GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR
TRANSFER LIQUID HELIUM FROM 1000 GALLON STORAGE CONTAINER INTO 500/1000 LITER SUPPLY DEWAR

To be performed at Vandenberg Air Force Base outside building 1610

WARNING: This document contains hazardous operations

P1040

November 13, 2002

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REVISION RECORD

REVISION	ECO	PAGES	DATE

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List of Abbreviations and Acronyms

AG-x	Gauge x of Gas Module auxiliary section
AMI	American Magnetics Inc.
ATC	Advanced Technology Center
Aux	Auxiliary
AV-x	Valve x of Gas Module auxiliary section
Bot	Bottom
CN [xx]	Data acquisition channel number
DAS	Data Acquisition System
EFM	Exhaust gas Flow Meter
EG-x	Gauge x of Gas Module exhaust section
EM	Electrical Module
ERV-x	Relief valve of Gas Module exhaust section
EV-x	Valve number x of Gas Module exhaust section
FCV	Fill Cap Valve
FIST	Full Integrated System Test
GHe	Gaseous Helium
GM	Gas Module
GP-B	Gravity Probe-B
GSE	Ground Support Equipment
GT	Guard Tank
GTVC	Guard Tank Vent Cap
GTVC-G	Guard Tank Vent Cap pressure gauge
GTVC-RV	Guard Tank Vent Cap relief valve
GTVC-V	Guard Tank Vent Cap valve
GTV-G	Guard Tank vent pressure gauge
GTV-RV	Guard Tank vent relief valve
GTV-V	Guard Tank vent valve
HX-x	Vent line heat exchanger in Gas Module
KFxx	Quick connect o-ring vacuum flange (xx mm diameter)
LHe	Liquid Helium
LHSD	Liquid Helium Supply Dewar
Liq	Liquid
LL	Liquid level
LLS	Liquid level sensor
LMMS	Lockheed Martin Missiles and Space
LMSC	Lockheed Missiles and Space Co.
MT	Main Tank
MTVC	Main Tank Vent Cap
MTVC-G	Main Tank Vent Cap pressure gauge
MTVC-RV	Main Tank Vent Cap relief valve
MTVC-V	Main Tank Vent Cap valve
NBP	Normal boiling point
ONR	Office of Naval Research
PFCG	Fill Cap assembly pressure Gauge
PFM	Pump equipment Flow Meter
PG-x	Gauge x of Pump equipment
PM	Pump Module
psi	pounds per square inch
psig	pounds per square inch gauge
PTD	Payload Test Director
PV-x	Valve x of the Pump equipment
QA	Quality Assurance
RAV-x	Remote Actuated Valve-x
RGA	Residual Gas Analyzer
SMD	Science Mission Dewar
STV	SMD Thruster vent Valve
SU	Stanford University
SV-X	SMD VALVE NUMBER X
TG-x	Gauge x of Utility Turbo System
TV-x	Valve x of Utility Turbo System
UTS	Utility Turbo System
Vac	Vacuum
VCP-x	Vent cap pressure gauge
VCRV-x	Vent cap relief valve
VCV-x	Vent cap valve
VDC	Volts Direct Current
VF-x	Liquid helium Fill line valve
VG-x	Gauge x of Vacuum Module
VM	Vacuum Module
VV-x	Valve x of Vacuum Module
VW-x	Valve x of Dewar Adapter

LIST OF SPECIFIC HEADING DEFINITIONS

Each type of alert message will precede the procedural step to which it applies

1. NOTE: Used to indicate an operating procedure of such importance that it must be emphasized
2. CAUTION: Used to identify hazards to equipment
3. WARNING: Used to identify hazards to personnel

A. SCOPE

This document contains detailed instructions for transferring liquid helium from a 1000 gallon Gardner Storage Container to a 1000 liter or 500 liter Liquid Helium Supply Dewar

The hazardous operation in this procedure is stinging and destinging the supply dewar.

