GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

WINDOW 4 ENVIRONMENT CONTROL AND MONITORING

To be performed at Vandenberg Air Force Base building 1610 and MST SLC-2W

THIS DOCUMENT DOES NOT CONTAIN HAZARDOUS OPERATIONS

P1053 Rev. -

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REVISION RECORD

REVISION	***ECO***	***CHANGES***	***DATE***

Table of Contents

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	PCI	PDU Circuit Instrumentation (Console)
EFM	Exhaust gas Flow Meter	PDU	Power Distribution Unit
EG-x	Gauge x of Gas Module exhaust section	PFCG	Fill Cap assembly pressure Gauge
EM	Electrical Module	PFM	Pump equipment Flow Meter
ERV-x	Relief valve of Gas Module exhaust section	PG-x	Gauge x of Pump equipment
EV-x	Valve number x of Gas Module exhaust section	PM	Pump Module
FCV	Fill Cap Valve	psi	pounds per square inch
FEE	Forward Equipment Enclosure	psig	pounds per square inch gauge
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	Space Vehicle
GTVC-RV	Guard Tank Vent Cap relief valve	SV-x	SMD Valve number x
GTVC-V	Guard Tank Vent Cap valve	TD	Test Director
GTV-G	Guard Tank vent pressure gauge	TG-x	Gauge x of Utility Turbo System
GTV-RV	Guard Tank vent relief valve	TV-x	Valve x of Utility Turbo System
GTV-V	Guard Tank vent valve	UTS	Utility Turbo System
HCU	(External) Heater Control Unit	VAFB	Vandenberg Air Force Base
HX-x	Vent line heat exchanger in Gas Module	Vac	Vacuum
KFxx	Quick connect o-ring vacuum flange (xx mm diameter)	VCP-x	Vent cap pressure gauge
LD	(Helium) Leak Detector	VCRV-x	Vent cap relief valve
LHe	Liquid Helium	VCV-x	Vent cap valve
LHSD	Liquid Helium Supply Dewar	VDC	Volts Direct Current
Liq	Liquid	VF-x	Liquid helium Fill line valve
LL	Liquid level	VG-x	Gauge x of Vacuum Module

LLS	Liquid level sensor	VM	Vacuum Module
LMMS	Lockheed Martin Missiles and Space	VV-x	Valve x of Vacuum Module
LMSC	Lockheed Missiles and Space Co.	VW-x	Valve x of Dewar Well
MPT	Medium Payload Transporter		

LIST OF SPECIFIC HEADING DEFINITIONS

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

Note:
Used to indicate an operating procedure of such importance that it must be emphasized.

CAUTION:
Used to identify hazards to equipment.

WARNING:
Used to identify hazards to personnel.

A Scope

This procedure is a master procedure that controls and monitors the environment of Window 4 . The procedure is divided into sections for each major space vehicle environmental change. The major sections are:

1610 pre-protective cover installation
1610 Boeing weight measurements
1610 space vehicle canning
Transportation to SLC-2W
Space Craft erection
MST DMA and Can removal
MST protective cover removal
MST fairing installation

Note: Appendix 3 provides contingency responses in case the dew point exceeds the specifications outlined in this procedure.

This is **not** a hazardous procedure.

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, LM/P479945 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

A rupture of the main tank burst disk(s) will be obvious due to the plume of cold gas. Emergency vent lines are installed over the burst disks on the SMD vacuum shell during this procedure to eliminate the possibility of direct plume impingement on personnel. Orderly evacuation shall be performed in the event one or more of these burst disks rupture. An oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5% will be set up in this procedure as an added precaution. Fall back area in the event of evacuation is building

1605. Temperature and pressure alarms, provided by the DAS, warn of potential over-pressure conditions.

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 a ladder. In the unlikely event of a large LHe spill all employees have been instructed to evacuate the room and contact NASA safety. Additional safety mitigations are specified in some of the procedures called by this procedure.

B.2.3 Other Hazards

All tools or other items used with the potential to damage the SV 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, burst disk failure) are listed in Appendix 3.

C Quality Assurance

C.1 QA Notification

The NASA program and 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 judgment of the TD or QA Representative, mission 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.

