STANFORD UNIVERSITY
W.W. HANSEN EXPERIMENTAL PHYSICS LABORATORY
GRAVITY PROBE B, RELATIVITY GYROSCOPE EXPERIMENT
STANFORD, CALIFORNIA 94305-4085

VENT SERVICE CART ACCEPTANCE TEST PROCEDURE

P0988 Rev –

22 April, 2003

PREPARED	R. Stephenson, GMA Engineer	Date
APPROVED	C. Gray, GMA REE	Date
APPROVED	Harv Moskowitz, LMSSC Safety Engineer	Date
APPROVED	D. Ross, Quality Assurance	Date
APPROVED	R. Brumley, Hardware Manager	Date

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REVISION HISTORY

Rev	Date	Comments
-	4/22/03	

A SCOPE

The purpose of this procedure is to perform an acceptance test of the Vent Service Cart (VSC). This involves a proof test to greater than 125% of MAWP, a leak test, a particle contamination test, functional test, and a helium purity check. Upon performance of this procedure, the VSC will be certified for connection to and service of flight hardware. Sections of this procedure should be completed in order, but there may be significant elapsed time between them.

B SAFETY

B.1 Ground Support Equipment (GSE)

All of the GSE used in this procedure have pressure ratings considerably higher than the maximum expected operating pressures. At times pressure up to 2000 psia may be used. At this time the same caution should be taken as when using a standard gas supply cylinder.

During the operation, some lines connecting equipment together will represent minor trip/snag hazards – these hazards shall be minimized by careful routing, securing, and/or marking of such lines. Only qualified personnel under the supervision of the Test Director should work directly with this equipment.

B.2 Contamination

Care should be exercised whenever venting any gas system to atmosphere to ensure that the internal volumes of the VSC plumbing are only exposed to appropriate environments. Improper venting of air into critical wetted areas can result in contamination requiring significant cleanup and verification. These operations are expected to occur in FIST Ops, a Class 100,000 clean room, but may occur in any similar environment. The operator making the connection shall visually inspect all fluid connections.

B.3 Personnel Threatening Emergencies

In the event of an emergency threatening personnel health or safety, the area shall be evacuated without regard for equipment safety. Post-emergency steps shall be documented by D-log as required.

C QUALITY ASSURANCE

C.1 QA Notification

This operation will be conducted on a formal basis to approved and released procedures. **The QA program office shall be notified 24 hours prior to the start of this procedure**. A Quality Assurance Representative, designated by D. Ross shall be present during the procedure and shall review any discrepancies noted and approve their disposition. Upon completion of this procedure, the QA Program Engineer, D. Ross or her designate, will certify 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 redline (make minor changes during execution) this procedure is given solely to the Test Director or his designate and shall be approved by the QA Representative.

C.3 Discrepancies

Discrepancies will be recorded in a D-log or as a DR per Quality Plan P0108.

D TEST PERSONNEL

The Test Director shall be Rick Stephenson or an alternate that he shall designate. The Test Director has overall responsibility for the implementation of this procedure and shall sign off the completed procedure and relevant sections within it. Additional personnel shall be assigned and supervised by the Test Director.

E REQUIREMENTS

E.1 Electrostatic Discharge Requirements

N/A

E.2 Lifting Operation Requirements

N/A

E.3 Hardware/Software Requirements

- Vent Service Cart (VSC)
- Leak detector, Alcatel internally calibrated, or equivalent
- Helium gas, 6.0 grade or better, at least 2000 psia for purity check
- Helium gas, 4.5 grade or better, for particle checking (may use same gas as above, if available)
- Nitrogen gas, 4.0 grade or better, at least 2200 psia for proof testing
- Pressure gauge, >2500 psia, NIST traceable calibrated;

  Serial number: _____ cal due date: _____
- Pressure gauge, >600 psia, NIST traceable calibrated

  Serial number: _____ cal due date: _____
- Hand held particle counter, calibrated

  Serial number: _____ cal due date: _____
- Sample bottle, 1 liter, prepared for use as helium purity sample
- High flow filter, 0.5 micron or better
- Appropriate connection plumbing (flex lines, tees, caps, plugs, elbows, valves, etc.)

