus
  - 1. Inverter #2 turn on and Inverter #1 turn off.
- Seq. 21: PGNS Activation (Para. 4.2.2.12.4)
  - A. LGC/DSKY Power turn-on
  - B. LGC self-check via DSKY
- Seq. 22: C/O Mission Timer (Para. 4.2.2.9.3)
- Seq. 23: Propellant and Helium Checkout (Para. 4.2.2.8.3.3 (n (b)))
  - A. Verification of Temperature and Pressure readings associated with Propellant and helium tanks.
    - 1. IQGS Sensor Test Dry Checkout
- Seq. 24: Verify and Set-RCS Flags/Valve Status Prior to Pressurization
  - A. Verify status of all RCS valves and associated instruments.
- Seq. 25: Activate VHF Data transmission to Command Module.
  - A. Configure and verify transfer to lo-bit rate.
  - B. Verify ACE - S/C decommutator lock-up (Lo Bit Rate)
  - C. Verify transmission of low-bit-rate split-phase RZ PCM data to CM via VHF Channel B.
  - D. Verify relay of S-Band voice backup transmission with low-bit-rate NRZ PCM data.
  - E. Configure and verify transfer to H1 Bit.
- Seq. 26: Maintain Communications with MSFN
  - A. Check S-Band Transmitter Frequency
- Seq. 27: Checkout RCA (Para. 4.2.2.6.4)
  - A. Verify end-to-end operation of gyros.
- Seq. 28: Pressurize RCS (Para. 4.2.3.1.0.2(a)d)
  - A. Set Master Alarm SW and RCS HE Press to C/O associated ED Simulators & C&WEA.

OCP OUTLINE

OCP-GF-61018-IM5

Test Description: (Cont)

- Seq. 29: IMU in Operate Mode
- A. Application of IMU Operate PWR
  - B. IMU Operational Test
  - C. G&N Voltage and Temperature Check
- Seq. 30: Checkout RCS Jets via ACA (Para. 4.2.2.6.3.7.1)
- A. ACA is exercised in roll, pitch and yaw while operating in AGS guidance and pulse mode. Jet Driver commands and Caution and Warning indications are verified for proper operation.
- Seq. 31: Deploy Landing Gear (Para. 4.2.2.10.4 (b) & 4.2.2.10.2)
- A. Command appropriate ED simulators to fire and verify associated CAUTION lights.
- Seq. 32: Activate and C/O AGS (Para. 4.2.2.6.5.3)
- A. AGS turn on and set to standby
  - B. Set AGS to Operate Mode and perform AEA self test.
- Seq. 33: G&N Fine Align
- A. Torque IMU to +10 -0.1 degrees azimuth.
  - B. Torque IMU to -5 0.1 degrees pitch.
  - C. Torque IMU to +30 0.1 degrees roll.
  - D. Verify Stabilization and Control subsystem in off mode.
- Seq. 34: Main propulsion flag/valve status
- A. Cycling ascent and descent regulator switches to checkout associated flags measurements.
- Seq. 35: Checkout LM Relay of CSM Data to MSFN
- A. Verification of VHF A (LMP) voice relayed via S-Band to CTS.
- Seq. 36: Align AGS to PGNS, Monitor FDAI's (Para. 4.2.2.6.5.7)
- A. Verify on FDAI the transfer of IMU Azimuth, pitch and roll angles to AGS.
- Seq. 37: DUA Turn-On (Para. 4.2.2.11.1.7.1)
- A. Turn-on DUA

OCP OUTLINE

OCP-GF-61018-LM5

Test Description: (Cont)

- B. Verification of Data Uplink
- C. Clearing DUA counts

Seq. 38: AGS State Vector Initialization (Para. 4.2.2.6.5.7)

- A. Verify at DEDA, the transfer of IM and CSM state vectors to the AEA.
- B. Leave AGS in orbit align mode.

Seq. 39: Ordeal Checkout (Para. 4.2.2.9.4)

- A. Turn-on ordeal assembly and c/o via FDAI's
- B. Verify IMU is aligned to 0° via measurement and meter monitoring.

Seq. 40: Checkout Docking Lts. (Para. 4.2.2.2.5)

- A. Activate docking lights
- B. Checkout docking lights
- C. Deactivate docking lights

J. Separation and First DPS Burn

Seq. 41: Load and Initialize for Separation Maneuver

- A. Verify jet driver outputs for -X translation initiated at the DSKY.

Seq. 42: Select Modes for First DPS Burn

Seq. 43: First DPS Burn

- A. Perform ullage maneuver.
- B. Start Descent Engine via DSKY command.
- C. Verify descent HE pressurization, and descent propellant, fuses are blown.

Seq. 44: C/O Tracking Light (Para. 4.2.2.2.5)

- A. Turn-on, checkout, and turn-off tracking light.

Seq. 45: Select EPS Modes for 2nd DPS Burn (Para. 4.2.2.2.3)

- A. Inverter #2 turn-off and inverter #1 turn on.
- B. Checkout amp and voltage readings on all batteries and buses.

Test Description: (Cont)Seq. 46: Propellants, Gases and Fluids Checkout

- A. Check RCS Systems A&B pressure and temperature Instrumentation  
Check descent and ascent propulsion tank instrumentation.

D. Lunar Descent and LandingSeq. 47: Suit Fan and Glycol Turn On (Para. 4.2.2.3.3)

- A. Turn on of suit fan #1 and Glycol Pump #1
- B. Monitor H<sub>2</sub>O Separator Rate, Glycol Pump Delta P
- C. Activate Auto-transfer power

Seq. 48: Initiate FCS Profile for Second DPS burn and simultaneous Self Check of LR (Para. 4.2.2.5.9.3)

- A. Self Check Landing Radar simultaneous to running of DUA tape #40.

Seq. 49: Suit Fan and Glycol Pump turn-off (Para. 4.2.2.3.3)

- A. Turn off of Suit Fan #1 and glycol pump #1.

Seq. 50: Major Functions Associated with Hover (Seq. 4.2.2.5.9.1)

- A. Verify Descent Rate Switch Operation
- B. Load LJA tape #33 into LGC
- C. Verify operation of CDR's ACA
- D. Command Descent Engine on Via DSKY
- E. Verify Operation of CDR's TTCA
- F. Verify Both Engine Stop Switches

E. Lunar StaySeq. 51: RR Turn-On, Adjustment for Thermal Balance and Turn-Off (Para. 4.2.2.5.7.6.1)

- A. RR power verification
- B. Adjustment and verification of RR subsystem operation
- C. RR power shut-off

Seq. 52: Deactivation of Subsystems

- A. CES Power down
- B. Vent Descent Fuel-Ox

Seq. 53: Checkout of EPS and ED (Para. 4.2.2.2.4 & 4.2.2.10.3)

- A. Post landing checkout of EPS
  - 1. Monitoring the voltage and amperage of the buses and batteries
  - 2. Inverter #1 turn off and inverter #2 turn on

OCP OUTLINE

OCP-GF-61018-LM5

Test Description: (Cont)

Seq. 53: (Cont)

- B. Manually fire and checkout master arm ED simulators

Seq. 54: AGS Lunar Align (Para. 4.2.2.6.5.7)

- A. PGNS GYRO - COMPASSING
- B. Lunar Align
- C. Align AGS to PGNS and c/o FDAI

Seq. 55: Deactivate PGNS Lunar Stay

Seq. 56: Lunar Stay COMM C/O and PLSS Test (Para. 4.2.2.11.1.7.2.1 & 4.2.2.11.1.7.4)

- A. S-Band Setup:
  - 1. Lo power config. (transceiver only, no pwr amp)
  - 2. Lo Bit rate (1.6K bits/sec.) PCM
  - 3. TV Transmission - Hi and Lo frame rate
  - 4. Relay of EVA voice and bio med data to MSFN
- B. VHF Set Up:
  - 1. Voice relay of MSFN to EVA
  - 2. Dual EVA - Both CDR and LMP using PLSS space Suit Comm Systems.

F. Pre-Launch

Seq. 57: Reactivation

- A. Reactivate subsystems for launch checkout

Seq. 58: Propellants, Gases and Fluids Status Check

- A. Check RCS Systems A&B pressure and temperature instrumentation
- B. Check ascent propulsion tanks and regulators instrumentation
- C. Check ascent and descent water tank instrumentation.

Seq. 59: Select EPS Modes for Ascent Burn (Para. 4.2.2.2.3.2)

- A. Tie ascent batteries in parallel with descent batteries.
- B. Turn off descent batteries.

Seq. 60: Activate Ascent and Descent O<sub>2</sub> Tanks.

- A. Checkout of associated C&WEA and instrumentation readings

Seq. 61: Activate Ascent H<sub>2</sub>O Tanks

- A. Checkout of associated C&WEA and instrumentation readings

Seq. 62: Checkout AGS (Para. 4.2.2.6.5.3)

- A. AEA Self-Check

OCP OUTLINE

OCP-GF-61018-LM5

Test Description: (Cont)

Seq. 63: Select Event Timer (Para. 4.2.2.9.2)

Seq. 64: Select Mode for Ascent

A. Configure cabin for ascent.

Seq. 65: Activate, Self-Test and Deactivate RR-Ascent Burns, Rendezvous & Docking

A. Verify manual slew of rendezvous radar

B. Self-Test rendezvous radar

C. Radar strobed by LGC for range and range rate output verified on DSKY

Seq. 66: RCS/ASC Interconnect

A. Valves connecting RCS and ascent propellants are opened and verified.

Seq. 67: Suit Fan #2 and Glycol Pump #2 turn off. (Para. 4.2.2.3.3)

G. Powered Ascent

Seq. 68: Powered Ascent Arm Ascent, Engine and Auto Ascent (Para. 4.2.2.5.10)

A. Enable and verify ascent engine

B. Initiate Auto ascent profiles.

1. Command ascent helium pressurization.

2. Load DUA Tape #31 into LGC and initiate

3. Verify ascent helium pressurization.

4. Auto Engine Off

Seq. 69: Suit Fan and Glycol Pump Turn-Off, Ascent Burns, Rendezvous & Docking (Para. 4.2.2.3.3)

A. Turn-off suit fan #2.

B. Turn-off glycol pump #2.

Seq. 70: VHF Ranging TBD

Seq. 71: Command X-Axis RCS Burn, Ascent Burns, Rendezvous & Docking (Para. 4.2.2.5.11)

A. Verify jet driver outputs for plus X translation initiated at the DSKY.



OCP OUTLINE

OCP-GF-61018-LM5

Test Description: (Cont)

Seq. 72: EPS Status Check - Ascent Burns, Rendezvous & Docking  
(Para. 4.2.2.2.4 & 4.2.2.3.3.2)

A. Verify ascent batteries and DC and AC buses.

Seq. 73: Exercise Manual Translation and ACA as per docking Ascent Burns (Para. 4.2.2.6.3.9.1)

A. Verify operation of commander's ACA

B. Place IMU in standby

C. Verify operation of commander's T/TCA.

Seq. 74: PGNS Shutdown

H. AGS Abort and Rendezvous

Seq. 75: AGS Abort-Abort Stage (Para. 4.2.2.6.5.9 & 4.2.2.6.5(j)(k))

A. Place LM in auto descent configuration

B. Reset event timer and install ED simulators

C. Initiate Abort and Abort Stage and monitor functions

D. Visually verify that proper ED simulators have fired.

Seq. 76: Analog Autopilot Rendezvous (Para. 4.2.2.6.3.9.2)

A. Exercise the commander's T/TCA with the balanced couple switch On, mode control switch in attitude hold, attitude control switches in pulse and the AEA in orbit align.

B. Place the X translation switch in 4-jet position and exercise the T/TCA.

C. Exercise the commander's ACA

D. Load DUA Tape #27 into the LGC and initiate at DSKY

Seq. 77: Securing After Test S&C Shutdown

Seq. 78: LV to HV Switchover

A. Perform the Descent LV to HV switchover if and when the D.C. Bus Voltage's falls below 27.0 V.D.C. during the running of this OCP.

## OCP OUTLINE

OCP-GF-62000-CON-LM-5

### Test Title:

LM Combined Subsystem Pre-FEAT Test - Control

### Subsystem:

All LM Spacecraft Subsystems

### Test Objective:

- a. Provide a controlling document which will demonstrate the functional performance and integration of multiple subsystems of the LM Spacecraft Vehicle.
- b. A Bar Chart will control the test flow serially or in parallel for:
  - OCP-GF-62000-ECS
  - OCP-GF-62000-INSTR
  - OCP-GF-62000-EPS
  - OCP-GF-62000-EDS
  - OCP-GF-62000-G&N
  - OCP-GF-62000-PROP
  - OCP-GF-62000-RCS
  - OCP-GF-62000-COMM
  - OCP-GF-62000-RAD
  - OCP-GF-62000-FCS
- c. A Constraint Chart will provide alternate test flow if desired flow cannot be maintained as a result of troubleshooting or other conditions.
- d. Insure control of GSE support equipment by means of OCP-GF-62000-IPC.
- e. Insure initial LM Spacecraft Cabin Configuration.
- f. Furnish the listings of applicable drawings, measurements monitored, non-standard abbreviations and symbols, personnel requirements, safety requirements, standard and special instructions, limited life equipment and communication channel assignments.

### Vehicle Configuration:

Ascent and Descent Stages mechanically and electrically mated.

### Location:

Integrated Workstand, Plant 5

### Hazardous Operations:

Hazardous working conditions as outlined in the referenced Satellites.

## OCP OUTLINE

OCP-GD-62000-CON-LM-5

### Equipment Under Test:

EPS - Electrical Power Subsystem  
LTG - Lighting Subsystems  
PGNS - Primary Guidance and Navigation Subsystem  
LR - Landing Radar Subsystem  
RR - Rendezvous Radar Subsystem  
AGS - Abort Guidance Subsystem  
CES - Control Electronics Section  
RCS - Reaction Control System  
PROP - Propulsion Subsystem  
EDS - Explosive Devices Subsystem  
COMM - Communications Subsystem  
INST - Instrumentation Subsystem (including Caution and Warning)  
D&C - Display and Controls  
ECS - Environmental Control Subsystem

### Test Description:

1. Authorizes the performance of all testing after ensuring that cooling support has been made available via SMP 3356.
2. The STE directs S/S TC's (EPS, RCS, INST & EDS) in the serial execution of discrete sequences within each of the satellites.
3. Parallel testing is initiated once the ECA's within the EPS S/S have been functionally verified. Upon completion of portions of EPS, RCS, COMM and EDS tests, parallel testing of the G&N and PROP S/S is begun.
4. Vehicle activities are constrained during AOT and Fine Alignment Sequences of the G&N satellite after which G&N is then used to support FCS for several sequences.
5. ECS and RAD testing commences in parallel. G&N support is directed for several sequences within the RAD satellite.
6. FCS testing is performed serially upon completion of RAD testing with G&N and RAD support directed as required.
7. ECS heat load tests are performed upon completion of FCS followed by

OCP OUTLINE

OCP-GD-62000-CON-LM-5

Test Description: (Cont)

parallel operation of the final sequences to verify performance of ECS, PROP, COMM and EPS.

8. The document provides the procedure for shutdown of Instrumentation, removal of electric power and shutdown of cooling support upon completion of all tests. This is followed by a verification of Bus Isolation per EPS satellite.
9. The control document authorizes sequences of satellites to be performed out of numerical order. This design permits maximum flexibility in performance of tests.

## OCP OUTLINE

OCP-GF-62000-ECS-IM-5

### Test Title:

LM Combined Subsystem Pre-FEAT Test - Environmental Control

### Subsystem:

Environmental Control Subsystem (ECS)

### Test Objectives:

- a. To verify pump parameters and the response of the Heat Transport Section (HTS) to the cabin temperature control valve settings.
- b. To verify the performance of the Atmosphere Revitalization Section (ARS).
- c. To verify the operation of the ECS Operational Instrumentation.
- d. To verify the operation of applicable ECS portions of the Caution and Warning Subsystems.
- e. To verify the integrated performance of the HTS and ARS.
- f. To verify the capability of the ECS cabin pressurization section to function properly in all of its operating modes while functionally interfaced with EPS and Instrumentation.
- g. To verify the various electrical interlocks between the oxygen demand regulators and the cabin pressure switch for the operation of the cabin repress valve, the suit diverter valve, and the cabin fans.
- h. To verify that WMS exhibits satisfactory flow characteristics with GN<sub>2</sub> and to functionally check the WQMD's.

### Vehicle Configuration:

Mated

### Location:

Integrated or Ascent Workstand, Plant 5

### Hazardous Operation:

Pneumatic pressure to 250 psig

### Equipment Under Test:

Heat Exchangers (H/X)

Temp Control Valves

Water Glycol Pumps (Primary & Secondary)

## OCP OUTLINE

OCP-GF-62000-ECS-LM-5

### Equipment Under Test: (Cont)

CO<sub>2</sub> Removal Cartridges  
Suit Circuit Fans  
Water Separators  
Water Glycol Accumulator  
Cabin Fans  
Pressure and Temperature Transducers  
CO<sub>2</sub> Pressure Sensor  
Caution and Warning Lights  
Circuit Breakers  
Display Meters  
Cabin Pressure Switch  
Suit Diverter Valve  
Secondary Water Regulator  
Cabin Repressurization Valve  
Primary Water Regulators  
Suit Isolation Valves (CDR, IMP)  
Water Quantity Measuring Device (WQMD)

### Test Description:

#### Seq. 01: Call to Stations

#### Seq. 02: Water Management Section

##### a. WQMD Calibration

The WQMD is calibrated for a 0.75 fill ratio for the Descent and Ascent H<sub>2</sub>O tanks. A zero setting is obtained at a pressure of 11.9 PSIA nominal, and a 100% setting at 47.0 PCTA nominal. (Para. 4.2.2.3.7.3)

##### b. Water Tanks

The water tanks are pressurized with GN<sub>2</sub> to check the Caution and Warning system at the following three points:  
(Para. 4.2.2.3.7.2)

1. Low level (16 PCT) of D/S water tank.
2. Non-fill condition (95 PCT) of either or both A/S water tanks.
3. Unequal level (15 PCT difference) between the two A/S water tanks.

## OCP OUTLINE

OCP-GF-62000-ECS-LM5

### Test Description: (Cont)

- c. WMS GN<sub>2</sub> Flow Tests  
(Para. 4.2.2.3.7)

Verification of GN<sub>2</sub> flow and pressure decay is accomplished with the primary, and redundant H<sub>2</sub>O regulators biased at 3.8 and 4.8 PSIG.

