SU/GP-B P0388 Rev –

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CLEANLINESS TEST OF PROBE SPINUP EXHAUST LINES

GP-B SCIENCE MISSION PROCEDURE

14 September, 1998

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1 SCOPE

NOTE: This is an Optional Procedure which does not verify any SM requirement

This document provides the procedure for checking the cleanliness of the four Spinup Exhaust Lines in Probe-C. This procedure is done after Probe delivery to Stanford, prior to installing the SIA. It assumes that Probe-C is mounted on the Precision Manipulator per P0205 in the HEPL Class 10 Cleanroom, and the Probe Vacuum Shell has been removed per P0376. Gaseous Nitrogen (GN_2) will be flowed through the exhaust lines from the Top Hat warm end to the cold end at the gyro locations (back-flow method). A particle counter is used to detect particles at the cold end for various flow rates of at least three times the nominal flow rate of 1000 sccm utilized during Science Mission spinup. This procedure is done prior to the Vatterfly Valves being installed on the exhaust lines.

Note: The use of nitrogen instead of helium makes no significant difference at ambient temperature and pressure because the flow rates are so much higher than during spinup.

1.1 Experiment Logic

This experiment is intended to provide an extreme worst case test and is meant only to give an indication of gross contamination in the lines within the probe. LMMS delivers the probe with all its internal parts, including the internal surfaces of these exhaust lines, certified to Mil Spec Level 100 cleanliness, and thus this experiment is primarily a confirmation of cleanliness under the extreme overkill conditions achievable at room temperature in the laboratory under ambient conditions.

During actual gyro spinup, GHe flows from the cold end of the lines to the Top Hat valve port at pressures well below 0.5 torr (< 0.001 atm.). The concern is that, at these low pressures, if there were significant particulate contamination in the region of the lines near the cold end, particles might possibly backstream against the ambient flow of approximately 1000 sccm and enter the gyroscope, which has no filter on its exhaust output.

To demonstrate that the lines are sufficiently clean in the cold region, gas flows = 3000 sccm are set up in the reverse direction to normal, i.e. towards the gyro end. A flow rate = 3000 sccm is dictated by the constraints of the experimental setup. A typical flow rate is usually approx. 4000 sccm corresponding to about 4 times the flow rate during spinup. In combination with other factors, this should cause similarly higher forces on any particulates present in the lines than would be experienced during spinup in Science Mission.

1.2 Result Goals

The goals are an estimate based on the worst case test logic described in Section 1.1 above, in order to determine if there is gross contamination that is inconsistent with cleaning methods previously applied. As a result of the qualitative, gross nature, of the test the goal is that the data show an average count rate = 1 particles (= 0.5 microns) per cu ft per minute (scfm) after initial flow is established for 2 minutes. The reason for waiting 2 minutes, allows particulates which may be present in the regions of the plumbing closer to the Top Hat (and due to the connection of experimental hardware) to be flushed out.

If gross contamination is suspected the lines will be flushed with nitrogen for at least 5 minutes and the experiment repeated.

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ACRONYMS AND APPLICABLE DOCUMENTS

2.1 Acronyms

The following acronyms are used in this document

PM	Precision Manipulator
GN_2	Gaseous Nitrogen
EV1-4	Exhaust Valve for Gyros 1-4, on Top Hat
PC	Particle Counter
l/m	liters per minute
l/s	liters per second
sccm	cubic centimeters per minute at standard temperature and pressure
scfm	cubic feet per minute at standard temperature and pressure
PC	Particle Counter

2.2 Applicable Documents

P0059	GP-B Contamination Control Plan
P0057	Stanford Magnetic Control Plan
P0205	Mounting Probe on Precision Manipulator
P0376	Removing the Probe Vacuum Shell

3

GENERAL REQUIREMENTS

3.1 Environmental Requirements

This procedure will be conducted in the Stanford Class 10 Cleanroom in the HEPL facility.

3.1.1 Room Cleanliness

The Class 10 clean room where this integration takes place shall be maintained at the cleanliness levels per Federal Standard 209D. All personnel in the clean room shall wear certified Class 10 cloth garments.

