GRAVITY PROBE-B

TEST PROCEDURE

PROBE INSERTION INTO SMD

March 30, 1995

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<td>621</td>
<td>8/15/97</td>
<td>Changes to Update for GTU1 redlines and modify for use of Science Mission Dewar (SMD) and SMD Ground Support Equipment</td>
<td>August 6, 1997</td>
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<td>782</td>
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ABBREVIATIONS

xxP  Kit number xx of P type kits (ref. SU GP-B P0141)
ALSP  Airlock Support Plate
ALSPV  Airlock Support Plate Valve
ATC  Advanced Technology Center (at LMSS)
AVxx  Gas Module valve number xx
BPS  Bellville Pre-load System
CNT  Composite Neck Tube of Probe
ESD  ElectroStatic Discharge
EVxx  Gas Module Valve number xx
AWG  American Wire Gauge
Cryoperm  Trade name for cryogenic magnetic shielding
CT  Cooling Tube
CTE  Cryogenic Test Engineer
DAS  Data Acquisition System
DEV-xx  Dewar Exhaust Valve number xx
DVM  Digital Volt Meter
EEBA  Emergency Evaluation Breathing Apparatus
EG-xx  Gas Module Exhaust Gauge number xx
EVRx  Gas Module Relief Valve number x
FIST  Final Integrated System Test
GHe  Gaseous Helium
GP-B  Gravity Probe-B program (also, Relativity Mission)
GRT  Germanium Resistance Thermometer
GSE  Ground Support Equipment
GTU-2  Ground Test Unit number 2
HEPA  High Efficiency Particulate Assembly
ISO  International Standards Organization
L.D.  Leak Detector
LGS  Leakage Gas System
LLS  Liquid Level Sensor
LMSS  Lockheed Martin Space Systems
LN2  Liquid Nitrogen
mG  milli Gauss
MHz  Megahertz
NPB  Normal Boiling Point
Ozsi  Ounces per square inch
PPS  Programable Power Supply
PWx  Well Pressure gauge x
QD  Quick Disconnect - O-ring seal under screw down cap
RCM  Rotating Coil Magnetometer
RGA  Residual Gas Analyzer
RSE  Responsible Safety Engineer
RQE  Responsible Quality Engineer
sccs  Standard cubic centimeters per second
SMD  Science Mission Dewar (of GP-B, Relativity Mission program)
SU  Stanford University
TAO  Thermal Acoustic Oscillation
TGxx  UTS Gauge xx
TM xx  Task Module number xx.
TVxx  UTS Valve xx
VMA  Valve of Mini-Airlock
UTS  Utility Turbo pumping Station
VFV  Vatterfly Valve
VSw  Valve number x on Shutter
VW-1  Valve on Dewar Adapter connecting Well to outside
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1 SCOPE

This procedure describes the steps necessary to effect the insertion of the instrument Probe into the Science Mission Dewar (SMD) and the removal and storage of the Helium Airlock. These are equipment associated with the Gravity Probe-B (GP-B) Program (Relativity Mission).

The tasks required to obtain the objectives of this procedure are:

a) Insert and secure the Probe into the SMD, and
b) Stow the Helium Airlock to ensure readiness for efficient Probe removal.

See Figure 1 for the Probe Insertion Flow Diagram.

2 REFERENCE DOCUMENTS

.1 Procedures:
The procedures listed are those required to insert a Probe into the SMD. P0143 presents an overview of the process and is for information only. The material of P0144 is used as a reference document with all the other procedures to identify the various attachment, lifting, etc. hardware that have been assembled into kits.

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<table>
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<td>Helium Airlock Assembly</td>
</tr>
<tr>
<td>5823341 Rev D</td>
<td>Helium Airlock Installation</td>
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<th>Title</th>
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.4 Supporting documentation

| .1   | GP-B Magnetic Control Plan, LMMS-5835031 |
| .2   | SMD Safety Compliance Assessment, LMMS GPB-100153C 100153C |
| .3   | SM Dewar FMECA, LMMS GPB-100333       |
| .4   | FIST Emergency Procedures SU/GP-B P0141 |
| .5   | Probe/Dewar Hardware Kit list, SU/GP-B P0144 |
| .6   | SMD Final Assembly, LMMS 5833500      |
| .7   | GP-B Contamination Control Plan SU/GP-B P059 |
TEST FLOW CHART
FOR
PROBE INSERTION
INTO SMD - P0135

TM 90
Align and Center
Probe

TM 91
Purge Airlock
with Helium Gas

TM 92
Insert Probe
into Dewar

SU P0210
Internal Well
Fill

End of Probe Insertion

Indicates TM called from
within preceding non-
shaded TM
Figure 2  Gas Module  Plumbing Schematic
3 SAFETY

.1 General

Personal injury and hardware damage can result during normal positioning, assembly and disassembly of hardware (e.g. positioning of Dewar in tilt stand; integration of probe into airlock; integration of airlock/probe onto Dewar; removal of airlock from Dewar; removal of probe from Dewar); and during positioning of support equipment (e.g. pressurized gas cylinders; supply dewars).

