

GRAVITY PROBE B PROCEDURE FOR SCIENCE MISSION DEWAR

Prep Payload for Thermal Vacuum Test

THIS DOCUMENT CONTAINS THE USE OF HAZARDOUS MATERIALS

ECO#1405

P0952A

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REVISION RECORD

REVISION	ECO	PAGES	DATE
A	1405	-Modify both Guard Tank and Main Tank plumbing configuration to minimize all viton seals -Add section to evacuate Guard Tank with Vacuum Module during TVAC test -Add section to verify operation of TVAC GSE vent heaters -Add section to verify operation/cal/base line of flow meter	3/19/03

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List of Abbreviations and Acronyms

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

A. SCOPE

This procedure provides the necessary steps to prepare the SMD for the Thermal Vacuum Test in Lockheed Martin building 156. The steps include

The following activities occur before the space vehicle is placed on the thermal vacuum chamber rails

2. Connect Main Tank vent extension and Main Tank Vent Cap to SMD
3. Connect Guard Tank pressurization/evacuation assembly to GTV-V'

The following activities occur after the vehicle is pushed into the thermal vacuum chamber

1. Connect Main Tank Vent Line Extension to Gas Module and Thermal Vacuum (TVAC) feed through plate
2. Install Guard Tank pressurization/evacuation line to TVAC feed through plate
3. Verify proper operation of all SMD vent heaters
4. Once TVAC chamber has been evacuated, evacuate Guard Tank with Vacuum Module

B. SAFETY**B.1. Potential Hazards**

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

In addition, 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 discusses 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

When working inside the SEP III chamber and in the area outside of the SEP III chamber in LM Building 156, an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5% will be utilized. 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 on the SMD vacuum shell.

1. Perform

Only authorized and trained LM and SU personnel are allowed in the high-bay without escort. All personnel working at a height 30 inches or more off the floor are required to have an LM approved air tank within easy reach. In the unlikely event of a large LHe spill all employees have been instructed to evacuate the room and contact LM 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 cryogenics exists or when handling equipment that has been cooled to cryogenic temperatures. Protective clothing and full-face shields are to be worn whenever the possibility of splashing cryogenics exists.

B.2.3. Other Hazards

When appropriate, 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 obtain medical treatment as follows
LM **Call 117**

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.

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 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 PTD 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 PTD 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 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 Test Director is the designated signer for the “witnessed by” sign-off located at the end of each procedure. The person in charge of the operation (Test Director or Test Engineer) is to sign the “completed 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. Qualified Personnel

<i>Test Director</i>	<i>Test Engineer</i>
Ned Calder Mike Taber Dave Murray	Tom Welsh

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

This procedure does not include any equipment sensitive to electrostatic discharge.

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, and the Vacuum 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. The Vacuum Module contains a turbo pump, backed by a vane pump, and provides the capability to pump out the SMD vacuum shell.

This procedure calls for use of hardware located in the Gas Module, and the Electrical Module (Table 1).

E.3.3. Computers and Software:

The Data Acquisition System (DAS) and data acquisition software are 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. Test Equipment

<i>Description</i>
Wet Test Meter: S/N: _____ Cal Due Date: _____
Helium leak detector
Helium leak detector calibrated leak; Calibrated leak S/N#: _____ Cal. due date: _____

E.3.5. Additional Hardware

No additional hardware is required.

E.3.6. Tools

No additional tools are required.

E.3.7. Expendables

<i>Description</i>	<i>Quantity</i>	<i>Mfr./Part No.</i>

Isopropyl	AR	N/A
99.999% pure gaseous helium	AR	N/A
Vacuum Grease	AR	Apeizon N or Dow Corning High Vacuum Grease

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 American Magnetics, Inc. 136	LLS Main Tank	96-409-11	No	-
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	

No.	Location	Description	Name	Serial No.	Cal Required	Status Cal due date
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 is at normal boiling point (NBP).

E.5.2. Guard Tank

The Guard-Tank must be depleted and pressurized.

E.5.3. Well

The Well is evacuated.

E.5.4. SMD Vacuum Shell

This procedure places no requirement on the vacuum shell pressure.

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 (CN 175) set at $T \leq 6.0$ K.
 - b. Top of lead bag temperature set (CN 178) at $T \leq 6.0$ K.
 - c. Relative Guard Tank Pressure (CN 46) set at $\Delta P \geq 0.3$ torr.

E.5.6. GSE and Non-flight Hardware

1. 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).

E.6. Optional Non-flight Configurations

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

1. N/A

F. REFERENCE DOCUMENTS**F.1. Drawings**

<i>Drawing No.</i>	<i>Title</i>
LMMS-5833394	<i>Instrumentation Installation</i>

F.2. Supporting documentation

<i>Document No.</i>	<i>Title</i>
LMMC-5835031	<i>GP-B Magnetic Control Plan</i>
GPB-100153C	<i>SMD Safety Compliance Assessment</i>
SU/GP-B P0141	<i>FIST Emergency Procedures</i>
LMSC-P088357	<i>Science Mission Dewar Critical Design Review</i>
SU/GP-B P0108	<i>Quality Plan</i>

LMMS GPB-100333	<i>Science Mission Dewar Failure Effects and Causes Analysis</i>
SU/GP-B P059	<i>GP-B Contamination Control Plan</i>
EM SYS229	<i>Accident/Mishap/Incident Notification Process</i>

F.3. **Additional Procedures**

No additional procedures are indicated.

Operation Number: _____

Date Initiated: _____

Time Initiated: _____

G. **OPERATIONS**

G.1. **Pre-Operations Verifications**

- o Verify SU QA notified.
Record: Individual notified _____,
Date/time ____/____.
- o Verify NASA representative notified.
Record: Individual notified _____,
Date/time ____/____.
- o Record calibration due dates in Table 1 (Sections. E.3.4, E.4)
- o Persons actually performing this procedure should initial their names in Sec D.3 and the name of the Test Director should be circled.
- o Verify completion of the Pre-Operations Checklist (Appendix 1).

