W. W. Hansen Experimental Physics Laboratory

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Gravity Probe B Relativity Mission

Proto-qual Thermal VacuumTest Procedure GMA Assembly (25110)

GP-B P0587 Rev.-

10 August, 2000

Prepared by: K. Burns GP-B Thermal Products Team Leader	Date
Approved: L. Sokolsky LMMS GMA Engineer	Date
Approved : G. Asher GMA Manager	Date
Approved : D. Ross Quality Assurance	Date
Approved : B. Muhlfelder Hardware Manager	Date

1 SCOPE

This Op Order is for protoqual thermal vacuum testing of the GMA assembly (25110). The test will demonstrate warm and cold GMA operation, verify heaters and thermostats, and will act as a workmanship test of the GMA.

The GMA will be mounted into a thermal enclosure, and the enclosure will then be placed in the thermal vacuum chamber. The electrical lines and thermocouples will pass through a vacuum connector bulkhead in the chamber. The GMA EMI Frame will be installed for the test. The test is to be performed in an LMSS thermal vacuum chamber located in Sunnyvale.

2 TEST INFORMATION

- Proper care should be taken in handling the GMA. Cleanliness must be preserved. The GMA must be kept bagged whenever it is not in the chamber, with the exception that the bag may be opened in order to instrument the GMA with accelerometers.
- Lab temperature: 15-26 º C
- Lab humidity: not critical

2.1 Cleanliness

2.1.1 Normal lab environment when GMA is bagged

2.1.2 Class 1000 Clean room when valves are open to atmosphere (use clean bench)

2.2 ESD precautions

2.2.1 None

2.3 Use of connector savers

2.3.1 Connector savers will be used on all gas and electrical connections.

ONR representative, and QA to be notified 24 hours prior to beginning this procedur
SU QA_____time & date ONR_____ time & date

2.4 Personnel, QA, and Documentation

2.4.1 Test Director

2.4.2 The Test Director (TD) shall be Kevin Burns or an alternate that he shall designate. The TD has overall responsibility for the implementation of this procedure and shall sign off the completed procedure and relevant sections within it. The GMA Manager shall also sign off the completed "As-Built" procedure.

2.4.3 Integration Engineers and other personnel. All engineers and technicians participating in this procedure shall work under the direction of the TD who shall determine personnel that are qualified to participate in this procedure.

2.4.4 The test shall be conducted on a formal basis to approved and released procedures. The QA program office shall be notified of the start of this procedure. A Quality Assurance Representative, designated by D. Ross shall be present during the procedure (if deemed necessary) and shall review any discrepancies noted and approve their disposition. Upon completion of this procedure, the QA Manager, D. Ross or her designate, shall certify their 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. Discrepancies will be recorded in a D-log or as a DR per Quality Plan P0108. If a re-test of any or all of the hardware is necessary, the TD will determine the appropriate changes in the procedure, with the QA and Payload Technical Manager's approval.

2.5 Red-line Authority

2.5.1 Authority to redline (make minor changes during execution) this procedure is given solely to the ITD or his designate, or the GMA Manager, and shall be approved by QA. Additionally, approval by the Payload Technical Manager shall be required, if in the judgment of the TD or QA Representative, experiment functionality may be affected.

3 APPLICABLE DOCUMENTS

3.1 Documents

Document number	Rev	Title
25110	B	Gas Management Assembly
PLSE-12	-	Science Payload Specification
LAC-3026	-	Environmental Control
C-12 Manual Environmental	-	LMMS Safety and Protection STDS
8A02056GSE	-	GMA Thermal Box
	-	Engineering unit ECU
	-	Test cables
MIL-STD-1450	C	Test Requirements for Space Vehicles

3.2 Flight Parts

F/N	Description	Part Number	Rev	Serial Number
1	**GMA Assembly**	**25110**		

Test Equipment

Equipment	Model and Serial Number	Calibration
Thermal Chamber		
Engineering unit ECU		

3.3 Materials

Type-T thermocouples, 30 gage
LAC 24-4451 Aluminum tape
LAC 24-4450-2000 Kapton tape
LAC 24-4655 Fiberglass tape

4 REQUIREMENTS

4.1 Definitions

4.1.1 Temperature Stabilization is achieved when the unit is within the specified test tolerance and the rate of temperature change is less than 3°C/hour for thirty minutes. Use the average temperature of the thermocouples located on the pallet to define the temperature of the GMA temperature.

