

**GRAVITY PROBE B
PROCEDURE FOR
PAYLOAD VERIFICATION**

**(PTP) REMOVE PROBE SPINUP
GAS/VAC. LINES
(+Z AXIS UP)**

10/19/99

Prepared by: M. Taber

Approvals:

Program Responsibility	Signature	Date
C. Warren Gas/Vac. Engineer		
M. Taber Payload Test Director		
D. Ross GP-B Quality Assurance		
S. Buchman GP-B Hardware Manager		

NOTES:

Level of QA required during performance of this procedure:

 X Stanford QA Representative

 Government QA Representative

All redlines must be approved by QA

Gravity Probe B

10/19/99

Remove Probe Spinup Gas/Vac. Lines

Procedure No. P0618 Rev. –

Page 2 of 15

Revision Record:

Rev	Rev Date	ECO #	Summary Description

Acronyms and Abbreviations:

Acronym / Abbreviation	Meaning
GSE	Ground Support Equipment
IG	Ionization Gauge
LD	Leak Detector
LGS	Leakage Gas System
LV-x	Probe Leakage Gas Valve #x (1 or 2)
PPMS	Probe Pressure Measurement System
RGA	Residual Gas Analyzer
SMD	Science Mission Dewar
UTS	Utility Turbopump System

Table of Contents

A Scope	4
B Requirements Verification	4
C Configuration Requirements.....	4
D Hardware Required	4
E Software Required	5
F Procedures Required.....	5
G Equipment Pretest Requirements	5
H Personnel Requirements.....	5
I Safety Requirements.....	5
J General Instructions.....	5
K References and Applicable Documents.....	5
L Operations.....	6

Gravity Probe B

10/19/99

Remove Probe Spinup Gas/Vac. Lines

Procedure No. P0618 Rev. –

Page 4 of 15

A Scope

This procedure effects the removal of gas/vacuum lines between the Probe and the Gyro Spinup Gas / Vac. GSE. These lines include the leakage gas pumping line, the spinup gas supply lines and the spinup gas exhaust lines.

B Requirements Verification N/A

C Configuration Requirements

Probe-C is integrated into the SMD per drawing 65113-1C34292 and oriented with the +Z axis vertical and the +X axis facing the LGS. The Leakage Gas pumping line is installed as depicted in Fig. 1. Installation of Spinup Supply and Exhaust lines is optional. The PPMS is installed per P0558. Pressure in the Probe is low enough for the RGA to function for the duration of this procedure. Installed Probe Gas/Vac. spinup lines to be removed are assumed to be evacuated with the Probe valves at the Probe interface being closed. It is assumed that Gamah-to-VCR "connector savers" are installed on the Gamah spinup gas fittings.

D Hardware Required

D.1 Flight hardware required

Description	No. Req'd
65113-1C34292 Probe-C / Science Mission Dewar Assembly	1

D.2 Commercial test equipment: N/A

D.3 Mechanical/Electrical special test equipment: N/A

D.4 GSE / hardware:

Description	No. Req'd
Leakage Valve (LV) cover assembly, cleaned for use	1
VCR cap(s) and gaskets for spinup connector savers and the spinup gas ports	A/R
Exhaust Valve cover assembly(s), cleaned for use	A/R
KF 50 caps for the exhaust gas ports on the leakage gas system	A/R
ISO 200 blankoff plate for the LGS pumping port with o-ring / centering ring	1
4' x 4' HEPA filter downflow unit with vinyl curtains mounted below gantry	1
Spinup line "connector savers" (1/4" female Gamah to 1/4" male VCR installed on Probe)	4
Probe Pressure Measurement System with RGA & IG readouts	1
Utility Turbopump System and pumping line	1

D.5 Tools

Description	No. Req'd
misc. wrenches including 17 mm	A/R
Proto 6169A Torque wrench, 0-75 in.-lb. or equivalent	1

Gravity Probe B

10/19/99

Remove Probe Spinup Gas/Vac. Lines

Procedure No. P0618 Rev. –

Page 5 of 15

D.6 Expendables

Description	Quantity
aluminum foil	A/R

E **Software Required:** N/A

F **Procedures Required:** N/A

G **Equipment Pretest Requirements:** N/A

H **Personnel Requirements**

This test to be conducted only by certified personnel. Persons certified to perform this procedure are Mike Taber, Chuck Warren, Ken Bower, and Tom Welsh with Mike Taber being the leader.