E.4 Instrument Pretest Requirements

All test equipment used to verify test data is required to be “in calibration.”

E.5 Configuration Requirements

- VSC should be completely assembled

E.6 Optional Non-flight Configurations

N/A

E.7 Verification/ Success Criteria

All requirements in Table 1 have been met.

E.8 Constraints and Restrictions

N/A

F REFERENCE DOCUMENTS

F.1 Drawings

- VSC Schematic
- VSC drawing, "VSC-A001"

F.2 Supporting documentation

N/A

F.3 Additional Procedures

N/A

G OPERATIONS

G.1 Verify Appropriate QA Notification

QA Notified_____
(Date & Time)

G.2 Proof Test and Pressure Gauge Verification

Started on: _____
Note: MAWP for the VSC is 1470 psig upstream, and 300 psi downstream.

G.2.1 Verify that the VSC is completely assembled, incorporating the Varian Pump Cart.

G.2.2 If necessary, remove the 1620 psig and 330 psig relief valves from the VSC and replace with VCR cap (or plug).

G.2.3 Close all VSC valves. Open VSC regulator (Vreg-1) slightly (clockwise).

G.2.4 Connect Nitrogen supply to service port and cap the output port. Use a VCR "tee" to connect a >600 psia calibrated pressure gauge (External Gauge 2) in line with the Nitrogen.

G.2.5 Start vacuum pump and slowly open GV-6, GV-7, GV-4, GV-3, and GV-2. Meter the flow if necessary using GV-6.

G.2.6 When pressure reaches $<5x10^{-3}$ torr, Close GV-2, GV-6, and Vreg-1 (CCW) and stop vacuum pump.

G.2.7 Introduce Nitrogen through GV-7 to a pressure of 350 (±25) psig.

G.2.8 Verify that VP-2 matches the External Gauge 2 within 10%.
Ex. Gauge 2: _____ VP-2: _____ Percent error: _____

G.2.9 Record VP-2 verification in Table 1.

G.2.10 Reset Bottle Regulator and slowly introduce Nitrogen through GV-7 to a pressure of 575 (±25) psig.

G.2.11 Once desired pressure is reached, close off the Nitrogen bottle regulator (CCW).

G.2.12 Wait for 10 minutes.

G.2.13 Slowly open GV-5 and vent the nitrogen to atmosphere. Meter the flow with the valve.

G.2.14 Close GV-5, GV-3, GV-4, and GV-7 when pressure reaches 10 psig (± 5 psi).

G.2.15 Record in Table 1 completion of low-pressure side proof test and proof pressure.

G.2.16 Close Bottle Valve and disconnect Nitrogen bottle. Leave the pressure gauge on the service port, but place a VCR cap (or plug) on the open port of the VCR "tee".

G.2.17 Connect Nitrogen bottle and high pressure calibrated gauge (External Gauge 1) to the fill port at GV-1 and open Bottle Valve.

G.2.18 Verify that GV-2 is open and Vreg-1 is as low as possible (fully CCW).

G.2.19 Slowly open GV-1.

G.2.20 Reset Bottle Regulator and slowly introduce Nitrogen through GV-1 to a pressure of 1850 (±10) psig.

G.2.21 Once desired pressure is reached, close the bottle valve.

G.2.22 Verify that VP-1 matches the External Gauge 1 within 10%.

Ex. Gauge 1: _____ VP-1: _____ Percent error: _____

G.2.23 Record VP-1 verification in Table 1.

G.2.24 Wait for 10 minutes.

G.2.25 Open Vreg-1 to about 50 psig.

G.2.26 Slowly open GV-3.

G.2.27 Slowly open GV-5 to vent the pressure from the system.

G.2.28 When pressure reaches 10 psig (± 5 psi) close GV-5, GV-3, GV-2, and GV-1.

G.2.29 Record in Table 1 completion of high-pressure side proof test and proof pressure.

G.2.30 Use bottle vent to vent the high pressure Nitrogen supply.

