GRAVITY PROBE-B

PROCEDURE FOR SCIENCE MISSION DEWAR

CERTIFY PUMP MODULE AFTER TRANSPORT

To be performed at Vandenberg Air Force Base building 1610

WARNING: THIS DOCUMENT CONTAINS HAZARDOUS OPERATIONS

P1025

October 28, 2002

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REVISION RECORD

REVISION	ECO	PAGES	DATE

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List of Abbreviations and Acronyms

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

LM	Lockheed Martin Co.

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 start up the Pump Module after transportation, and check all gauges, pneumatic valves, and pumps for proper operation.

The hazardous operation contained in this procedure is the acoustic noise level generated by the Pump Module. This risk is mitigated by properly installing a sound proof cover. In addition, adding liquid nitrogen to the leak detector posses a cryogenic hazard.

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 VAFB building 1610, the GP-B cryogenic team provides an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5%. Additional temperature and pressure alarms, provided by the DAS, warn of potential over-pressure conditions. Emergency vent lines 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

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

B.3. **Mishap Notification**

B.3.1. Injury

In case of any injury or illness requiring 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/emergency (e.g., power failure) are listed in Appendix 3.

C. QUALITY ASSURANCE

C.1. **QA Notification**

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

C.2. **Red-line Authority**

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

C.3. **Discrepancies**

A Quality Assurance Representative designated by D. Ross shall review any discrepancy noted during this procedure, and approve its disposition.

Discrepancies will be recorded in a D-log or a DR per Quality Plan P0108. Any time a procedure calls for verification of a specific configuration and that configuration is not the current configuration, it represents a discrepancy of one of three types. These types are to be dealt with as described below.

1. If the discrepancy has minimal effect on procedure functionality (such as the state of a valve that is irrelevant to performance of the procedure) it shall be documented in the procedure, together with the resolution. Redlines to procedures are included in this category.
2. If the discrepancy is minor and affects procedure functionality but not flight hardware fit or function, it shall be recorded in the D-log. Resolution shall be in consultation with the PTD and approved by the QA representative.
3. All critical and major discrepancies, those that effect flight hardware fit or functions, shall be documented in a D-log and also in a Discrepancy Report, per P0108.

D. TEST PERSONNEL

D.1. Personnel Responsibilities

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

D.2. Personnel Qualifications

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

D.3. Required Personnel

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

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

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

When working on the space vehicle, proper ESD protection is required. ESD wrist-straps will be checked on 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. Ground Support Equipment

None required

E.3.2. Test Equipment

Description
Varian Leak Detector S/N #_____ Cal Due Date:_____

E.3.3. Additional Hardware

1. 4 liter cryogenic thermos (used for nitrogen trap fills)
2. Pump Module Sound Proof Enclosure

E.3.4. Tools

None required

E.3.5. Personnel Protective Equipment

1. Cryogenic safety gloves and apron
2. Face Shield
3. Goggles/glasses
4. Non-absorbent shoes

E.3.6. Expendables

Description	Quantity	Mfr./Part No.
Liquid nitrogen	AR	N/A
99.999% pure helium gas	AR	N/A

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	
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,	VG-1, VG-2	96021521	No	-

No.	*Location*	*Description*	*Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
		Granville-Phillips 360	VG-5			

E.5. Configuration Requirements

N/A

E.6. Optional Non-flight Configurations

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

F.3. Additional Procedures

Document No.	*Title*
SU/GP-B P0879	Accident/Incident/Mishap Notification Process
SU/GP-B P1015	Connect Vacuum Module to SMD
SU/GP-B P0875	GP-B Maintenance and Testing at all Facilities
SU/GP-B P1024	Prepare Payload GSE for Transport

Operation Number:_____

Date Initiated:_____

Time Initiated:_____

G. OPERATIONS

G.1. Pre-Operations Verifications

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify NASA program representative notified.

  Record: Individual notified _____,

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

  Record: Individual notified _____

  Date/Time:_____,

- Record calibration due dates in sections. E.3.2
- Persons actually performing this procedure should list their names in Sec D.3.
- Verify completion of the pre-operations checklist (Appendix 1).
- Verify proper operation of GP-B Cryogenic Team oxygen monitor
- Verify availability and functioning of emergency shower.