C.3.1 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.

C.3.2 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.

C.3.3 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 Pump Module, and 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 Pump Module is cooled by a circulating chilled water unit. The vent output of the Gas Module flows through the Pump Module. The Electrical Module contains instrumentation and provides remote control of valves in the Gas Module, Pump Module, and SMD. The External Heater Control Unit (HCU) is a separate unit which provides power and temperature control of various external heaters associated with the Main Tank and Guard Tank vent plumbing. Other GSE and non-flight items that are part of the initial hardware configuration are noted in E.5.5.

E.3.3 Computers and Software:

The Data Acquisition System (DAS) and data acquisition software are required for some of the procedures called by 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:

Description	***Manufacturer***	***Model***
Dew Point Meter	_____	_____
O_2 Monitor and Alarm	Alpha-Omega Instruments	1000

E.3.5 Additional Hardware:

Description	*Manufacturer*	*Model*
Misc Polypropylene Tubing (Class 250) 1/4”	N/A	
Misc clean (Class 250) 1/4” copper tubing	N/A	–
Misc clean (Class 250) SS 1/4” bellows line with VCR fittings	Swagelok	
Assorted regulators and VCR/Swagelok fittings	N/A	–

E.3.6 Personnel Protective Equipment: N/A

E.3.7 Tools: N/A

Description
Misc hand tools

E.3.8 Expendables N/A

Description	*Quantity*	*Mfr./Part No.*
Gaseous Nitrogen-certified to MIL 27401D 1B	N/A	N/A

E.4 Instrument Pretest Requirements: N/A

E.5 Configuration Requirements

E.5.1 Main Tank
N/A

E.5.2 Guard Tank
N/A

E.5.3 Well
N/A

E.5.4 SMD Vacuum Shell
N/A

E.5.5 GSE and Non-flight Hardware

E.5.5.1 N/A.

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
EM SYS229	Accident/Mishap/Incident Notification Process
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
EWR 127- 1	Eastern and Western Range Safety Requirements
KHB 1710.2 rev E	Kennedy Space Center Safety Practices Handbook

F.3 Additional Procedures

Document No.	***Title***

Op. Order No._____
Date Initiated_____
Time Initiated_____

G Operations

G.1 Verify preparations

- o Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- o Verify NASA Program representative notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- o Verify that the persons performing this procedure, the test director, and safety engineer are identified in Sec. D.3.

- o Verify performance of pre-operations checklist (Appendix 1).

- o Verify availability of equipment, hardware, tools, and expendables listed in sections E.3.2 through E.3.8.

Note:
The following sections detail the steps to be taken to mitigate possible condensation on window 4. Each section covers a different space vehicle configuration and provides the proper monitoring and controls necessary for that environment.

Caution:
This procedure establishes monitoring of the dew point in building 1610, the MST and the payload fairing via temperature and humidity. A dew point meter is provided and should be used as necessary. If the dew point might exceed 10 degrees C, steps must be taken to mitigate possible moisture condensation on window 4. Appendix 3 provides the steps necessary for contingency situations when the dew point nears or exceeds 10 degrees C.

G.2 VAFB B1610 Pre-Protective Cover Installation

G.2.1 Establish nitrogen purge to Sun shade

G.2.1.1 Install clean, class 250, 1/4” polypropylene tubing to the 2 micron filter on the sun shade protective cover. Note: There are two filters on the sun shade cover, an input and output, ensure the input filter is used.

G.2.1.2 Record approximate length and weight of tubing used:_____lbs

G.2.1.2.1 Record scale cal due date:_____

G.2.1.2.2 Weight measurements should be taken to an accuracy of +/- .1 lb

G.2.1.3 Ensure nitrogen facility supply meets MIL standard 27401D 1B requirements.

G.2.1.3.1 The gas during all building 1610 activities is supplied by a 50,000cf trailer located outside the building

G.2.1.3.2 Record Air Force certification:_____

G.2.1.3.3 Record certification date:_____

G.2.1.4 Adjust flow rate to 2scfh and while purging connect facility nitrogen to tubing from G.2.1.1.