Undesired events associated with these operations include: (1) Personnel or other objects are struck (e.g. by forklift or crane load) when hardware is being moved. (2) Personnel who are positioning hardware get their hands or feet caught between objects as hardware is moved into place. (3) Suspended hardware is dropped. (4) Personnel who are present during hardware movements (e.g. by forklift; crane) are caught between objects (e.g. forklifts and walls; loads and building support columns).

.2 Lifting operations

The following Paras. apply to lifting operations.

.1 Hard hats shall be available and used by personnel working around elevated working platforms.

.2 Hoisting equipment operators shall be trained and qualified in the safe operation of all lifting equipment employed. They shall be competent in rigging lifting hardware. It is the responsibility of these individuals to ensure proper lifting configuration, based upon a review of procedures, drawings, training and experience.

.3 Movements shall be verbally rehearsed before performing them.

.4 All personnel in the area of hoisting operations shall wear hard hats.

.5 Spotters shall be used as required. The crane operator and spotters shall agree upon and use a standard safety signal system prior to the start of any lifting operation.

.6 Personnel who are positioning hardware shall use extreme caution so that they don’t get their fingers pinched between the load and other objects.

.7 Standard rigging fittings and lifting devices specially designed for the specific task shall be used at all times for hoisting material and equipment. The use of C-clamps, mild steel bolts and non-shouldered eye bolts are prohibited for use as rigging fittings.
.8 Safety hoist ring bolts shall be tightened to the torque value indicated on the safety hoist rings. Safety hoist rings shall not be modified in any manner. The use of substitute parts is expressly prohibited. Only those replacement or exchange parts recommended by the manufacturer are authorized.

.9 The hoist operator shall visually inspect accessory hoisting equipment for damage or defects prior to each use. Particular attention shall be paid to the condition of slings (e.g. broken wires, fraying, excessive wear, abrasions, kinks, deformation, cracks, etc.). Equipment found to be defective shall be immediately removed from service and reported to the supervisor.

.10 The hoist operator shall inspect cranes, hoists and all other primary lifting equipment each day before the initial use and before any critical lifting operation as specified by procedure. He shall perform a hoist checkout, or verify one has been performed that day.

.11 The hoist operator shall be responsible for the rigging of each lifting operation called out in each procedure. The lifting sling, attachment, etc., shall be selected from P0144, Probe-B/SMD Hardware Kit List.

.12 The hoist operator shall be responsible for the safety of all lifting operations.

.3 Injuries
In case of any injuries adhere to the following:

.1 Obtain medical treatment. Call 9-911

.2 Notify Test Director, Mike Taber, telephone 54136 or beeper (9) 599-8033

.4 Liquid Helium Dump
Certain failure modes of the SMD can lead to a rapid dump of liquid/gaseous helium into the room. The following precautions will minimize possibly injury to personnel.

.1 Non-flight diverters (90-deg elbows) are to be attached to the outboard flange of the two Main Tank and two Vacuum Enclosure burst disk assemblies. These diverters shall be positioned to direct the potential helium flow to the floor (or other designated safe dump area).

.2 When the diverters are directed to the floor, drip pans shall be placed under them to prevent liquid oxygen collection on the floor.

.3 In the case of a fast helium dump the oxygen concentration may be lowered below a safe level (19.5%). In this case an oxygen concentration sensor mounted on the west wall will sound an alarm. All personnel shall immediately exit the FIST Operations room.
.5 Genie Operations
Work at the top of the Airlock after it has been integrated with the SMD requires the use of Genie personnel lifts. The following steps shall be used whenever the Genie lifts are employed.

.1 Before raising the Genie ensure the four outriggers (or floor anchors) have been installed and locked and the leveling jacks have been adjusted to firmly touch the floor and the base is level.

.2 Do not adjust outriggers or reposition the machine while the platform is raised.

.3 No work should be performed by leaning out over the rails.

.4 Those working at the top of the Airlock shall each have easy access to an EEBA (Emergency Exit Breathing Apparatus) to be used for evacuating the room in case of a sudden dump of the helium cryogen and resultant depletion in oxygen concentration in the room.

.6 Safety
The SMD Safety Compliance Assessment, LMMS GP-B 1000153C, discusses the safety design, operating and maintenance requirements of the SMD. This document should be reviewed for applicability at any facility where the hardware is operated.

.7 Hazards Analysis
The GP-B SM Dewar FMECA, LMMS GP-B 100333, discusses hazards inherent in ATC-developed SMD hardware in detail.

.8 Emergency Procedures
The FIST Emergency Procedures, SU/GP-B P0141, sets forth the procedures to be taken in case of facility power loss, arming and disarming the FIST alarm system and safeing of equipment in case of a sudden loss of liquid helium from the Dewar.

4 CONTAMINATION CONTROL

.1 Particulate Contamination:
The control of particulate contamination of the probe is described in GP-B Contamination Control Plan SU/GP-B P059. Specific cases that require special methods are treated individual in this procedure. In general the when the Probe is in the FIST Lab it should be covered in clean room plastic and handled with gloves.

