GE Medical Systems

Technical Publications

Direction 2141548
Revision 2

GE 1.5T SV Active Shield Magnet And Cryogens Subsystem

Operating Documentation

DAMAGE IN TRANSPORTATION

All packages should be closely examined at time of delivery. If damage is apparent, have notation **"damage in shipment"** written on **all** copies of the freight or express bill **before** delivery is accepted or "signed for" by a General Electric representative or a hospital receiving agent. Whether noted or concealed, damage **MUST** be reported to the carrier **immediately** upon discovery, or in any event, within **14** days after receipt, and the contents and containers held for inspection by the carrier. A transportation company will not pay a claim for damage if an inspection is not requested within this **14** day period.

Call Traffic and Transportation, Milwaukee, WI (414) 785–5052/8*323–5052 **immediately** after damage is found. At this time be ready to supply name of carrier, delivery date, consignee name, freight or express bill number, item damaged and extent of damage.

Complete instructions regarding claim procedure are found in Section "S" of the Policy & Procedure Bulletins.

3/12/92

GE Medical Systems

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Shortlands, Hammersmith, London W6 8BX U.K.

WARNING

- THIS SERVICE MANUAL IS AVAILABLE IN ENGLISH ONLY.
- IF A CUSTOMER'S SERVICE PROVIDER REQUIRES A LANGUAGE OTHER THAN ENGLISH, IT IS THE CUSTOMER'S RESPONSIBILITY TO PROVIDE TRANSLATION SERVICES.
- DO NOT ATTEMPT TO SERVICE THE EQUIPMENT UNLESS THIS SERVICE MANUAL HAS BEEN CONSULTED AND IS UNDERSTOOD.
- FAILURE TO HEED THIS WARNING MAY RESULT IN INJURY TO THE SERVICE PROVIDER, OPERATOR OR PATIENT FROM ELECTRIC SHOCK, MECHANICAL OR OTHER HAZARDS.

AVERTISSEMENT

- CE MANUEL DE MAINTENANCE N'EST DISPONIBLE QU'EN ANGLAIS.
- SI LE TECHNICIEN DU CLIENT A BESOIN DE CE MANUEL DANS UNE AUTRE LANGUE QUE L'ANGLAIS, C'EST AU CLIENT QU'IL INCOMBE DE LE FAIRE TRADUIRE.
- NE PAS TENTER D'INTERVENTION SUR LES ÉQUIPEMENTS TANT QUE LE MANUEL SERVICE N'A PAS ÉTÉ CONSULTÉ ET COMPRIS.
- LE NON-RESPECT DE CET AVERTISSEMENT PEUT ENTRAÎNER CHEZ LE TECHNICIEN, L'OPÉRATEUR OU LE PATIENT DES BLESSURES DUES À DES DANGERS ÉLECTRIQUES, MÉCANIQUES OU AUTRES.

WARNUNG

- DIESES KUNDENDIENST–HANDBUCH EXISTIERT NUR IN ENGLISCHER SPRACHE.
- FALLS EIN FREMDER KUNDENDIENST EINE ANDERE SPRACHE BENÖTIGT, IST ES AUFGABE DES KUNDEN FÜR EINE ENTSPRECHENDE ÜBERSETZUNG ZU SORGEN.
- VERSUCHEN SIE NICHT, DAS GERÄT ZU REPARIEREN, BEVOR DIESES KUNDENDIENST–HANDBUCH NICHT ZU RATE GEZOGEN UND VERSTANDEN WURDE.
- WIRD DIESE WARNUNG NICHT BEACHTET, SO KANN ES ZU VERLETZUNGEN DES KUNDENDIENSTTECHNIKERS, DES BEDIENERS ODER DES PATIENTEN DURCH ELEKTRISCHE SCHLÄGE, MECHANISCHE ODER SONSTIGE GEFAHREN KOMMEN.

AVISO

- ESTE MANUAL DE SERVICIO SÓLO EXISTE EN INGLÉS.
- SI ALGÚN PROVEEDOR DE SERVICIOS AJENO A GEMS SOLICITA UN IDIOMA QUE NO SEA EL INGLÉS, ES RESPONSABILIDAD DEL CLIENTE OFRECER UN SERVICIO DE TRADUCCIÓN.
- NO SE DEBERÁ DAR SERVICIO TÉCNICO AL EQUIPO, SIN HABER CONSULTADO Y COMPRENDIDO ESTE MANUAL DE SERVICIO.
- LA NO OBSERVANCIA DEL PRESENTE AVISO PUEDE DAR LUGAR A QUE EL PROVEEDOR DE SERVICIOS, EL OPERADOR O EL PACIENTE SUFRAN LESIONES PROVOCADAS POR CAUSAS ELÉCTRICAS, MECÁNICAS O DE OTRA NATURALEZA.

ATENÇÃO

- ESTE MANUAL DE ASSISTÊNCIA TÉCNICA SÓ SE ENCONTRA DISPONÍVEL EM INGLÊS.
- SE QUALQUER OUTRO SERVIÇO DE ASSISTÊNCIA TÉCNICA, QUE NÃO A GEMS, SOLICITAR ESTES MANUAIS NOUTRO IDIOMA, É DA RESPONSABILIDADE DO CLIENTE FORNECER OS SERVIÇOS DE TRADUÇÃO.
- NÃO TENTE REPARAR O EQUIPAMENTO SEM TER CONSULTADO E COMPREENDIDO ESTE MANUAL DE ASSISTÊNCIA TÉCNICA.
- O NÃO CUMPRIMENTO DESTE AVISO PODE POR EM PERIGO A SEGURANÇA DO TÉCNICO, OPERADOR OU PACIENTE DEVIDO A‘ CHOQUES ELÉTRICOS, MECÂNICOS OU OUTROS.

AVVERTENZA

- IL PRESENTE MANUALE DI MANUTENZIONE È DISPONIBILE SOLTANTO IN INGLESE.
- SE UN ADDETTO ALLA MANUTENZIONE ESTERNO ALLA GEMS RICHIEDE IL MANUALE IN UNA LINGUA DIVERSA, IL CLIENTE È TENUTO A PROVVEDERE DIRETTAMENTE ALLA TRADUZIONE.
- SI PROCEDA ALLA MANUTENZIONE DELL'APPARECCHIATURA SOLO DOPO AVER CONSULTATO IL PRESENTE MANUALE ED AVERNE COMPRESO IL CONTENUTO.
- NON TENERE CONTO DELLA PRESENTE AVVERTENZA POTREBBE FAR COMPIERE OPERAZIONI DA CUI DERIVINO LESIONI ALL'ADDETTO ALLA MANUTENZIONE, ALL'UTILIZZATORE ED AL PAZIENTE PER FOLGORAZIONE ELETTRICA, PER URTI MECCANICI OD ALTRI RISCHI.

警告

・このサービスマニュアルには英語版しかありません。
・ＧＥＭＳ以外でサービスを担当される業者が英語以外の言語を要求される場合、翻訳作業はその業者の責任で行うものとさせていただきます。
・このサービスマニュアルを熟読し理解せずに、装置のサービスを行わないで下さい。
・この警告に従わない場合、サービスを担当される方、操作員あるいは患者さんが、感電や機械的又はその他の危険により負傷する可能性があります。

注意:

- 本维修手册仅存有英文本。
- 非 GEMS 公司的维修员要求非英文本的维修手册时，客户需自行负责翻译。
- 未详细阅读和完全了解本手册之前，不得进行维修。
- 忽略本注意事项会对维修员，操作员或病人造成触电，机械伤害或其他伤害。

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SET UP AND CALIBRATION (continued)

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RENEWAL PARTS (continued)

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RIGGING

SECTION 1 – DOCUMENTATION ORGANIZATION

1–1 SYSTEM DOCUMENTATION ORGANIZATION

The documentation structure for the Magnetic Resonance Signa® Advantage™ 1.5T System can be found in *Direction 15400, Signa® Advantage™ 1.5T & 0.5T.*

The Signa Service Manuals have been divided Into an Installation Manual, a System Manual, a Subsystem Manual, Renewal Parts Manual, and a Mobile System Manual. The installation Manual contains hardware installation instructions and acts as an overall steering document to guide you through Installation setup and adjustment procedures in the other manuals. The System Manual contains all system level procedures, and the Subsystem Manual contain subsystem level procedures. The Option / Upgrade Installation Manual contains instructions for installing Signa options and a tabbed division which serves as a holding place for individual upgrade directions.

Note

Should you find any errors in this manual, or should you like to suggest additional material, please use the “Report on Technical Publications” form at the front of this manual. Your feedback is important!

Note

All electrical installations that are preliminary to positioning of the equipment at the site prepared for the equipment shall be performed by licensed electrical contractors. In addition, electrical feeds into the Power Distribution Unit shall be performed by licensed electrical contractors. Other connections between pieces of electrical equipment, calibrations, and testing shall be performed by qualified GE Medical personnel. The products involved (and the accompanying electrical installations) are highly sophisticated, and special engineering competence is required. In performing all electrical work on these products, GE will use its own specially trained field engineers. All of GE’s electrical work on these products will comply with the requirements of the applicable electrical codes. The purchaser of GE equipment shall only utilize qualified personnel (i.e., GE’s field engineers, personnel of third–party service companies with equivalent training, or licensed electricians) to perform electrical servicing on the equipment.

1–2 SUBSYSTEM MANUAL (DIRECTION 2141548) ORGANIZATION

Note
Direction 2141548 – GE1.5T SV Active Shield Magnet and Cryogens Subsystem covers 1.5T Magnet Systems used on 1.5T Signa products. Applicable magnet Model / Assembly numbers shown in Table 1–1.

TABLE 1–1
MAGNET MODEL / ASSEMBLY NUMBERS

MAGNET MODEL NUMBER	MAGNET ASSEMBLY NUMBER
2131600	2131604

INTRODUCTION

Documentation organization, system and component identification and safety considerations are in this section.

SET UP AND CALIBRATION PROCEDURES

Magnet system installation, commissioning, adjustment, and calibration procedures are in this section. Procedures from supplier manuals are referenced where applicable.

FUNCTIONAL CHECKS

Procedures for performing subsystem checks are in this section, such as procedures done for diagnostics and periodic maintenance. Magnet Resistance Values and Guideline Tables are provided in this section.

REPLACEMENT/MAINTENANCE

Procedures and Illustrations to aid in subsystem maintenance and component replacement are in this section.

1–2 SUBSYSTEM MANUAL (DIRECTION 2141548) ORGANIZATION (continued)

SCHEMATICS / INTERCONNECTS

A cable Interconnect diagram for the system, schematics for all nonsupplier subsystem circuits and power supply controls, meters and Indicators are in this section.

RENEWAL PARTS

Renewal part identification and exploded views for the Magnet / Cryogen Subsystem and GE Part Number Reference Tables for supplier renewal parts are in this section.

DATA SHEETS

Contains logs, charts and tables for Helium Fill, Ramping and Shimming.

RIGGING

Procedures and illustrations for uncrating, rigging and moving the magnet into the exam room are covered in this section. Magnet leveling is also included.

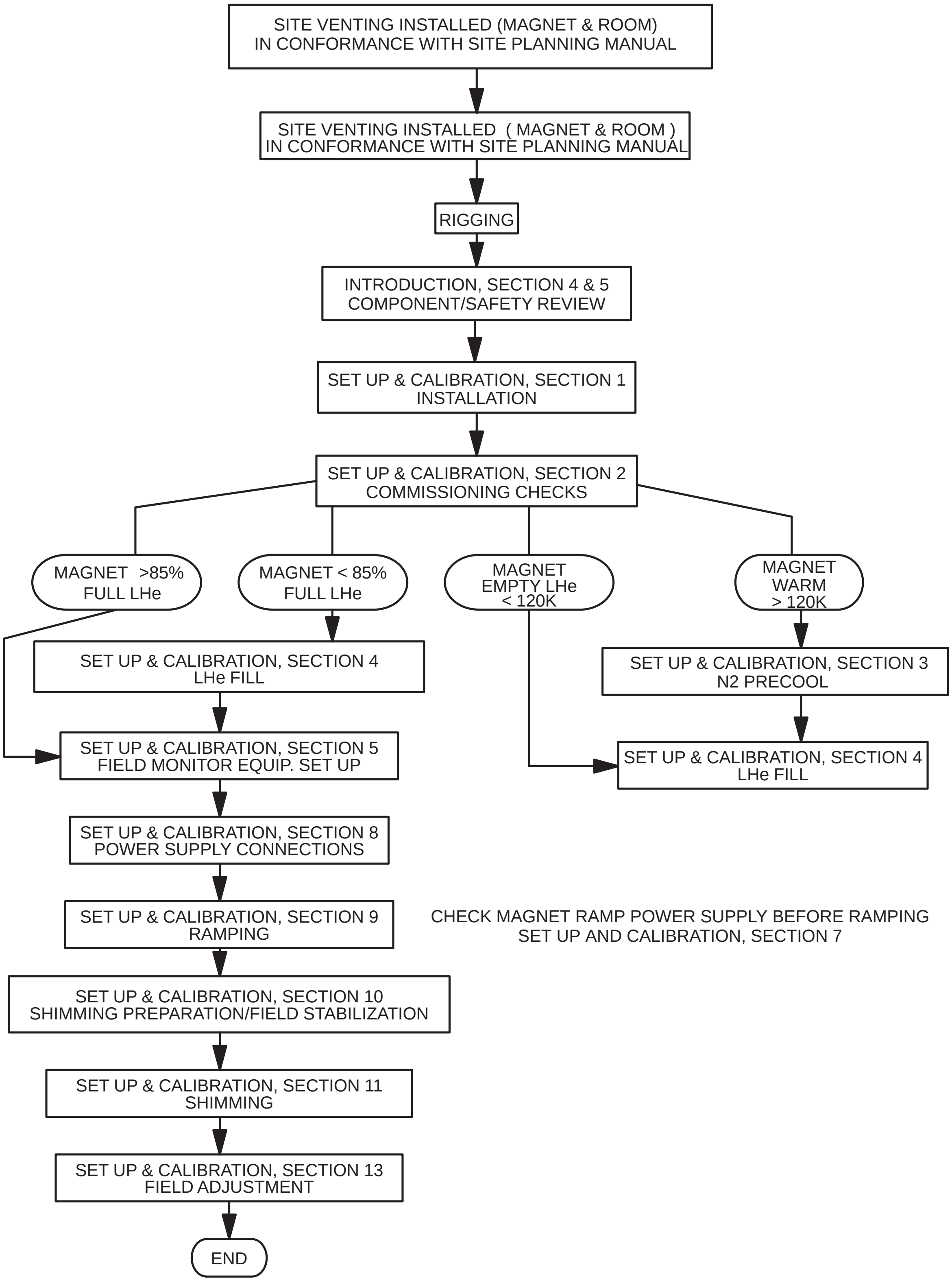
Note
Manual sequence for Magnet Commissioning is shown in Illustration 1–1.

Note
All schematics / circuit diagrams, component parts lists, descriptions, adjustments / calibrations and other information necessary for the field service of this Magnet System, are contained within *DIRECTION 2141548.*

CAUTION

In accordance with International Standard, IEC 601–1, the manufacturer is not responsible for any consequences caused by unauthorized modification of this type B Equipment.

All procedures covered in this manual, other than the indicator lamp checks on the Magnet Rundown Unit, should be performed by a General Electric authorized service representative.



MAGNET COMMISSIONING FLOW DIAGRAM
ILLUSTRATION 1–1

SECTION 2 – SAFETY CONSIDERATIONS

2–1 MAGNETIC FIELD CONSIDERATIONS

The magnetic field strength used in MR is approximately 30,000 times that of the Earth's Magnetic Field. This field is three–dimensional. Therefore, magnetic field precautions must be applied to the floors above and below the Magnet, as well as to the surrounding space on the same level.

To prevent danger to persons and equipment when the Magnet is at field, follow the precautions below:

- Post WARNING signs outside the 5 gauss zone alerting personnel with cardiac pacemakers, neurostimulators and other biostimulation devices of the effect of the magnetic field on these devices. See Illustration 5–1. Place these signs, two days, prior to ramping magnet for maximum impact.
- Post SECURITY signs outside the exam room to alert personnel of the high magnetic field and not to bring ferromagnetic objects into the exam room. See Illustration 5–2.

Note

These signs will be provided by the local GE Field Service Operation, in the primary local languages. They are available in English from GE Medical Systems; Waukesha, WI, USA, under the part numbers shown. Highly visible (orange, black & white) security and warning signs are available under the following catalog numbers.

E8819AA – MR Warning Sign Set (2 security signs, 10 exclusion signs) in English
E8819A – One MR Security Warning Sign, in English.
E8819B – One MR Exclusion Warning Sign, in English.
E8819C – One MR Security Warning Sign, in Spanish.
E8819D – One MR security Warning Sign, in French.
E8819BA – MR Warning Label Kit (Peel Off Back).

- Notify responsible personnel two days prior to ramping the Magnet to allow for preparatory actions to be accomplished.
- Do not bring ferromagnetic objects (e.g., TOOLS, pens, tape measures, steel–toe shoes, vacuum pumps, etc.) into the exam room when the Magnet is at field. Do not bring large metal objects near the outside walls of the exam room. Refer to *Direction 15201, MR Max Site Planning, Section 2,* for equipment proximity limits.
- Use only nonmagnetic cylinders and dewars when transferring cryogens into an energized Magnet.
- Do not take self–winding watches, magnetically–coded credit cards, magnetic recording heads, magnetic tapes or cameras near the Magnet when it is at field.

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)

46–255325P1

MAGNETIC FIELD SECURITY SIGN
ILLUSTRATION 5–1

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)

46–255325P1

MAGNETIC FIELD SECURITY SIGN
ILLUSTRATION 5–2

2–2 EMERGENCY RAMP DOWN OF MAGNETIC FIELD

Description

If a ferromagnetic object has become attached to the magnet and cannot be safely removed by two people, the magnet will have to be ramped down in conformance with the Main Coil Ramp Down procedure covered in REPLACEMENT / MAINTENANCE, Section 2.

If an Emergency Ramp Down of the magnet is required (e.g., a person is trapped between a ferromagnetic object and the magnet) use the following procedure to rapidly ramp the magnet down to zero field. Ramping the magnet down using Methods 1 through 4 below will cause a magnet Quench.

Follow the sequence given in the procedure to minimize the magnet damage resulting from the ramp down! Methods 2 through 4 are back up and normally will not be required.

Procedure:

WARNING!

MAKE SURE THAT MAGNET VENTING IS INSTALLED PRIOR TO RAMP DOWN TO REMOVE THE LARGE AMOUNTS OF GASEOUS HELIUM AND NITROGEN, CREATED BY THE RAMP DOWN, FROM THE EXAM ROOM AND PREVENT ASPHYXIATION.

INCORPORATE THE SAFETY PRECAUTIONS LISTED IN THE NEXT SECTION (5.3) CRYOGENS.

Note

Method 1 is all that should be required to Rundown the magnet.

METHOD 1

Open the clear plastic cover on the Magnet Rundown Unit and firmly depress the red “RUNDOWN” switch. The switch will stay depressed for approximately 30 seconds as the magnetic field is collapsed.

METHOD 2

Connect the Main Switch Heater Leads from J3 on the Power Supply to J5 on the Magnet Terminal Box (MS1 –A3, A1) and energize the Main Switch Heater. The Shim Lead Assembly must be in the “ENGAGED” position to use this method. See SET UP AND CALIBRATION, Sections 6 and 7.

METHOD 3

If the Shim Lead Assembly cannot be “Engaged”, the magnet can be ramped down by using the Auxiliary Rampdown Cable as shown in SCHEMATICS/INTERCONNECTS, Illustration 2–1.

Note

If Method 4 is used to ramp down the magnetic field, the magnet may be damaged and will have to be warmed up and pumped down. The minimum time to restore the magnet to service will be one month.

METHOD 4

If attempts to ramp down the magnetic via Methods 1,2, and 3 fail, the Vacuum Break Tool (46–260852G3) may be connected a the Seal Off Valve on the Pump Out Port of the magnet and the vacuum broken to ramp down the magnetic field.

5–3 CRYOGEN SAFETY

HANDLING:

Liquid helium and liquid nitrogen are odorless, colorless and nontoxic. They are extremely cold (liquid helium = –452° F [–269° C] and liquid nitrogen = –320° F [– 196° C]) and cause severe cold contact burns if the liquids or exhausting vapors contact the skin. Wear nonabsorbent, thermally insulated gloves and nonabsorbent clothing when handling cryogens or when exposed to cryogen exhaust from the magnet.

Contact of liquid cryogens or their vapors with the eyes can cause severe frostbite even when the contact is too brief to affect the skin. Protect eyes with safety goggles or a face shield.

Gaseous helium and nitrogen both displace air without warning and can cause rapid asphyxiation if ventilatlon is insufficient. Store cryogen cylinders and dewars in a well–ventilated area.

Rooms where cryogen Iiquids are handled must be designated no smoking areas. The extreme low temperatures of liquid helium and nitrogen cause oxygen from the air to liquify on cold surfaces (e.g., on transfer lines) and thus increase its concentration locally. If hot grease or oil come in contact with these surfaces, they may catch on fire.

Vent helium boil–off to the outside air at all times except during precooling of the transfer line. Precool the transfer line with the plume directed award the ceiling.

Never allow any unprotected part of the body to touch uninsulated pipes or vessels containing cryogenic fluid. The extreme cold causes the flesh a stick and tear when one attempts a withdraw from it. Wear face shield when working on top of the magnet.

CRYOGEN SAFETY:

WARNING!

HELIUM GAS IS EXHAUSTED INTO THE MAGNET ROOM DURING MAGNET RAMPING, SHIMMING, FILLING WITH LIQUID HELIUM AND SERVICE PROCEDURES WHICH OPEN THE HELIUM VESSEL TO ATMOSPHERE, SUCH AS SHIM LEAD REMOVAL. FURTHERMORE, IN THE UNLIKELY EVENT OF A MAGNET VENT FAILURE DURING A MAGNET QUENCH, LARGE QUANTITIES OF HELIUM GAS WOULD RAPIDLY ENTER INTO THE MAGNET ROOM.

IT IS ESSENTIAL THAT PROVISIONS ARE MADE TO EXHAUST THE HELIUM FROM THE MAGNET ROOM TO PREVENT DISPLACEMENT OF AIR AND THE POTENTIAL OF ASPHYXIATION DURING CONDITIONS OF HELIUM EXHAUST FROM THE MAGNET SUCH AS IDENTIFIED ABOVE.

BOTH MAGNET AND ROOM VENTING REQUIREMENTS / DESIGNS ARE PROVIDED IN THE SITE PLANNING MANUAL (REV. 4 AND ABOVE). IT IS ESSENTIAL THAT THESE VENT REQUIREMENTS ARE INCORPORATED INTO THE MAGNET ROOM AND INSPECTED BY A QUALIFIED PERSON PRIOR TO MAGNET DELIVERY INTO THE ROOM.

CRYOGEN SAFETY:

WARNING!

MAKE SURE THE SAFETY PRECAUTIONS LISTED BELOW ARE COMPLETELY FOLLOWED WHEN PERFORMING ANY SERVICE THAT WILL RESULT IN HELIUM EXHAUST FROM THE MAGNET.

1. **MAKE SURE BOTH MAGNET AND ROOM VENT REQUIREMENTS ARE INCORPORATED, IN CONFORMANCE WITH THE SITE PLANNING MANUAL (REV. 4 AND ABOVE), PRIOR TO DELIVERING THE MAGNET INTO THE MAGNET ROOM.**

2. **SECURE THE MAGNET ROOM DOOR IN THE OPEN POSITION AND TURN ON MAGNET ROOM VENT EXHAUST FAN, OR OPEN THE ROOM "HATCH" IF A MOBILE VAN, BEFORE INITIATING ANY MAGNET SERVICE THAT WILL RESULT IN HELIUM EXHAUST. IN ADDITION TO ELIMINATING THE POSSIBILITY OF ASPHYXIATION, THE ABOVE ACTION WILL PREVENT THE MAGNET ROOM FROM BECOMING PRESSURIZED, PREVENTING THE DOOR FROM BEING OPENED, IN THE UNLIKELY EVENT OF A MAGNET QUENCH AND A HELIUM VENT FAILURE.**

3. **MAKE SURE A SECOND PERSON IS PRESENT (GE OR HOSPITAL PERSONNEL) WHILE SERVICING THE MAGNET, IN CASE OF ANY EMERGENCY.**

4. **IN CASE OF A MAGNET QUENCH WHERE HELIUM ENTERS INTO THE ROOM, MAKE SURE THE MAGNET ROOM VENT EXHAUST FAN IS "ON" AND IMMEDIATELY EXIT THE ROOM. IF CAUGHT IN THE MAGNET ROOM DURING A QUENCH AND VENT FAILURE AND THE DOOR CANNOT BE OPENED:**

   A. **STAY NEAR THE FLOOR WHERE THE OXYGEN WILL BE.**

   B. **KNOW WHAT TO USE TO BREAK THE WINDOW. YOU SHOULD BE ABLE TO OPEN THE DOOR AFTER BREAKING THE WINDOW.**

   C. **IF THE ROOM HAS PIPED IN OXYGEN OR AIR, KNOW WHERE IT IS AND HOW TO USE IT.**

Note

All hospital personnel involved with the MR equipment, need to be trained in the cryogen safety precautions identified above.

5–4 FIRST AID

Move persons suffering from lack of oxygen to an area with normal atmosphere. Seek medical assistance immediately. Self–contained breathing apparatus may be required to prevent asphyxiation of rescue workers.

Flush frostbitten or cold contact "burn" areas with large volumes of tepid water (105°F to 115°F [41° C to 46°C]). Do not rub frozen parts. Loosen any clothing restricting circulation. Do not apply dry heat.

5–5 TRAINING – THE BEST INVESTMENT IN SAFETY

Explain the following subjects to all persons working with cryogenic liquids:

- Nature and properties of liquid and gaseous helium and nitrogen.
- Specific instructions on the equipment and clothing.
- Use and care of protective equipment and clothing.
- Safety and first aid.
- Handling emergency situations such as leaks, spills and fires.
- Good housekeeping practices.

Note

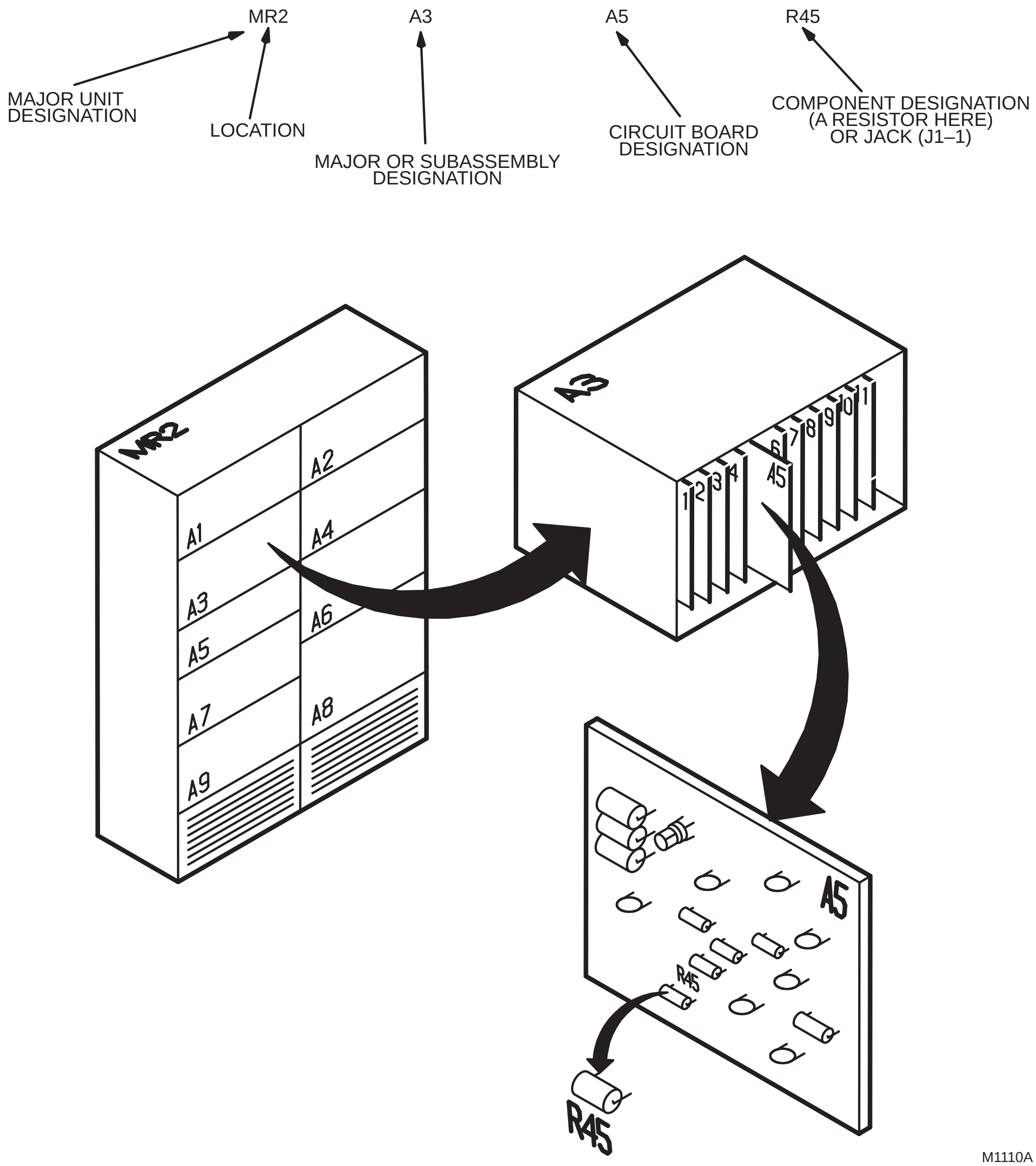
The Compressed Gas Association's publication CGA P–12, Safe Handling of Cryogenic Liquids, is recommended as a reference.

SECTION 9 – VENDOR MANUAL MATRIX

EQUIPMENT	VENDOR	GE AND VENDOR MANUAL NUMBERS	GE AND VENDOR MODEL NUMBERS
CRYOGEN MONITOR CABINET	AMERICAN MAGNETICS INC. (AMI)	46–294439P1 AMI – MAY 1993	46–281811G1 AMI MODEL 133GE
CRYOGEN MONITOR CABINET	AMERICAN MAGNETICS INC. (AMI)	2120209 AMI	2122498 AMI MODEL 111GE
SHIELD COOLER COLD HEAD AND COMPRESSOR	LEYBOLD	46–294439P4 GA 12.117; REV. 6	2100832 – RGD 5/100–2 46–294100P1 – RGD 580–GE 46–294141G1,G2 – 4000 / 4200
MAIN POWER SUPPLY CABINET	ELECTRONICS MEASUREMENTS INC. (EMI)	46–294439P6 83–452–010 REV 4 04/03/92	46–260776G3 EMI MODEL 452–62–1
SUPERCONDUCTING SHIM POWER SUPPLY CABINET	ELECTRONICS MEASUREMENTS INC. (EMI)	46–294439P7 83–452–011 REV 3 06/12/92	46–260777G3 EMI MODEL 452–62–2
MAGNET RUNDOWN UNIT SERVICE	AMERICAN MAGNETICS INC. (AMI)	46–318393 05 FEBRUARY 1993 REV 8	46–294231G1 GE–MRU
MAGNET RUNDOWN UNIT OPERATION	AMERICAN MAGNETICS INC. (AMI)	46–318394 03 MAY 1993 REV 6	46–294231G1 GE–MRU

SECTION 8 – EXPLANATION OF DESIGNATOR SYSTEM

The Component Designator System identifies all system components consistently throughout this manual. See Illustration 3–1 for an explanation of the system

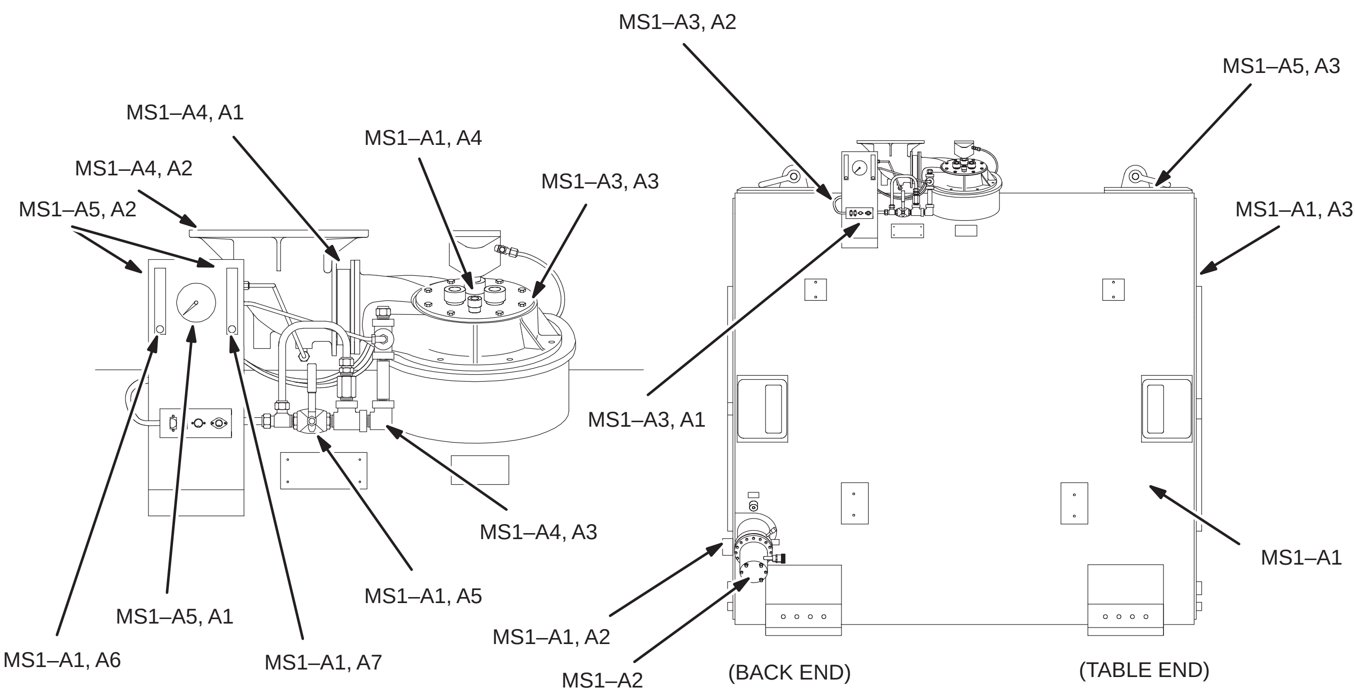


COMPONENT DESIGNATOR SYSTEM
ILLUSTRATION 3–1

SECTION 7 – COMPONENT IDENTIFICATION

This manual covers the major components shown in illustration 4–1 through 4–8.