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

G.2.1. Record serial number of 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. Record Initial Configuration and Configure Misc. Items

Note:

The following activities are to be performed while the SV is vertical before the space vehicle is put on the thermal vacuum chamber rails

- G.3.1. Record initial liquid helium levels as appropriate.
1. Main Tank (LL-1D or LL-2D) _____%
 2. Record Date/Time _____/_____
- G.3.2. Remove plastic bag securing dewar vent thermal couple wires
- G.3.3. Ensure protective covers removed from caging line burst disks
- G.3.4. Remove plastic covers and deflectors from burst disks
- G.3.5. Remove plastic bags containing wood blocks securing Vatterfly Valve Cover Valves off of all 6 valves
- G.3.6. Secure Vac Ion Pump (VIP)
1. Turn on VIP and record time of day: _____
 2. Use CN 99 to monitor VIP and after reading is steady record VIP pressure: _____ torr
 3. Verify VIP < 9*E-6 torr
 4. Begin new data cycle
 5. After data cycle complete, turn off VIP
 6. Remove VIP magnet and cover, being careful not to damage ceramic feed through
- G.3.7. Install Flight Fill Cap Assembly
1. Remove Fill Cap Assembly and install Flight Fill Cap Assembly (FFCV)
 2. Attach UTS to FFCV
 3. Ensure FFCV open
 4. Turn on Vane Pump and Converter
 5. Open TV-2 and TV-4
 6. When TG-4 reads < 1 torr Press Start on turbo controller
 7. When turbo fully up to speed close TV-4 and open TV-1
 8. Leak check flight fill cap assembly
 - a. Ensure Leak Detector calibrated
 - b. Connect leak detector to TV-3

- c. Open TV-3 and close TV-2
 - d. Record Initial background:_____scc/s He
 - e. Leak check FFCA
 - f. Record final background:_____scc/s He
 - g. Verify no rise $>10^{-6}$ sccs
 - h. Close TV-3 and open TV-2
 - i. Close FFCV
 - j. Vent and disconnect leak detector
- 9. Close TV-1
 - 10. Connect source of He gas to TV-5
 - 11. Open TV-5 and backfill line to 800 torr as read on TG-2
 - 12. Close TV-5
- G.3.8. Perform leak back test on FFCV:
- 1. Record TG-2:_____torr; time: _____
 - 2. Monitor TG-2 for half an hour and verify no decrease >1 torr in pressure at TG-2 Record TG-2:_____torr; time: _____
 - 3. Disconnect UTS from FFC and install swagelok cap
- G.3.9. Verify Well Pump-out port secure
- 1. Ensure VW-1 and VW-2 closed
 - a. If necessary, torque to 70-80in-lbs
 - b. Record Torque wrench serial/cal due date:_____
 - 2. Ensure Well Pump-out port cap removed
- G.3.10. Remove plastic pump-out port cap on flight Guard Tank vent line vacuum jacket.
- G.3.11. Install plug in fill line relief assembly

Section complete QA Witness:_____

G.4. Connect Main Tank Vent Extension and Main Tank Vent Cap to SMD

Note:
 The following steps are to be performed before the space vehicle is relocated onto the thermal vacuum chamber rails

Note:

The following steps connect a 1.5" bellows hose and all metal valve TVV-1 to the Main Tank Vent and then reinstalls the vent cap on the end of this hose/valve assembly

- G.4.1. Reference figure 2 for final configuration. The following puts the main tank vent in an intermediate configuration with a cap installed at TVV-1 rather than being connected to the chamber feed through plate.
- G.4.2. Perform Procedure P0676 to install Main Tank Vent Cap with the following blue lines
 - 1. Install vent cap on end of TVV-1/Main Tank Vent line extension assembly
 - 2. Obtain zero for Main Tank Vent endevco
 - 3. Leak check SV-9 Stem

Note:

Main Tank relief now through MTVC-RV .3 psig

G.5. **Configure Initial Guard Tank Pressurization for Thermal Vac**

Note:

The following steps are to be performed before the space vehicle is relocated onto the thermal vacuum chamber rails

- G.5.1. Close GTV-V' and torque to 70-80 in-lbs (ref. Figure 3).
- G.5.2. Disconnect the existing GT pressurization line and assemble Guard Tank Thermal Vac Pressurization Assembly between GTV-V' and leak detector connected to HPLV-2 (omitting the chamber feedthrough)
- G.5.3. Leak check all plumbing connections between GTV-V' and HPLV-2
 - 1. Record calibrated leak rate: _____ scc/s He
 - 2. Record measured leak rate: _____ scc/s He
 - 3. Verify open HPLV-1 and HPLV-2
 - 4. Ensure background on E-7 sccs range
 - 5. Record initial leak rate: _____ scc/s He
 - 6. Leak check all joints
 - 7. Record final leak rate: _____ scc/s He
 - 8. Verify no rise detected
 - 9. Close HPLV-1 and HPLV-2
 - 10. Vent and disconnect leak detector
- G.5.4. Stake or lock all plumbing connections on the dewar side of of HPLV-1
- G.5.5. Open GTV-V'
- G.5.6. Verify GTV-G pressure > 100 torr
- G.5.7. Set He Supply regulator to ~2 psig

- G.5.8. Open HPLV-2, and while purging from both directions connect HPLV-2 to He supply regulator
- G.5.9. Tape closed GTV-RV

Section complete QA Witness: _____

Note:
Guard Tank relief now through Guard Tank Pressurization Assembly relief valve

Note:
The following steps are to be performed after the space vehicle has been pushed into the thermal vacuum chamber.