.2 Magnetic Contamination:
The control of magnetic cleanliness of the probe and/or dewar is described in GP-B Magnetic Control Plan, LMMS-5835031. Specific cases that require special tools and handling are treated individually in this procedure.

5 TEST PERSONNEL

.1 Personnel Qualifications:
The performance of the two Probe insertion procedures, P0134, Airlock/Dewar Integration and P0135, Probe Insertion into Dewar, require a Test Director and crew of from 1 to 3 Cryogenic Test Engineer (CTE) and one Responsible Safety Engineer (RSE). The minimum number of personnel to accomplish most of the Task Modules of these procedures is: Test Director and one CTE. However, a crew of Test Director and two CTE would be more efficient for several of the Task Modules. The one exception to this manning scheme is the Task Module 92, Lower Probe into Dewar, for which the required manning is Test Director and three CTE and the RSE. The RSE attendance for Test Modules 92 and 93 is required; his attendance at other portions of the procedures is at his discretion.

The test director is the designated signer for the witnessed signoffs located at the end of each procedure/task module.

.2 Qualification of Personnel:

The Test Director must have a detailed understanding of all procedures and facility operations and experience in all of the Probe insertion operations.

The Cryogenic Test Engineers must have Probe/FIST operations experience and an understanding of the operations and procedures used for the cryogenic servicing/maintenance of the Dewar.

At present (May, 1998) the personnel who qualify for the above categories are:

- **Test Director:**
  - Mike Taber: Stanford University
  - Dave Murray: Lockheed

- **Cryogenic Test Engineer:**
  - Tom Welsh: Lockheed
  - Dave Frank: Lockheed
  - Dean Read: Lockheed
  - Chuck Warren: Stanford University
  - Mike Taber: Stanford University
  - Dave Murray: Lockheed
  - Bill Thresher: Lockheed

- **Quality Engineer:**
  - Ben Taller: Stanford University
  - Dorrene Ross: Lockheed

- **Safety Engineer:**
  - John Janicki: Lockheed
  - A. Rodriguez: Lockheed

.3 Redline Authority

The persons authorized to create and sign-off on redline modifications of the procedure as it is performed are the test directors, M. Taber and D. Murray. The redlines will be reviewed and approved by the RQE during or after the performance of the redline.
.4 Critical Operations Review

At the start of this procedure and before any test procedures have been initiated an operations review meeting will be held with all personnel in attendance who have been assigned or who could be assigned (on a replacement basis) responsibilities. This meeting will cover the following all safety precautions described above and in particular instructions on the location and operation of the Crane Disconnect Switch. Emergency egress from scaffolding, room and building will be discussed.

All operations which are deemed critical by the test director(s), e.g., any moving or lifting of the Probe, shall have one Test Director in attendance.

.5 Quality Assurance

Quality Assurance engineering shall be notified at least 48 hours prior to the start of this procedure. In the event of a failure during the execution of testing, Quality Assurance shall be contacted. Any redlines made to this procedure shall be initialed by a program RQE prior to his/her final sign off.
6 OPERATIONS

.1 Verify that the Critical Operations Review meeting of Para. 4.3 has been completed and that all applicable personnel have attended or been briefed of the results.

.2 Test Director for this Procedure is: ____________________.
Starting Date & Time: ____________________.

.3 Verify responsible safety and quality engineers have been notified at:

.4 Verify that the Critical Operations Review meeting of Para. 4.3 has been completed and that all applicable personnel have attended or been briefed of the results.

.5 Verify Completion of procedure P0134 Airlock/Dewar Integration

.6 Verify that a 500 liter supply of liquid helium is on hand.

.7 Perform, in sequence, the following Task Modules:

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<th>Completed Date</th>
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.8 Probe Insertion into Dewar complete

Completed by:
Witnessed by:
Date:
Time:
RQE:
APPENDIX A

TASK MODULES

FOR

PROCEDURE

P0135
A SCOPE

.1 This module effects the aligning and centering of the Probe with respect to the center line of the Dewar Well.

B GENERAL REQUIREMENTS

.1 Magnetic screened tools, obtained from non-magnetic tool box are used for all open-well operations. Magnetic Zone SP, black marking (shrink tubing), is to be assumed unless Zone 2, yellow marking, is specifically called out.

.2 All O-rings installed shall be visually inspected, cleaned with isopropyl /ethyl alcohol as required and installed dry unless otherwise specified.

C CONFIGURATION REQUIREMENTS:

.1 The successful completion of Task Module 88: Install Airlock/Probe onto Dewar.

D HARDWARE REQUIRED

.1 Hardware installed/used:

a)  Probe Centering Assembly
b)  One-axis inclinometer assembly
c)  Two-axis inclinometer assembly
d)  Compliance Device (Lockheed P/N 5829166-106)
e)  Load Cell Assembly (Lockheed P/N 5833512-101)
f)  Kits Removed: 17G

.2 Tools required

a)  Overhead Crane
b)  Miscellaneous hand tools
E OPERATIONS

WARNING
All personnel in or around crane handling operations must be wearing hardhats at all times.

1 Checking Dewar and Guide Rod alignment:

.1 Verify RSE has been notified of moving of flight hardware. Date/Time: ________________.