B. SAFETY

B.1. Description of Potential Hazards

Personal injury and hardware damage can result during normal positioning, assembly and disassembly of hardware.

Liquid helium used in the 1000 gallon supply dewar represents a hazardous material for the personnel involved in the operations. Cryogenic burns can be caused by contact with the cold liquid or gas, high pressures can result if boiling liquid or cold gas is confined without a vent path, and asphyxiation can result if the vent gas is allowed to accumulate.

The SMD Safety Compliance Assessment, document GPB-100153C and the Missile System Prelaunch Safety Package, LM/P479945 discuss the safety design, operating requirements and the hazard analysis of the SMD.

B.2. Mitigation of Potential Hazards

B.2.1. Lifting hazards

There are no lifting operations in this procedure

B.2.2. Cryogenic Hazards

Only authorized and trained personnel are allowed in VAFB facilities without escort. All personnel working on platforms at a height 30 inches or more off the floor are required to have an approved air tank (emergency breathing apparatus) within easy reach. Note that tank need not be kept available when working from ladder. In the unlikely event of a large LHe spill all employees have been instructed to evacuate the area and contact NASA and VAFB safety.

The following additional requirements apply to all personnel involved directly in cryogenic operations. Gloves that are impervious to liquid helium and liquid nitrogen are to be worn whenever the possibility of splashing or impingement of high-velocity cryogens exists or when handling equipment that has been cooled to cryogenic temperatures. Protective clothing, non-absorbent shoes and full-face shields with goggles/glasses are to be worn whenever the possibility of splashing cryogens exists.

B.2.3. Other Hazards

When appropriate, tools or other items used with the potential to damage the space vehicle shall be tethered.

B.3. Mishap Notification

B.3.1. Injury

In case of any injury or illness requiring medical treatment **Dial 911**

B.3.2. Hardware Mishap

In case of an accident, incident, or mishap, notification is to proceed per the procedures outlined in Lockheed Martin Engineering Memorandum EM SYS229 and Stanford University GP-B P0879. Additionally, VAFB NASA Safety and 30th Space Wing Safety will be notified as required.

B.3.3. Contingency Response

Responses to contingencies/emergency (e.g., power failure) are listed in Appendix 3.

C. QUALITY ASSURANCE

C.1. QA Notification

The NASA program and the NASA safety representative and SU QA shall be notified 24 hours prior to the start of this procedure. Upon completion of this procedure, the QE Manager will certify his/her concurrence that the effort was performed and accomplished in accordance with the prescribed instructions by signing and dating in the designated place(s) in this document.

C.2. Red-line Authority

Authority to red-line (make minor changes during execution) this procedure is given solely to the TD or his designate and shall be approved by the QA Representative. Additionally, approval by the Payload Technical Manager shall be required, if in the judgement of the TD or QA Representative, experiment functionality may be affected. Within hazardous portions of this procedure, all steps shall be worked in sequence. Out of sequence work or redlines shall be approved by NASA Safety prior to their performance.

C.3. Discrepancies

A Quality Assurance A Quality Assurance Representative designated by D. Ross shall review any discrepancy noted during this procedure, and approve its disposition. Discrepancies will be recorded in a D-log or a DR per Quality Plan P0108. Any time a procedure calls for verification of a specific configuration and that configuration is not the current configuration, it represents a discrepancy of one of three types. These types are to be dealt with as described below.

1. If the discrepancy has minimal effect on procedure functionality (such as the state of a valve that is irrelevant to performance of the procedure) it shall be documented in the procedure, together with the resolution. Redlines to procedures are included in this category.
2. If the discrepancy is minor and affects procedure functionality but not flight hardware fit or function, it shall be recorded in the D-log. Resolution shall be in consultation with the PTD and approved by the QA representative.