3.1.2 Particulate Contamination

All parts and tools shall be cleaned at least to the cleanliness levels of the rooms where they are used for assembly or testing. In addition, all parts shall be maintained at level 100 cleanliness per GP-B Contamination Control Plan (P0059). A portable particle counter shall be set up on a table downstream of the local work area, and monitored to ensure that particulate counts are consistent with GP-B Contamination Control Plan P0059. Take all necessary precautions to keep tools and handling equipment free of particulate contamination.

To the maximum extent possible, personnel shall keep all parts of their bodies downstream of the probe, defined by the direction of HEPA airflow.

3.1.3 Magnetic Contamination

All parts and tools shall be cleaned using methods consistent with achieving Mil Spec Level 100 cleanliness. In addition, all parts shall be maintained at level 100 cleanliness per GP-B Magnetic Control Plan, Science Mission (P0057). Take all necessary precautions to keep tools and handling equipment free of particulate contamination. Tools to be sprayed with Freon from Pressure can (filtered to < 0.2 micron) prior to use, or when contaminated.

3.2 Integration Personnel

3.2.1 Integration and Test Director

The Integration and Test Director (ITD) shall be Dr. Doron Bardas. He has overall responsibility for the implementation of this procedure and shall sign off the completed procedure.

3.2.2 Personnel

All engineers and technicians participating in this procedure shall work under the direction of the ITD who shall determine whether the person is qualified to participate in this procedure.

3.3 Safety

3.3.1 General

Personnel working in the Class 10 Cleanroom must be cognizant of the base of the Precision Manipulator, and take special care to avoid tripping or bumping into it.

3.3.2 Hardware Safety

Extreme care must be taken to avoid accidentally bumping the Probe. Keep body parts downstream of the Probe relative to the HEPA wall, especially below the Station 200 ring.

3.3.3

Maximum Number of People in Cleanroom

Under normal operating conditions, there shall be no more than 5 people in the Class 10 Cleanroom. This is to avoid violating legal make up air requirements, and to provide an efficient workspace. Exceptions must be for short periods only, and be approved by the test director.

3.4 Quality Assurance

Tests 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 B. Taller shall review any discrepancy noted during this procedure, and approve its disposition. Redlines shall be stamped by the QA rep. The QA representative will nominally be A. Nakashima. Upon completion of subsections of this procedure agreed to be of lesser importance, the QA Representative shall sign in the designated location. Upon completion of this procedure, the QA program engineer,
B. Taller or P. Unterreiner, will certify his concurrence that the effort was performed and accomplished in accordance with the prescribed instructions by signing the completed procedure for compliance.

3.5 Red-line Authority

Authority to red-line (make minor changes during execution) this procedure is given solely to the ITD or his designate. Approval by the Hardware Director shall be required, if in the judgment of the ITD or QA program engineer, experiment functionality may be affected. QA concurrence is required before final review/buyoff (on last page) of the completion of the activity described in this procedure.

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REQUIRED EQUIPMENT

Flight Hardware

Hardware	Part Number
Probe-C Assembly, without sunshade	1C34115-102

Ground Support Equipment

Note: ***Recent calibration of hardware used is <u>not required</u> due to the qualitative nature of the experiment and the fact that this is an Optional Procedure which does <u>not</u> verify any SM requirement .***

GN_2 Gas Supply with Built-in Regulator
Pressure Gauge
Flow controller/meter
In-line high flow gas filter
Gas Particle Counter MET1 217A or equivalent (in-draw ~ 0.1 scfm)
Adaptation hardware or bagging to the Top Hat exhaust lines
Custom bagging and hardware to contain gas exiting cold-end exhaust lines
Cleanroom tape