.2 Remove Airlock Bottom Door.

.3 Place the two halves of the Probe Centering Assembly in the Airlock.

.4 Remove Airlock Windows as required.

.5 Using the single-axis inclinometer assembly, verify/adjust level of Guide Rods to within 2 arc minute by loosening the screws on the Guide Rod/Bridge Flanges and repositioning these flanges. Tighten the screws after each change.

+ Y rod: 
X axis

- Y* rod:
X axis

Y axis

CAUTION
In the following, take care that the inclinometer assembly does not rest on the foil strips which protect the Probe Vacuum Shell heater and thermometer instrumentation.

.6 Attach the two-axis inclinometer assembly to the Probe Vacuum Shell with the inclinometer sensing direction aligned with the Y and X axes.

.7 Verify Crane functional check-out has been performed within the last week:
Confirmed by Crane operator: ____________.

.8 Inflate the Inflatable Seal to 5 psig (10 psig max.).

.9 Connect the Crane directly to the Compliance Device with the Load Cell Assembly.

.10 Using Crane raise the Piston/Probe slightly until the four Bridge/Piston bolts (17G) are free to be removed.

.11 Remove the 4 bolts and washers used to fasten the Piston to the Bridge and stow in Kit No. 17G.

CAUTION
Do not allow the Probe to touch the Well Cover Assembly.

.12 Lower the Piston/Probe hardware sufficiently to allow removal of the two Centering Sleeves.
Removing the two Centering Sleeves:

**NOTE**

The Probe is suspended by the three remaining spherical nuts during these sub-steps.

.1 One at a time, remove from the appropriate stud of the Probe Lifting Flange;
   a) One Spherical nut and washer.
   b) The Centering Sleeve.

.2 Reinstall Spherical washer and nut hand tighten to seat on Vertical Jack Screws.

.3 Repeat sub-steps 1.12.1 thru 1.12.2 for other Centering Sleeve.

.14 Back away the 4 vertical jack screws 2 turns or enough to allow the Probe to suspend freely from the four spherical nuts/washers.

.15 Verify the radial jack screws backed-off one turn or sufficiently from the Probe Lifting Flange to allow clearance for aligning.

Aligning the Probe:

**CAUTION**

In all of the following operations care must be taken to not apply side or bending loads to the Probe as these may damage the neck tube.

.1 Using the double-axis inclinometer align the Probe to within 1 arc minute by performing the following sub-steps.

**NOTE**

Be sure to subtract out any zero offset specified on the inclinometer readout.

.1 Determine the direction the Probe needs to be moved for aligning.

.2 One at a time, loosen the appropriate Spherical nut.

.3 Tighten the Spherical nut 180° from the one that was loosened in the previous sub-step.

.4 Repeat sub-steps 2.1.1 thru 2.1.3 until Probe is aligned to within 1 arc minute.
Task Module 90: Align and Center Probe

2 Record the above measured alignment:
   a) #1 sensor is _____ axis, with + rotation top dewar towards _____ axis.
   b) #2 sensor is _____ axis, with + rotation top dewar towards _____ axis.

<table>
<thead>
<tr>
<th>Probe Vacuum Shell Tilt</th>
<th>in units of degrees of arc</th>
</tr>
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<tbody>
<tr>
<td>Try No.</td>
<td>+ Y axis</td>
</tr>
<tr>
<td>Zero Corr.</td>
<td>&gt;</td>
</tr>
<tr>
<td>offset</td>
<td>&gt;</td>
</tr>
</tbody>
</table>

After centering
of para. 3.6

3 Centering the Probe over the Well:

1 Verify the Probe Centering Assembly has been installed on the Dewar Well Cover.
2 Install a dial indicator mounted to the rotating member of the Centering Assembly.
3 Tighten the vertical jack screws finger tight.
4 Adjust the radial jack screws to center the Probe in the Centering Assembly.
5 Record the centering measurement: setting the dial indicator to zero on +Y axis and record the indicator on each of the indicated locations:

   Note
   Increasing dial indicator readings indicate increasing radial location.

<table>
<thead>
<tr>
<th>Probe Vacuum Shell Run-out</th>
<th>in units of 0.001 in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Try No.</td>
<td>+Y axis   +X axis   -Y axis   -X axis</td>
</tr>
</tbody>
</table>
.6 Verify that the Probe verticality has remained unchanged.

.7 Repeat the alignment and centering steps above until the alignment is within +/- 1 minutes of arc and the centering run-out is less than 0.010-in peak-to-peak.

.8 Record final tilt angles in table of para. 2.2.

.9 Remove the dial indicator from the Centering Assembly, disassemble it and remove form Airlock via the Airlock bottom door. Hardware goes into Kit 24P.

.10 Measure scribe mark separation on the centering tool and record.
   Value of D: ____________
   Calc. angle: ___________
.1 Verify the 4 screws that hold the Piston to the Bridge are removed.

.2 Deflate the Inflatable Seal.

.3 Record weight from load cell: ______________.

.4 Install the 4 screws from Kit 17G which hold the Bridge to the Piston; verify screws are adjusted such that equal lengths are visible above Bridge.

