# GRAVITY PROBE-B

# TEST PROCEDURE

# PROBE INSERTION INTO SMD

March 30, 1995

Originator:

D. Murray

Approval:

| | |
|---|---|
| Mike Taber Date<br>GP-B GTU Cryogenics Ops Mgr. | D.O. Murray Date<br>Lockheed Test Engineer |
| Doron Bardas GP-B Date<br>GP-B Integrated Systems Tests Mgr. | Art Nakashima Date<br>Lockheed System Engineer |
| Ben Taller Date<br>GP-B Quality Assurance | J. Regimbal Date<br>Lockheed Safety Engineer |
| John P. Turneaure Date<br>GP-B Hardware Manager | |

| REV-ISION | ECO NUM-BER | ECO DATE | PAGES | DATE/ APPROVALS |
|---|---|---|---|---|
| Original | - | - | All | 30 JAN 1995 |
| A | 621 | 8/15/97 | Changes to Update for GTU1 redlines and modify for use of Science Mission Dewar (SMD) and SMD Ground Support Equipment | August 6, 1997 |
| B | 782 | 4/24/98 | Changes to update for GTU2 redlines and modify for use of Probe-C with Bellville Pre-load System. | April 24, 1998 |
| C | 1009 | 6/23/99 | Incorporate red lines from Probe C fit Check operations. | June 24, 1999 |

**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 Evauation Breathing Apparatus |
| EG-xx | Gas Module Exhaust Gauge number xx |
| ESD | ElectroStatic Discharge |
| 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 |
| $LN_2$ | 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 |
| VSx | Valve number x on Shutter |
| VW-1 | Valve on Dewar Adapter connecting Well to outside |

Table of Contents

## 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.

| Procedure No. | Title |
|---|---|
| P0210 | SMD Tank to Well Helium Transfer |
| P0207 | SMD Main Tank Normal Boiling Point Fill |
| P0133 | Preparation for Probe/Airlock Integration |
| P0134 | Airlock/Dewar Integration |
| P0135 | Probe Insertion into Dewar |
| P0141 | FIST Emergency Procedures |
| S0317 | Probe/SMD Insertion Overview |
| S0318 | Prove/SMD Hardware Kit list |

.2 Drawings:

| Lockheed Dwg No. | itle |
|---|---|
| 5833519 Rev C | Helium Airlock Assembly |
| 5823341 Rev D | Helium Airlock Installation |
| 5813359 | Axial-lock Assembly |
| 5813395 | SMD External plumbing |

.3 Figures

| | |
|---|---|
| Fig. 1 | Test Flow for Probe Insertion |
| Fig. 2 | Gas Module Plumbing Configuration |