G.6. Connect Main Tank Vent Line Extension

- G.6.1. Close TVV-1 and torque to between 100-130 in-lbs
 - 1. Record S/N#: _____
 - 2. Cal Due Date: _____
- G.6.2. Input comment to DAS, "Close TVV-1, Main Tank Vent valve"
- G.6.3. Remove Main Tank Vent Cap Assembly
- G.6.4. Connect TVV-1 to TVAC feed through plate
- G.6.5. Connect Main Tank Vent Line extension from TVAC feed through plate to Gas Module Main Tank heat exchanger with appropriate Linde-to-KF adapter
- G.6.6. Verify Gas Module configured as indicated in Figure 1.
- G.6.7. Leak check all connections on Main Tank Vent for Thermal Vac
 - 1. Turn on and verify calibration of leak detector. Record
 - a. calibrated leak value _____ sccs
 - b. measured leak value _____ sccs
 - 2. Connect leak detector to the UTS at Leak check access port .
 - 3. Ensure all EV and AV valves closed, except EV-7a/b
 - 4. Ensure EV-7a/b 100% open
 - 5. Ensure RGA-LV and RGA-SOV closed
 - 6. Install UTS/Leak detector to EV-21 access port of Gas Module and start the UTS (Figure 3) pumping up to closed EV-21/22, as follows:
 - a. Place valve interlock switch in "over-ride" position.
 - b. Turn on vane pump and converter (Note: converter switch provides power to turbopump controller and pirani and cold-

- cathode vacuum-gauge display.
- c. Push the red “reset” button to activate the interlock override circuit. (the yellow-orange indicator light will come on).
 - d. Turn “foreline” switch on, to open TV-2, and verify that the switch is illuminated.
 - e. Push the “Sensor” button on the vacuum gauge display to read the foreline pressure (TG-4). This is the pirani gauge. The “Pir” annunciator will appear in upper left corner of the display).
 - f. Slowly open TV-4.
 - g. When foreline pressure (TG-4) < 1 torr, push “Start” button on turbo controller.
 - h. When the “Normalbetrieb” light illuminates on turbo controller, indicating turbopump is up to speed, close TV-4 and open gate valve TV-1.
 - i. Switch the valve interlock switch to the “protected” position.
 - j. Push the “Sensor” button on the vacuum gauge readout so that the “Hi-Vac” annunciator shows, and push the “Emis” button to turn on the cold cathode gauge (TG-1).
 - k. Record the pumping line pressure (TG-1) _____ torr.
7. Evacuate Main Tank vent and Gas Module plumbing with AP-1
- a. Ensure AP-1 on.
 - b. Open valves EV-4, 5, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, and 20
 - c. Ensure closed EV-6, 18, 23, and 24
 - d. Open valves AV-1, 2, 3, 5, 6, 8, 10, 4, 7
 - e. Ensure closed AV-9, and 11
 - f. Ensure open PCV-1 and PCV-2
 - g. Once pressure is < 25 mtorr as measured at AG-2b, close AV-8 and AV-6
8. Evacuate with UTS/leak detector, as follows:
- a. Open EV-21
 - b. Verify that leak detector is operational and pumping up to closed valve TV-3.
 - c. Slowly open TV-3 and close the foreline valve (TV-2)
 - d. Pump until background level is on 10^{-6} scc/s range.
9. Leak Check connections inside chamber- bag seals and purge bags

with GHe for 2 minutes and record:

- a. Seal location: MT VL Extension to TVAC feed through plate inside

Time (min)	0	1/2	1	1 1/2	2
LD (ssc/s)					

- b. Pass/Fail: _____ (Pass= **no** increase from initial background)

- c. Seal location: Main Tank VL Extension to TVV-1 downstream)

Time (min)	0	1/2	1	1 1/2	2
LD (ssc/s)					

- d. Pass/Fail: _____ (Pass= **no** increase from initial background)

10. Leak check connections outside chamber

- a. Ensure background on E-6 scc/s range
- b. Record initial background: _____ scc/s
- c. Leak check TVAC feed through plate (outside) to Main Tank Vent line
- d. Leak check Main Tank heat exchanger and adapter
- e. Leak check EV-5 (Access 3) connection
- f. Leak check connections for PCV-1
- g. Leak check connection for PCV-2
- h. Leak check connections for PCG-1
- i. Leak check connection for Access 1
- j. Leak check all internal plumbing in the Gas Module
- k. Record final background: _____ scc/s, ensure no rise detected

QA Witness: _____

11. Close all AV and EV valves

12. Remove UTS/Leak detector from EV-21

13. Verification of flow meter zero

- a. Connect a water bubbler, trap and wet test meter (WTM) at the output of AP-1. Record the WTM serial no. _____, and cal. due date: _____

- b. Ensure open EV-7a/b
 - c. Open EV-4, 5, 14, 17, PCV-1 and PCV-2
 - d. Open AV-3 and AV-8
 - e. Turn on AP-1
 - f. Record WTM flow: _____ slpm (measured over a 10 minute period)
 - g. Verify WTM reads < .03 slpm
 - h. Close AV-3 and AV-8
 - i. Close EV-4, 5, 14, and 17
14. Open EV-9, EV-10, EV-12 and EV-17
 15. Open AV-9 and backfill Main Tank Vent Line extension to 0.0 psig as read on AG-1
 16. Close AV-9
 17. Close EV-10, 12, and 17
 18. Open TVV-1
 19. Open EV-9
 20. Input comment to DAS, "Main Tank now venting through Gas Module at EV-9"
 21. Ensure Main Tank venting
 22. **OPTION:** Control of the Main Tank Vent will be transferred to procedure XXX
 - a. Record Op. Number: _____