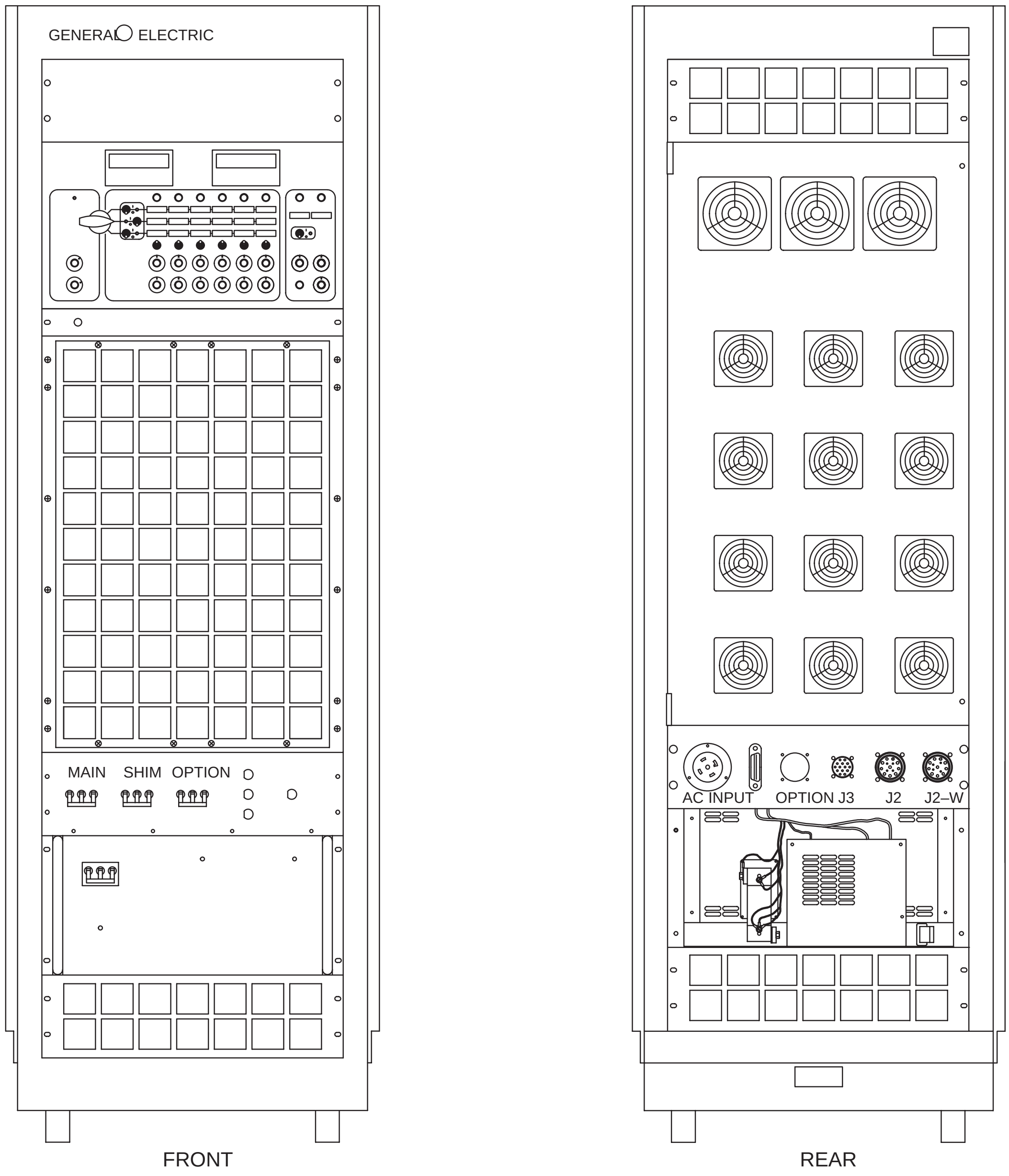
MS1 1.5T SUPERCONDUCTING MAGNET/CRYOSTAT



DESIGNATOR	DESCRIPTION	DESIGNATOR	DESCRIPTION
MS1–A1	CRYOSTAT	MS1–A3, A2	HARNESS LEAD
MS1–A1, A2	VACUUM PUMP OUT PORT	MS1–A3, A3	SERVICE TURRET
MS1–A1, A3	VACUUM MONITORING PORT	MS1–A4	HELIUM VENTING
MS1–A1, A4	HELIUM FILL VALVE (V1)	MS1–A4, A1	BURST DISC
MS1–A1, A5	HELIUM VENT VALVE (V2)	MS1–A4, A2	VENT ADAPTER
MS1–A1, A6	SHIM LEAD VENT VALVE (V3)	MS1–A4, A3	VENT PLUMBING
MS1–A1, A7	INSTRUMENTATION LEAD VENT VALVE (V4)	MS1–A5	SERVICE EQUIPMENT/ INSTRUMENTATION
MS1–A2	SHIELD COOLER COLD HEAD	MS1–A5, A1	PRESSURE GAUGE
MS1–A3	MAGNET ELECTRICAL HARNESS	MS1–A5, A2	FLOW METERS
MS1–A3, A1	MAGNET INSTRUMENTATION CONNECTOR BOX	MS1–A5, A3	LIFTING SHACKLES

1.5T SUPERCONDUCTING MAGNET/CRYOSTAT
COMPONENT DESIGNATIONS
ILLUSTRATION 4–1

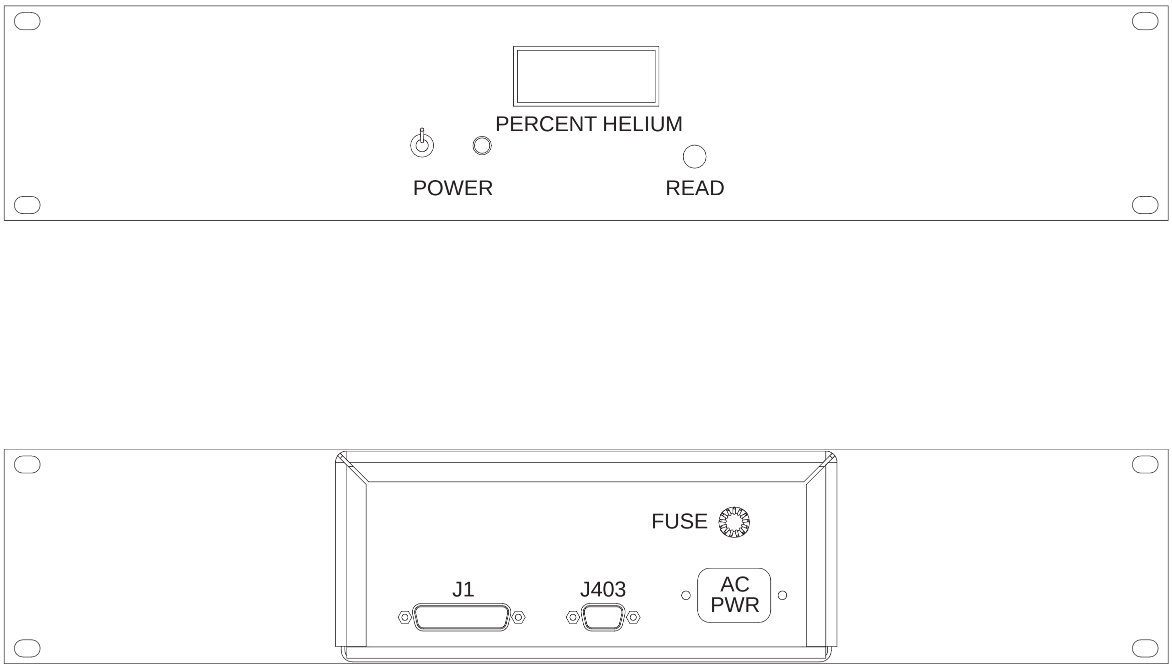
MS2 MAGNET / SHIM PHASE III–A POWER SUPPLY SYSTEM OPTION



Note
MS2 Option used with same cabling delineated for MS6 & MS7 Service Power Supplies.

MS2 MAGNET / SHIM PHASE III–A POWER SUPPLY SYSTEM
ILLUSTRATION 4–2

MR2–A6 CRYOGEN MONITORING SYSTEM



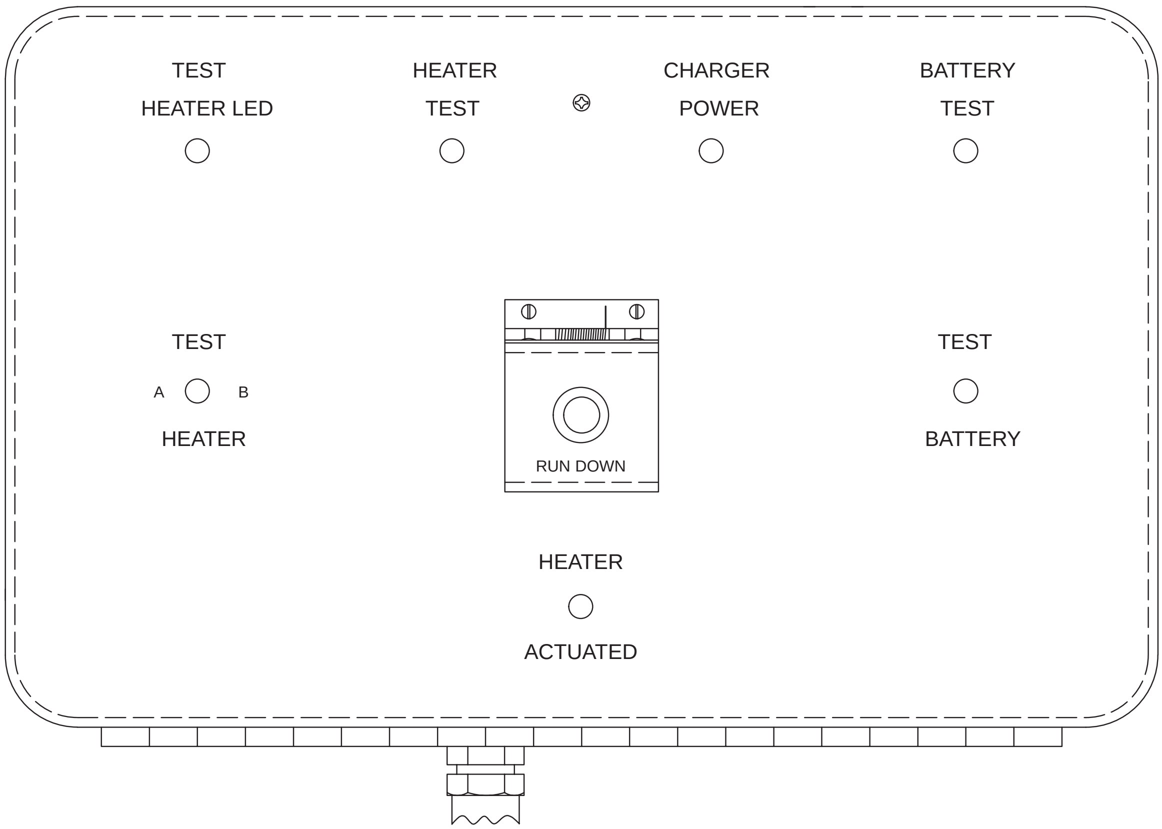
CRYOGEN MONITORING CABINET
MR2–A6,A 1

DESIGNATOR	DESCRIPTION
MR2–A6,A1	CRYOGEN MONITORING CABINET
MR2–A6,A2	INSTRUMENTATION CABLE

CRYOGEN MONITORING
COMPONENT DESIGNATIONS

ILLUSTRATION 4–3

MS4 MAGNET RUNDOWN UNIT (MRU)

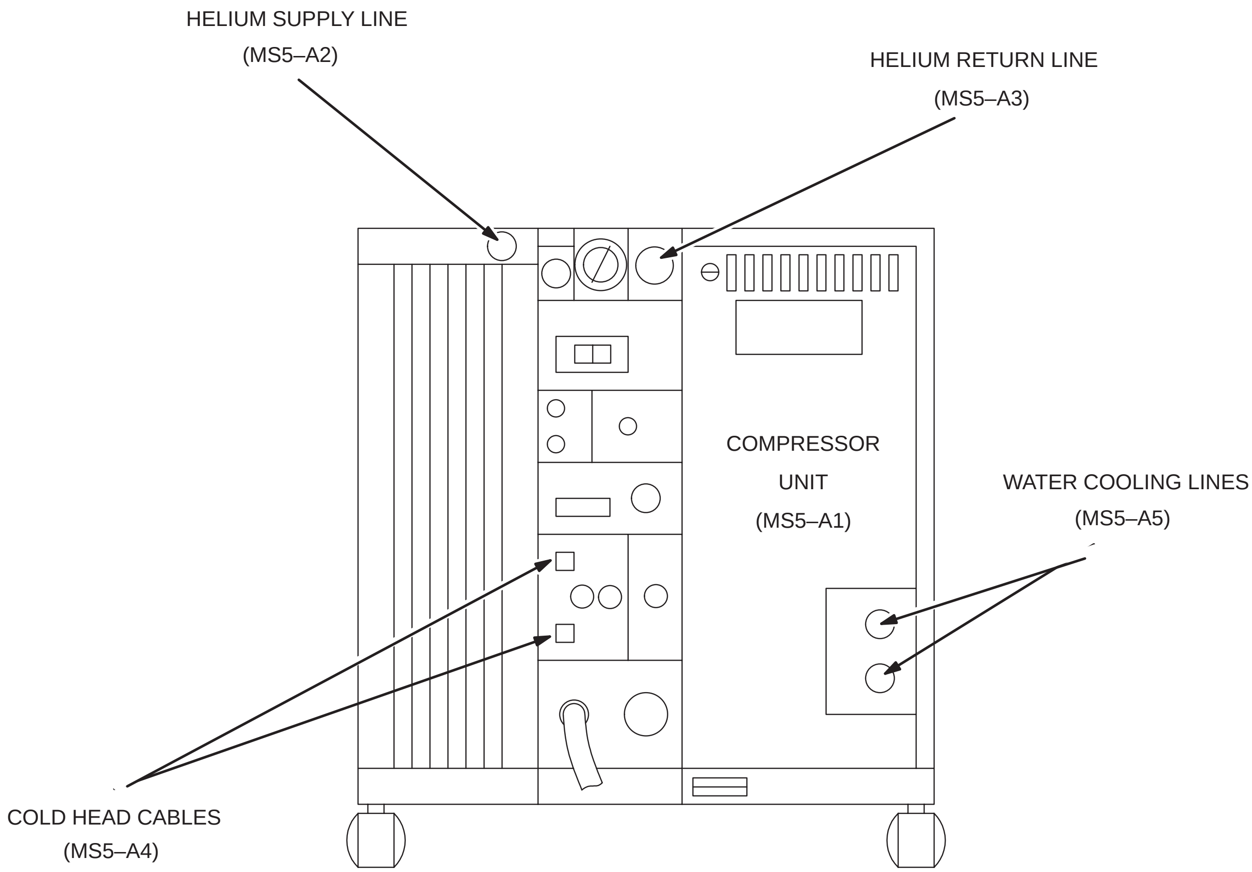


MAGNET RUNDOWN CABINET
(MS4A–A1)

DESIGNATOR	**DESCRIPTION**
MS4–A1	MAGNET RUNDOWN UNIT
MS4–A2	MAGNET RUNDOWN UNIT CABLE

MAGNET RUNDOWN UNIT (MRU)
COMPONENT DESIGNATIONS
ILLUSTRATION 4–4

MS5 SHIELD COOLER COMPRESSOR

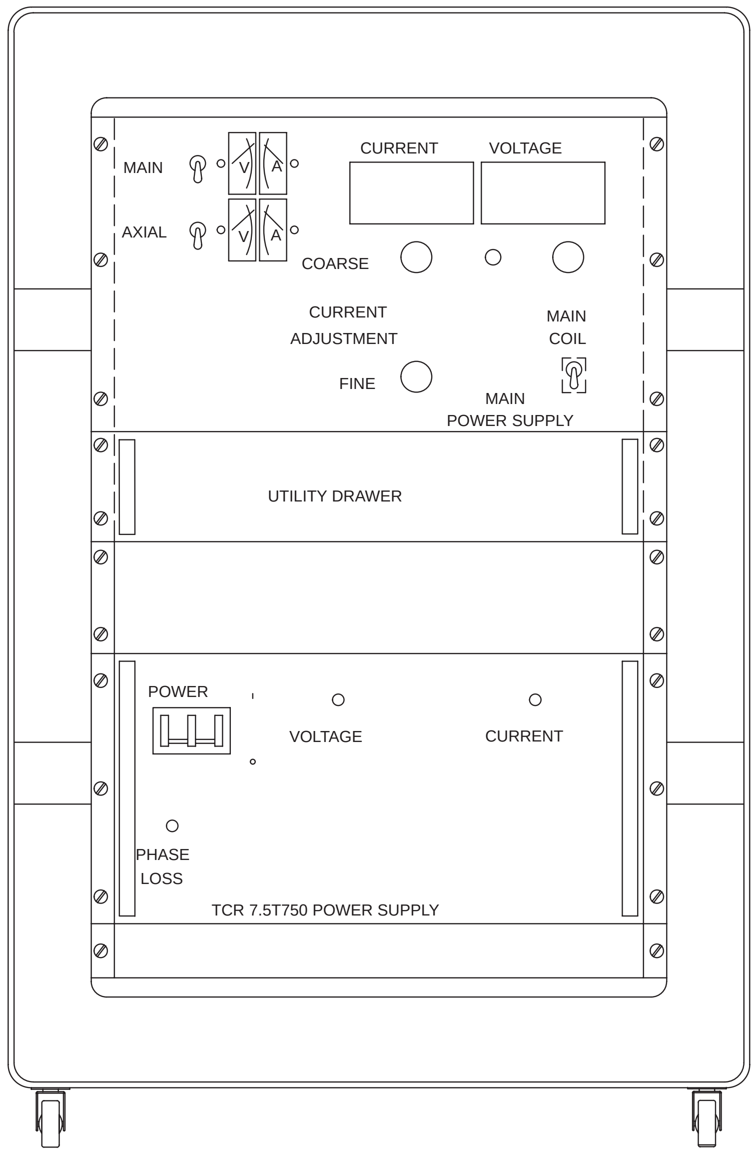


DESIGNATOR	DESCRIPTION
MS5–A1	* SHIELD COOLER COMPRESSOR
MS5–A2	HELIUM SUPPLY LINE
MS5–A3	HELIUM RETURN LINE
MS5–A4	COLD HEAD CABLES
MS5–A5	WATER COOLING LINES

SHIELD COOLER COMPRESSOR
COMPONENT DESIGNATIONS

ILLUSTRATION 4–5

MS6 MAGNET SERVICE POWER SUPPLY CABINET

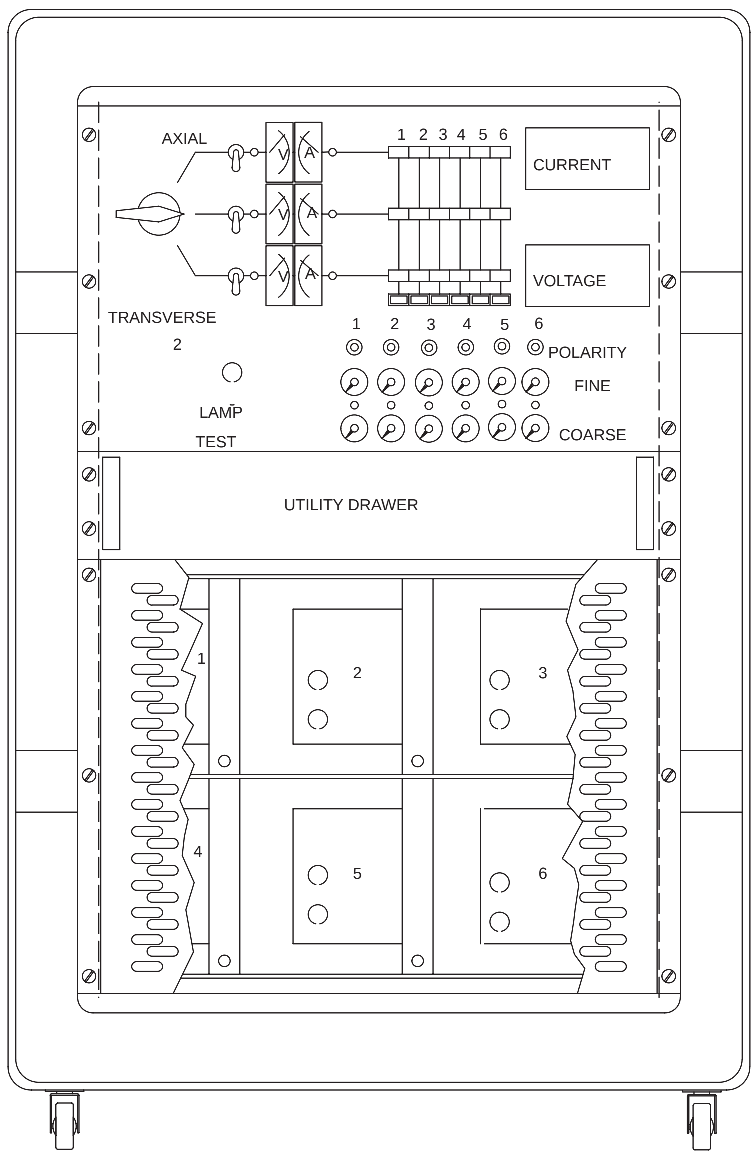


DESIGNATOR	DESCRIPTION
MS6–A1	MAGNET SERVICE POWER SUPPLY CABINET
MS6–A2	MAIN COIL POWER LEADS
MS6–A3	INPUT POWER CORD

MS6 MAGNET SERVICE POWER SUPPLY CABINET

ILLUSTRATION 4–6

MS7 SHIM SERVICE POWER SUPPLY CABINET



DESIGNATOR	DESCRIPTION
MS7–A1	SHIM SERVICE POWER SUPPLY CABINET
MS7–A2	SUPERCONDUCTING SHIM COIL WIRE HARNESS
MS7–A3	HEATER WIRE HARNESS
MS7–A4	INPUT POWER CORD

MS7 SHIM SERVICE POWER SUPPLY CABINET

ILLUSTRATION 4–7

SECTION 1 – MAGNET SYSTEM INSTALLATION

WARNING!

MAKE SURE BOTH MAGNET AND ROOM VENTING SYSTEMS ARE INSTALLED IN THE MAGNET ROOM, IN CONFORMANCE WITH THE SITE PLANNING MANUAL (REV. 4 AND ABOVE), PRIOR TO BRINGING THE MAGNET INTO THE ROOM. LARGE QUANTITIES OF GASEOUS HELIUM ARE DISCHARGED FROM THE MAGNET DURING INSTALLATION AND COMMISSIONING ACTIVITIES, WHICH WILL REQUIRE EXHAUSTING TO PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

Procedures for moving the magnet into the exam room and leveling the magnet are covered in GE Magnet Rigging section of this manual.

It is essential that the Magnet is in its permanent location and leveled before commencing with this Section.

Review component identification and safety considerations in INTRODUCTION, Sections 4 and 5, of this manual before initiating the installation.

1–1 CONVERSION TO OPERATING CONFIGURATION

Description:
The magnet arrives at the installation site in a shipping configuration and requires the actions covered in this procedure to convert it to the operating configuration. Ground shipments (over land or sea) are made with all Helium Vent Plumbing installed on the magnet. Air shipments are made with the following:

- Vent Adapter removed.
- Blanking Plate and Relief Valve installed in place of the Burst Disk.
- A 1/2 inch Plumbing Plug to blank off 1/2 inch line removed from the Vent Adapter.
- A 1/4 inch Plumbing Plug to blank off 1/4 inch line removed from the Vent Adapter.
- 17.5 PSIA Relief Valve. See Illustration 1–1.

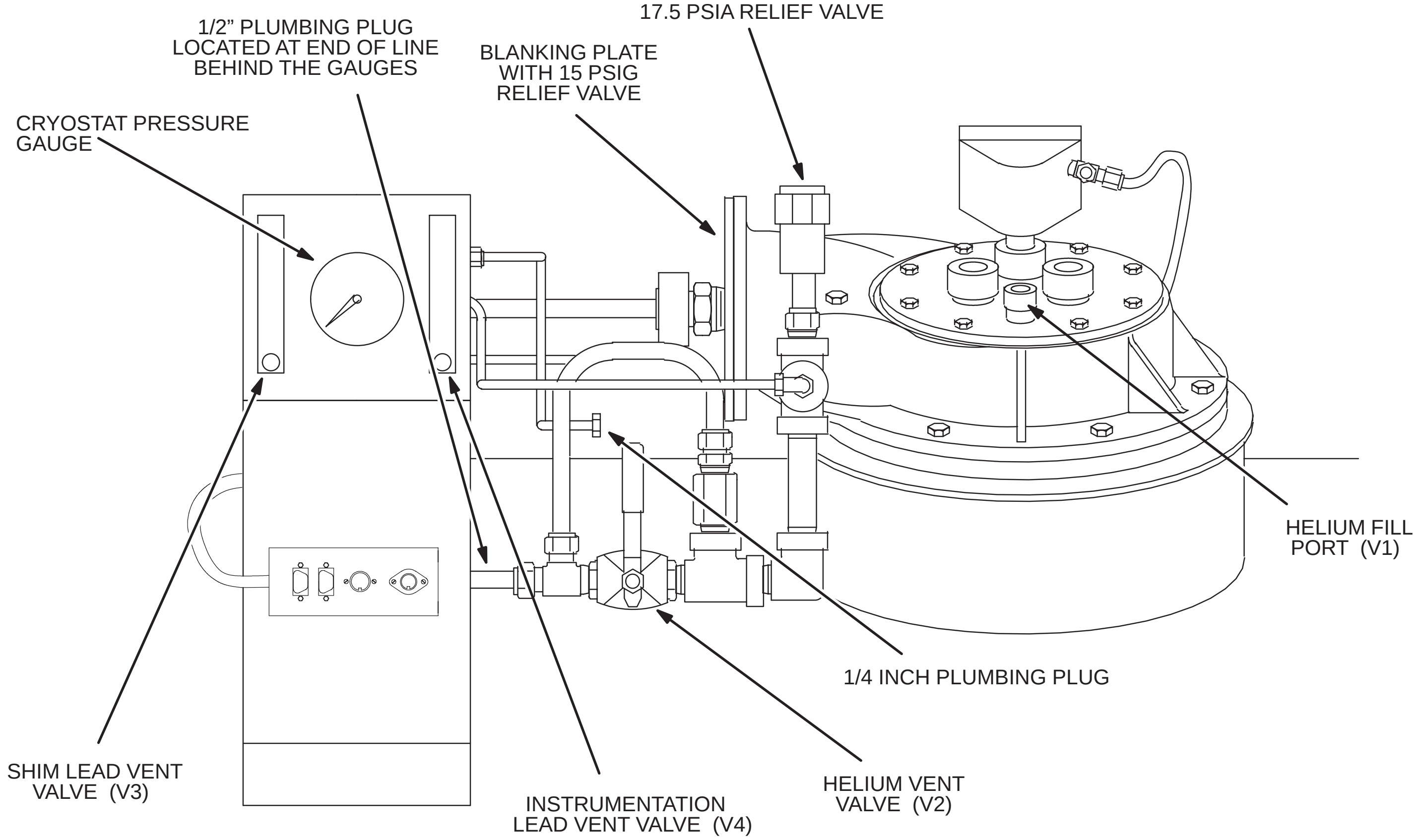
1–1 CONVERSION TO OPERATING CONFIGURATION (continued)

Procedure:

7. Make sure plumbing valves are in the following positions. See Illustration 1–1.

   V2 – Closed   * V3 – Partially Open   * V4 – Partially Open

   * V3 and V4 factory set for shipment achieve maximum cooling efficiency during shipment.



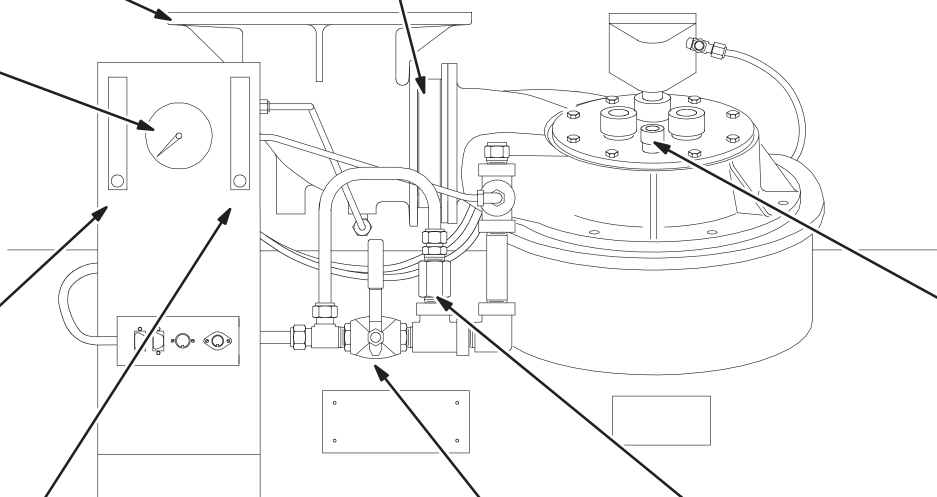
MAGNET AIR SHIPMENT CONFIGURATION
ILLUSTRATION 1–1

8. Record the Cryostat Pressure Gauge reading in the DATA SHEETS tab, Table 1–1. See Illustration 1–1.

Note

Steps 4 through 18 are not performed for Ground shipped magnets. Perform these steps only for Air shipped magnets with the Vent Adapter Plumbing and Burst Disc removed.

1–1 CONVERSION TO OPERATING CONFIGURATION (continued)



VALVE LOCATIONS
ILLUSTRATION 1–2

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

RAPID EXHAUSTING OF COLD HELIUM GAS WILL BE ENCOUNTERED WHEN REPLACING THE HELIUM VENT PLUMBING AND BURST DISC. WEAR NON–ABSORBENT GLOVES AND GOGGLES OR FACE SHIELD WHEN PERFORMING THESE OPERATIONS.

MAKE SURE THAT NO PERSON IS NEAR PLUME PATH WHEN HELIUM VENT VALVE (V2) IS OPENED.

9. Remove the plug at the end of the 1/2 inch plumbing. See Illustration 1–1.
10. Remove the plug at the end of the 1/4 inch plumbing. See Illustration 1–1.

1–1 CONVERSION TO OPERATING CONFIGURATION (continued)

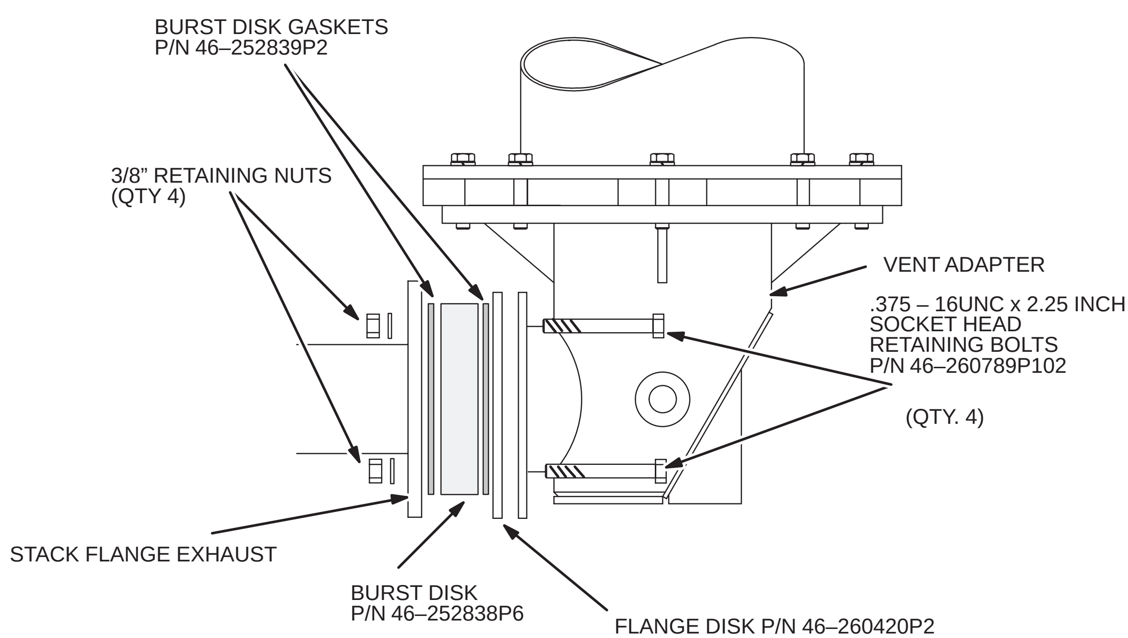
11. Close valves V3 and V4 at the base of the flow meters. See Illustration 1–2.
12. Slowly open Vent Valve V2 and allow the Cryostat to exhaust until the pressure, indicated on the pressure gauge on top of the magnet, is between 0.2 and 0.3 PSI. Close V2.

CAUTION

Perform Steps 8 through 11 rapidly to prevent condensation and icing within the Vertical Stack.

13. Remove the 17.5 psia, Absolute Pressure Relief Valve, located on the Magnet Vent Plumbing adjacent to Valve V2. Quickly wrap the threads with Teflon Tape and install the 1/2 Brass Pipe Plug (P/N 46–252552P4), shipped with the magnet, onto the Threaded Tee where the relief valve was removed.
14. Unpack the 20 psi Burst Disc from its container, located in the Venting Hardware Kit, and inspect it for visible damage (nicks/scratches). Make sure that the Burst Disc has the proper part number (46–252838P6) and rating plate marking of 20 psi.
15. Loosen the four Socket Head Retaining Bolts, which secure the 15 psi Shipping Relief Valve and Blanking Plate to the Stack Flange Exhaust, and remove the top two bolts, while holding the Blanking Plate and Flange Disc. A 5/16 inch Allen Wrench Tool will be needed to remove the Socket Head Retaining Bolts See Illustration 1–1.
16. Remove the 15 psi Shipping Relief Valve and Blanking Plate.
17. Install the Burst Disc and Gaskets with the flat face of the disc facing out from the Stack Flange. See Illustration 1–3.