5 Task Module 90 completed:
Task Module 91: Purge Airlock with Helium Gas

A SCOPE

.1 This module effects the purging of the Airlock in preparation for installation of the Probe.

B GENERAL REQUIREMENTS

.1 Magnetic screened tools, obtained from non-magnetic tool box are used for all open-well operations. Magnetic Zone SP, black marking (shrink tubing), is to be assumed unless Zone 2, yellow marking, is specifically called out.

.2 All O-rings installed shall be visually inspected, cleaned with isopropyl/ethyl alcohol as required and installed dry unless otherwise specified.

.3 For all Sub-Steps herein adjust the helium gas purge into the Airlock as necessary to maintain a positive pressure.

C CONFIGURATION REQUIREMENTS

.1 The successful completion of Task Module 90: Align & Center Probe

D HARDWARE REQUIRED

.1 Hardware installed/used:

a) Kits Installed:
   14G gloves;
   15G Airlock window bolts;
   22P clocking template;
   14P, Well Cover-to-Dewar bolt assemblies
b) O-Ring Installed: No. 7
c) Well Cover Assembly and handle
d) Two dial indicator assemblies
e) Probe/Dewar Split Flange (SK031998A)

.2 Tools required:

a) 7/16 end wrench (2), nonmagnetic
b) Slot head screwdriver, nonmagnetic
c) String for tethering tools
E OPERATIONS

WARNING
All personnel in or around crane handling operations must be wearing hardhats at all times.

1 Preparing the Airlock:

.1 Place the following tools into the Airlock:
   a) slot head screwdriver
   b) Needle nosed pliers
   c) Phillips screw driver

.2 Place the following hardware items into the Airlock (ref. Para. D):
   a) Well Cover Assembly with handles
   b) two Dial Indicator Assemblies
   c) Kits 14P(Well Cover to Dewar bolts)
   d) 22P clocking template (2).
   e) Probe/Dewar Split Flange (SK031998A)
   f) Station 200 radial gap gauges

.3 Tether all tools and loose hardware with string to the Guide Rods.

.4 Inspect for and remove any tools or other unnecessary objects that may have been placed inside the Helium Airlock.

.5 Verify installed 3-ft length of 1-in flexible vacuum line to one port of the Well Exhaust Manifold per Fig. 1.

.6 Verify fastened, Well Cover Handles to the Well Cover Assembly.

.7 Install Gloves onto the Airlock. Locations, as numerically inscribed in the Airlock’s ports, are as follows:

   .1 Port No. 16: Right hand glove.
   .2 Port No. 18: Right hand glove.
   .3 Port No. 20: Right hand glove.
   .4 Port No. 22: Right hand glove.

2 Sealing the Helium Airlock.

.1 Install Airlock Windows over all open access holes in the Airlock. Use O-ring No. 7 and 8 screws, washers, and lock washers from Kit No. 15G per Access Cover.

.2 Install Airlock Bottom Door.

.3 Inflate the Piston inflatable seal to 5 +/-1 psig.

.4 Prepare to introduce helium gas to purge the Airlock via the quick disconnect fitting located on the support plate.
Task Module 91: Purge Airlock with Helium

.5 Verify the 0-10-in H₂O pressure gauge has been installed in the Support Plate

3 Setting up Well Transfer:

.1 Initiate helium gas purge of Airlock via facility helium supply.

.2 Maintain pressure at regulator to produce a flow of ~ 100 cuft/hr (6 pack in 12 hrs.); use 6 pack supply pressure to track flow rate using 2 psig (6 pack) ~ 1 cuft.

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>6 pack Press</th>
<th>Flow Rate</th>
<th>Date/Time</th>
<th>6 pack Press</th>
<th>Flow Rate</th>
<th>Date/Time</th>
<th>6 pack Press</th>
<th>Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>---</td>
<td>psig</td>
<td>cuft/hr</td>
<td>---</td>
<td>psig</td>
<td>cuft/hr</td>
<td>---</td>
<td>psig</td>
<td>cuft/hr</td>
</tr>
</tbody>
</table>

.3 Turn on power to O₂ Sensor.

.4 Purge the Helium Airlock until the O₂ level is < 0.2 %.

CAUTION When shutting down purge flow, take care that Airlock pressure does not go to zero, maintain sufficient flow to maintain > 0.2 in H₂O.

.5 Verify Valve EV-11 and EV-19 are closed.

.6 Verify valves DEV-15 and DEV-16 are closed.

.7 Close VW-C and disconnect exhaust line from VW-C.

Task Module 91 complete.

Completed by:  
Witnessed by:  
Date:  
Time:  
RQE:
Task Module 91: Purge Airlock with Helium

Blank-off to be removed after Airlock purge

3' x 1" flex hose to VW-3

Airlock Support Plate

RVW-4
0.5 psig

DEV-15

DEV-16

ToAccess-1

0.5 psig

To Facility Vent

Gas Module

EV-19

EV-11

Fig. 91-1 Well Vent Plumbing for Probe-C Insertion
Figure 91-2  Probe Exhaust Valving.

wellvent.1
Task Module 91: Purge Airlock with Helium

A SCOPE

A.1 This module effects the insertion of a Probe into the SMD (Science Mission Dewar).