Section complete QA Witness: _____

G.7. **Configure Guard Tank Pressurization/Evacuation for Thermal Vac**

- G.7.1. Calibrate leak detector
 1. Record calibrated leak rate: _____ scc/s He
 2. Record measured leak rate: _____ scc/s He
- G.7.2. Close HPLV-1 and HPLV-2
- G.7.3. Disconnect HPLV-1 from 20' metal flex hose
- G.7.4. Connect HPLV-1 to inside thermal vac feed through plate
- G.7.5. Connect 20' section metal flex hose to outside of thermal vac feed through plate
- G.7.6. Connect HPLV-2 to leak detector
- G.7.7. Leak check all plumbing connections between HPLV-1 and HPLV-2

1. Record background:_____ scc/s He
2. Verify background is on 10⁻⁷ scc/s range.
3. Record final leak rate:_____ scc/s He
4. Verify no rise detected

G.7.8. Close HPLV-2

G.7.9. Vent and disconnect leak detector

G.7.10. Stake or lock all connections downstream of HPLV-1

G.7.11. Open GTV-V'

G.7.12. Verify GTV-G pressure >100 torr

G.7.13. Set He Supply regulator to ~2 psig

G.7.14. Open HPLV-2, and while purging from both directions connect HPLV-2 to He supply regulator

Section complete QA Witness:_____

G.8. Verify SMD heater operation

G.8.1. Fill in the following table (refer to figure 4, 5, 6)

1. Note: If the location is controlled by test services, verify that test services has performed a check out of that TC/heater combination

Location	Temp Controller Units	Heater Number	TC-1/TC-2 (PRT-1/2) Ambient Value	TC-1/TC-2 PRT (1/2) Set Points	Heater I/V Limits	
1. SV-9 Stem						
2. SV-9 Knob						
3. Main Tank Bayonet Inboard						
4. Main Tank Bayonet Nut						
5. Bayonet/ Conflat Adapter (TV FT)						
6. TVV-1 inner flange (TVCO)						
7. TVV-1 outer flange (TVCI)						
9. Guard Tank Bayonet						

Section complete QA Witness: _____

Note:

The following operations are to be performed after the door to the TVAC chamber is closed and the chamber is at vacuum.

G.9. Evacuate Guard Tank with Vacuum Module

- G.9.1. Ensure VV-1, 2, 3, 4, 5, 6,7, 8, 9, 10, 11 and VV-RGA closed
- G.9.2. Ensure Thermal Vacuum Chamber pressure $< 10^{-4}$ torr
 - 1. Record TVAC chamber pressure: _____
- G.9.3. Close HPLV-2
- G.9.4. Connect HPLV-2 to VV-10 of Vacuum Module
 - 1. Install lock on connection
- G.9.5. Leak Check HPLV-2/VM junction
 - 1. Record leak detector measured cal: _____
 - 2. Record leak detector standard leak: _____
 - 3. Connect leak detector to Leak Check Access Port
 - 4. Turn on VP-2
 - 5. Open VV-4, VV-3 VV-10 and VV-6
 - 6. When VG-5 < 50 mtorr, press start on turbo
 - 7. When turbo up to speed , close VV-3 and VV-6
 - 8. Open VV-1
 - 9. Close VV-6 and VV-3
 - 10. Start leak detector pumping up to VV-7
 - 11. Open VV-7 and close VV-4
 - 12. Leak check HPLV-2 /VM junction
 - a. Record initial background: _____ scc/s
 - b. Record Final background: _____ scc/s
 - c. Ensure no leaks greater than $1E-7$ scc/s detected
 - 13. Close VV-7 and open VV-4
 - 14. Vent and disconnect leak detector
- G.9.6. Press stop on turbo controller
- G.9.7. Enter comment to DAS, "Begin Guard Tank Evacuation"
- G.9.8. Start special data for channels 46, 49, 171, and 175
- G.9.9. Slowly open HPLV-2 to evacuate guard tank and maintain VG-4 < 100

torr

- G.9.10. When VG-3 < 100 mtorr and HPLV-2 fully open, press start on turbo controller
- G.9.11. Ensure over-ride switch in off position
- G.9.12. Ensure VG-1 and alarmed in data system
 - 1. Record set point: _____

Section complete QA Witness: _____

G.10. Final Configuration

- G.10.1. Record DAS alarm set points:
 - 1. VG-1: _____
 - 2. Lead Bag CN 175/178: _____ / _____
 - 3. Main Tank Pressure EG-3: _____
- G.10.2. Ensure test services recording heater data
- G.10.3. Verify completion of post operations checklist

H. PROCEDURE COMPLETION

Completed by: _____

Witnessed by: _____

Date: _____

Time: _____

Quality Manager _____ **Date** _____

Payload Test Director _____ **Date** _____

Figure 1. Gas Module Note: Pressure control components (PCV-1, -2, PCG-1) and associated plumbing are temporary external features added to the Gas Module. PCV-2 is a proportioning solenoid valve operated by a valve controller.