I **Safety Requirements**

These operations are to be performed in the vicinity of flight equipment. Two persons are required for manipulation of the 8" pumping line and care should be taken to prevent impacting of the flight equipment. Movement of the gantry used to support the HEPA downflow booth also requires two persons. Care should also be taken to prevent scratching or otherwise damaging vacuum sealing surfaces, particularly those which are on flight equipment and/or must be sealed with metal gaskets.

J **General Instructions**

J.1 Redlines can be initiated by Mike Taber and must be approved by QA.

J.2 Any nonconformance or test anomaly should be reported per Quality Plan, P0108. Do not alter or break test configuration if a test failure occurs; notify quality assurance.

J.3 Work done inside the HEPA filter downflow unit should with proper clean room garb consistent with Class 1000 conditions.

K **References and Applicable Documents:** N/A

Op. Order No. _____
Date Initiated _____
Time Initiated _____

L Operations

- L.1 Record the current configuration of spinup supply, exhaust and leakage gas lines between the Gas/Vac. GSE and the Probe:
 - L.1.1 Identify which Probe spinup supply valves are connected to spinup supply lines:
☐ S1 ☐ S2 ☐ S3 ☐ S4
 - L.1.2 Verify by physical examination that each of the connected spinup supply valves is closed and check off:
☐ S1 ☐ S2 ☐ S3 ☐ S4
 - L.1.3 Identify which spinup exhaust valves are connected to exhaust lines:
☐ V1 ☐ V2 ☐ V3 ☐ V4
 - L.1.4 Verify by reference to the appropriate procedure(s) that each of the connected exhaust valves is in a closed state and record the relevant Op. Nos.:
 - L.1.5 Identify which 6" Vatterfly valve is connected to the leakage gas pumping line
☐ LV1 (in -X, -Y quadrant) ☐ LV2 (in -X, +Y quadrant)
 - L.1.6 Verify by reference to the appropriate procedure that the connected 6" Vatterfly valve is in a closed state and record the relevant Op. No.:
- L.2 Gas/Vac GSE preparation (see Fig. 2):
 - L.2.1 Verify that all GSV, AXV, SEV (except SEV-5) valves are closed.
 - L.2.2 Turn on SEP-1, -2 and verify that SEG-2 drops to less than 20 millitorr.
 - L.2.3 Open AXV-8, -5, -6 and pump spinup supply and exhaust manifolds until SEG-2 indicates less than 20 millitorr.
 - L.2.4 Place system in Interlock Defeat mode.
 - L.2.5 Open the GSV valves appropriate to the valves indicated in L.1.1; i.e., if S1 is connected, open GSV-7, if S2 is connected, open GSV-8, etc.
 - L.2.6 Likewise, open SEV valve(s) appropriate to the valve(s) indicated in L.1.3.
 - L.2.7 When SEG-2 indicates less than 20 millitorr, close the valves opened in the two previous steps.
 - L.2.8 Close AXV-5, -6.
 - L.2.9 Verify that LGG-3 is less than 100 millitorr; if not, briefly open AXV-7 until it does.
 - L.2.10 Close AXV-8.

Gravity Probe B

10/19/99

Remove Probe Spinup Gas/Vac. Lines

Procedure No. P0618 Rev. –

Page 7 of 15

L.3 Set up RGA:

- L.3.1 Power up RGA and verify connection to a computer equipped with TranspectorWare software.
- L.3.2 Start up the TranspectorWare program using a recipe that includes He in the scan list and has an update interval of one minute or less.
Record filename:_____.
- L.3.3 Verify that the Probe temperatures are stable.
- L.3.4 Determine the stability of the He partial pressure by measuring the partial pressure over a period of a half hour:

Date : _____/_____/_____ time: _____				
He partial pressure (torr)				