B GENERAL REQUIREMENTS

.1 For all Sub-Steps herein adjust the helium gas purge into the Airlock as necessary to maintain a positive pressure.

.2 This Task Module requires a minimum of five persons including a safety observer.

.3 Special Considerations:
   a) All personnel in or around handling operations must be wearing hardhats at all times.

   b) Liquid helium levels shall be maintained at all times. Use SMD Cryogen Handling procedures as required.

   c) Tension shall be maintained in the Overhead Crane at all times. Loss of tension in the Overhead Crane may be the result of excessive helium gas pressure in the Helium Airlock due to a high boil-off rate. Excessive pressure will be prevented by backup relief through the spring loaded Airlock Piston window in the Piston Plate.

   d) Positive pressure is to be maintained in the Helium Airlock at all times. A loss of pressure could result in the incursion of air into the SMD Well. This is most likely to occur in the event of a large leak or in an attempt to initiate Probe removal in an emergency.

   e) The crane shall be operated only at minimum vertical speed. A cover shall be affixed over the buttons which control crane traversal to prevent inadvertent horizontal operation.
C CONFIGURATION REQUIREMENTS

.1  The successful completion of Task Module 91: Purge Airlock with Helium Gas.
.2  A 500 liter supply of liquid helium.

D HARDWARE REQUIRED

.1  Hardware installed/used:
   a)  Overhead Crane
   b)  Load Cell Assembly (Lockheed P/N 5833512)
   c)  Compliance Device (Lockheed P/N 5829166-106)
   d)  Crane Test Load - 1400 lbs.
   e)  Crane Control Lock-out Device
   f)  Dial Indicator Assemblies (2 each)
   g)  Strip chart recorder
   h)  Kit 31P, Probe Dewar Split Flange

.2  Tools required
   a)  Miscellaneous hand tools
E OPERATIONS

WARNING
All personnel in or around crane lifting operations must be wearing hardhats at all times.

1 Preparing for Probe Insertion:

.1 Verify RSE has been notified of moving of flight hardware. Date/Time: ______________.

.2 Verify Crane functional check-out has been performed within the last week:
   Confirmed by Crane operator: __________.

.3 De-mate the Crane from the Piston Assembly/Compliance Device and move it to the lower floor area.

.4 Install/verify installed the crane radio control Lockout Device which prevents $\alpha_{\text{East}}$, $\alpha_{\text{West}}$ and A$\text{P}^2$" (fast) button operations.

.5 Set the crane load limit to 1400 lbs. (This is the required setting for the case the Probe insertion is aborted and the Probe needs to be removed.)

.6 Verify that the crane can lift the 1500 lb Test Load but shuts off by 1600 lbs: use the Load Cell Assembly to verify the weight limits.

.7 Connect the Crane with Load Cell Assembly to the Compliance Device previously mounted on the Piston.

.8 Connect the analog output of the load cell readout to a chart recorder set for 10 cm/hr and annotate the paper for load and chart speed; facility DAS and BPS DAS.

2 Verifying Liquid Helium levels:

.1 Verify that 500 liters of liquid helium is on hand for the performance of this procedure.

.2 Verify that the liquid helium level in the SMD Axial-Lock is greater than 0%. If not, perform an Internal Well Fill, SU P0210. Record Op. No.__________.

.3 Verify that the liquid helium level in the Main Tank is greater than 50%. If not, perform an External NBP Tank Fill, procedure P0207. Record Op. No.__________.

.4 Verify Guard Tank is empty: record T16D (CN 25): ______________ K.

.5 Record liquid helium levels.

| Tank (>50%) | __________ % |
| Well (>=100%) | ________ % |
| Guard Tank (=0%) | ________ % |
| Axial Lock (>0%) | ________ % |

Time
Date
CAUTION

The helium level in the Well must be kept above the top of the 10-in Lead Bag. During probe insertion this requires that the helium level not be allowed to drop below 0% on the Axial Lock sensor.

.6 Have two persons lift the well baffle assemble retraction device; pulling up the strings and attached baffle plates.

.7 Tie off the baffle lifting strings to secure the baffles to the Well cover.

.8 Remove the 3 Well Cover fasteners (Kit 14P).

CAUTION

Take care to not bang the Well Cover into the Probe Vacuum Shell in the following steps.

CAUTION

Take extreme care in the following step to not drop the Well Cover O-ring into the Well.

.9 Lift the Well Cover Assembly with the attached baffles off the Dewar.

.10 Move the Well Cover Assembly to the +X area of the Helium Airlock, remove both handles and prop it up against the side of the Airlock.

.11 Remove spool on -X string of top hat baffle strings and wrap around relief valve to allow clearance with Probe Vacuum Shell.

.12 Remove Probe/Dewar Split Flange.

CAUTION

In the following take care when working with hands near dewar mouth that the high velocity flow of the cold helium gas does not cause low temperature burns.