SIDE VIEW OF MAGNET OPPOSITE THE COLD HEAD



HELIUM VESSEL BURST DISC ASSEMBLY
ILLUSTRATION 1–3

1–1 CONVERSION TO OPERATING CONFIGURATION (continued)

Note

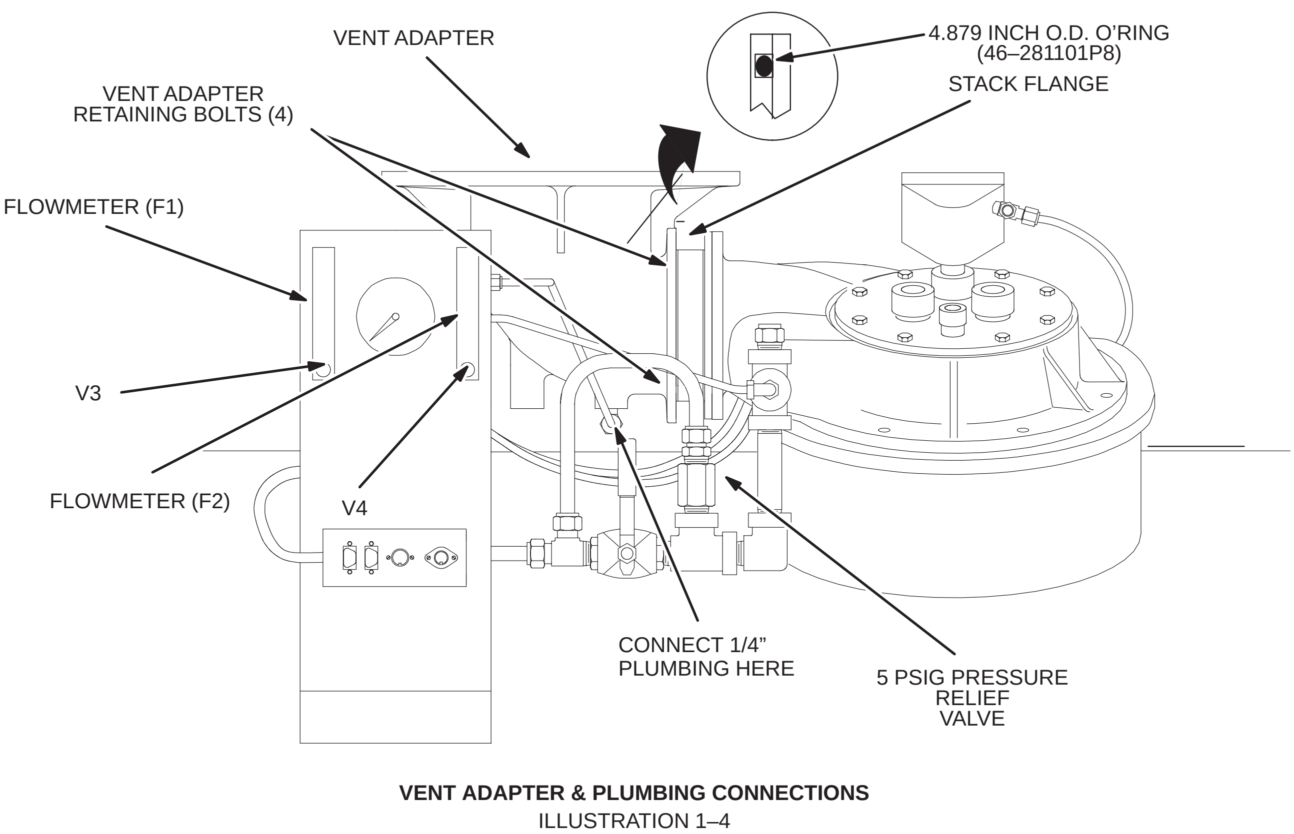
Make sure that the Burst Disc is fully sandwiched between the two rubber gaskets, (i.e., the gaskets are flat and the Burst Disc is not in contact with the flanges).

18. Assemble and tighten the four Retaining Bolts sufficiently to prevent leakage around the gaskets.

Note

See Illustration 1–4 for Steps 13 through 16.

19. Install the 4 inch “O”– Ring (46–281101P8), located in the Venting Hardware Kit, in the groove of the Vent Adapter.
20. Remove the four Retaining Bolts for the Vent Adapter from the Stack Flange and install the Vent Adapter to the Stack Flange, using the same bolts.
21. Connect the 1/2 inch Plumbing line, where the Plumbing Plug was connected, to the Vent Adapter.
22. Connect the 1/4 inch Plumbing, from the Swagelok Fitting on the Flowmeter, to the under side of the Vent Adapter.



VENT ADAPTER & PLUMBING CONNECTIONS
ILLUSTRATION 1–4

1–1 CONVERSION TO OPERATING CONFIGURATION (continued)

23. Open valves V3 and V4 on Flowmeters F1 and F2.

24. Remove the 15 psi Relief Valve from the Blanking Plate. Pack and return the 17.5 psia and 15 psig Relief Valves to:

GE MAGNET SYSTEMS
3001 W. RADIO DRIVE
FLORENCE, SOUTH CAROLINA 29501
ATTN: MATERIALS GROUP

CAUTION

Cryostat exhaust flow rate and pressure must be checked and adjusted as required after magnet installation, ramping and shimming to ensure that proper cooling conditions are maintained and no leaks are present in the Helium Exhaust System or Vent Valve (V2).

25. Open Vent Valve (V2) to depressurize the Cryostat a 0.25 psig. Close V2.

Note
Read all flow rates from the bottom of the float (ball) on the flow meters.

26. Set Instrumentation Lead Vent Valve (V4) for a reading between 0.8 – 1.2 SCFH on Flowmeter F2.

27. Set Shim Lead Vent Valve (V3) for a reading between 1.8 – 2.2 SCFH on Flowmeter (F1) to maintain a Cryostat Pressure Gauge reading between 0.25 – 0.50 psig.

28. Make sure flow rate through F2 is equal or greater than 0.8 SCFH.

29. If flow rate through F2 is less than 0.8 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and bubble test all exhaust plumbing joints, Relief Valve and Shim Lead Connector. Make sure V2 is fully closed. Repair any leaks. If a 0.8 SCFH flow rate through F2 cannot be achieved, under the above conditions, contact your Region Magnet Service Engineer.

30. Make sure the following conditions are maintained. Recheck settings in three days and again after one week:

INSTRUMENTATION LEAD FLOWMETER (F2) = 0.8 – 1.2 SCFH
SHIM LEAD FLOWMETER (F1) = 1.8 – 2.2 SCFH
CRYOSTAT GAUGE PRESSURE = 0.25 – 0.50 psig

31. Remove the Lifting Shackles from the Magnet Lifting Brackets and store outside the exam room.

1–2 VENTING INSTALLATION

WARNING!

TO AVOID BURNS FROM COLD EXHAUST GAS, MAKE SURE THAT ACCESS TO WITHIN 7.62 METERS (25 FT) OF THE EXHAUST DUCT EXIT, IS RESTRICTED.

PROTECT THE VENTILATION EXHAUST OPENING FROM ENTRY OF RAIN, SNOW OR DEBRIS THAT COULD BLOCK THE EXHAUST SYSTEM.

THE MAXIMUM ALLOWABLE PRESSURE DROP IN THE VENT LINE (FROM THE MAGNET INTERFACE TO THE OUTSIDE THE BUILDING) IS 17 PSI (117.2 KPa).

1. Make sure that the pressure drop in the Vent System does not exceed 17 psi (117.2 KPa) from the Vent Adapter to the exit at the outside the building. Use Table 1–1 to compute the pressure drop in the system.

CAUTION

Insulate Vent Pipe In Exam Room if there are horizontal sections that could collect condensation end drip on personnel.

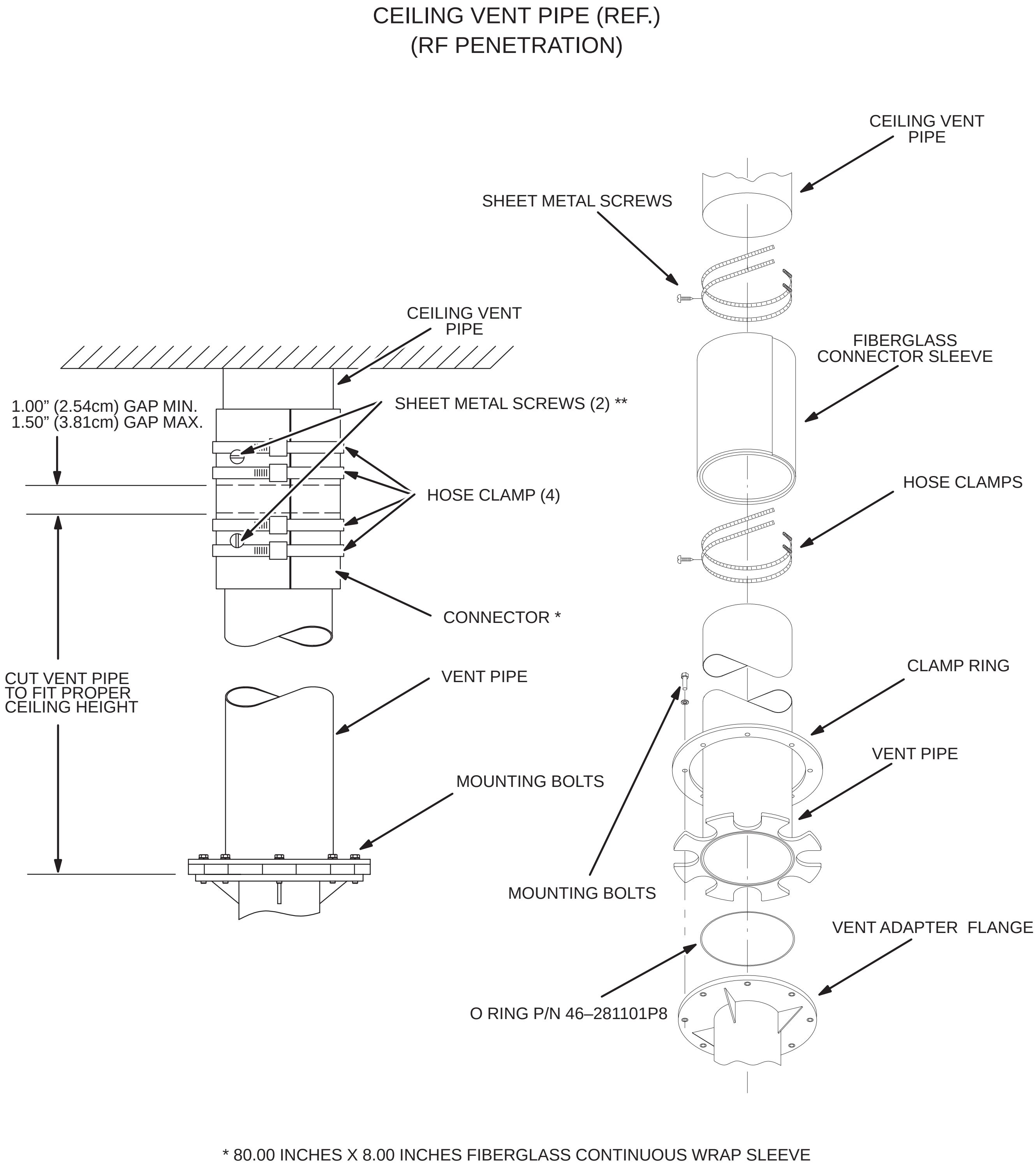
Note
Make sure the Clamp Ring is placed on the Vent Pipe before connecting the Vent Pipe to the Ceiling Vent Pipe.

2. Measure and cut the Vent Pipe for proper gap, at the Ceiling Vent Pipe, shown in Illustration 1–5.
3. Apply vacuum grease to surface of O–Ring and install O–Ring to top flange of Vent Adapter.
4. Install Clamp Ring onto Vent Pipe and loosely connect Vent Pipe to Vent Adapter using the 8 mounting bolts supplied.

Note
The Vent Pipe can be adjusted radially, one inch (25.4mm), in any direction to fit Ceiling Vent Pipe.

5. Align the Vent Pipe to the Ceiling Vent Pipe by moving the Vent Pipe at the Vent Adapter flange.
6. Tighten in an alternating pattern, the 8 mounting bolts installed in Step 4.

1–2 VENTING INSTALLATION (continued)

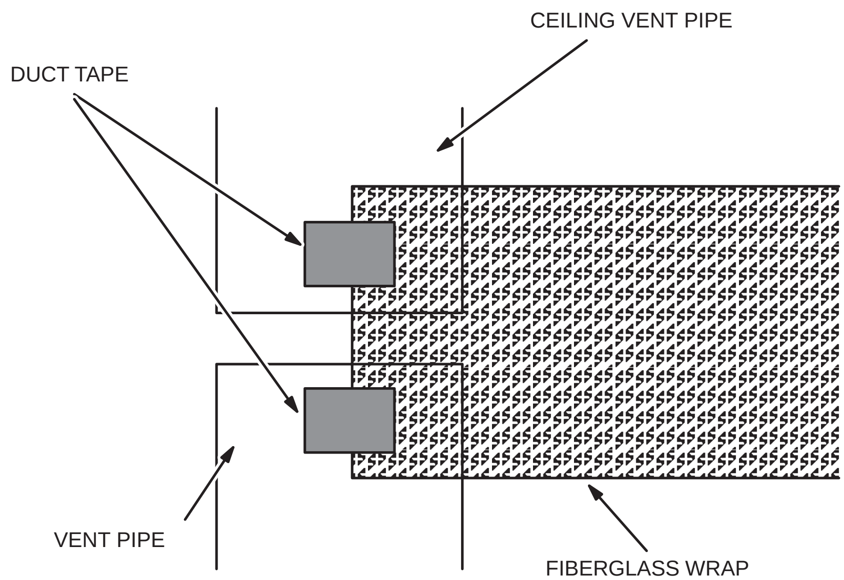


* 80.00 INCHES X 8.00 INCHES FIBERGLASS CONTINUOUS WRAP SLEEVE
** INSTALL SCREWS AS LAST STEP IN ASSEMBLY AFTER DRILLING HOLES ADJACENT TO HOSE CLAMPS AS SHOWN.

HELIUM VENT KIT ASSEMBLY P/N 46–318057G1
ILLUSTRATION 1–5

1–2 VENTING INSTALLATION (continued)

7. Tape one end of Fiberglass wrap, using 2 pieces of Duct Tape, over the Vent Pipe/Ceiling Vent Pipe joint as shown in Illustration 1–6.



FIBERGLASS WRAP INSTALLATION
ILLUSTRATION 1–6

8. Wrap the entire roll of Fiberglass wrap tightly around the joint.

9. Install 2 Hose Clamps on each side of the joint to hold Fiberglass Wrap in position. Space Clamps about 1/2 inch apart and about 1 inch from the joint. See Illustration 1–5.

10. Drll 2 holes, using a number 17 Drill Bit (4.4mm), as shown in Illustration 1–5. Holes should be drilled near Hose Clamps in order for the Sheet Metal Screw head to seat onto the clamps as shown in Illustration 1–5.

11. Install 2 (#10 x 1.00 inch) Self Tapping Sheet Metal Screws into the drilled holes. Make sure the head of the Sheet Metal Screw is seated onto the Hose Clamp.

12. Inspect the Vent System for integrity and blockages before connecting it to the Magnet.

1–2 VENTING INSTALLATION (continued)

TABLE 1–1
HELIUM VENT LINE PRESSURE DROP MATRIX

CRYOGENIC VENT SYSTEM PRESSURE DROP MATRIX FOR A 1.5 TESLA MAGNET					PRESSURE DROP PER ELBOW USED ANYWHERE WITHIN A 20 FT VENT SEGMENT							
INSIDE DIAMETER OF VENT PIPE	DISTANCE OF VENT SYSTEM COMPONENT FROM MAGNET		PRESSURE DROP FOR STRAIGHT VENT PIPE WITH SMOOTH INSIDE SURFACE		STANDARD SWEEP 45° ELBOW		STANDARD SWEEP 90° ELBOW		LONG SWEEP 45° ELBOW		LONG SWEEP 90° ELBOW	
in. (mm)	ft	(m)	psi/ft	(KPa/m)	psi	(KPa)	psi	(KPa)	psi	(KPa)	psi	(KPa)
6 (152)	0–20	(0–6.1)	0.41	(9.27)	3.40	(23.44)	6.60	(45.51)	1.71	(11.79)	3.28	(22.62)
	20–40	(6.1–12.2)	0.83	(18.77)	6.20	(42.75)	11.50	(79.29)	3.10	(21.37)	5.75	(39.65)
	40–60	(12.2–18.3)	1.21	(27.37)	8.80	(60.68)	16.40	(113.08)	4.38	(30.20)	8.22	(56.68)
	60–80	(18.3–24.4)	1.60	(36.19)	11.40	(78.60)	21.20	(146.17)	5.69	(39.23)	10.62	(73.22)
	80–100	(24.4–30.5)	2.05	(46.37)	14.20	(97.91)	26.60	(183.41)	7.12	(49.09)	13.29	(91.63)
8(203)	0–20	(0–6.1)	0.10	(2.26)	1.10	(7.58)	2.06	(14.20)	0.55	(3.79)	1.03	(7.10)
	20–40	(6.1–12.2)	0.21	(4.75)	2.10	(14.48)	3.70	(25.51)	1.03	(7.10)	1.85	(12.76)
	40–60	(12.2–18.3)	0.30	(6.79)	2.88	(19.86)	5.21	(35.92)	1.44	(9.93)	2.60	(17.92)
	60–80	(18.3–24.4)	0.38	(8.60)	3.70	(25.51)	6.71	(46.27)	1.85	(12.76)	3.36	(23.17)
	80–100	(24.4–30.5)	0.47	(10.63)	4.52	(31.17)	8.22	(56.68)	2.26	(15.58)	4.11	(28.34)
10(254)	0–20	(0–6.1)	0.03	(0.68)	0.55	(3.79)	0.82	(5.65)	0.27	(1.86)	0.41	(2.83)
	20–40	(6.1–12.2)	0.07	(1.58)	0.82	(5.65)	1.51	(10.41)	0.41	(2.83)	0.75	(5.17)
	40–60	(12.2–18.3)	0.10	(2.26)	1.23	(8.48)	2.19	(15.10)	0.62	(4.27)	1.10	(7.58)
	60–80	(18.3–24.4)	0.12	(2.71)	1.51	(10.41)	2.74	(18.89)	0.75	(5.17)	1.37	(9.45)
	80–100	(24.4–30.5)	0.16	(3.62)	1.92	(13.24)	3.43	(23.65)	0.96	(6.62)	1.71	(11.79)
12(305)	0–20	(0–6.1)	0.013	(0.29)	0.27	(1.86)	0.41	(2.83)	0.14	(0.97)	0.21	(1.45)
	20–40	(6.1–12.2)	0.027	(0.61)	0.41	(2.83)	0.82	(5.65)	0.21	(1.45)	0.41	(2.83)
	40–60	(12.2–18.3)	0.041	(0.93)	0.55	(3.79)	1.10	(7.58)	0.27	(1.86)	0.55	(3.79)
	60–80	(18.3–24.4)	0.054	(1.22)	0.69	(4.76)	1.37	(9.45)	0.34	(2.34)	0.69	(4.76)
	80–100	(24.4–30.5)	0.069	(1.56)	0.96	(6.62)	1.51	(10.41)	0.48	(3.31)	0.75	(5.17)
	100–120	(30.5–36.6)	0.08	(1.81)	1.09	(7.52)	1.77	(12.2)	0.55	(3.79)	0.88	(6.07)
	120–140	(36.6–42.7)	0.10	(2.26)	1.27	(8.76)	2.07	(14.3)	0.63	(4.34)	1.04	(7.17)
	140–160	(42.7–48.8)	0.11	(2.49)	1.43	(9.86)	2.36	(16.3)	0.72	(4.96)	1.19	(8.21)
	160–180	(48.8–54.9)	0.12	(2.71)	1.6	(11.0)	2.53	17.4)	0.80	(5.52)	1.27	(8.76)
	180–200	(54.9–61.0)	0.17	(3.85)	1.75	(12.1)	2.93	(20.2)	0.88	(6.07)	1.47	(10.14)

Note 1: Elbows with angles greater than 90° must not be used.

Note 2: The table data is based on the following:
a. Initial flow conditions at magnet interface
b. Gas temperature starting at 4.5 Kelvin (–452° F or –268° C).
c. Helium gas flow rate of 2737 cubic feet per minute (77.5 cubic meters per minute)
d. 45° standard sweep elbow K = 15 F_t
e. 90° standard sweep elbow K = 30 F_t
f. 45° long sweep elbow K = 7.5 F_t
g. 90° long sweep elbow K = 15 F_t
h. No offset between magnet vent adapter and ceiling RF vent adapter.

NOTE: MAXIMUM PRESSURE DROP = 17 PSI (117.22 KPa)
PRESSURE DROP MEASURED FROM MAGNET VENT ADAPTER TO EXIT OF BUILDING

Note

If the total pressure drop calculated exceeds the maximum specified pressure drop off 17 psi (117.22 KPa), then larger diameters for some of the vent line sections would have to be selected and the total pressure drop recalculated until it is less than 17 psi (117.22 KPa).

1–3 SHIELD COOLER INSTALLATION AND CHECK OUT

Description:

The Shield Cooler System comes with a Cold Head already installed on the Magnet and a separate Compressor Unit, which will be located in the Equipment Room. A power cable and gas supply and return lines connect the two units. Locate and read the vendor manual supplied with your system to become thoroughly familiar with the configuration and procedures before installation. Compressor installation instructions are covered in the vendor manual. The shield Cooler Interconnect Diagram is shown in SCHEMATICS/INTERCONNECTS, Illustration NO TAG.

1–4 SHIELD COOLER SYSTEM

1–4–1 Preparation For Increasing Shield Cooler Gas Pressure

CAUTION

The following procedure purges air out of the regulator and connecting lines before the line is connected to a new cylinder of certified 99.999% helium gas.

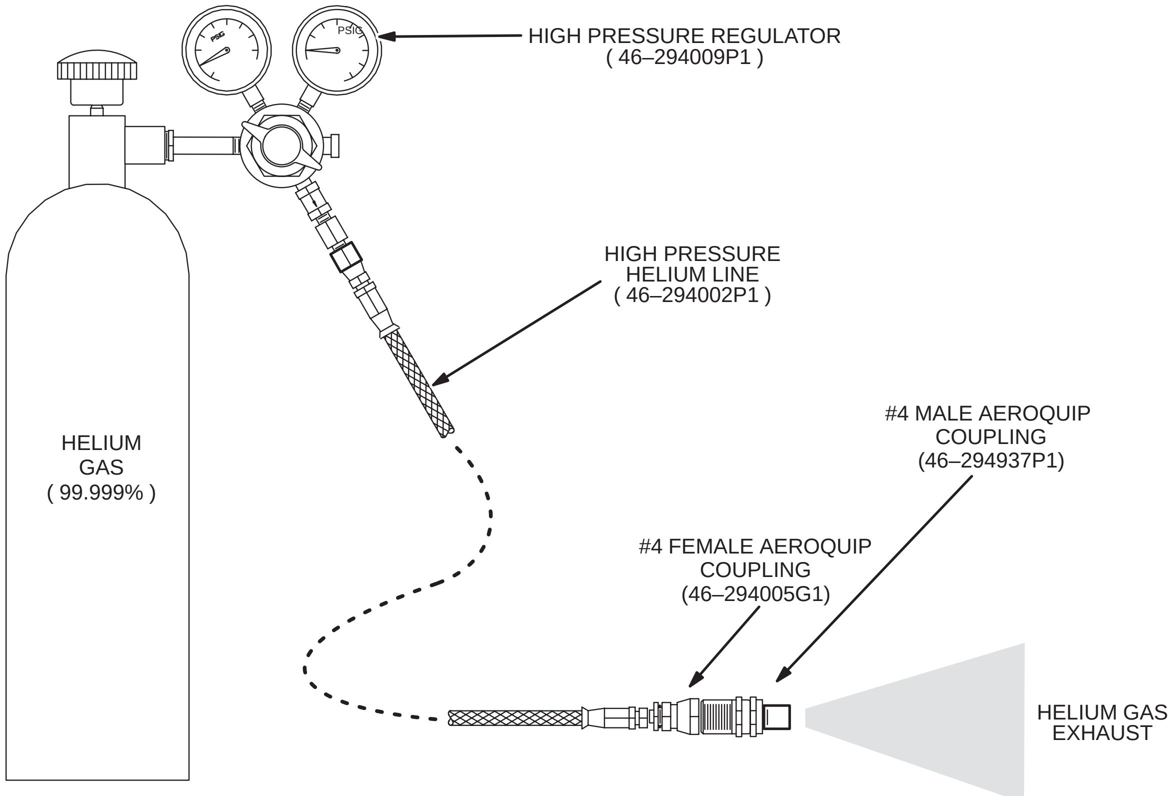
1. Refer to the vendor manual (P/N 722–78–037; GE P/N 46–294439P4) for instructions on compressor installation, power, cooling requirements, leaks etc.

2. Obtain a cylinder of 99.999% Helium Gas.

3. Loosely attach the high pressure regulator (46–294009P1) to the gas cylinder, per the following steps.
   A. Thread in the screw that connects the regulator to the Helium bottle about 2 turns.
   B. Turn Regulator handle fully clockwise to open the regulator.
   C. Open Helium bottle, and immediately tighten the Regulator to the Helium bottle.
   D. Close the Regulator Valve by turning the handle counter clockwise.

4. Attach high pressure helium line (46–294002P1) to regulator at shut off valve. See Illustration 1–7.

1–4–1 Preparation For Increasing Shield Cooler Gas Pressure (continued)



SET–UP FOR COMPRESSOR CHARGING
ILLUSTRATION 1–7

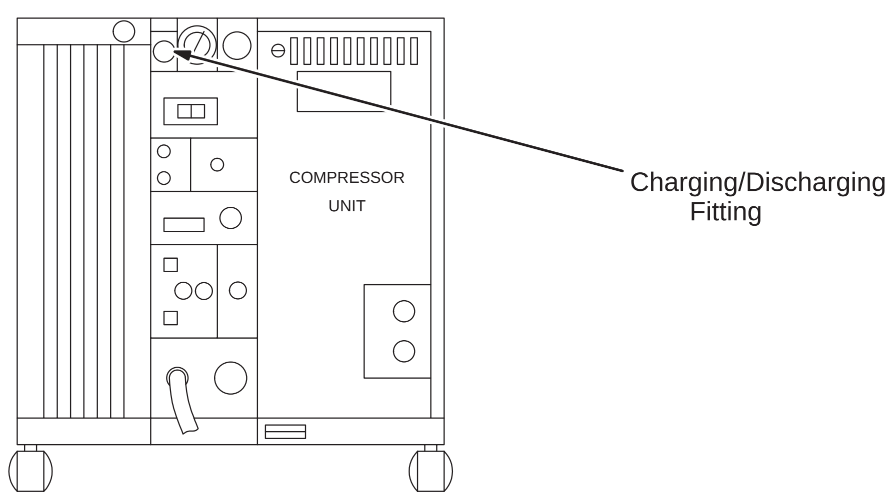
1–4–1 Increasing Shield Cooler Gas Pressure Preparation (continued)

5. Attach the #4 Female Aeroquip Coupling (46–294005G1) to the end of the high pressure charging line. See Illustration 1–7.

DANGER!!

FATAL EXPLOSIVE HAZARD!! TO PREVENT POSSIBLE FATAL EXPLOSIVE RELEASE OF GAS, OPEN MAIN VALVE ON GAS CYLINDER VERY SLOWLY. GAS IS AT 2400 PSI.

6. Attach #4 Male Aeroquip Coupling (46–294937P1) to the #4 Female Aeroquip Coupling. Hand tighten the fittings together. This will open the Helium circuit to allow the charging assembly to be purged.
7. Establish gas flow through the Helium line and fittings by slowly opening the main valve on the gas cylinder and tightening the male fitting into the female Aeroquip.
8. Allow Helium to purge out the assembly for 2 minutes.
9. Remove the male Aeroquip fitting coupling from the female coupling.
10. Close regulator. Shut off compressor power to let supply and return pressures equalize in compressor.
11. Fully open valve on gas cylinder.
12. Adjust regulator control valve to achieve a pressure of approximately 200 psig.
13. Attach purged charging line assembly with the female Aeroquip coupling to the charging fitting on the front of the compressor. See Illustration 1–8.



CHARGING FITTING LEYBOLD COMPRESSOR
ILLUSTRATION 1–8

1–4–2 Increasing Gas Pressure

1. Increase compressor Helium pressure by adjusting regulator until compressor's high side gauge reads 218–232 psig (15.03 – 16.00 Bar).
2. If too much Helium gas has been added, refer to Section 1–4–3, Decreasing Shield Cooler Gas Pressure, to lower the Helium Pressure.

1–4–3 Decreasing Gas Pressure

1. Remove Protective Cap from compressor front panel fitting.
2. Connect oil charging hose and fitting (46–294003P1) to the small fitting on the front of the compressor. See Illustration 1–8.
3. Slowly tighten fitting until you hear gas escaping.
4. When a pressure of 218–232 psig (15.03 – 16.00 Bar) is reached, immediately unscrew fitting and hose to prevent further gas removal.
5. Replace protective cap on front panel fitting.

1–4–4 Disconnection and Stowage of Hoses and Regulator

1. Remove Aeroquip Coupling from Compressor. Restore Compressor power.
2. Close Regulator Valve.
3. Attach high pressure hose and Female Aeroquip to the Male Aeroquip #4 until the Helium circuit is opened and gas is flowing.
4. Allow high pressure line and Aeroquip to depressurize.
5. Remove #4 male Aeroquip, and remove the female Aeroquip from the high pressure charging line.
6. Remove the high pressure charging line from the regulator.
7. Close valve on Helium cylinder. Bleed off pressure from regulator.
8. Remove regulator from Helium bottle.
9. Store all equipment in carrying case from kit 46–281088G3, Shield Cooler Installation/Maintenance Kit.

1–4–5 Flexible Gas Line Connections

Note

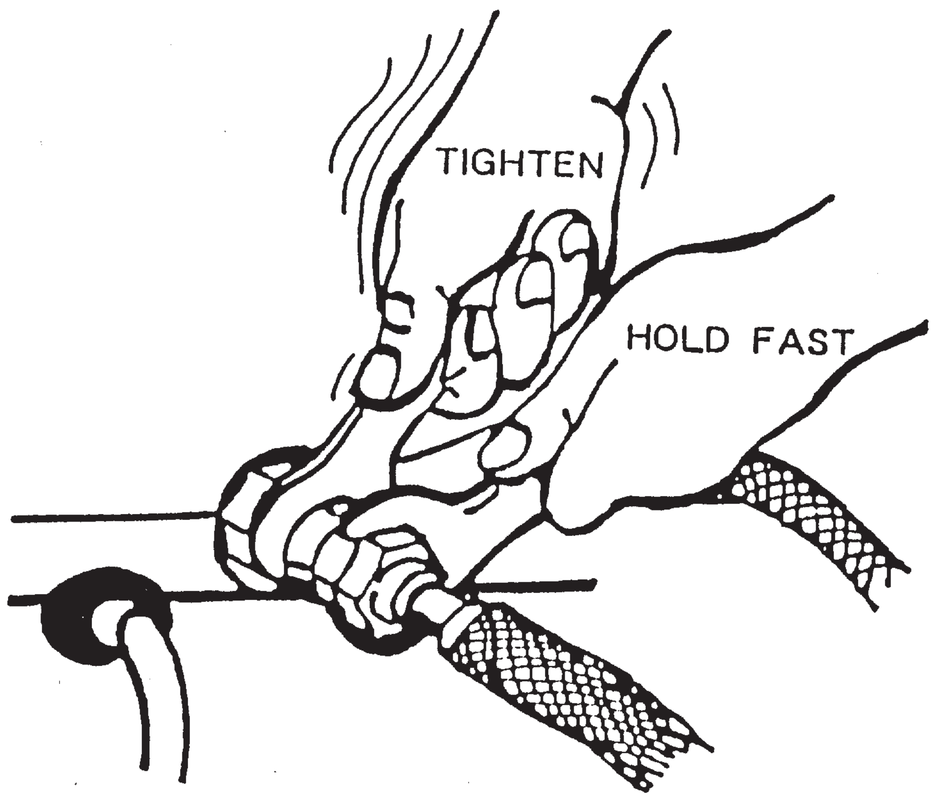
Refer to REPLACEMENT/MAINTENANCE, Section NO TAG, for details on connecting and disconnecting Aeroquip coupling.

CAUTION

Flex Lines, with a 1 inch (25.4 mm) inside diameter, have a minimum "Flexing Bend Diameter" of 17 Inches (432mm). Bending the flex lines beyond this point can damage the flex lines.

1. Feed the flexible Gas Supply Line (RUN 621) through either port (55mm hole) in the penetration panel and position one end at the compressor and the other at the Cold Head on the Magnet Cryostat.

1–4–5 Flexible Gas Line Connections (continued)



PROPER TECHNIQUE FOR CONNECTION OF AEROQUIP COUPLINGS
ILLUSTRATION 1–9

2. Similarly feed the flexible Gas Return Line (RUN 622) through the other port in the penetration panel and route in parallel with the supply line.

3. Connect the lines to the compressor using the appropriate Aeroquip connection wrenches. See Illustration 1–9. Always use two wrenches as shown, so that the back adaptor connection is not disturbed, to prevent system gas leaks from occurring.

4. Observe the compressor pressure gauge reading after connecting the gas lines, the reading should remain constant.

Note

If the reading is lower, this indicates that the gas lines were not fully charged when received, or that one could have a leak. Refer to the vendor manual for troubleshooting instructions.

5. Route the Flexible Gas Lines through the base pad of the magnet before connecting them at the Cold Head. See Illustration 1–10.

1–4–5 Flexible Gas Line Connections (continued)

CAUTION

Flex line noise (chirping) is a function of the number of loops in the Flex line. Try to minimize number of loops formed when storing the flex line slack.