Section G.2 complete. QA _____

G.3 Relief Valve Check and VSC Pressure Regulator Verification

Started on: _____

G.3.1 Verify proof test is successfully complete (section G.2).

G.3.2 Install the relief valves on the high and low-pressure sides of the VSC.

G.3.3 Open GV-1, GV-2, GV-3, and GV-7.

G.3.4 Slowly introduce Nitrogen through GV-1 to about 1500 psig. Through this whole section, monitor the calibrated gauge at the service port to make sure there is no unexpected pressure build up.

G.3.5 Monitor the high-pressure calibrated gauge and continue to increase pressure until the relief valve cracks. Note this pressure and back off the bottle regulator (CCW) until the relief valve reseats. Note cracking pressure here:_____

G.3.6 Repeat step G.3.4 three times to get an average cracking pressure. Record those pressures here: #1_____ #2_____ #3_____

G.3.7 Back the bottle regulator off a small amount and record the completion of the high-pressure relief valve check and the average and minimum cracking pressures in Table 1.

G.3.8 Slowly open Vreg-1 (CW) until the downstream pressure is about 250 psig.

G.3.9 Monitor the low-pressure calibrated gauge at the service port and continue to increase pressure until the relief valve cracks. Note this pressure and back off Vreg-1 (CCW) until the relief valve reseats. Note cracking pressure here:_____

G.3.10 Repeat step G.3.9 three times to get an average cracking pressure. Record those pressures here: #1_____ #2_____ #3_____

G.3.11 Back Vreg-1 off a small amount and record the completion of the low-pressure relief valve check and the average and minimum cracking pressures in Table 1.

G.3.12 Close the bottle regulator completely (full CCW).

G.3.13 Slowly open GV-5 and vent the pressure from the VSC.

G.3.14 When pressure reaches 10 psig (± 5 psi) close GV-5, GV-7, and GV-1.

G.3.15 Start the pump cart.

G.3.16 Slowly open GV-6 to evacuate the VSC.

G.3.17 Disconnect the Nitrogen bottle and calibrated pressure gauges and cap (or plug) the Service Port.

Section G.3 complete. QA _____

G.4 Leak Check

Started on: _____

G.4.1 Verify that leak detector is warmed up and calibrated.

G.4.2 Verify that VSC valves GV-7, GV-5, GV-4, and GV-1 are closed.

G.4.3 Verify that VSC valves GV-2, GV-3, GV-6, and regulator are open.

G.4.4 Connect leak detector to the Service Port of the VSC.

G.4.5 Start leak detector and evacuate up to GV-7.

G.4.6 Close GV-6 and open GV-7.

G.4.7 When leak detector goes into test mode, spray a small amount of Helium around each VSC connection and component while monitoring the leak detector. Start at GV-1 and work towards the leak detector.

G.4.8 Fix any leaks that are found above $5x10^{-7}$ sccs and repeat step G.4.7 as needed.

G.4.9 Verify that GV-4 is closed and remove plug from outlet port.

G.4.10 Spray helium in the outlet port to check the through leak of GV-4. Leak rate must be less than $<1x10^{-6}$ sccs.

G.4.11 Record completion of the leak check and highest leak measured in Table 1.

Section G.4 complete. QA _____

G.5 Valve Closure Check

Started on: _____
Note: Criterion for all valves is a through leak of $<1x10^{-6}$ sccs.

G.5.1 Connect plumbing to the external Helium supply bottle (for purging) and set the bottle regulator so that a small amount of gas is flowing from the plumbing (this requires that the Bottle Valve be open and the Bottle Vent be closed).

G.5.2 Allow to purge for 2 minutes and install high flow filter to the plumbing outlet where it will connect to the VSC.

G.5.3 Connect Helium supply and filter to GV-1.

G.5.4 Verify that VSC manual valves GV-2, GV-3, and GV-7 are open, and that Vreg-1 is still somewhat open. Verify that GV-1, GV-4, GV-6, and GV-5 are closed.

G.5.5 Verify that leak detector is operating correctly and the background is $<10^{-6}$ sccs.