### Seq. 03: OCPS Verification and Descent and Ascent O<sub>2</sub> Tank Checkout

#### a. OCPS Verification

1. Operation of the suit isolation valves is checked by simulating loss of cabin pressure and suit pressure.  
(Para. 4.2.2.3.5.2a)
2. The cabin repress valve, diverter valve and cabin pressure switch are checked out with the O<sub>2</sub> pressure regulators in all logic configurations.  
(Para. 4.2.2.3.5.4)

#### b. O<sub>2</sub> Tanks - C&WEA Verification

1. Descent O<sub>2</sub> Tank - 'low level' caution light is activated at 135 ± 85 PSIA. (Para. 4.2.2.3.5.6)
2. Ascent O<sub>2</sub> Tank #1 - 'low level' caution verification of caution light at 100 ± 30 PSIA.  
(Para. 4.2.2.3.5.6)

### Seq. 04: Atmosphere Revitalization Section (ARS)

#### Seq. 04-001: Suit Fan 1 Test and Checkout of Suit Flow Valves in Suit Disconnect Position (Normal Mode) (Para. 4.2.2.3.3a)

- a. Verify that the valve position indicators (event lights) at ACE operate for:
1. Cabin gas return valve
  2. O<sub>2</sub> pressure regulators A & B
  3. Suit isolation valves
  4. Suit circuit relief valve
- b. Verify the operating parameters of suit fan 1.
- c. Verify the flow division characteristic of either the CDR's or LMP's suit isol. valve in the suit disconnect position.

#### Seq. 04-031: CO<sub>2</sub> Meter and C/W Test (Para. 4.2.2.3.2)

- a. Verify CO<sub>2</sub> instrumentation and the high CO<sub>2</sub> input to the ECS caution light of the Caution and Warning Subsystem.

## OCP OUTLINE

OCP-GF-62000-ECS-LM5

### Test Description: (Cont)

Seq. 04-052: Installation of LiOH Cartridges and C/O of Suit Fan 1 Flow Through Cartridges in Normal and Egress Mode  
(Para. 4.2.2.3.3)

- a. Verify that with the LiOH cartridges installed and simulated suit pressure drops, suit fan 1 can supply the minimum specified flow in the normal and egress mode (4.8 and 3.7 PSIA respectively).
- b. Verify speed of water separators 1 and 2.
- c. Vary suit differential pressure and record corresponding suit supply flow.

Seq. 04-096: Pump Failure C/W Test

- a. Verify the primary glycol pump failure input to the ECS caution light of the Caution and Warning Subsystem.

Seq. 04-105: Suit Fan 1 and Water Separator C/W Test

- a. Verify suit fan 1 failure and water separator failure inputs to the ECS caution light of the Caution and Warning Subsystem.

Seq. 04-127: Suit Fan 2 Test (Normal and Egress Mode)

- a. Verify the operating parameters of suit fan 2 with simulated suit pressure drops and the suit loop in the normal and egress mode (4.8 and 3.7 PSIA respectively).
- b. Vary suit differential pressure and record corresponding suit supply flow.

Seq. 04-164: Suit/Fan 2 C/W Test

- a. Verify suit fan 2 failure input to the suit/fan warning light of the Caution and Warning Subsystem.

Seq. 04-176: Removal of LiOH Cartridge

- a. With suit loop at atmospheric pressure, remove primary and PLSS LiOH cartridges.

Seq. 05: Heat Transport Section (HTS) - Coolant Pump Checkout

a. Primary Glycol Pump Tests

1. Activate pump No. 2 and record its operating parameters and then deactivate.
2. Activate pump No. 1 and record its operating parameter and deactivate.



## OCP OUTLINE

OCP-GF-62000-ECS-L1.5

### Test Description: (Cont)

#### b. Primary Glycol Pump Auto-Switchover (S/O)

1. Verification of the automatic S/O to glycol pump No. 2 in the event glycol pump No. 1 fails. Pump No. 1 CB is pulled simulating failure and S/O is verified by observing the ACE event and component caution light are on and the maintenance of pump pressure.

#### c. Secondary Glycol Pump Test (Para. 4.2.2.3.6.1)

1. Activate secondary glycol pump and record its operating parameters and deactivate.

#### d. Glycol Overtemp and Glycol Accumulator Low Level Test (Para. 4.2.2.3.6.2)

1. Verifies the High Glycol Temp Input - greater than 50 deg. F, (nominal) to the glycol caution light. Dry ice is used to lower the temp at the transducer inhibiting the caution light which is activated once more at the end of this sequence upon rise of temp due to removal of the dry ice. The temperature at which the glycol caution light is reactivated is recorded.
2. Verifies the low glycol accumulator level input at ten percent (10%) nominal to the glycol caution light. While the temperature is inhibited by the dry ice, the accumulator low level input is verified.
3. Verification of proper accumulator level at glycol caution light activation is accomplished by draining the accumulator into the Portable Fill Reservoir (PFR).
4. Verify springload of accumulator at 5 to 15 percent by observing that the pump outlet pressure (static) is within specification limits.
5. Restore normal accumulator configuration. Remove dry ice and verify high glycol temperature input to caution light greater than 50 deg. F.

#### Seq. 06: ECS HTS System Head Curves

- a. Vary glycol flow and temperature through primary glycol loop and record delta P across the pumps and pump discharge pressure at each flow.
- b. Vary glycol flow and temperature through secondary glycol loop and record pump discharge pressure at each flow.

## OCP OUTLINE

OCP-GF-62000-ECS-LM5

### Test Description: (Cont)

Seq. 07: H/X and Cabin Temperature Control Functional Test  
(Para. 4.2.2.3.6.3)

- a. Verify the ability of the glycol loop to respond to hot and cold cabin temperature control valve settings by establishing and recording relationships of temperature at various points in the primary glycol loop for the maximum cool, normal, and maximum heat positions of the cabin temperature control valve.

Seq. 08-000

To

Seq. 08-055: Suit Circuit Assembly - Heat Transport Section Interface Functional Test (Egress Mode, 3.8 PSIA Nominal)

- a. Verify the ability of the suit loop and the HTS to function together to control the suit loop temperature and to remove simulated metabolic water which is introduced into the suit loop as steam.  
(Para. 4.2.2.3.3 b & 4.2.2.3.6.4)

Seq. 08-057

To

Seq. 08-112: Suit Circuit Assembly - Heat Transport Section Interface Functional Test (Normal Mode, 4.8 PSIA Nominal)

- a. Verify the ability of the suit loop and the HTS to function together to control the suit loop temperature and to remove a simulated metabolic load which is introduced into the suit loop as water and heat.  
(Par. 4.2.2.3.3 & 4.2.2.3.6.4)

Seq. 09: ECS Shutdown and Water Collection

- a. Shutdown ECS and GSE which were operational in previous sequences.
- b. Drain accumulated water in suit loop and GSE.
  1. Record volume in GSE water reservoir.
  2. Record volume of H<sub>2</sub>O from lines to reservoir.
  3. Verify less than 25 CC of H<sub>2</sub>O per separator has collected in H<sub>2</sub>O separator housing drain tank and record.
  4. Drain H<sub>2</sub>O accumulated in 'canned-man' (ISC 430-91033-11) from H<sub>2</sub>O drain, cabin port and suit port and record.
  5. Reconfigure to all fittings and valves to OCP initial configuration.

OCP OUTLINE

OCP-GF-62000-ECS-LM5

Test Description: (Cont)

Seq. 10: Drying Suit Loop and Canned Man

- a. Dry the Stimuli Generator Test Set (SGTS) and the Suit Circuit Assy. (SCA).
  - 1. Remove the hoses from the SCA to SGTS.
  - 2. GN<sub>2</sub> flow established through the SCA's and also through the SGTS (ISC 430-91033-11)
  - 3. After drying is accomplished, original equipment configuration is established.

Seq. 11: Securing After Test

- a. During Seq. 11 a pressure integrity and leak check is performed at the WMS/ARS interface which consists of the H<sub>2</sub>O separator discharge lines and reference pressure lines.

OCP OUTLINE

OCP-GF-62000-INSTR-LM5

Test Title:

LM Combined Subsystem Pre-FEAT Test - INSTR

Subsystem:

Instrumentation

Test Objectives:

- a. To turn-on the LM Instrumentation Subsystem and to provide minimal verification of the adequate operation of the PCMTEA.
- b. To test the logic of those CWEA data channels available at the SCEA GSE Connectors.

Vehicle Configuration:

1. Planned - Electrically connected stages (Ascent and Descent)
2. Minimum - Ascent Stage with staging interconnections shorted to simulate attached Descent Stage

Location:

Integrated Test Stand, Plant 5 CEF

Hazardous Conditions:

Not Applicable

Equipment Under Test:

PCMTEA  
SCEA # 1  
SCEA # 2  
CWEA  
Selected Transducers

Test Descriptions:

Seq. 001: Call to Stations

Seq. 002: Instrumentation Turn-On and Verification

- a. PCMTEA/GSE Umbilical Interface Verification (Hi-Bit Rate)
- b. PCMTEA mission elapsed time reset verification.
- c. EPS AC and DC CRT bus readout check.
- d. PCMTEA and SCEA remote turn-on verification.
- e. PCMTEA oscillator failure detection circuit (Hi-Bit Rate).

Seq. 003: CWEA Displays Turn-On and Self-Test

- a. CWEA displays turn-on
- b. CWEA displays self-test

OCP OUTLINE

OCP-GF-62000-INSTR-LM5

Test Description: (Cont)

Seq. 004: CWEA Stimuli Generator Test

- a. CES AC Warning
- b. CES DC Warning
- c. AGS Warning
- d. Pre Amps Caution
- e. Heater Caution
- f. O<sub>2</sub> Qty Caution
- g. Inverter Caution
- h. ASC Hi Reg Caution
- i. RCS Caution
- j. ASC Press Warning
- k. Water Qty Caution
- l. Battery Caution
- m. ASC Qty Caution
- n. Des Qty Caution ,

## OCP OUTLINE

OCP-GF-62000-EPS-LM5

### Test Title:

LM Combined Subsystem Pre-FEAT Test - EPS

### Subsystem:

Electrical Power Subsystem (EPS)

### Test Objective:

- a. Demonstration of proper functional operation of Ascent Stage EPS and related controls and displays.
- b. Demonstration of proper functional operation of Descent Stage EPS and related Ascent Stage EPS controls, displays and interfaces.
- c. Verification of accuracy of EPS cabin meters and ACE-S/C voltage and current readouts.
- d. Measurement of resistance of EPS main power paths.
- e. Verification of isolation of translunar busses.
- f. Verification of external LM power interfaces.
- g. Demonstration of proper functional operation of interior and exterior lights operated by cabin panel controls.

### Vehicle Configuration:

Mated Stages

### Location:

Integrated Workstand, Plant 5 CEF

### Hazardous Operations:

Tracking light operation (eye protection needed)

### Equipment Under Test:

Ascent Stage Electrical Control Assemblies (2)  
Inverters (2)  
Deadface Relay  
Relay Junction Box  
Descent Stage Electrical Control Assemblies (2)  
Lighting Control Assembly (ICA)  
Tracking Lights  
Docking Lights  
Flood Lights  
Panel Lights  
Portable Utility Lights

OCP OUTLINE

OCP-GF-62000-EPS-LM5

Test Description:

Seq. 01: Call to Stations

- a. Verification that required personnel are at their respective stations.

Seq. 02: EPS Activation Bus Power on, via J167

- a. Verification that the GSE and the vehicle are in the proper configuration for application of power, and the applying of GSE power to the vehicle busses. (Para 4.2.2.2.2.C2)

Seq. 03: AC Isolation Power Transformer Turn-on

- a. Utilization of ground AC power is required for preliminary instrumentation checkout.

Seq. 04: Lighting Test Set Set-Up

- a. Verification that the Lighting Test Set is properly configured to support lighting requirements.

Seq. 05

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Seq. 06: Inverter Functional Test

- a. Verification, for each inverter, of output voltage and frequency, on ACE-S/C. (Para. 4.2.2.2.4 a2)
- b. Verification, for each inverter, of output voltage on the cabin voltmeter. (Para. 4.2.2.2.4 a1)
- c. Verification of inverter selection by means of cabin controls. (Para. 4.2.2.2.4 b & c)
- d. Measurement of each AC bus voltage under load (utilizing GSE load bank).
- e. Response of caution and warning

Seq. 07: Ascent ECA power on Procedure

- a. Verification that the GSE and the vehicle are in the proper configuration for ascent vehicle power, and the actual turn-on of ascent vehicle power.

OCP OUTLINE

OCP-GF-62000-EPS-LM5

Test Description (Cont)

Seq. 08

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Seq. 09: Ascent Battery Cabin Displays, ACE-S/C Displays, and Feeder Line Verification

- a. Verification for each ascent stage ECA, of:  
(Para. 4.2.2.2.2. a2)
  1. Normal main feeder contactor operation.
  2. Alternate main feeder contactor operation.
  3. Associated cabin battery status flags and controls.
- b. Comparison of precision voltmeter readings with LM cabin voltmeter and ACE-S/C readouts of voltage for each of the following vehicle measurements points: (Para. 4.2.2.2.2. a1)
  1. Commander's DC bus
  2. System Engineer's DC bus
  3. Each of the ascent battery feeders
- c. Utilizing GSE load bank, comparison of precision ammeter readings with LM cabin ammeter and ACE-S/C readouts of current for each of the ascent battery feeder current monitors.  
(Para. 4.2.2.2.2b)

Seq. 10,

11, 12,

13, 14,

15 : Ascent ECA Malfunction Logic

- a. Verification, for each ascent stage ECA, of:
  1. Response to simulated reverse current condition. (LSP470-2 Part II Para. 4.2.2.2.3.2 a,e,f,g,i and k)
  2. Response to simulated over-current condition. (LSP470-2 Part II Para. 4.2.2.2.3.2 a,b,c and d)
  3. Response to simulated over temperature condition.
  4. Response of caution and warning to simulated over-current and reverse current. (Para. 4.2.2.2.3 b)

Seq. 16: Verification of Display Circuit Operation

- a. Verification of control over EPS displays by operating the display circuit breaker.



OCP OUTLINE

OCP-GF-62000-EPS-LM5

Test Description: (Cont)

Seq. 17: Independency of ECA Controls

- a. Verification of Commander's and System Engineer's redundant control circuitry as follows:
  - 1. ASC ECA (Para. 4.2.2.2.2. g3)
  - 2. ASC ECA Control (Para. 4.2.2.2.2. g4)

Seq. 18: Check of Battery Isolation From the Busses

- a. Verification that the ascent batteries feed the proper bus both in the normal and back-up modes of operation.

Seq. 19: Verification of LMP and CDR Independency

- a. Verification of isolation between Commander's DC bus and System Engineer's DC bus.

Seq. 20: Descent ECA Power on Procedure

- a. Verification that the GSE and the vehicle are properly configured for application of descent vehicle power, and the actual application of descent vehicle power.

Seq. 21,

22, 23,

24, 25 : Descent Battery Cabin Displays, ACE-S/C Displays and Feeder Line Verification

- a. Verification, for each descent stage ECA electrical control sub-assembly, of: (Para. 4.2.2.2.2. a2)
  - 1. Battery high voltage main feeder contactor operation
  - 2. Battery low voltage main feeder contactor operation
  - 3. Associated cabin battery status flags and controls
- b. Comparison of precision voltmeter readings with LM cabin voltmeter and ACE-S/C readouts of voltage for each of the following vehicle measurement points:  
(Para. 4.2.2.2.2a1)
  - 1. Commander's DC bus
  - 2. System Engineer's DC bus
  - 3. Each of the Descent battery feeders

## OCP OUTLINE

OCP-GS-62000-EPS-LM5

### Test Description: (Cont)

- c. Utilizing GSE load bank, comparison of precision ammeter readings with LM cabin ammeter and ACE-S/C readouts of current for each of the descent feeder current monitors.  
(Para. 4.2.2.2.2. b)

#### Seq. 26: Cross Tie Balance Load Feeder Line Check

- a. Measurement of voltage drop of Cross Tie Balance Load Feeder Lines.

#### Seq. 27: LUT Feeder Line Verification (Para. 4.2.2.2.2 P/O d)

- a. Verification of LUT power transfer interface
  - 1. Relay junction box LUT power contactor operation
- b. Measurement of voltage drop of LUT feeder line.

#### Seq. 28, 29,30 : Descent Battery Cabin Displays, ACE-S/C Displays, and Feeder Line Verification

- a. Verification, for each descent stage ECA electrical control sub-assembly, of:  
(Para. 4.2.2.2.2. a2)
  - 1. Battery high voltage main feeder contactor operation
  - 2. Battery low voltage main feeder contactor operation
  - 3. Associated cabin battery status flags and controls
- b. Comparison of precision voltmeter readings with LM cabin voltmeter and ACE-S/C readouts of voltage for each of the following vehicle measurement points:  
(Para. 4.2.2.2.2 a1)
  - 1. Commander's DC bus
  - 2. System Engineer's DC bus
  - 3. Each of the descent battery feeders
- c. Utilizing GSE load bank, comparison of precision ammeter readings with LM cabin ammeter and ACE-S/C readouts of current for each of the descent feeder current monitors.  
(Para. 4.2.2.2.2. b)

OCP OUTLINE

OCP-GF-62000-EPS-LM5

Test Description: (Cont)

Seq. 31: Redundant EPS CB Verification

- a. Verification of Commander's and System Engineer's redundant control circuitry as follows:
  - 1. DES ECA (Para. 4.2.2.2.2 g1)
  - 2. DES ECA Control (Para. 4.2.2.2.2 g2)
- b. Verification of battery deadface relay contactor operation (relay junction box and deadface relay box) (Para 4.2.2.2.2 f2)

Seq. 32: DC Bus Isolation

- a. Verification of isolation between Commander's DC bus and System Engineer's DC bus.

Seq. 33: Docking Lights Checkout with Simulated Components

- a. Verification of docking light operation. (Para. 4.2.2.2.5 P/O a)

Seq. 34: LM/CSM Interface Verification  
(Para. 4.2.2.2.2 e)

- a. Verification of CSM power transfer interface.
  - 1. Operation of power contactors connecting CSM power to LM Commander's DC bus.
  - 2. CSM control of descent stage contactors.

Seq. 35: LUT/Descent ECA Switchover  
(Para. 4.2.2.2.2 d)

- a. Verification of LUT control of descent stage ECS power contactors.

Seq. 36

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Seq. 37: DC/Bus Fault Light Verification  
(Para. 4.2.2.2.2 P/O i)

- a. Verification of DC Bus Fault Light by:
  - 1. Energizing Commander's bus with de-energized System Engineer's bus shorted to ground (bus tie circuit breakers open)
  - 2. Energizing System Engineer's bus with de-energized Commander's bus shorted to ground (bus tie circuit breakers open)

## OCP OUTLINE

OCP-GF-62000-EPS-LM5

### Test Description: (Cont)

#### Seq. 38: X-Lunar Bus Isolation Check (1st Run)

- a. Verification of isolation of translunar busses from vehicle ground with translunar loads disconnected.

#### Seq. 39: Automatic Power Switchover with Abort Stage Switch (Para. 4.2.2.2.2 P/O f3)

- a. Verification of Abort Stage Switch - commanded automatic power switchover between Descent Stage and Ascent Stage power sources without power interruption under worst case conditions of:
  - 1. Minimum voltage
  - 2. Removing of redundant paths of ECA control from the Commander's DC bus then the System Engineer's DC bus.