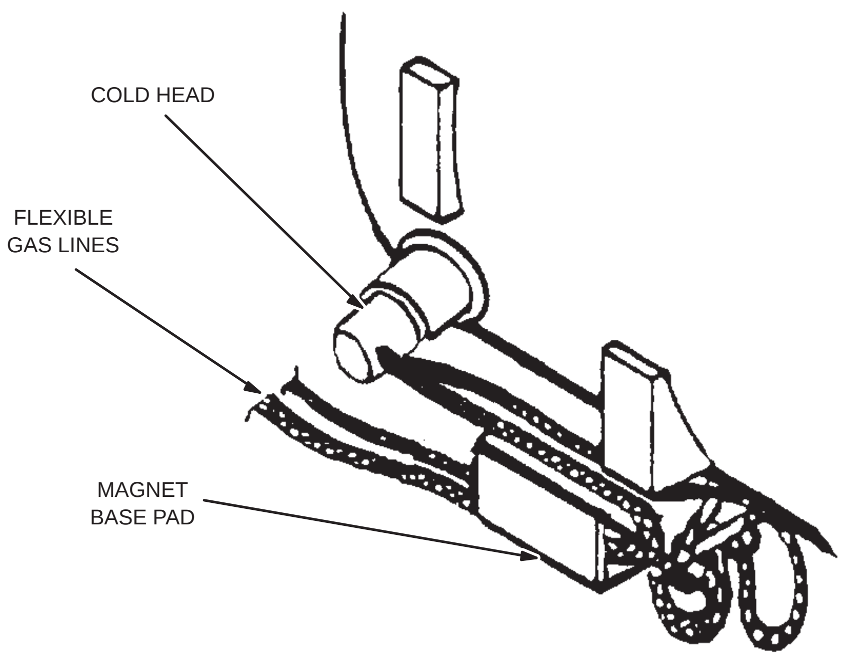
6. Connect the other ends of the flex lines to the Cold Head. Connect the free ends of the flex lines at the mating fittings on the Cold Head, using two wrenches on the fittings.
7. Observe the reading on the compressor pressure gauge. If the pressure reading is constant, then a leak is not suspected.
8. If the reading is above 232 psig (1498 KPa) or below 218 psig (1402 KPa) then refer to vendor manual for troubleshooting instructions.
9. Press lines in a gentle curve award the center of the magnet and adjust line slack and angles a minimize tension and noise (chirping).

Note

The lines will eventually be routed out of a rectangular opening at the bottom, center of the Rear Enclosure Cover. Always adjust line slack after routing.

If site conditions permit, the line slack can be neatly placed below the floor either in the Exam Room or the Computer Room.

Make sure Gas Lines are secure and do not vibrate or rub on other metal surfaces as this will cause image artifact.



FLEXIBLE GAS LINE ROUTING AT MAGNET
ILLUSTRATION 1–10

1–4–6 Shield Cooler Electrical Cable Connections

1. Connect the four ring terminals on the end of the Cold Head Electrical Cable (RUN #624) to the four studs of the Noise Filter on the inside the Penetration Panel. See Illustration 1–11

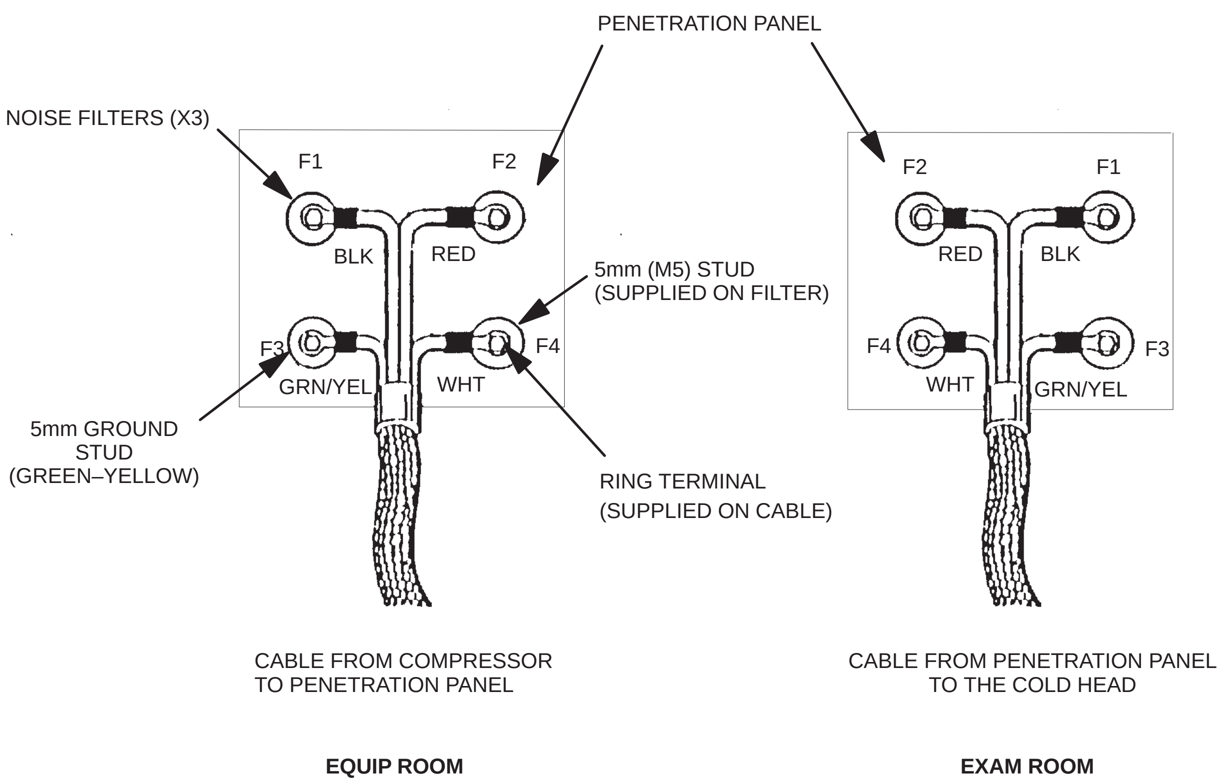
2. Connect the other end of the cable to the mating connector on the Cold Head.

3. Connect the four ring terminals on the end of the Compressor Electrical Cable (RUN #623) to the four studs of the Noise Filter on the outside the Penetration Panel (equipment room side).

CAUTION

Make sure that the wire colors and numbers are properly matched on the noise filter studs on both sides of the Penetration Panel to prevent improper operation or damage.

4. Connect the other end of this cable to the Cold Head Connector on the Compressor



SHIELD COOLER ELECTRICAL CABLE CONNECTIONS
ILLUSTRATION 1–11

1–4–7 Monitoring Shield Cooler Temperatures

Description

New diode types, SI 410, are used for both the Cold Head and the Magnet Cartridge. See graphs 2–1 and 2–2, in SET UP AND CALIBRATION, Section 2, for the correct voltage to temperature conversion when using the Low Cost Diode Box.

1. Use the Lakeshore Cryotronics Digital Cryogenic Thermometer Model 208 Thermometer Kit (46–301477G2) or the Low Cost Shield Temperature Diode Box (46–317543G2) to monitor Cold Head first and second stage temperatures**.** If using the Lakeshore 208 Thermometer, make the Curve 6 selection. This is equivalent to DT470 Curve 10. Refer to the vendor manual supplied with the Lakeshore, or refer to Service Note 63033 for programming instructions.

2. Connect the Cryogenic Thermometer to the Cold Head in conformance with Illustration 1–12.

3. Select the Cold Head stage to be monitored as shown below.

STAGE	DRC – 80	2O8 THERMOMETER KIT
FIRST	PRESS “A” BUTTON	SELECT CHANNEL 1
SECOND	PRESS “B” BUTTON	SELECT CHANNEL 2

Note

Both temperatures should begin falling after the Cold Head begins operating. Equilibrium temperatures are 32 K to 60 K for the first stage and 7 K to 17 K for the second stage. Time to reach equilibrium may be up to four days, depending upon initial shield temperatures.

4. Read and record “FIRST STAGE” and “SECOND STAGE” Shield Temperatures at equilibrium. Record the readings in Table 1–1, DATA SHEETS.

CAUTION

The Magnet temperature sensors are designed to be driven by a 10 microampere source; some ohmmeters exceed this rating. Do not use any sensing or troubleshooting equipment which exceeds 10 microamperes to prevent diode destruction. The equipment/circuit In this section may be used with a voltmeter to troubleshoot the sensor circuit

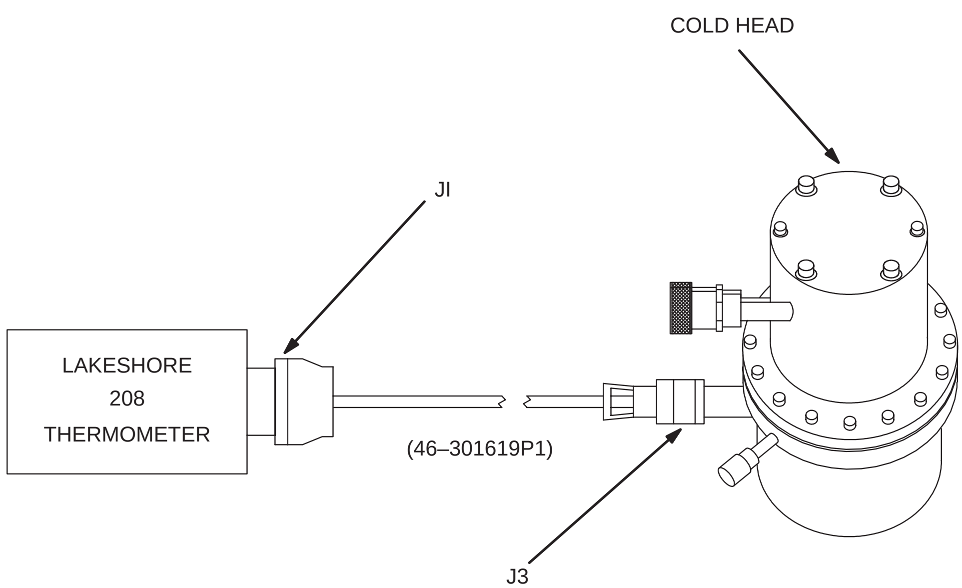
Note

A SHORTED sensor circuit will cause the meter to display a reading of approximately 400 K whereas an OPEN sensor circuit will cause the meter display to flash. Check for problems in the connector cable or for proper plug termination before ruling the sensing diode detective.

1–4–7 Monitoring Shield Cooler Temperatures (continued)

Note

Differences in diode mounting techniques and diode lead heat stationing used to intercept heat propagated down the leads from the outside the magnet, have produced increased variation in shield cooler diode temperature readings. Because of this condition, the acceptable diode temperature range (magnet operating with boil–off in specification) has exceeded the original temperature range established for field reference, for a small number of magnets. It is important to identify acceptable diode temperature readings which exceed the field reference range, as the "diagnostic threshold" for proper shield cooler operation. Diode temperature reading values are recorded on the Acceptance Test Report (ATR) sent with each magnet. Where the recorded value exceeds the field reference range documented in the above note, use the recorded value as the nominal value for proper shield cooler operation on the referenced magnet. Acceptable ranges around these nominal values are:
$\pm$ 10 K FIRST STAGE $\pm$ 5 K SECOND STAGE
Starting March 1, 1993 all diode temperature reading values which exceed the field reference range will be recorded on a label attached to the coldhead sleeve, in addition to being recorded on the ATR.



SHIELD COOLER TEMPERATURE MEASUREMENT SET–UP
ILLUSTRATION 1–12

1–4–8 Setting Cold Head Tension

Description:

During magnet installation or anytime the Cold Head has been shut off for a considerable length of time (days), the Cold Head will contract as it begins operating and cooling down. The tightness of the Cold Head Mounting Bolts will need to be checked, and they may need to be adjusted periodically to ensure that good contact is maintained between the Cold Head and the Cold Head Sleeve.

Procedure:

1. Monitor the Cold Head First and Second Stage Temperatures in conformance with the Magnet Service Manual, Section 1–4–7, SET–UP AND CALIBRATION (Monitoring Shield Cooler Temperatures).

CAUTION

Overtightening the Cold Head Mounting Bolts can damage the Cold Head Sleeve.

2. When the Cold Head is first turned on, the Mounting Bolts should be adjusted finger tight. Leave the Belleville Washers uncompressed for now.

   Note

   Set the gap by tightening to the proper setting. Do not set gap by overtightening then loosening as insufficient pressure will result, due to the hysteresis characteristic of the Belleville Washers.

3. After the Cold Head has been operating and cooling for approximately two hours, tighten the mounting bolts in a CW rotation pattern to achieve the Belleville Washer Gap setting shown in Illustration 1–13. Do not set gap by overtightening then loosening as insufficient pressure will result.

4. After tightening the Mounting Bolts, the Sleeve temperatures will decrease rapidly for a period of time, then will stabilize as the Cold Head cools and contracts away from the Sleeve. So periodically check the Mounting Bolts for tightness (approximately every 8 hours) and tighten them as needed to restore the proper Belleville Washer Gap. See Illustration 1–13.

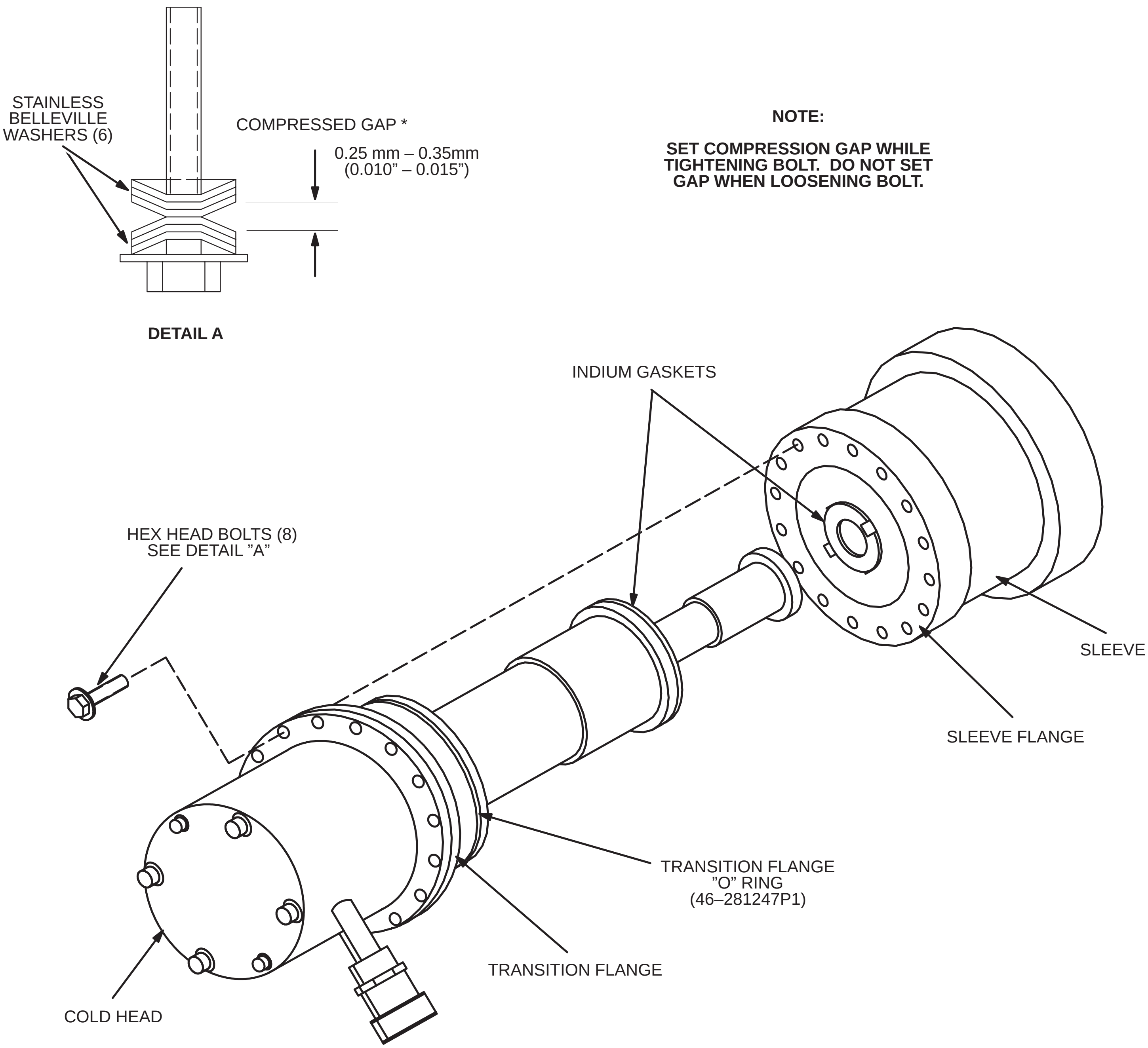
5. This process will continue from 1 to 4 days until the Cold Head reaches its ultimate operating temperature. At this time, the Belleville Washers will be set to the proper gap, but the temperatures will no longer decrease.

6. The operating temperatures should be within the following ranges:

   First Stage: 35 – 60 K
   Second Stage: 7 – 17 K

   Note

   The temperatures readings, taken for your magnet at the factory, were recorded in the Acceptance Test Report (ATR). If temperatures are higher than those values, perform the tests listed in FUNCTIONAL CHECK*S,* Section 4 of this manual.



COLD HEAD MOUNTING BOLT GAP SETTING
ILLUSTRATION 1–13

1–4–9 RF Shielding

Note

The shielding is performed from the Equipment Room side of the Penetration Panel using the following procedure. The procedure is applicable for both the Helium supply and Return Lines.

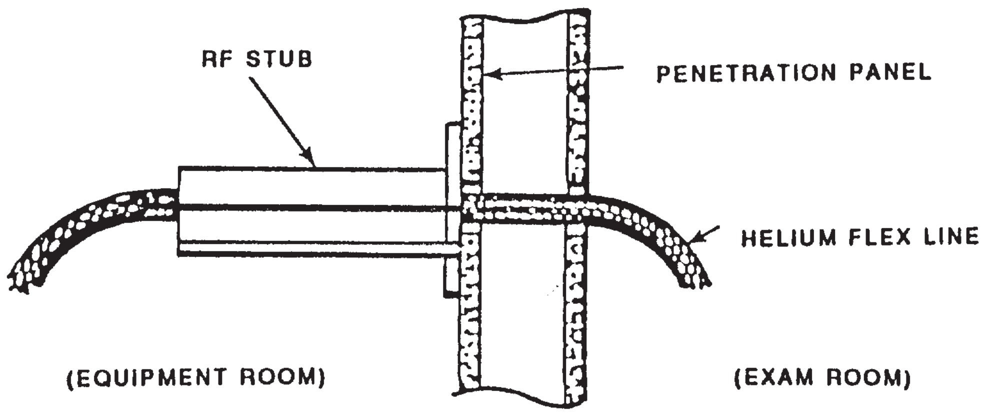
1. Adjust the slack on the Helium Supply and Return Flex lines for the most suitable length on both sides of the Penetration Panel.
2. Position half of the RF Stub Assembly (46–260860G1*)* underneath the Helium Supply Line, with the flange end oriented toward the Penetration Panel. See Illustration 1–11.

Note

Make sure RF Stub Assembly is clean (bright copper appearance). Wire brush the surface, as required, to insure a clean surface.

3. Secure the flange of the RF Stub Assembly to the Penetration Panel with four screws, aligning the flange holes with the holes In the Penetration Panel.
4. Insert Bronze Wool (46–318068P1) around the Helium Supply Line (top and bottom) over the length of the RF Penetration Stub.
5. Position the other half of the RF Stub Assembly over the Helium Supply Line, with the flange oriented toward the Penetration Panel and align it over the lower half.

1–4–9 Rf Shielding (continued)



RF STUB ASSEMBLY MOUNTING
ILLUSTRATION 1–14

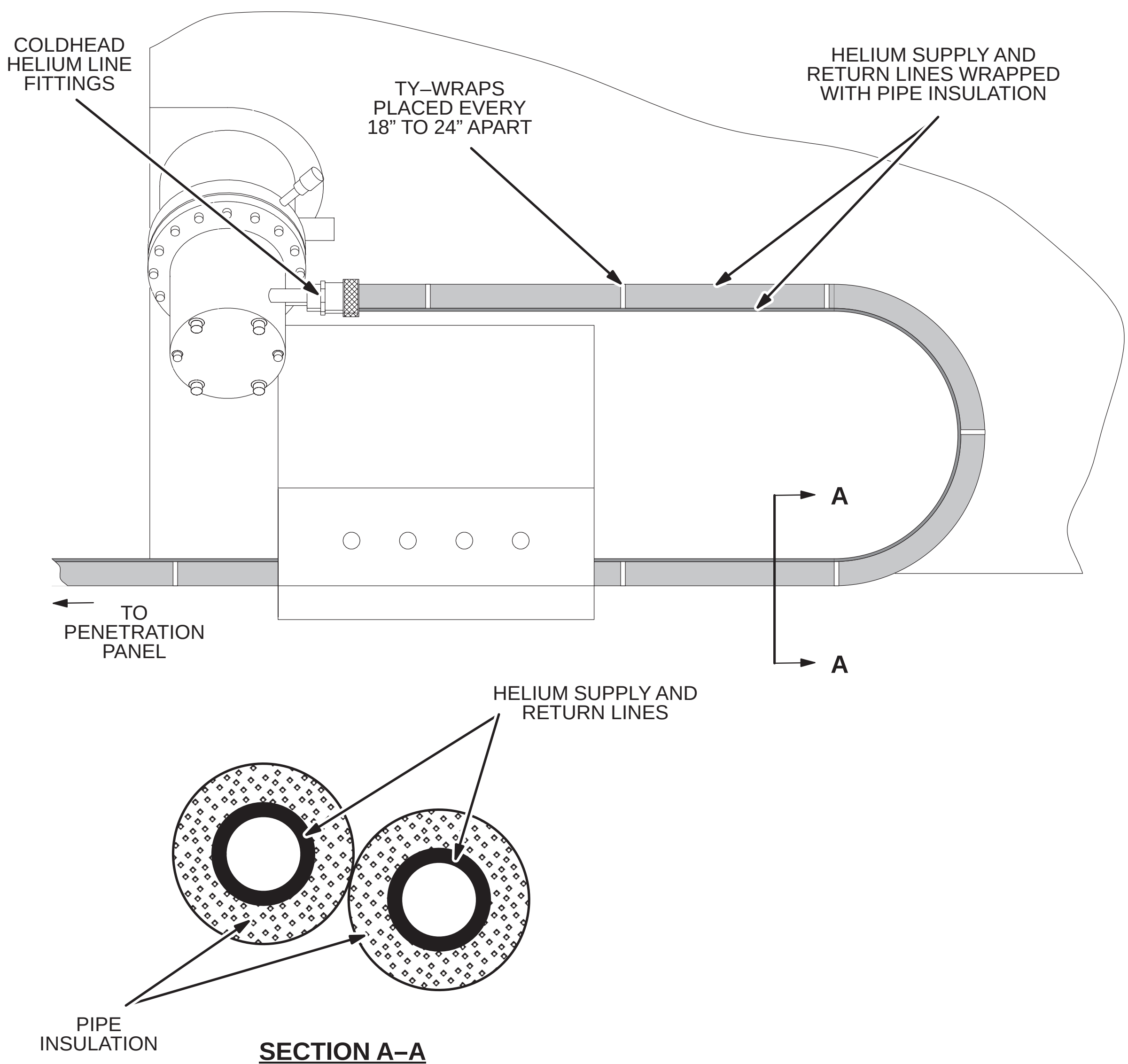
6. Secure the flange of the top half of the RF Penetration Stub Assembly to the Penetration Panel with four screws, aligning the flange holes with holes in the Penetration Panel.

7. Repeat the procedure for the Helium Return Line.

1–4–10 Installing Helium Line Insulation Kit

Note
Helium Gas Line Insulation Kit (2156980) has been created to isolate helium gas lines from each other and from ground to prevent spike noise. See Illustration 1–10 for routing of helium lines.

Pipe insulation should cover lines completely from the helium line fittings on the coldhead to the penetration panel where the lines exit the magnet room. See Illustration 1–15.



HELIUM INSULATION KIT
ILLUSTRATION 1–15

1–5 MAGNET RUNDOWN UNIT (MRU) INSTALLATION

1. Install and inspect the “MRU” in conformance to the vendor service manual supplied with the unit.

2. Batteries are installed and fully charged before leaving the factory. The Charge should be verified according to the vendor service manual.

Note

MRUs are shipped strapped for 115V AC at 50–60 Hz. Refer to vendor manual for local requirements.

3. Perform all adjustments and functional checks in conformance to the vendor service manual.

CAUTION

The MRU Cable is a shielded cable with the shield terminated at only the MRU end. It is essential that the cable be properly connected.

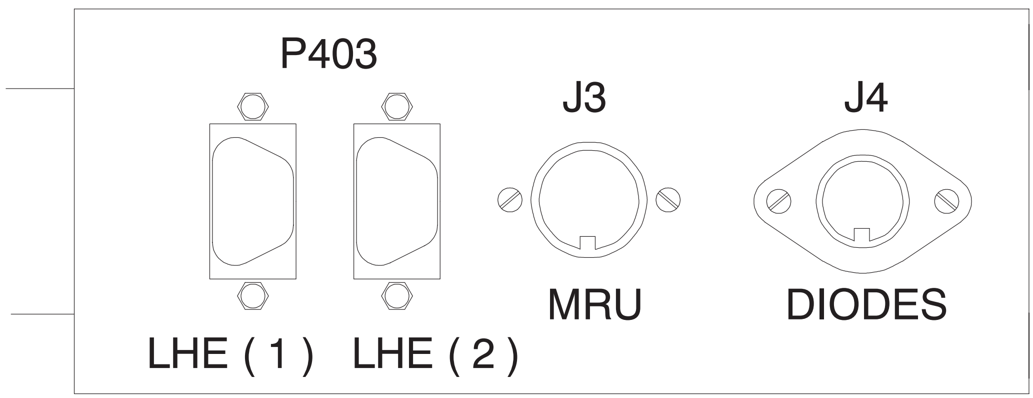
WARNING!

CHARGE BATTERIES FOR 24 HOURS AND MAKE SURE THE RED RUNDOWN SWITCH IS NOT PUSHED IN BEFORE PERFORMING STEP 5 BELOW.

4. Connect Lemo Connector (P2), on MRU Cable (RUN #606), to (J2) located behind front cover on MRU. Close and fasten the MRU cover. Wiring diagram shown in SCHEMATICS /INTERCONNECTS, Illustrations NO TAG and NO TAG.

5. Connect connector (P3) on MRU Cable (RUN #606) to (J3) on Magnet Harness Terminal Box (MS1–A3,A1) on Back Flange of magnet; MRU is now operable. See Illustration 1–16 for (J3) Location.

1–5 MAGNET RUNDOWN UNIT (MRU) INSTALLATION (continued)



MAGNET HARNESS TERMINAL BOX
ILLUSTRATION 1–16

1–5 MAGNET RUNDOWN UNIT (MRU) INSTALLATION (continued)

6. Verify that all connectors are mated on the top of the magnet: (J1–A), (J1–B), (P1–C).

WARNING!

EXTREME CAUTION MUST BE TAKEN WHILE PERFORMING THE FOLLOWING FUNCTIONAL CHECKS AS INADVERTENTLY ACTIVATING THE “RUN DOWN” SWITCH WILL QUENCH THE MAGNET.

7. Perform functional checks in conformance with the vendor service manual.

Note
MRU functional checks are also covered in FUNCTIONAL CHECKS, Section 2 of this manual.

1–6 CRYOGEN MONITOR INSTALLATION

1. Install and inspect the Cryogen Monitor in conformance to the vendor service manual supplied with the unit. This unit is installed in the MR System Cabinet (MR2).

CAUTION

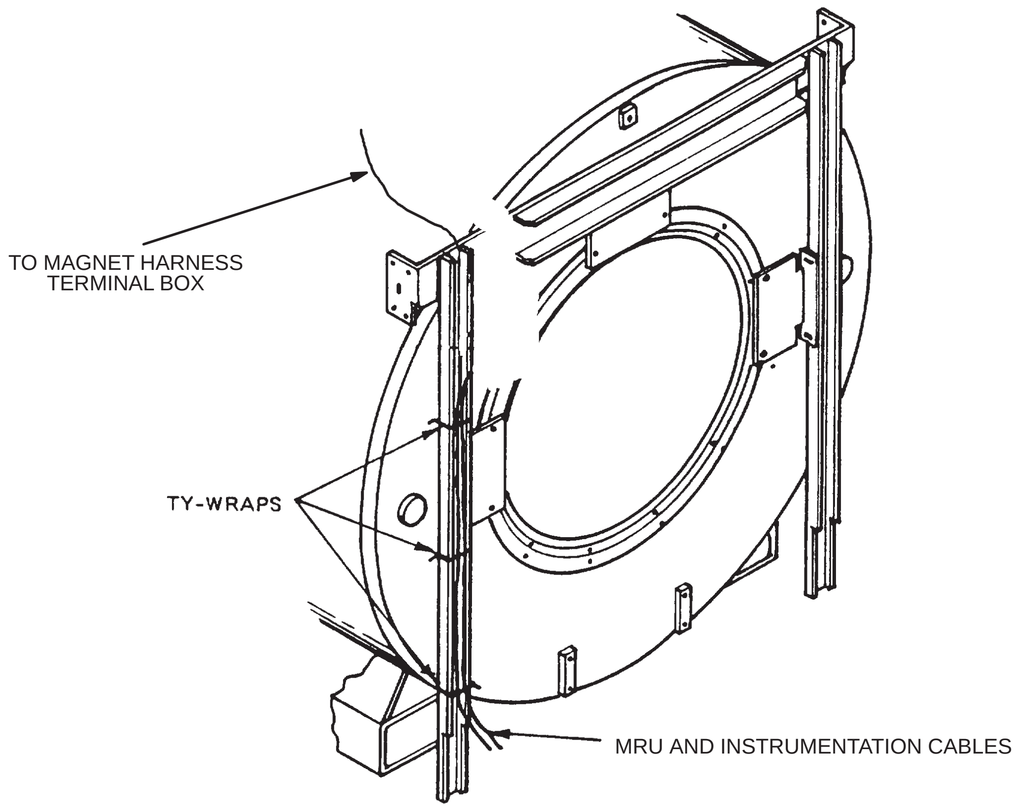
Establish power source values and make sure Cryogen Monitor is properly wired for input power in conformance to Section 3 of the vendor service manual for proper operation. A change to the power cord plug may be required.

2. Connect Instrumentation Cable #1 (RUN #605) from (J403) on the Cryogen Monitor to (P403) on the Penetration Panel. Wiring diagram shown in SCHEMATICS/INTERCONNECTS, Illustration NO TAG.

3. Connect Instrumentation Cable #1 (RUN #605) from (J403) on the Magnet Harness Terminal Box to (J403) on the Penetration Panel. See Illustration 1–16 for (P403) location.

4. Ty–wrap MRU Cable (RUN #606) and Instrumentation Cable (RUN #605) to Back End, left Vertical Shroud Channel. See Illustration 1–17.

1–6 CRYOGEN MONITOR INSTALLATION (continued)



MRU & INSTRUMENTATION CABLE ROUTING
ILLUSTRATION 1–17

Note

Cryogen Monitor Calibration is covered in *Direction 15494,* Signa Advantage 1.5T & 0.5T PM Manual.

5. Perform the calibration procedure, covered in the PM manual, at least once every six months. Perform sensor length calibration and warning/alarm setting.

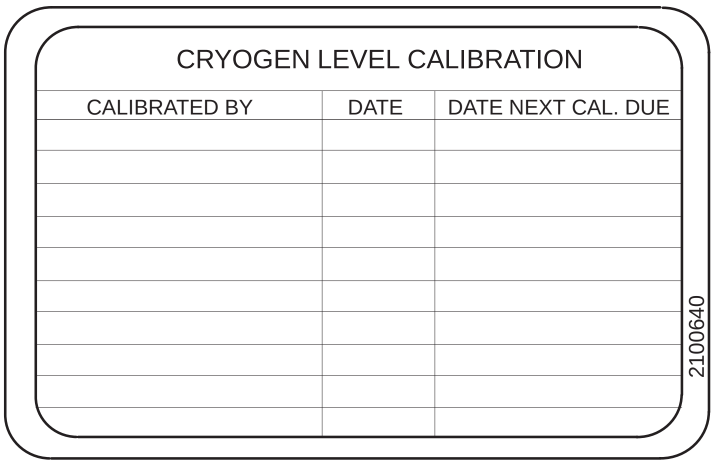
6. Sign and date the Cryogen Level Calibration label (P/N 2100640), located on the Cryogen Monitor front panel, after performing the cryogen monitor calibration. See Illustration 1–18.

Note

A Helium Resistance Box Service Tool (46–265286G1) should be obtained for fast/accurate calibration, checking of sensor length calibration linearity and check out of warning and alarm set points.

7. Perform the calibration procedure covered in the vendor service manual supplied with the unit. Perform sensor length calibration and warning/alarm setting.

1–6 CRYOGEN MONITOR INSTALLATION (continued)


CRYOGEN LEVEL CALIBRATION

CALIBRATED BY	DATE	DATE NEXT CAL. DUE

CRYOGEN LEVEL CALIBRATION LABEL
ILLUSTRATION 1–18

8. Use the following values for the warning and alarm set points.

<u>FUNCTION</u>	<u>LHE%</u>
WARNING	50
ALARM	50

9. Set sample interval to 24 hours using thumb wheels on front of Cryogen Monitor.
10. Record the initial Liquid Helium level.

SECTION 2 – LIQUID HELIUM FILL

The following table should be used for determining minimum cryogen levels. The shaded regions indicate the preferred target levels.

MAGNET TYPE	3 Dewars (250 Liter)	2 Dewars (250 Liter)	1 Dewar (250 Liter)	Emergency	Minimum Ramping Level	Minimum Shimming Level
SV	50 – 55% (Unramped Only)	70 – 75%	76 – 90%	50%	85%	65%

The "Target Levels" are established for magnets with normal or "in–spec" boil–off. Magnets with "out–of–spec" boil–off may require emergency fills at Helium levels higher than defined in the table above. Contact your MAC Team Leader or the Magnet Support Team at the Online Center for assistance in determining whether an emergency transfill is required.

DESCRIPTION

Helium fills should be preformed as "TOP FILLS" using the indicated equipment unless it is the initial Dewar fill into a empty magnet. Top filling the magnets with helium will result in lower cryostat pressures and higher transfer efficiencies.

<u>TOP FILL</u>: Top Fill is the preferred fill method and should be used if any liquid helium exists in the magnet.

<u>BOTTOM FILL</u>: A Bottom Fill is performed only when there is no liquid helium in the magnet such as after a quench.