3. All critical and major discrepancies, those that effect flight hardware fit or functions, shall be documented in a D-log and also in a Discrepancy Report, per P0108

D. TEST PERSONNEL

D.1. Personnel Responsibilities

The performance of this procedure requires a minimum complement of personnel as determined by the Test Director. The person performing the operations (Test Director or Test Engineer) is to sign the "Completed by" sign-off. Any other qualified person or QA person who can attest to the successful performance of this procedure may sign the "Witnessed by" sign-off. The Test Director will perform Pre-Test and Post-Test Briefings in accordance with P0875 "GP-B Maintenance and Testing at all Facilities." Checklists will be used as directed by P0875.

D.2. Personnel Qualifications

The Test Director must have a detailed understanding of all procedures and facility operations and experience in all of the SMD operations. Test Engineers must have SMD Cryogenic operations experience and an understanding of the operations and procedures used for the cryogenic servicing/maintenance of the Dewar.

D.3. Required Personnel

The following personnel are essential to the accomplishment of this procedure:

FUNCTIONAL TITLE	NUMBER	AFFILIATION
Test Director/Test Engineer	1	Stanford
GP-B Quality Assurance Stanford	1	
NASA Safety Rep	1	SFAO or ANALEX

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

This procedure does not include any equipment sensitive to electrostatic discharge. All Wrist Straps will be checked using a calibrated checker prior to use.

E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

E.3. Hardware/Software Requirements

E.3.1. Commercial Test Equipment:

1. None

E.3.2. Ground Support Equipment:

1000 gallon, liquid He, Gardner Storage Container (SC)and associated AMI Liquid Helium Level Meter, Model 110A

500/1000 liter Cryofab liquid He Supply Dewar.(LHSD)

Transfer Line and Stinger.

Gaseous helium for pressurizing

E.3.3. Computers and Software:

1. None

E.3.4. Additional Test Equipment:

1. None

E.3.5. Additional Hardware

Description
N/A

E.3.6. Tools

Description
N/A

E.3.7. Expendables

WARNING
Ethanol is highly flammable and vapor/air mixtures are Explosive.
Exposure hazards include: Inhalation (headache/fatigue),
skin (dryness, eyes (redness/pain/burning)

Description	*Quantity*	*Mfr./Part No.*
99.99p% pure gaseous helium	AR	N/A
Vacuum Grease	AR	Apiezon N or Dow Corning

E.4. Configuration Requirements:

E.4.1. 1000 gallon Storage Container that has at least 1500 liters in it.

E.4.2. 500/1000 liter Supply Dewar is purged.

F. REFERENCE DRAWINGS

F.1. Drawings

Drawing No.	*Title*
LMMS-5833394	Instrumentation Installation

A.2. Supporting documentation

Document No.	*Title*
LMMC-5835031	GP-B Magnetic Control Plan

GPB-100153C	SMD Safety Compliance Assessment
LM/P479945	Missile System Prelaunch Safety Package
SU/GP-B P0141	FIST Emergency Procedures
LMSC-P088357	Science Mission Dewar Critical Design Review
SU/GP-B P0108	Quality Plan
LMMS GPB-100333	Science Mission Dewar Failure Effects and Causes Analysis
SU/GP-B P059	GP-B Contamination Control Plan
EM SYS229	Accident/Mishap/Incident Notification Process
EWR 127-1	Eastern and Western Range Safety Requirements
KHB 1710.2 rev E	Kennedy Space Center Safety Practices Handbook

A.3. Additional Procedures

Document No.	***Title***
SU/GP-B P0879	Accident/Incident/Mishap Notification Process
SU/GP-B P1015	Connect Vacuum Module to SMD
SU/GP-B P0875	GP-B Maintenance and Testing at all Facilities

. Operation Number:_____.

Date Initiated:_____.

Time Initiated:_____.

G. OPERATIONS

G.1. Pre-Operations Verifications

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify NASA program representative notified.

  Record: Individual notified _____,

- Verify NASA safety representative notified and concurrence has been given to proceed.