#### Seq. 40: Window Heater Check and Isolation Power Transformer Turn-On

- a. Verification of AC window heater operation
- b. Verification of DC window heater operation
- c. Utilization of Ground AC power is required to support other sub-systems.

Seq. 41,  
42, 43,  
44, 45,  
46, 47,  
48

#### : Descent ECA Malfunction Logic

- a. Verification, for each battery malfunction circuitry in descent stage ECA's of:
  - 1. Response to simulated battery over temperature
  - 2. Response to simulated HV overcurrent condition (Para. 4.2.2.2.3.1-a, b, c, d, e, f and P/O m)
  - 3. Response of Caution and Warning to simulated overcurrent. (Para. 4.2.2.2.3 P/O b)

#### Seq. 49: Descent ECS Low Voltage Taps On

- a. Preparation of descent battery taps for following sequences (Para. 4.2.2.2.2 P/O a)

OCP OUTLINE

OCP-GF-62000-EPS-LM5

Test Description: (Cont)

Seq. 50,  
51, 52,  
53 : Descent ECA's Low Voltage Overcurrent Test

- a. Verification, for each battery malfunction circuitry in descent stage ECA's of:
  - 1. Response to simulated LV overcurrent condition
  - 2. Response of Caution and Warning

Seq. 54: Descent ECA High Voltage Taps On

- a. Preparation of descent battery taps for following reverse current sequences. (Para. 4.2.2.2.2 P/O a)

Seq. 55,  
56, 57,  
58 : Descent ECA's Reverse Current Test

- a. Verification, for each battery malfunction circuitry in descent stage ECA's, of:
  - 1. Response to simulated reverse current condition  
(Para. 4.2.2.2.3.1 - a,g,h,i,j,k,l & m)
  - 2. Response of Caution and Warning to simulated reverse current.  
(Para. 4.2.2.2.3 P/O b)

Seq. 59: LM/CSM Interface Continuity Verification

- a. Verification of CSM interface continuity.

Seq. 60: Configuration for EPS Support

- a. Verification that EPS Subsystem is secured and prepared to support other subsystem testing.

Seq. 61,  
62, 63,  
64, 65,  
66, 67,  
68, 69,  
70, 71,  
72, 73,  
74, 75,  
76 : Lighting Tests  
(Para. 4.2.2.2.5 a)

- a. Verification of power failure indicator (PFI) lights using Lighting Test Set (LTS).

OCP OUTLINE

OCP-GF-62000-EPS-LM5

Test Description: (Cont)

- b. Verification of integral lighting and override control using LTS.
- c. Verification of crewman's optical alignment sight interface using COAS Test Set.
- d. Verification of tracking light wiring using the tracking light simulator.
- e. Verification of flood lighting and dimmer control response using the LTS. (Para. 4.2.2.2.5 b1)
- f. Verification of numeric lights interface
  - 1. Checks utilizing GSE LTS to preclude damage to Light Control Assembly (LCA).
- g. Verification of Sequence Camera interface using Sequence Camera Test Set.
- h. Verification of Portable Utility Light interface using Sequence Camera Test Set.
- i. Verification of actual vehicle tracking light.
- j. Provision for utilizing the lighting test set for extended periods in order to support other subsystems.
- k. Verification of numeric lighting outputs from LCA.
- l. Provision for demating Lighting Test Set.
- m. Verification of numeric lighting outputs from LCA.
  - 1. Check of dimmer control response. (Para. 4.2.2.2.5 b2)
  - 2. Check of dimmer override. (Para. 4.2.2.2.5 b2)
- n. Verification of integral lighting outputs from LCA.
  - 1. Check of dimmer control response. (Para. 4.2.2.2.5 b3)
  - 2. Check of dimmer override. (Para. 4.2.2.2.5 b3)
- o. Verification of annunciator light output from LCA
  - 1. Check of dimmer control response. (Para. 4.2.2.2.5 b2)
  - 2. Check of dimmer override. (Para. 4.2.2.2.5 b2)

OCP OUTLINE

OCP-GF-62000-EPS-LM5

Test Description: (Cont)

Seq. 77: X-Lunar Bus Isolation Check (Final Run)

- a. Verification of isolation translunar busses from vehicle ground with translunar loads connected. (Para. 4.2.2.2.2 h)

OCP OUTLINE

OCP-GF-62000-EDS-LM5

Test Title:

LM Combined Subsystem Pre-FEAT Test - EDS

Subsystem:

Explosive Devices Subsystem (EDS)

Test Objectives:

- a. Demonstration of proper functional operation of Explosive Devices Circuitry.
- b. Verification of proper circuit isolation and firing circuit resistance.

Vehicle Configuration:

Mated Stages

Location:

Integrated Workstand, Plant 5 CEF

Hazardous Operations:

Not Applicable

Equipment Under Test:

ED Relay Boxes

Delay Timer

Pyrotechnic Batteries

Test Description:

Seq. 01: Call to Station

Seq. 02: EDIS Resistance Measurements

Seq. 03: Megohmmeter Measurement Checks

- a. Verification of 100 megohms minimum isolation between:  
(Para. 4.2.2.10.3)
  1. Active Conductors
  2. Active Conductors and Ground



OCP OUTLINE

OCP-GF-62000-EDS-LM5

Test Description: (Cont)

Seq. 04: Firing Line Resistance Measurement Of System A  
(Para. 4.2.2.10.3)

- a. Verification, by precision measurements, that firing circuit resistances are within specified critical range.
- b. Verification of circuit integrity.

Seq. 05: Firing Line Resistance Measurement of System B  
(Para. 4.2.2.10.3)

- a. Verification by precision measurements, that firing circuit resistances are within specified critical range.
- b. Verification of circuit integrity

Seq. 06: ED Battery Check

- a. Verification of ED Battery Polarity
- b. Check of ED Battery Voltage

Seq. 07: Staging Timing Sequence Set-Up

- a. Installation and check of staging timing circuitry initiator simulators. (Para. 4.2.2.10.2 a)

Seq. 08: Staging Timing Sequence Check

- a. Verification of correct staging timing operation. (Para.4.2.2.10.2 c)

Seq. 09: Firing Line Verification Check

- a. Installation and check of firing circuit initiator simulators.  
(Para. 4.2.2.10.2 a)

Seq. 10: ED Functional Test Set-Up

Seq. 11: System A and System B Battery Functional Check

- a. Check of ED battery circuitry

Seq. 12: System A Functional Check

- a. Firing of related initiator simulators and closing of associated relays during activation of manual cabin ED controls.  
(Para. 4.2.2.10.3)
- b. Monitoring of the above via the ACE-S/C. (Para. 4.2.2.10.2 g)

## OCP OUTLINE

OCP-GF-62000-EDS-LM5

### Test Description: (Cont)

- c. Monitoring of transient responses throughout the functional check.  
(Para. 4.2.2.10.3)

#### Seq. 13: System B Functional Check

- a. Firing of related initiator simulators and closing of associated relays during activation of manual cabin ED controls.  
(Para. 4.2.2.10.3)
- b. Monitoring of the above via the ACE-S/C. (Para. 4.2.2.10.2 g)
- c. Monitoring of transient responses throughout the functional check.  
(Para. 4.2.2.10.3)

#### Seq. 14: System A and System B Functional Check

- a. Firing of related initiator simulators and closing of associated relays during activation of manual cabin ED controls.  
(Para. 4.2.2.10.3)
- b. Monitoring of the above via the ACE-S/C. (Para. 4.2.2.10.2 g)
- c. Monitoring of transient responses throughout the functional check.  
(Para. 4.2.2.10.3)

#### Seq. 15: Abort Stage Asc Press Check

- a. Check of Ascent Engine Pressurization of both System A and System B separately using the Abort Stage switch. (Para. 4.2.2.10.3)
- b. Monitoring of transient responses throughout the function check  
(Para. 4.2.2.10.3)

#### Seq. 16: Descent Engine (He) Pressurization Check

- a. Check of Descent Engine Pressurization utilizing DECA engine on command. (Para. 4.2.2.10.3)
- b. Monitoring of Descent Engine (DE) Pressurization function check via the ACE-S/C (Para. 4.2.2.10.2.G.2)
- c. Monitoring of transient responses throughout the functional check.  
(Para. 4.2.2.10.3)

#### Seq. 17: Stage Command Verification

- a. Verification of stage command to System A and System B separately via AELD engine start command. (Para. 4.2.2.10.3)

OCP OUTLINE

OCP-GF-62000-EDS-LM5

Test Description: (Cont)

- b. Monitoring of stage command verification by the ACE-S/C.  
(Para. 4.2.2.10.2.G.3)
- c. Monitoring of transient responses throughout the function check  
(Para. 4.2.2.10.3)

Seq. 18: Landing Gear Deploy Switches Check

- a. Check of Landing Gear Deploy switches circuitry.  
(Para. 4.2.2.12.2.1.A)

Seq. 19: Temperature Transducer Simulation Check

- a. Check of temperature transducer circuitry. (Para. 4.2.2.12.3.1.a).

OCP OUTLINE

OCP-GF-62000-G&N-LM5

Test Title:

LM Combined Subsystem Pre-FEAT Test -G&N

Subsystem:

Guidance and Navigation

Test Objectives:

- a. To verify normal operation of the Guidance and Navigation power supplies and IMU temperature control circuitry.
- b. To operationally check the LM Guidance Computer and DSKY.
- c. To verify accuracy of the LGC clock.
- d. To verify operation of the computer control and reticle dimmer assembly.
- e. To verify dynamic operation of each Gimbal stabilization loop.
- f. To verify operation of each Gimbal torquing loop.
- g. To verify proper operation of turn-on and shutdown procedures.
- h. To verify that the G and N subsystem is operationally ready to support further vehicle integrated testing.
- i. To verify all stimuli and response between ACE-S/C and G and N subsystem.
- j. To verify proper operation of the LGC at high and low operating levels of the LGC +4 and +14 VDC power supplies.
- k. To verify PIPA and IRIG operation during IMU operational test.
- l. To verify IMU CDU moding, CDU repeating accuracy, CDU command accuracy, CDU command rate, and FDAI linearity test.
- m. To verify signal conditioning assembly/PCM interface.
- n. To obtain and verify IRIG scale factor error for each IRIG.
- o. To obtain and verify PIPA bias and scale factor error for each PIPA.
- p. To obtain and verify stable member normal bias drifts about the input axes of the IRIG's (NBDX, NBDY, NBDZ).
- q. To obtain and verify stable member acceleration sensitive drifts about the input axes of the IRIG's due to acceleration along the spin reference axes (ADSRAX, ADSRAY, ADSRAZ).

## OCP OUTLINE

OCP-GF-62000-G&N-LM5

### Test Objectives: (Cont)

- r. To obtain and verify stable member acceleration sensitive drifts about the the input axes of the IRIG's due to acceleration along the input axes (ADIAX, ADIAY, ADIAZ).
- s. To determine aximuth and elevation measurement of the AOT three LOS's by means of optical targets. Calculation of the angles between the LOS's and verification by LGC computation using AOT optical sighting data.
- t. To determine the ability of the G&N system to align the stable member to a pre-determined orientation with respect to an earth reference coordinate frame, based on optical sightings.

### Min Vehicle Configuration:

Ascent Stage/Descent Stage

### Location:

Integrated Workstand, Plant 5

### Hazardous Operation:

Not applicable.

### Equipment Under Test:

Inertial Measurement Unit (IMU)  
LM Guidance Computer (LGC)  
Coupling Data Unit (CDU)  
Power and SERVO Assembly (PSA)  
Computer Control Reticle Dimmer Assy(CCRDA)  
Pulse Torque Assembly (PTA)  
Displays and Keyboard (DSKY)  
Signal Conditioner Assembly (SCA)  
Alignment Optical Telescope (AOT)  
Navigation Base (Nav Base)  
"A" Harness  
"B" Harness

## OCP OUTLINE

OCP-GF-62000-G&N-LM5

### Test Description:

- Seq. 01: Call to Stations
- Seq. 02: Support Systems Status Verification
- Seq. 03: Preliminary AOT Mechanical Check and Heater Current Test
  - a. AOT Mechanical Operation Check
  - b. AOT Heater Current Checks
- Seq. 04: IMU Standby Power Turn-On
  - a. Application of IMU Standby Power.
  - b. Verification of Portable temperature controller. (PTC) transfer of IMU Heater Power to vehicle power.
- Seq. 05: LGC/DSKY Power Turn-On
  - a. Application of LGC/DSKY power.
  - b. Verification of LGC Power Supply.
- Seq. 06: LGC Operational Test
  - a. DSKY Check
    - 1. Verification of DSKY capability for Data Entry.
    - 2. Operational check of DSKY Status Lights and Electroluminescent Numeric Elements.
  - b. LGC Check
    - 1. LGC Self Test
    - 2. Verification of alarms and interrupt programs.
    - 3. Verification of LGC arithmetic operations, and timing operations.
- Seq. 07: LGC Voltage Margin Test
  - a. Insertion of known voltages into + 4VDC and +14VDC power supply feedback loops.
  - b. Verification of proper LGC operation at the following combinations of voltage levels.

## OCP OUTLINE

OCP-GF-62000-G&N-LM5

### Test Description: (Cont)

1. High + 14VDC High + 4VDC
2. High + 14VDC Low + 4VDC
3. Low + 14VDC Low + 4VDC
4. Low + 14VDC High + 4VDC

#### Seq. 08: LM Guidance Computer Clock Test

- a. Operational Check of Computer Clock by averaged computed readings.
- b. LGC Clock Test in the LGC Standby Mode.

#### Seq. 09: Computer Control and Reticle Dimmer Assembly Check

- a. Verification of CCRD Capability for LGC Data Entry.
- b. Check of AOT Reticle Dimming Control.

#### Seq. 10: IMU Operate Power Turn-On Test

- a. Application of IMU Operate Power.
- b. Verification of G&N ACE-S/C Measurements.

#### Seq. 11: Temperature Control Verification Test

- a. Verification of PIPA's temperature and stabilization during G&N standby and operate modes.

#### Seq. 12: G&N Parameter Test

- a. Verification at ACE-S/C of G&N measurements.
- b. Functional checkout of PIPA pattern selection using PSAAM and ACE-S/C Controls.
- c. Verification of G&N High Rate Measurements.

#### Seq. 13: IMU Operational Test

- a. Verification of proper IMU operation by performance of test program which computes values of local 'g' and horizontal earth rate.

#### Seq. 14: PGNS Operational Test

- a. Verifies the IMU, CDU repeating accuracy, CDU command accuracy, CDU command rate, FDAI and Gasta commands.

OCP OUTLINE

OCP-GF-62000-G&N-LM5

Test Description: (Cont)

Seq. 15,  
16, 17 : IMU Gimbal Friction Test

- a. Determination of IMU Gimbal friction levels of the outer, inner and middle gimbal by means of gimbal torquing through positive and negative angles.

Seq. 18,  
19, 20 : IMU Gimbal Step Response Test

- a. Verification of stabilization loop response of inner, outer and middle gimbal by means of step voltage inputs to each servo amplifier.

Seq. 21: Verification of Gimbal Friction and Step Response Tests

Seq. 22: IMU Cage Test

- a. Verification of IMU Cage Switch operation by means of monitoring platform response.

Seq. 23: IRIG Scale Factor Test

- a. Torquing of platform through predetermined angles.
- b. Computation by LGC of each IRIG scale factor error.
  1. Display of scale factor errors on DSKY and at ACE-S/C.
- c. Determination of  $\pm X$ ,  $\pm Y$ ,  $\pm Z$ , IRIG scale factor errors by averaging of Data from all three test runs.

Seq. 24: IMU Performance Test

- a. Positioning of platform in various preselected orientations.
- b. Display of individual test results on DSKY and at ACE-S/C.
- c. Calculations on Data resulting from IMU performance test program to obtain and verify the following IMU parameters:
  1. PIPA bias parameters.
  2. PIPA Scale Factor Parameters.
  3. Normal Bias drift parameters (NBDX, NBDY, NBDZ)
  4. Acceleration sensitive drift parameters, due to acceleration along spin reference axes (ADSRAX, ADSRAY, ADSRAZ)
  5. Acceleration sensitive drift parameters, due to acceleration along input axes, (ADIAX, ADIAY, ADIAZ)



## OCP OUTLINE

OCP-GF-62000-G&N-LM5

### Test Description: (Cont)

- d. Comparison of results with last three sets of lab determined parameters.
  - 1. Provision in OCP for performance of two additional runs of IMU Performance Test if out of tolerance conditions are shown by the comparison.

Seq. 25

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Seq. 26: IMU Performance Test

- a. Retest No. 1
- b. Retest No. 2

Seq. 27: Preliminary Positioning and Adjustment of Optical Targets

- a. Calibration Data is inserted into computer for all six detent positions.
- b. Position all three theodolites for max AOT field of view.
  - 1. With dioptrimeter mount adjusted for max focus.
  - 2. Azimuth scales set to zero.

Seq. 28: AOT Functional Accuracy

- a. Sighting of optical targets (theodolites) by AOT in three detent positions.
- b. Measurement of LOS Azimuth and Elevation angles by optical targets.
- c. Measurements of LOS shaft and trunnion angles by AOT.
- d. Calculation of AOT line of sight angles (X and XZ)
- e. LGC computation of AOT line of sight angles. (X1 and X2) using AOT shaft and trunnion angle measurements and manufacturer's calibration data.
- f. Comparison of LGC computed LOS (X1, and X2) with same angle calculated from optical target data.

Seq. 29: G&N Fine Alignment

- a. Verification of accuracy of command IMU orientation, based on optical sighting data.
  - 1. Determination of IMU present and desired orientation at start of alignment test.

## OCP OUTLINE

OCP-GF-62000-GN-LM5

### Test Description: (Cont)

- a. Sighting of optical targets by AOT.
- b. Measurement of true azimuth and elevation of optical targets.
- c. Measurement of optical target shaft and trunnion angles by AOT
- d. Entry into LGC of:
  1. IMU stable member azimuth
  2. Site Latitude
  3. True azimuth and elevation of optical targets
  4. AOT detent code and star code
  5. AOT sighting measurements

#### 2. Fine Alignment

- a. IMU stable member alignment to desired orientation.
- b. Monitoring of gravitational components of horizontal PIPA outputs to determine accuracy of alignment.
- c. Repeat of alignment procedures using another orientation in which different PIPA's are in the horizontal plane.

#### Seq. 30: PGNS Shutdown

- a. Verification of gimbal parking procedure.
- b. Removal of IMU operate, LGC/DSKY, and IMU standby power.
- c. Verification of transfer of IMU Heater power to PTC.

#### Seq. 31: G&N Abbreviated Turn-On

- a. Abbreviated secondary turn-on of the G&N subsystems with only necessary verification made of the following:
  1. IMU standby power turn-on.
  2. LGC/DSKY power turn-on.
  3. IMU operate power turn-on.
  4. Coarse align to zero.

OCP OUTLINE

OCP-GF-62000-G&N-LM5

Test Description: (Cont)

Seq. 32: Downmode to G&N Standby

- a. The transfer of G&N system from the operate to standby mode, for support of related OCP.