Tools and Miscellaneous

Wrenches and drivers, various

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SETUP AND BACKGROUND TEST

5.1 Initial Preparations

Record Start Date and Time__________________________

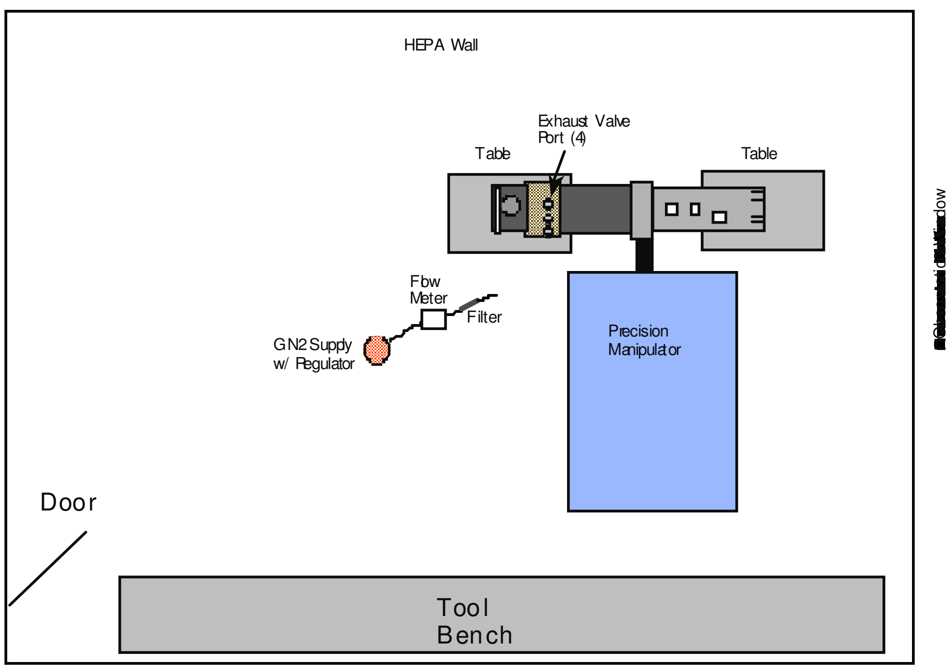
5.1.1 The Probe should be horizontal on the Precision Manipulator at a height of approximately four feet, with the cold end toward the observation window.

5.1.2 Clear off a suitable table and situate it under the cold end of the probe.

5.1.3 Clear adequate space on another table near the Top Hat end of the probe.

5.1.4

Set up a GN2 supply with Regulator. This may be the room supply that is provided by the boiloff of liquid nitrogen from pressure vessels, and is therefore very pure and moisture free. This gas is provided at approximately 40 psid and already has a regulator incorporated. (Alternatively, an ultrapure supply bottle of pressurized nitrogen may be used). Connect the line from the Regulator to the input of the flow controller/meter. Connect the 0.1 micron final filter to the output of the flow controller/meter. The output of the flow controller/meter is connected to Level 100 clean tubing. This is then used to



supply gas to the particle counter system or to the Top Hat exhaust lines.

Figure 1. Room Set-Up Top View (not to scale)

5.2 Measure Cleanliness of the Supply Gas

5.2.1 Fashion clean bag of approximately one liter volume, and with small openings at opposite ends. These will be later attached, as described below, to the gas source tube and the inlet to the particle counter respectively, The bag serves as a gas conduit maintained at pressure ≅ 1 ATM. This is important because the pressure in the bag should be just above ambient, but not so high that it interferes with the operation of the particle counter. This ensures that the particle counter which samples at ~ 2800 sccm senses gas representative of the source. In practice, this requires adjustment of the gas flow to a value typically about 4000 sccm.

5.2.2

Set up and turn on the particle counter in the vicinity of where this test will take place. Do not attach the particle counter to the hole at the other end of the bag at this time. The particle counter should be operating and integrating particles = 0.5 µm for one minute increments. Confirm that it is reading the expected ambient counts, i.e. < 10 counts/scfm, consistent with Class 10 cleanroom standards when sampling uncontaminated cleanroom air. Record the data in Table 1 below. The particle counter should typically read = 3 count per scfm if no particulates are generated upstream in the vicinity of the device. Otherwise check operation and repeat.