2–1 EQUIPMENT

<u>TOP FILL EQUIPMENT</u>

Liquid Helium Transfer Line 46–294512P1 12 feet (3658mm) or 46–294512P2 8 feet (2438mm)
14.75 inch (375mm) Liquid Helium Cryostat Stinger Assembly 46–294512P4
250 liter/500 liter Dewar Stinger Assembly 46–294511P1 / P2

<u>BOTTOM FILL EQUIPMENT</u>

Liquid Helium Transfer Line 46–294512P1 12 feet (3658mm) or 46–294512P2 8 feet (2438mm)
Liquid Helium Cryostat Stinger Assembly with 7.00 inch (178mm) long stinger 46–294512P3
16.00 inch (406mm) Cryostat Stinger Extension 46–294512P12
250 liter/500 liter Dewar Stinger Assembly 46–294511P1 / P2

Note

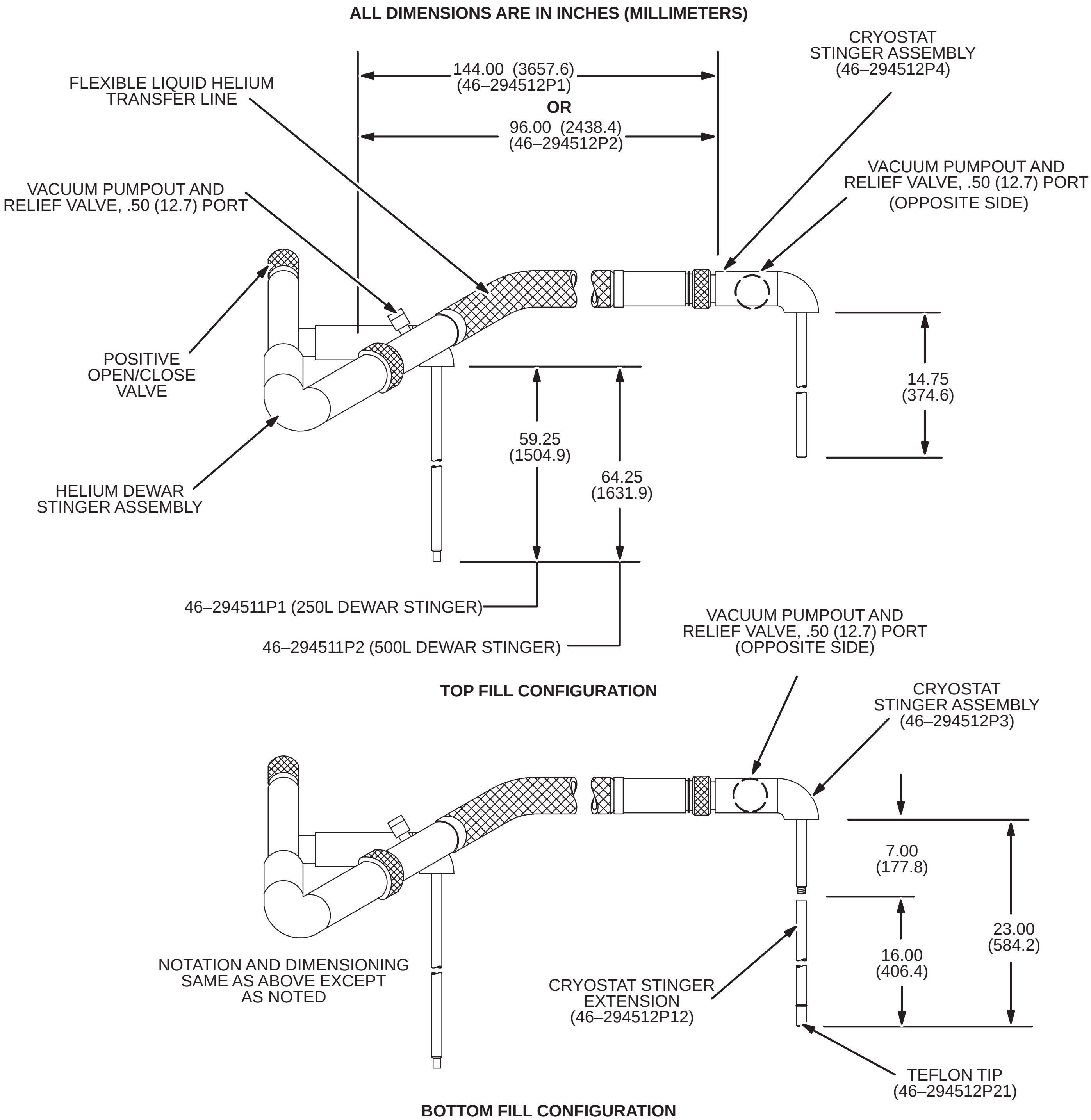
A Teflon Tip is installed on each cryostat stinger and stinger extension to protect the threads. Cryostat Stinger Teflon Caps must be removed from threads prior to fill.

<u>OTHER EQUIPMENT NEEDED</u>

Regulator Kit 46–306734G1 Hose Assembly 46–271135P16
Safety Face Shield Kit 46–271137G1 Nonmagnetic Tools Heat Gun (TC402274)
Compression Fitting (with retaining ring and o–ring) 46–318619P1, 46–260272P1, 46–260342P9

1. Select proper cryostat and Dewar stinger lengths to be used during the fill. Refer to Illustration 4–1 for appropriate stinger configuration.

2–1 EQUIPMENT (continued)



VACUUM JACKETED HELIUM TRANSFER LINE AND DEWAR/CRYOSTAT STINGER ASSEMBLIES
ILLUSTRATION 4–1

2–1 EQUIPMENT (continued)

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

NEVER BRING HELIUM DEWARS, OR GAS CYLINDERS THAT ARE MADE FROM FERROMAGNETIC MATERIAL INTO THE MAGNET ROOM. FERROMAGNETIC OBJECTS WILL BECOME DANGEROUS PROJECTILES IN A STRONG MAGNETIC FIELD. MAKE SURE ALL EQUIPMENT AND TOOLS USED IN THE MAGNET ROOM ARE NON–FERROMAGNETIC.

SKIN CONTACT WITH LIQUID CRYOGENS WILL CAUSE BURNS. WEAR PROTECTIVE CLOTHING, GLOVES (NONABSORBENT MATERIAL) AND GOGGLES OR FACE SHIELD WHEN TRANSFERRING CRYOGENS.

SMOKING IS PROHIBITED IN THE MAGNET AND CRYOGEN STORAGE ROOMS. LIQUID CRYOGENS CAN LIQUIFY ATMOSPHERIC OXYGEN THUS PRODUCING A HIGHLY ENRICHED OXYGEN LIQUID.

CAUTION

If Bottom Filling, make sure that Teflon Tip is fully threaded onto the Cryostat Stinger Extension (16 inch) to prevent it from loosening and falling into magnet during liquid helium fill.

Procedure:

2–2 PREPARATION

CAUTION

Make sure that Cryogen Level Meter has been calibrated in conformance with Signa Planned Maintenance Manual, *Direction 15343.* The calibration should be done yearly, and is recorded in the Planned Maintenance Report in the Site Log. A calibrated Cryogen Level Meter is required to accurately determine helium fill level and efficiency.

2–2 PREPARATION (continued)

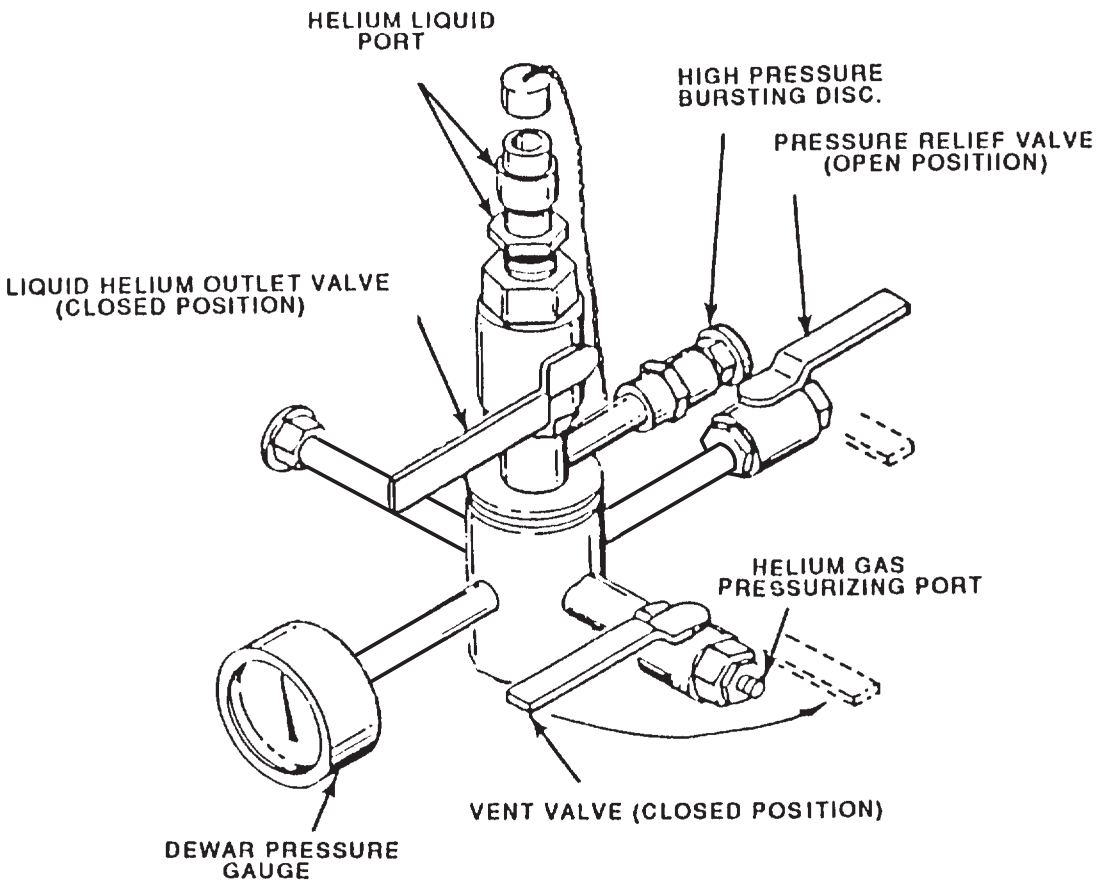
Note

Refer to "Volumetric Conversion Of Liquid Helium Level", in the DATA SHEET tab, to determine approximate quantity of liquid helium required to fill the cryostat. An empty and partially warmed cryostat will require an additional quantity of liquid helium to cool the cryostat down to the 4.3K temperature where liquid helium will begin to collect in the cryostat.

1. If there is helium in magnet, go to Step 2. If magnet does not have helium, refer to SET UP AND CALIBRATION, Section 1–4–7, for instruction on checking the shield temperatures. If temperature is greater than 100K, refer to SET UP AND CALIBRATION, Section 7–2, for Cryostat Cooling/Filling Requirements.

2. Check cryogen meter calibration and record liquid helium level in the Cryostat Performance Log. Make sure cryogen meter sample rate is set to 11. Refer to vendor manual for cryogen meter calibration.

3. Obtain full liquid helium Dewar. Check Dewar pressure gauge. If pressure is above 1 psig, slowly open Dewar Vent Valve and reduce Dewar pressure to 1 psig. See Illustration 4–2.



DEWAR CONNECTIONS
ILLUSTRATION 4–2

2–2 PREPARATION (continued)

WARNING!

IF DEWAR PRESSURE DOES NOT VENT DOWN TO 1 PSIG, VERIFY THAT DEWAR PRESSURE RELIEF VALVE IS LEFT IN THE OPEN POSITION. CONTACT CRYOGEN SUPPLIER IMMEDIATELY.

Note

The Pressure Relief Valve is normally open during shipping and storage to prevent excessive build up of pressure in the Dewar. Therefore, always reopen Pressure Relief Valve after using Dewar.

Note

If 99.999% Helium Gas is used (five nines certified gas), the purity of the gas remaining in the cylinder will degrade as a result of this process (i.e., the purity of the remaining gas will be something less than 99.999%).

4. Obtain 1 full GHe aluminum cylinder (135 SCF) for every 2 liquid helium dewars (250 liter) required.

WARNING!

SECURE CYLINDER, ON GAS BOTTLE CART, BEFORE REMOVING PROTECTIVE VALVE CAP TO PREVENT CYLINDER FROM FALLING, WHICH COULD RESULT IN SHEARING VALVE OUTLET AND CAUSING HAZARDOUS HIGH PRESSURE GAS RELEASE.

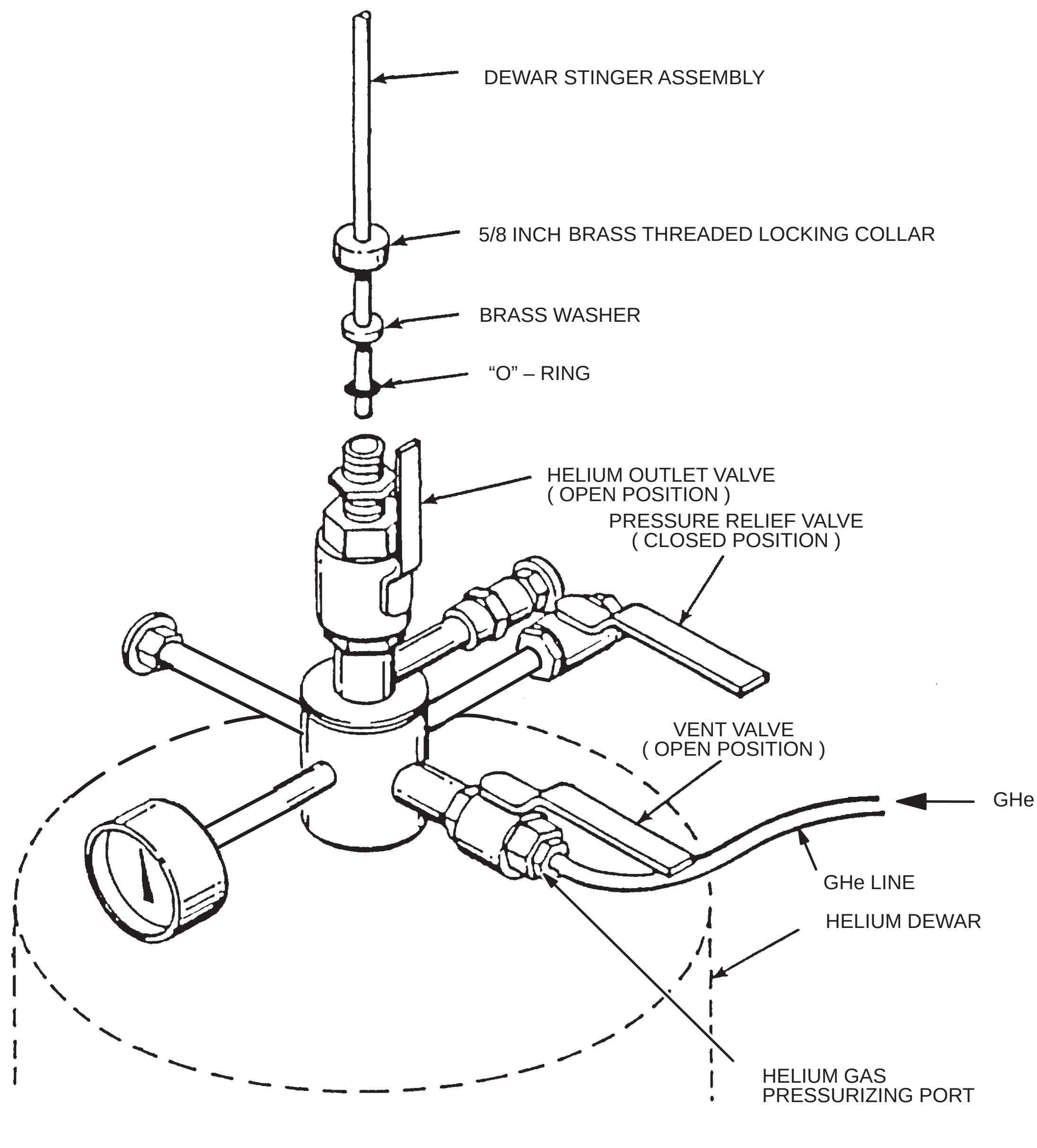
5. Connect standard GHe Cylinder Regulator And Hose Assembly to Valve Outlet (CGA 580) on GHe cylinder.
6. Make sure that Regulator Adjusting Handle is fully backed out, then slowly open GHe Cylinder Valve.
7. Observe Regulator High Pressure Gauge. Make sure indicated pressure is approximately 2000 psig indicating full cylinder.
8. Record Cryostat Pressure Gauge reading in DATA SHEET tab, Magnet Commissioning Log.
9. Vent magnet by temporarily opening Helium Vent Valve, V2, as required to obtain 0.3 – 0.5 psig pressure. Record final pressure in Cryostat Performance Log.

2–3 LIQUID HELIUM FILL

1. Verify Dewar LIQUID HELIUM OUTLET Valve is in the closed position. See Illustration 4–2.
2. Loosen 5/8 inch Locking Collar.

2–3 LIQUID HELIUM FILL (continued)

3. Remove 1/2 inch Cap and Adapters exposing 5/8 inch Brass Locking Collar.
4. Verify that Pressure Relief Valve is in the open position. See Illustration 4–3.
5. Make sure Dewar Stinger Assembly Valve is closed. Insert Dewar Stinger Assembly thru 5/8 inch locking collar until Stinger Tip contacts Helium Outlet Valve. See Illustration 4–3.
6. Open Helium Outlet Valve.



HELIUM DEWAR TRANSFER LINE EXTENSION CONNECTION
ILLUSTRATION 4–3

2–3 LIQUID HELIUM FILL (continued)

7. Slowly insert Dewar Stinger Assembly into Dewar until Stinger Tip contacts liquid helium (indicated by pressure increase on Dewar Pressure Gauge and expulsion of gas from Pressure Relief Valve Port).
8. Continue to insert Dewar Stinger Assembly at a rate that maintains a maximum 5 psig reading on the Dewar Pressure Gauge.
9. When Dewar Stinger Assembly contacts bottom of Dewar, raise Stinger Assembly 1 inch and securely tighten 5/8" Threaded Locking Collar.

Note

If ceiling height prohibits insertion of Dewar Stinger Assembly into dewar, dewar must be moved to an area with higher ceiling height and transported back into exam room.

CAUTION

If Bottom Filling and ceiling height prevents insertion of Cryostat Stinger in Step 20, install Brass Blanking Cap on Cryostat Stinger Assembly. Remove Extension from Cryostat Stinger and place a brass alligator clip near the top end of the Cryostat Stinger. Partially insert Extension into Fill Port V1, then reattach Extension.

10. When dewar pressure stabilizes at or below 5 psig, close PRESSURE RELIEF VALVE.
11. Attach selected Cryostat Stinger Assembly onto Helium Transfer Line.
12. Install Threaded Locking Collar, Retainer Ring, and O–Ring on Cryostat Stinger.
13. Attach opposite end of Helium Transfer Line onto Dewar Stinger Assembly.

WARNING!

FIRMLY HOLD UNATTACHED END OF HOSE WHILE PURGING REGULATOR AND GAS LINE ASSEMBLY TO PREVENT WHIPPING MOTION.

14. Purge GHe Regulator and Gas Line Assembly by alternately turning Regulator Handle fully in and out 3 times. Upon completion of purge, back Regulator out until minimal flow is felt exiting the Gas Line Assembly.

Note

Steps 14 and 15 will provide a helium rich environment for connecting the GHe line to the Helium Gas Pressurizing Port.

15. Open Helium Dewar VENT VALVE to allow a small amount of gas flow.
16. Attach purged Gas Line Assembly to Liquid Helium Dewar Helium Gas Pressurizing Port. See Illustration 4–3.

2–3 LIQUID HELIUM FILL (continued)

17. Back out the Regulator Handle all the way.
18. Open Helium Vent Valve (V2) on magnet. Vent Magnet Cryostat Pressure below 0.5 psig.

CAUTION

To avoid damaging the helium line and causing a magnet quench, make sure cryostat stinger pumpout port does not come into contact with the shim lead connector housing during the helium fill.

19. Partially open Dewar Stinger Assembly Valve allowing liquid helium to purge and precool Transfer Line Assembly until a liquid plume is observed exiting the assembly allowing the dewar pressure to go down less than 3psig before continuing.
20. With plume present, uncap Fill Port (V1), and fully insert Cryostat Stinger Assembly then securely tighten Fill Port Compression Fitting at V1.
21. Fully open Dewar Stinger Assembly Valve.

Note
If gas is observed escaping from Compression Fitting on Fill Port V1 or on Helium Dewar, use a heat gun to warm Compression Fitting and recheck compression fitting tightness.

22. Open Vent Valve at Helium Gas Pressurizing Port on dewar.

Note
Maximum Transfer Efficiency occurs when the dewar pressure is near 2 psi.

23. Verify GHe Cylinder Valve is fully open and adjust GHe Cylinder Regulator to obtain a dewar pressure which is 1.5 psig above the cryostat pressure during the entire fill. Do not set Dewar Pressure above 3.5psig.

CAUTION

Normal Cryostat pressure, during Helium fill, is approximately 1 psi. Cryostat Pressure will rise to just above 1 psi, at the beginning of the fill, and then slowly drop back to around 1 psi. Make sure that 1.5 psig cryostat pressure is not exceeded during fill. If pressures exceeding 2 psig exist on cryostat pressure gauge, stop fill immediately and check fill equipment for loss of vacuum, high dewar pressure etc..

If frost is detected on the transfer line, stop fill immediately (as if dewar is empty) to avoid a magnet quench.

Note
Helium Vent Port V2 should be frosting up indicating there is no restriction in venting circuit.

24. Check He Cryogen Meter for increase in the He level and then monitor cryogen level readings, during fill process, once every minute for the first five minutes of the fill. Monitor the He Cryogen Meter every three minutes after the initial five minute interval.

2–3 LIQUID HELIUM FILL (continued)

CAUTION

If the Cryogen Meter is not increasing, check magnet and fill equipment for frosting or blockage. If it is decreasing, stop fill immediately, remove stinger from magnet, and contact service.

Note
Multiple dewars may be required to achieve 100% fill of magnet cryostat.

WARNING!

DO NOT ALLOW AN EMPTY DEWAR TO BLOW WARM HELIUM GAS INTO RAMPED MAGNET AS A QUENCH COULD OCCUR.

25. Monitor dewar transfer, for one or more of the following, to prevent blowing helium gas into the helium vessel.
    a. Listen for a whistling sound coming from the transfer line indicating the dewar is empty. Depending on equipment and conditions, the whistle may not always be heard.
    b. Monitor the dewar pressure gauge and watch for a decrease in pressure (a decrease in cryostat pressure could also be caused by an empty gas cylinder).
    c. Monitor the percent change on the LHe meter. Stop the transfill when there is no positive (increasing) change in the meter reading.
    d. Make sure the dewar stinger remains frost free during the transfill. Frost on the stinger is one indicator for passing helium vapor. Stop transfill if frost is present.
26. Record information for each dewar in Table 3–1 of data sheets or on Magnet Fill Record.
27. When cryostat is full (100%), or when changing helium dewars, close valve on dewar stinger assembly, close GHe Cylinder Valve, close Dewar Vent Valve, and open Dewar Pressure Relief Valve.
28. Remove the Cryostat Stinger from the Fill Port (V1) and immediately replace the Fill Port Cap.
29. If additional dewars are required, change helium dewars in conformance with Section 4–4, “Changing Helium Dewars”, before continuing with this procedure.
30. Monitor cryostat pressure. When cryostat pressure drops below 1.0 psig, close Helium Vent Valve V2 on magnet.

Note
A heat gun may be required to remove frost from the V1 Fill Port assembly before removing Stinger.

31. Tighten Compression Fitting at V1 to prevent a leak from occurring.

2–3 LIQUID HELIUM FILL (continued)

32. Disconnect Helium Transfer Line Assembly from Helium Dewar Stinger Assembly.
33. Make sure Helium Dewar is under 1 PSI, then remove Helium Dewar Stinger Assembly from helium dewar.
34. Close GHe Cylinder Valve.
35. Disconnect Helium Gas Line from dewar Helium Gas Pressurizing Port.
36. Back off Pressure Regulator Adjusting Handle (CCW) on helium gas cylinder until no resistance is felt.
37. Verify following dewar configuration.
    a. Liquid Helium Outlet Valve closed
    b. Helium Vent Valve closed
    c. Pressure Relief Valve open
    d. Replace all adapters on Liquid Helium Valve Outlet
38. Remove GHe Cylinder Regulator from helium gas cylinder and install protective valve cap on cylinder.
39. Check and record cryogen level meter and cryostat pressure readings. Make sure cryostat pressure is at 1.5 psig or less before leaving site.

2–4 CHANGING HELIUM DEWARS

CAUTION

Always remove the Cryostat Stinger from the Fill Port and start Fill Procedure over again when changing helium dewars with the magnet at field. This is done to avoid the possibility of introducing helium gas into the magnet, from the helium transfer line, thereby causing a magnet quench.

1. Close Helium Vent Valve (V2) on magnet.

Note

If 99.999% Helium Gas is used, the purity of the gas remaining in the cylinder will degrade as a result of this process (i.e., the purity of the remaining gas will be something less than 99.999%).

2. Obtain full liquid helium dewar. Check dewar pressure gauge. If pressure is above 1 psig, slowly open Dewar Vent Valve and reduce dewar pressure to 1 psig. See Illustration 4–3.

WARNING!

IF DEWAR PRESSURE DOES NOT VENT DOWN TO 1 PSIG, VERIFY THAT DEWAR PRESSURE RELIEF VALVE IS LEFT IN THE OPEN POSITION. CONTACT CRYOGEN SUPPLIER IMMEDIATELY.

Note

The Pressure Relief Valve is normally open during shipping and storage to prevent excessive build up of pressure in the dewar. Therefore, always leave Pressure Relief Valve open after using dewar.

3. Observe GHe Cylinder regulator High Pressure Gauge. Make sure indicated pressure is at least 1000 psig indicating sufficient gas volume for transferring full 250 liter helium dewar.

WARNING!

SECURE CYLINDER BEFORE REMOVING PROTECTIVE VALVE CAP TO PREVENT CYLINDER FROM FALLING, WHICH COULD RESULT IN SHEARING VALVE OUTLET AND CAUSING HAZARDOUS HIGH PRESSURE GAS RELEASE.

4. If new GHe Aluminum Cylinder is required in Step 3, connect standard GHe regulator and hose assembly to valve outlet (CGA 580) on GHe cylinder.

2–4 CHANGING HELIUM DEWARS (continued)

5. Make sure that regulator adjusting handle is fully backed out, then slowly open GHe cylinder valve.
6. Refer to equipment in Helium Fill Section for appropriate equipment.
7. Observe cryostat pressure gauge and vent, temporarily opening Helium Vent Valve as required to obtain 0.5 psig pressure or below.
8. Verify Helium Outlet Valve is closed on full dewar.
9. Loosen 5/8 inch Locking Collar on full dewar.
10. Remove 1/2 inch cap and adapters exposing 5/8 inch Brass Locking Collar.
11. Verify that Pressure Relief Valve is in the open position.
12. Verify Dewar Stinger Assembly Valve is in the closed position. Disconnect Helium Transfer Line from Dewar Stinger Assembly.
13. Remove Dewar Stinger Assembly from empty dewar.
14. Wipe off frost or moisture on Dewar Stinger and insert Dewar Stinger Assembly thru 5/8 inch Locking Collar until stinger tip contacts Helium Outlet Valve in full dewar. See Illustration 4–3.
15. Insert Dewar Stinger Assembly through 5/8 inch locking collar until stinger tip contacts Helium Outlet Valve.
16. Open Helium Outlet Valve.
17. Slowly insert Dewar Stinger Assembly into dewar until Stinger Tip contacts liquid helium (indicated by pressure increase on dewar pressure gauge and expulsion of gas from pressure relief valve port).
18. Continue to insert Dewar Stinger Assembly at a rate that maintains a maximum 5 psig reading on the Dewar Pressure Gauge.
19. When Dewar Stinger Assembly contacts bottom of dewar, raise Stinger Assembly 1 inch and securely tighten 5/8 inch Threaded Locking Collar.

Note

If ceiling height prohibits insertion of Dewar Stinger Assembly into dewar, dewar must be moved to an area with higher ceiling height and transported back into exam room.

20. When dewar pressure stabilizes at 5 psig, close Pressure Relief Valve.
21. Attach Helium Transfer Line onto Dewar Stinger Assembly.

2–4 CHANGING HELIUM DEWARS (continued)

WARNING!

FIRMLY HOLD UNATTACHED END OF HOSE WHILE PURGING REGULATOR AND GAS LINE ASSEMBLY TO PREVENT WHIPPING MOTION.

22. Disconnect Helium Gas Line from empty dewar. Purge GHe Cylinder Regulator and Gas Line Assembly by alternately turning Regulator Handle fully in and out 3 times. Upon completion of purge, back Regulator out until minimal flow is felt exiting the Gas Line Assembly.

23. Slightly open He Gas Vent Valve to allow for He gas flow from dewar.

24. Attach purged gas line assembly to dewar Helium Gas Pressurizing Port. Fully back out Regulator Adjusting Handle.

25. Attach the Cryostat Stinger to the Transfer Line.

26. Prepare empty dewar as follows:

    a. Liquid Helium Outlet Valve closed

    b. Helium Vent Valve closed

    c. Pressure Relief Valve open

    d. Replace all adapters on Liquid Helium Valve Outlet

27. Proceed with “LIQUID HELIUM FILL, Section 4–3, Step 18.

SECTION 7 – MAGNET COMMISSIONING CHECKS

Refer to FUNCTIONAL CHECKS, Section 1, for Commissioning Guidelines.

7–1 MAGNET ELECTRICAL CHECK

Perform electrical checks called out in Functional Checks, Section 2.

7–2 CRYOSTAT TEMPERATURE CHECK & COOLING/FILLING REQUIREMENTS

Description:

This Section describes the procedures and equipment used to establish the temperature inside the Helium Vessel of the Cryostat. It is essential to establish this temperature in order to determine the cool down and Liquid Helium Filling requirements of the Cryostat prior to the magnet commissioning.

The GE Magnet is equipped with two sensors requiring a 10 microampere current source with a stability of +0.005%. Sensor (Diode) 1 is mounted on the top, Table End of the Magnet Assembly. Sensor (Diode) 2 is mounted on the bottom, Back End of the Magnet Assembly. The Magnet Assembly is inside of the Helium Vessel. (These sensor diodes are identical to those found on the Cold Head Sleeve.).

CAUTION

Magnet temperature sensors are designed to be driven by a 10 microampere source; some ohmmeters exceed this rating. Do not use any sensing or troubleshooting equipment which exceeds 10 microamperes. A Voltmeter can also be used to troubleshoot the sensor circuit.

Procedure:

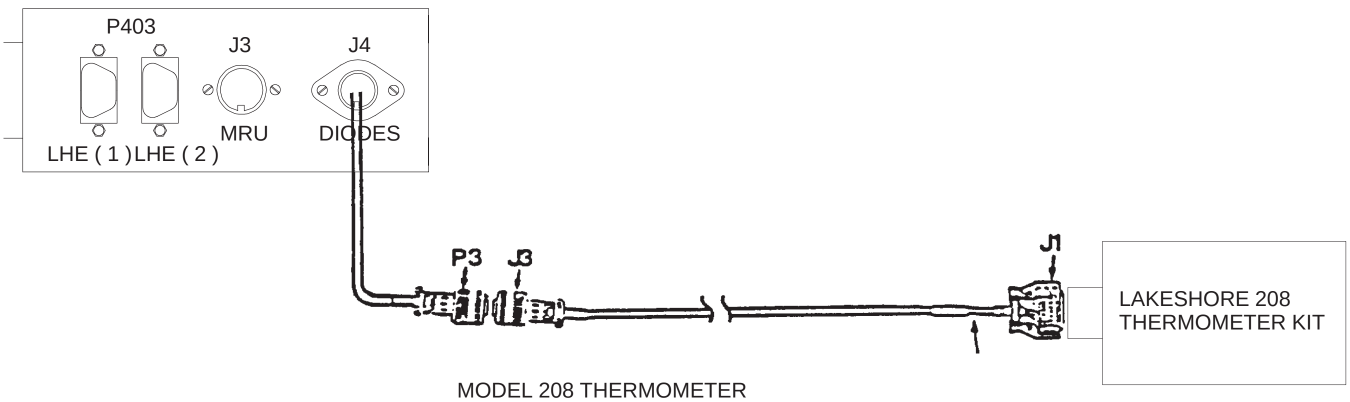
7–2–1 Use of Lakeshore Cryotronics Model 208 – Digital Cryogenic Thermometer Kit (46–301477G2)

1. Use the equipment referenced above to establish the Cryostat temperature.
2. Connect the Lakeshore Cryotronics Digital Thermometer to the Diode Connector on the Magnet Connector Assembly (MS1–A3, A1) in conformance with Illustration 2–1. Select Curve 6 (equivalent of DT 470 Curve 10).
3. Select the Diode to be monitored as shown in Table 2–1.

7–2–1 Use of Lakeshore Cryotronics Model 208 – Digital Cryogenic Thermometer Kit (continued)

TABLE 2–1
HELIUM VESSEL TEMPERATURE MONITOR DIODES

STAGE	208 THERMOMETER KIT
DIODE 1 DIODE 2	SELECT CHANNEL #1 SELECT CHANNEL #2



CRYOSTAT TEMPERATURE MEASUREMENT SET–UP
ILLUSTRATION 2–1

Note

A SHORTED sensor circuit will cause the meter to display a reading of approximately 400K, whereas an OPEN sensor circuit will cause the meter display to flash. Check for problems with the instrumentation box connector and external wiring before ruling the temperature sensing diode as being defective.