G.5.6 Set Helium Supply bottle regulator to about 300 psig.

G.5.7 Monitor leak detector for any leaks through GV-1.

G.5.8 Close VSC valve GV-2.

G.5.9 Slowly open GV-1.

G.5.10 Monitor leak detector for any leaks through GV-2.

G.5.11 Close GV-3 and slowly open GV-2.

G.5.12 Set VSC regulator Vreg-1 to about 200 psig.

G.5.13 Monitor leak detector for any leaks through GV-3.

G.5.14 Close GV-7 and slowly open GV-3.

G.5.15 Monitor leak detector for any leaks through GV-7.

G.5.16 Close GV-7 and shut down and remove leak detector.

G.5.17 Record completion of valve through leak test and highest leak rate in Table 1.

Section G.5 complete. QA _____

G.6 Particle Test

Started on: _____

G.6.1 Verify that Helium supply is connected per steps G.5.1 through G.5.3.

G.6.2 Close VSC regulator Vreg-1 down to a minimal pressure.

G.6.3 Open GV-4.

G.6.4 Set Vreg-1 to provide a reasonable flow from the outlet of the VSC (~1-10 lpm).

G.6.5 Let the VSC purge like this for at least 5 minutes.

G.6.6 Fashion a clean room bag into an air trap with small openings at either end.

G.6.7 Affix air trap to the VSC outlet. Set flow with Vreg-1 so that gas slightly inflates the air trap.

G.6.8 Insert particle counter inlet loosely into other end of air trap.

G.6.9 Allow gas to flow for at least 2 minutes to purge line.

G.6.10 Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 10 per cubic foot. Record samples #1 ___ #2 ___ #3 ___ #4___ #5 ___

G.6.11 If VSC does not pass, allow to purge for a reasonable amount of time and repeat step G.5.13. If a source of contamination is suspected, clean up or remove this source before repeating test.

G.6.12 Close GV-4 and GV-1.

G.6.13 Disconnect Helium supply.

G.6.14 Start vacuum pump and open GV-6 to evacuate the VSC.

G.6.15 Record completion of particle check and average number of particles in Table 1.

Section G.6 complete. QA _____

G.7 Purity Check

Started on: _____

G.7.1 Connect the high purity Helium supply to the VSC fill port per diagram 1. Make sure to add a vent to the supply plumbing.

G.7.2 Close the supply Bottle Valve.

G.7.3 Verify that VSC valves GV-1, GV-5, GV-4, and GV-7 are closed.

G.7.4 Verify that VSC valves GV-2, GV-3, and GV-6 are open and the vacuum pump is operating.

G.7.5 Open GV-1 to evacuate plumbing line.

G.7.6 Connect an evacuated sample bottle to the VSC outlet.

G.7.7 Close GV-3 and slowly open GV-4.

G.7.8 When vacuum stabilizes, open GV-3 and the sample bottle valve.

G.7.9 Allow the VSC to sit in this state for a sufficiently long time (minimum 24 hours). Record hold time here: _____

G.7.10 Close GV-3 and GV-4.

G.7.11 Open the Helium bottle regulator a small amount and open the Helium Bottle valve.

G.7.12 Set Helium pressure to between 800 and 1000 psig.

G.7.13 Set Vreg-1 to between 250 and 300 psig.

G.7.14 Slowly open GV-3.

G.7.15 Close GV-1 and disconnect Helium supply.

G.7.16 Allow the VSC to sit in this state for a sufficiently long time (minimum 24 hours). Record hold time here: _____

G.7.17 Slowly open GV-4.

G.7.18 When pressure stabilizes, increase pressure using the VSC regulator to at least 300 psig if necessary. Do not exceed the minimum cracking pressure of the relief valve as measured above.

G.7.19 Close sample bottle valve.

G.7.20 Slowly open GV-5 to vent the VSC.

G.7.21 When pressure reaches 10 psig (±5 psi) close GV-5, GV-4, and GV-3.

G.7.22 Remove sample bottle and cap the bottle and the outlet port of the VSC.

G.7.23 Send sample to Atlantic Analytical for purity analysis.

