GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

Internal Guard Tank Fill – Guard Tank Vent Line Connected

To be performed at Vandenberg Air Force Base building 1610

THIS PROCEDURE CONTAINS NON-HAZARDOUS OPERATIONS

P1029

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REVISION RECORD

REV	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
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
TD	Test Director
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 procedure describes the steps necessary to transfer normal boiling point liquid helium from the Main Tank to the Guard Tank of the Science Mission Dewar. This procedure requires that the Guard Tank vent line is connected to the Gas Module. The steps include;

Raise internal fill line pressure to Main Tank pressure – open RAV-1.

Increase Main Tank pressure – close vent valve, turn on heater.

Initiate transfer – open RAV-2.

Terminate transfer – close RAV-1 and RAV-2.

Reestablish Main Tank venting.

The Main Tank vent line may either be connected or disconnected from the Gas Module.

B. SAFETY

B.1. Potential Hazards

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

Liquid helium used in the SMD 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 discuss the safety design, operating requirements and the hazard analysis of the SMD.

B.2. Mitigation of Hazards

B.2.1. Lifting hazards

There are no lifting operations in this procedure

B.2.2. Cryogenic Hazards

. In addition, the GP-B cryogenic team provides an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5%. Evacuate the building to the fall back area building 1605. Additional temperature and pressure alarms, provided by the DAS, warn of potential over-pressure conditions. Emergency vent line deflectors are installed over the four burst disks to direct any flow to an outside area.

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 room 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

All tools or other items used with the potential to damage the SMD or Probe shall be tethered.

B.3. Mishap Notification

B.3.1. Injury

In case of any injury or illness requiring emergency 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 (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.

C.3. Discrepancies

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 TD 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	1	Stanford

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

Any person who comes in contact with the SV must use a grounding wrist strap that has been tested that day. Appropriate attachment points are positioned around the SV. 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

No commercial test equipment is required for this operation.

E.3.2. Ground Support Equipment

The Ground Support Equipment includes the Gas Module, the Electrical Module. The Gas Module provides the capability to configure vent paths, read pressures and flow rates, and pump and backfill vent lines. The Pump Module provides greater pumping capacity than the Gas Module, together with additional flow metering capabilities. The vent output of the Gas Module flows through the Pump Module. The Electrical Module contains the instruments listed in Table 1, and provides remote control of valves in the Gas Module, Pump Module, and SMD.

E.3.3. Computers and Software:

The Data Acquisition System (DAS) is required for this procedure. The DAS reads and displays pressures, temperatures, and flow rates and monitors critical parameters. No additional computers or software are required.

E.3.4. Additional Test Equipment

E.3.5. Additional Hardware

Description
Main Tank vent cap assembly – See Figure 2

E.3.6. Tools

Description
Torque Wrench, 1-1/4-in socket, 60 +/- 5 in-lb Cal Due Date:_____S/N

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.***
Ethanol	AR	N/A
99.999% pure gaseous helium	AR	N/A
Vacuum Grease	AR	Dow Corning High Vacuum or Apiezon N

E.4. Instrument Pretest Requirements

The GSE instruments required to perform this procedure are listed in Table 1, together with their serial numbers, where available. Instruments that are required to have current calibrations are indicated in the Cal-Required column. Instruments that do not require calibration are those not used to verify performance requirements and are not connected to flight instrumentation. The status column is to be filled in with the due date of the instrument calibration sticker and verified to be in calibration by QE or QE designee.

Table 1. Required Instrumentation and Calibration Status

No.	***Location***	***Description***	***Name***	***Serial No.***	***Cal Required***	***Status Cal due date***
1	DAS	Power Supply, H-P 6627A	-	3452A01975	Yes	
2	DAS	Power Supply, H-P 6627A	-	3452A01956	Yes	
3	DAS	Data Acquisition/Control Unit H-P 3497A	-	2936A245539	No	-
4	DAS	Digital Multimeter H-P 3458A	-	2823A15047	Yes	
5	EM	Vacuum Gauge Controller Granville-Phillips Model 316	EG-1a, -1b	2827	No	-
6	EM	Vacuum Gauge Controller Granville-Phillips Model 316	AG-2a, -2b	2826	No	-
7	EM	Vacuum Gauge Controller Granville-Phillips Model 316	EG-3	2828	No	-
8	EM	MKS PDR-C-2C	EG-2, FCG	92022108A	No	-
9	EM	Flow meter – Matheson 8170	EFM-1	96186	No	-
10	EM	Flow meter totalizer Matheson 8124	EFM-1	96174	No	-
11	EM	Liquid Helium Level Controller	LLS Main	96-409-11	No	-