G.2.2 Establish monitoring of B1610/ Window 4 environment and nitrogen purge

G.2.2.1 Four times a day record data in table 1

G.2.2.1.1 Note that the window 4 frame temperature can only be recorded when the ECU is turned on and therefore this may be less than 4 times a day depending on vehicle activities

G.2.2.1.2 The dew point is determined from the temperature and relative humidity. A table is included in appendix 4 for calculating the dew point from temperature and humidity

QA Witness:_____

G.3 B1610 Boeing Weight Measurements

Note:
. The sunshade purge will be temporarily disconnected while Boeing uses the crane to make a weight measurement of the space vehicle . Constant monitoring of the facility environment is necessary for this short time period.

G.3.1 Ensure configuration is as outlined in G.2

G.3.2 Ensure B1610 dew point below 12C before proceeding.

G.3.2.1 Record dew point:_____

G.3.3 After the space vehicle is attached to the crane and prior to removing the bolts securing it to the assembly stand, disconnect sun shade purge line from regulator, cover open ends of the line and tie off remaining line to

vehicle

G.3.3.1 The time that the sun shade purge is disconnected should be no longer than 10 minutes.

G.3.3.2 Record time the sunshade purge is removed _____.

G.3.3.3 If necessary due to time constraints, reconnect sun shade purge for 30 minutes restart G.3.3

G.3.4 Constant monitoring of the B1610 environment should be maintained while sun shade purge is disconnected, including recording data in Table 1.

G.3.5 When weight measurements complete and the vehicle is set in the assembly stand while the crane is still connected, while purging reconnect sun shade purge line to nitrogen supply and establish flow rate of 2scfh

G.3.6 Record the time the flow rate is established _____.

G.3.7 Discontinue constant monitoring and reestablish monitoring as outlined in G.2.2

QA Witness:_____

Note: It will be necessary to provide Boeing with weight of tubing based on length recorded in G.2.1.2

Note: At this point, the space vehicle will be lifted by the crane and mated to the PAF. The sun shade purge will remain connected for this time period.

G.4 B1610, Mating of the Space Vehicle to the DMA

G.4.1 Ensure B1610 dew point below < 12C before proceeding.

G.4.1.1 Record dew point:_____

G.4.2 When Boeing prepared to install the DMA on to PAF/Space Vehicle, disconnect sun shade purge, cover open ends of line and tie off remaining line to vehicle

G.4.2.1 The time that the sun shade purge is disconnected should be no longer than 10 minutes.

G.4.2.2 Record the time the sunshade purge is removed _____.

G.4.2.3 If necessary due to time constraints, reconnect sun shade purge for 30 minutes and restart G.4

G.4.3 Constant monitoring of B1610 environment should be maintained while the purge is disconnected, including recording data in table 1

G.4.4 After Boeing mates the DMA to the PAF/Space Vehicle, while purging reconnect sun shade purge to nitrogen supply, ensuring the line is fed out in the appropriate configuration for transport to MST and space vehicle erection

G.4.5 Reestablish flow rate of 2scfh

G.4.6 Record the time the flow rate is established_____

G.4.7 Discontinue constant monitoring and reestablish monitoring as outlined in G.2.2

QA Witness:_____

G.5 Transport to SLC-2W

G.5.1 Ensure nitrogen supply for canister meets MIL standard 27401D 1B

G.5.1.1 Record Air Force certification:_____

G.5.1.2 Record certification date:_____

G.5.2 Ensure 2 bottles (T or K) of nitrogen loaded on the transporter for sun shade purge are certified to MIL standard 27401D 1B. Note that one T or K bottle at a pressure > 2000 psi and a flow rate of 20 scfh will last > 10 hours.

G.5.2.1 Record nitrogen bottles serial numbers:_____/_____

G.5.2.2 Record Air Force certification:_____

G.5.2.3 Record certification date:_____

G.5.2.4 Ensure pressure in both bottles >2000 psi

G.5.2.4.1 Record pressures:_____/_____

G.5.3 After Can/Space Vehicle installed on transporter, disconnect sun shade purge from facility nitrogen supply and connect purge to transporter bottles. Note the time the sun shade purge will be disconnected is less than 2 minutes

G.5.4 Establish flow rate of 20 scfh

QA Witness:_____

Note:
The window #4 environment is protected during this operation, when the sun shade purge is disconnected, by the nitrogen purge of the canister.