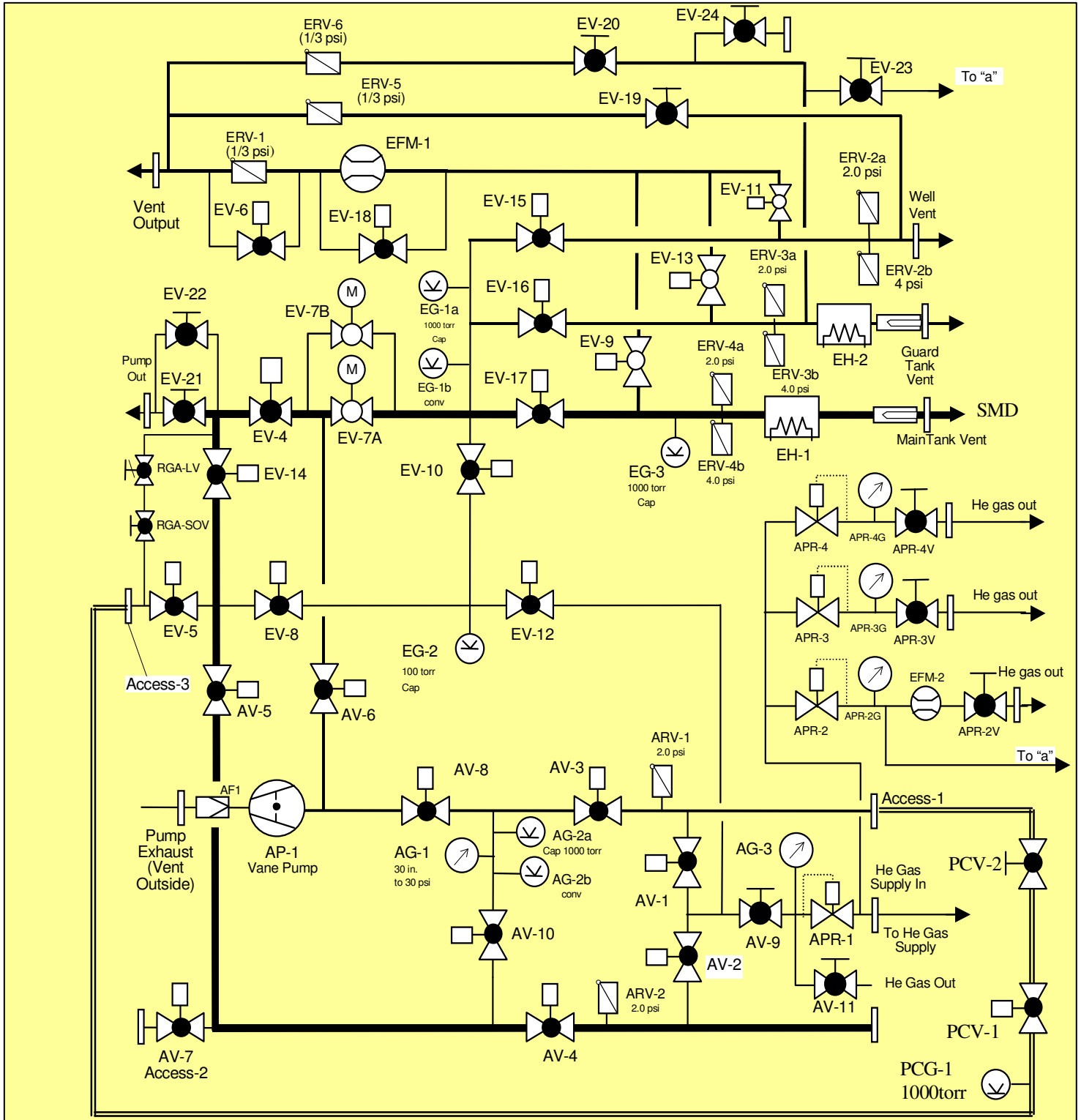


Figure 2 Main Tank Vent Configuration

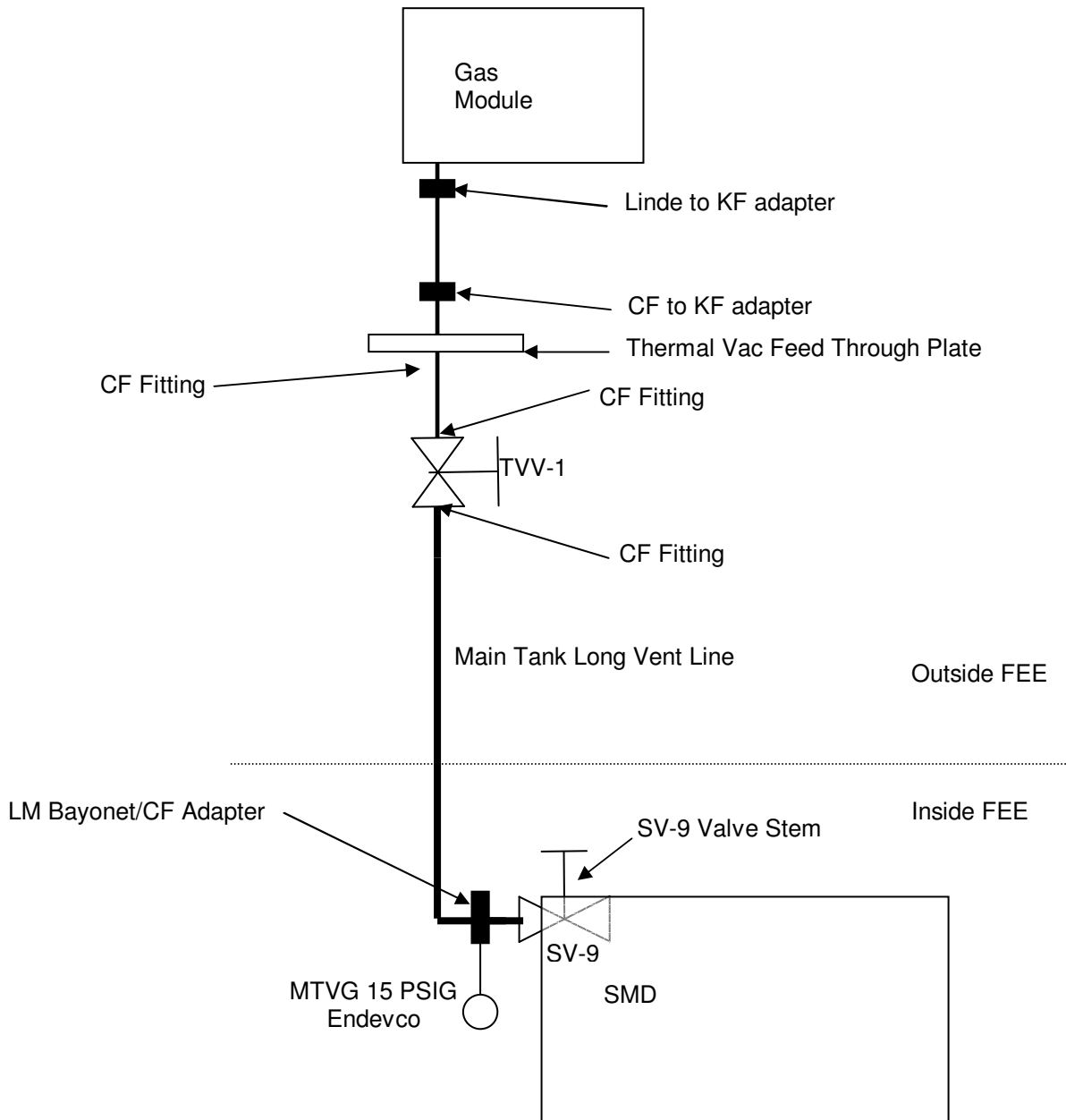