No.	*Location*	*Description*	*Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
		American Magnetics, Inc. 136	Tank			
12	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Guard Tank	96-409-10	No	-
13	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Well	96-409-9	No	-
14	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Axial Lock	96-409-12	No	-
15	EM	Pressure Controller – MKS 152F-92	EV-7a, -7b	96203410A	No	-
16	EM	Power Supply HP 6038A	H08D Tank Heater	96023407A	Yes	
17	EM	Power Supply HP 6038A	H09D Tank Heater	3511A-13332	Yes	
18	EM	Power Supply HP 6038A	RAV Power Supply	3329A-12486	Yes	
19	EM	Vac Ion Pump power supply Varian 929-0910, Minivac	SIP	5004N	No	-
20	EM	Flow meter totalizer Veeder-Root	PFM-1	576013-716	No	-
21	GM	Pressure Gauge, Heise	AG-1	CC-122077	No	-
22	GM	Pressure Gauge, Marshall Town	AG-3	N/A	No	-
23	GM	Main Tank Heat Exchanger: a) Thermocouple, b) Current meter, c) Temperature set point controller	-	C-19950	No	-
24	GM	Guard Tank Heat Exchanger: a) Thermocouple, b) Current meter, c) Temperature set point controller	-	C-09920	No	-
25	VM	Vacuum Gauge readout, Granville-Phillips 316	VG-3 VG-4	2878	No	-
26	VM	Vacuum Gauge readout, Granville-Phillips 360	VG-1, VG-2 VG-5	96021521	No	-

E.5. Configuration Requirements

E.5.1. Main Tank

Liquid in the Main Tank must be at its normal boiling point (NBP)

E.5.2. Guard Tank

The Guard Tank may contain liquid or be depleted.

E.5.3. Well

The Well is evacuated.

E.5.4. SMD Vacuum Shell

The Vacuum Shell pressure must be less than 5x 10-5 torr. Document P1015, *Connect Vacuum Module to SMD*, contains the procedure for connecting to and pumping on the SMD vacuum shell.

E.5.5. Alarm System

1. The DAS alarm system must be enabled and contain the following alarm set-points:
   a. Top of lead bag temperature set (CN 40 and CN 41) at T ≤ 6.0 K.
   b. Relative Guard Tank Pressure (CN 46) set at □P ≥ 0.3 torr.
2. The DAS watchdog timer and alarm are enabled.

E.5.6. GSE and Non-flight Hardware

1. The ion-pump magnet is installed.
2. GSE cabling must be connected between the SMD and the Electrical Module (P/N 5833812) and between the SMD and the Data Acquisition System (P/N 5833811).
3. The Guard Tank vent line must be connected to the Gas Module with a vacuum insulated line (P/N 5833813). Procedure No. P1008, *Connect Guard Tank Vent Line to Gas Module*, contains the procedures for connecting vent lines.
4. The Fill Cap Assembly must be installed at SV-13 (See Figure 3)
5. Dewar Adapter heaters on SMD must be installed and operational.

E.6. Optional Non-flight Configurations

The following modifications or non-flight arrangement of the basic flight configuration may also be in place. They are incidental to the performance of this procedure and not required.

1. The SV may be installed in its transportation fixture or in its assembly fixture.
2. The Vacuum shell pump out port at SV-14 may be connected to the Vacuum Module (P/N 5833816) via a 2-in valve and pumping line, with the valve in either the closed position or in the open position. The Vacuum Module pump may be; off, actively pumping the pumping line up to a closed SV-6, or actively pumping the vacuum shell.

F. REFERENCE DOCUMENTS

F.1. Drawings

Drawing No.	*Title*
LMMS-5833394	Instrumentation Installation

F.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 Test Range Safety Requirements
KHB 1710, rev E	Kennedy Space Center Safety Practices Handbook

F.3. Additional Procedures

Document No.	***Title***
SU/GP-B P1008	Connect Guard Tank Vent Line to Gas Module
SU/GP-B P0879	Accident/Incident/Mishap Notification Process
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 _____,

Date/time _____/_____.

- Record calibration due dates in Table 1 (Section E.4), and Sections E.3.4, and E.3.6
- Persons performing this procedure should list their names in Sec D.3
- Verify completion of the Pre-Operations Checklist (Appendix 1).
- Verify proper operation of the GP-B Cryogenic Group oxygen monitor
- Verify that the Spacecraft is powered up, arming plug P222 is installed, and control personnel are prepared to command RAV-2 when requested.
- Verify availability and functioning of an emergency shower

QA Witness:_____

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

G.2.1. Record serial number on helium bottle/s.