.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

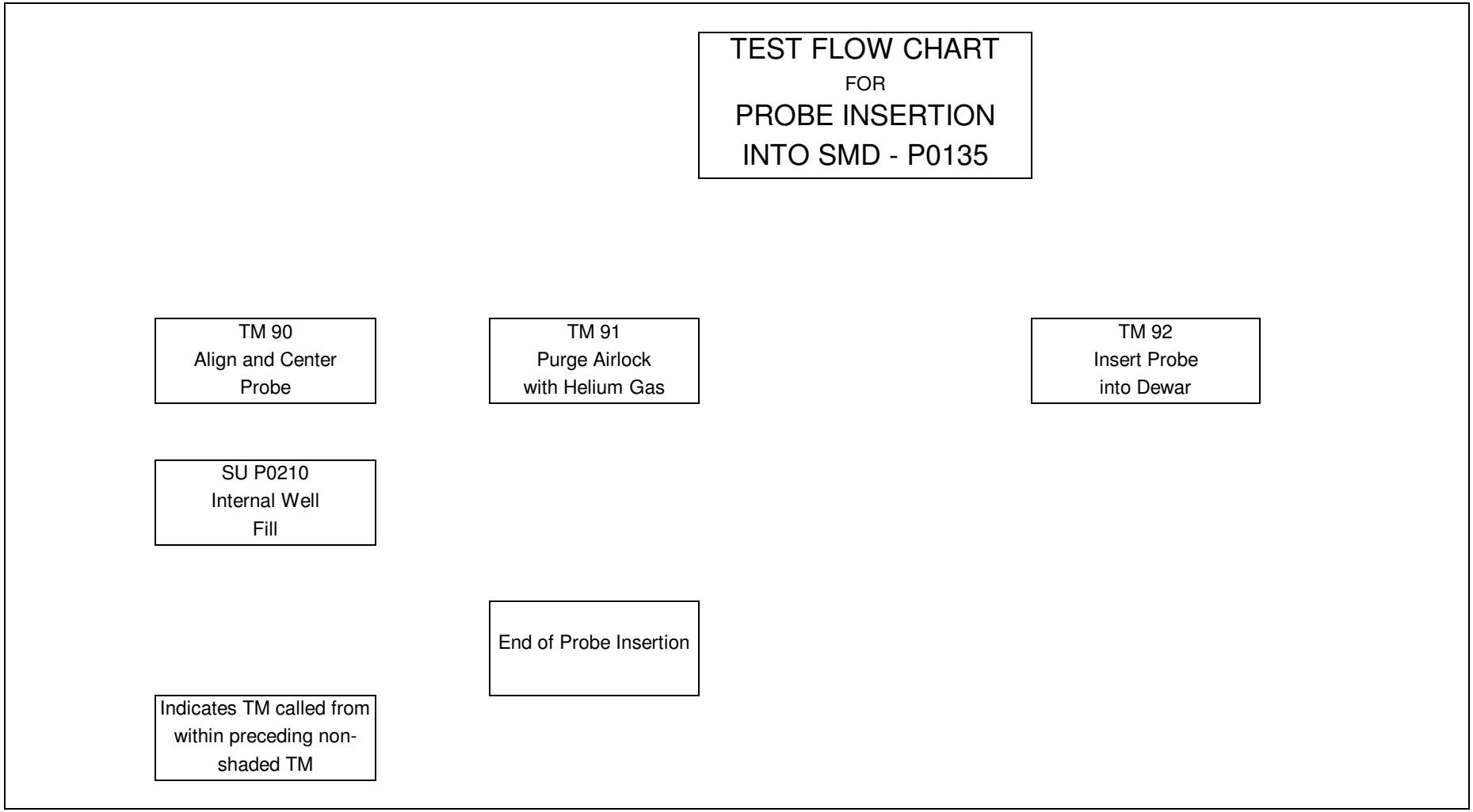

TEST FLOW CHART
FOR
PROBE INSERTION
INTO SMD - P0135
TM 90
Align and Center
Probe
TM 91
Purge Airlock
with Helium Gas
TM 92
Insert Probe
into Dewar
SU P0210
Internal Well
Fill
End of Probe Insertion
Indicates TM called from
within preceding non-
shaded TM

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 Awitnessed by≅ 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:

Time/Date

.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:

| Task Modules for Probe Insertion Para. No. | Task Module | Op. No. | Started Date | Started Time | Completed Date | Completed Time |
|---|---|---|---|---|---|---|
| 5.3.1 | Task Module 90: Align & Center Probe | | | | | |
| 5.3.2 | Task Module 91: Purge Airlock for Insertion | | | | | |
| 5.3.4 | Task Module 92: Lower Probe into Dewar | | | | | |
| 5.3.6 | SU/GP-B/P0210: Internal Well Fill | | | | | |
| 5.3.5 | Task Module 93: Remove Airlock from Dewar w/o Probe | | | | | |

.8 Probe Insertion into Dewar complete

.

Completed by:
Witnessed by:
Date:
Time:
RQE:

# APPENDIX A

# TASK MODULES

# FOR

# PROCEDURE
# P0135

**Task Module 90: Align and Center Probe**

Task Module 90: Align and Center Probe

Operations Number
Date Initiated
Time Initiated

## 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

**Task Module 90: Align and Center Probe**

**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: | -Y* rod: |
|---|---|
| X axis | X axis |
| Y 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 no t allow the Probe to touch the Well Cover Assembly.**

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

**Task Module 90: Align and Center Probe**

.13 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.

**2 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 180E 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.

Probe Vacuum Shell Tilt in units of degrees of arc

| Try No. | + Y axis | - X axis |
|---|---|---|
| Zero Corr. > offset > | _____ | _____ |

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.