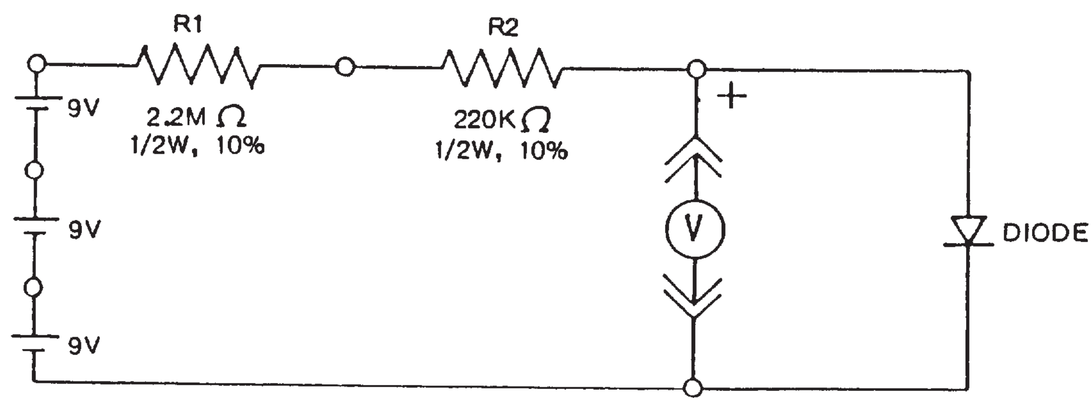
7–2–2 Diode Temperature Sensing Circuit

Description:

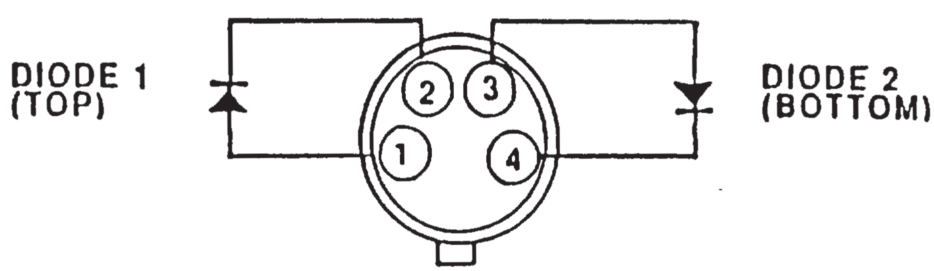
If the Lakeshore Cryotronics 208 Thermometer Kit is not available, the following temperature sensing circuit can be fabricated from commonly available components for temperature measurements.

Procedure:

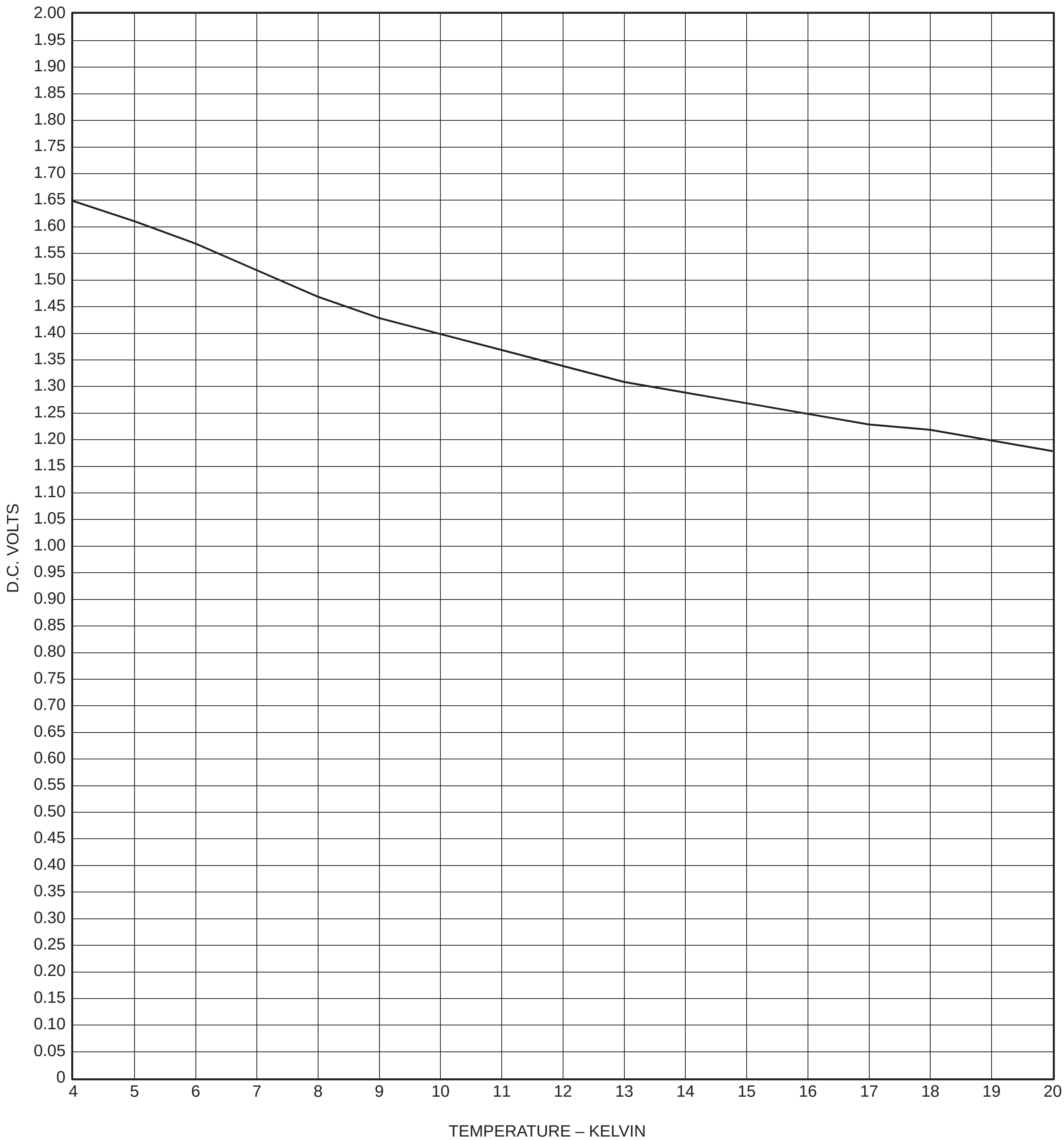
1. Assemble three 9 VDC Batteries and a series resistance of 2.4 to 2.7 Megohms, as shown in Illustration 2–2. Adjust resistance as required to obtain 10 ± 1 μ A current.
2. Connect a Digital Voltmeter (DVM) across the diode with the polarity shown in Illustration 2–2. See Illustration 2–3 for the pin polarities at the J4 Connector.
3. Record the voltage reading on the DVM and determine the temperature readings from Chart 2–1.



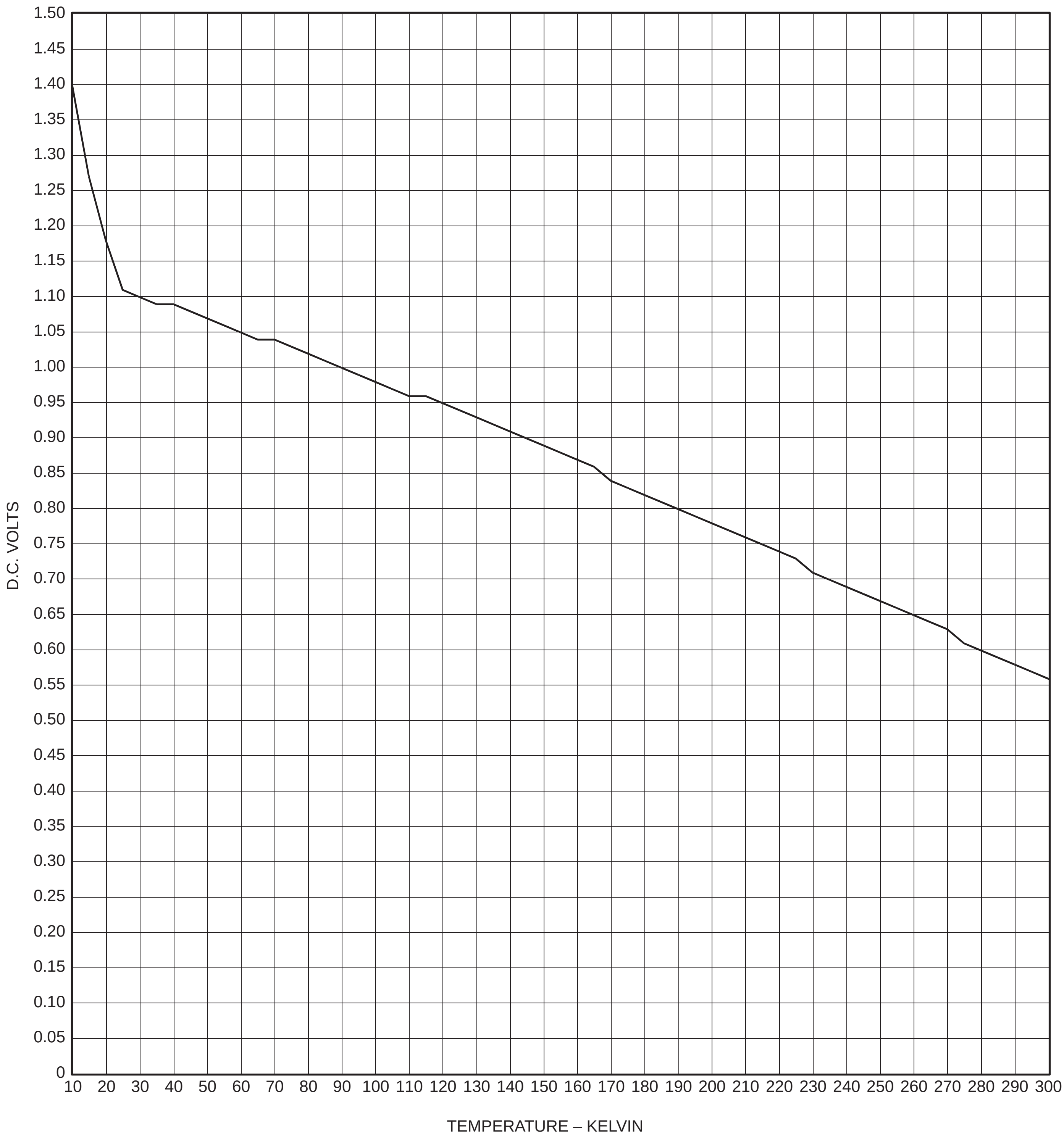
TEMPERATURE SENSING CIRCUIT
ILLUSTRATION 2–2



DIODE POLARITIES
ILLUSTRATION 2–3



GRAPH 2–1
SI410 DIODE VOLTAGE TO TEMPERATURE CONVERSION



GRAPH 2–2
SI410 DIODE VOLTAGE TO TEMPERATURE CONVERSION

7–2–3 Cryostat Cooling/Cryogen Filling Requirements

1. Record temperature sensing diode readouts on the Magnet Commissioning Log in the DATA SHEET Tab.

CAUTION

Magnet temperature checks are performed during installation to determine the Cryostat cooling/cryogen filling requirements prior to ramping. It is essential that the magnet is greater than 85% full of Helium before ramping.

2. Use chart below to establish the required Cryostat cooling/cryogen filling requirements, based upon temperature readout and Cryogen Monitor reading (installed in SET UP AND CALIBRATION, Section 1–6).

DIODE TEMPERATURE	CRYOSTAT COOLING/CRYOGEN FILLING REQUIREMENTS (MANUAL SECTIONS)
> 220K	FUNCTIONAL CHECKS, Sections 3 through 4 and SET UP AND CALIBRATION, Sections NO TAG through 4
> 100K and < 220 K	SET UP AND CALIBRATION, Sections 3–2 through 4
< 100K	SET UP AND CALIBRATION, Section 4 if empty NO ACTION IF > 85% FULL OF LHE

CAUTION

Do not proceed with SET UP AND CALIBRATION, Section NO TAG through 2 or initiate magnet ramping, prior to establishing the Cryostat cooling/cryogen filling requirements in conformance with this Section.

7–3 CRYOSTAT PRESSURE / FLOW CHECK

1. Observe Cryostat Pressure and Exhaust Flow Readings. If readings outside of specified range shown below, perform adjustments in Step 2 through 7.

   INSTRUMENTATION Flowmeter (F2) = 0.8 – 1.2 SCFH
   SHIM LEAD Flowmeter (F1) = 1.8 – 2.2 SCFH
   Cryostat Gauge Pressure = 0.25 – 0.50 PSIG

2. Open Vent Valve (V2) to depressurize the Cryostat to 0.25 psig. Close V2.

Note
Read all flow rates from the bottom of the float (ball) on the flowmeters.

3. Set Instrumentation Lead Vent Valve (V4) for a reading between 0.8 – 1.2 SCFH on Flowmeter (F2).
4. Set Shim Lead Vent Valve (V3) for a reading between 1.8 – 2.2 SCFH on Flowmeter (F1) to maintain a Cryostat Pressure Gauge reading between 0.25 – 0.50 psig.
5. If flow rate through F2 is less than 0.8 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and “bubble test” all exhaust plumbing joints, relief valve and Shim Lead Connector. Make sure V2 is fully closed. Repair any leaks. If a 0.8 SCFH flow rate through F2 cannot be achieved, under the above conditions,contact your Region MAC Team Representative.
6. Make sure the following conditions are maintained. Recheck settings in three days and again after one week:

   INSTRUMENTATION Flowmeter (F2) = 0.8 – 1.2 SCFH
   SHIM LEAD Flowmeter (F1) = 1.8 – 2.2 SCFH
   Cryostat Gauge Pressure = 0.25 – 0.50 PSIG

SECTION 8 – FIELD MONITORING EQUIPMENT SET–UP & OPERATION FOR 45CM DSV

Description:

The Field Mapping Fixture, capable of providing three axis positioning (radial, angular and axial) for the Teslameter Probe, is used to position the probe at specific points within the magnet bore in order to determine the magnetic field inhomogeneity. Use mapping fixture P/N 46–294060G3 to map the 45cm DSV.

This section covers magnet access for mounting field monitoring equipment, mapping fixture assembly and mounting, probe positioning and the set up and use of the Teslameter for the 45cm DSV.

At installation, the Enclosure Frame, Brackets, RF and Gradient Coils and Front Enclosure should be assembled before setting up the field monitoring equipment and ramping the magnet. This permits the use of steel (magnetic) tools.

8–1 MAGNET ACCESS

1. Run Head Coil Carriage and Cradle to Service End of magnet, using IN/OUT Button.
2. Reach into the Table End of the magnet bore and unlatch the Cradle.
3. Pull Cradle back and lock onto Table.
4. Undock Table and move to the side.
5. Pull Front Cover forward.
6. Remove the two Allen Screws where the Slide Fixture attaches to Front Cover.
7. Disconnect Head Coil Carriage Top Assembly (remove the four mounting screws, slide assembly forward and lift) disconnect cables and move assembly out of the bore.
8. Remove Rear Pedestal side trim covers.
9. Unlatch the Rear Cover and move cover to the side.

Note

At installation the Front Bridge Support should be disconnected until the Shimming Procedure is complete, in order to remove the Passive Shim Drawers.

10. Disconnect the Front Bridge Support.

8–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G3)

Note

The Magnet Interface Rings should now be exposed and the Magnet Bore clear for mounting and operating the Field Mapping Fixture.

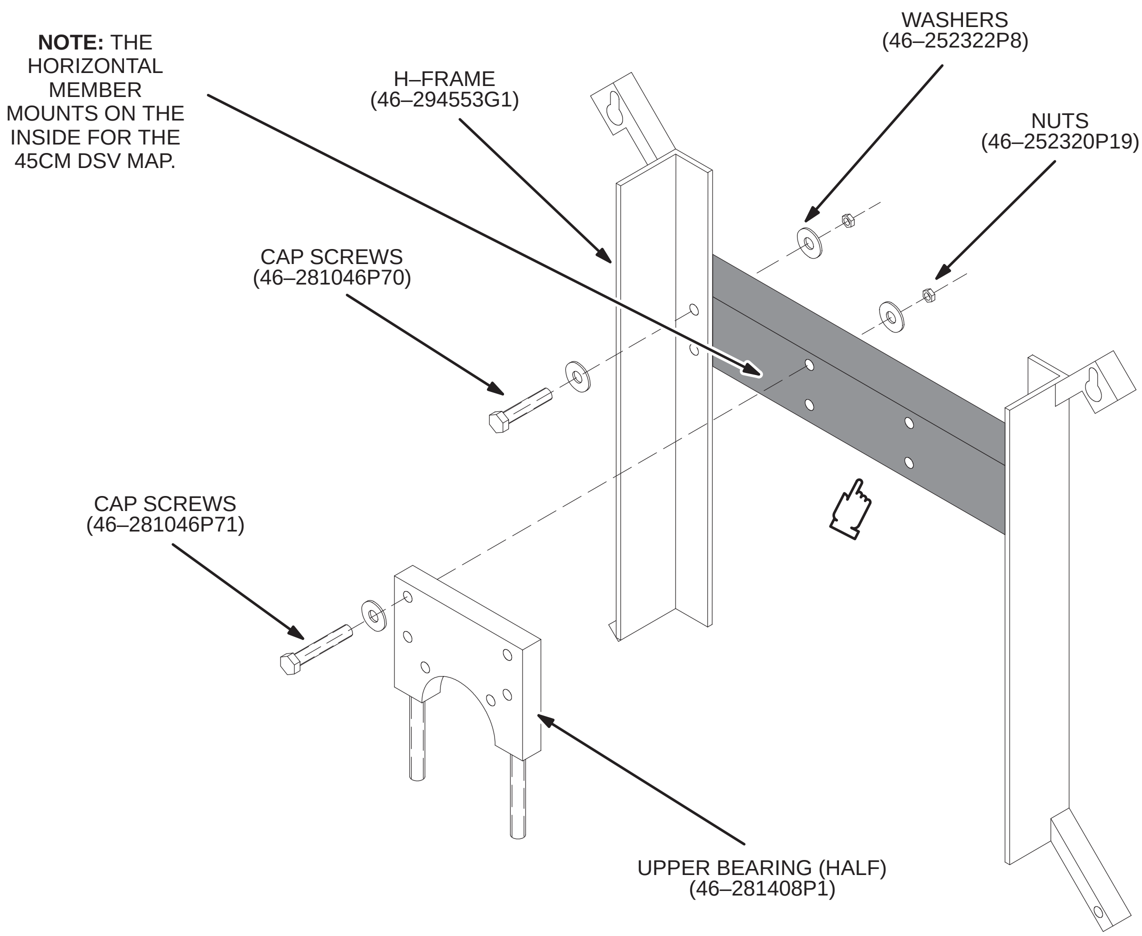
Note

Field mapping is performed from the Table End of the magnet.

CAUTION

Do not use any ferromagnetic material or hardware in the assembly of the mapping fixture as it will affect shimming.

1. Assemble H–Frames using 2.75 inch long 3/8– 16 brass bolts, washers, and nuts. Install the horizontal member of the H–Frame as shown in the illustration below. See Illustration 5–1.

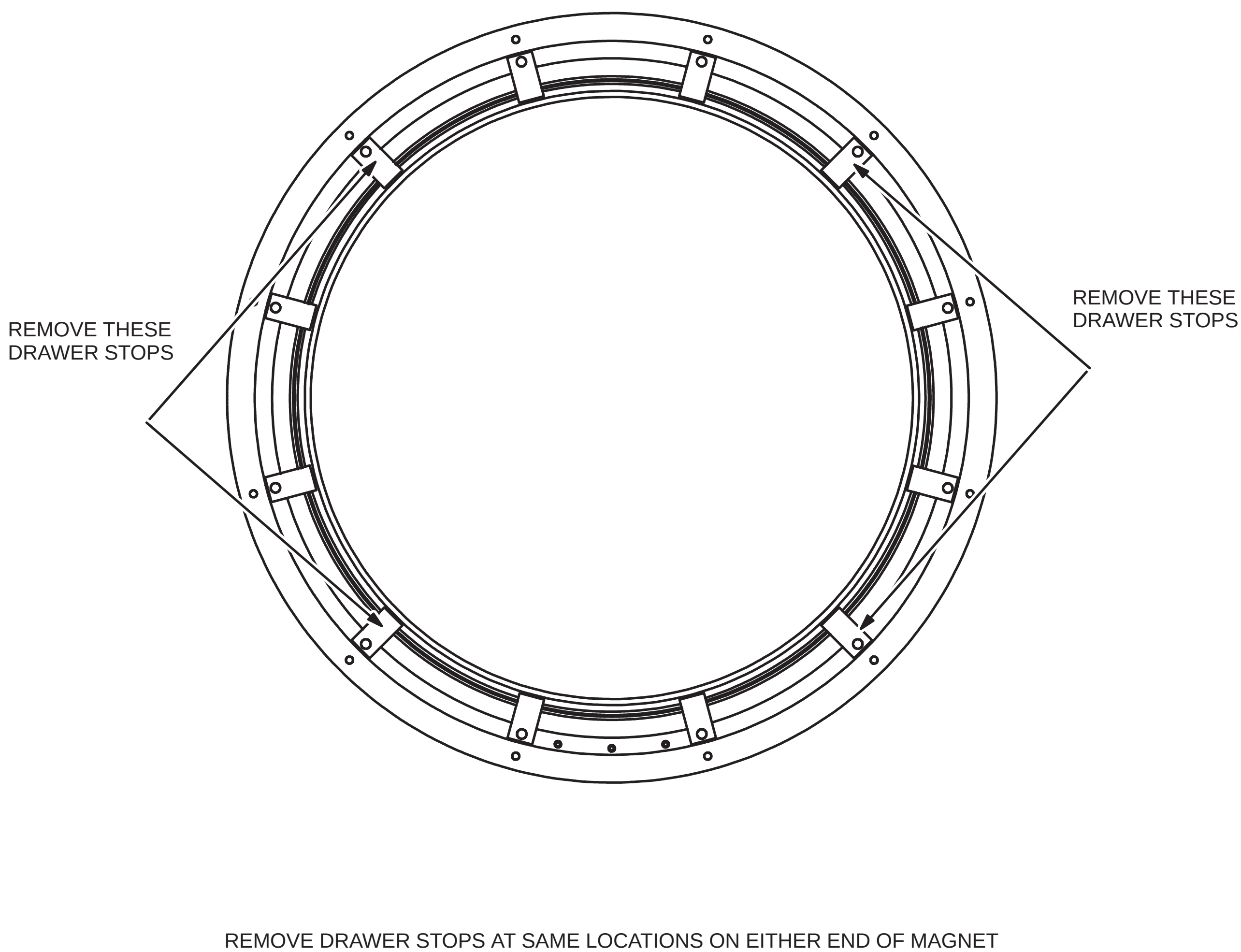


ATTACHMENT OF UPPER BEARING (HALF)/ASSEMBLY OF H–FRAME
ILLUSTRATION 5–1

8–2 SERVICE TOOL MAPPING FIXTURE SETUP (MODEL #46–294060G3) (continued)

2. Attach the upper bearings to the H–Frame cross beams using 3.5 inch long cap screws, washers, and nuts. See Illustration 5–1.

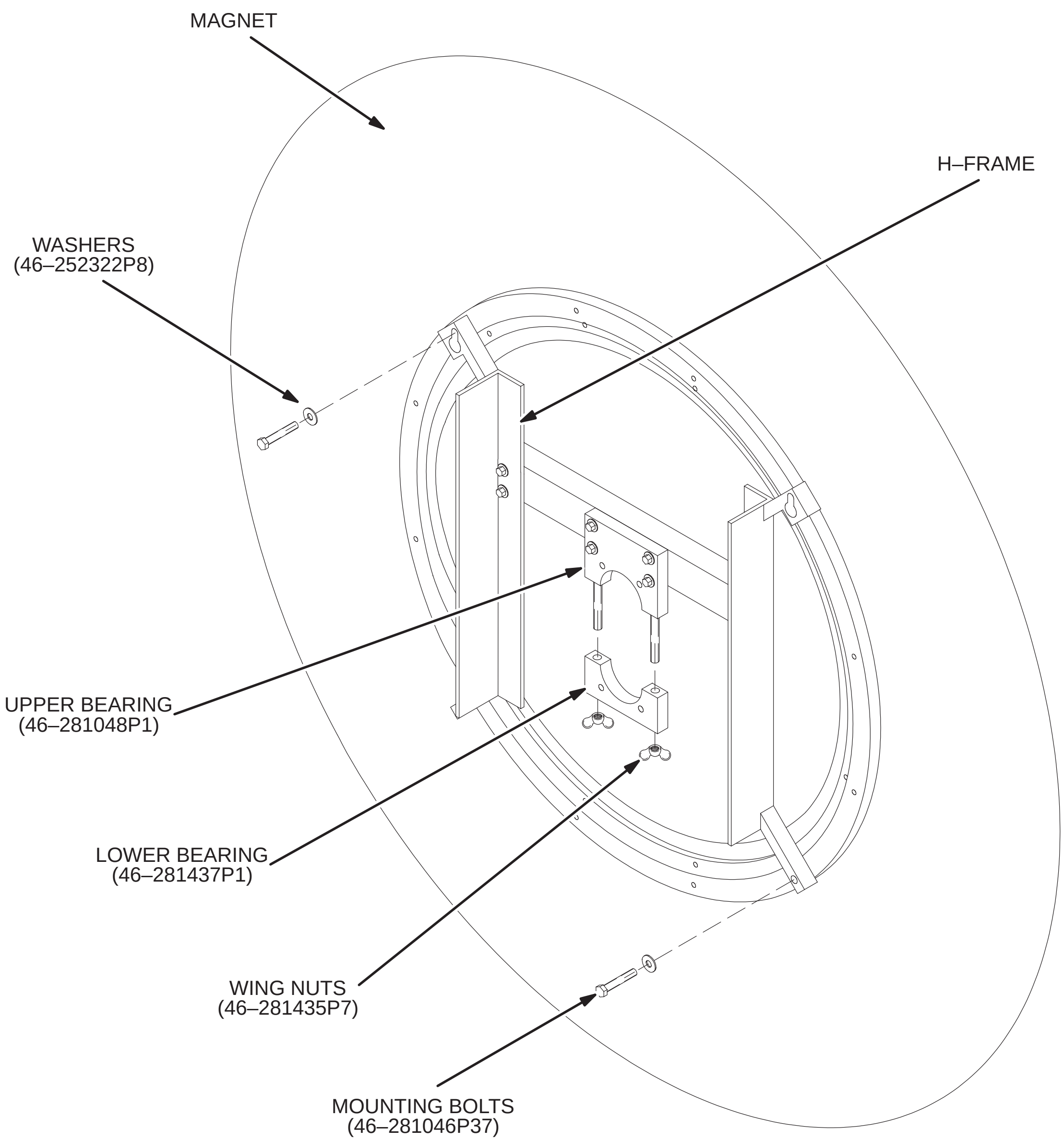
3. Remove four Drawer Stops from both ends of the magnet. See Illustration 5–2.



DRAWER STOP REMOVAL FOR H–FRAMES
ILLUSTRATION 5–2

8–2 SERVICE TOOL MAPPING FIXTURE SETUP (MODEL #46–294060G3) (continued)

4. Attach one of the H–Frames to the Interface Ring on Back End of the magnet with four 1.5 inch long 3/8–16 brass bolts, at the 45 degree positions. See Illustration 5–3. Use of Permatex (1 oz. tube – 2119594) or Bustik (4 oz. can – 46–294151P8) anti–seize lubricant is recommended.

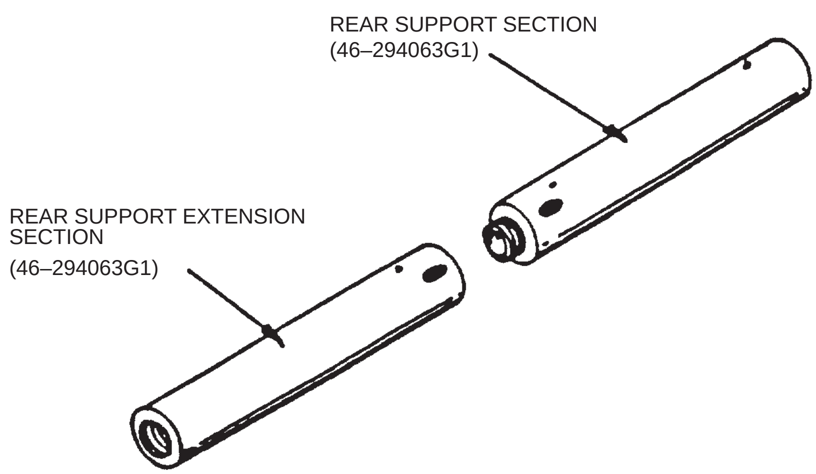


H–FRAME MOUNTING & LOWER HALF BEARING ATTACHMENT
ILLUSTRATION 5–3

8–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G3) (continued)

5. Loosely attach the lower half of the bearing to the upper half of the bearing on both H – Frames. Use the Wing Nuts to support the lower half of the bearing. See Illustration 5–3.

6. Thread the Rear Support Extension Section into the Rear Support section. Twist them together as tightly as possible by hand then use a torquing bar (46–294019P1) through the holes near each joint as leverage to tighten the joint. See Illustration 5–4.



ATTACHMENT OF THE AXIAL TUBE EXTENSION SUPPORT SECTION TO THE REAR SUPPORT SECTION
ILLUSTRATION 5–4

CAUTION

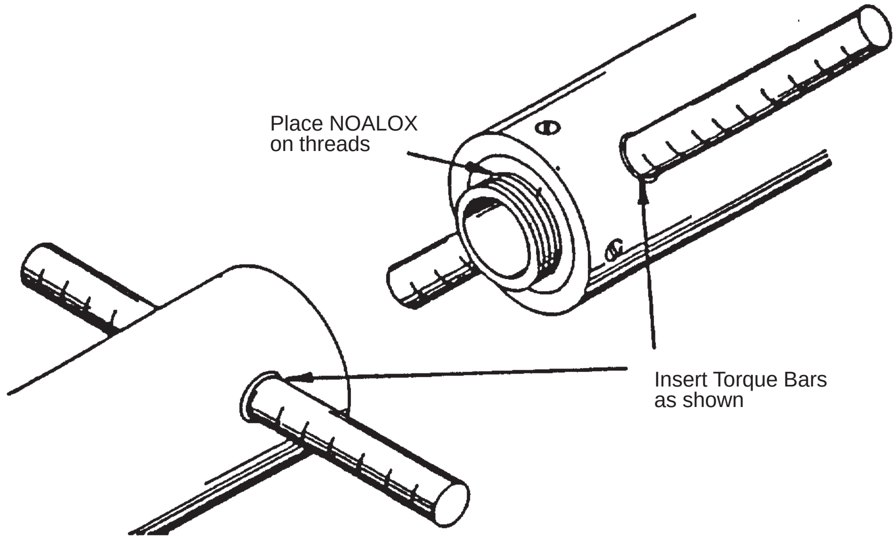
Stainless Steel Torquing Bars may be slightly magnetic. Do not use near the magnet bore.

Note

Threads and the Aluminum edges of the tubes need lubrication to prevent galling during assembly. NOALOX compound lubricant (46–252065P65) is recommended, but any mechanical grease is better than none. For grease placement, see Illustration 5–5.

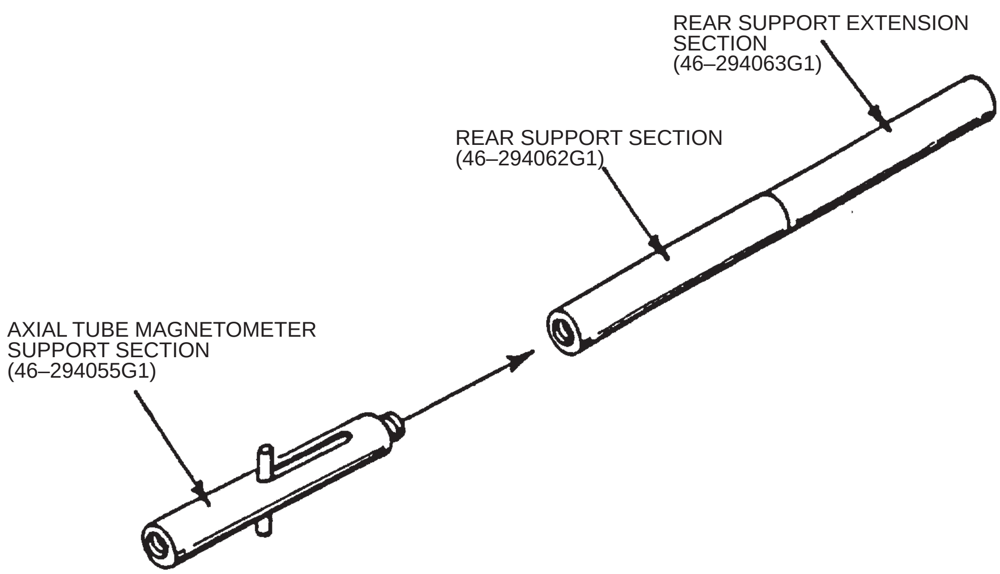
If it is difficult to align the tubes by hand, then use Torquing Bars as follows: All tubes have a pair of 3/4 inch diameter holes near each end. These holes should be used to insert Torquing Bars for leverage when torquing the tubes together. See Illustration 5–5.

8–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G3) (continued)



LUBRICATION POINTS
ILLUSTRATION 5–5

7. Thread the Axial Tube Magnetometer Support Section into the Rear Support Section. Tighten joint in same fashion as Step 6. See Illustration 5–6.