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

G.2.2. Verify helium bottle/s have been tested for purity and record Op. Number.
Op. Number:_____
Record Date:_____

QA Witness:_____

G.3. Verify Configuration Requirements

G.3.1. Verify liquid in Main Tank at NBP (4.2<T<4.3) and record temperature at bottom of tank CN [09] _____K.

G.3.2. Ensure ion-pump magnet installed.

G.3.3. Ensure Vacuum Shell Pressure < 5 x 10-5 torr.

1. Turn on Vac-ion pump and record time of day _____
2. Use DAS [Monitor Data] for CN 99.
3. When value is steady, record pressure (IP) _____ torr. If pressure is above $5x10^{-5}$ torr, turn off Vac-ion pump and perform procedure P1015, *Connect Vacuum Module to SMD*, to connect Vacuum Module and pump out SMD vacuum shell.
4. Exit [Monitor Data] and collect data with [Set Data Interval] to 5 min.
5. When data cycle is complete, turn off Vac-ion pump.

CAUTION
This procedure necessitates closure of the Main Tank vent. During the period of closure the temperatures at the top of the lead bag are to be continuously monitored by the test director. Ensure that these temperatures are on the DAS alarm list and appropriately alarmed. Failure to comply may result in hardware damage.

G.3.4. Ensure DAS alarm system enabled and record set points.

1. ***Top of lead bag temperature*** – ensure CN [40] on DAS alarm list and set to alarm at T ≤ 6.0 K. Record set point. _____K
2. ***Top of lead bag temperature*** – ensure CN [41] on DAS alarm list and set to alarm at T ≤ 6.0 K. Record set point. _____K
3. ***Relative Guard Tank Pressure*** – ensure CN [46] on DAS alarm list and set to alarm at ΔP ≥ 0.3 torr. Record set point. _____torr

G.3.5. Ensure liquid-level alarms enabled and record set points.

1. ***Main Tank*** – ensure liquid-level alarm set ≥ 20%. Record set point. _____ %
2. ***Guard Tank*** – ensure liquid-level alarm set ≥ 20%. Record set point. _____ %

G.3.6. Ensure GSE cabling connected between SMD and Electrical Module and between SMD and Data Acquisition System.

G.3.7. Ensure Guard Tank vent line connected to Gas Module. If not, perform

procedure P1008, *Connect Guard Tank Vent Line to Gas Module,* to connect Guard Tank vent.

G.3.8. Ensure Fill Cap Assembly installed at SV-13.

QA Witness:_____

G.4. Establish Gas Module Configuration and Record Initial Conditions

G.4.1. Ensure Guard Tank Vent Valve (GTV-V) open.

G.4.2. Ensure closed EV-4, EV-5, EV-8, EV-10, EV-12, EV-15, EV-19, EV-21/22, EV-24

G.4.3. Ensure all AV valves closed

G.4.4. Establish Guard Tank and Main Tank vent configurations.

Initial Guard Tank Vent Configuration:

- Guard Tank contains liquid and is venting in common manifold mode:
  1. Verify EV-13 and EV-16 open
  2. Verify EV-20 and EV-23 closed

- Guard Tank contains liquid and is venting in bypass mode:
  1. Verify EV-16 and EV-20 open
  2. Verify EV-13 and EV-23 closed

- Guard Tank depleted – pressure independently regulated to maintain positive pressure:
  1. Verify EV-16, EV-23 open
  2. Verify EV-20 and EV-13 closed

- Main Tank Vent Line Connected to Gas Module
  1. Verify EV-9 open
  2. Verify SV-9 open
  3. Verify EV-17 closed

- Main Tank Vent Line not connected to Gas Module
  1. Verify SV-9 open

G.4.5. Record pressures:

1. Guard Tank pressure (EG-1a) _____ torr.
2. Main Tank pressure (EG-3) _____ torr.

G.4.6. Record liquid helium levels:

1. Main Tank level (LL-1D or LL-2D) _____%
2. Guard Tank Level (LL-5D or LL-6D) _____%

G.4.7. Turn on pump AP-1.

G.4.8. Turn on Guard Tank vent-line heat exchanger (EH-2).

QA Witness:_____

G.5. Verify SMD in Standard Configuration

G.5.1. Using the RAV log book verify that the dewar's internal valves are in the following positions. If not, investigate to ensure previous RAV operations properly recorded. If necessary, note resolution in D-log.

1. Open: RAV-3, and RAV-6B.
2. Closed: RAV-1, RAV-2, RAV-5, RAV-6A, and RAV-7.

G.5.2. Verify that SMD external valves are in the following positions.