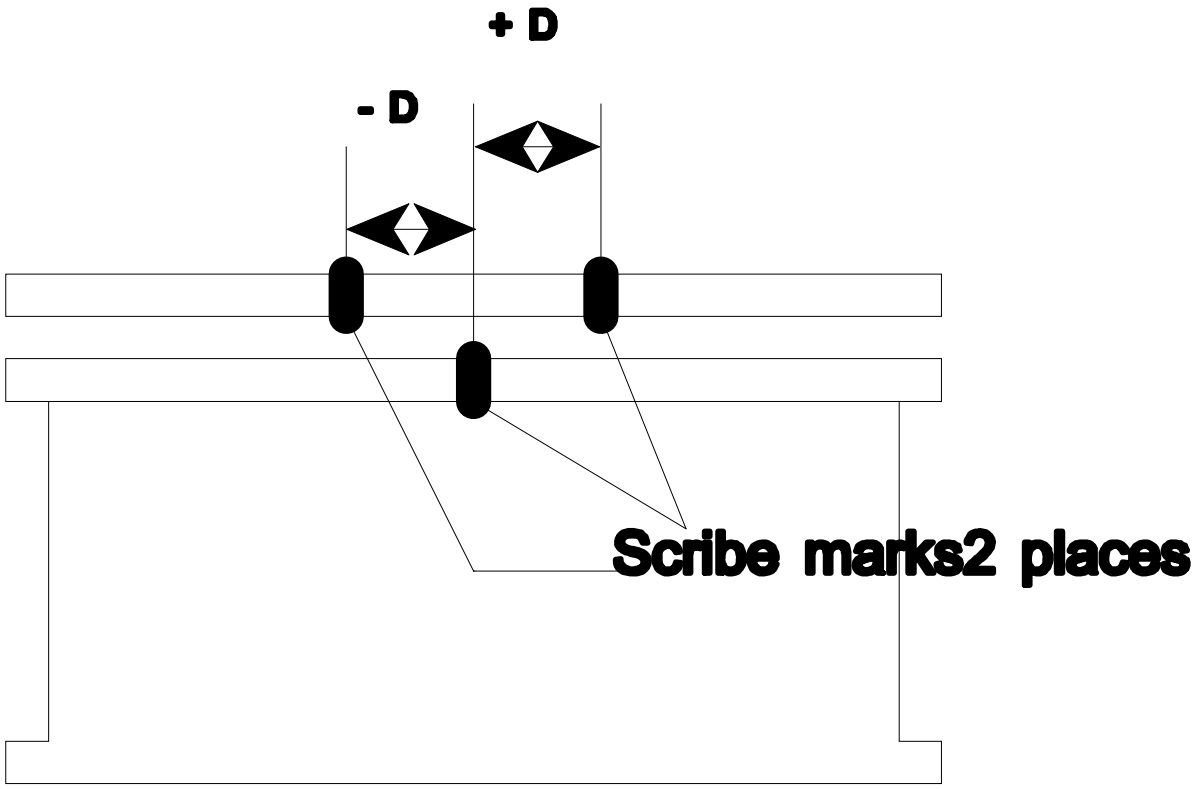
.5 Record the centering measurement: setting the dial indicator to zero on +Y axis and record the indicator on each of the indicated locations:

**Note**
**Increasing dial indicator readings indicate increasing radial location.**

Probe Vacuum Shell Run-out - in units of 0.001 in.

| Try No. | +Y axis | +X axis | -Y axis | -X axis |
|---|---|---|---|---|

**Task Module 90: Align and Center Probe**




.6 Verify that the Probe verticality has remained unchanged.

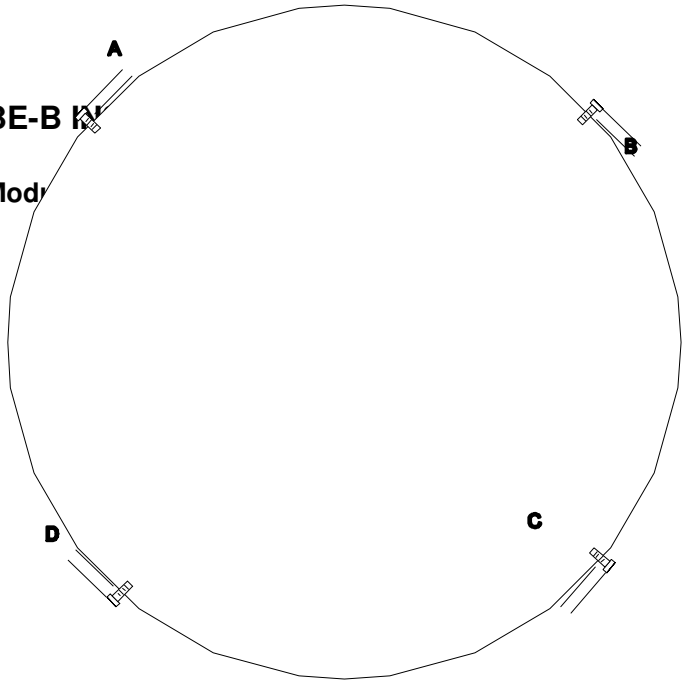
.7 Repeat the alignment and centering steps above until the alignment is within +/- 1 minutes of arc and the centering run-out is less than 0.010-in peak-to-peak.