4.1.2 The transition rate between hot and cold shall be at an average rate of 3 to 5 °C/min and not less than 1 °C/Min.

4.2 Special

4.2.1 Always wear clean, dry nylon or surgery type gloves when handling the GMA to prevent damage caused by skin oil and/or perspiration.

4.2.2 The GMA is extremely fragile and any damage can critically affect the performance of the GMA.

4.2.3 When necessary, 2-Propanol alcohol shall be the solvent used in cleaning all surfaces. Cotton swabs shall be used as the wiping material for fingerprints, smudges, lint, dust, etc. Care shall be taken not to damage the surfaces or interconnects.

4.2.4 All loose objects, such as pencils, pens, badges, etc., shall be removed from open pockets when working on or adjacent to the GMA.

4.2.5 In the event that thermal vacuum testing is temporarily discontinued for extended periods of time, the GMA shall be controlled to a temperature of 25°C ±10°C and shall remain under vacuum.

4.3 Safety

4.3.1 Personnel shall be clear of potentially hazardous areas during tests.

4.3.2 During test and at all times prior to delivery to the user, the unit shall be protected from damage.

4.3.3 Safety requirements specified in LMMS Safety and Environmental Protection Standards, C-12 Manual shall be rigidly complied with during performance of all tests defined herein.

5 INSTRUMENTATION / TEST SET-UP

5.1 Notify ONR representative (Ed Ingraham) of start of GMA thermal vacuum test.

Person contacted_____

Date & time_____

5.2 QA to witness all testing.

5.3 Chamber Setup

5.3.1 Clear out a large area in front of chamber so that all operations may be performed without interference.

5.4 Test Setup

5.4.1 Move the Shipping Container with the Test Specimen to the front of the chamber.

5.4.2 Open the Shipping Container carefully, using best shop practice. Inspect the GMA for damage.

Unit Condition is Acceptable_____.

REE

(If the REE is not available, the **Responsible Test Engineer** may sign)

5.4.3 Check for any other items mounted on the GMA or the special test equipment that must be removed prior to test.

5.4.4 Install thermocouples per para 8. Place two thermocouples near each of the three sets of thermostats that control the three heaters on the edge of the pallet. Place two thermocouples at the center of the pallet. Place thermocouples on the valves per engineering direction.

5.4.5 Verify operation and identity of thermocouples with a hand held T/C reader. If they are not operating properly, repair before installing the GMA in the chamber. Secure the thermocouple wires to the GMA.

5.4.6 Place the GMA in the GMA Thermal Box (8A02056GSE).

5.4.7 Place the GMA Thermal Box in the chamber.

5.4.8 Connect all thermocouples to the Chamber data acquisition system.

5.4.9 Attach the GMA cables to the chamber feed-throughs.

5.4.10 Perform final check on the test article and chamber.

Check List:

1. Remove any connector caps.
2. Remove all extraneous tape from the STE and GMA
3. Check for extraneous tools or materials.
4. Verify that all the T/C's are functioning.
5. Strain relief T/C's.

5.4.11 Prior to running the Ambient Functional Test, the test setup must be inspected and approved by the REE or Responsible Test Engineer.

Approved: _____ Date/Time: _____

REE

(If the REE is not available, the **Responsible Test Engineer** may sign)

NOTE: Any further adjustment or modification of the test set-up must be approved by the REE.

6 TEST OPERATION

6.1 Prepare the facility for operation.

6.1.1 Verify that all chamber equipment has been calibrated and that all calibrated equipment certificates will be in calibration for the duration of the test. If the calibration certificates for a piece of equipment expires before the completion of the test, then the equipment is to be re-calibrated prior to the start of the test.