1. Open: SV-9.
2. Closed: SV-13, SV-12 and FCV.

QA Witness:_____

G.6. Check Initial pressure in Fill Line

G.6.1. Install a pumping line between valve FCV on the Fill Cap Assembly and the Access Port #1 of the Auxiliary gas section.

G.6.2. Open AV-8.

G.6.3. Open AV-3.

G.6.4. Open valve FCV and evacuate to 20 mtorr as measured at AG-2.

G.6.5. Close AV-8 and FCV.

G.6.6. Once the pressure in the Fill Cap Assembly (PFCG) has stabilized, record Fill Cap Assembly pressure (PFCG): _____ torr.

G.6.7. Open valve SV-13 and bring the Fill Cap Assembly up to the pressure in the SMD fill line and record fill line pressure (PFCG): _____ torr.

QA Witness:_____

G.7. Raise Pressure in Fill Line by opening RAV-1

G.7.1. Ensure all RAV controller selection switches in OFF position.

G.7.2. Turn on RAV power supply and adjust current limit to 1.85 amps.

G.7.3. Adjust power supply to 28 VDC.

G.7.4. Power up controller #1.

G.7.5. Position controller #1 selection switch to RAV-1.

G.7.6. Record initial switch status: Open: θ θ Closed: θ θ

G.7.7. Activate controller #1 to open RAV-1 and record:

1. Run time: _____ seconds
2. Current draw: _____ amp
3. Time of day: _____

G.7.8. Record final switch status: Open: θ θ Closed: θ θ

G.7.9. When convenient, record operation in RAV log book.

NOTE
Do not power off controller.

G.7.10. Verify that the Fill Cap Assembly pressure (PFCG) rises to the Dewar Main Tank pressure EG-3 and record

1. Fill line pressure (PFC): _____ psig/torr.
2. Main Tank Pressure (EG-3/STG) _____ torr.

QA Witness:_____

G.8. Set up Data Acquisition

Note: Refer to Operating Instructions for mechanics of DAS keyboard/mouse operations.

G.8.1. Set Main Tank sampling interval to 1 minute.

G.8.2. Set Guard Tank sampling interval to 1 minutes.

QA Witness:_____

G.9. Prepare to Transfer

G.9.1. Confirm that operations personnel are ready to operate RAV-2.

G.9.2. Record Main Tank pressure (EG-3/STG): _____ torr.

G.9.3. Record Guard Tank pressure (EG-1a): _____ torr.

G.9.4. Record Main Tank pressure desired for initiating transfer _____ torr. **Comment:** typically a value 15 torr greater than EG-1a is sufficient.

G.9.5. Record the desired final Guard Tank level: _____ %.

G.9.6. Input comment to DAS “Start Internal transfer to Guard Tank”.

CAUTION
This procedure necessitates closure of the Main Tank vent. During the period of closure the temperature of the top of the lead bag are to be continuously monitored. Failure to comply may result in equipment damage.

G.9.7. Close Main Tank vent as appropriate and record time: _____ .

- Main Tank Vent Line Connected to Gas Module
  1. Close EV-9
- Main Tank Vent Line not connected to Gas Module
  1. Close SV-9

G.9.8. Enter comment in DAS, "Closed Main Tank Vent"

G.9.9. Turn on Tank Heater (H-8D or H-9D) power supply and adjust current limit to 1.25 amps.

G.9.10. Adjust power supply to 30 VDC and record:

V: _____ Vdc and I: _____ A

QA Witness:_____

G.10. Initiate Transfer

G.10.1. When the Main Tank pressure (EG-3/STG) reaches the desired initial pressure as noted in G.9.4, open RAV-2 and initiate transfer as follows:

G.10.2. Close/Verify Closed EV-23

G.10.3. Request operations personnel to open RAV-2

G.10.4. When convenient, record operation in RAV log book.

G.10.5. Open/Verify Open EV-13, EV-6, and EV-18 and record time: _____.

G.10.6. Record pressures:

1. EG-3/STG: _____ torr
2. EG-1a: _____ torr

G.10.7. Adjust Main Tank heater voltage, as necessary, to maintain desired transfer pressure, and record data in the following table.

Time	MT Pressure EG-3 (torr)	GT Pressure EG-1a (torr)	MT Heater Voltage (V)	MT LLS (%)	GT LLS (%)	Flow Rate PFM-1 (LL/hr)	Comments

QA Witness:_____

G.11. Terminate Transfer to Guard Tank

G.11.1. When the Guard Tank level reaches the value chosen in Paragraph G.9.5 Turn off Main Tank heater

G.11.2. Request operations personnel to close RAV-2

G.11.3. When convenient, record operation in RAV log book.