.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: _____ .

**Figure TM90-2**






.11 Record bolt locations in Fig. TM90-2

**4 Establishing Piston loading for Probe insertion into the Dewar:**

.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:**

Completed by:
Witnessed by:
RSE:
Date:
Time:
RQE:

**Task Module 91: Purge Airlock with Helium**

Task Module 91: Purge Airlock with Helium Gas

Operations Number
Date Initiated
Time Initiated

## 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

**Task Module 91: Purge Airlock with Helium**

## 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 $H_2O$ 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.

| Date/ Time --- | 6 pack Press psig | Flow Rate cuft/hr | Date/ Time --- | 6 pack Press psig | Flow Rate cuft/hr | Date/ Time --- | 6 pack Press psig | Flow Rate cuft/hr |
|---|---|---|---|---|---|---|---|---|

.3 Turn on power to $O_2$ Sensor.

.4 Purge the Helium Airlock until the $O_2$ 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 $H_2O$.**

.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**

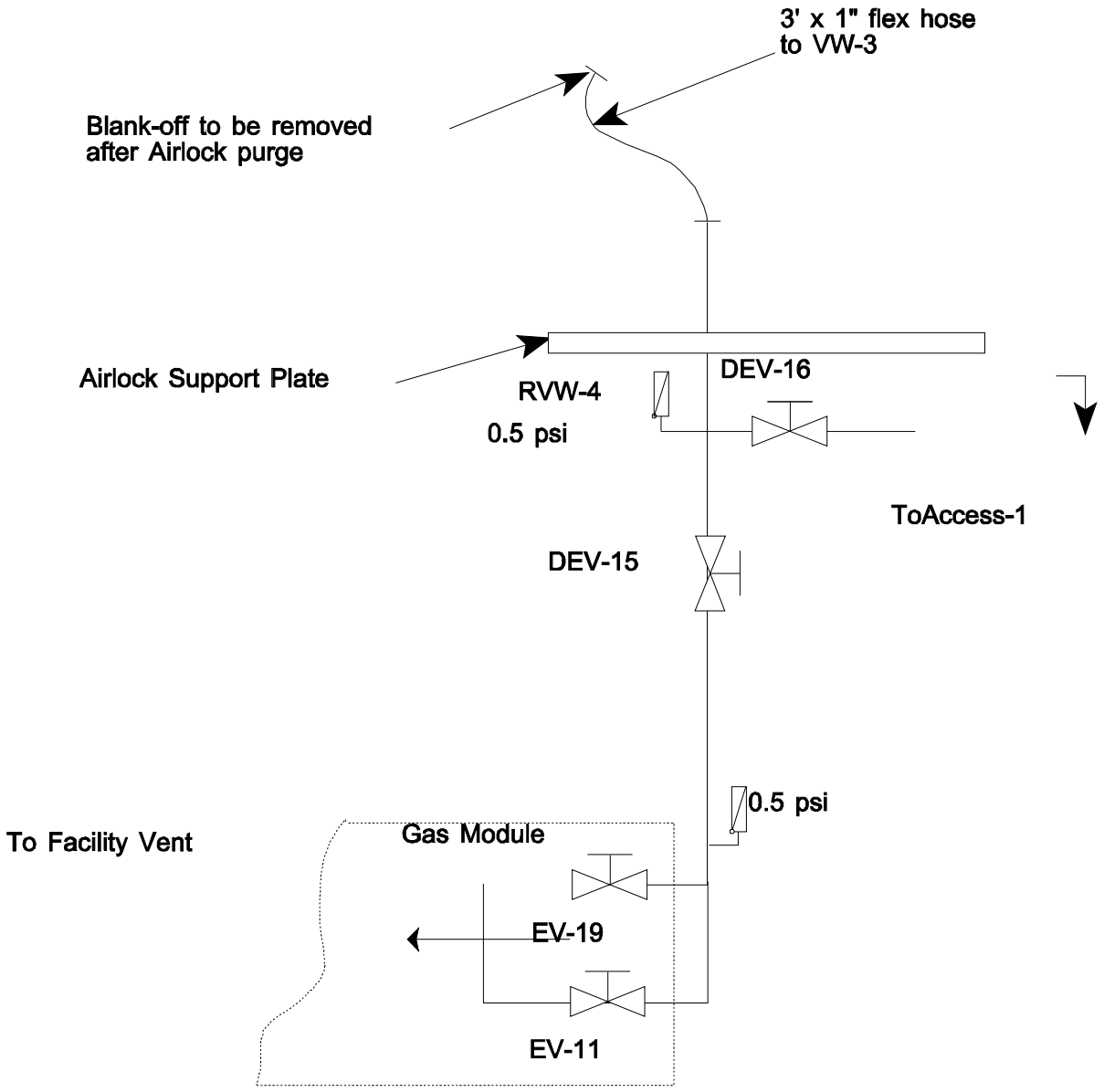



Fig. 91-1 Well Vent Plumbing for Probe-C Insertion