.13 If an O-ring has been used for Probe-to-Dewar closure then, install the two dial indicator Assemblies 90-deg apart (at approximately -Y, -X axes) on top of the Dewar using the Dewar/Probe Top Hat interface bolt holes.

.14 Initiate a Internal Well Fill, SU P0210, to maintain liquid helium level in the Dewar Axial Lock between 0 and 20%. This level must be maintained throughout the rest of this Task Module. After initiating the transfer (Para. 4 of P0210), reduce the voltage settings on the tank heater to maintain proper liquid level. Record the liquid levels and power setting of the
Tank Heater in Table 1 at the end of this procedure. Record Op. Order No.__________.

.15 Inspect the pneumatic hoses leading to the Inflatable Seal and Airlock for any possibility of pinching as the Piston is lowered into the Airlock Cylinder.

.16 Manning requirements during probe insertion:

a) One person will monitor liquid He levels and control the internal LHe transfer process (using Procedure SU/P210), monitor DAS output, monitor the helium boil-off rate and record data in Table 1;

b) One person will observe the piston motion from the top of the airlock, assure that the inflatable seal pressurization line and electrical lines pay out properly, and measure and report the probe position (as measured by the distance between the top of the airlock and the top of the piston);

c) One person will be responsible for monitoring compliance with this Procedure, for control of the crane and monitoring the load cell during probe motion;

d) One person will be responsible for visually monitoring conditions inside the airlock (including dial gauge indicators, if used), for monitoring the pressure in the airlock, and for recording the probe position and pressure as a function of time and manually entering probe position into DAS;

e) One person will be the safety observer but may assist the other individuals to the extent that responsibility for safety allows.

3 Inserting Probe into Dewar:

.1 Initiate a new DAS data log file using 2 minute logging intervals.
PROBE-B INSERTION INTO SMD

Task Module 92: Insert Probe into Dewar

Note

In the following, the Probe position will be referred to as the Logged Probe Position (LPP) which is the distance between the top of the airlock (bottom of the bridge) and the top of the airlock piston. The relationships between this distance and the location of key Probe features relative to the SMD (using the Science coordinate system) are as follows:

- Location of bottom of Probe-C = 240.79 - LPP
- Location of bottom of QB = 248.49 - LPP
- Location of QB/QBS interface = 265.32 - LPP
- Location of top of QB = 271.52 - LPP
- Location of top of telescope = 286.26 - LPP
- Location of Probe STA 200 = 307.27 - LPP
- Location of Probe top hat flange mating surface = 341.60 - LPP

(LPP = 107.75 when Probe B/GTU1 was fully inserted, ~ 8 when starting out)
(LPP for GTU2 will be 107.75 -.38(adapter plate)= 107.37)
(LPP for Probe-C will be 107.75 -.48(adapter plate)= 107.27)

CAUTION

During Probe insertion do not allow any or Station 200 to exceed a cooldown rate of 100 K/hr.

.2 Verify that the Probe and Piston load is on the Crane and that the load cell chart recorder is running.

.3 The LPP readings shall be entered into the DAS as they are called out following each movement.

.4 Remove the 4 bolts holding the Piston to the Bridge and store in Kit 17G.

.5 Verify the 4 bolts holding the Piston to the Bridge have been removed.

.6 Record initial Logged Probe Position (LPP): ___________ inches and enter into Table 1. Date _________ Time

NOTE

Pull back dial indicator plungers as required to allow Vacuum Shell to pass.

.7 Lower the Probe to LPP = 6.50-in and visually verify that the bottom of the Probe is at the top surface of the SMD (STA 234.4).

.8 Verify installed the two threaded rods in the top of the Piston.

.9 Add or remove weights in pairs (8 lbs each or 16 lbs. per pair) on the two threaded rods to
Task Module 92: Insert Probe into Dewar

give a suspended weight of 880 lbs, -0 lbs, +16 lbs.

.10 Record final adjusted weight: _____ no. pairs x 16 lbs = _____ lbs
    Wt from TM90 = _____ lbs
    Total weight = _____ lbs

.11 Record Airlock pressure: ________ in-water.

.12 Insert comment to DAS, ΛStart Probe lowering≡

.13 Lower Probe ~ 3-in, LPP = 10-in, while holding both dial indicators back until the dial
    indicators can seat on the Probe Vacuum Shell.

.14 Shut off external GHe purge.

.15 As the Probe is lowered the LPP shall be logged into the DAS and a record of the Dial
    indicators shall be kept, using Table 1.

NOTE
In the following contact of the vacuum shell with the
liquid helium will be indicated by the Vacuum Shell
temperature sensors cooling rapidly to ~ 10K.

.16 Lower the Probe in one inch increments. Wait until the boil-off returns to a steady-state
    value before lowering another increment. Do not lower at a rate exceeding 1-in every two
    minutes. When LPP = 36-in, stop lowering the probe. (The bottom of the Probe will be
    at approximately STA 205° at this point.)

    Date _________  Time __________

.17 Monitor the temperature of T-7Q (the silicon diode thermometer between the third and
    fourth gyro positions). When T-7Q reaches 140 K, proceed with the next step.