G.11.4. Close relief bypass valves EV-6 and EV-18.

G.11.5. Close EV-13 to isolate the Guard Tank and record:

1. Guard Tank Pressure (EG-1a):_____ torr
2. Main Tank pressure (EG-3/STG): _____ torr

G.11.6. Open Main Tank vent

- Main Tank Vent Line Connected to Gas Module
  1. Open EV-9
- Main Tank Vent Line not connected to Gas Module
  2. Open SV-9

G.11.7. Establish Guard Tank Vent Configuration:

- Main Tank Vent Line Connected to Gas Module-Manifold Guard Tank and Main Tank Vent Paths
  1. Once Main Tank Pressure (EG-3) is within 3 torr of Guard Tank pressure (EG-1a), open EV-13
     Note: EV-6 may be opened for short periods to promote depressurization of Main Tank
  2. Close/Verify Closed EV-20
- Main Tank Vent Line not connected to Gas Module
  1. Open EV-13
  2. Close/Verify Closed EV-20

G.11.8. Record flowrate EFM-1: _____.

G.11.9. Ensure EV-13 and EV-16 open.

G.11.10. If Main Tank Vent Line connected ensure EV-9 open

G.11.11. Once conditions have stabilized, record final transfer conditions:

1. Main Tank level (LL-1D or LL-2D) _____%
2. Guard Tank Level (LL-5D or LL-6D) _____%

QA Witness:_____

G.12. Condition Dewar Fill Line and Fill Cap Assembly.

G.12.1. Ensure pumping line installed between Fill Cap Assembly at valve FCV and Auxiliary Gas Section access port no. 1.

G.12.2. Ensure FCV closed.

G.12.3. Close/verify closed AV-1 and AV-9.

G.12.4. Open AV-8 and AV-3 and evacuate pumping line to <25 mtorr measured at AG-2b.

G.12.5. Close RAV-1 as follows :

Note:
Relief of the Dewar fill line will be through the relief valve in the Fill Cap Assembly until the next operation.

1. Verify controller #1 already powered up and controller #1 selection switch set to RAV-1. If not, perform the following steps:
2. Ensure controller #1 selection switch in off position
3. Power up controller #1.
4. Position controller #1 selection switch to RAV-1.
5. Record initial switch status: Open: θ θ Closed: θ θ
6. Activate controller #1 and record:
   a. Run time:_____ seconds
   b. Current draw:_____ amp
   c. Time of day:_____
7. Record final switch status: Open: θ θ Closed: θ θ
8. Turn controller #1 selection switch to OFF.
9. Power off controller #1.
10. Turn off RAV power supply.
11. When convenient, record operation in log book.

G.12.6. Open FCV and evacuate Dewar fill line to < 25 mtorr as measured at AG-2b, and record AG-2b: _____ torr

G.12.7. Close SV-13 and torque to 60 +/- 5 in-lbs.

Quality_____

G.12.8. Close AV-8.

G.12.9. Open AV-1

G.12.10. Open AV-9 until pressure reaches 0.5 psig at AG-1, then close AV-9.

G.12.11. Close AV-1 and AV-3.

G.12.12. Close FCV.

G.12.13. Turn off pump AP-1.

G.12.14. Remove pumping line from Fill Cap Assembly.

G.12.15. Install KF-25 blank-off cap on valve FCV and record:

1. PFCG pressure:_____
2. Time of day: _____

G.12.16. Verify closure of SV-13 by observing the pressure in the Fill Cap Assembly (PFCG) until satisfied that no gas is leaking into the Dewar Fill line. After 30 minutes record:

Time of day:_____

PFCG pressure:_____

Comment: If PFCG drops by more than 0.5 torr in 30 minutes, retorque SV-13 and repeat steps G.11.8 through G.11.16.

QA Witness:_____

G.13. Configure the DAS and Liquid Level Sensors

G.13.1. Input comment to DAS "End of Internal transfer to Guard Tank".

G.13.2. Set the DAS data cycle to 15 minutes.

G.13.3. Set all the liquid level sampling intervals to 10 minutes.

G.13.4. Ensure DAS alarm enabled and record set points if changed

- Thermal conditions substantially unchanged, alarm set points for lead bag unchanged
- Thermal conditions substantially changed, temperature alarm points reset as follows:

1. Top of Lead Bag set point [CN 40] _____ K (≤ 6.0 K)
2. Top of Lead Bag set point [CN 41] _____ K (≤ 6.0 K)

G.13.5. Ensure liquid level sensor alarms enabled and record set points if changed.