G.2. Establish Initial Condition of Pump Module

G.2.1. Visually inspect Pump Module. Record damage: _____

_____

G.2.2. Verify all access ports are capped.

1. Primary pump-out port (at PV-1)
2. WTM set up (PV-5 and PV-6)

G.2.3. Connect the 30A power cord to the PDU

G.2.4. Connect the 60A power cord to the corresponding hub on the wall

G.2.5. Connect the water cooling lines to the chiller and verify a flow rate of .8 gpm

G.2.6. Connect source of compressed air to compressed air input port

G.2.7. Connect cable XYZ to the Electrical Module

G.2.8. Power of both the 60A and the 30A breakers

G.2.9. Record status of pneumatic valves per lighted switches.

Valve	*Switch Light on (Open)*	*Switch Light off (Closed)*	*Expected Status*
PV-1 (Gate Valve)			Closed
PV-2			
PV-3			Closed

G.2.10. Record Status of Manual Valves

Valve	*Status*	*Expected Status*
PV-4		Closed
PV-5		
PV-6		

G.2.11. Turn on/verify on pressure gauges PG-1.

G.2.12. Record PG-1:_____torr

G.2.13. Install sound proof enclosure around Pump Module

G.2.14. Verify normal operation rotary vane pump (RVP) and roots blower (RBP) as follows:

1. Turn on RVP and verify proper pump rotation
2. Turn on RBP and verify proper rotation
3. Verify decrease in pressure at PG-1

G.2.15. Verify normal operation of PV-1.

1. Record pressures
    a. PG-1 _____ torr.
2. Turn off RVP and RBP
3. Open PV-1 and verify rise in pressure at PG-1
    a. PG-1:_____
4. Turn off the 60A breaker and verify PV-1 closes
5. Turn back on the 60A breaker
6. Ensure PV-1 closed

G.2.16. Verify proper operation of PV-3

WARNING
The following operations involve steps that pose a cryogenic safety hazard. When filling the nitrogen trap in the leak detector, wear cryogenic safety apron, gloves, face shield with goggles/glasses, and non-absorbent shoes. Failure to comply may result in personal injury.

G.3. **Connect PM to Gas Module**

G.3.1. Request NASA Safety Make PA Announcement that hazardous operations are about to begin.

G.3.2. Request area warning light be changed to amber.

G.3.3. Establish a controlled area of 15 feet.

G.3.4. Ensure all nonessential personnel are clear of controlled area.

G.3.5. Verify closed EV-21, EV-22, EV-5, EV-4, RGA-LV, RGA-SOV, and EV-14

G.3.6. Ensure PV-1 closed.

G.3.7. Connect the Pump Module to the Gas Module at the Pump Out port on the Gas Module

G.3.8. Ensure a two feet clear area established around leak detector

G.3.9. Turn on and verify calibration of leak detector. Record

1. Calibrated leak value _____ sccs; cal exp. Date:_____
2. Measured leak value _____ sccs

G.3.10. Open EV-5, EV-14, and EV-21

NOTE
The operations that involve steps that pose a cryogenic safety hazard are now complete.

G.3.11. Request NASA Safety make PA Announcement that hazardous operations are now complete.

G.3.12. Request area operation light be returned to green.

G.3.13. Disband controlled area.

G.3.14. Connect leak detector to Access 3 port of Gas Module

G.3.15. Leak check all joints between Gas Module and Pump Module

1. Ensure background on the 10*E-6 range
2. Record initial background:_____scc/s He
3. Record final background:_____scc/s He