  Record: Individual notified _____

  Date/Time:_____,

- Record calibration due dates in Table 1 (Sections. E.3.4, E.4)
- Persons actually performing this procedure should list their names in Sec D.3.
- Verify completion of the pre-operations checklist (Appendix 1).
- Verify proper operation of GP-B Cryogenic Team oxygen monitor
- Verify availability and functioning of an emergency shower.

Section Complete QA Witness:_____

G.2. Verify Purity of All Sources of Helium Gas

Record serial number on helium bottle/s.

1. _____ 2._____ 3. _____
4. _____ 5 _____ 6. _____

Verify helium bottle/s have been tested for purity and record Op. Number.
Op. Number:_____

QA Witness:_____

G.3. Prepare LHSD

G.3.1. Record: LHSD S/N_____ ; record LHSC S/N _____.

G.3.2. If scales are being used then:

G.3.3. Record LHSD gross wt. _____ lb.

G.3.4. Record LHSD tare wt. _____ lb.

G.3.5. Record LHSD net wt. _____ lb.

G.3.6. Calculated liquid Helium _____ liter(3.64 liters/lb).

G.3.7. Zero the scale and record:

G.3.8. Record LHSD gross wt. _____ lb.

G.3.9. Verify LV-1 and LV-2 are closed and LV-3 is open.

G.3.10. Connect the Liquid Level Sensor and record the amount: _____% .

WARNING:

The following step contains hazardous operations. The individual performing the followings steps must wear cryogenic safety gloves, a cryogenic apron, goggles/glasses, face shield, and non-porous shoes. Failure to comply may result in personal injury

G.3.11. Sting 500/1000 liter Liquid Helium Supply Dewar (LHSD) using the EDD large bore stinger.

Note:

In the following do not allow enough cold gas to escape that would cause any condensation to form on the stinger.

1. Ensure 15 foot clear area around hazardous operation
2. Request NASA Safety make PA announcement that a hazardous operation is about to begin.
3. Request the area operation light be changed to amber.
4. Ensure all nonessential personnel are out of the clear area.
5. Open valve EDDV-1 on stinger to allow purging of stinger during insertion.
6. Loosen QD and remove 3/8 inch plug from the QD stack on the LHSD.
7. Insert stinger into QD; open LV-1 and slowly lower stinger into LHSD, while purging, until maximum insertion is obtained (desired depth is between 34 and 40 inches).
8. Close EDDV-1.
9. Tighten QD.

10. Disband the clear area.

11. Ensure area operation light is turned to Green.

12. Request NASA Safety make PA announcement that the Hazardous operation is completed.

Note:
The hazardous operation is now complete..

Section Complete QA Witness:_____

G.4. Set Up Pressurization

G.4.1. If the Pressurization Assembly (PA) is not installed from previous transfers, do the following steps (see Fig 1).

1. Connect to PA to the Vent outlet (1-in female pipe fitting) of SC
2. Open PA-1 and SCV-7 and allow purge of PA and then close PA-1.

G.4.2. Verify helium gas supply bottle has been set up per Fig. X and regulator set at 8 psig.

G.4.3. Slightly open PA-1 and PA-2 and while purging both connect helium supply to PA-1.

G.4.4. Close PA-1.

Section Complete QA Witness:_____

G.5. Prepare the Storage Container

G.5.1. Verify SCV-9, SCV-10 and SCV–12 are open and SCV-11 closed.

G.5.2. Record pressure and liquid level of Storage Container:

Pressure:_____ Liquid Level: _____ .

G.5.3. Attach the 9 inch end of the transfer line to the stinger.

G.5.4. Slightly open SCV-2 and EDDV-1(FV-1) and while purging in both directions connect loose end of transfer line to LHSC at CP-1.

Section Complete QA Witness:_____

G.6. Start Transfer

G.6.1. Verify closed LV-3.

G.6.2. Fully open SCV-2, EDDV-1 and LV-2(LHSD vent).

G.6.3. Verify PAV-1 and SCV-7 are open.