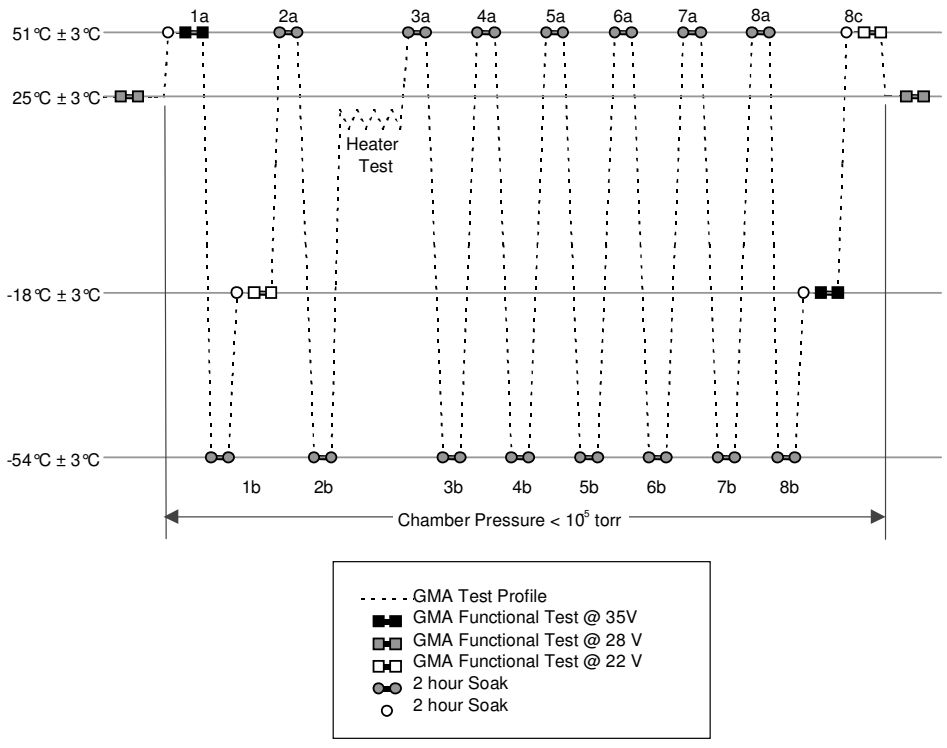
6.1.2 Initiate data acquisition system and verify that all readings are nominal.

6.2 Proto-qualification Testing

6.2.1 Pre-TVAC Ambient Functional Testing – cycle all valves and record all pressure and flow rate readings

6.2.1.1 Perform thermal vacuum cycling as shown in Figure 6-1.

Figure 6-1
Thermal Vacuum Cycling Diagram



6.2.1.2 Enter the test start time and date.

Date/Time:	
GMA avg pallet temp	
GMA avg box temp	

6.2.1.3 With the GSE power supply initialized, turn ON the GMA and perform a GMA functional test: cycle all valves and record all pressure readings. Attach readings to back of procedure.

Date/Time:	
Pass/Fail	
Verify	
GMA avg pallet temp	
GMA avg box temp	

6.2.1.4 Seal chamber and evacuate to a pressure of less than 10^{-5} torr.

Date/Time:
Pressure:

6.2.2 Cycle No. 1

6.2.2.1 Ramp the temperature of the GMA to **+51°C ±3°C.**

6.2.2.2 When the GMA has stabilized per para. 4.1.1 to **+51°C ±3°C,** soak GMA at **+51°C +3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.2.3 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.2.4 Perform a GMA Functional test at **+51°C ±3°C.** With the GSE power supply initialized, turn ON the GMA and perform a GMA functional test: cycle all valves and record all pressure readings. Attach readings to back of procedure.

Date/Time:	
Pass/Fail	
Verify	
GMA avg pallet temp	
GMA avg box temp	

6.2.2.5 Ramp GMA temperature to **-54°C ±3°C,** per para. 4.1.2.

6.2.2.6 When the GMA has stabilized per para. 4.1.1 to **-54°C ±3°C**, record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.2.7 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.2.8 Ramp GMA temperature to **-18°C +3°C,** per para. 4.1.2.

6.2.2.9 When the GMA has stabilized per para. 3.1.1 to **-18°C ±3°C**, soak GMA at **-18°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.2.10 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.2.11 Perform a GMA functional test at **-18°C ±3°C**. With the GSE power supply initialized, turn ON the GMA and perform a GMA functional test: cycle all valves and record all pressure readings. Attach readings to back of procedure.