G.3.16. Close EV-5, EV-14, and EV-21

G.3.17. Vent and disconnect leak detector

G.3.18. Cap Access Port 3 on GM

G.4. **Verify Final Configuration**

G.4.1. Ensure all Pump Module Valves Closed

G.4.2. Ensure RVP and RBP off

G.4.3. Verify completion of post operations checklist

H. PROCEDURE COMPLETION

Completed by:_____

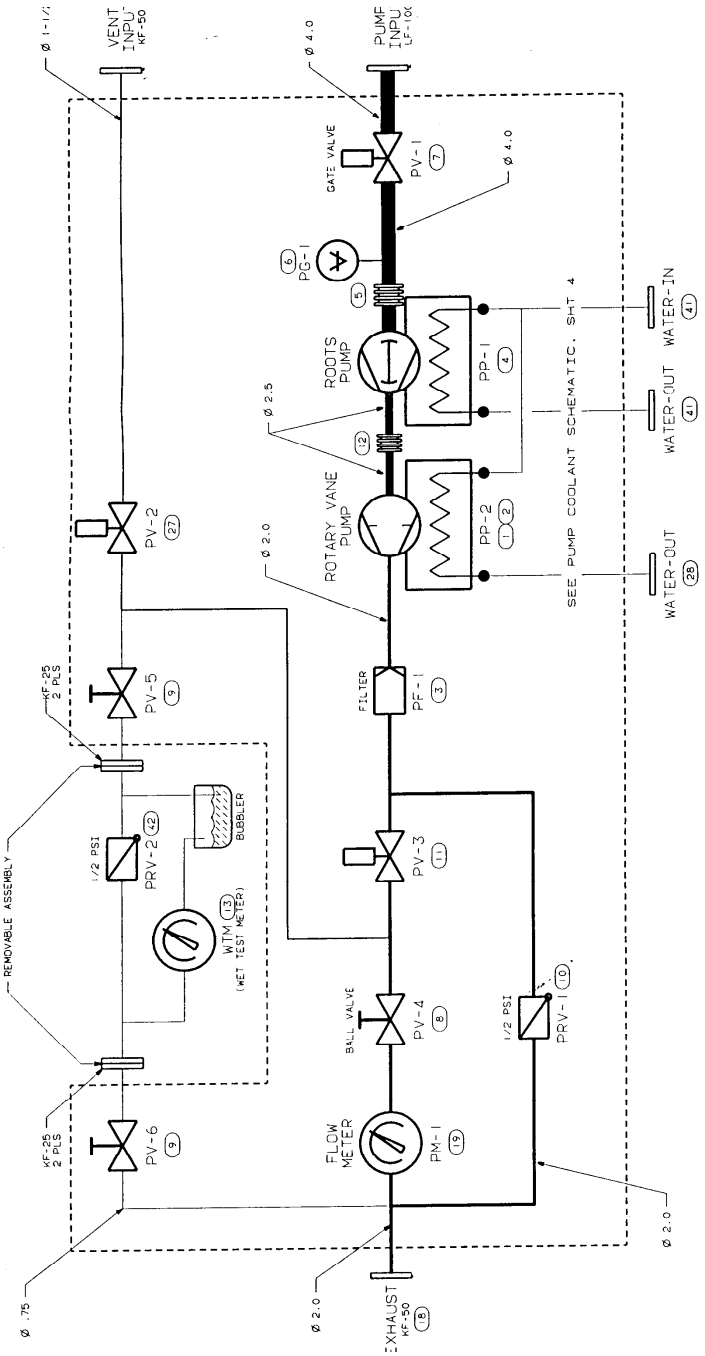
Witnessed by:_____

Date: _____

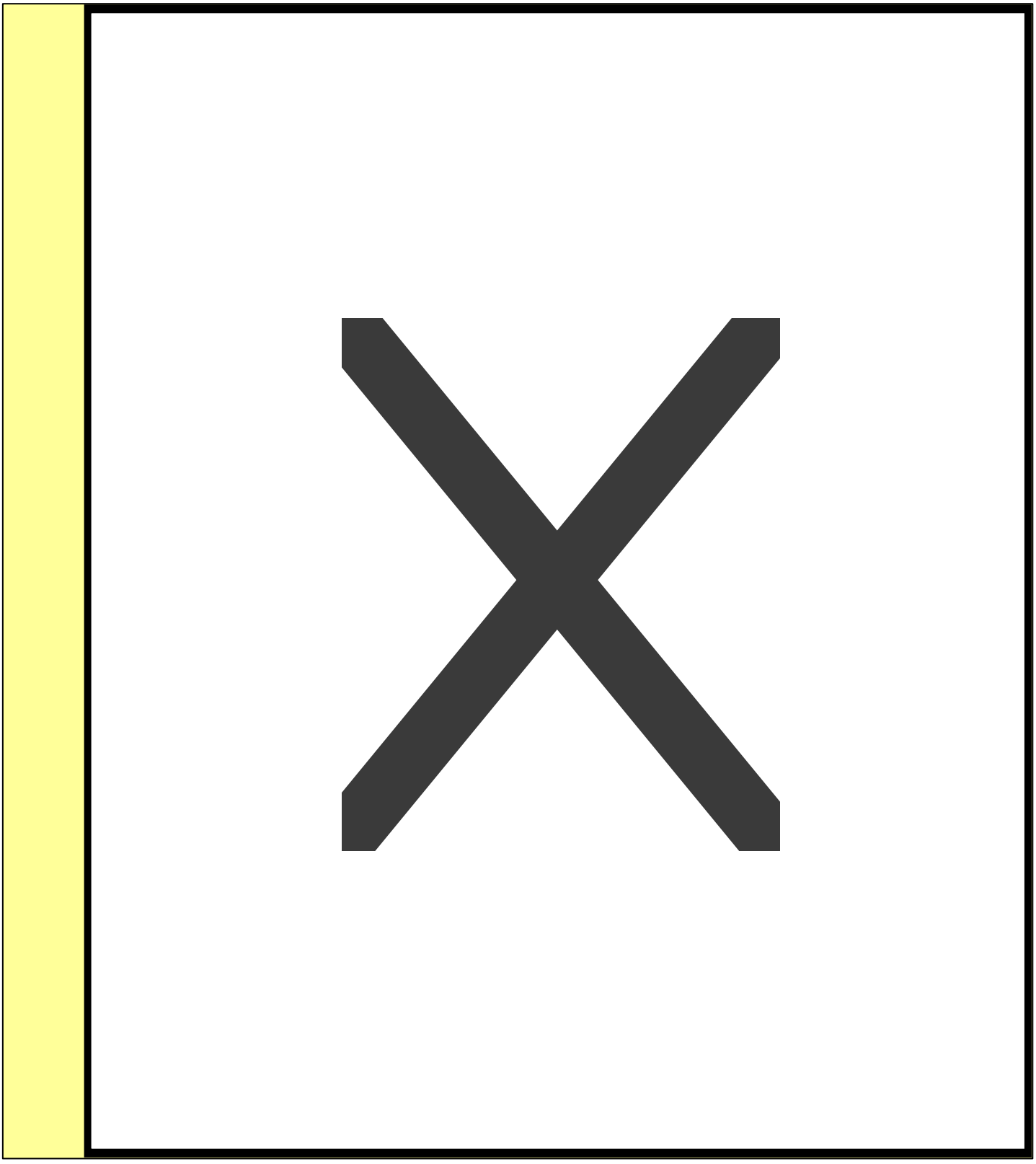
Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____


VENT INPUT KF-50
PUMP INPUT LF-100
Ø 1-1/2
Ø 4.0
GATE VALVE
PV-1 7
Ø 4.0
PG-1 6
ROOTS PUMP
PP-1 4
Ø 2.5
ROTARY VANE PUMP
PP-2 1 2
Ø 2.0
SEE PUMP COOLANT SCHEMATIC, SHT 4
WATER-IN 41
WATER-OUT 41
WATER-OUT 28
PV-2 27
KF-25 2 PLS
PV-5 9
FILTER
PF-1 3
REMOVABLE ASSEMBLY
1/2 PSI
PRV-2 42
BUBBLER
WTM 13 (WET TEST METER)
PV-3 11
BALL VALVE
PV-4 8
1/2 PSI
PRV-1 10
KF-25 2 PLS
PV-6 9
FLOW METER
PM-1 19
Ø 2.0
Ø .75
Ø 2.0
EXHAUST KF-50 18

Gas Module Diagram



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. Perform Engineering/Safety high-bay walk down. Ensure all discrepancies are corrected prior to start of operations.		
	11. Confirm that each test team member understands that there will be a post-test team meeting.		
	Team Lead Signature: _____		

I. 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: _____		

J. APPENDIX 3– CONTINGENCY/EMERGENCY RESPONSES

Condition	Circumstance	Response
Power Failure	Anytime	Wait for power restoration, and resume procedure
Liquid nitrogen spill	Anytime	Clear area until all spilled liquid has evaporated
Temperature limits (CN 29 or 28) exceeded	Any time	Close EV-17 (if open) and open EV-9. 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.
Burst disk rupture (MT/GT)	Any time	Evacuate room
Pressure in Main Tank exceeds limit	Anytime	Open Main Tank Vent Valve
Oxygen monitor alarm	Anytime	Evacuate room