G.6 Space Craft Erection

G.6.1 Once the space vehicle has arrived at SLC-2W, verify sun shade purge intact.

G.6.2 Verify canister purge functioning

G.6.3 When can/space vehicle ready to lift, disconnect sun shade purge from the transporter supply bottle, cover open end of line and tie off lines as appropriate.

QA Witness:_____

Note:
The following section should be performed immediately after PAF/Space Vehicle secured to Delta vehicle and access is possible

G.7 Space Vehicle Can and DMA Removal in MST

G.7.1 Ensure clean, class 250, line installed between nitrogen supply on MST

level 3 and space vehicle access level 5

G.7.1.1 Ensure tubing has been capped after installation to ensure the cleanliness has been maintained.

Note:
The Boeing, at SLC-2W, will install a purge line under direction from the SU cryogenics team member to allow for immediate purging once the PAF/Space Vehicle is secured to Delta . Verify nitrogen supply has been certified to MIL standard 27401D IB

G.7.1.2 Ensure two nitrogen six packs available for use on the MST

G.7.1.2.1 Ensure pressure in both six packs greater than 2000 psi

G.7.1.2.2 Note that more bottles can be brought up through the elevator if circumstances should warrant it.

G.7.1.3 Record Air Force certification date:_____

G.7.1.4 Record certification supplier:_____

G.7.2 After PAF/Space Vehicle secured to Delta, while purging reconnect sun shade purge and establish flow rate of 2scfh

Note:
At this point Boeing will remove can sections from the Space Vehicle.

G.7.3 Ensure MST dew point below < 12C before proceeding.

G.7.3.1 Record dew point:_____

G.7.4 When Boeing prepared to remove the DMA from the PAF/Space Vehicle, disconnect sun shade purge

G.7.4.1 Record the time the sunshade purge is removed _____.

G.7.4.2 The time that the sun shade purge is disconnected should be no longer than 10 minutes.

G.7.4.3 If necessary due to time constraints, reconnect sun shade purge for 30 minutes and restart G.7.3

G.7.5 Constant monitoring of MST environment should be maintained while the purge is disconnected, including recording data in table 1

G.7.6 After Boeing removes the DMA from the PAF/Space Vehicle, while purging, reconnect sun shade purge to nitrogen supply.

G.7.7 Record the time the flow rate is established_____

G.7.8 Reestablish flow rate of 2scfh

G.7.9 Discontinue constant monitoring and reestablish monitoring as outlined in G.2.2

QA Witness:_____

Note:
The following sections remove the sun shade purge to support removal of the space vehicle sun shade protective cover and fairing installation. After the fairing is installed a conditioned air purge is established until launch. Also, after the protective cover removal, the only contingency response to a rising dew point is to turn on the window 4 heaters. In order to turn on the window 4 heaters the space vehicle must be powered up. This process may take multiple hours and hence the monitors should take the appropriate conservatism, vis-à-vis a rising dew point, to allow for this delay.

G.8 MST Protective cover removal, fairing not installed

G.8.1 Ensure MST dew point < 10 degrees C

G.8.2 When LM team prepared to remove protective cover, disconnect sun shade purge

G.8.3 Monitoring of the MST environment should be increased to every 30 minutes

G.9 Fairing installed

G.9.1 After fairing has been installed, begin monitoring and recording in data sheet fairing temperature and humidity in addition to MST temperature and humidity

G.9.1.1 Monitoring should be maintained at 30 minutes intervals

G.9.2 Prior to any access hatch removal, ensure MST environmental requirements satisfied and note hatch removal in log