Seq. 33: Mode to G&N Operate

- a. Enables the G&N system to transfer from standby back to an operate mode to support related OCP.

## OCP OUTLINE

OCP-GF-62000-PROP-LM5

### Test Title:

LM Combined Subsystem Pre-FFAT Test - Propulsion

### Subsystem:

Propulsion (PROP)

### Test Objectives:

#### Test No. 1

To provide an end-to-end check or channel identification of electrical paths associated with pressure transducers, temperature transducers, and valve position indicators of the Descent and Ascent Propulsion Subsystems.

#### Test No. 2

To verify performance of the Descent Propellant Quantity Gaging System Control Unit.

To verify D/C PQGS Control Unit Telemetry Outputs and cabling interfaces with ACE-S/C.

To verify D/S PQGS Sensor Circuitry.

To verify operation of the D/S PQGS (Quantity Indicator) cabin display.

To verify operation of the Ascent and Descent Engine Propellant low level sensors under empty tank conditions via ACE-S/C Telemetry Downlink.

#### Test No. 3

To verify the Functional Operation and leakage integrity of the Descent Engine at low pressure.

To ascertain that the propellant feed section and descent engine propellant passages do not have any restrictions.

To verify the proper operation of the thermal relief capability of the engine pre-valves and check internal leakage of the valves.

To provide an end-to-end check or Channel I.D. of electrical paths associated with the Descent Engine Instrumentation.

### Vehicle Configuration:

Ascent and Descent Mated

### Location:

Integrated Workstand, Plant 5

### Hazardous Operation:

Pneumatic Pressures up to 200 PSIG

OCP OUTLINE

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Equipment Under Test:

Ascent Fuel Propellant Section  
Ascent Oxid Propellant Section  
Descent Fuel Propellant Section  
Descent Oxid Propellant Section  
Ascent Helium Supply Section  
Descent Helium Supply Section  
PQGS Control Unit  
Sensing Probes (4 D/S and 2 A/S)  
Display Meter  
Propellant Shut-Off Valves, A, B, C & D  
Solenoid Valves A, B, C & D  
Fuel Pre-Valves (2)

Test Description:

Seq. 01: Call to Station

Seq. 02: Ascent Propulsion Transducer Ambient Check and Valve Position Indicator Channel I. D.

- a. Verification of the functional operation and Channel I.D. of the individual Ascent He Reg 1 and Ascent He Reg. 2 Solenoid Latching Valves during cycling by:
  1. Actuating solenoids by Ascent He Reg. switches .  
(Para. 4.2.2.9.1 (b) )
  2. Verification of proper cabin flag displays. (Para. 4.2.2.9.1 (a) and (b))
  3. Verification of proper ACE displays. (Para. 4.2.2.12.2.1(b))
- b. Recording of APS pressure and temp. transducers at their associated ACE displays.
  1. Verification that transducers ambient readouts are within the end-to-end ACE tolerances. (Para. 4.2.2.12.3.1(a))
- c. Recording of APS pressure and temp. transducers at their associated Cabin displays.

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### Test Description: (Cont)

1. Verification that transducers ambient readouts are within the end-to-end cabin display tolerances. (Para. 4.2.2.9.1 (a))

#### Seq. 03: APS Helium Tank No. 1 Transducer Channel ID at 215 PSIA

- a. Recording of ambient readouts of Helium Tank No. 1 Temperature Transducers by:
  1. Verification of proper ACE end-to-end display tolerances. (Para. 4.2.2.12.2.1(b))
  2. Operation of 'Helium Mon' select switch and verification of proper cabin display end-to-end tolerances (Para. 4.2.2.9.1 (a) and (b))
- b. Verification of Helium Tank No. 1 Pressure Transducers Channel I.D. by:
  1. Application of known gaseous nitrogen stimuli (215 PSIA) to Helium Tank No. 1 Pressure Transducer only.
  2. Verification of known He Tank No. 1 Press Transducer output on the proper ACE displays. (Para. 4.2.2.12.2.1 (b))
  3. Operation of the 'Helium Mon' select switch and verification of the known He Tank No. 1 Press. Transducer press on the proper cabin displays. (Para. 4.2.2.12.2.1 (b))
- c. Venting of 'He Tank No. 1' to blanket pressure and Channel ID of Tank No. 1 Temp. Transducer by:
  1. Recording of temp. transducer decrease on proper ACE display. (Para. 4.2.2.12.2.1(b))
  2. Operation of 'Helium Mon' selector switch and recording of temp. decrease on proper cabin display. (Para. 4.2.2.9.1(a) & (b))

#### Seq. 04: APS Helium Tank No. 2 Transducer Channel I.D. at 215 PSIA

- a. Recording of ambient readouts of Helium Tank No. 2 Temperature Transducer by:
  1. Verification of proper ACE end-to-end display tolerances. (Para. 4.2.2.12.2.1(b))
  2. Operation of 'Helium Mon' select switch and verification of proper cabin display end-to-end tolerances. (Para. 4.2.2.9.1 (a) and (b))

OCP OUTLINE

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Test Description: (Cont)

- b. Verification of Helium Tank No. 2 Press. Transducers Channel I.D. by:
  - 1. Application of known gaseous nitrogen stimuli (215 PSIA) to Helium Tank No. 2 Press. Transducer only.
  - 2. Verification of known 'He Tank No. 2 Press. Transducer' output on the proper ACE displays. (Para. 4.2.2.12.2.1(b))
  - 3. Operation of the 'Helium Mon' select switch and verification of the known 'He Tank No. 2 Press. Transducer' press on the proper cabin displays. (Para. 4.2.2.9.1 (a) & (b))
- c. Venting of 'He Tank No. 2' to blanket pressure and channel ID of tank No. 1 Temp Transducers b.
  - 1. Recording of Temp. Transducer decrease on proper ACE display (Para. 4.2.2.12.2.1(b))
  - 2. Operation of 'Helium Mon' selector switch and recording of temp. decrease on proper cabin display. (Para. 4.2.2.9.1 (a) & (b))

Seq. 05: APS He Reg Outlet Manifold Transducer End-to-End Check at 65 PSIA

- a. Verification of APS He Reg Outlet Manifold Transducers End-to-End by:
  - 1. Application of known gaseous nitrogen stimuli (65 PSIA) to He Outlet Manifold transducers only.
  - 2. Verification of He Reg Outlet Manifold transducers outputs on the proper ACE displays. (Para. 4.2.2.12.2.1(b))

Seq. 06: APS Fuel Section Transducer End-to-End Check at 65 PSIA

- a. Verification of APS Fuel Tank Bulk Temp Transducer Ambient readout by:
  - 1. Recording of proper ACE End-to-End display tolerances. (Para. 4.2.2.12.2.1(b))
  - 2. Operation of Prop Temp/Press Man Sw. and verification of proper cabin displays end-to-end tolerances. (Para. 4.2.2.9.1 (a) and (b))
- b. Verification of APS Fuel Tank Ullage Press and Fuel Isol Valve Inlet Press Transducers and Fuel Tank Transducer end-to-end checks by:
  - 1. Application of known gaseous nitrogen stimuli (65 PSIA) to Fuel Section transducers only.

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Test Description: (Cont)

2. Verification of a temp. increase on tank temp. transducers output at:
    - a. ACE Display (Para. 4.2.2.12.2.1(b))
    - b. Cabin Meter (Para. 4.2.2.9.1(a))
  3. Verification of known fuel isol valve inlet press. transducer output in proper ACE displays. (Para. 4.2.2.12.2.1(b))
  4. Verification of the known Fuel Tank Ullage Press Transducer output on the proper cabin meter displays. (Para. 4.2.2.12.2.1(b))
- c. Venting of Fuel Section to blanket press.

Seq. 07: APS Oxid Section Transducer End to End Check at 65 PSIA

- a. Verification of APS Oxid Tank Bulk Temp Transducer readout by:
  1. Recording of proper ACE end to end display tolerances (Para. 4.2.2.12.2.1 (b))
  2. Operation of Prop Temp/Press. Man Switch and verification of proper cabin display end to end tolerances (Para. 4.2.2.9.1 (a) and (b))
- b. Verification of APS Oxid Tank Ullage press and Fuel Isol Valve Inlet Pressure Transducers and Fuel Tank Temperature Transducer end to end checks by:
  1. Application of known gaseous nitrogen stimuli (65 PSIA) to Oxid section transducers only.
  2. Verification of a temperature increase on tank temperature transducer output at:
    - a. ACE Display (Para. 4.2.2.12.2.1 (b))
    - b. Cabin Meter (Para. 4.2.2.9.1 (a))
  3. Verification of known Oxid Isolation Valve Inlet Pressure Transducer Output in proper ACE displays (Para. 4.2.2.12.2.1 (b))
  4. Verification of the known Oxid Tank Ullage Press Transducer output on the proper cabin meter displays (Para 4.2.2.12.2.1(b))
- c. Venting of Oxid Section to blanket pressure



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### Test Description: (Cont)

#### Seq. 08: Descent Propulsion Transducer Ambient Check and Valve Position Indicator Channel ID

- a. Verification of the functional operations and channel ID of individual Descent Propulsion Solenoid Latching Valves during cycling by:
  - 1. Actuation of solenoids by Des. He Reg. 1 and 2 switches and Des. Propul - Fuel Vent and Oxid Vent Switches (Para.4.2.2.9.1 (b))
  - 2. Verification of proper cabin flag displays (Para.4.2.2.9.1 (a))
  - 3. Verification of proper ACE displays (Para. 4.2.2.12.2.1 (b))
- b. Recording of all Des. press and temp transducers and valve mid-position indicators at their associated ACE displays.
  - 1. Verification that transducer ambient readouts are within the end-to-end ACE tolerances. (Para. 4.2.2.12.3.1 (a))
- c. Operation of Helium Mon Select and Propellant Temp/Press Mon Switches and recording of all Des. Press and temperature transducers at their associated cabin displays (Para. 4.2.2.9.1 (a) and (b))
  - 1. Verification that transducer ambient readouts are within the end to end cabin display tolerances (Para. 4.2.2.12.3.1 (a))

#### Seq. 09: Supercritical Helium Tank Transducer Check at 115 PSIA

- a. Verification of the Functional Operation of the Helium Tank Transducer by:
  - 1. Application of known gaseous nitrogen stimuli (115 PSIA) to the Supercritical tank transducers only.
  - 2. Recording of known SHe Supply Tank Press Transducer output on the proper ACE displays (Para. 4.2.2.12.2.1 (b))
  - 3. Operation of 'Helium Mon' select switch and recording of the known Supercritical Press Transducer Output on the proper cabin display (Para. 4.2.2.12.2.1 (b))
- b. Venting of Supercritical He Tank to blanket pressure

#### Seq. 10: Ambient Helium Storage Tank Transducer Channel ID at 115 PSIA

- a. Verification of the functional operation and channel ID of the ambient Helium Storage Tank Transducers only:

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### Test Description: (Cont)

1. Application of known gaseous nitrogen stimuli (115 PSIA) to the Ambient He Storage Press. transducer only.
  2. Recording of the Amb. He Storage Tank Press transducer output on the proper ACE display. (Para. 4.2.2.12.2.1 (b))
  3. Operation of the 'Helium Mon' select switch and recording of the known Amb. He Storage Tank Press Transducer output on the proper cabin displays (Para. 4.2.2.9.1 (a) and (b))
  - b. Venting of Ambient He Storage Tank to Blanket Pressure.
- Seq. 11: DPS Helium Regulator Output Manifold Transducer End to End check at 65 PSIA.
- a. Verification of the functional operation and end to end check of the Helium Reg Outlet Manifold Pressure Transducer individually by:
    1. Application of a known gaseous nitrogen stimuli (65 PSIA) to the two (2) He Reg. Outlet Manifold Pressure Transducers only.
    2. Recording of the two (2) known He Reg. Outlet Pressure Manifold Transducer outputs on their proper ACE displays (Para. 4.2.2.12.2.1 (b))
  - b. Venting of the entire He Manifold to blanket pressure.
- Seq. 12: DPS Fuel Section Transducers End to End check or channel ID at 65 PSIA
- a. Verification of functional operation and channel ID of the Fuel Tank Bulk Temperature Transducers only by:
    1. Recording of the Fuel tank 1 and 2 temperature transducers ambient outputs on their proper ACE display (Para. 4.2.2.12.2.1(b))
    2. Operation of the 'Propellant Temp/Press Mon' switch in Des. 1 and Des. 2 positions and recording of temperature transducers ambient outputs on the proper cabin meter display (Para. 4.2.2.9.1 (a) & (b))
    3. Application of Heat to Fuel Tank #1 Temp transducer only.
    4. Verification of temp increase at Tank #1 transducer only at proper ACE displays (Para 4.2.2.12.2.1 (b))
    5. Operation of Temp/Press Mon Switch and verification of temp increase at tank #1 Cabin meter display only (Para. 4.2.2.9.1(b))
    6. Application of Heat to Fuel Tank #2 transducer only

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Test Description: (Cont)

7. Verification of temp increase at Tank #2 transducer only at Tank #2 transducer only at proper ACE display (Para. 4.2.2.12.2.1 (b))
  8. Operation of Temp/Press Mon Switch and verification of temp increase at Tank #2 cabin meter display only (Para. 4.2.2.9.1 (b))
  - b. Verification of the functional operation and end to end check of the Eng Fuel Interface Press Transducer and Fuel Tank #1 Ullage Pressure Transducer at 65 PSIA by:
    1. Application of a known gaseous nitrogen stimuli (65 PSIA) to the Fuel Tank #1 Ullage and Engine Fuel Interface press. transducers.
    2. Recording of the known Engine Fuel Interface Pressure Transducer output on the proper ACE display (Para. 4.2.2.12.2.1 (b))
    3. Operation of the Temp/Press Mon Switch in the Des 1 and Des 2 positions and recording of the known fuel tank #1 ullage pressure transducer output on the proper cabin display (Para. 4.2.2.9.1 (a and b))
  - c. Venting of DPS fuel manifold to blanket pressure.
- Seq. 13: DPS Oxidizer Section Transducer End to End or Channel ID Transducer Check at 65 PSIA
- a. Verification of the functional operation and channel ID of the Oxid Tank Bulk Temp Transducers only by:
    1. Recording of the Oxid Tank #1 and #2 temperature transducers ambient outputs on their proper ACE displays (Para. 4.2.2.12.2.1 (b))
    2. Operation of the 'Propellant Temp/Press Mon' switch in Des 1 and Des 2 positions and recording of Oxid Temp Transducers ambient outputs on the proper cabin meter displays (Para. 4.2.2.9.1 (a) and (b))
    3. Application of heat to Oxid tank #1 temp transducer only.
    4. Verification of temp increase at tank #1 transducer only at proper ACE display (Para. 4.2.2.12.2.1 (b))
    5. Operation of 'Temp/Press monitor' switch and verification of temp increase at tank #1 cabin meter display only (Para. 4.2.2.9.1 (b))
    6. Application of heat to oxid tank #2 transducer only.
    7. Verification of temp increase at Tank #2 transducer only at proper ACE display (Para. 4.2.2.12.2.1 (b))

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Test Description: (Cont)

8. Operation of Temp/Press Mon switch and verification of temperature increase at tank #2 cabin meter display only (Para. 4.2.2.9.1 (b))
- b. Verification of the functional operation and end to end check of the Engine Oxid Interface Press Transducer and Oxid Tank #1 Ullage Pressure Transducer at 65 PSIA by
  1. Application of a known gaseous nitrogen stimuli (65 PSIA) to the Oxid Tank #1 Ullage and Oxid Interface pressure transducers.
  2. Recording of the known Engine Oxid Interface Pressure Transducer output on the proper ACE display (Para. 4.2.2.12.2.1 (b))
  3. Operation of the Temp/Press Mon switch in the Des 1 and Des 2 positions and recording of the oxid tank #1 Ullage pressure transducer output on the proper cabin display (Para. 4.2.2.9.1 (a) and (b))
- c. Venting of the DPS Oxid manifolds to blanket pressure.

Seq. 14: Securing After Test No. 1

Seq. 15: Propellant Quantity Gaging System/Level Verification

- a. Verification of the performance of the PQGS Control Unit by:
  1. Application of known values of voltage stimuli (0-5 VDC) to individual sensor channels of the Fuel Tanks No. 1 and No. 2 and Oxid Tanks No. 1 and No. 2 (Note - the resultant measurements are converted within the PQGS into percent values of quantity from zero (0%) to maximum 97%) (Para. 4.2.2.8.3.3 (n) (a))
  2. Recording of the known measurement outputs for each set of stimuli voltage level on the proper ACE displays. (Para. 4.2.2.12.2.1 (b))
  3. Operation of the "PRPLNT QTY MON" switch in the Des. 1 and Des. 2 positions individually and verification of known proper Ox and Fuel Qty Cabin Displays. (Para. 4.2.2.9.1 (a) & (b))

Seq. 16: PQGS Sensor Test Dry

- a. Verification of the PQGS Dry Sensor Test by:
  1. Application of a known voltage stimuli (contact closure) to the control unit (PQGS) (Para. 4.2.2.8.3.3 (n) (b1))

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Test Description: (Cont)

2. Recording of the outputs of the Ox and Fuel quantity sensors on the proper ACE Displays. (Para. 4.2.2.12.2.1 (b))
3. Operation of the 'PRPLNT QTY MON' switch in the Des. 2 and Des. 1 positions and recording of the Ox and Fuel sensor outputs on cabin displays. (Para. 4.2.2.9.1 (a)(b))
4. Comparison of the recorded dry sensor measurements to the data supplied by the vendor. (Para. 4.2.2.8.3.3 n b 2 & 3)

Seq. 17: D/S and A/S Propellant Liquid Level Low

- a. Verification of the DPS Prop Liquid Low Level sensor under empty tank conditions by: (Para. 4.2.2.8.3.3 n (c))
  1. Application of vehicle power to the low level sensor.
  2. Recording of the Prop Lqd Level Low sensor warning indications at the proper ACE display. (Para. 4.2.2.12.2.1 (b))
  3. Removal of vehicle power by opening CB Propul-PQGS and recording the removal of the Low Level warning indications at ACE displays. (Para. 4.2.2.12.2.1 (b))
- b. Verification of the APS Fuel and Ox Tank Low Level sensors under empty tank conditions by:
  1. Recording of the APS Fuel and Ox tank low level warning indications on the proper ACE displays. (Para. 4.2.2.12.2.1 (b))
  2. Removal of conditioning power to the APS low level sensors by operation of the 'Inst-Sig Sensor' CB and recording the removal of the low level warning indications at ACE displays. (Para. 4.2.2.12.2.1 (b))

Seq. 18: PQGS Fuel/Oxid Quantity Tank

- a. Re-verification of the DPS PQGS Fuel/Oxid Tank Quantity Sensors by:
  1. Application of a known value (1 volt) of voltage stimuli to individual sensor channels of the fuel tanks No. 1 and No. 2 and Oxid tanks No. 1 and No. 2 (Para. 4.2.2.8.3.3 (n) (a))
  2. Recording of the known liquid level sensor outputs on the proper ACE displays. (Para. 4.2.2.12.2.1 (b))
  3. Operation of the 'PRPLNT QTY MON' Sw in the Des. 1 and Des. 2 positions and recording of known Fuel and Oxid sensor outputs on cabin displays. (Para. 4.2.2.9.1 (a)(b))

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### Test Description: (Cont)

- b. Channel ID of the No. 1 Tank Fuel and Oxid sensors versus the No. 2 sensors by:
  - 1. Application of known stimuli to No. 2 Tank sensor probes only.
  - 2. Recording of the No. 1 and 2 Tank Qty Sensor outputs on the proper ACE displays and recording of No. 2 Tank Fuel and Oxid Qty Sensor remaining unchanged from item 1 above.  
(Para. 4.2.2.12.2.1 (b))
  - 3. Operation of "Prplnt Qty Mon" switch and recording of the known Tank No. 1 Oxid and Fuel sensor outputs on the proper cabin displays. (Para. 4.2.2.9.1 (a)(b))
  - 4. Reversal of the known voltage stimuli to Tanks No. 1 & 2.
  - 5. Recording of the complete known reversal of the sensor outputs between Tanks No. 1 and 2 on the proper ACE displays.  
(Para. 4.2.2.12.2.1 (b))
  - 6. Operation of the "Prplnt Qty Mon" switch in Des. 1 & Des. 2 and recording of the individual known sensor outputs on the proper cabin displays. (Para. 4.2.2.9.1 b)
- c. Removal of vehicle power and GSE stimuli from the DPS PQGS Control Unit.