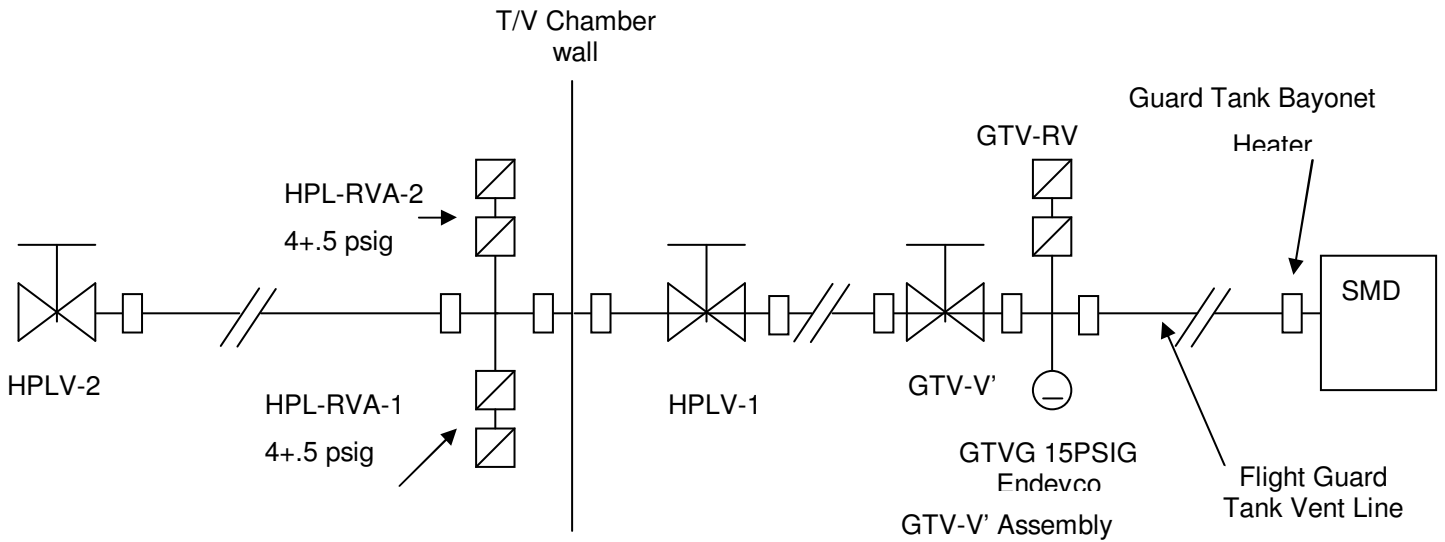
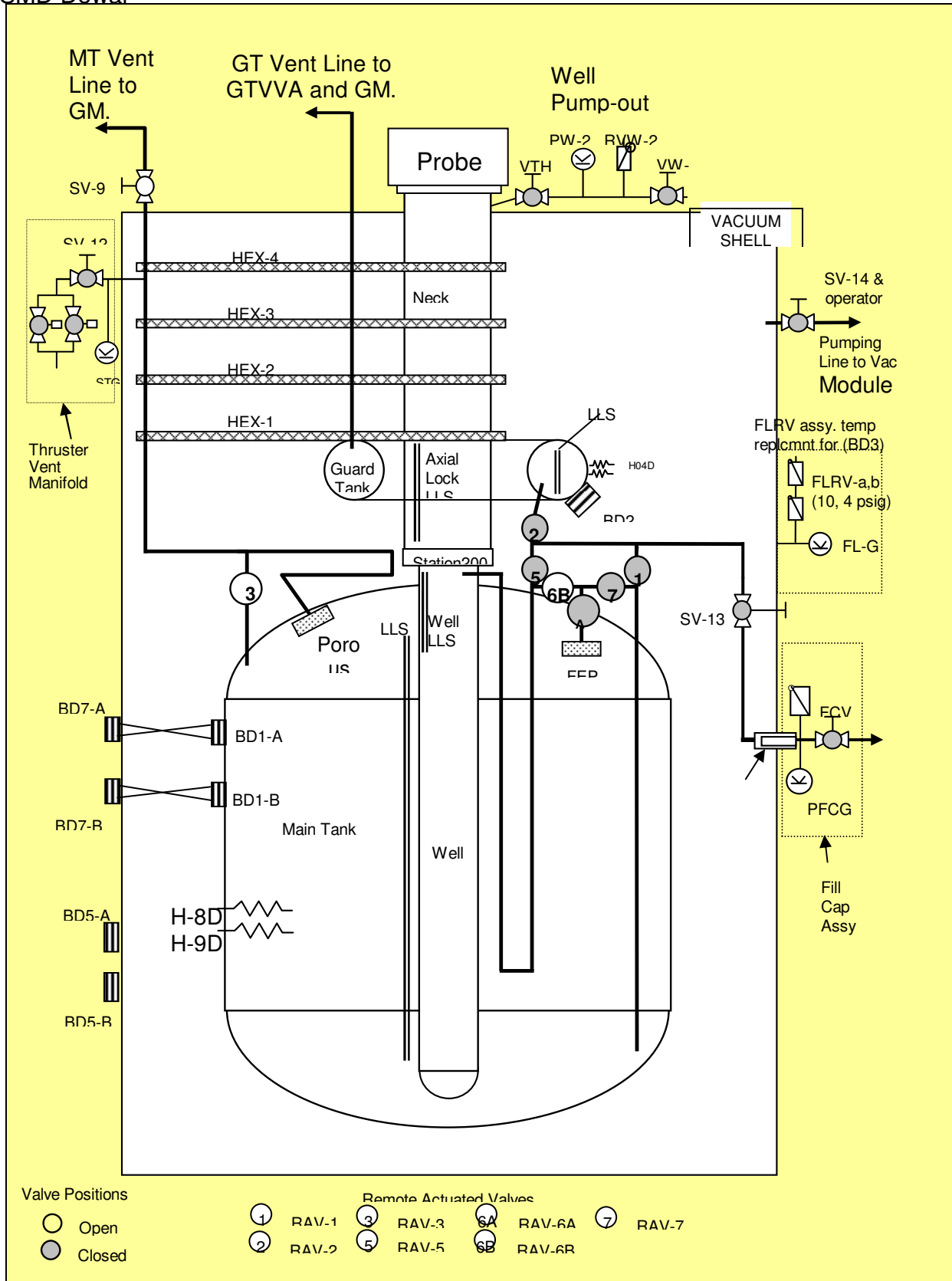