Date/Time:	
Pass/Fail	
Verify	
GMA avg pallet temp	
GMA avg box temp	

6.2.3 Cycle No. 2

6.2.3.1 Ramp GMA temperature to **+51°C ±3°C** per para 4.1.2.

6.2.3.2 When the GMA has stabilized per para. 3.1.1 to **+51°C ±3°C**, soak GMA at **+51°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.3.3 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.3.4 Ramp GMA temperature to **-54°C ±3°C** per para 4.1.2

6.2.3.5 When the GMA has stabilized per para. 3.1.1 to **-54°C ±3°C**, soak GMA at **-54°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	

Date/Time:

6.2.3.6 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.4 Heater Test

6.2.4.1 Enable GMA pimary heaters. Heaters will drive pallet to 20°C

6.2.4.2 Cycle primary heaters on/off a minimum of 2 times (2 on/off cycles)

6.2.4.3 Disable primary heaters

6.2.4.4 Enable secondary heaters

6.2.4.5 Cycle secondary heaters on/off a minimum of 2 times (2 on/off cycles)

6.2.5 Cycle No. 3

6.2.5.1 Ramp GMA temperature to **+51°C ±3°C** per para 4.1.2.

6.2.5.2 When the GMA has stabilized per para. 3.1.1 to **+51°C ±3°C**, soak GMA at **+51°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.5.3 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.5.4 Ramp GMA temperature to **-54°C ±3°C** per para 4.1.2

6.2.5.5 When the GMA has stabilized per para. 3.1.1 to **-54°C ±3°C**, soak GMA at **-54°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.5.6 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.6 Cycle No. 4

6.2.6.1 Ramp GMA temperature to **+51°C ±3°C** per para 4.1.2.

6.2.6.2 When the GMA has stabilized per para. 3.1.1 to **+51°C ±3°C**, soak GMA at **+51°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	

Date/Time:

6.2.6.3 Record time and temperature at end of soak.

Temperature pallet	
Date/Time:	

6.2.6.4 Ramp GMA temperature to **-54°C ±3°C** per para 4.1.2

6.2.6.5 When the GMA has stabilized per para. 3.1.1 to **-54°C ±3°C**, soak GMA at **-54°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.6.6 Record time and temperature at end of the soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.7 Cycle No. 5

6.2.7.1 Ramp GMA temperature to **+51°C ±3°C** and per para 4.1.2.

6.2.7.2 When the GMA has stabilized per para. 3.1.1 to **+51°C ±3°C**, soak GMA at **+51°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.7.3 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.7.4 Ramp GMA temperature to **-54°C +3°C** per para 4.1.2

6.2.7.5 When the GMA has stabilized per para. 3.1.1 to **-54°C ±3°C**, soak GMA at **-54°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.7.6 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.8 Cycle No. 6

6.2.8.1 Ramp GMA temperature to **+51°C ±3°C** per para 4.1.2.

6.2.8.2 When the GMA has stabilized per para. 3.1.1 to **+51°C ±3°C**, soak GMA at **+51°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	

Date/Time:

6.2.8.3 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.8.4 Ramp GMA temperature to **-54°C ±3°C** per para 4.1.2

6.2.8.5 When the GMA has stabilized per para. 3.1.1 to **-54°C ±3°C**, soak GMA at **-54°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.8.6 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.9 Cycle No. 7

6.2.9.1 Ramp GMA temperature to **+51°C ±3°C** per para 4.1.2.

6.2.9.2 When the GMA has stabilized per para. 3.1.1 to **+51°C ±3°C**, soak GMA at **+51°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.9.3 Record time and temperature at end of soak.

Temperature pallet	
Date/Time:	

6.2.9.4 Ramp GMA temperature to **-54°C ±3°C** per para 4.1.2

6.2.9.5 When the GMA has stabilized per para. 3.1.1 to **-54°C ±3°C**, soak GMA at **-54°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.9.6 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.10 Cycle No. 8

6.2.10.1 Ramp GMA temperature to **+51°C ±3°C** per para 4.1.2.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.10.2 When the GMA has stabilized per para. 3.1.1 to **+51°C ±3°C**, soak GMA at **+51°C +3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.10.3 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.10.4 Ramp GMA temperature to **-54°C ±3°C** per para 4.1.2

6.2.10.5 When the GMA has stabilized per para. 3.1.1 to **-54°C ±3°C**, soak GMA at **-54°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.10.6 Record time and temperature at end of soak.