### Seq. 19: Engine Solenoid Valve Leakage Check and Engine Pre-Valve Thermal Relief Check

- a. Leakage rate thru each of the 4 DPS Engine Solenoid Valves are checked by: (Para. 4.2.2.8.3.7 (d))
  - 1. Application of 200 PSIG gaseous N<sub>2</sub> pressure upstream of the valves.
  - 2. Verification of constant blanket pressure in DPS upstream of Propellant Shut-Off valves via ACE displays.
  - 3. Measurement of GN<sub>2</sub> leakage rate of each individual solenoid at each solenoid drain using volumetric leak detector.
- b. Pre-Valve Thermal Relief Pressure checked by:
  - 1. Venting of upstream side of Fuel Pre-Valves to 0 PSIG.
  - 2. Application of 200 PSIG GN<sub>2</sub> to downstream side of both Pre-valves.
  - 3. Monitoring of GSE pressure gage in downstream side of Pre-valve circuit until stabilization occurs. This is pre-valve thermal relief cracking pressure.

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Test Description: (Cont)

- c. Venting and removal of all GSE pressure sources from DPS.

Seq. 20: Propellant Feed Section/Engine Gaseous Blowdown, Engine Solenoid Pre-Valve Leak Check, and Engine Ball-Valve Position Monitoring.

- a. Verification of internal leakage rates of the DPS Pre-Valves at 50 PSIG by:
1. Application of a known gaseous N<sub>2</sub> pressure (50 psig) to the DPS Fuel and Oxid sections resulting in 50 psig upstream of the Pre-valves.
  2. Recording of known Fuel & Oxid Engine Interface Pressure transducer outputs at ACE displays.
  3. Application of a GSE Leak Displacement meter at the Pre-Valve Test Port and measurement of internal leakage thru Pre-valves.
- b. Verification of Propellant Shut-Off Valves A & B Cracking and Full Open Pressure Engine Blowdown and Channel ID of Shut off valve A & B Mismatch signals by:
1. Gradual application of a gaseous N<sub>2</sub> pressure stimulus to the "B" actuator of the "series" shutoff valves actuators.
  2. Recording of "B" Shut-Off valve cracking pressure (at first indication of "S/O Vlv A/B" mismatch signal actuation at ACE display).
  3. Continued application of GN<sub>2</sub> pressure to the "B" actuator for full position.
  4. Application of GN<sub>2</sub> pressure to the "A" actuator of the "series" shutoff valve actuators.
  5. Verification of "A" shutoff valves full open by removal of "S/O Vlv A/B" mismatch signal at ACE.
  6. Verification of A & B Shut-off valves full open by "Blowdown" GN<sub>2</sub> flow thru the descent engine.
  7. Cessation of "Blowdown" at a predetermined Prop Tank Pressure (as displayed at ACE) by venting the SOV 'A' actuator.
  8. Verification that only "S/O Vlv A/B" mismatch signal appears at ACE.
  9. Application of GN<sub>2</sub> pressure to "A" shutoff actuator.
  10. Verification of A shutoff "full open" by removal of "S/O Vlv A/B" Mismatch signal at ACE.

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Test Description: (Cont)

11. Measurement of the fully open actuated pressure in 'in. H<sub>2</sub>O' GSE gage.
12. Removal of "B" shutoff valve actuator pressure and shutoff valve B closure.
13. Verification of "S/O Vlv A/B" mismatch on indication at ACE.
14. Application of GN<sub>2</sub> pressure to "B" shutoff actuator.
15. Verification of "B" shutoff "full open" by removal of "S/O Vlv A/B" mismatch signal at ACE.
16. Measurement of the "fully open" actuator pressure in "in. H<sub>2</sub>O" on GSE gage.
17. Venting of A & B shutoff valves actuators.
18. Verification "S/O Vlv A/B" mismatch signal remain off indicating shutoff A & B closed.
19. Gradual application of a GN<sub>2</sub> pressure stimulus to the "A" actuator of the series shutoff valves actuators.
20. Recording of the "A" shutoff valve cracking press. (at first indication "S/O Vlv A/B" mismatch on signal at ACE)
21. Venting of "A" shutoff actuator and closure of "A" shutoff valve.
- c. Verification of propellant shutoff valves C & D cracking and full open pressures; engine blowdown and channel ID of shutoff valve C & D mismatch signals by:
  1. Reapplication of a known GN<sub>2</sub> pressure (50 psig) to the DPS Fuel and Oxid sections.
  2. Recording of the known Fuel & Oxid Engine Interface Pressure transducer outputs at ACE displays.
  3. Repeat of same procedural steps of item 2a thru 2u, except substitute valve C for B operations, and valve D for A operations.

Seq. 21: Propellant Ball Valve Internal Leak Check (50 PSIG)

- a. Measurement of combined gross internal leakage of fuel and oxid shutoff ball valves. (A + B + C + D) by:
  1. Application of 50 PSIG GN<sub>2</sub> pressure at the upstream ox and fuel (balls) shutoffs.



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### Test Description: (Cont)

2. Verification of the fuel and oxid engine interface pressures via ACE displays.
  3. Measurement of total leakage thru fuel and oxid ball valves A, B, C and D at the descent engine throat plug with a GSE Leak Displacement Meter.
- b. Measurement of the combined gross internal leakage of oxid. shutoff ball valves ( A + B + C + D ) by:
1. Venting of GN<sub>2</sub> pressure at fuel ball valves to ambient pressure.
  2. Measurement of leakage rate thru oxid ball valves A, B, C & D at the descent engine throat plug with a GSE Leak Displacement Meter.
  3. Subtraction of the oxid valves A, B, C & D gross leakage rate from the fuel and oxid valves A, B, C & D gross leakage rate determines the fuel valves A, B, C & D gross leakage rate.
- c. Measurement of leakage rate of oxid valves B and C only by:
1. Application of 200 psig GN<sub>2</sub> at the A & D shutoff valve actuators; opening ball valves A & D actuators.
  2. Measurement of leakage rate of oxid valves B and C at the throat plug leakage port with the GSE Leak Displacement Meter.
- d. Measurement of leakage rate of fuel/oxid valves B & C by:
1. Application of 50 psig GN<sub>2</sub> pressure at the upstream fuel (balls) shutoffs.
  2. Measurement of leakage rate of fuel/oxid ball valves B & C at the throat plug leakage port with GSE Leak Displacement Meter.
  3. Subtraction of the oxid valves B & C leakage rate from the fuel and oxid valves B & C leakage rate determines the fuel valves B & C leakage rate.
- e. Measurement of leakage rate of fuel/oxid valves A & D by:
1. Application of 200 psig GN<sub>2</sub> at the downstream test ports of the solenoid valves B & C actuator opening ball valves B & C.
  2. Measurement of leakage rate of fuel/oxid ball valves A & D at the throat plug leakage port with the GSE leak displacement meter.
  3. Venting of oxid tanks to ambient pressure.

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Test Description: (Cont)

- f. Measurement of leakage rate of fuel ball valves A & D only by:
  - 1. Measurement of leakage rate of ball valves A & D at the throat plug leakage port with the GSE Leak Displacement Meter.
  - 2. Subtraction of the fuel valves A & D leakage rate from the fuel and oxid valves A & D leakage rate determines the oxid valves A & D leakage rate.
  - 3. Venting of fuel tanks to pad pressure.
  - 4. Application of GN<sub>2</sub> pad pressure to the oxid propellant section.
  - 5. Vent downstream solenoid test valves.
- g. Verification of the functional operation of the Engine Chamber Pressure Transducer by:
  - 1. Application of 25 psig GN<sub>2</sub> pressure in the engine chamber.
  - 2. Verification of the engine chamber pressure in psia via ACE displays.
  - 3. Operation of cabin CB 'FLT DISP-THRUST'
  - 4. Recording of chamber thrust on proper cabin displays.
  - 5. Verification of the redundant engine chamber pressure in psia via ACE displays.

Seq. 22: Securing After Test No. 3

OCP OUTLINE

OCP-GF-62000-COMM-LM5

Test Title:

LM Combined Subsystem Pre-FEAT Test - COMM

Subsystem:

Communications

Test Objective:

Verification of basic S-Band and VHF Communication modes of operation.

Verification of voice performance.

Min. Vehicle Configuration:

Ascent Stage

Location:

Integrated Workstand, Plant 5 - CEF

Hazardous Operation:

S-Band Steerable Antenna Radiation.

Equipment Under Test:

Signal Processor Assy

VHF Transceiver

S-Band Transceivers

S-Band Power Amplifiers

S-Band Steerable Ant. (SBSA)

Data Storage Electronic Assy (DSEA)

Test Description:

Seq. 01: Call to Stations

Seq. 02: Communications Turn-On

a. Specific circuit breaker actuation

Seq. 03: S-Band Steerable Antenna

Manual Tracking Capability Test

a. Verification of pitch and yaw synchro controls, angle readouts, mode select switch positions. (Para. 4.2.2.11.1.6.4 b1 to 5)

OCP OUTLINE

OCP-GF-62000-COMM-LM5

Test Description: (Cont)

Seq. 04: MIC and BIO Voltage Test

- a. Verification of mike and BIO power supplies to CDR position.
  - 1. When BU and normal positions of switch are used on both LMP and CDR Panels. (Para. 4.2.2.11.1.3 ab)

Seq. 05: ICS Test - CDR to LMP

- a. Verification of no output at the CDR when CDR ICS T/R switch is off. (Para. 4.2.2.11.1.2 b)
- b.
  - 1. Verification of audio level between 14 DBM and 20 DBM into CDR 600 OHM headset for any position of mode switch.
  - 2. Verification of NLT 30 DB signal to noise ratio.
  - 3. Verification of NLT 32 DB ICS volume control range
  - 4. Verification of NLT 30 DB master volume control range (Para. 4.2.2.11.1.2 f)
- c. Verification of audio levels and signal to noise measurements as in part b, for both CDR and LMP normal/BU switches in BU position. (Para. 4.2.2.11.1.2 g)

Seq. 06: LMP ICS and Master Volume Control Attenuation Test

- a.
  - 1. Verification of audio level from 14 DBM to 20 DBM into LMP 600 OHM headset for any position of mode switch.
  - 2. Verification of NLT 30 DB signal to noise ratio.
  - 3. Verification of NLT 32 DB ICS volume control range
  - 4. Verification of NLT 30 DB master volume control range (Para. 4.2.2.11.1.2 f)

Seq. 07: VOX Sensitivity Test CDR

- a. Verification of ICS sensitivity for max setting of VOX sensitivity control. (Para. 4.2.2.11.1.2 a)
- b. Verification of ICS sensitivity for min setting of VOX sensitivity control. (Para. 4.2.2.11.1.2 c)

Seq. 08: ICS Test-LMP to CDR

- a. Verification of 14 to 20 DBM in CDR headset for input at LMP mike. (Para. 4.2.2.11.1.2 f)

OCP OUTLINE

OCP-GF-62000-COMM-LM5

Test Description: (Cont)

- b. Measurement and calculation of signal pulse noise to noise for CDR ICS channel. (Para. 4.2.2.11.1.2 f)
- c. Verification of signal loss in CDR headset when ICS T/R Switch is in off position. (Para. 4.2.2.11.1.2 b)
- d. Verification of signal in CDR headset when VOX switch is in ICS position. (Para. 4.2.2.11.1.2 d)
- e. Verification of BU control of LMP PTT function. (Para. 4.2.2.11.1.2 g)

Seq. 09: CDR ICS and Master Volume Control Attenuation Test

- a.
  - 1. Verification of audio level from 14 DBM to 20 DBM into CDR 600 OHM headset for any position of mode switch.
  - 2. Verification of NLT 30 DB signal to noise ratio.
  - 3. Verification of NLT 32 DB ICS volume control range
  - 4. Verification of NLT 30 DB master volume control range (Para. 4.2.2.11.1.2 f)

Seq. 10: VOX Sensitivity Test LMP

As in Sequence 07 using LMP panel switch path.

Seq. 11: Sensitivity Test VHF B/LMP HDST

- a. Verification of NMT 2.8 microvolt VHF B signal producing a NLT 10 DB signal to noise ratio at LMP headset. (Para. 4.2.2.11.1.4.2 b)

Seq. 12: Squelch Test - VHF B RCVR/LMP HDST

- a. Verification of -77.6 DBM - VHF B signal producing a maximum squelchable signal. (Para. 4.2.2.11.1.4.2 a)

Seq. 13: Volume Control Test VHF B

- a. Verification CDR and LMP dynamic volume control range of NLT 32 DB. (Para. 4.2.2.11.1.4.2 a)
- b. Verification of VHF B turn-off when receiver power is turned off. (Para. 4.2.2.11.1.4.2 b)

Seq. 14: Sensitivity Test VHF A/CDR HDST

- a. Same as Sequence 11 using CDR position and VHF A carrier path. (Para. 4.2.2.11.4.2 b)

OCP OUTLINE

OCP-GF-62000-COMM-LM5

Test Description: (Cont)

Seq. 15: Squelch Test VHF A RCVR/CDR HDST

- a. Same as Sequence 12 using CDR position and VHF A carrier path. (Para. 4.2.2.11.1.4.2 b)

Seq. 16: Volume Control Test VHF A

- a. Same as Sequence 13 a and 13 b using VHF A carrier path, and same reference para.

Seq. 17: Transmitted S+N/N VHF B XMTR/LMP Mike

- a. Verification of downlink VHF B signal to noise ratio of NLT 25 DB over LMP mike paths. Also verification of LMP VHF B T/R switch controlling VHF B carrier. (Para. 4.2.2.11.1.4.1 c)
- b. Same as in a, except for CDR (mike 2) (Para. 4.2.2.11.1.4.1 c)

Seq. 18: Transmitted S+N/N VHF A XMTR/CDR Mike

- a. Same as in Sequence 17 a, except for VHF A signal carrier used. (Para. 4.2.2.11.1.4.1 a)
- b. Same as in a, above using CDR (mike 2). (Para. 4.2.2.11.1.4.1 a)

Seq. 19: VHF Ranging Test (RTTA)

Test to be determined later

Seq. 20: PLSS Insertion Loss Test

- a. Determination of insertion loss of VHF B XMTR to pre-egress connector. (Para. 4.2.2.11.1.4.3 d)

Seq. 21: Freq. Test/Pri. RCVR (PM)

- a. Verification of ACE Station TLM AGC measurement of NLT 0.5 V. Also, verified signal strength meter in cabin. (Para. 4.2.2.11.1.10a)
- b. Verification of ACE TLM static phase error of NMT  $\pm 3$  degrees. (Para. 4.2.2.11.1.10 b)
- c. Verification of PRI S-Band power of between 0.75 and 2.00 watts at ACE. (Para. 4.2.2.11.1.10 c)

Seq. 22: Freq. Test/Sec RCVR (PM)

- a. Verification of ACE Station TLM AGC measurement of NLT 0.5 volt. Also, verified signal strength on cabin meter. (Para. 4.2.2.11.1.10 a)

OCP OUTLINE

OCP-GF-62000-COMM-1M5

Test Description: (Cont)

- b. Verification of ACE TLM Static Phase error of NMT  $\pm 3$  degrees.  
(Para. 4.2.2.11.1.10 b)
- Seq. 23: Quieting Sensitivity - Pri XCVR CDR HDST
  - a. Verification of NLT 20 db. S+N/N output at CDR HDST for a carrier signal of NMT - 103 dbm at S-Band Diplexer. Verification also, of NLT 32 db dynamic range of S-Band volume control at CDR HDST.  
(Para. 4.2.2.11.1.5.1 a)
- Seq. 24: Quieting Sensitivity - SEC XCVR LMP HDST
  - a. Verification of NLT 20 db. S+N/N output at LMP HDST for a carrier signal of NMT - 103 dbm at S-Band Diplexer. Verification also, of NLT 32 db dynamic range of S-Band volume control at LMP HDST.  
(Para. 4.2.2.11.1.5.1 c)
- Seq. 25: S-Band Power Ampl. Margin Test PRI XMTR/RCVR, PRI Pwr Ampl
  - a. Verification of maintenance of amp. lock within a  $\pm 10$  percent power variation around the nominal primary PA current variation.  
(Para. 4.2.2.11.1.6.1)
- Seq. 26: S-Band Power Ampl Margin Test SEC XMTR/RCVR, SEC Pwr Ampl
  - a. Verification of maintenance of amp. lock within a  $\pm 10$  percent power variation around the nominal secondary PA current variation.  
(Para. 4.2.2.11.1.6.1)
- Seq. 27: DUA Calibration Test
  - a. Tie-in of Digital Command Test Assy Test set and calibration via up-link S-Band of vehicle Digital Uplink Assy. (DUA)
- Seq. 28: Decoding Capability Test
  - a. Verification of a 'Valid' uplink message producing a "Transfer" and a 'Invalid' uplink message producing a "No Transfer". This is accomplished via S-Band PCM mode.  
(Para. 4.2.2.11.1.7.2 a)
  - b. Verification of a downlink Bit Error Rate (BER) of NMT 10 bits in 10 million bits. (Para. 4.2.2.11.1.7.2 b)
- Seq. 29: DUA 70 KHZ Uplink Back-Up Voice Test and Level
  - a. Verification of a CDR HDST of -1 to +5 dbm on a 70 KHZ subcarrier via S-Band uplink. Verification of DUA/Voice - Data switch operation via signal loss in off position. Verification of total power is -90 dbm. (Para. 4.2.2.11.1.5.5)

## OCP OUTLINE

OCP-GF-62000-COMM-LM5

### Test Description: (Cont)

#### Seq. 30: DUA/LGC Interface Checkout

- a. Verification of an uplink and return downlink message via S-Band with ACE CRT validation. (Para. 4.2.2.11.1.7.1 a, b)

#### Seq. 31: Data Storage Electronics Assembly Checkout

- a. Verification of proper DSEA operation by use of cabin indicator. Recording of approx. two minutes of tone. Verification of DSEA off with DSEA on-off switch in off position. (Para. 4.2.2.11.1.8)

#### Seq. 32: Signal Data Demod. Cal.

- a. Internal amplifier calibration adjustments of SDD in the Comm. Test Sta.