1. Main Tank Level Set Point _____%
2. Guard Tank Level Set Point _____%

CAUTION

The Guard Tank may tend to subcool following the completion of this procedure. Establish continuous monitoring of the Guard Tank pressure by placing it on the DAS alarm list. Maintain positive pressure in the Guard Tank by regulating the pressure through EV-23 as necessary. Failure to comply may result in equipment damage.

G.13.6. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr differential or greater.

QA Witness: _____

G.14. Verify Final Configuration

G.14.1. Turn off Guard Tank vent-line heat exchanger (EH-2).

G.14.2. Verify final valve states

	Main Tank Vent Line Connected		**Main Tank Vent Line Not Connected**	
	Open	Closed	Open	Closed
EV Valves	EV-13, EV-9, EV-16, EV-7a/b	All other EV valves	EV-16, EV-13, EV-7a/b	All other EV-Valves
AV Valves	none	All	none	All

G.14.3. Confirm that all liquid level sensors are set at a sampling rate of 10 minutes.

G.14.4. Ensure that power to Vac-Ion pump is off.

G.14.5. Ensure all RAV operations recorded in log book

1. RAV-1
2. RAV-2

G.14.6. Record Main Tank liquid usage:

a) Start level: _____ %, Finish level: _____%.

b) Amount transferred: _____ liters (use 1 % = 24 l)

G.14.7. Verify Completion of Post Operations Checklist

QA Witness:_____

H. PROCEDURE SIGN OFF

Completed by:_____

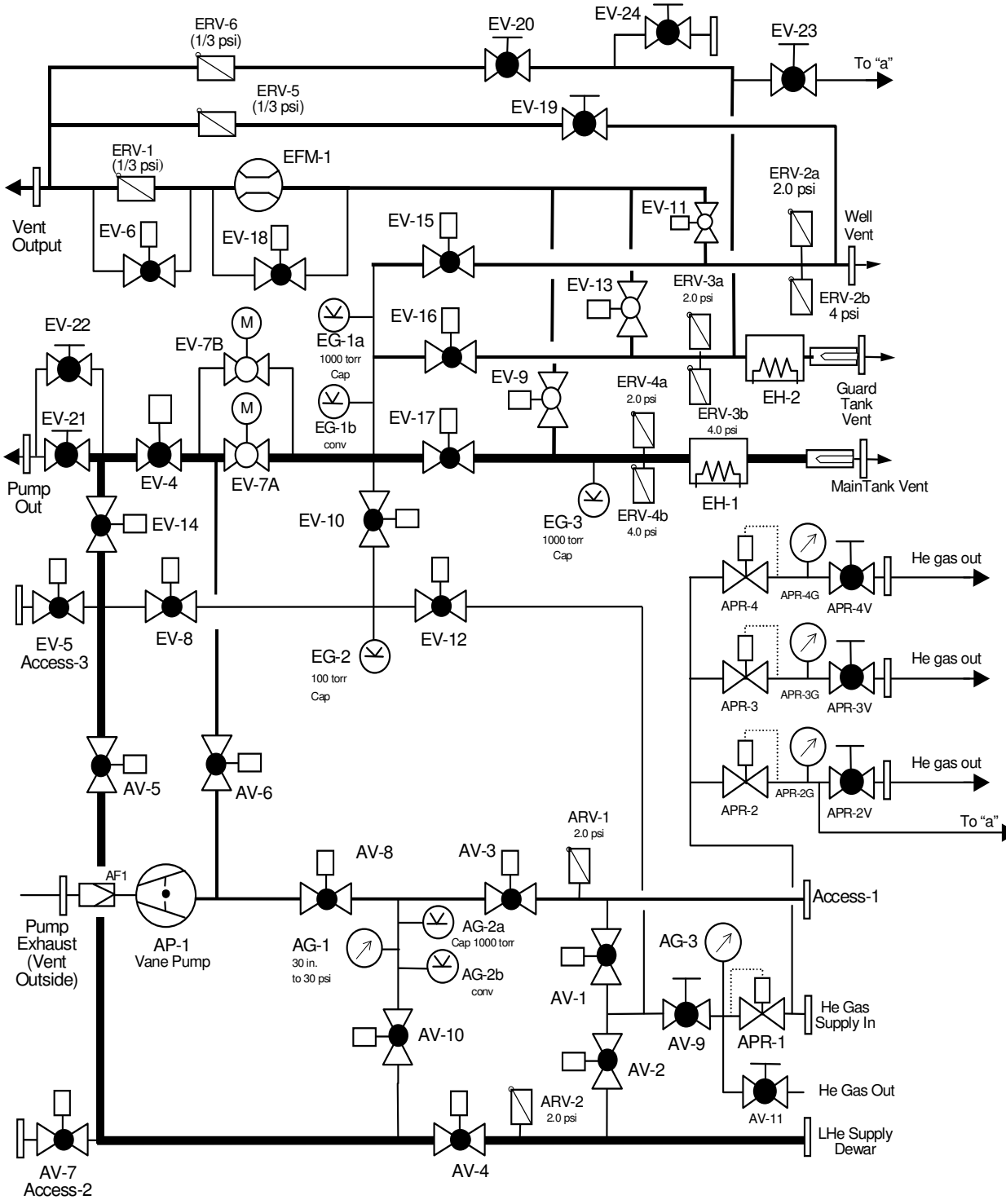
Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____