Table 1. Ambient Particle Counts per scfm ≥ 0.5 µm

Sample 1	0
Sample 2	0
Sample 3	0
Sample 4	0
Sample 5	0
Average	**0**

5.2.3 Now insert the tubing attached to the exit line of the filter directly into the clean bag. Tape the bag with cleanroom tape so that it is well sealed on this exit line. Set the flow controller/meter to approximately 0.15 scfm (4200 sccm) by adjusting the flow controller/meter and its input pressure. Note that 4200 sccm is over 4.2 times the flow during spinup.

5.2.4 Carefully insert the sampling tube of the particle counter, as shown in Figure 2, into the exit hole of the bag and tape in place. Do not seal this opening. Verify that the bag is loosely inflated which ensures that the pressure in the bag is approx. at ambient pressure. If inflated too tightly, decrease the flow or let more gas escape from the bag at/near the attachment point to the sampling tube of the PC and vice versa if the bag does not inflate sufficiently. Record data in Table 2. after 2 min have elapsed. Take five 1 minute samples with the PC.

5.2.5 Data should average = 1 count/scfm. indicating a source gas of sufficient cleanliness that will be put into the exhaust lines. If this is not true, disconnect, clean and flush the system and repeat this test, recording the data in Table 2A. Otherwise do not enter data into Table 2A

5.2.6 Remove the bag from the particle counter while gas is still flowing. Let purge for = 1 min.

5.2.7 Close bag outlet end slowly, fold and seal it, while shutting slowly off gas supply.

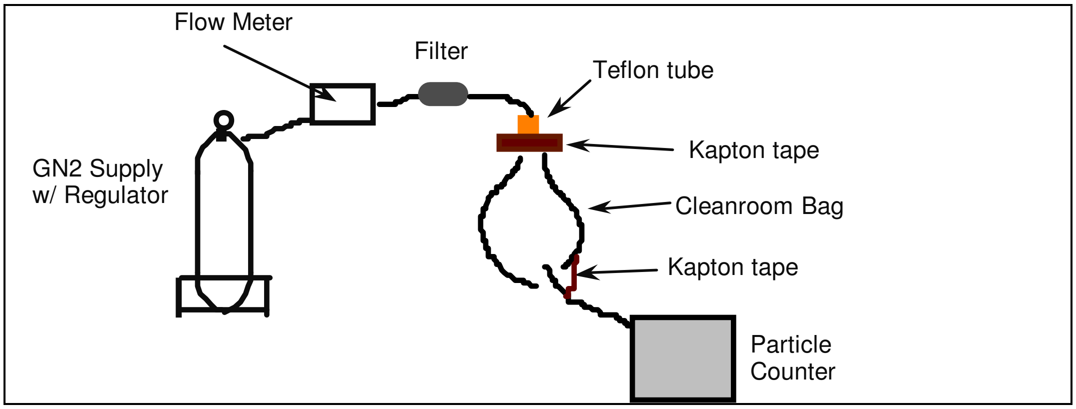


Figure 2. Gas Cleanliness Measurement Set-up

Table 2. Source Gas Cleanliness

1 min Sample Sequence Number	FLOW RATE (sccm)	INTEGRATED NUMBER OF PARTICLES per scfm = 0.5 µm
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
Average	**0.0**	**0.0**

Table 2A. Source Gas Cleanliness*

1 min Sample Sequence Number	FLOW RATE (sccm)	INTEGRATED NUMBER OF PARTICLES per scfm = 0.5 µm
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
Average	**0.0**	**0.0**

* Table 2A only applicable if Section 5.2.5 applies. Otherwise leave blank

Approval of Section 5.