Figure 3: Guard Tank Pressurization Line Assembly

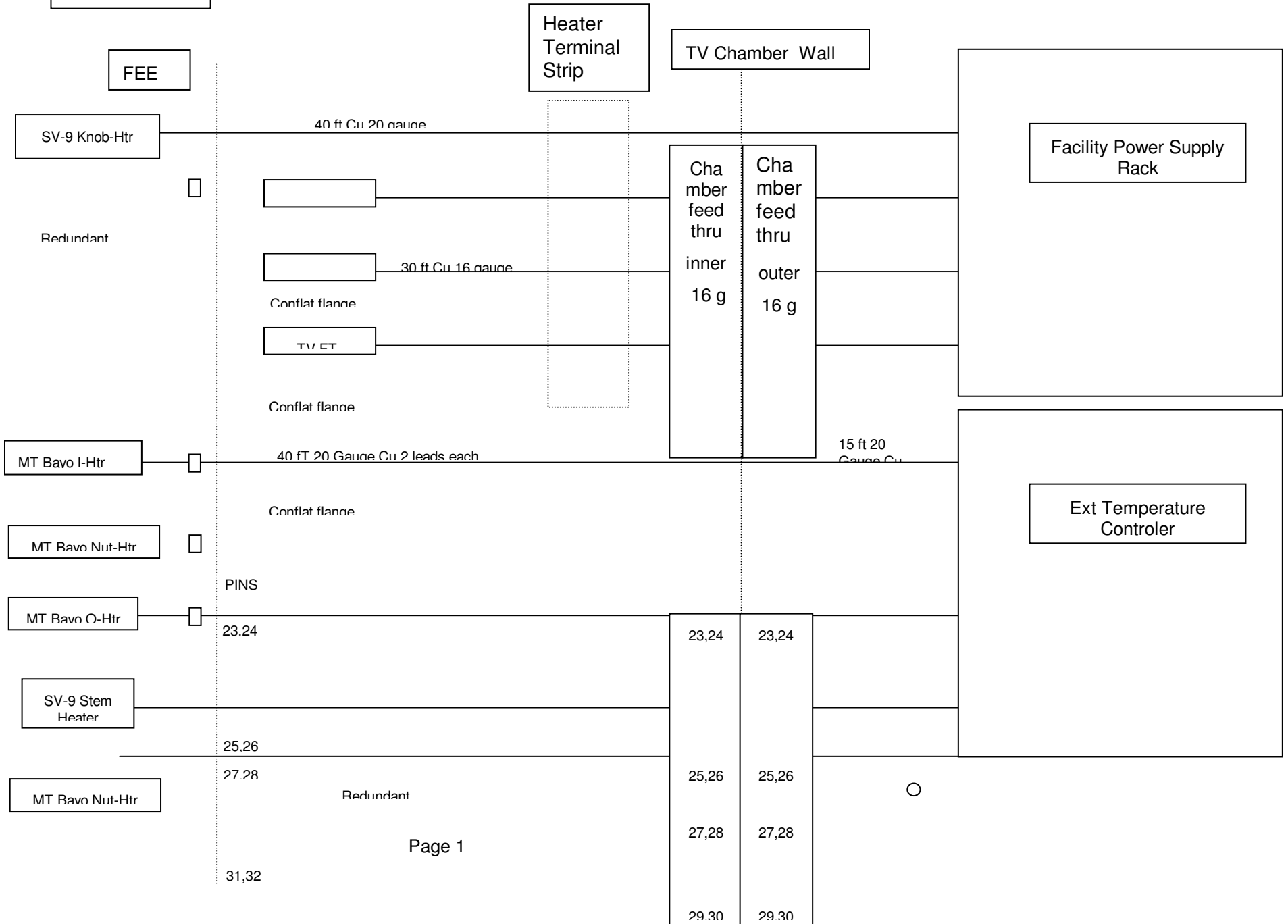
Note: All joints are 1/4" VCR with SS gaskets, except the standard Lockheed bayonet joint at the dewar and at the end of the flight guard tank vent line.