G.6.4. Use Facility helium supply to maintain 5 to 8 psi on Pressure gauge of 1000 gallon Storage Container.

G.6.5. Record Data in Table 1.

G.6.6. Option: if pressurization line is plugged: ensure SCV-3 is closed and close SCV-7 and open SCV-6

π Option not used π Option used

Table 1 Transfer Data

Time/ Date	LHSD LLS	LHSD Wt	LHSD Pressure	Storage Container Liquid Level	Storage Container Pressure	Comments
	%	lb	psig	in H_2O	psig	

G.7. Termination of Transfer

G.7.1. When LHSD LLS reads 100% or net weight gain indicates a full dewar, do the following:

G.7.2. Close SCV-2.

G.7.3. Close EDDV-1 and immediately remove transfer line from stinger.

Note:

If the transfer line is not vented the liquid helium will pressurize the transfer line.

G.7.4. Close PAV-1

G.7.5. Verify SC has pressure relief via SCV-2 to PARV-1,-2.

G.7.6. Remove transfer line from SCCP-2.

G.7.7. Went venting from LV-2 subsides close LV-2 and open LV-3.

Section Complete QA Witness:_____

WARNING:

The following step contains hazardous operations. The individual performing the followings steps must wear cryogenic safety gloves, a cryogenic apron, goggles, face shield, and non-porous shoes. Failure to comply may result in personal injury.

G.8. Remove stinger from LHSD

G.8.1. Establish a 15 foot controlled area.

G.8.2. Request PA announcement that hazardous task is about to begin.

G.8.3. Clear area of all nonessential personel.

G.8.4. Relieve pressure in LHSD to <1psig

G.8.5. Remove stinger from LHSD and immediately close LV-1

Note:

The hazardous operation is now complete.

G.8.6. It is now safe to disband controlled area.

G.8.7. Request PA announcement that hazardous task is complete.

G.8.8. Request area operation light be returned to green.

G.9. Final Configuration

G.9.1. LV-1 and LV-2 are closed.

G.9.2. LV-3 is open and QD is capped.

G.9.3. SCV-2 and SCV-3 are closed.

G.9.4. SCV-7 is open.

G.9.5. Record pressure and liquid level in LHSD:

G.9.6. Pressure:____ Liquid level:_____

G.9.7. Record pressure and liquid level in SC:

G.9.8. Pressure:____ Liquid level:_____

Amount used: _____ lb

Section Complete QA

Witness:_____

H. PROCEDURE COMPLETION

Completed by:_____

Witnessed by:_____

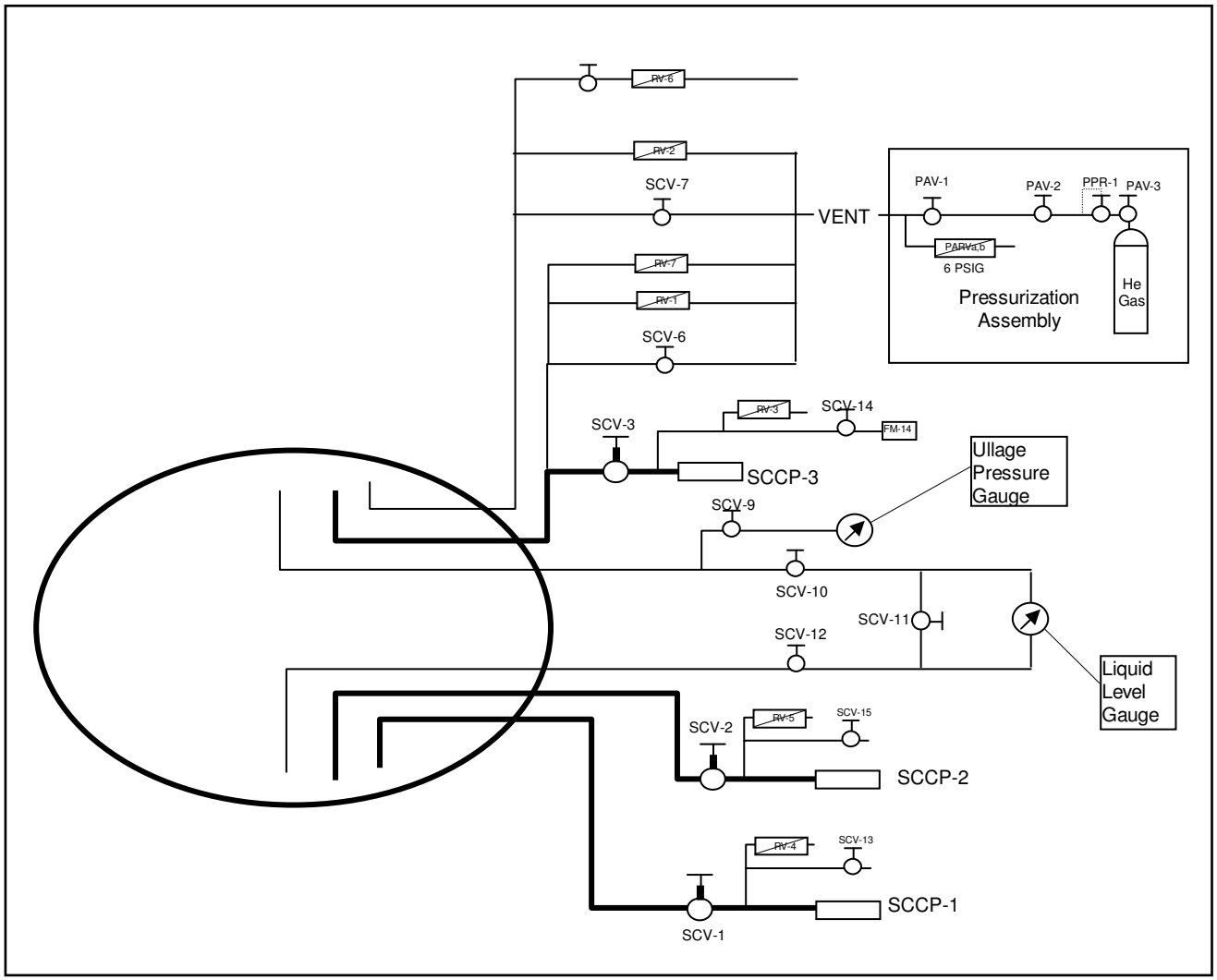
Date: _____

Time:_____

Quality Manager_____Date_____

Payload Test Director_____Date_____

Figure 1 Storage Container Plumbing Configuration

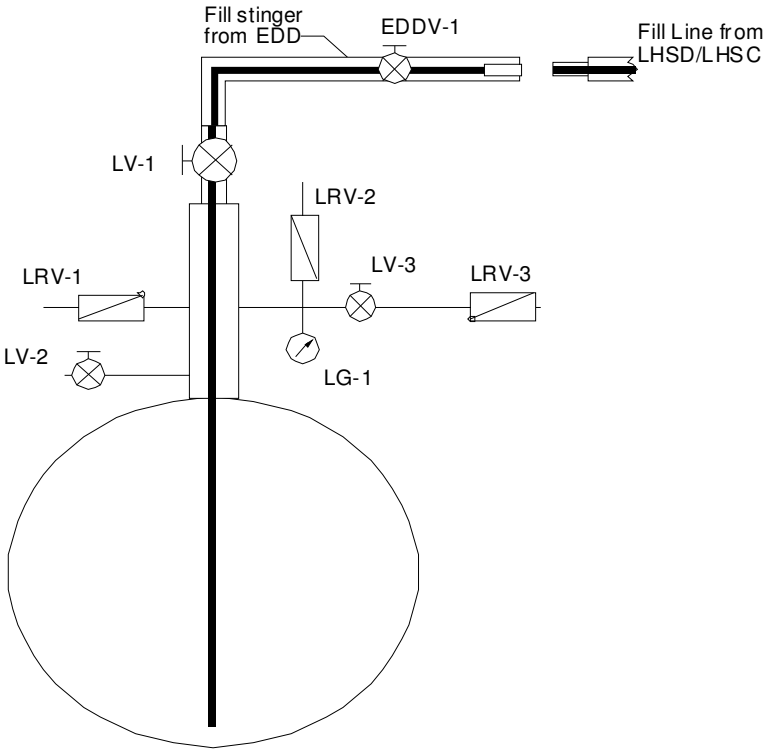


SCV-1	Main fill and withdrawal	SCV-15	Small dewar fill & withdrw Bayonet purge	PSIG
SCV-2	Small dewar fill and withdrawal	SCV-16	Thermocouple pump out	
SCV-3	Main vent	CP-1	Main fill & withdrawal female bayonet	
SCV-4	Shield vent pressure selector	CP-2	Small dewar fill & withdrwl female bayonet	-
SCV-5	Annular space evacuation	CP-3	Main vent female bayonet	-
SCV-6	Blow down	RV-1	Inner tank relief	25
SCV-7	Shield blow down	RV-2	Inner tank relief	20
SCV-8	Tank vacuum thermocouple shutoff	RV-3	Main vent bayonet purge relief	100
SCV-9	Pressure gauge shutoff	RV-4	Main fill & withdrawal bayonet purge relief	100
SCV-10	Upper liquid level shutoff	RV-5	Small dewar fill & withdrw baynt purge relief	100
SCV-11	Gauge equalizer	RV-6	Shield relief (absolute)	1.3
SCV-12	Lower liquid level shutoff	RV-7	Inner tank relief	25
SCV-13	Fill and withdrawal bayonet purge	SD-1	Annular space relief disk	1.35

SCV-14	Main vent bayonet purge			

FIGURE 2.

500/1000 liter LHSD



APPENDIX 1 PRE OPERATIONS CHECKLIST

DATE	CHECKLIST ITEM	COMPLETED	REMARKS
	1. Verify the test procedure being used is the latest revision.		
	2. Verify all critical items in the test are identified and discussed with the test team.		
	3. Verify all required materials and tools are available in the test area.		
	4. Verify all hazardous materials involved in the test are identified to the test team.		