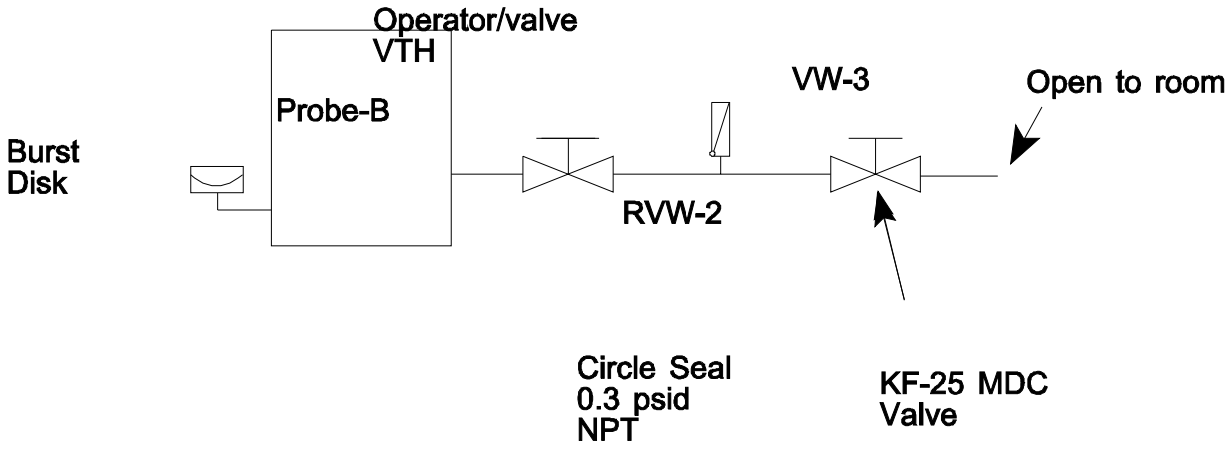



Figure 91-2 Probe Exhaust Valving.

wellvent.1

**Task Module 91: Purge Airlock with Helium**

Task Module 92: Insert Probe into Dewar

Operations Number
Date Initiated
Time Initiated

## 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.

**Task Module 92: Insert Probe into Dewar**

## 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

**Task Module 92: Insert Probe into Dewar**

## 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 AEast≅, AWest≅ and AP2" (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

**Task Module 92: Insert Probe into Dewar**

## 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

**Task Module 92: Insert Probe into Dewar**

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.

**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, AStart 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-

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

| Trial No. | +Y 0.001-in | +X 0.001-in | -Y 0.001-in | -X 0.001-in | Comment |
|---|---|---|---|---|---|

.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 "Probe 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:

**Task Module 92: Insert Probe into Dewar**

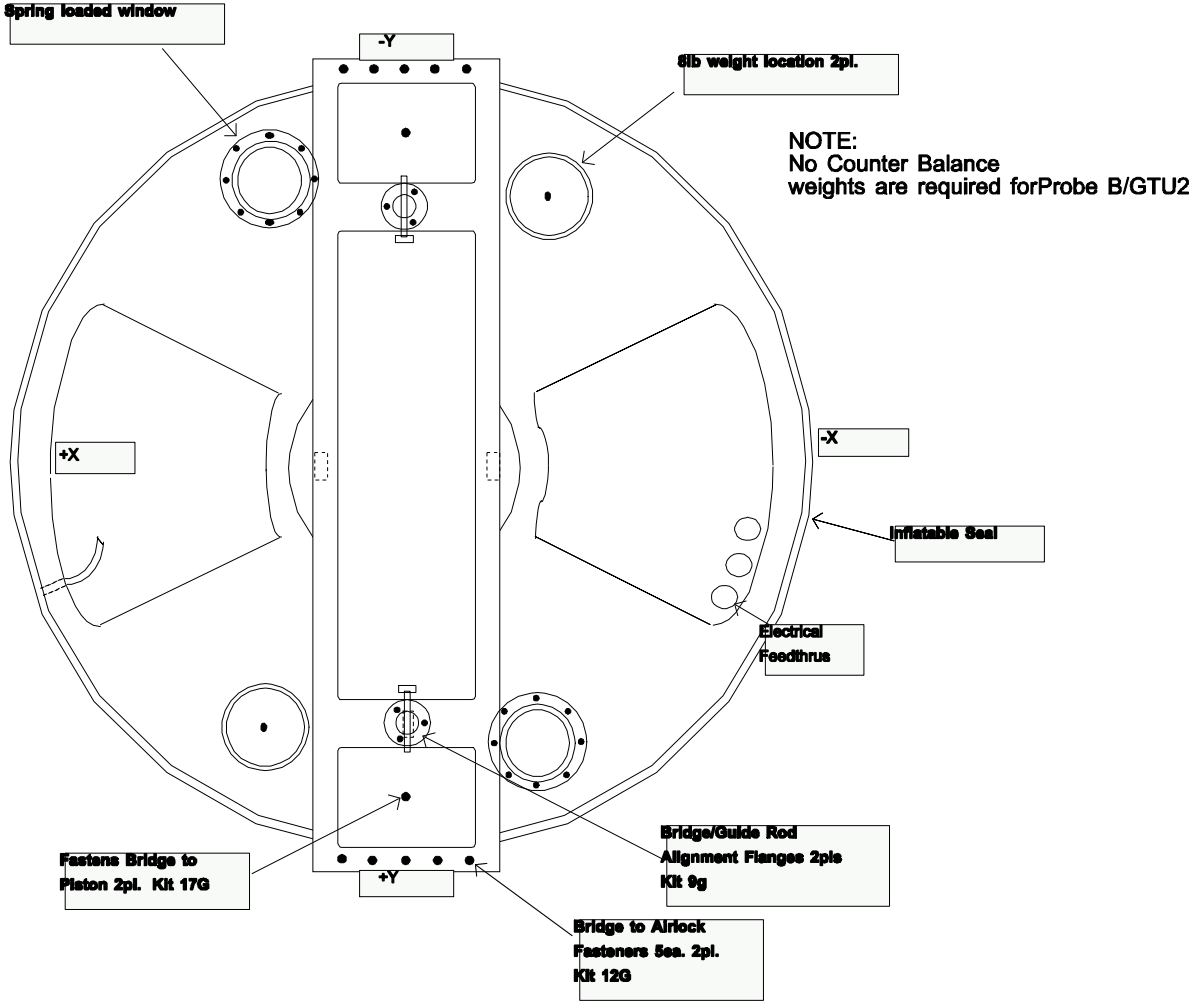
# Table 1 PROBE INSERTION TEMPERATURE DATA

| | A/L | DEWAR | PROBE-B/GTU-2 | Dial Ggs | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE/ TIME | LPP | Pre A/L | Sta 200 T01D | HEX4 T08D | Tank Liq L | Well Liq L | Ax Lk Liq L | Main Tank Heater | Vac Space | Tank Press | Sta 200 T12P | Vac Shell T14P | Tele T16Q | G3/ G4 T07Q | QB nr PM T18Q | Press Vac Can | -X | -Y | |
| | -- | -- | C1 | C8 | C101 | C104 | C103 | C105 | | - | EG-3 | C*145 | C*147 | C*150 | C*171 | C*17222 212 | C*57 | in | |
| in | in | in-W | K | K | % | % | % | vdc | Torr | Torr | 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