L.4 Vent and disconnect spinup supply lines

- L.4.1 Verify torque wrench calibration: Cal. due date: _____
- L.4.2 Torque all Probe spinup valves specified in L.1.1 to 60 in-lbs. and check off:
☐ S1 ☐ S2 ☐ S3 ☐ S4

QA witness: _____

L.4.3 Perform leak-through check of Probe spinup valves:

- L.4.3.1 Open / verify open spinup gas supply valves V5, V6 with LGR-1 set to 2-5 psig.
- L.4.3.2 If not already the case, place KS-1 in Interlock Defeat mode.
- L.4.3.3 Open all the GSV valves appropriate to the valves indicated in L.1.1; i.e., if S1 is connected, open GSV-7, if S2 is connected, open GSV-8, etc.
- L.4.3.4 Verify that flow controller set point for GSV-4 is set to zero and the mode switch is "off".
- L.4.3.5 Open GSV-1, -2.
- L.4.3.6 Set the mode switch for GSV-4 to "auto" and start monitoring the He partial pressure with the RGA.
- L.4.3.7 Slowly turn up the set point for GSV-4 until a flow rate of ~5 sccm is obtained. Verify that there is no change in the partial pressure of He in the Probe.
- L.4.3.8 When the pressure read by GSG-4 reads ~9.5 torr, turn the GSV-4 set

Gravity Probe B

10/19/99

Remove Probe Spinup Gas/Vac. Lines

Procedure No. P0618 Rev. –

Page 8 of 15

point down to zero, and change the mode switch to "off".

- L.4.3.9 Measure the He partial pressure on the RGA and the pressure at GSG-4 for a period of at least half an hour and record:

Date : _____/ time:				
He partial pressure (torr)				
GSG-4 (torr)				

- L.4.3.10 Verify that the rise in the He partial pressure over a period of half an hour is not more than 10% of the initial value over the rise that would be expected from L.3.4.

- L.4.3.11 Verify that the pressure drop at GSG-4 does not exceed 0.02 torr over the last twenty minutes of the above measurements.

- L.4.3.12 Set the mode switch for GSV-4 to "auto" and continue monitoring the He partial pressure with the RGA.

- L.4.3.13 Bring GSG-4 up to 1 atm. by turning up the GSV-4 set point to ~50 sccm.

- L.4.3.14 When GSG-4 reaches one atmosphere, turn the GSV-4 set point to zero and set the mode switch to "off".

- L.4.3.15 Close all GSV valves and turn off the Interlock Defeat.

- L.4.3.16 Measure the He partial pressure on the RGA and the pressure at GSG-4 for a period of at least half an hour and record:

Date : _____/ time:				
He partial pressure (torr)				
GSG-4 (torr)				

- L.4.3.17 Verify that the rise in the He partial pressure over a period of half an hour is not more than 10% of the initial value over the rise that would be expected from L.3.4.

- L.4.3.18 Verify that the pressure drop at GSG-4 does not exceed 0.2 torr over the last twenty minutes of the above measurements.

- L.4.4 Locate the 4' x 4' HEPA filter downflow unit with vinyl curtains mounted below gantry over the Probe.

Gravity Probe B

10/19/99

Remove Probe Spinup Gas/Vac. Lines

Procedure No. P0618 Rev. –

Page 9 of 15

- L.4.5 Turn on the HEPA downflow unit and allow to run at least an hour to clean up before performing operations under the downflow unit.
- L.4.6 For each of the spinup lines, disconnect the spinup line VCR and install VCR caps on the connector savers.
- L.4.7 Wrap the open VCR glands on the ends of the spinup lines with a double layer of aluminum foil.
- L.5 Vent and disconnect spinup exhaust lines
 - L.5.1 Perform leak-through check of Probe spinup valves:
 - L.5.1.1 Open / verify open spinup gas supply valves V5, V6 with LGR-1 set to 2-5 psig.
 - L.5.1.2 If not already the case, place KS-1 in Interlock Defeat mode.
 - L.5.1.3 Open the SEV valves appropriate to the valves indicated in L.1.3; i.e., if V1 is connected, open SEV-1, if V2 is connected, open SEV-2, etc.
 - L.5.1.4 Verify that flow controller set point for GSV-5 is set to zero and the mode switch is "off".
 - L.5.1.5 Open GSV-1, -3.
 - L.5.1.6 Set the mode switch for GSV-5 to "auto" and start monitoring the He partial pressure with the RGA.
 - L.5.1.7 Slowly turn up the set point for GSV-5 until a flow rate of ~100 sccm is obtained. Verify that there is no change in the partial pressure of He in the Probe.
 - L.5.1.8 When the pressure read by GSG-4 reads ~9.5 torr, turn the GSV-5 set point down to zero, and change the mode switch to "off".
 - L.5.1.9 Measure the He partial pressure on the RGA and the pressure at GSG-4 for a period of at least half an hour and record:

Date : _____ / time:				
He partial pressure (torr)				
GSG-4 (torr)				

- L.5.1.10 Verify that the rise in the He partial pressure over a period of half an hour is not more than 10% of the initial value over the rise that would be expected from L.3.4.

- L.5.1.11 Verify that the pressure drop at GSG-4 does not exceed 0.02 torr over the last twenty minutes of the above measurements.
- L.5.1.12 Set the mode switch for GSV-5 to "auto" and continue monitoring the He partial pressure with the RGA.
- L.5.1.13 Bring GSG-4 up to 1 atm. by slowly turning up the GSV-5 set point to ~1000 sccm.
- L.5.1.14 When GSG-4 reaches one atmosphere, turn the GSV-5 set point to zero and set the mode switch to "off".
- L.5.1.15 Close all GSV and SEV valves and turn off the Interlock Defeat.
- L.5.1.16 Measure the He partial pressure on the RGA and the pressure at GSG-4 for a period of at least half an hour and record:

Date : _____/ time: _____				
He partial pressure (torr)				
GSG-4 (torr)				

- L.5.1.17 Verify that the rise in the He partial pressure over a period of half an hour is not more than 10% of the initial value over the rise that would be expected from L.3.4.
- L.5.1.18 Verify that the pressure drop at GSG-4 does not exceed 0.2 torr over the last twenty minutes of the above measurements.
- L.5.2 Position the 4' x 4' HEPA filter downflow unit with vinyl curtains mounted below gantry over the Probe if not already so positioned.
- L.5.3 Turn on the HEPA downflow unit and allow to run at least an hour to clean up before performing operations under the downflow unit.
- L.5.4 One at a time disconnect the exhaust line(s) from the Probe exhaust valve(s) and swing aside sufficiently to install the exhaust valve cover assembly(s). Provide temporary support for the exhaust lines as necessary. Install an exhaust gas valve cover assembly on the 2.5" Vatterfly valve as each line is disconnected.
- L.5.5 Wrap the open ends of the exhaust lines with a double layer of aluminum foil.
- L.6 Vent and disconnect leakage gas line
 - L.6.1 Close / verify closed valves LGV-1, -3.
 - L.6.2 Turn off / verify off IG LGG-1.
 - L.6.3 Install / verify installed a blankoff plug at AUX.1.

Gravity Probe B

10/19/99

Remove Probe Spinup Gas/Vac. Lines

Procedure No. P0618 Rev. –

Page 11 of 15

L.6.4 Perform leak-through check of Probe spinup valves:

L.6.4.1 Verify that SEP-1, -2 are on and open AXV-8.

L.6.4.2 Open AXV-3 to pump out auxiliary manifold.

L.6.4.3 Close AXV-8 and open AXV-7.

L.6.4.4 Slowly open AXV-1 and bleed in enough He to indicate ~900 millitorr on LGG-3.

L.6.4.5 Close AXV-3. Measure the He partial pressure on the RGA and the pressure at LGG-3 for a period of at least half an hour and record:

Date : _____/ time: _____				
He partial pressure (torr)				
LGG-3 (torr)				

L.6.4.6 Verify that the rise in the He partial pressure over a period of half an hour is not more than 10% of the initial value over the rise that would be expected from L.3.4.

L.6.4.7 Verify that the pressure drop at LGG-3 does not exceed 5 mtorr over the last twenty minutes of the above measurements.