#### Seq. 33: FM Calibration

- a. Internal calibration adjustments of (S-Band) Communication Test Station.

#### Seq. 34: S-Band D/L Deviation Test

- a. Verification of signal to noise ratios of voice, 1.25 MHZ and 1.024 MHZ for PM Hi power mode. Also, deviations for above signals are verified for same conditions. Verification of S-Band modulation disappearance for off position of voice/on voice BU switch. Verification of no modulation on 1.25 MHZ for CDR S-Band T/R switch in off position.  
(Para. 4.2.2.11.1.5.2 a)  
(Para. 4.2.2.11.1.5.2 b)
- b. Verification of signal to noise ratios and deviation ratio for Emergency Key at PM Lo power with PMP prime power removed.  
(Para. 4.2.2.11.1.5.2 c)
- c. For Lo power mode, verification is made for deviation ratios and signal to noise measurements of voice, 1.024 MHZ and 1.25 MHZ sub-carriers. In addition, the CDR S-Band T/R switch is verified for proper operation, with Bio-med in active position and Voice/DN Voice BU in DN Voice BU position.  
(Para. 4.2.2.11.1.5.2 d)  
(Para. 4.2.2.11.1.5.2 e)
- d. Finally, verification is made of TV mode at 500 KC using Hi power mode and FM modulation. Measurements of signal to noise and deviation are verified for 500 KHZ, 1.25 MHZ and 1.024 MHZ in this set of conditions.  
(Para. 4.2.2.11.1.5.2 f)



OCP OUTLINE

OCP-GF-62000-COMM-LM5

Test Description: (Cont)

Seq. 35: 1.25 MHZ Subcarried Modulation Indices Verification

- a. Deviation and signal to noise measurements of the 1.25 MHZ subcarrier are verified for the 8 sub-carriers using both relay switches (CDR + LMP)  
(Para. 4.2.2.11.1.5.4)

Seq. 36: ST2 (SR-6)

- a. Verification of Transfer for a Valid message and a No Transfer for an Invalid message via PCM (S-Band up and down link)  
(Para. 4.2.2.11.1.7.1.2 a)
- b. Verification of a good BER (NMT 10 bits in 10 million)  
(Para. 4.2.2.11.1.7.1.2 b)
- c. Measurement of ranging delay time, verification of ranging correlation and ranging disable when Off/Reset and TV/CWEA Enable switch positions are selected.  
(Para. 4.2.2.11.1.7.1.2 c)
- d. Voice conference (using VHF and S-Band) involving EVA and MSFN.  
(Para. 4.2.2.11.1.7.1.2 b)

Seq. 37: ST-6 (SR-2)

- a. Verification of Lo Power downlink 512 KHZ emergency key PMP prime power off. Verification of Lo Power uplink voice via 30 KHZ SC PMP prime power off. (Para. 4.2.2.11.1.7.3)

Seq. 38: ST-10 (SR-2)

- a. Verification of the following:
  - 1. Satisfactory TV reproduction (D/L)
  - 2. NMT 10 bit errors in 10 million. (Hi Bit)
  - 3. Duplex VHF and S-Band voice communication (involving EVA, Crewman and MSFN)
  - 4. Satisfactory EMU transmission from EVA to MSFN.
- b. Validation of proper switch operation preventing S-Band from functioning normally when 30 KHZ SC is not present due to S-Band Squelch switch in on position.  
(Para. 4.2.2.11.1.7.4.2)

OCP OUTLINE

OCP-GF-62000-COMM-LM5

Test Description: (Cont)

Seq. 39: VHF PCM Bit Error Test

- a. Verification of a minimum BEC via downlink VHF B at Lo Bit Rate (1.6 KBS) in 10 million total bits.  
(Para. 4.2.2.11.1.9)

Seq. 40: ST-4 (SR-2)

- a. Verification of duplex voice communication between LM + MSFN via S-Band in back-up mode (No SPA power)  
(Para. 4.2.2.11.1.7.2.2 a)
- b. Validation of minimum bit error count in 10 million at Lo Bit Rate on 1.024 MHZ SC downlink (Para. 4.2.2.11.1.7.2.2 b)

Seq. 41: Mode ST-8A

- a. Calibration of Pen recorders.
- b. Verification of satisfactory voice transmission between EVA and MSFN via LM.
- c. Validation of presence of Bio-med channels D/L on MSFN sonic analyzer.
- d. Validation of LMP EKG
- e. Lo Bit D/L PCM data verification.  
(Para. 4.2.2.11.1.7.5.2)

Seq. 42: S-Band Steerable Antenna Path Verification

- a. Validation of RF free space and hardlink signal path providing a locked U/L & D/L S-Band signal.
- b. Verification of S-Band Heater operation.

Seq. 43: Automatic Acquisition Test - Pri XCVR

- a. Verification of proper automatic lock-on of SBSA to a remote 2101.8 MHZ signal when signal source is within  $\pm 8$  degree offset from nominal center line of LOS in both Yaw and Pitch planes.  
(Para. 4.2.2.11.1.6.4 (b) 6 to 9)

Seq. 44: Communications Shutdown

- a. Normal procedure for placing vehicle equipment ERA's into dormant state.
- b. CTS and support test equipment power-down.

## OCP OUTLINE

OCP-GF-62000-RAD-LM5

### Test Title:

LM Combined Subsystem Pre-FEAT Test - Radar

### Subsystem:

Guidance and Navigation

### Test Objectives:

Verification of performance characteristics for the Rendezvous and Landing Radars and to support subsequent FCS Tests.

### Vehicle Configuration:

Mated Stages

### Location:

Integrated Workstand, Plant 5

### Hazardous Operation:

This is a hazardous OCP whenever either Radar is free to radiate without a suitable Hat.

### Equipment Under Test:

RR Electronics Assembly

RR Antenna Assembly

LR Electronics Assembly

LR Antenna Assembly

### Test Description:

Seq. 01: Call to Stations

Seq. 02: RR GSE Turn-On

Seq. 03: Activation of LM Cabin Controls and Displays

Seq. 04: RR Turn-On

- a. Verification of internal power supply voltages, DC.
- b. Verification of presence of 800 HZ
- c. Monitoring of RR Antenna temperature (all Seq.)
- d. Verification of POWER ON/LGC MODE discrete

OCP OUTLINE

OCP-GF-62000-RAD-LM5

Test Description: (Cont)

Seq. 05: RR Self Test

- a. Verification, in self test, of signal strength meter readings for:
  - 1. Xmtr output power
  - 2. AGC voltage
  - 3. Shaft error
  - 4. Trunnion error  
(Para. 4.2.2.5.7.1)
- b. Verification of Range and Range Rate self test values.  
(Para. 4.2.2.5.7.1)
- c. Verification of Shaft and Trunnion motion during self test.  
(Para. 4.2.2.5.7.1)
- d. Verification of proper operation of No-Track Light.

Seq. 06: Angular Coverage, Slew and Drift Rate Tests

- a. Verification of Shaft and Trunnion axes angular capability.  
(Para. 4.2.2.5.7.2)
- b. Verification of Shaft and Trunnion axes slew rates.  
(Para. 4.2.2.5.7.2)
- c. Verification of Shaft and Trunnion axes drift rates.  
(Para. 4.2.2.5.7.2)
- d. Check of proper X-Pointer operation.

Seq. 07: RR Gyro Torquing Test

- a. Check of Compensated-Gyro-Error saturation voltage for both primary and redundant paths.

Seq. 08: RR RF Test (Para. 4.2.2.5.7.4)

- a. Verification of transmitter output power.
- b. Verification of transmitter output frequency.
- c. Check spectral purity of transmitted output.
- d. Check modulation indices.

Seq. 09: RR Acquisition Test

- a. Verification of acquisition time.  
(Para. 4.2.2.5.7.5)

OCP OUTLINE

OCP-GF-62000-RAD-LM5

Test Description: (Cont)

- b. Verification of acquisition capability at a simulated range of 400 NM.  
(Para. 4.2.2.5.7.5)

- c. Determination of AGC voltage vs range.

Seq. 10: RR Trunnion and Shaft Angle Tracking

- a. Verification of Shaft and Trunnion angle tracking errors at ranges of 400 NM, 100 NM and minimum GSE - range.  
(Para. 4.2.2.5.7.3)

Seq. 11: Antenna Designation

- a. Verification of the capability of the LGC to position the RR Shaft and Trunnion axes to several selected angles.  
(Para. 4.2.2.5.7.6.1)
- b. Check of the dynamic nulling characteristics.

Seq. 12: RR Range Rate Test (Para. 4.2.2.5.7.5)

- a. Verification of Range Rate accuracy at several range rate values.

Seq. 13: RR Range Verification

- a. Verification of Range accuracy at several static values of Range.  
(Para. 4.2.2.5.7.5)
- b. Verification of LGC Range-Readout capability.  
(Para. 4.2.2.5.7.6.3)
- c. Check Dynamic-Range capability at ranges of 350, 150 and 60 NM.

Seq. 14: Securing After RR Tests

Seq. 15: LR GSE Turn-On

Seq. 16: LR Power Turn-On

- a. Check of LR Antenna temperature.
- b. Check of Internal Power Supply Voltages.
- c. Check of Altitude Transmitter and Velocity Transmitter output power on Cabin Signal Strength Meter.  
(Para. 4.2.2.5.8.1 a)

OCP OUTLINE

OCP-GF-62000-RAD-IM5

Test Description: (Cont)

Seq. 17: LR Self-Test Verification

- a. Initiation of In-Flight Self-Test by means of cabin switch.
- b. Verification, in response to internally generated signals, of altitude, altitude rate, forward and lateral velocity indications on cabin display meters.  
(Para. 4.2.2.5.8.1 b)
- c. Verification of self-test frequencies.

Seq. 18: LR Transmitter Verification

- a. Verification by means of Antenna Hat and GSE.
  1. Verification of frequency and power output of both the Altimeter and Velocity Transmitters.  
(Para. 4.2.2.5.8.2)
  2. Check of Altimeter Transmitter for Linearity, Modulation Rate and Frequency Deviation in the two modes of range operation.

Seq. 19: Gain State Switching Verification

- a. Measurement of input R.F. power level at which gain state switching occurs for each of the four receiver channels.

Seq. 20: Acquisition Threshold and Acquisition Time Verification

- a. Verification of acquisition threshold; the minimum RF power level at which lock on (tracker lock) is achieved for each of the four receiver channels (Para. 4.2.2.5.8.3.1).
- b. Verification of tracker acquisition probability - number of times lock on is achieved out of number of times lock on is attempted within specified allowable acquisition time for each of the four receiver channels.  
(Para. 4.2.2.5.8.3.2)

Seq. 21: LR Display Accuracy Check

- a. Simulation by GSE of specific altitude and velocity Standard Test Condition (STC) signals that are fed into the four receiver channels.
- b. Verification of predetermined responses as indicated by cabin display readouts. The STC signal selected will determine the magnitude and direction of display readout.  
(Para. 4.2.2.5.8.5)

## OCP OUTLINE

OCP-GF-62000-RAD-LM5

### Test Description: (Cont)

#### Seq. 22: LR CWEA Checkout and Tracker Lock Chan ID

- a. Verification of the LR Caution and Warning Interface. This is accomplished by attenuating the stimuli to each of the four trackers, one at a time, and check for the initiation of the caution and warning displays.
- b. Verification of the LR Meter Display Warning circuitry. Altitude and Altitude Rate Signals are removed from meter displays initiating the Rng/Rng Rt - Alt/Alt Rt warning lite.
- c. Verification of the LR Caution and Warning Displays during LR power turn off.

#### Seq. 23: Forced Tracker Search Verification

- a. The verification of the LR to unlock from simulated signals generated by GSE when the radar test switch is momentarily placed in the LDG and then off position.

#### Seq. 24: LR Antenna Tilt Verification

- a. Verification of antenna travel and time for position change.  
(Para. 4.2.2.5.8.4)
  1. Descent to Hover
  2. Hover to Descent

#### Seq. 25: Dynamic Test, High and Low Range

- a. Verification of maximum Doppler frequency change rates through which tracker lock is maintained. Both the high and low range modes are verified.

#### Seq. 26: Tracking Through Zero Doppler (Low Range)

- a. Verification of maintaining velocity tracker lock through zero doppler in a simulated low altitude condition.

#### Seq. 27: Preamp Scan

- a. Measurement of noise amplitude at pre-amp outputs with no input signal.

#### Seq. 28: Channel Cross-Talk Verification

- a. Measurement of signal leakage between channels measured at pre-amp outputs.

OCP OUTLINE

OCP-GF-62000-RAD-LM5

Test Description: (Cont)

Seq. 29: LDG Radar and LGC Interface Test

- a. Verification of altitude and velocity accuracies using standard test conditions (STC) generated from GSE and measured at ACE-S/C via LGC Downlink.  
(Para. 4.2.2.5.8.5 & 4.2.2.5.8.6)
- b. LR output discretes verified at ACE-S/C via LGC Downlink.  
(Para. 4.2.2.5.8.5)
- c. Verification of the LGC Ant Auto function in positioning the LR Antenna from Descent to Hover.

Seq. 30: Securing After Test

- a. LR Shutdown

Seq. 31: LR/GSE Power Turn-On

- a. FCS Support

Seq. 32: LR/GSE Power Turn Off

- a. FCS Support

Seq. 33: RR/GSE Power Turn On

- a. FCS Support

Seq. 34: RR/GSE Power Turn Off

- a. FCS Support



OCP OUTLINE

OCP-GF-62000-RCS-LM5

Test Title:

LM Combined Subsystem Pre-FEAT Test - Reaction Control.

Subsystem:

Reaction Control (RCS).

Test Objectives:

- a. Determine end-to-end check or channel identification of electrical paths associated with:
  1. Valve Position Indicators.
  2. C & W Indicators (associated with (a)).
  3. Pressure Transducers.
  4. Temperature Transducers.
- b. Demonstration of functional operation of the A/B-1 and A/B-2 thruster cluster heater assemblies; and lower limit levels of associated C&WEA circuitry.
- c. Establishment of a 'Heater Current' measurement on a per Quad per System basis.

Vehicle Configuration:

Ascent Stage.

Location:

Integrated Workstand, Plant 5 CEF.

Hazardous Operations:

Pressurization of tanks and lines above blanket pressure values.

Equipment Under Test:

RCS Propellant Section Components.

RCS Helium Pressurization Section.

RCS System A/B 1 and A/B-2 Thruster Heaters.

Main Shutoff Valves.

Asc/RCS Int. Valves.

Crossfeed Valves.

OCP OUTLINE

OCP-GF-62000-RCS-LM5

Equipment Under Test: (Cont)

Isolation Valves.

Reg. Out. Transducer.

Manifold Transducers.

Helium Tank Transducer.

Tank Temperature Transducers.

Thruster Heater Bands.

Regulator A and B CWEA Indicators.

Heater CWEA Indicators.

Test Description:

Seq. 01: Call to Stations

Seq. 02: RCS Power On and Pressure Venting

- a. All RCS Solenoid Latching Valve CB's energized.
- b. RCS Flags, Meter Display and Heater Display CB's energized.
- c. Verification and setting of RCS Latching Valve flags as an initial condition for later testing.
- d. Venting of Ascent Propellant Tanks to ambient pressure.
- e. Venting of entire RCS, i. e., lines and tanks, to ambient pressure.

Seq. 03: RCS Transducer Check Under Ambient Conditions

- a. Recording of all RCS pressure and temperature transducers at their associated ACE displays.
  1. Verification that transducer ambient readouts are within the end-to-end ACE tolerances (Paragraph 4.2.2.12.3.1 (a)).
- b. Verification of all Thrust Chamber Pressure Switches 'CLOSED' via ACE displays.
- c. Recording of all RCS pressure and temperature transducers at their associated cabin displays. (Paragraph 4.2.2.9.1 (a) and (b)).
  1. Verification that transducer ambient readouts are within the end-to-end cabin display tolerances. (Paragraph 4.2.2.12.3.1(a)).

OCP OUTLINE

OCP-GF-62000-RCS-LM5

Test Description: (Cont)

Seq. 04: RCS - Solenoid Latching Valve Channel ID and CWEA Check

- a. Verification of the functional operation and channel ID of each individual RCS/Asc Interconnect Solenoid Latching Valve during cycling by:
  - 1. Physically feeling for solenoid movement by hand.
  - 2. Verification of proper cabin flag displays (Paragraph 4.2.2.9.1 (a) and (b)).
  - 3. Verification of proper ACE displays (Paragraph 4.2.2.12.2.1 (b)).
- b. Verification of the functional operation and channel ID of the RCS Crossfeed Solenoid Latching Valves during cycling by:
  - 1. Physically feeling for solenoid movement by hand.
  - 2. Verification of proper cabin flag displays (Paragraph 4.2.2.9.1 (a) and (b)).
  - 3. Verification of proper ACE displays (Paragraph 4.2.2.12.2.1 (b)).
- c. Verification of the functional operation and channel ID of the RCS Main Shutoff Solenoid Latching Valves and 'Reg A and B' warning light functions during cycling by:
  - 1. Physically feeling for solenoid movement by hand.
  - 2. Verification of proper cabin flag displays (Paragraph 4.2.2.9.1 (a) and (b)).
  - 3. Verification of proper ACE displays (Paragraph 4.2.2.12.2.1 (b)).
  - 4. Verification of 'Master Alarms' and individual 'RCS Reg A or RCS Reg B' warning activation during "OPEN" cycles (Paragraph 4.2.2.12.4).
  - 5. Verification of 'Master Alarm' resets and 'Reg A and B' warning inhibits during "CLOSE" cycles (Paragraph 4.2.2.12.4).
- d. Verification of the functional operation and channel ID of the RCS Isolation Solenoid Latching Valves during cycling by:
  - 1. Physically feeling for solenoid movement by hand.
  - 2. Verification of proper cabin flag displays (Paragraph 4.2.2.9.1 (a) and (b)).
  - 3. Verification of proper ACE displays (Paragraph 4.2.2.12.2.1 (b)).

OCP OUTLINE

OCP-GF-62000-RCS-LM5

Test Description: (Cont)

- e. De-activation of all power for RCS Solenoid Latching Valves by opening of valve circuit breakers.