I. **Figure1.** Schematic of Gas Module Plumbing.

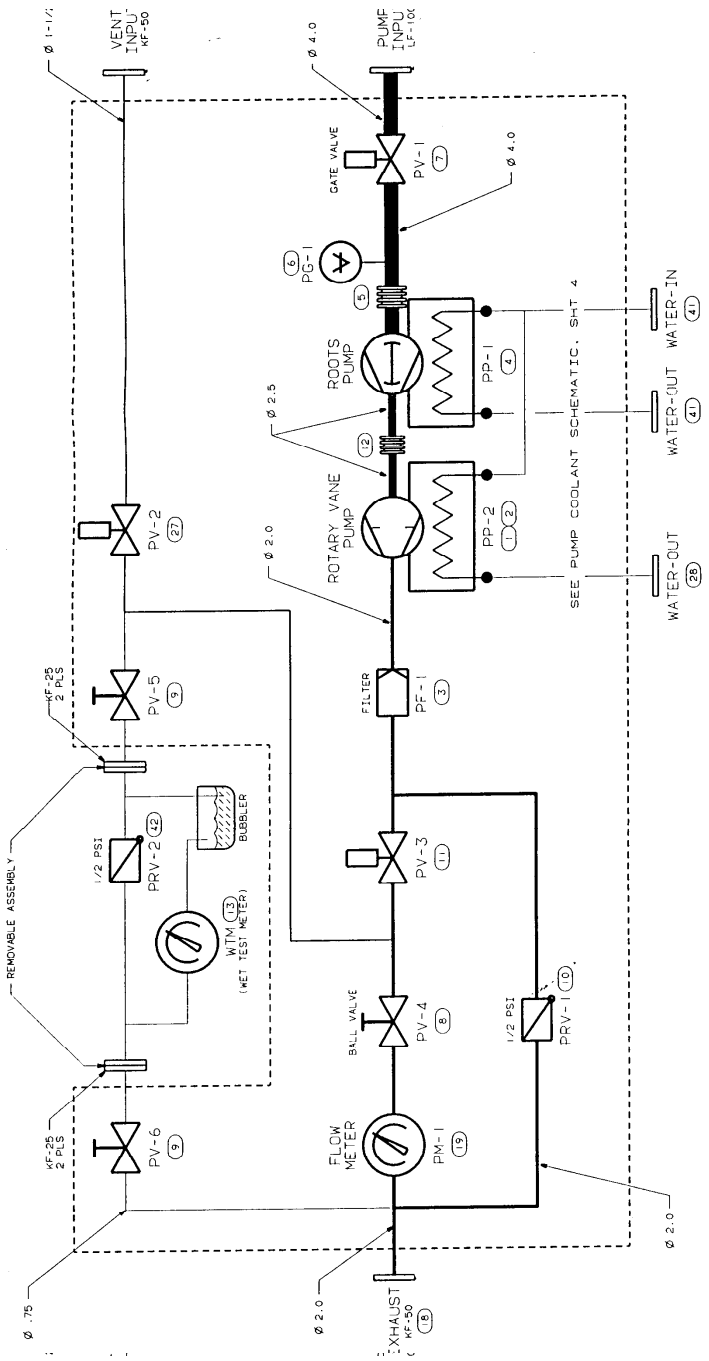


Figure 2. Schematic of Pump Module plumbing.