QA Witness:_____

G.10 Verify Completion of Post-Operations Checklist

H **Operation completed.**

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____Date_____

Payload Test Director_____Date_____

Date Time	Temp -C	Relative Humidity	Inferred Dew Point	Nitrogen Purge Supply Pressure (psi)	Nitrogen Purge Flow Rate (scfh)	Fairing Temp (C)	Fair Humd.	Window 4 Temp (K)	Space Vehicle Loca /Comments

l Appendix 1 – Pre-Procedure 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-Procedure 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	Dew Point of Building 1610, MST or ambient atmosphere predicted to exceed 10 degrees C	Including and before sections G.7	Increase sun shade purge flow rate to 20 scfh until dew point drops below 10 degrees C and the cause for the out of spec condition is corrected
		Including and after section G.8	1. Request space vehicle powered on 2. Using scripts win4_off.prc and win4_off.prc, cycle window 4 heaters on and off to maintain window temperature above dew point. Note that the window frame temperature is ~6 C cooler than actual window temperature, and the temperature controlled by the ECU is the frame temperature. 3. The temperature of the frame should not exceed 35 C . 4. Continue constant monitoring while recording data every 10 minutes until environmental problem root cause identified and resolved 5. After problem resolved, space vehicle power is no longer needed and can be powered down as needed
4	Burst disk rupture (MT/GT)	ANYTIME	Evacuate room
5	Oxygen Meter Alarm	ANYTIME	Evacuate room

Appendix 4 Dew Point Determination Chart (Dew Point in degrees C)

	%RH								
Temperature(F)	30	35	40	45	50	55	60	65	70
50	-6.76	-4.74	-2.96	-1.37	0.07	1.39	2.60	3.73	4.79
51	-6.28	-4.25	-2.46	-0.87	0.58	1.91	3.13	4.26	5.32
52	-5.80	-3.76	-1.96	-0.36	1.09	2.42	3.65	4.79	5.85
53	-5.31	-3.27	-1.47	0.15	1.61	2.94	4.17	5.32	6.39
54	-4.83	-2.77	-0.97	0.65	2.12	3.46	4.70	5.85	6.92
55	-4.35	-2.28	-0.47	1.16	2.63	3.98	5.22	6.37	7.45
56	-3.86	-1.79	0.03	1.66	3.14	4.49	5.74	6.90	7.98
57	-3.38	-1.30	0.53	2.17	3.65	5.01	6.26	7.43	8.52
58	-2.90	-0.81	1.03	2.67	4.16	5.53	6.79	7.96	9.05
59	-2.41	-0.32	1.53	3.18	4.68	6.05	7.31	8.48	9.58
60	-1.93	0.17	2.03	3.68	5.19	6.56	7.83	9.01	10.11
61	-1.45	0.66	2.52	4.19	5.70	7.08	8.35	9.54	10.64
62	-0.97	1.15	3.02	4.69	6.21	7.60	8.88	10.07	11.18
63	-0.49	1.64	3.52	5.20	6.72	8.11	9.40	10.59	11.71
64	0.00	2.13	4.02	5.70	7.23	8.63	9.92	11.12	12.24
65	0.48	2.62	4.52	6.21	7.74	9.15	10.44	11.65	12.77
66	0.96	3.11	5.01	6.71	8.25	9.66	10.96	12.17	13.30
67	1.44	3.60	5.51	7.22	8.76	10.18	11.49	12.70	13.83
68	1.92	4.09	6.01	7.72	9.27	10.69	12.01	13.23	14.37
69	2.40	4.58	6.50	8.22	9.78	11.21	12.53	13.75	14.90
70	2.88	5.07	7.00	8.73	10.29	11.73	13.05	14.28	15.43
71	3.36	5.56	7.50	9.23	10.80	12.24	13.57	14.81	15.96
72	3.84	6.05	7.99	9.73	11.31	12.76	14.09	15.33	16.49
73	4.32	6.54	8.49	10.24	11.82	13.27	14.61	15.86	17.02
74	4.80	7.03	8.99	10.74	12.33	13.79	15.13	16.38	17.55
75	5.28	7.51	9.48	11.24	12.84	14.30	15.66	16.91	18.08
76	5.76	8.00	9.98	11.75	13.35	14.82	16.18	17.44	18.62
77	6.24	8.49	10.47	12.25	13.86	15.34	16.70	17.96	19.15
78	6.72	8.98	10.97	12.75	14.37	15.85	17.22	18.49	19.68
79	7.19	9.46	11.46	13.25	14.88	16.37	17.74	19.01	20.21
80	7.67	9.95	11.96	13.76	15.39	16.88	18.26	19.54	20.74