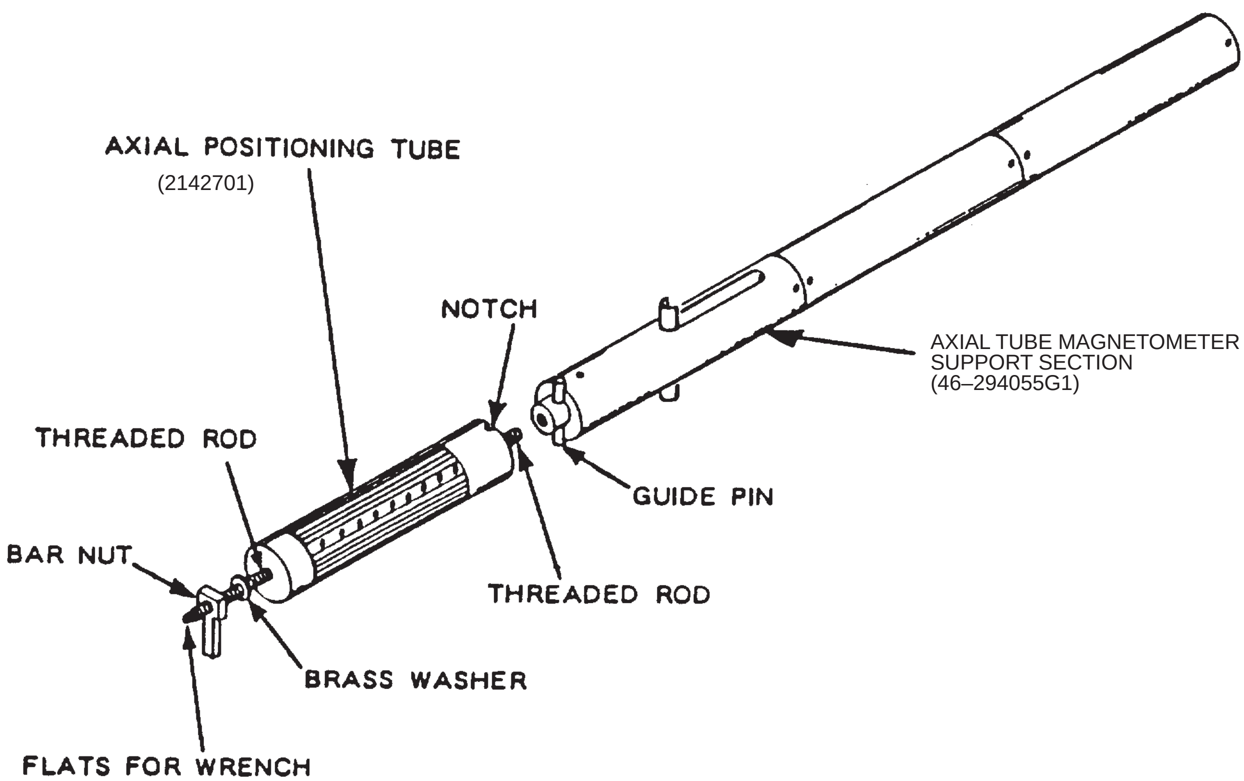


ATTACHMENT OF THE AXIAL TUBE MAGNETOMETER SUPPORT SECTION TO THE REAR SUPPORT SECTION AND THE REAR SUPPORT SECTION EXTENSION
ILLUSTRATION 5–6

8–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G3) (continued)

8. Join the Axial Positioning Tube (46–294054G1), See Illustration 5–7, to the other assembled tubes as described below:

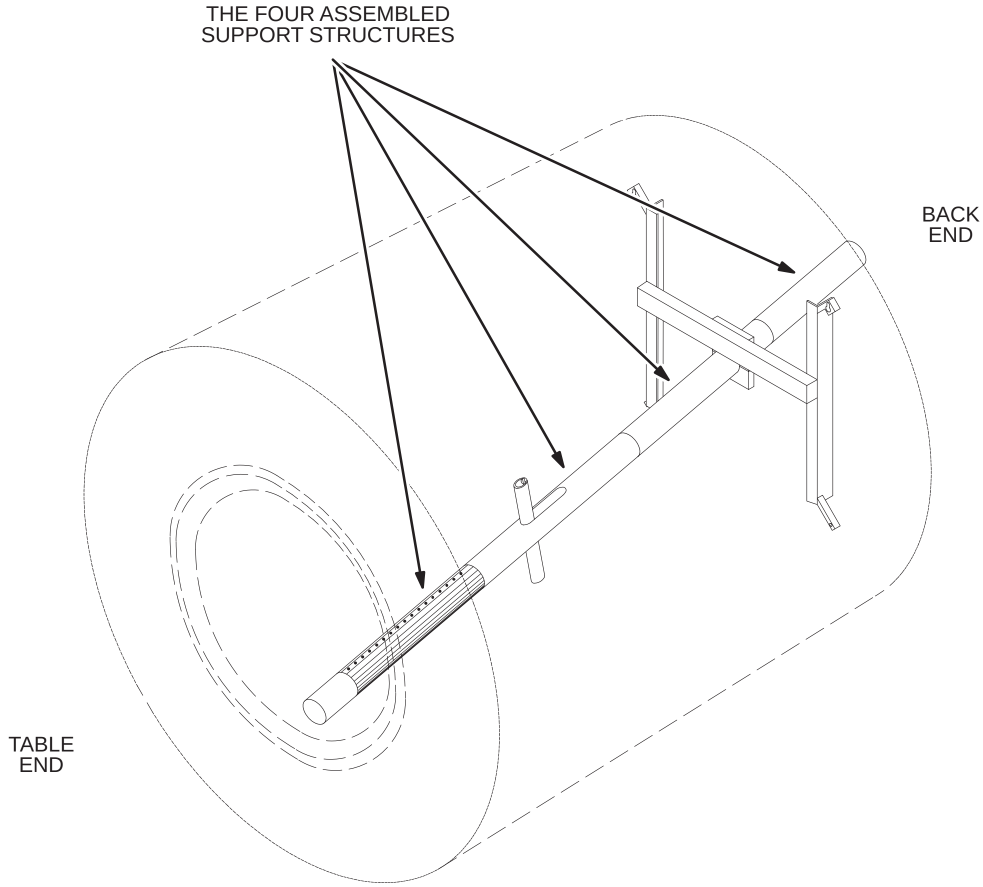
   - Line up the notch in the Axial Positioning Tube with the pin in the front of the Magnetometer Support Tube and slide the tubes together.
   - Using a 9/16 inch wrench on the “Flats” of the threaded brass rod, turn the rod until it engages the Magnetometer Support Tube (at least 4 turns).
   - Turn the Bar Nut (46–294072P1) to snug the two tubes firmly against each other.



ATTACHMENT OF AXIAL POSITIONING TUBE
ILLUSTRATION 5–7

8–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G3) (continued)

9. Place the four–piece tube assembly into the bore of the magnet, entering from the Table End of the magnet with the Rear Support Section. Insert the Rear Support Section into the open bearing at the Back End of the magnet and slide the tube assembly through until the tube assembly at the Table End is even with the front of the magnet. See Illustration 5–8.



INSERTION OF THE FOUR ASSEMBLED SUPPORT TUBES
ILLUSTRATION 5–8

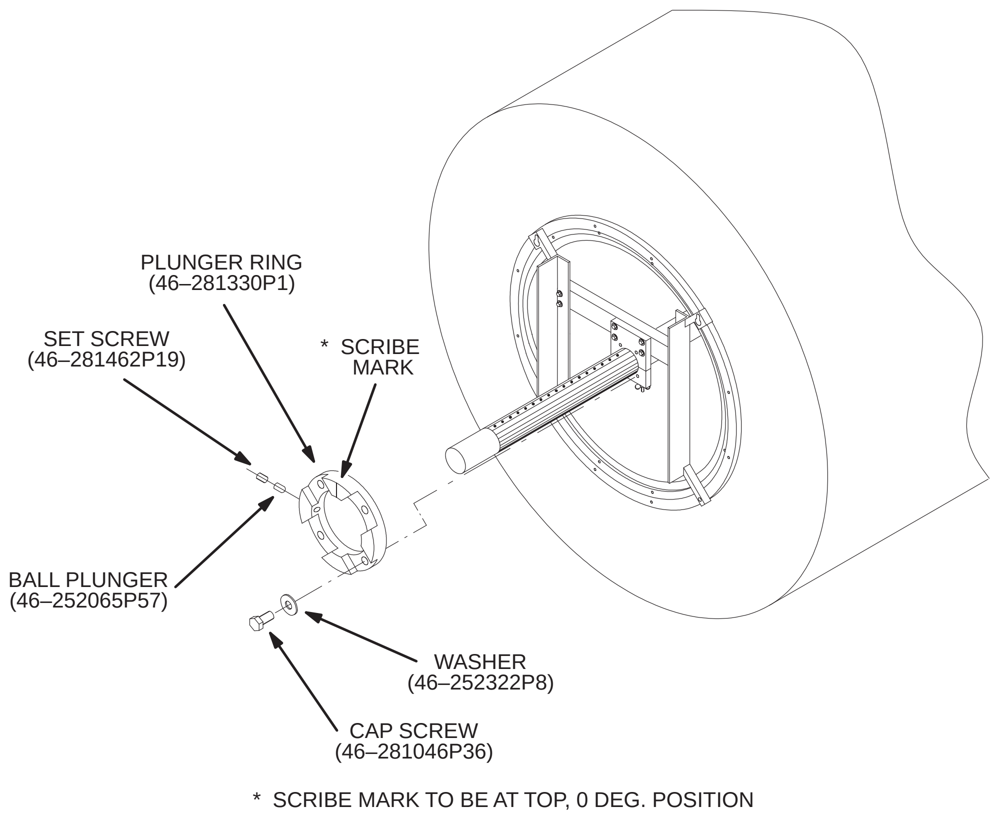
10. Attach the remaining H–Frame to the Table End of the magnet.

11. Lift and pull the tube assembly through the Table End bearing hole until the tube assembly is supported by the H–Frames. See Illustration 5–9.

12. Tighten the wing nuts, on both Lower Bearings, hand tight.

13. Slide the Plunger Ring onto the Axial Positioning Tube and secure it to the bearing with four 1.5 inch long 3/8 – 16 cap screws. Back out the Set Screw and Ball Plunger if it interferes with this process. See Illustration 5–9.

8–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G3) (continued)



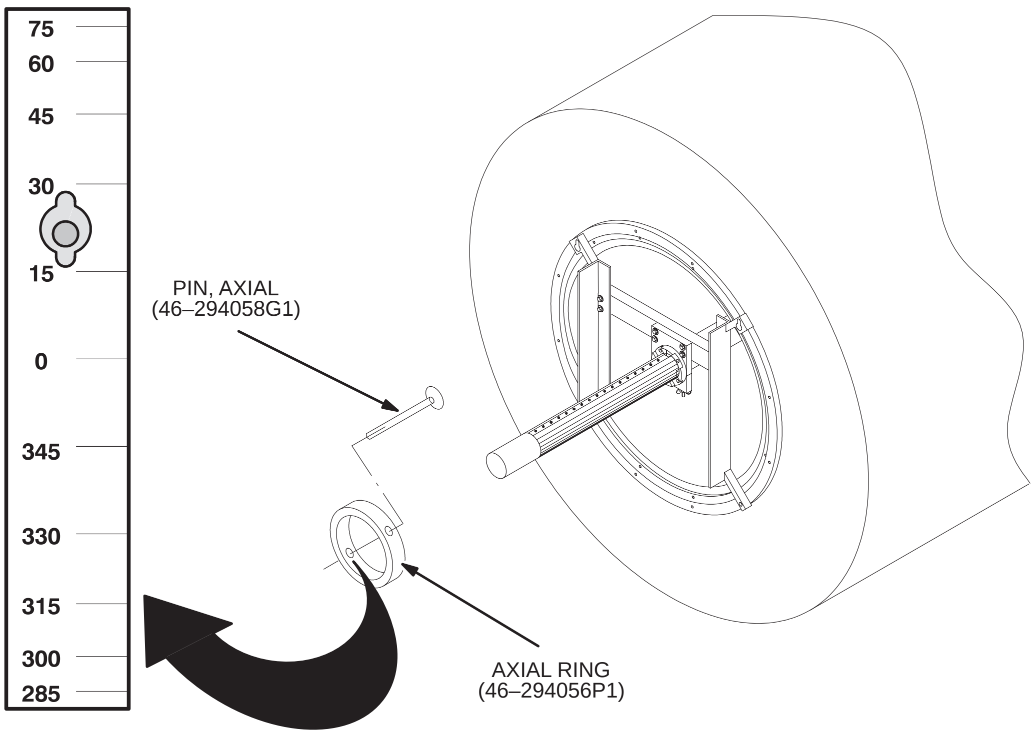
ATTACHMENT OF THE PLUNGER RING
ILLUSTRATION 5–9

IMPORTANT

There is a different Axial Positioning Ring (P/N 2142702) for the 45cm DSV. The index marks are stamped in Red and the Pin Hole is 30 degrees offset from the Pin Hole in the C6 Axial Positioning Ring. See Illustration 5–10.

14. Slide the Axial Positioning Ring on the Axial Positioning Tube. Pin it at a convenient axial position. Make sure the Axial Positioning Ring is oriented with degree numbers advancing in a clockwise direction. See Illustration 5–10.

8–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G3) (continued)



ATTACHMENT OF AXIAL POSITIONING RING
ILLUSTRATION 5–10

8–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G3) (continued)

15. Attach the Handles to the Axial Positioning Tube. See Illustration 5–11.

CAUTION

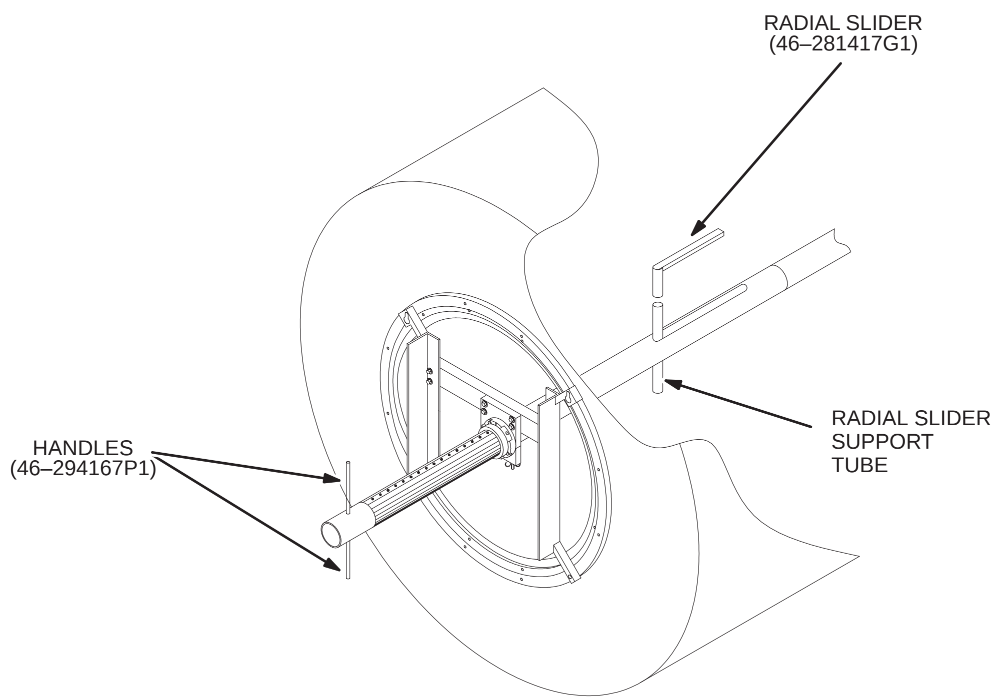
Do not overtighten Ball Plunger as damage could result. Back Set Screw out as far as possible to still maintain "detent action".

16. Adjust the Ball Plunger. Move the fixture circumferentially to establish sufficient Plunger pressure to "click" in detente without binding. Adjust the Set Screw to maintain the Plunger at the proper pressure. See Illustration 5–9.
17. Attach 45cm DSV Radial Slider Tube to Magnetometer Support Table. See Illustration 5–12.

Note

A dry silicon lubricant may be used to improve axial and circumferential fixture action.

18. Draw the Mapping Fixture out and insert the Radial Slider with its Magnetometer Support Table into the Slider Support Tube. Pin the Radial Slider at a convenient position for attachment of the Magnetometer Probe to the Magnetometer Probe Support.



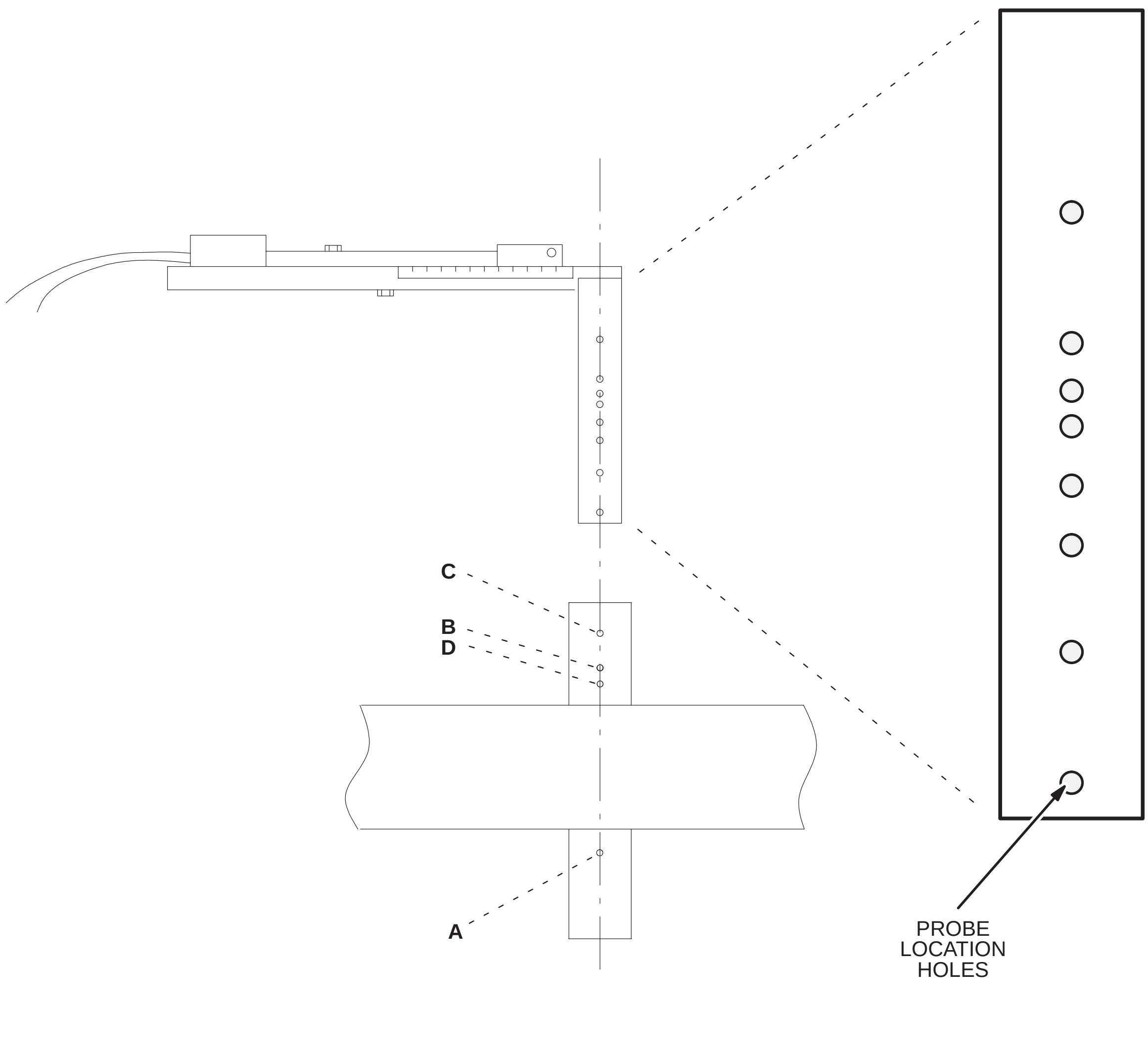
INSERTION OF THE RADIAL SLIDER AND ATTACHMENT OF HANDLES
ILLUSTRATION 5–11

8–3 PROBE POSITION REFERENCE ADJUSTMENTS (RADIAL, ANGULAR & AXIAL)

Magnetic field mapping is accomplished by the three separate adjustments referenced in Steps 1, 2 and 3 below:

MODEL #46–294060G3

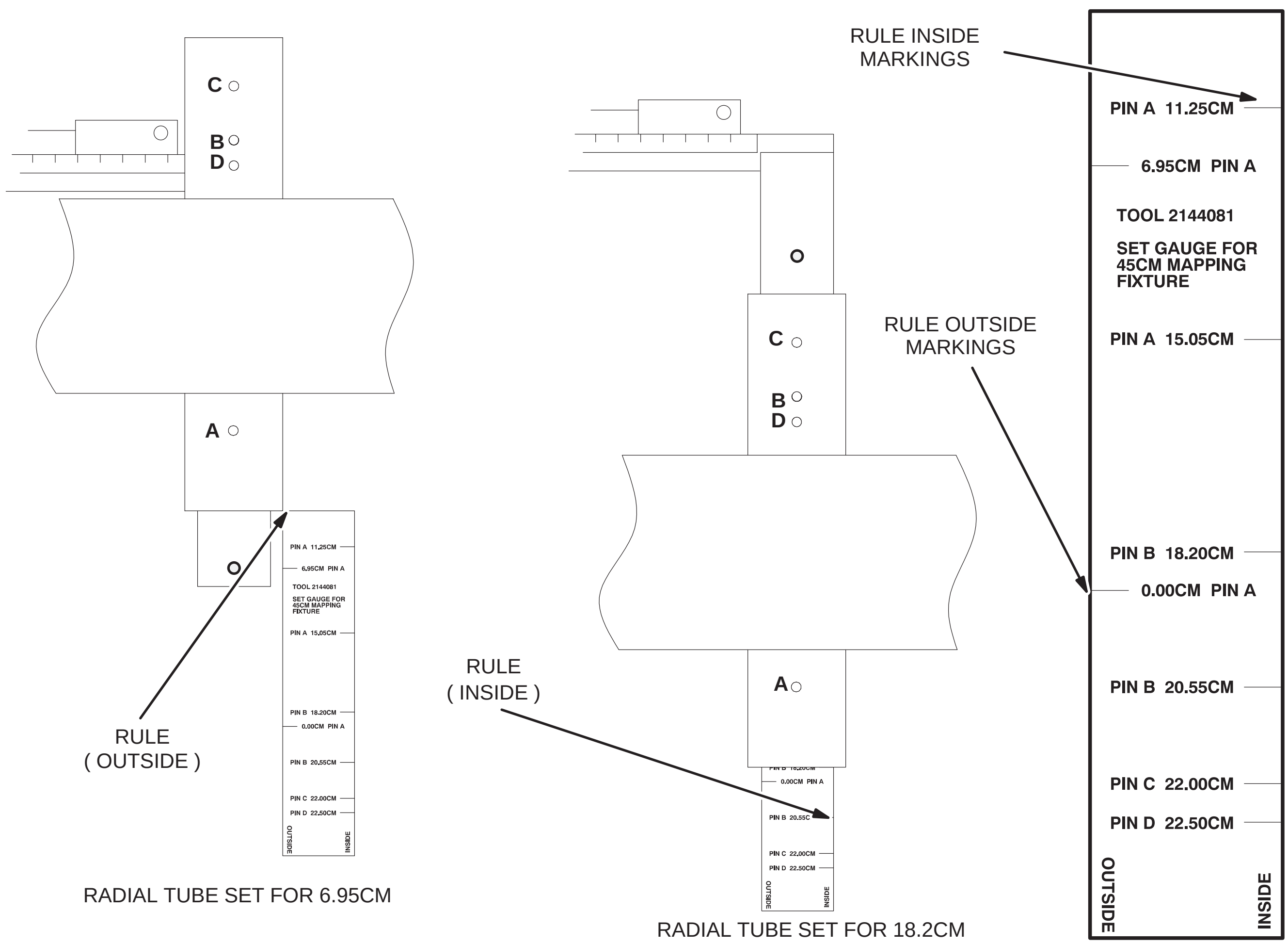
1. Radial Positioning: Adjust the Radial Slider Tube in the Radial Support Tube and pin through the desired position holes. See Illustration 5–12, 5–13 and Table 5–1 for correlation to Holes A, B, C and D. A ruler is available to help set the correct Radius. See Illustration 5–12.



RADIAL POSITIONING HOLES
ILLUSTRATION 5–12

TABLE 5–1
RADIAL ARM PINNING LOCATIONS

RADIUS (CM)	PIN
0.00	A
6.95	A
11.25	A
15.05	A
18.20	B
20.55	B
22.00	C
22.50	D

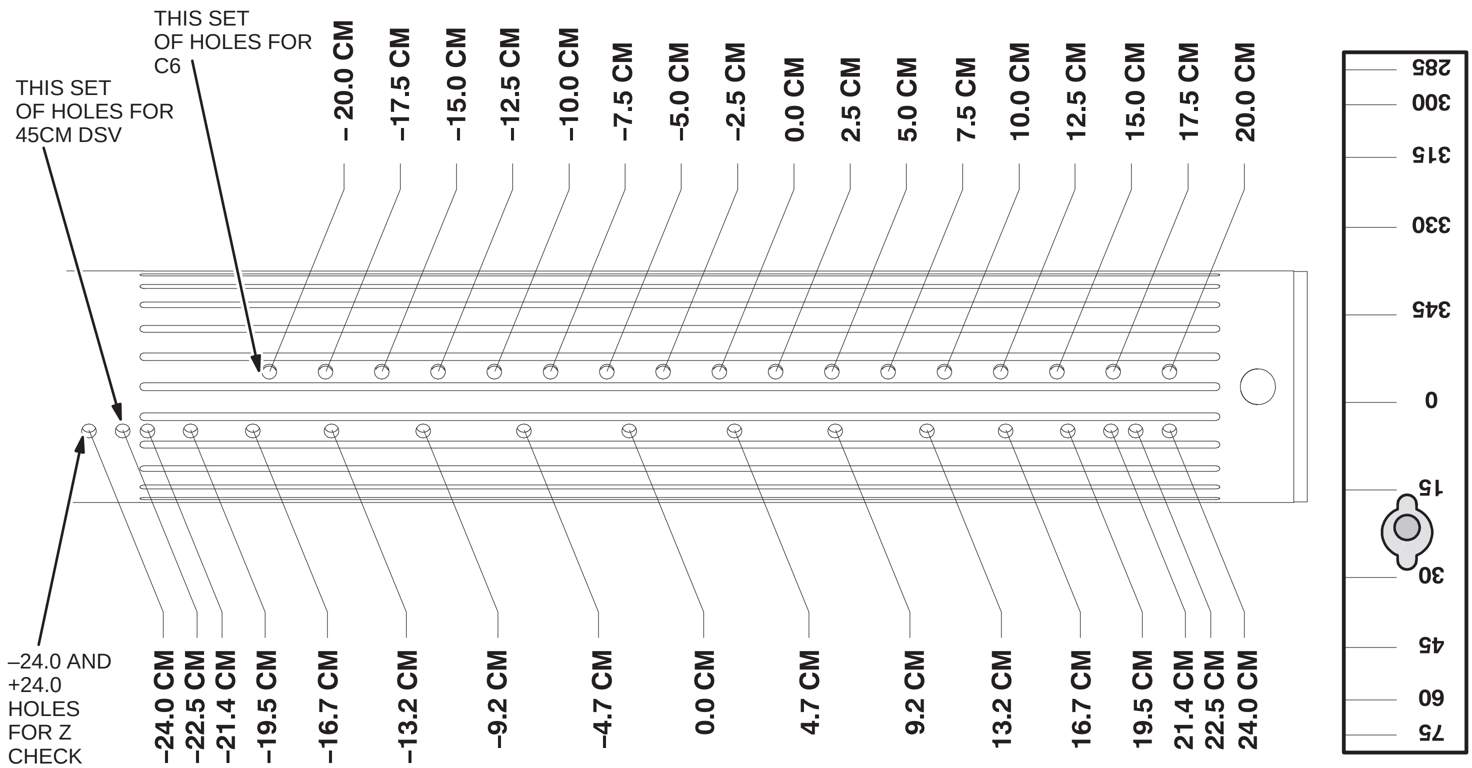


RADIAL ARM PINNING LOCATIONS
ILLUSTRATION 5–13

8–3 PROBE POSITION REFERENCE ADJUSTMENTS (RADIAL, ANGULAR & AXIAL) (continued)

2. Angular Positioning: Angular positions are obtained by rotating the Axial Positioning Tube through the specific 15 degree detente positions, shown on the tube. The angular markings on the Axial Positioning Ring will display the specific angle at the top (90 degree vertical position) when the Ball Plunger is seated Into the detente on the Axial Positioning Tube. The collar used for 45cm DSV shimming has red index markings. See Illustration 5–14.

3. Axial Positioning: Slide the Axial Positioning Tube along the bore of the magnet and insert Locating Pin through the desired axial position reference hole. The holes used for 45cm DSV shimming are marked by red ink on either side of the hole location. See Illustration 5–14.



ANGULAR/AXIAL POSITIONING
ILLUSTRATION 5–14

8–4 TESLAMETER PROBE MECHANICAL CENTERING

Description:

Precise magnetic field measurements are made with the Teslameter and Probe when properly set up and positioned in the Magnet Bore.

The Only method for Transverse Probe Centering is mechanical. There is no Transverse Magnetic Centering for the SV magnet.

Make sure keys are aligned, on all Shim Connectors and Cables, when connecting the shim cables to the magnet. Never force or twist the connectors as damage may result.

8–4 TESLAMETER PROBE MECHANICAL CENTERING

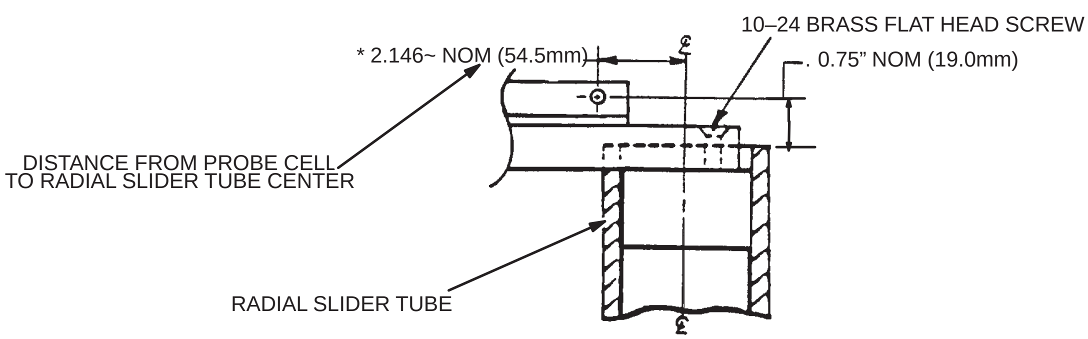
Procedure:

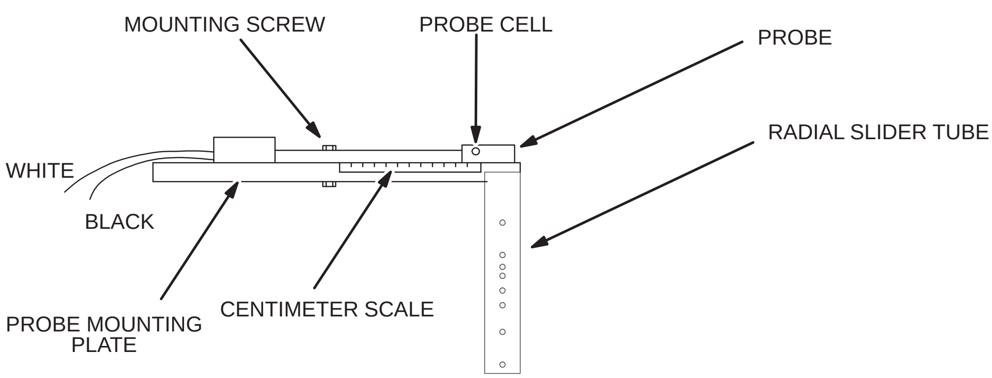
1. Attach the Probe to the probe mounting plate with brass machine screws as shown in illustration 5–15.

Note

To get proper radial spacing of the probe (0.75 inches from the top of the Radial Slider Tube), Nylon Spacers (46–294059P1 and P2) are included with the Service Tool Mapping Fixture (46– 294060G2). These Shims should only be needed with the Metrolab Probe. The total distance from the Radial Slider Tube and the center of the Probe Cell should be 0.75 inches.

2. Loosen Probe Mounting Screw and set the Probe Cell 2.146 inches from the center of the Radial Slider Tube. See Illustration 5–15.
3. Install Shims, if necessary, to bring Probe height to 0.75 inches; measured from the center of the Probe Cell to the top of the Radial Slider Tube. See illustration 5–15.





* Loosen Mounting Screw to Adjust Probe to Magnet Center.

AXIAL MECHANICAL CENTERING OF MAGNETOMETER PROBE
ILLUSTRATION 5–15

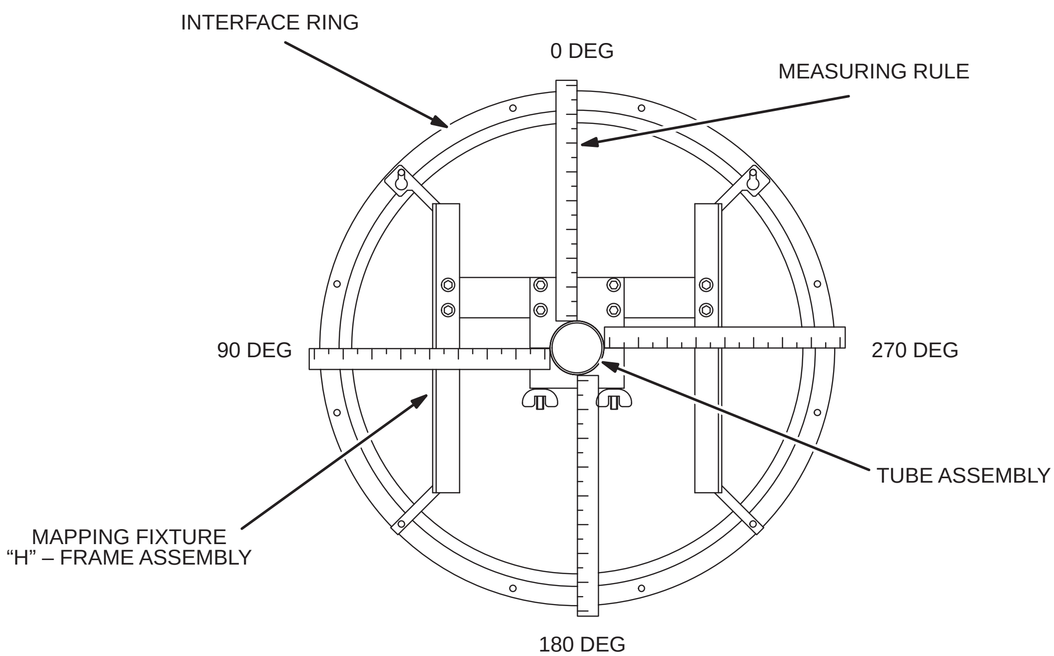
8–4 TESLAMETER PROBE MECHANICAL CENTERING (continued)

4. Measure the distance from the outside the Interface Ring to the 0°, 180°, 90°, and 270° points on the Tube Assembly, using a rule capable of measuring to within 1mm. See Illustration 5–16.

5. Check the distances between 0 degrees (top) and 180 degrees (bottom), 90 degrees (right) and 270 degrees (left). The two distances should be equal within ± 1 mm (0.04 in).

6. Loosen the four H–Frame Mounting Bolts on the appropriate H–Frame slightly and adjust the H–Frame in the appropriate direction to bring the distances within the ± 1 mm tolerance.