Seq. 05: RCS System A Helium Regulator Outlet Transducer Channel ID at 65 psia

- a. Pressurization of Reaction Control System A Helium Section to 65 psia utilizing gaseous nitrogen.
  - 1. Manifolding of gas and liquid sides of propellant tank bladders with the 'He Test Port' gas supply to maintain zero (0)  $\Delta P$  throughout section.
- b. Verification of the known 'He Reg Outlet' pressure on the proper ACE displays (Paragraph 4.2.2.12.2.1 (b)).
- c. Operation of 'Temp/Press Mon' select switch and verification of the known 'He Reg Outlet' transducer pressure on the proper cabin meter display (Paragraph 4.2.2.9.1 (a) and (b)).
- d. Venting and sequential removal of GHQD's from Sys A propellant tanks and helium test port for maintenance of proper blanket pressure in helium section.

Seq. 06: RCS System B Helium Regulator Outlet Transducer Channel ID at 65 psia

- a. Pressurization of Reaction Control System B Helium Section to 65 psia utilizing gaseous nitrogen.
  - 1. Manifolding of gas and liquid sides of propellant tank bladders with the 'He Test Port' gas supply to maintain zero (0)  $\Delta P$  throughout section.
- b. Verification of the known 'He Reg Outlet' pressure on the proper ACE displays (Paragraph 4.2.2.12.2.1 (b)).
- c. Operation of 'Temp/Press Mon' select switch and verification of the known 'He Reg Outlet' transducer pressure on the proper cabin meter display (Paragraph 4.2.2.9.1 (a) and (b)).
- d. Venting and sequential removal of GHQD's from System B propellant tanks and 'He Test Port' for maintenance of proper blanket pressure in helium section.

Seq. 07: RCS System A Fuel Manifold Transducer Channel ID at 65 psia

- a. Pressurization of Reaction Control System A Fuel Manifold to 65 psia utilizing gaseous nitrogen.

OCP OUTLINE

OCP-CF-62000-RCS-LM5

Test Description: (Cont)

- b. Verification of the known A and B System 'Fuel Manifold Pressure Transducer' outputs on the proper ACE displays (Paragraph 4.2.2.12.2.1 (b)).
- c. Operation of 'Temp/Press Mon' select switch and verification of the known 'Fuel Manifold' transducers pressure on the proper cabin meter displays (Paragraph 4.2.2.9.1 (a) and (b)).
- d. Venting of System A Fuel Manifold to blanket pressure.

Seq. 08: RCS System A Oxid Manifold Transducer Channel ID at 65 psia

- a. Pressurization of Reaction Control System A Oxidizer Manifold to 65 psia utilizing gaseous nitrogen.
- b. Verification of the known A and B System 'Oxid Manifold Pressure Transducer' outputs on the proper ACE displays (Paragraph 4.2.2.12.2.1 (b)).
- c. Operation of 'Temp/Press Mon' select switch and verification of the known 'Oxid Manifold' transducers pressures on the proper cabin meter displays (Paragraph 4.2.2.9.1 (a) and (b)).
- d. Venting of System A Oxidizer Manifold to blanket pressure.

Seq. 09: RCS System B Fuel Manifold Transducer Channel ID at 65 psia

- a. Pressurization of Reaction Control System B Fuel Manifold to 65 psia utilizing gaseous nitrogen.
- b. Verification of the known 'Fuel Manifold Press' transducer output on the proper ACE displays (Paragraph 4.2.2.12.2.1 (b)).
- c. Operation of 'Temp/Press Mon' select switch and verification of the known Fuel Manifold Press Transducer pressure on the proper cabin meter display (Paragraph 4.2.2.9.1 (a) and (b)).
- d. Venting of System B Fuel Manifold to blanket pressure.

Seq. 10: RCS System B Oxid Manifold Transducer Channel ID at 65 psia

- a. Pressurization of Reaction Control System B Oxid Manifold to 65 psia utilizing gaseous nitrogen.
- b. Verification of the known 'Oxid Manifold Press' transducer output on the proper ACE displays (Paragraph 4.2.2.12.2.1 (b)).

OCP OUTLINE

OCP-GF-62000-RCS-LM5

Test Description: (Cont)

- c. Operation of 'Temp/Press Mon' select switch and verification of the known Oxid Manifold Press Transducer pressure on the proper cabin meter display (Paragraph 4.2.2.9.1 (a) and (b)).
- d. Venting of System B Oxid Manifold to blanket pressure.

Seq. 11: RCS Helium Tank A Transducer Channel ID at 215 psia

- a. Pressurization of RCS Helium Tank A to 215 psia utilizing gaseous nitrogen.
- b. Verification of the known 'He Tank Press' transducer out on the proper ACE display (Paragraph 4.2.2.12.2.1 (b)).
- c. Operation of 'Temp/Press Mon' select switch and verification of the known 'He Tank' Press Transducer pressure on the proper cabin meter display (Paragraph 4.2.2.9.1 (a) and (b)).
- d. Venting of 'RCS Helium Tank A' to blanket pressure.

Seq. 12: RCS Helium Tank B Transducer Channel ID at 215 psia

- a. Pressurization of RCS Helium Tank B to 215 psia utilizing gaseous nitrogen.
- b. Verification of the known 'He Tank Press' transducer output on the proper ACE display (Paragraph 4.2.2.12.2.1 (b)).
- c. Operation of 'Temp/Press Mon' select switch and verification of the known 'He Tank' press transducer pressure on the proper cabin meter display (Paragraph 4.2.2.9.1 (a) and (b)).
- d. Venting of 'RCS Helium Tank B' blanket pressure.

Seq. 13: RCS Fuel Tank Temperature Transducer Channel ID

- a. Verification of Fuel Tank A Temperature Transducer ambient temperature readout on proper ACE display.
- b. Application of heat to Fuel A Temperature Transducer only.
- c. Verification of temperature increase at Fuel Tank A Temperature Transducer on proper ACE display (Paragraph 4.2.2.12.2.1 (b)).
- d. Operation of 'Temp/Press Mon' select switch and verification of a 'Fuel Tank A' temperature greater than ambient and the 'Fuel Tank B' temperature still ambient on the proper cabin meter display (Paragraph 4.2.2.9.1 (a) and (b)).
- e. Application of heat to Fuel B Temperature Transducer only.

OCP OUTLINE

OCP-GF-62000-RCS-LM5

Test Description: (Cont)

- f. Verification of temperature increase of Fuel Tank B Temperature Transducer on proper ACE display (Paragraph 4.2.2.12.2.1 (b)).
- g. Operation of 'Temp/Press Mon' select switch and verification of the temperature increase of Fuel Tank B Temperature Transducer on the proper cabin meter display (Paragraph 4.2.2.9.1 (a) and (b)).

Seq. 14: Quad I A/B-1 and A/B-2 Heater Functional Test and C&W Verification  
Paragraph 4.2.2.7.4 (a), (b), (c), (d), (e) and (f)).

- a. Setting of all 'Htr Cont - RCS Sys A/B-2 Quad' switches to "AUTO".
- b. Operation of 'Temp Mon' select switch and verification of Quad I ambient temperature indication on cabin display meter.
- c. Verification of ambient temperature indication at Quad I ACE display.
- d. Verification of all RCS Quad I GSE thermocouples at ambient temperature.
- e. Application of power in automatic mode to Sys A/B-2 Quad I heaters.
- f. Verification of temperature rise of the Quad I A/B-2 heater bands via GSE thermocouples.
- g. De-activation of the A/B-2 Quad I 'Htr Con' switch.
- h. Verification of temperature decrease at each A/B-2 heater band via the GSE Quad I thermocouples.
- i. Application of power in auto mode to Sys A/B-1 Quad I heaters.
- j. Verification of Quad I A/B-1 heater band operation via GSE thermocouples.
- k. Application of power in "AUTO" mode to Quad I A/B-2 heaters.
- l. Verification of maximum and minimum Quad temperatures via GSE thermocouples, cabin and ACE displays.
- m. Application of power in 'Man' mode to Quad I A/B-2 heaters.
- n. Determination of time to reach temperature stabilization of Quad I heaters via GSE thermocouples and ACE.
- o. Application of power in "AUTO" mode to Quad I A/B-2 heaters.
- p. Determination of time to reach temperature stabilization of Quad I heaters via ACE display.

OCP OUTLINE

OCP-GF-62000-RCS-LM5

Test Description: (Cont)

- q. De-energization of Quad I heaters and verification of 'Heater' caution light activation at less than 120°F.
  - r. Verification of caution temperature level via cabin display and ACE.
  - s. Verification of caution reset circuitry.
- Seq. 15: Quad II A/B-1 and A/B-2 Heater Functional Test and C & W Verification (Paragraph 4.2.2.7.4 (a), (b), (c), (d), (e) and (f)).
- a. Operation of 'Temp Mon' select switch and verification of Quad II ambient temperature indication on cabin display meter.
  - b. Verification of ambient temperature indication at Quad II ACE display.
  - c. Verification of all RCS Quad II GSE thermocouples at ambient temperature.
  - d. Application of power in automatic mode to System A/B-2 Quad II heaters.
  - e. Verification of temperature rise of the Quad II A/B-2 heater bands via GSE thermocouples.
  - f. De-activation of the A/B-2 Quad II 'Heater Con' switch.
  - g. Verification of temperature decrease at each A/B-2 heater band via the GSE Quad II thermocouples.
  - h. Application of power in auto mode to System A/B-1 Quad II heaters.
  - i. Verification of Quad II A/B-1 heater band operation via GSE thermocouples.
  - j. Application of power in "AUTO" mode to Quad II, A/B-2 heaters.
  - k. Verification of maximum and minimum Quad temperatures via GSE thermocouples, cabin and ACE displays.
  - l. Application of power in "Man" mode to Quad II A/B-2 heaters.
  - m. Determination of time to reach temperature stabilization of Quad II heaters via GSE thermocouples and ACE.
  - n. Application of power in "AUTO" mode to Quad II A/B-2 heaters.
  - o. Determination of time to reach temperature stabilization of Quad II heaters via ACE display.
  - p. De-energization of Quad II heaters verification of 'Heater' caution light activation at less than 120°F.



OCP OUTLINE

OCP-GF-62000-RCS-LM5

Test Description: (Cont)

- q. Verification of caution temperature level via cabin display and ACE.
- r. Verification of caution reset circuitry.

Seq. 16: Quad III A/B-1 and A/B-2 Heater Functional Test and C & W Verification (Paragraph 4.2.2.7.4 (a), (b), (c), (d), (e), and (f))

- a. Operation of 'Temp Mon' select switch and verification of Quad III ambient temperature indication on cabin display meter.
- b. Verification of ambient temperature indication at Quad III ACE display.
- c. Verification of all RCS Quad III GSE thermocouples at ambient temperature.
- d. Application of power in automatic mode to Sys A/B-2 Quad III heaters.
- e. Verification of temperature rise of the Quad III A/B-2 heater bands via GSE thermocouples.
- f. De-activation of the A/B-2 Quad III 'Htr Con' switch.
- g. Verification of temperature decrease at each A/B-2 heater band via the GSE Quad III thermocouples.
- h. Application of power in auto mode to Sys A/B-1 Quad III heaters.
- i. Verification of Quad III A/B-1 heater band operation via GSE thermocouples.
- j. Application of power in "AUTO" mode to Quad III A/B-2 heaters.
- k. Verification of maximum and minimum Quad temperatures via GSE thermocouples, cabin and ACE displays.
- l. Application of power in 'Man' mode to Quad III A/B-2 heaters.
- m. Determination of time to reach temperature stabilization of Quad III heaters via GSE thermocouples and ACE.
- n. Application of power in "AUTO" mode to Quad III A/B-2 heaters.
- o. Determination of time to reach temperature stabilization of Quad III heaters via ACE display.
- p. De-energization of Quad III heaters and verification of 'Heater' caution light activation at less than 120°F.
- q. Verification of caution temperature level via cabin display and ACE.

OCP OUTLINE

OCP-GF-62000-RCS-LM5

Test Description: (Cont)

- r. Verification of caution reset circuitry.
- Seq. 17: Quad IV A/B-1 and A/B-2 Heater Functional Test and C & W Verification (Paragraph 4.2.2.7.4(a), (b), (c), (d), (e) and (f))
  - a. Operation of 'Temp Mon' select switch and verification of Quad IV ambient temperature indication on cabin display meter.
  - b. Verification of ambient temperature indication at Quad IV ACE display.
  - c. Verification of all RCS Quad IV GSE thermocouples at ambient temperature.
  - d. Application of power in automatic mode to Sys A/B-2 Quad IV heaters.
  - e. Verification of temperature rise of the Quad IV A/B-2 heater bands via GSE thermocouples.
  - f. De-activation of the A/B-2 Quad IV 'Htr Con' switch.
  - g. Verification of temperature decrease at each A/B-2 heater band via the GSE Quad IV thermocouples.
  - h. Application of power in auto mode to Sys A/B-1 Quad IV heaters.
  - i. Verification of Quad IV A/B-1 heater band operation via GSE thermocouples.
  - j. Application of power in "AUTO" mode to Quad IV A/B-2 heaters.
  - k. Verification of maximum and minimum Quad temperatures via GSE thermocouples, cabin and ACE displays.
  - l. Application of power in 'Man' mode to Quad IV A/B-2 heaters.
  - m. Determination of time to reach temperature stabilization of Quad IV heaters via GSE thermocouples and ACE.
  - n. Application of power in "AUTO" mode to Quad IV A/B-2 heaters.
  - o. Determination of time to reach temperature stabilization of Quad IV heaters via ACE display.
  - q. De-energization of Quad IV heaters and verification of 'Heater' caution light activation at less than 120°F.
  - r. Verification of caution temperature level via cabin display and ACE.
  - s. Verification of caution reset circuitry.

OCP OUTLINE

OCP-GF-62000-RCS-IM5

Test Description: (Cont)

Seq. 18: Securing After Test

Seq. 19: Call to Stations

Seq. 20: RCS Heater Current Measurement  
(Paragraph 4.2.2.7.4 (g))

- a. Verification of vehicle "No Load Residual" bus current (less than 2.5 amps DC).
- b. Application of power to Quad I A/B-1 heaters.
- c. Recording of A/B-1, Quad I total current draw, via GSE ammeter.
- d. Deactivation of Quad I A/B-1 heaters.
- e. Application of power to Quad I A/B-2 heaters in the auto mode, and recording of total current draw on GSE ammeter.
- f. Application of power to Quad I A/B-2 heaters in the 'Man' mode and recording of total current draw on GSE ammeter.
- g. Deactivation of Quad I A/B-2 heaters and recording of residual current.
- h. Repeat of preceding checks for each of the other three RCS Quads.

## OCP OUTLINE

OCP-GF-62000-FCS LM5

### Test Title:

LM Combined Subsystem Pre-FEAT Test - FCS

### Subsystem:

Flight Control Subsystem (FCS)

### Test Objectives:

To verify the functional performance of the Control Electronics Section (CES)

To verify the functional performance of the Abort Guidance Section (AGS)

To verify the functional performance of the Integrated Flight Control Subsystem (FCS), consisting of CES, AGS and PGNS integrated in the LM.

### Vehicle Configuration:

Ascent and Descent Stages electrically mated.

### Location:

Integrated Workstand, Plant 5

### Hazardous Operations:

Not applicable

### Equipment Under Test:

<u>CES</u>	<u>AGS</u>	<u>G&amp;N</u>	<u>FCS</u>
ATCA	AEA	IMU	FCS Caution & Warning
RGA	ASA	CDU	FDAI
DECA	DEDA	DSKY	Ordeal
Control Assy No. 1-3		LGC	Event Timer
GDA			Mission Timer
16 RCS Jets (Primary & Secondary,			
Descent Engine			
Ascent Engine			
ACA			
TTCA			

### Test Description:

Seq. 01: Call to Stations

Seq. 02: PGNS Steering Error Checkout. (Para. 4.2.2.5.14 (b))

Verification of FDAI's steering error indicators for roll, pitch, and yaw in response to LGC test profiles.

OCP OUTLINE

OCP-GF-62000-FCS LM5

Test Description: (Cont)

Seq. 03: PGNS X-Pointers and Alt/Alt Rate Meter Checkout.  
(Para. 4.2.2.5.14 (c) (d))

- a. Verification of X-Pointer indicators (forward and lateral velocity)
- b. Verification of Alt/Alt Rate displays.

Seq. 04: CES Turn-On and Caution/Warning Checkout. (Para. 4.2.2.6.4 (a) (i))

Verification of:

- a. RGA run-up time
- b. RGA run-down time
- c. CES power Caution/Warning operation.

Seq. 05: Event Timer Checkout. (Para. 4.2.2.9.2)

Verification of:

- a. Slew
- b. Count up/down
- c. Start/Stop/Reset

Seq. 06: Mission Timer Checkout (Para. 4.2.2.9.3)

Verification of:

- a. Slew
- b. Count up
- c. Start/Stop/Reset
- d. External Sync

Seq. 07: ACA Direct, Hardover and + X-Translation Override Checkout.  
(Para. 4.2.2.6.3 7.3, 4.2.2.6.3.7.4, 4.2.2.6.3.8)

- a. Verifies operation of the secondary RCS jets with ACA in hardover control.
- b. Verifies operation of Enable/Disable functions of ACA/4 Jet Enable switches.
- c. Verifies operation of the secondary RCS Jets in plus X-Translation Override control.
- d. Verifies operation of the secondary RCS jets in Direct Mode.

Test Description: (Cont)

- Seq. 08: ACA Proportional Mode Checkout (Para. 4.2.2.6.3.7.2)
- a. Verifies operation of the primary RCS Jets, with ACA proportional rate signals, in AGS Mode, and Mode Control selection.
  - b. Operation of Enable/Disable functions of ACA Prop Enable switches in AGS Mode.
  - c. Verifies operation ATT/TRANSL 2/J 4/J switch.
- Seq. 09: ACA/RGA Gimbal Trim Checkout.
- a. Verifies operation of Pitch and Roll GDA's in AGS Mode, controlled by RGA pitch and roll signals.
  - b. Verifies operation of Pitch and Roll GDA's in AGS Mode, controlled with a ACA in proportional rate mode. Also verifies ATCA pulse MODE inhibits gimbaling.
  - c. Verifies operation of Eng Gmb1 caution light for Pitch and Roll GDA's malfunctions.
  - d. Verification of Eng Gimbal Enable/Disable switch.
  - e. Verification of Gimbal Fail Resets.
- Seq. 10: TTCA Checkout. (Para. 4.2.2.6.3.9.2)
- a. Verifies operation of the primary RCS jets with TTCA's in AGS Mode.
  - b. Verifies operation of On/Off functions of Bal CPL switch.
  - c. Verifies operation of Enable/Disable functions of TTCA/Transl Enable switches in AGS Mode.
  - d. Verifies operation ATT/TRANSL 2/J 4/J switch.
- Seq. 11: PRM Checkout. (Para. 4.2.2.6.3.5)
- a. Verifies duration of PRM time-on pulses.
  - b. Verifies pulse ratio frequency of PRM.
- Seq. 12: Attitude Controller Assembly Pulse Mode Checkout.  
(Para. 4.2.2.6.3.7.1)
- a. Verifies operation of RCS primary jets with ACA's in Pulse Mode.
- Seq. 13: Jet Logic Checkout. (Para. 4.2.2.6.3.6)
- a. Verification of Horizontal and Vertical Jet Logic.
- Seq. 14: Lunar Probe Interface Checkout. (Para. 4.2.2.1.3 (a))
- a. Verifies operation of Lunar Contact lights controlled by each of the four landing probes.