G.7.24 Record completion of purity sampling in Table 1.

G.7.25 Determine which configuration to leave the VSC in and perform the appropriate section of this procedure (G.7 or G.8).

G.7.26 When results are obtained, record completion of purity check and the results in Table 1.

Section G.7 complete. QA _____

G.8 VSC Final Configuration, Charged

Started on: _____
Note: This section may be performed before G.6.26 is completed. If the VSC is to be evacuated for shipping, this section may be skipped.

G.8.1 Verify that all VSC valves are closed and that the downstream pressure is near 10 psig.

G.8.2 Place a VCR cap (or plug) on the Output, Fill, and Service ports (where necessary).

G.8.3 Close Vreg-1 (full CCW).

G.8.4 Slowly open GV-2 and record tank pressure here: _____.

G.8.5 Set Vreg-1 to about 20 psig.

G.8.6 Open GV-3 and wait for pressure to stabilize.

G.8.7 Close GV-2 and GV-3.

G.8.8 Shut down turbo pump, disconnect any remaining GSE, and lock valves GV-1, GV-5, GV-4, GV-7 and GV-6 closed.

G.8.9 Record final state of VSC in Table 1.

Section G.8 complete. QA _____

G.9 VSC Final Configuration, Evacuated

Started on: _____
Note: This section may be performed before G.6.26 is completed. If the VSC is to be left charged, this section may be skipped.

G.9.1 Verify that all VSC valves are closed and that the downstream pressure is near 5 psig.

G.9.2 Place a VCR cap (or plug) on the Output, Fill, and Service ports (where necessary).

G.9.3 Close off Vreg-1 (full CCW).

G.9.4 Slowly open GV-2.

G.9.5 Set Vreg-1 to a minimal pressure and slowly open GV-3.

G.9.6 Slowly open GV-5 to vent the VSC. Use GV-5 to meter the flow.

G.9.7 When pressure reaches 5 psig (±5 psi) close GV-5.

G.9.8 Start pump cart and slowly open GV-6 to evacuate the VSC. Use GV-6 to meter the flow if necessary.

G.9.9 When VSC is evacuated (below 10^{-3} torr), close GV-2, GV-3, and GV-6.

G.9.10 Shut down turbo pump, disconnect any remaining GSE, and lock valves GV-1, GV-5, GV-4, GV-7, and GV-6 closed.

G.9.11 Record final state of VSC in Table 1.

Section G.9 complete. QA _____

H PROCEDURE SIGN OFF

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

_____ date: _____
Test Director/GMA Engineer

Discrepancies if any:

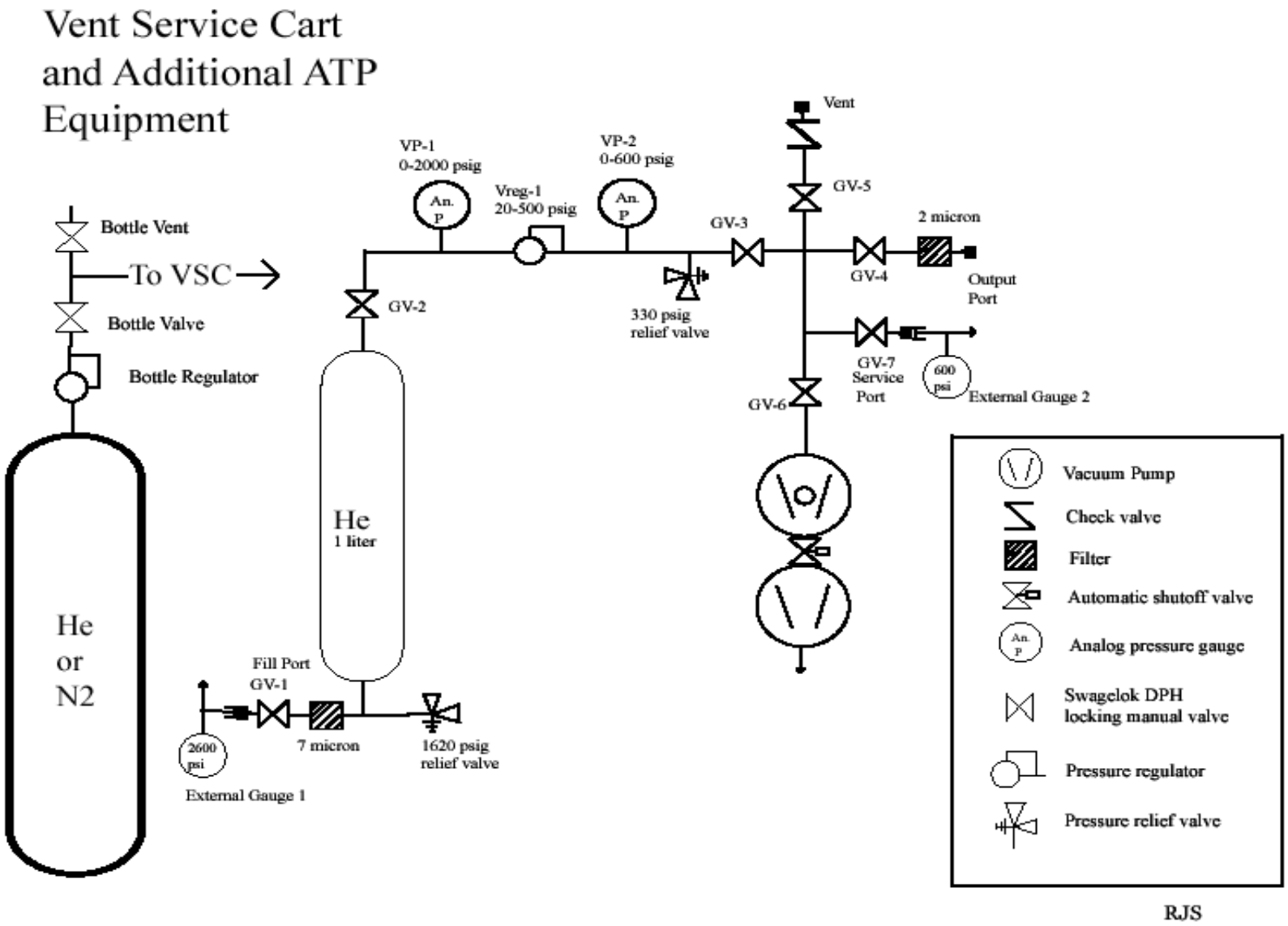
Approved: _____ date: _____
C. Gray, GMA REE

Approved: _____ date: _____
QA Representative

Approved: _____ date: _____
D. Ross, QA

I ILLUSTRATIONS AND TABLES

I.1 Figure 1 – VSC Schematic



I.2 Figure 1 – VSC Schematic

procedure section	Completion Date	Complete (initial)	Data	Requirement	Data name	comments
G.2.9 VP-2 Verification				Within 10% of calibrated gauge	VP-2 accuracy	
G.2.15 Low Pressure Proof Test				>550 psig	Proof Pressure	
G.2.23 VP-1 Verification				Within 10% of calibrated gauge	VP-1 accuracy	
G.2.29 High Pressure Proof Test				>1840 psig	Proof Pressure	
G.3.7 High Pressure Relief Valve Check				1620 psig 10% tolerance	Average Cracking Pressure	
					Minimum Cracking Pressure	
G.3.11 Low Pressure Relief Valve Check				330 psig 10% tolerance	Average Cracking Pressure	
					Minimum Cracking Pressure	
G.4.11 Leak Check				$<5x10^{-7}$ sccs	Highest Leak Rate	
G.5.17 Valve Through Leak Check				$<1x10^{-6}$ sccs	Highest Through LeakRate	
G.6.15 Particle Test				$<10/ft^3$	Average 0.5 micron particles	
G.7.24 Purity Sample taken			N/A	N/A	N/A	
G.7.26 Purity Check Results				>99.9995%	Helium purity by percent	
G.8.9 or G.9.11 Final VSC State (circle one)				N/A	Downstream pressure	
Evacuated or Charged:				N/A	Bottle pressure	