L.6.4.8 Open AXV-3 and continue monitoring the He partial pressure with the RGA.

L.6.4.9 Bleed AXG-1CAP up to 1 atm. by slowly opening AXV-1.

L.6.4.10 When AXG-1CAP reaches one atmosphere, close AXV-1 and AXV-3.

L.6.4.11 Measure the He partial pressure on the RGA and the pressure at AXG-1CAP for a period of at least half an hour and record:

Date : _____/ time: _____				
He partial pressure (torr)				
AXG-1CAP (torr)				

L.6.4.12 Verify that the rise in the He partial pressure over a period of half an hour is not more than 10% of the initial value over the rise that would be expected from L.3.4.

- L.6.4.13 Verify that the pressure drop at AXG-1CAP does not exceed 1 torr over the last twenty minutes of the above measurements.
- L.6.5 Position the 4' x 4' HEPA filter downflow unit with vinyl curtains mounted below gantry over the Probe if not already so positioned.
- L.6.6 Turn on the HEPA downflow unit and allow to run at least an hour to clean up before performing operations under the downflow unit.
- L.6.7 Loosen the spherical nuts on the threaded rods supporting the bellows near the LGS sufficiently to allow the pumping line to be swung away from the Probe.
- L.6.8 Support the leakage gas pumping line with a ladder or other suitable object. Also unlash the spinup supply lines from the leakage gas line and support independently.
- L.6.9 Unbolt the clamps holding the adapter flange to the 6" Vatterfly valve and carefully swing the pumping line far enough away to allow the 6" Vatterfly cover to be installed.
- L.6.10 Install the 6" Vatterfly cover using the ISO clamps just removed.
- L.6.11 Cover the open end of the leakage gas pumping line with a double layer of aluminum foil.
- L.7 Locate the 4' x 4' HEPA filter downflow unit with vinyl curtains mounted below gantry over the LGS adapter cone. Use the crane as necessary to lower the height of the downflow unit.
- L.8 Turn on the HEPA downflow unit and allow to run at least an hour to clean up before performing operations under the downflow unit.
- L.9 Remove the spinup gas/vac. lines from the ports on the LGS:
 - L.9.1 While temporarily supporting the Probe end of the spinup lines, disconnect the other end of each line one at a time and install a VCR cap on the supply port and cover the open end of the line with a double layer of aluminum foil.
 - L.9.2 Stow the spinup lines such that the ends are protected from contamination and the bellows are protected from damage.
 - L.9.3 While temporarily supporting the Probe end of the exhaust lines, disconnect the other end of each line one at a time and install a KF cap on the exhaust port and cover the open end of the line with a double layer of aluminum foil.
 - L.9.4 Stow the exhaust lines such that the ends are protected from contamination and the bellows are protected from damage.
 - L.9.5 While temporarily supporting the Probe end of the leakage gas line, disconnect the other end of the line and install an ISO 200 blankoff plate on the LGS pumping port with a clean o-ring / centering ring.
 - L.9.6 Cover both ends of the leakage gas pumping line with a double layer of aluminum foil and protect with plastic covers.
- L.10 Secure the HEPA downflow system as required per engineering instruction.

Gravity Probe B

10/19/99

Remove Probe Spinup Gas/Vac. Lines

Procedure No. P0618 Rev. –

Page 13 of 15

- L.11 Pump out and back fill Vatterfly cover assemblies:
 - L.11.1 Attach a pumping line from the UTS to the 6" Vatterfly cover access valve.
 - L.11.2 Start up the UTS forepump and pump out cap assembly to <25 millitorr as read at the UTS.
 - L.11.3 Backfill the 6" Vatterfly cover assembly with filtered He gas to a pressure of 1 psig as read on the gauge on the cover assembly and close access valve.
 - L.11.4 Disconnect the UTS from the cover assembly and cap the cover assembly access valve.
 - L.11.5 If an exhaust line has been removed, attach a pumping line from the UTS to the 2.5" Vatterfly cover access valve.
 - L.11.6 Pump out cap assembly to <25 millitorr as read at the UTS.
 - L.11.7 Backfill the 2.5" Vatterfly cover assembly with filtered He gas to a pressure of 1 psig as read on the gauge on the cover assembly and close access valve.
 - L.11.8 If a two exhaust lines have been removed, repeat steps L.11.5 through L.11.7 on the second 2.5" Vatterfly valve.