Temperature pallet	
Date/Time:	

6.2.10.7 Ramp GMA temperature to **-18°C ±3°C** per para 4.1.2

6.2.10.8 When the GMA has stabilized per para. 3.1.1 to **-18°C +3°C**, soak GMA at **-18°C +3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.10.9 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.10.10 Perform a GMA Functional Test at **-18°C ±3°C** per procedure GMA 0FF.

Date/Time:	
Pass/Fail	
Verify	
GMA avg pallet temp	
GMA avg box temp	

6.2.10.11 Ramp GMA temperature to **+51°C ±3°C** and per para 4.1.2.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.10.12 When the GMA has stabilized per para. 3.1.1 to **+51°C ±3°C**, soak GMA at **+51°C ±3°C** for 2 hours. Record time and temperature at start of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.10.13 Record time and temperature at end of soak.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

6.2.10.14 Perform a GMA Functional Test at **+51°C ±3°C** per procedure GMA 0FF.

Date/Time:	
Pass/Fail	
Verify	
GMA avg pallet temp	
GMA avg box temp	

6.2.11 Ramp GMA temperature to **25°C ±3°C** per para 3.1.2.

GMA avg pallet temp	
GMA avg box temp	
Date/Time:	

Note: Prior to opening the chamber door, the GMA temperature shall be above the dew point.

6.2.12 Post-TVAC Ambient Test

6.2.12.1 Return the chamber to ambient pressure.

6.2.12.2 Open chamber door.

6.2.12.3 After the temperature of the GMA has stabilized to ambient conditions, perform a GMA functional test. With the GSE power supply initialized, turn ON the GMA and perform a GMA functional test: cycle all valves and record all pressure and flow rate readings. Attach readings to back of procedure.

Date/Time:	
Pass/Fail	
Verify	
GMA avg pallet temp	
GMA avg box temp	

6.3 Terminate Facility Operation.

6.3.1.1 Record any test anomalies such as appearance, failures, problems, etc on a test discrepancy report.

Test complete / OK to disconnect _

REE

(If the REE is not available, the **Responsible Test Engineer** may sign)

7 GMA REMOVAL

7.1 Disconnect Instrumentation and Specimen Removal

7.1.1 Disconnect thermocouple instrumentation from the GMA and secure thermocouple leads

7.1.2 Carefully remove the GMA from the chamber and place it in its shipping container or on an appropriate work surface per best shop practice.

7.1.3 Inspect the GMA for deformities and damage.

7.1.4 Disassemble the test set-up.

7.1.5 Unit Condition is Acceptable_____

REE

(If the REE is not available, the **Responsible Test Engineer** may sign)

7.1.6 Close the Shipping Container

7.2 Shipping

7.2.1 Notify REE or a designated Program person that the GMA is ready for shipment.

7.3 Test Conclusion

7.3.1 Clean up Area

7.3.2 Deliver all hard copy temperature plots of required thermocouples, and data to Thermodynamics or a designated Program person.

8 THERMOCOUPLE INSTALLATION

8.1 Clean Surface

Gently clean the area to be instrumented using a cotton swab wetted with 2-Propanol alcohol. While wet, surface shall be wiped dry using absorbond TX 409 cloth.

8.2 T/C Type and Insulation

All thermocouples will be welded 30 gage Type T, do not use Delta Bond. The T/C's will be isolated with the double back Kapton tape.

8.3 Sandwich Thermocouples

Sandwich all thermocouple's in double back Kapton tape. (LAC 24-4378C). Build and install thermocouple's using E8-10 thermocouple standards.

8.4 Place on surface

Place 30 gage Cu-Cn thermocouple (Type T) on surface.

8.5 Tape Thermocouple

Adhere thermocouple with 3/4" x 1" piece of aluminum tape. (LAC 24-4451, 1" side along length of thermocouple wire).

8.6 Strain Relief

Put a strain relief on the T/C wire one (1) to two (3) inches from the bead.

Figure 8-1 - GMA Thermal Vacuum Test Profile

9 PROCEDURE COMPLETION

The results obtained in the performance of this procedure are acceptable:

9.1

_____ date: _____
GMA Thermal Vacuum Test Director

Discrepancies if any:

Approved: _____ date: _____
GMA REE

Approved: _____ date: _____
QA Manager

10 6. DATA BASE ENTRY

The following data shall be entered into the GP-B Database:

- Name, number and revision of this procedure
- Date of successful completion of procedure.
- Part numbers and serial number of GMA assembly and components