SMD Dewar



HEATERS



29,30

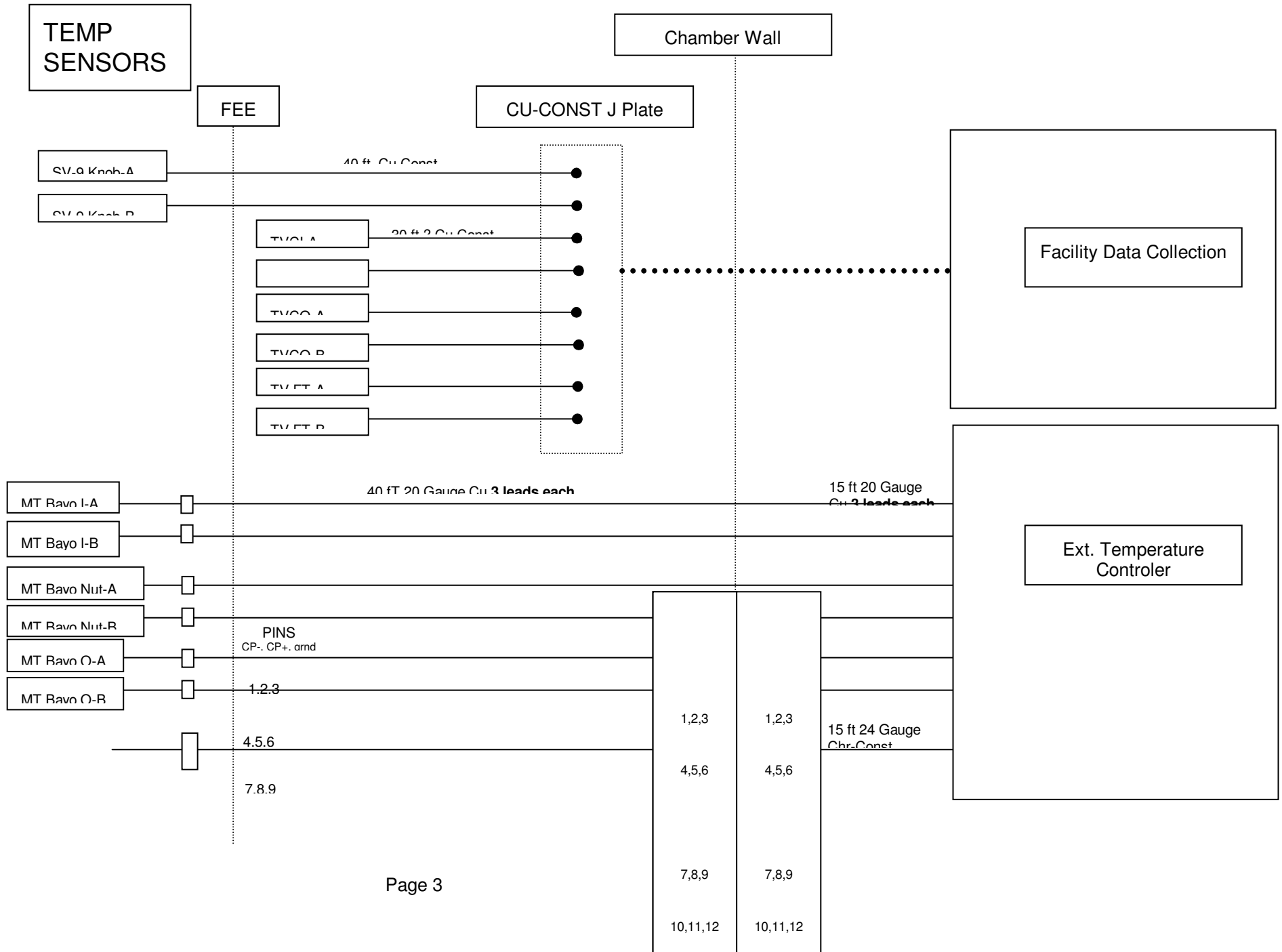
Conflat flange



36 pin Male

Part of 36 pin 20
gauge feed thru

Shaded heaters are existing in place



10.11.12

13.14.15

16.17.18

PINS
Chr-Const
19,20

40 ft 24 Gauge Chr-Const

SV-9 Stem
Chr-Const

3 pin Cu-Cu Omega connector

Chr-Const TC connector

Part of 37 pin 20
guage feed thru

i. TV Cryo heater construction

Conflat flanges, Four each:

- Four heaters using H28 in configuration 3
- Length 17.5 inches
- Configuration No. 3, 2 in parallel with 2 pairs in series
- Resistance: 19 ohms
- 3 heaters: Wiring 16 gauge to heater terminal block
- 1 heater: Wiring is 3 ft 20 guage wire terminating in pigtails

SV-9 Knob, one only:

- One heater using E28
- Length 8.7 inches
- Configuration No. 2, all 4 wires in series
- Resistance: 38.2 ohms
- Wiring: 20 gauge, 3 feet long terminated in pigtail

Bayo Nut, one only:

- One heater using E28-4
- Length 14 inches
- Configuration No. 2, all 4 wires in series
- Resistance: 32.7 ohms
- Wiring: 20 gauge, 3 feet long terminated in pigtail

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. 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.		
	Team Lead Signature: _____		

Appendix 3– Contingency Responses

Condition	Circumstance	Response
Temperature limits (CN 1 or 28) exceeded	Any time	Open EV-9 to Vent Main Tank
Burst disk rupture (MT/GT)	Any time	Evacuate room