NOTE
At a height of 52.5 inches above the top of the SMD
(LPP = 60-in), the guide rods begin to taper and allow the
Piston to move in X and Y. This allows the Retainer to
align the Probe throughout the final insertion process
(Over the 52.5-in length, the rod diameter decreases by
0.026 inch.)

Just beyond this point the jack screws are released so
the Probe is free to align with the Retainer and not be
subject to frictional loading at the Probe Flange.

.18 Lower the Probe in one inch increments at a rate of 1-in every 4 minutes until at LPP = 60-
Task Module 92: Insert Probe into Dewar

in. The airlock piston will now be below the upper port windows. Date __________  Time

CAUTION
In the following step be careful to not dislodge SMD Top Plate O-ring or it may be damaged.

NOTE
The one half of the split flange clocks to the thruster vent and Well vent bosses on the Dewar.

.19 Remove upper windows and back off vertical jack screws ~ 2 turns and horizontal jack screws ~5 turns.

.20 Continue lowering the Probe at a rate of 1-in every 20 minutes until the LPP = 62-in. (This puts all of the QB below the liquid level.) Date __________  Time

.21 Remove the two dial indicators.

.22 Continue lowering the Probe at a rate of 1-in every 10 minutes until LPP=73 and the Probe STA 200 is just above the mouth of the Dewar. Date __________  Time

.23 Install the Station 200 Clocking Template on the -X axis or +/- 120-deg from this axis (choose the location which is most convenient).

.24 Center Probe:
.1 Measure gap between Probe Sta 200 and Dewar opening; record in Table 3.24
.2 Remove -Y and +Y windows from the upper Airlock Cylinder.
.3 Using data from Table 3.24, adjust Probe to center on Dewar.
.4 Measure gap and record in Table 3.24
.5 Repeat last two steps until Probe is centered to +/- 0.010-in.

Table 3.24

<table>
<thead>
<tr>
<th>Trial No.</th>
<th>+Y</th>
<th>+X</th>
<th>-Y</th>
<th>-X</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.001-in</td>
<td>0.001-in</td>
<td>0.001-in</td>
<td>0.001-in</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

.25 Verify that the Probe Axial Lock pocket falls with +/- 1-deg of the 0-deg location marked on
Task Module 92: Insert Probe into Dewar

the Clocking Template. Record the observed values:

- X: _____ Deg. in direction: _______; -Y: _____ Deg. in direction: _______.

**NOTE**
The value found in para. 3.21 for both Probe B, GTU1 and Probe B GTU2, was 1/2-deg clockwise.

.26 Remove the Clocking Template.

.27 Continue lowering the Probe at a rate of 0.5-in every 20 minutes until the Probe STA 200 cools to 100 K.

.28 When the internal transfer is no longer necessary, complete the open Internal Transfer operation, P210, starting at Para. 5. Date __________ Time

.29 Install the Probe/Dewar Split Flange (Kit 31P)

.30 Continue lowering the Probe at a rate of 1-in every 2 minutes while visually checking for obstructions through the lower windows until the Probe flange is seated on the top of the Probe/Dewar Split Flange. Date __________ Time

.31 Record final LPP value: _______-in.

4 Configuring Probe/Dewar:

.1 Connect Probe plumbing to the Well Exhaust Manifold per Fig. TM92-2.

.2 Open/verify open VW-3, EV-19 and DEV-15.

.3 Verify closed/close EV-11 and DEV-16.

.4 Input comment to DAS ΛProbe insertion complete.

.5 Record final Liquid Levels:

a) Record tank liquid level ______ %.  
b) Record well liquid level ______ %.

5 Module 92 completed.

Completed by:

Witnessed by:

RSE:

Date:

Time:

RQE:
Table 1  PROBE INSERTION TEMPERATURE DATA

<table>
<thead>
<tr>
<th>A/L</th>
<th>DEWA PROB</th>
<th>Dial Ggs</th>
<th>B/GTU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DATE/</td>
<td>LPP</td>
<td>Pre</td>
<td>Sta 200</td>
</tr>
<tr>
<td>TIME</td>
<td>A/L</td>
<td>T01D</td>
<td>T08D</td>
</tr>
</tbody>
</table>

in | in | in-W | K | K | % | % | % | vdc | Torr | Torr | K | K | K | K | K | K | K | K | Torr |

1. LPP for fully inserted Probe is 107.27 for Probe-C insertion.  
   C= channel Nos. on SMD DAS;  C*= channel Nos. on facility DAS
PROBE-B INSERTION INTO SMD

Task Module 92: Insert Probe into Dewar

Fig. TM92-1  Piston Plate Configuration

NOTE:
No Counter Balance weights are required for Probe B/GTU2
## Task Module 92: Insert Probe into Dewar

### Table 2  Probe Insertion Logged Probe Position Data

<table>
<thead>
<tr>
<th>Time/Date</th>
<th>Logged Probe Position in.</th>
<th>Bottom Probe Sta in.</th>
<th>-X Dial Indicator in.</th>
<th>-Y Dial Indicator in.</th>
<th>Comment</th>
</tr>
</thead>
</table>