OCP OUTLINE

OCP-GF-62000-FCS LMS

Test Description: (Cont)

- b. Verifies operation of Lunar Contact lights via redundant circuits.
- Seq. 15: PGNS Gimbal Trim Checkout. (Para. 4.2.2.5.9.3 (a), (d))
  - a. Verification of Pitch and Roll GDA's in PGNS Mode.
- Seq. 16: PGNS ACA Checkout. (Para 4.2.2.5.3 (f) Partial, 4.2.2.5.13 Partial).
  - a. Verification of DES Rate switch for +1 FPS and -1 FPS command inputs to LGC.
  - b. Verification of ACA's in PGNS Mode, for out-of-detent signal inputs to LGC.
  - c. Verification of ACA's in PGNS Mode, for proportional rate command inputs to LGC.
  - d. Verification of Enable/Disable functions of ACA Prop Enable switches.
- Seq. 17: PGNS TTCA Checkout. (Para. 4.2.2.5.3 (f), 4.2.2.5.13 Partial)
  - a. Verification of TTCA's in PGNS Mode for translation command inputs to LGC.
  - b. Verification of Enable/Disable functions of TTCA/Transl Enable switches.
- Seq. 18: PGNS RCS Checkout (Para. 4.2.2.5.11)
  - a. Verification of operation of the primary RCS jets in PGNS Mode.
- Seq. 19: PGNS Descent Engine Checkout. (Para. 4.2.2.5.9.1 (a), 4.2.2.5.9.1 (b) Partial)
  - a. Verification of On/Off Control of the Descent Engine in PGNS Mode.
  - b. Manual On/Off Control of the Descent Engine by means of start push-button and the stop push-buttons. Determination of the time delay between the DECA Engine-On command and the Descent Engine Helium pressurization functions.
  - c. Checkout of DECA logic.
- Seq. 20: PGNS Ascent Engine Checkout. (Para. 4.2.2.5.10 (a), 4.2.2.5.10 (b) Partial)
  - a. Verification of On/Off Control of the Ascent Engine in PGNS Mode.
  - b. Verifies operation of Ascent Quantity caution light.

## OCP OUTLINE

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### Test Description: (Cont)

- c. Verification of manual On/Off control of the Ascent Engine in PGNS Mode, by means of start push-button and the stop push-buttons.
- d. Ascent Engine Control Assembly Logic Checkout.
- Seq. 21: PGNS Abort/Abort Stage Checkout. (Para. 4.2.2.5.9.1 (b) Partial, 4.2.2.5.12, (e), (f), (g))
  - a. Verification of Abort and Abort Stage push-buttons function in PGNS Mode.
  - b. Verification of time delay interval between the initiation of the Abort Stage and the On command to the Descent Engine.
- Seq. 22: Descent Engine Override Checkout. (Para. 4.2.2.5.9.1 (b) Partial)
  - a. Verification of Manual On/Off control of the Descent Engine, with Start/Stop push-buttons.
  - b. Verification of On/Off operation of the Descent Engine pre-valves A & B (primary and secondary).
  - c. Verification of On/Off operation of the Descent Engine solenoid valves A, B, C and D (primary and secondary).
  - d. Verification of Caution/Warning logic for the Descent Regulator.
  - e. Verification of On/Off functions of Des Eng Cmd Ovrdr switch.
- Seq. 23: Auto/Manual Throttle Checkout. (Para. 4.2.2.6.3.9.1 Partial, 4.2.2.5.9.2 (b))
  - a. Verification of Descent Engine throttling with TTCA's, in Manual Throttle Mode.
  - b. Verification of Descent Engine throttling in Automatic Throttle Mode, controlled by LGC.
- Seq. 24: DECA Power Supply Redundancy Checkout
  - a. Verification of DECA operation (manual and auto throttle, engine on/off) with both primary and auxiliary DECA power supplies on.
  - b. Verification of DECA operation with the auxiliary power off.
  - c. Verification of DECA operation with ATCA power supply turned off.



## OCP OUTLINE

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### Test Description: (Cont)

- Seq. 25: PGNS FDAI Total Attitude Checkout. (Para. 4.2.2.5.14 (a))
- a. Verification of FDAI's total attitude displays initiated by LGC Profile.
- Seq. 26: PGNS Automatic Descent. (Para. 4.2.2.5.9.1 (a) Partial, 4.2.2.5.9.3 Partial, 4.2.2.5.9.3 (a), (c), (d), 4.2.2.5.11 Partial)
- a. Verification of FCS functions in a simulated run of the descent phase of IM mission. The following functions are performed with PGNS in control using a LGC test profile:
    1. On/Off control of the Descent Engine.
    2. Automatic throttling of the Descent Engine.
    3. Gimballing of the Descent Engine.
    4. On/Off operation of 16 primary RCS jets.
    5. LR information processed during profile run.
- Seq. 27: PGNS Automatic Ascent. (Para. 4.2.2.5.10 (a) Partial, 4.2.2.5.11 Partial)
- a. Verification of the FCS functions in a simulated run of the ascent phase of IM mission. The following functions are performed with PGNS in control using a LGC test profile;
    1. On/Off control of the Ascent Engine.
    2. On/Off operation of 16 primary RCS jets
    3. RR information processed during profile run.
- Seq. 28: RCS TCA Malfunction Mode Checkout. (Para. 4.2.2.12.4 Partial)
- a. Verification of RCS Caution/Warning logic for the following conditions:
    1. Long fail malfunctions.
    2. Short fail malfunctions.
    3. No fail operation.
    4. Opposing jets malfunctions.

## OCP OUTLINE

OCP-GF-62000-FCS LM5

### Test Description: (Cont)

Seq. 29: AGS Turn-On. (Para. 4.2.2.6.5.1 (b) Partial, (c), (d), (g), (f))

- a. Verification of switchover of ASA Heater power source from PTMU to IM power.
- b. ASA temperature operating point.
- c. ASA gyros run-up and run-down time, via SMRD monitoring.
- d. AEA internal power supply voltages.
- e. AGS timing pulses.

Seq. 30: Data Entry and Display (DEDA) Verification. (Para. 4.2.2.6.5.2, 4.2.2.6.5.3 Partial)

- a. Verification of DEDA status lights and electroluminescent numeric elements.
- b. Verification of DEDA entry and display alarm logic.
- c. Verification of DEDA for AEA data entry.

Seq. 31: AEA Self Test. (Para. 4.2.2.6.5.3 Partial)

- a. Verification of AEA Arithmetic operations and memory content.
- b. AGS warning light.
- c. DEDA in and out shifting pulses.

Seq. 32: AEA Load and Verify Routine

- a. Verifies AEA capability to accept and process the load and verify program. (Executive program)
- b. Verifies operation of ACE-S/C uplink, carry-on, and downlink equipment associated with the AGS.

Seq. 33: AEA Self Test Addendum Verification. (Para. 4.2.2.6.5.3 Partial)

- a. Verifies operation of data entry and readout in memory.
- b. Cross-talk check, verifying that the newly entered data does not affect the previous entries.
- c. Verifies DEDA binary to decimal conversion capability, and display of all readout positions.

## OCP OUTLINE

OCP-GF-62000-FCS IM5

### Test Description: (Cont)

- Seq. 34: AGS/FDAI Total Attitude Checkout. (Para. 4.2.2.6.5.5 (a) (2), 4.2.2.6.5.5 (b) (1))
- a. Verification of AEA capability to drive FDAI total attitude displays in response to AEA test program.
- Seq. 35: AGS/FDAI Attitude Error Checkout, at Maximum Deadband. (Para. 4.2.2.6.5.5 (a) (1), 4.2.2.6.5.5 (b) (5))
- a. Verification of AEA capability to drive FDAI attitude error displays at maximum deadband, in response to AEA test program.
- Seq. 36: AGS/FDAI Attitude Error Checkout, at Minimum Deadband. (Para. 4.2.2.6.5.5 (a) (1), 4.2.2.6.5.5 (b) (5))
- a. Verification of AEA capability to drive FDAI's attitude error displays at minimum deadband, in response to AEA test program.
- Seq. 37: AGS Alt/Alt Rate Checkout. (Para. 4.2.2.6.5.5 (a) (4), (b) (4); (a) (5), (b) (3))
- a. Verification of AEA capability to drive Altitude and Altitude Rate Indicators in response to AEA test program.
- Seq. 38: AGS Cross-Pointer Checkout. (Para. 4.2.2.6.5.5 (a) (3), (b) (2))
- a. Verification of AEA capability to drive Cross-Pointer Indicators in response to lateral velocity signals of the AEA test profile.
- Seq. 39: AGS Gyro and Accelerometer Scale Factors and Polarity Verification (Para. 4.2.2.6.5.6)
- a. Optical determination of the vehicle azimuth.
  - b. Verification of accumulation of AEA processed accelerometer and gyro outputs for five minutes of time, utilizing AEA test program.
  - c. Verification of output of accumulated data to ACE-S/C via downlink telemetry.
  - d. Verification of ACE-S/C recording and reduction of data for determination of polarity scale factors of gyros and accelerometers.
  - e. Verification of orientation of ASA axes relative to the local vertical, by means of ASA accelerometers.
- Seq. 40: AGS Pre-Launch Gyro Calibration. (Para. 4.2.2.6.5.8 (b) Partial)
- a. Insertion of compensation factors for AEA accelerometers and gyros.
  - b. Insertion of vehicle azimuth and of site latitude for computation of nominal earth rate effect on gyros.

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### Test Description: (Cont)

- c. Determination of Non-G drift factors for X, Y and Z gyros.
- Seq. 41: AGS Flight Program Insertion. (Para. 4.2.2.6.5.9)
  - a. Flight program load into AEA via ACE-S/C uplink.
  - b. Verification of flight program by AEA Self-Test and operation in the Orbit Align Mode.
- Seq. 42: AGS Inertial Reference and Polarity Verification  
(Para. 4.2.2.6.5.3 Partial, 4.2.2.5.5.1 (h), (i), (j), (k), (l), (m), (n))
  - a. Verification of AEA output discretes, required for the inertial reference operational modes.
  - b. Determination of accelerometer polarity by means of AEA flight program.
- Seq. 43: PGNS/AGS State Vector Transfer
  - a. PGNS CDU zero
  - b. AGS IMU align
  - c. AGS initialization
  - d. Readout of state vector on DEDA
- Seq. 44: PGNS/AGS Attitude Alignment (Para. 4.2.2.6.5.7)
  - a. PGNS attitude alignment transfer
  - b. AGS orbit align
  - c. AGS IMU align
  - d. Verification of AGS/PGNS alignment, utilizing readouts of FDAI's total attitude.
  - e. Verification of AGS/PGNS alignment, utilizing DEDA and DSKY readouts.
- Seq. 45: ORDEAL Checkout (Orbital Rate Drive Electronics for Apollo & LM)  
(Para. 4.2.2.9.4)
  - a. Verification of operation of ORDEAL slew control, driving CDR and LMP FDAI's total attitude displays.
  - b. Verification of operation of ORDEAL in Lunar Orbit Mode at 40 NM and 80 NM, with determination of drive rates for CDR and LMP FDAI's.
  - c. As (b) above for Earth Orbit Mode at 310 & 100 NM.
  - d. As (b) & (c) above at 70° and 250°.

OCP OUTLINE

OCP-GF-62000-FCS LM5.

Test Description: (Cont)

- c. Verification of operation of ORDEAL in Earth Orbit Mode at 40 NM and 310 NM, with determination of drive rates for CDR and LMP FDAI's.
- d. Verification of operation of ORDEAL lighting in Bright and Dim Modes.

Seq. 46: PGNS Gyro Compassing

- a. Determines the orientation of the LM navigation base with respect to earth coordinates.

Seq. 47: AGS Lunar Align

- a. Nulling out of earth rate effects on ASA gyros.
- b. Alignment of ASA inertial reference to the local vertical by Y and Z accelerometers.
- c. Verification of vertical alignment by the directional cosines matrix.
- d. Comparison of AGS directional cosine angles with the respective PGNS CDU angles. (PGNS in gyro-compassing mode)

Seq. 48: PGNS/AGS Alignment Verification. (Para. 4.2.2.6.5.7)

- a. Accumulation of ASA accelerometers and gyros pulses over an extended sampling period.
- b. Verification of PGNS/AGS alignment by comparison of data obtained from PGNS and AGS accelerometers.

Seq. 49: Deadband and DECA Gimbal Threshold Checkout. (Para. 4.2.2.6.3.1 (c), 4.2.2.6.3.4 (b) (1) (a), (b) (1) (b))

- a. Verification (via AGS Program) of minimum and maximum deadband of ATCA attitude control loops. (yaw, pitch, and roll)
- b. Verification of ATCA/DECA gimbaling control loops of pitch and roll at a minimum deadband.

Seq. 50: Descent Limiter and RGA Checkout. (Para. 4.2.2.6.3.2)

- a. Verification (via AGS Program) of ATCA descent limiters in yaw, pitch, and roll control loops. AEA test program is utilized to generate attitude error signals.
- b. Verification of response of RGA to gyro-torquing test by the Gyro Test switch.
- c. Verification of FDAI's Rate Indicators in response to RGA gyro test outputs.

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Test Description: (Cont)

Seq. 51: Ascent Limiter Checkout. (Para. 4.2.2.6.3.3)

- a. Verification (via AGS Program) of ATCA ascent limiter in yaw, pitch, and roll control loops. AEA test program is utilized to generate attitude error signals.
- b. Verification of Algebraic summation of RGA outputs and AEA attitude error signals in yaw, pitch, and roll control loops.
- c. Verification of FDAI's Rate Indicators in response to RGA gyro test outputs.

Seq. 52: AGS Abort/Abort Stage. (Para. 4.2.2.6.5.1 (f), (l), (k), (m))

- a. Verification of FCS functions during the Abort and Abort Stage operation in AGS guidance mode. By means of AGS test profile, the following functions are exercised and verified in the Abort, and Abort Stage operation:

Abort:

1. Initialization of AGS Abort Test Profile is accomplished by pressing the Abort push-button.
2. Arming of the Descent Engine.
3. Turn-on of the Descent Engine.
4. Gimbaling of the Descent Engine in positive and negative pitch and roll.
5. On/Off operation of the primary RCS jets in positive and negative yaw, pitch and roll.

Abort Stage:

1. Initialization of AGS Abort Stage Test Profile is accomplished by pressing the Abort Stage push-button.
2. Simulation of staging by ACE-S/C R-Start command.
3. Turn-off of the Descent Engine.
4. Arming of the Ascent Engine.
5. Turn-on of the Ascent Engine.
6. On/Off operation of the primary RCS jets in positive and negative yaw, pitch and roll.

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OCP-GF-62000-FCS IM5

Test Description: (Cont)

Seq. 53: AGS Attitude Hold Checkout (Para. 4.2.2.6.5.4. (f))

- a. Verification of AGS Attitude Hold capability by monitoring the AEA steering error outputs, resulting from the yaw, pitch, and roll components of the earth rate vector.

Seq. 54: AGS Turn-Off

- a. AGS power turn-off.
- b. Transfer of ASA heaters operation to external control (PTMU).

Seq. 55: RCS Shutdown

- a. Deactivation of RCS Subsystem.
- b. Determination of the final status of RCS valves by IM cockpit displays.
- c. Deactivation of RCS displays.

Seq. 56: Descent Engine Throttle Current Check

- a. Verification of the current values at the inputs to the descent engine including TVA, pre-valves and Diode redundancy.

Seq. 57: ATCA Free Run and Mission Timer Checkout. (Para. 4.2.2.6.4 (a) (2), (a) (3))

- a. Ability of ATCA 800 cps power supply to operate in a free running mode.

800 cps frequency of ATCA power supply is evaluated by comparison of RGA motor speeds obtained with and without the synchronization signal from the PCM/TE clock.

- b. Run-down time of RGA gyros.
- c. Ability of Mission Timer to maintain full performance with 'Internal Synch'.

OCP OUTLINE

OCP-GF-62000-IPC-LM5

Test Title:

LM Combined Subsystem Pre-FEAT Test - Initialization and Pre-Checkout

Subsystem:

GSE for all LM Spacecraft Subsystems, ACE-S/C and ACE - Carry-on

Test Objective:

- a. Provide initialization (test set-ups) and pre-checkout procedures (Pre-Checkout Preparation Checklist) required to support LM Combined Subsystem Pre-FEAT Test.
- b. Provide a detailed test equipment matrix containing group (S/S and ACE/Carry-on/Spacecraft) usage and quantity available vs. quantity required.
- c. A vehicle connector list will verify proper vehicle connector configuration as required to support the start of the Pre-FEAT Test.
- d. Vehicle equipment installation will be verified utilizing the flight hardware lists.
- e. Provide the initial cabin configuration to support start of the Pre-FEAT Test.

Vehicle Configuration:

Ascent and Descent Stages mechanically and electrically mated.

Location:

Integrated Workstand, Plant 5

Hazardous Operations:

Not Applicable

Equipment Under Test:

GSE and support equipment for the following groups:

- a. ACE
- b. ACE Carry-on
- c. Spacecraft
- d. Instrumentation Subsystem
- e. Communications Subsystem
- f. Electrical Power Subsystem



OCP OUTLINE

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Equipment Under Test: (Cont)

- g. Environmental Control Subsystem
- h. Propulsion Subsystem
- i. Abort Guidance Subsystem
- j. Control Electronics Section
- k. Displays and Controls Subsystem
- l. Primary Guidance, Navigation and Control Subsystem
- m. Landing Radar Subsystem
- n. Rendezvous Radar Subsystem
- o. Reaction Control Subsystem
- p. Explosive Devices Subsystem

Test Description:

- 1. Prepares workstand and vehicle for Pre-FEAT Test by configuring GSE and support equipment for groups listed in "Equipment Under Test" section of Outline.
- 2. Performs checkout procedures and initial settings for GSE and support equipment listed in "Equipment Under Test" section of outline.
- 3. During the running of the Pre-FEAT Test portions of the test set-ups and pre-checkout preparation checklist will be performed as specified by the control document.

4.0

TEST REQUIREMENTS MATRIX

4.1

Description:

The cross reference index supplies a paragraph correlation between the Quality Assurance Provisions (Section #4) of LSP-470-2, Part II, Test and Checkout Requirement Document (TCRD), and vehicle OCP test sequences where required. The function of this matrix is to confirm that vehicle tests are in agreement with the governing performance specification.

4.2

Top Spec/TCRD/OCP Sequence Matrix  
(to be supplied)