	5. Verify all hazardous steps to be performed are identified to the test team.		
	6. Verify each team member knows their individual responsibilities.		
	7. Confirm that each test team member clearly understands that he/she has the authority to stop the test if an item in the procedure is not clear.		
	8. Confirm that each test team member clearly understands that he/she must stop the test if there is any anomaly or suspected anomaly.		
	9. Notify management of all discrepancy reports or d-log items identified during procedure performance. In the event an incident or major discrepancy occurs during procedure performance management will be notified immediately.		
	10. Verify/perform pre-task engineering/safety high-bay walk down. Verify noted discrepancies have been corrected.		
	11. Confirm that each test team member understands that there will be a post-test team meeting.		
	Team Lead Signature: _____		

APPENDIX 2 POST OPERATIONS CHECKLIST

DATE	CHECKLIST ITEM	COMPLETED	REMARKS
	1. Verify all steps in the procedure were successfully completed.		
	2. Verify all anomalies discovered during testing are properly documented.		
	3. Ensure management has been notified of all major or minor discrepancies.		
	4. Ensure that all steps that were not required to be performed are properly identified.		
	5. If applicable sign-off test completion.		
	6. Verify all RAV valve operations have been entered in log book		
	7. Verify the as-run copy of procedure has been filed in the appropriate binder		
	Team Lead Signature: _____		

APPENDIX 3– CONTINGENCY/EMERGENCY RESPONSES

Condition	Circumstance	Response
Power Failure	Anytime	Wait for power restoration and resume procedure
Oxygen Monitor Alarm	Anytime	Evacuate area
Liquid Helium Spill	Anytime	If possible flush the contaminated area. Evacuate Area