Operation completed.

Completed by: _____

QA witness: _____

Date: _____

Time: _____

PTD: _____

RQE: _____

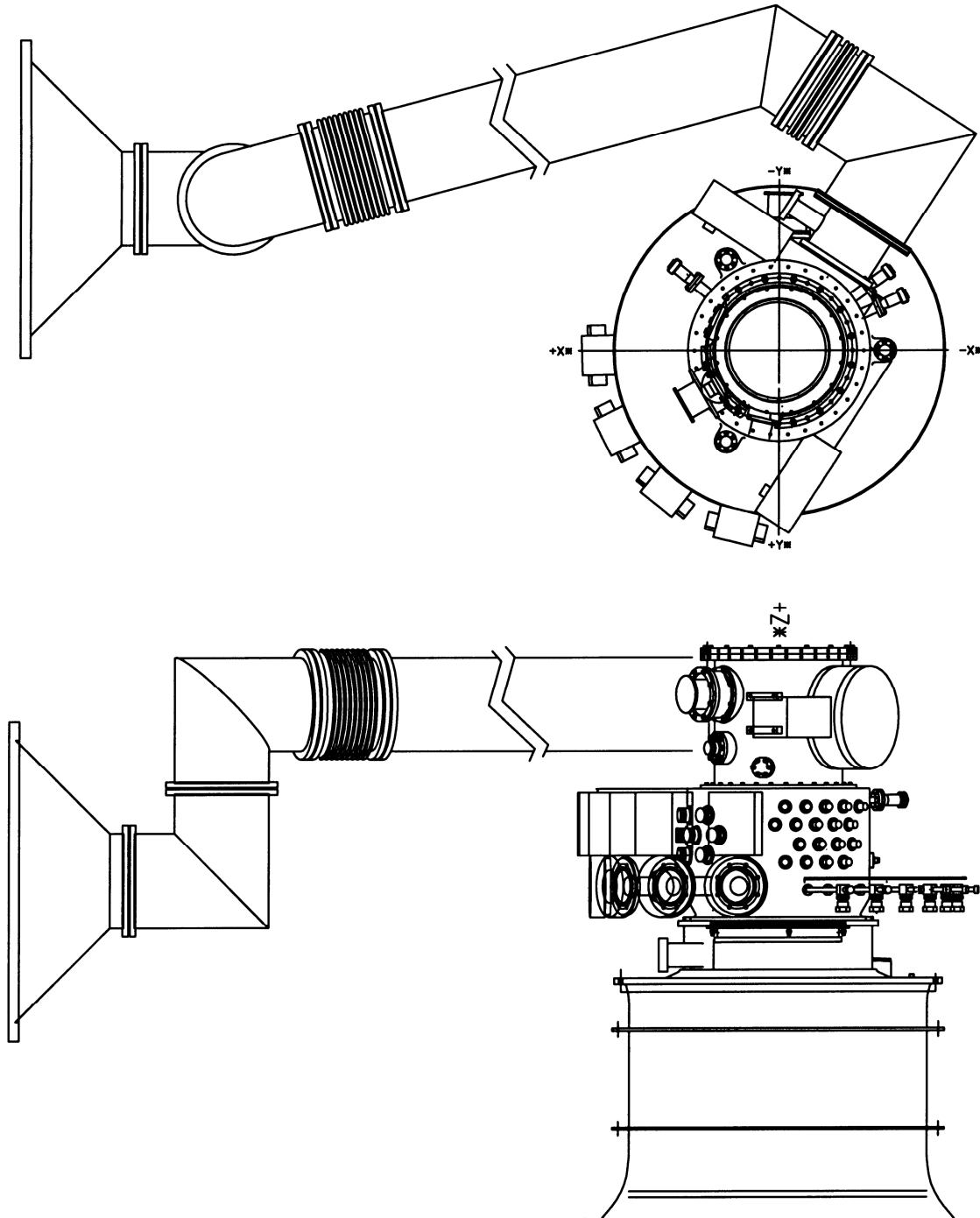


Figure 1

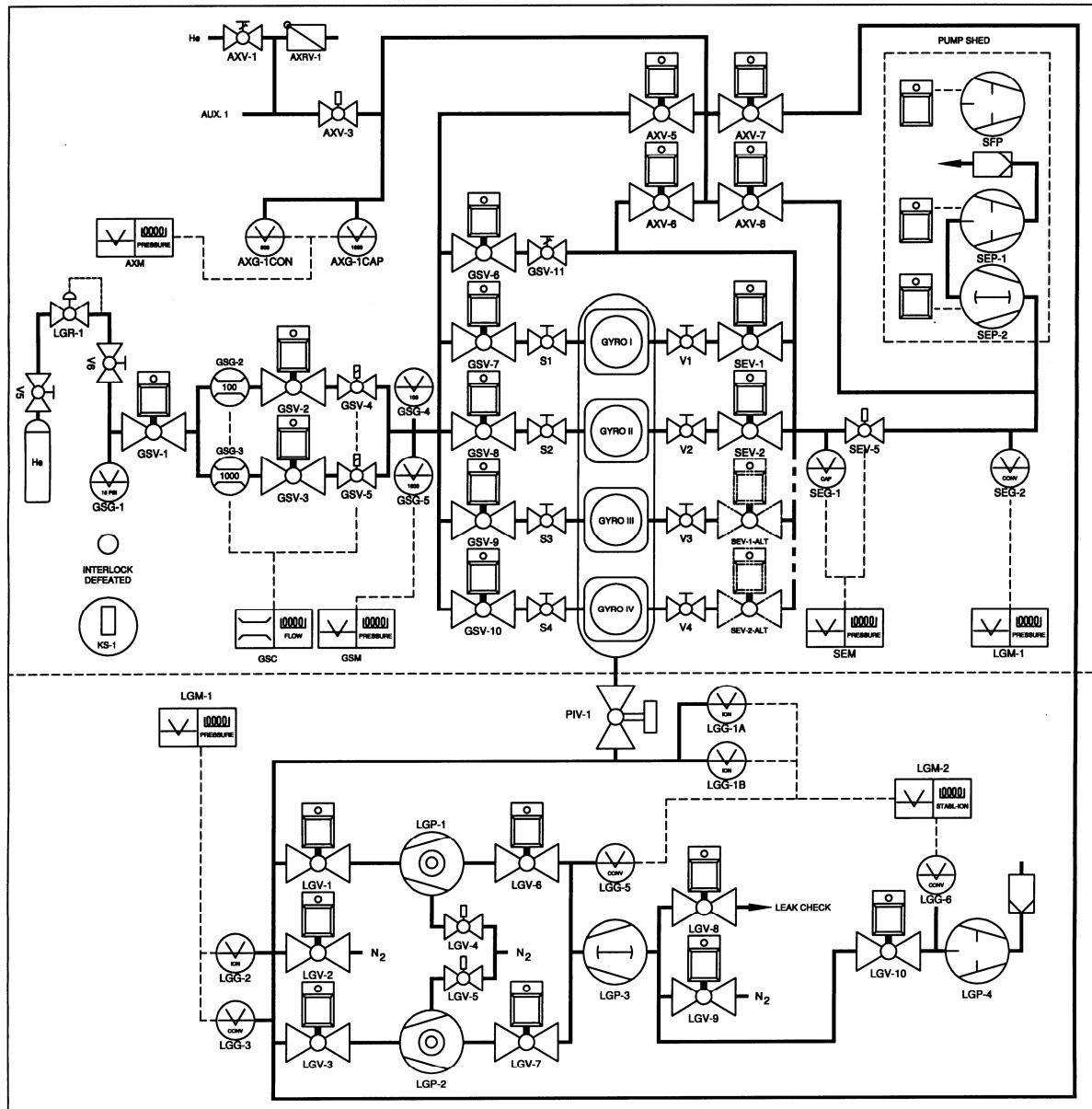


Figure 2