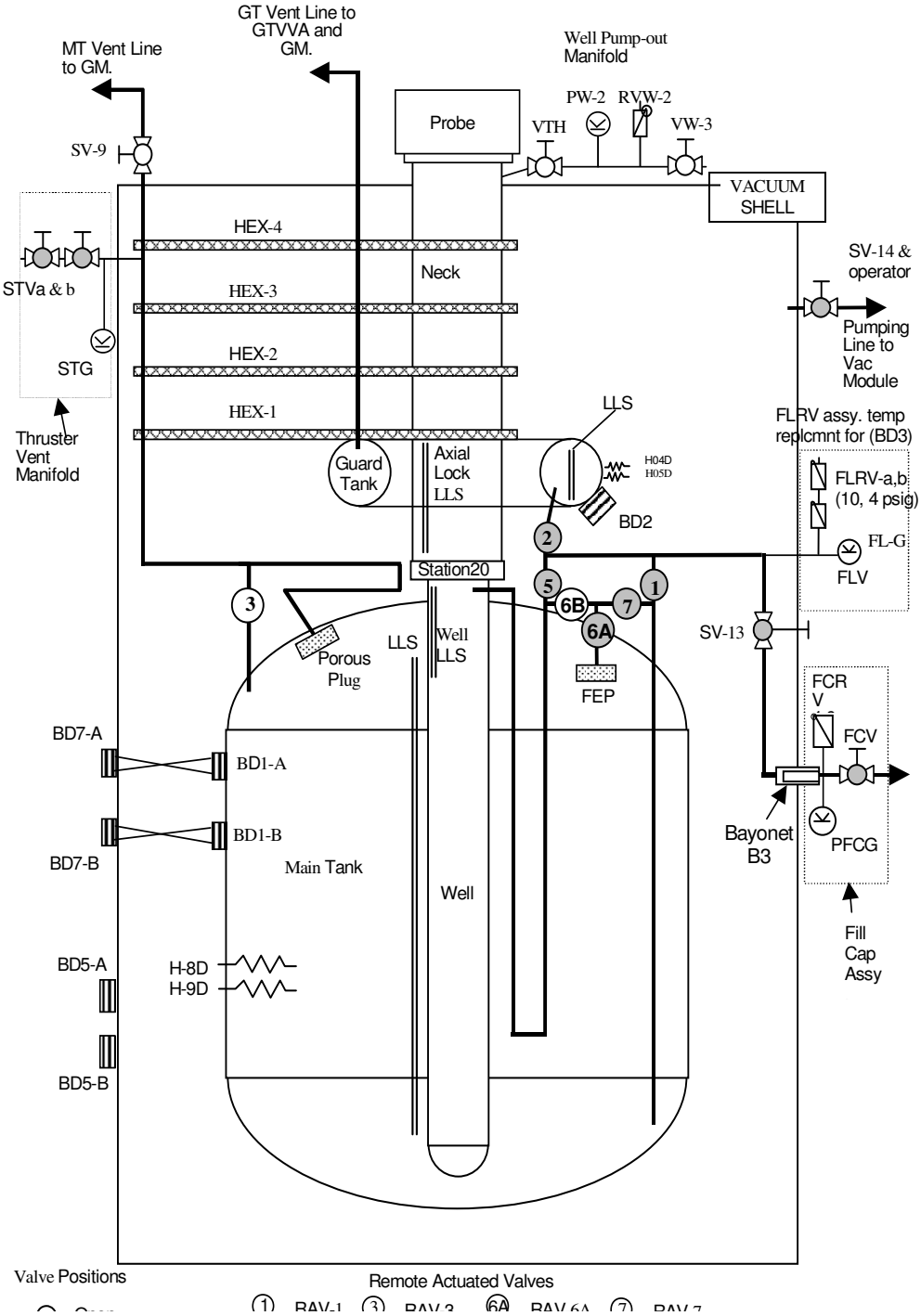


Figure 3. Schematic of Science Mission Dewar plumbing.

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 is certified for the task being performed and knows their 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: _____		

J. 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: _____		

K. APPENDIX 3– CONTINGENCY RESPONSES

	Condition	Circumstance	Response
1	Temperature limits (CN 29 or 28) exceeded	Main tank is not venting	ALLOW MAIN TANK TO VENT If SV-9 is closed: **Close EV-17 (if open) and verify EV-9 open, crack open SV-9 to allow MT to vent. Adjust SV-9 as necessary to restore temperature(s) below alarm limits. Open EV-6 and EV-18 if higher flow rate is needed.** If SV-9 open and EV-9 closed: **Open EV-9 for short periods (~15 sec) and allow increased flow from Main tank; in addition, Open EV-6 and EV-18 if higher flow rate is needed.** If SV-9 and EV-9 open **Open EV-6 and EV-18 for higher flow** **If problem persists see item 3**
2		Main tank is venting	PROMOTE INCREASE IN MAIN TANK VENTING Power up heater at H08D or H0-9D and starting at 15 vdc input increase power until increased flow has cooled the problem area
3	**Burst disk rupture (MT/GT)**	**Anytime**	Request 100% facility make-up air purge **Evacuate room**
4	**Liquid helium leak**	**Anytime**	Clear area until all liquid has evaporated
5	**Oxygen Monitor Alarm**	**Anytime**	Evacuate