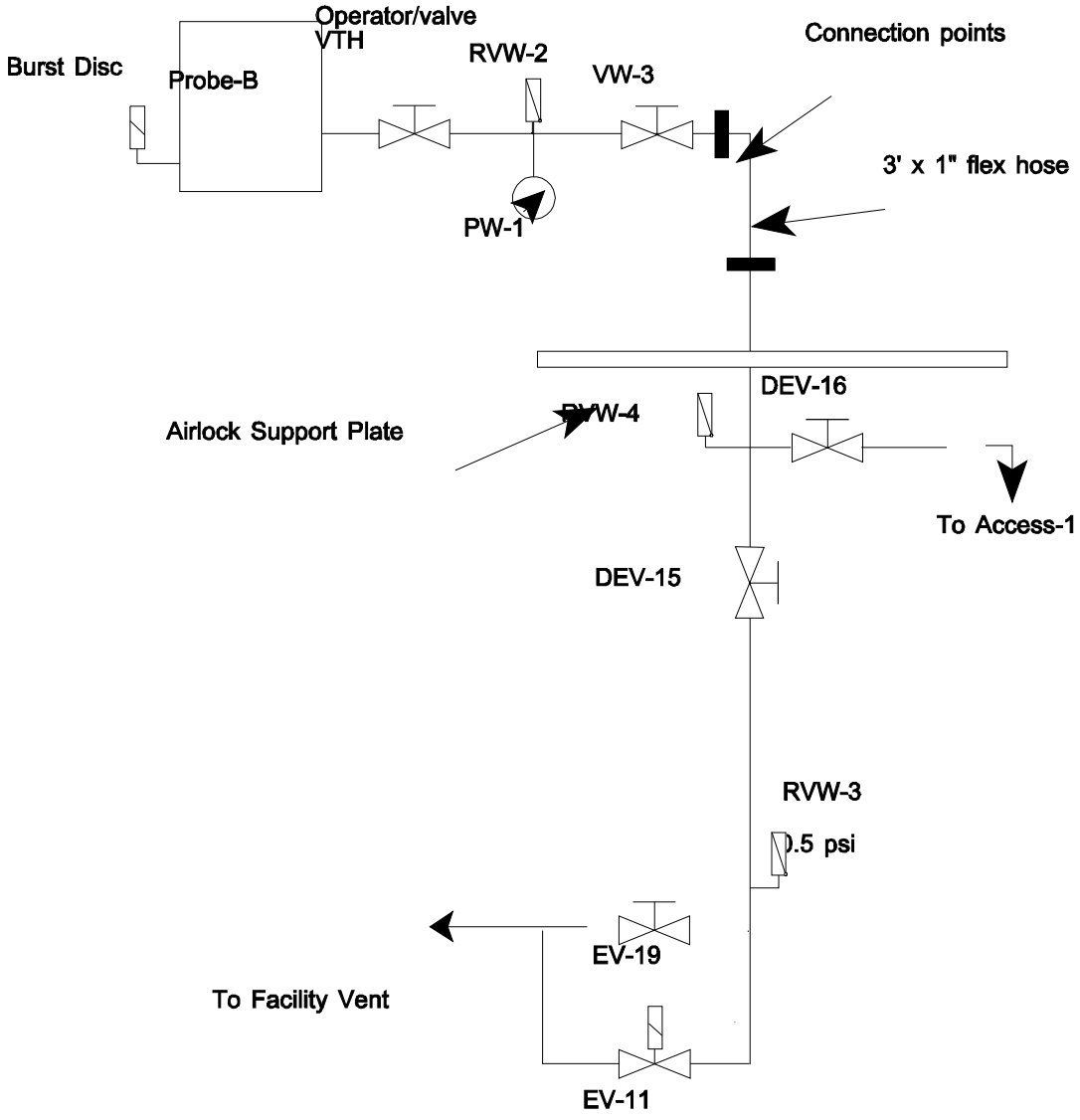
**Task Module 92: Insert Probe into Dewar**

Fig. TM92-1 Piston Plate Configuration



**Task Module 92: Insert Probe into Dewar**

Figure TM92-2



**Task Module 92: Insert Probe into Dewar**

Table 2 Probe Insertion Logged Probe Position Data

| Time/ Date | Logged Probe Position in. | Bottom probe Sta in. | -X Dial Indicator in. | -Y Dial indicator in. | Comment |
|---|---|---|---|---|---|