Completed: ___________________________________ date: ___________________
Integration Engineer

Discrepancies if any:

Approved: ____________________________________ date: ___________________
ITD

Approved: ____________________________________ date: ___________________
QA Representative

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MEASURE PARTICULATE COUNTS FROM EXHAUST LINES

6.1 Test Setup

6.1.1 __Record Start Date and Time

Figure 3 Schematic of Particle Counter Setup (4200 sccm)

6.1.2 Connect a cleaned Teflon interface coupler (made from the same tubing type as the final interface couplers which will later be installed between the probe and the gyro exhaust nipples in the gyro spinup retainer assemblies) to each of the probe's aluminum exhaust plumbing nipples . These should be sufficiently long to allow them to remain on the aluminum nipples after this procedure and be pinched off to preserve cleanliness of the lines.

6.1.3 For each exhaust flange on the Top Hat, fashion a gas "conduit" by taping the open end of a cleanroom bag securely around the perimeter of each Exhaust Valve flange. Do not touch the front surface of the valve flange since the "C" seal groove in its surface is easily damaged.

6.1.4 Seal the through-holes in the Valve flanges with tape applied from the Top Hat side.

6.1.5 Make a small hole in the opposite end of the bag and seal it securely with tape to the tubing from the gas supply filter.

6.1.6 Now insert the interface coupler into the small inlet hole of the clean bag (or similar) from Section 5. Tape the bag with cleanroom tape so that it is well sealed on this exit line. Set the flow to approximately 0.15 scfm (4200 sccm) by adjusting the flow controller/meter and its input pressure. Note that 4200 sccm is over 4.2 times the flow during spinup.

6.1.7 Carefully insert the sampling tube of the particle counter, as shown in Figure 2, into the exit hole of the bag and tape in place. Do not seal this opening. Verify that the bag is loosely inflated which ensures that the pressure in the bag is approx. at ambient pressure. If inflated too tightly, decrease the flow or let more gas escape from the bag at/near the attachment point to the sampling tube of the PC and vice versa if the bag does not inflate sufficiently. Flow for approx. 2 min. and then begin taking data as in 6.2 below.

6.2

Performing cleanliness test and removal of bag setups

6.2.1 After the purge take five, 1 minute samples with the PC and record in the appropriate Table (3, 4, 5 or 6) below. Note that the desirable average count rates should be between 0 and the average of the source gas cleanliness data of Section 5.2

6.2.2 While maintaining the flow of gas, remove the bag from the PC's sampling tube.

6.2.3 While continuing to maintain the flow of gas, remove the bag from the Teflon interface coupler on the probe's aluminum nipple.

6.2.4 Stop the gas flow. Pinch the end of the coupler, fold it over, and tape to itself to seal.

6.2.5 Disconnect plumbing and bag from the Top Hap valve flange. Remove any tape residue.

6.3 Repeat steps 6.1.3 through 6.2.5 for the other exhaust lines.

Table 3. Cleanliness of Probe Exhaust Line EV1

1 min Sample Sequence Number	FLOW RATE (sccm)	INTEGRATED NUMBER OF PARTICLES per scfm = 0.5 µm
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
Average	**0.0**	**0.0**

Table 4. Cleanliness of Probe Exhaust Line EV2

1 min Sample Sequence Number	FLOW RATE (sccm)	INTEGRATED NUMBER OF PARTICLES per scfm = 0.5 µm
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
Average	**0.0**	**0.0**

Table 5. Cleanliness of Probe Exhaust Line EV3

1 min Sample Sequence Number	FLOW RATE (sccm)	INTEGRATED NUMBER OF PARTICLES per scfm = 0.5 µm
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
Average	**0.0**	**0.0**

Table 6. Cleanliness of Probe Exhaust Line EV4

1 min Sample Sequence Number	FLOW RATE (sccm)	INTEGRATED NUMBER OF PARTICLES per scfm = 0.5 µm
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
Average	**0.0**	**0.0**

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7 PROCEDURE COMPLETION

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

Integration Engineer ______________________________ Date _______________

ITD ____________________________________ Date _______________

Discrepancies if any:

The information obtained under this assembly and test procedure is as represented and the documentation is complete and correct:

QA Representative _________________________________ Date ______________

QA Program Engineer______________________________ Date ______________

8 DATA BASE ENTRY

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

8.1.1 Name, number and revision of this procedure

8.1.2 Date of successful completion of procedure.