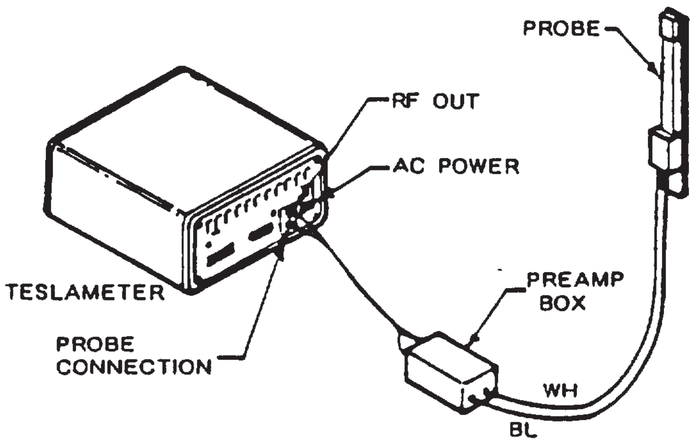
7. Repeat Steps 3 through 5 for both sides of the Mapping fixture.



TRANSVERSE MECHANICAL CENTERING OF MAPPING FIXTURE
ILLUSTRATION 5–16

8–5 TESLAMETER ADJUSTMENT (RAMP UP)

1. Connect the Probe Output Cables to the Preamp Box. See Illustration 5–17.
2. Connect the preamp box to the two probe connection input plug on the Teslameter.
3. Position the Magnetometer probe at physical center of the bore (R= 0, Z = 0).

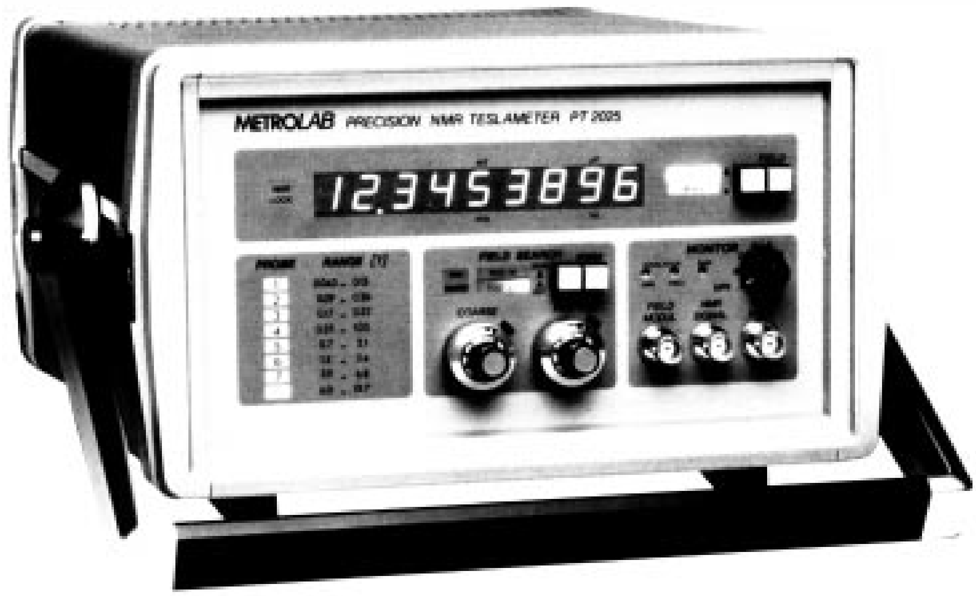


TESLAMETER INTERCONNECTIONS
ILLUSTRATION 5–17

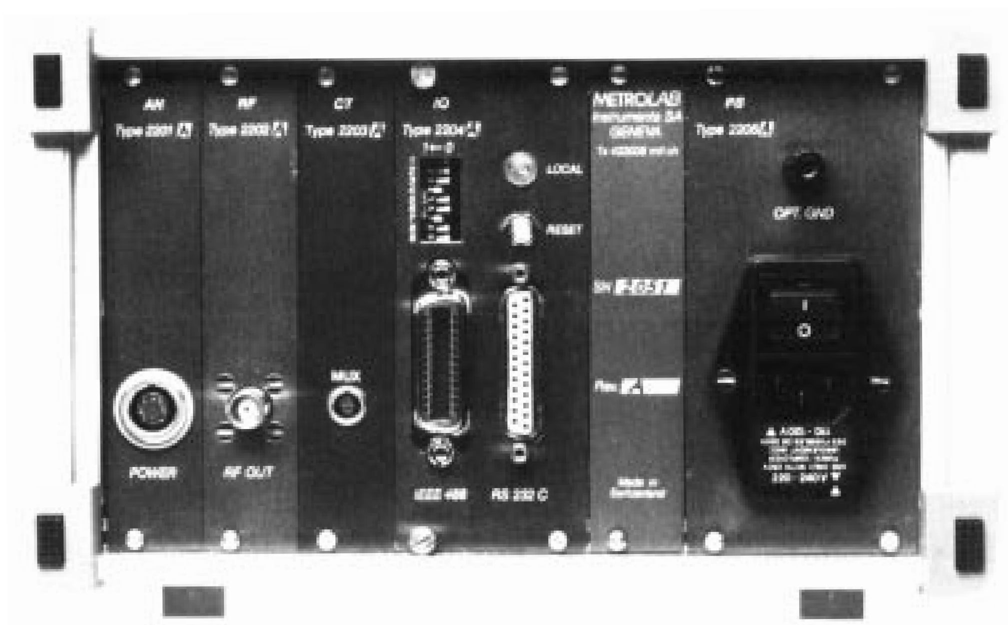
4. Turn on AC power to the meter. See Illustration 5–18 rear view.
5. Place the “LOCK/MANUAL’’ switch in the MANUAL position.

CAUTION

If “LOCK/MANUAL” switch is not in MANUAL at start of field search during ramping, its sweep will be in the +/– 1 Tesla range and the system could lock on to the mechanical oscillation harmonic of the Shield Cooler Cold Head and result in an erroneous reading.



FRONT VIEW



REAR VIEW

TESLAMETER
ILLUSTRATION 5–18

6. Set the COARSE and FINE control knobs fully counterclockwise (CCW).

7. Set the “NMR FREQ/FIELD’’ switch to the FIELD position.

The Teslameter is now set up and prepared to start monitoring the field when ramping commences.

Note

The Teslameter will not lock in on a probe signal until magnetic field is approximately 0.7 Tesla.

8–6 TESLAMETER ADJUSTMENT (RAMP UP) (continued)

8. Once ramping has started, monitor the power supply current meter until an indication of approximately 350 amps is approached. Now, start monitoring the Teslameter.

9. As the developing field approaches the lower limit of the teslameter probe (approximately 0.7 Tesla), the “NO STROBE SIGNAL’’ LED will start blinking. Observe when the LED goes out.

10. When the “NO STROBE SIGNAL’’ LED is out, change the “LOCK/MANUAL’’ switch to the LOCK position. See Illustration 5–18.

Note
If the signal does not lock in, change the position of the PROBE MODULATION switch.

11. As the field continues to increase, note when the “HI’’ LED to the right of the COARSE control begins to light. Turn the COARSE control clockwise (towards the lighted LED) until the LED is extinguished.

Note
As the magnetic field Increases, the probe sample resonant frequency will increase above the range setting of the Teslameter. Therefore, increase the setting of the COARSE knob periodically to keep the teslameter locked on the probe sample.

Note
The FINE knob does not function when the “LOCK/MANUAL’’ switch Is in the LOCKED position.

8–7 TESLAMETER ADJUSTMENT (RAMP DOWN)

1. Increase the COARSE control knob until a field reading of approximately 1.5 Tesla is obtained. You should be near but slightly below the actual field.

2. Slowly start increasing the FINE control knob while watching the “NO STROBE SIGNAL’’ LED. When the LED stops blinking and remains out, reposition the “LOCK/MANUAL’’ switch to the LOCK position.

Note
If the signal will not lock on, change the position of the PROBE MODULATION switch.

3. Now that the teslameter is locked on the field, note that either the LO or HI LED is lighted. Turn the COARSE control in the direction of whichever LED is on. Slowly it will go out and stay out.

4. As the magnetic field decreases, the probe sample resonant frequency will decrease below the present setting of the Teslameter. Therefore, decrease the setting of the COARSE control knob to keep the Teslameter locked on the probe sample.

Note
The FINE control does not function when the “LOCK/MANUAL’’ switch is in the LOCKED position.

8–8 TESLAMETER RESYNCHRONIZATION.

If the Teslameter should go out of sync while ramping the magnet up (or down), it can easily be resynchronized by the following procedure.

Manual Resynchronization

1. Re–position the “LOCK/MANUAL'' switch to MANUAL.

Note

The “NO STROBE'' SIGNAL will be on; the LO/HI LEDs will be oscillating, indicating a search mode.

2. Note the present current reading on the Main Power Supply Current Meter.
3. Multiply the current times 20 gauss (approximately 20 gauss/amp). The meter should be set at the resultant gauss level.
4. Slowly start Increasing (if ramping up) the COARSE and/or FINE control knob while monitoring the “NO STROBE SIGNAL'' LED.
5. Once the LED extinguishes, quickly place the “LOCK/MANUAL'' switch to the LOCK position. The meter will now be “SYNCHRONIZED”.

Note

If the HI LED is lit, the COARSE control knob will have to be turned in the HI direction until the LED goes out. Repeat this adjustment as required until the parking field Is reached.

Manual Resynchronization (with scope)

An oscilloscope can be set up near the Teslameter to display and trigger on the “FIELD MODULATION'' signal from a jack on the Teslameter front panel. Adjust the time base to display one or two ramp waveforms. On the second channel, display the “NMR SIGNAL” from the front panel of the teslameter.

1. Leave the Teslameter in the “LOCKED'' position.
2. Slowly turn the COARSE control knob in the direction the field is going; i.e., if ramping up, turn the control knob up to the higher numbers.
3. As the meter is approaching the actual field, the baseline of the “FID'' display will start to wander. Once the meter is in range of the field, the “FID'' will appear on the scope trace as the meter locks on.
4. Again, when locked on, the “NO STROBE SIGNAL'' LED will be out; readjust,slightly, the COARSE control knob in the direction of the lighted LO/HI LED until that LED goes out.
5. Maintain tracking through end of ramp sequence.

SECTION 8 – ELECTRICAL CONNECTIONS FOR RAMPING AND SHIMMING

Description:

Main and Superconducting Shim Power Supply Input/Output Connections have the same (P/J) designations, used in this procedure, for both the Service and Phase III Power Supply Units.

Make sure that the Power Supply Cabinets are installed and checked out in conformance with the supplier manual, supplied with the unit, before making any power supply connections to the magnet. See INTRODUCTION, Section 2 (“Vendor Manuals”) for supplier manual numbers.

SCHEMATICS/INTERCONNECTS, Section 1–1 (“Magnet Interconnect Diagram”) shows the Cable Numbers, Run Numbers and Interconnect Pattern covered in this section.

If Ramp and Shim Cables were not ordered with the magnet, Field Ramp Cable Kit P/N 2135435 will be needed to ramp the magnet and Field Shim Cable Kit P/N 2135558 will be needed to shim the magnet. If Ramp and Shim Cables will remain on site, order the appropriate R–Cat numbers as explained in Service Note 63034.

Procedure:

9–4 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS

1. Verify that input power to the Superconducting Shim Coil Power Supply is disconnected.

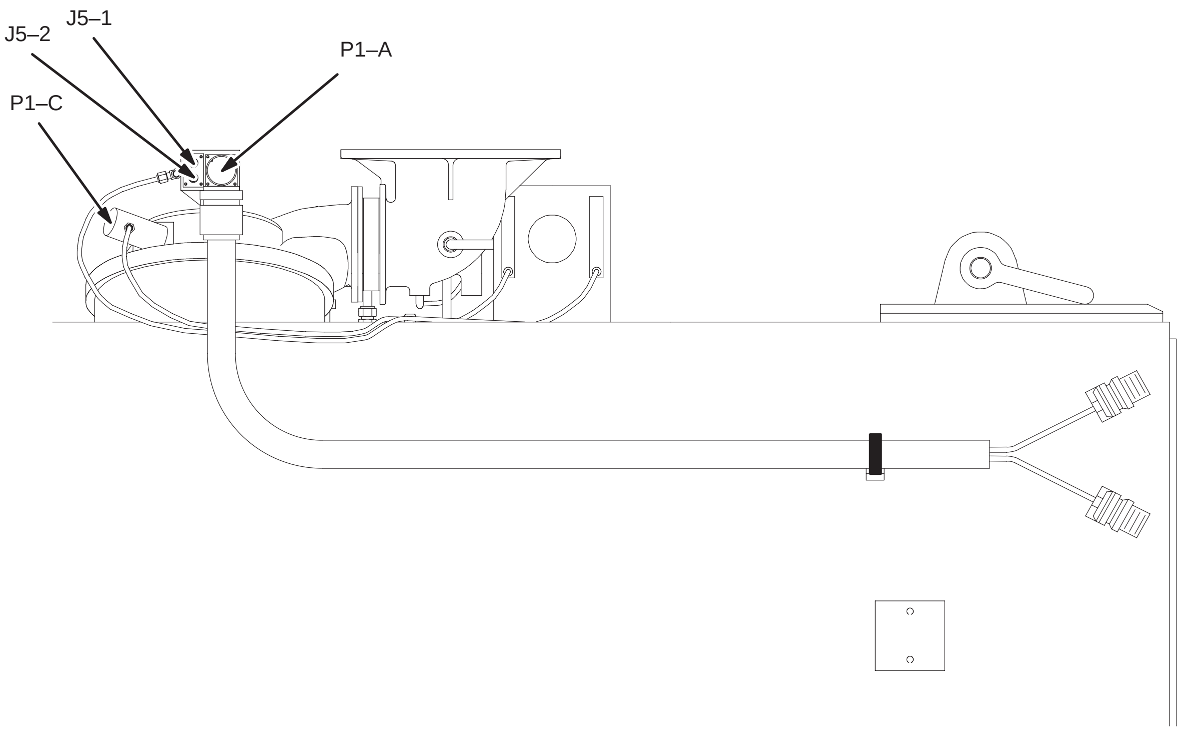
WARNING!

DO NOT CONNECT INPUT POWER TO OR TURN ON SUPERCONDUCTING SHIM COIL POWER SUPPLY UNTIL IT IS VERIFIED THAT ALL CURRENT CONTROLS ARE SET AT ZERO, FULLY COUNTERCLOCKWISE AND ALL HEATER SWITCHES ARE IN THE OFF POSITION.

2. Connect Shim Lead Pigtail Cable (P/N 2135362) to the Shim Lead Connector P1A. See Illustration 8–1.

3. Ty–wrap the end of the shim lead pigtail cable to the magnet lifting lug. See Illustration 8–1.

9–4 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)



MAGNET ELECTRICAL CONNECTIONS
ILLUSTRATION 8–1

WARNING!

CONNECTING THE SUPERCONDUCTING SHIM COIL HARNESS TO THE MAGNET WHEN THE SUPERCONDUCTING SHIM COIL POWER SUPPLY IS ON MAY CAUSE IRREPARABLE DAMAGE TO THE VAPOR COOLED SHIM LEADS.

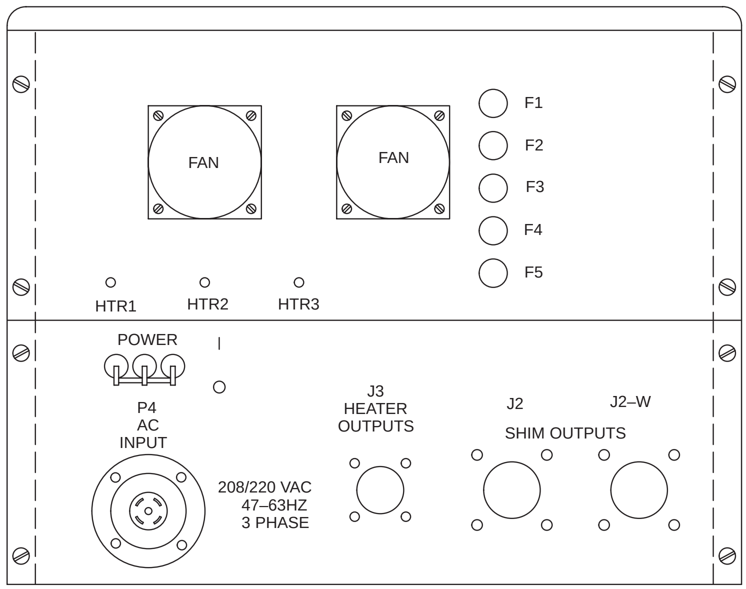
4. Connect the Shim Power Supply Heater Cable to J5–1 or J5–2.

5. Connect (J2 & J2–W) of the Superconducting Shim Coil Cable to the corresponding connectors on the Shim Lead Pigtail Cable intalled in Step 2.

Note
Vapor Cooled Shim Leads, and Shim Lead Baffle Trees are field replacement items. See REPLACEMENT/MAINTENANCE, Section NO TAG.

6. Connect P2 and P2–W of the Superconducting Shim Coil Cable to J2 and J2–W on the Superconducting Shim Power Supply. See Illustration 8–2.

9–4 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)



SHIM POWER SUPPLY OUTPUT CONNECTIONS
ILLUSTRATION 8–2

9–5 MAIN COIL POWER SUPPLY CONNECTIONS

1. Verify that the input power to the Main Coil Power Supply is disconnected.
2. Connect (P703) on Heater Wire Harness (RUN #604) to Heater Outputs (J3) on the rear of the Main Coil Power Supply Cabinet (MS6–A1). See Illustration 8–3.
3. Connect (P5) on Heater Wire Harness (RUN #604) to (J5–1 or J5–2) on the Shim Lead Assembly. See Illustration 8–1.

Note

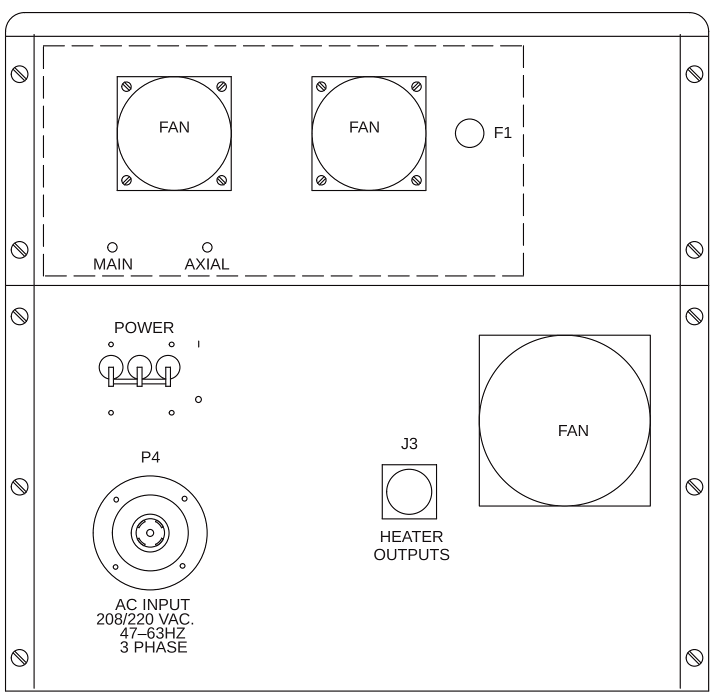
A "Scotch Brite" scouring pad can be used to clean all connections in Step 4.

4. Clean all connection points on Power Leads and Power Lead Extensions to prevent high resistance contacts and minimize voltage drops.

Note

Make sure the nuts are tightened sufficiently to prevent a high resistance contact. Connect (Red) Cables to the (+) Buss Bar and (Black) Cables to the (–) Buss Bar. Two Red and two Black Cables are connected in parallel to the Buss Bars. Make sure that the Cable Lugs and/or exposed wire from the Ramp Cables are not touching the case of the Main Coil Power Supply.

5. Connect the Main Coil Power Cables (RUN #601 & #602) to the Main Power Supply Buss Bars with the Brass Nuts and Bolts provided in the service kit.
6. Place the other end of the Main Power Cables across the top of the magnet. Allow for 3 feet (1 meter) of slack there.
7. Check Cryostat Pressure Gauge. If the pressure is above 0.25 psi, slowly open Helium Vent Valve (V2) and allow pressure to drop to 0.25 psi. Then close valve (V2).



MAGNET POWER SUPPLY CONNECTIONS
ILLUSTRATION 8–3

9–5 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

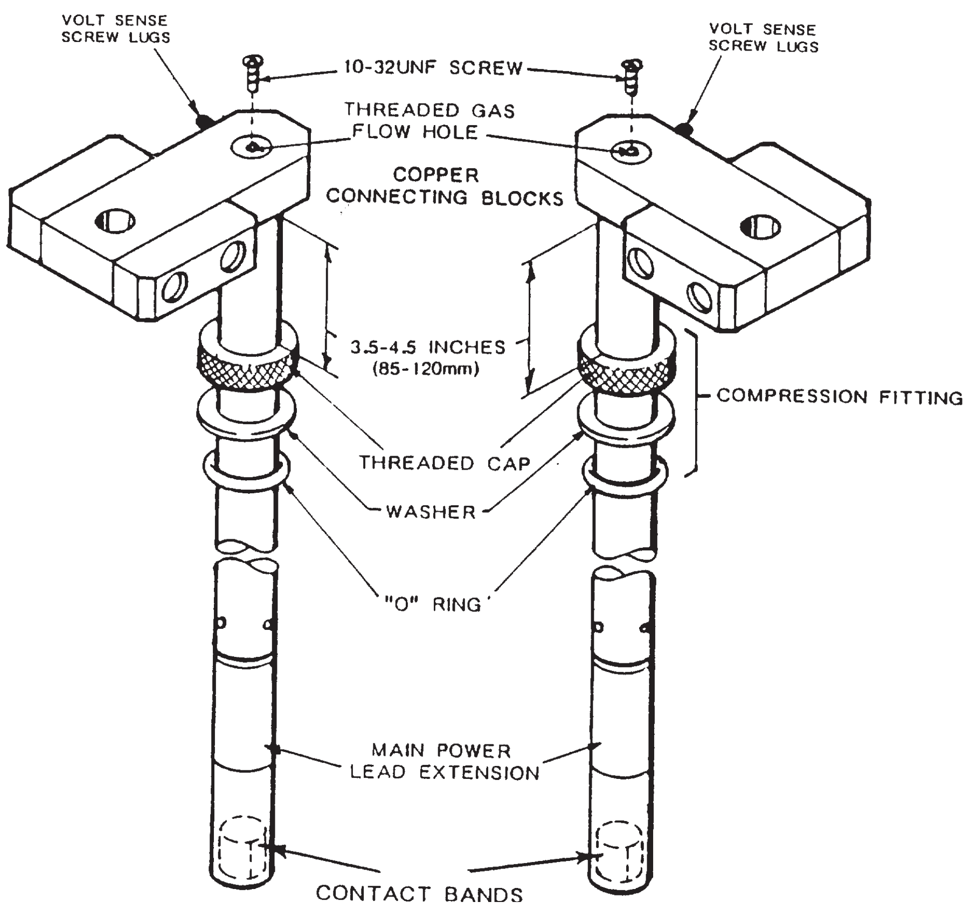
CAUTION

The Main Power Lead Extensions for the Active Shield magnets are different from other magnets. The Active Shield Lead Extensions can be recognized by a Helium Flow Hole as viewed from the Contact Band End of each Extension. These Ramp Lead Extensions are also shorter than the SIII Ramp Leads. Make sure the Power Lead Extensions, used for Active Shield magnet, (P/N 46–294204G1) are used for this procedure.

Note

Use a new set of Contact Bands for each ramp performed.

8. Replace Contact Bands on Main Power Lead Extensions. Make sure gas flow holes are not blocked. See REPLACEMENT/MAINTENANCE, Section NO TAG.
9. Remove the Threaded Caps, Washers and “O” Rings (46–294104P1, 46–294105P1 & 46–260389P1) from the plastic bag, taped to the Shim Lead Assembly in a plastic bag, and mount them on the Main Power Lead Extensions. See Illustration 8–4.



COMPRESSION FITTING MOUNTING ON MAIN POWER LEAD EXTENSION
ILLUSTRATION 8–4

9–5 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

IF THE MAGNET IS RAMPED UP, WAIT FOR THE LEAD EXTENSIONS TO COOL SUFFICIENTLY (A FOG OR WATER VAPOR FORMS AROUND THE LEAD EXTENSIONS) BEFORE FULLY ENGAGING THEM TO PREVENT THE RISK OF QUENCHING THE MAGNET.

A SUPERCONDUCTING MAGNET AT FIELD IS A HIGH ENERGY STORAGE DEVICE CAPABLE OF DISCHARGING RAPIDLY. DO NOT TOUCH THE MAIN LEAD EXTENSIONS SIMULTANEOUSLY OR ALLOW THEM TO COME IN CONTACT WITH EACH OTHER WHEN THE MAGNET IS BEING RAMPED OR AT FIELD AS A RAPID DISCHARGE WOULD RESULT THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER BECOMES ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS.

WARNING!

TO PREVENT THE POSSIBILITY OF MIS–WIRING AND A RESULTANT QUENCH DURING FUTURE RAMPING OF THE MAGNET, CONNECTION POLARITIES MUST BE NOTED AND RECORDED IN THE DATA SHEET TAB, TABLE 6–1.

Note

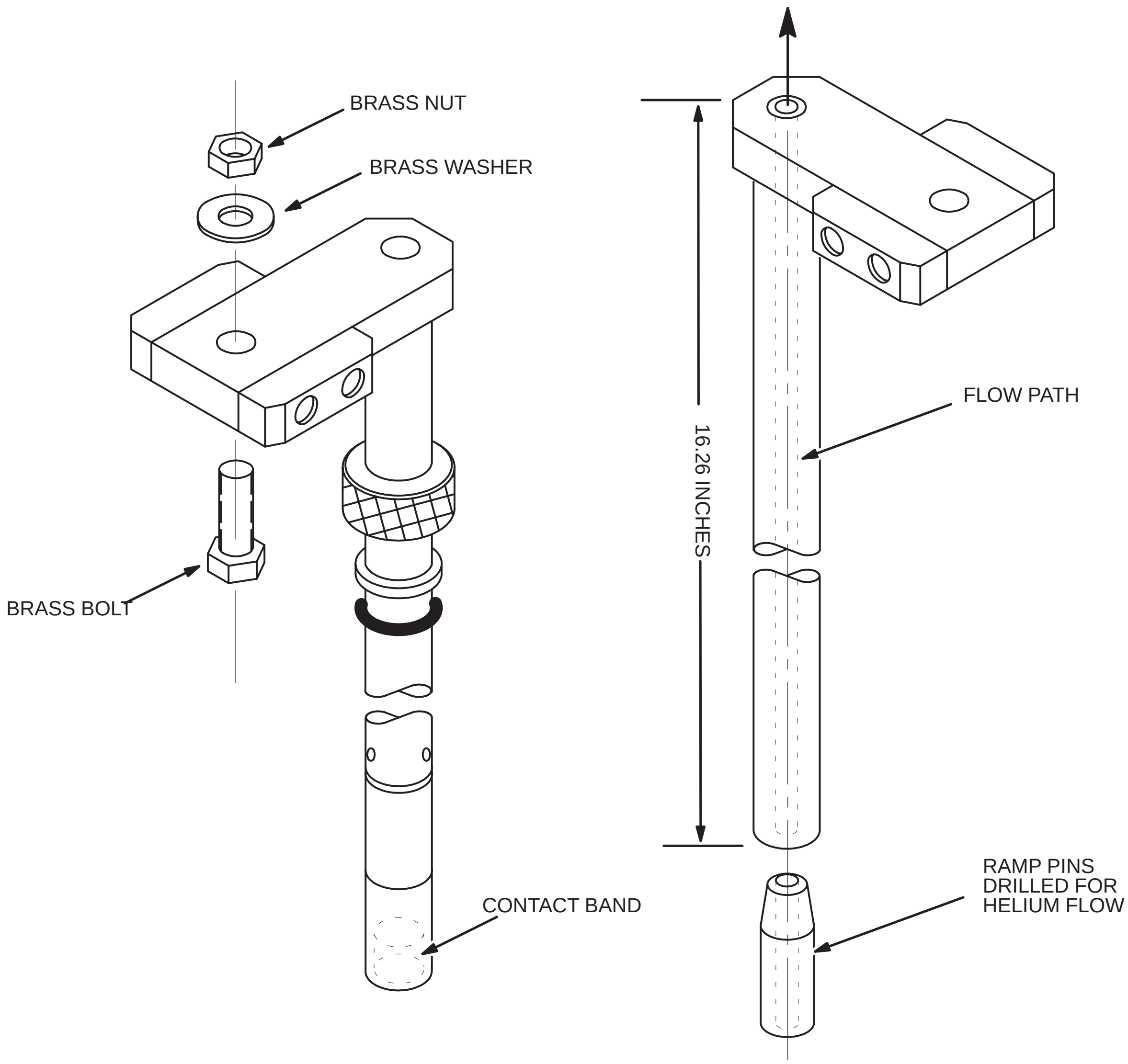
Use only Brass Washers when connecting Main Power Leads to the Main Lead Extensions to keep voltage drops to a minimum.

CAUTION

Make sure the Brass Bolts in Step 10 are installed as shown in Illustration 8–5 to prevent any possibility of contact with the Fill Port Cap during ramping which would quench the magnet.

10. Connect the other end of the Main Power Cables to the main Power Lead Extensions with the 1 inch (25.4mm) Brass Bolts as shown in Illustration 8–5. Secure bolts with the Brass Nuts and Brass Washers provided. Tighten the connections sufficiently to provide a good electrical connection.
11. Install the 10–32UNF Gas Flow Hole Screws into the gas flow holes on each Ramp Lead Extension. See Illustration 8–4.

9–5 MAIN COIL POWER SUPPLY CONNECTIONS (continued)



HARDWARE MOUNTING ON RAMP LEAD EXTENSIONS
ILLUSTRATION 8–5

9–5 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

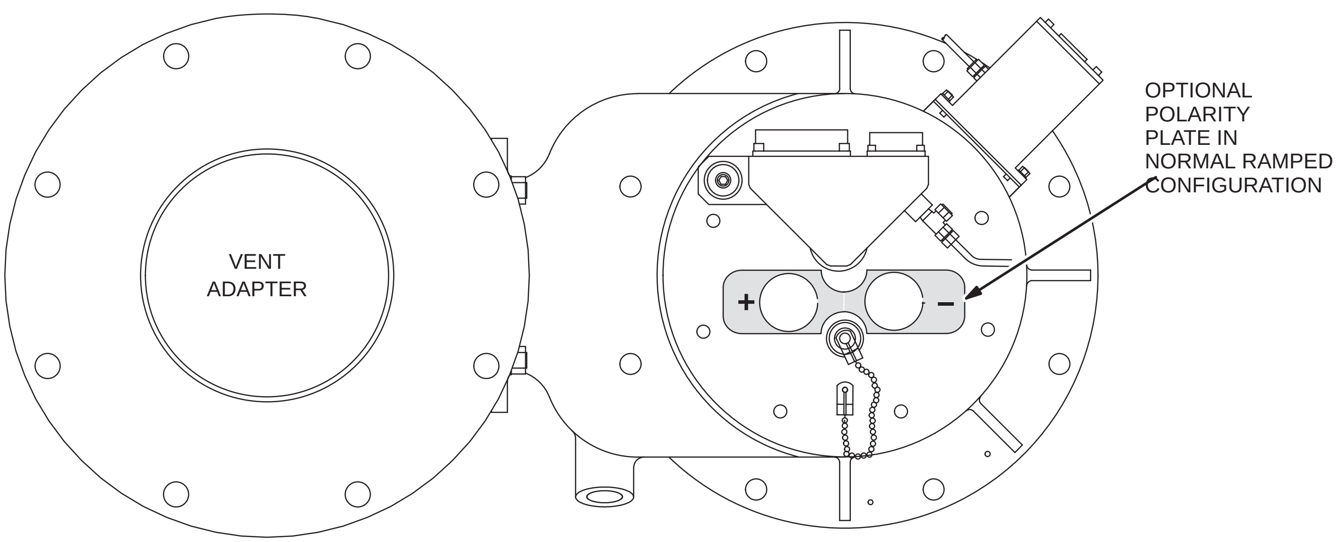
CAUTION

The "Normal" ramp polarity is "+" on the left and "–" on the right as viewed from the cold head side of the magnet. "Reversed" ramp polarity has "+" on the right and "–" on the left as viewed from the cold head side of the magnet. If using the Polarity Plate, make sure that the Polarity Plate properly indicates which polarity the magnet is to be ramped. Make sure the chosen ramp polarity is recorded in the DATA SHEET tab, Section NO TAG.

Note

The Ramp Polarity Plate position is changed by first venting the magnet to below 0.5 psi, then removing both ramp port caps. Pull the polarity plate up over the ramp ports and reinstall the plate to indicate the chosen polarity. Replace Ramp Port Caps.

1. The Optional Polarity Plate, P/N 2111737, is normally used only to indicate a reverse ramped magnet. The plate can be ordered if desired. To install, open Vent Valve V2 until the magnet pressure is around 0.2 psi. Then quickly unscrew both Ramp Port Caps and place the Polarity Plate, with the desired Ramp Polarity indicated, over the Ramp Port openings. See Illustration 8–6 for Reverse Ramp Indication.



RAMP LEAD POLARITY
ILLUSTRATION 8–6

2. Remove the cap of the "+" Main Power Lead Extension Receptacles located on the vertical stack of the magnet. Make sure that the gasket inside the cap does not get lost. See Illustration 8–6.

Note

Screw Main Lead Extension Compression Nut onto the Ramp Port, quickly, to prevent icing of threads.

9–5 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

Note

For Reverse Ramped magnet, reverse the connections in Step 3 (i.e., insert the Positive (red cables attached) Ramp lead Extension into the "–" Ramp Lead Port and insert the Negative (black cables attached) into the "+" Ramp Lead Port).

3. Quickly insert the Positive (red cables attached) Main Power Lead Extension, about halfway, into the open receptacle. Loosely screw the Compression Nut onto the Ramp Lead Port. See Illustration 8–6 for correct connection polarities.

4. Repeat Steps 2 through 3 for the other Lead Extension.

5. Connect the volt sense leads to the Main Power Lead Extensions. See Illustration 8–7. Terminate other end of volt sense leads to a DVM or VOM placed near the Main Coil Power Supply.

6. Remove Flow Hole Screws. See Illustration 8–7.

Note

Lead Extensions will depress approximately 1 inch (25mm) from the point of contact to the fully engaged position. A firm contact will be felt when fully engaged. Do not rotate Lead Extensions excessively when in the engaged position as internal contact wear could result.

WARNING!

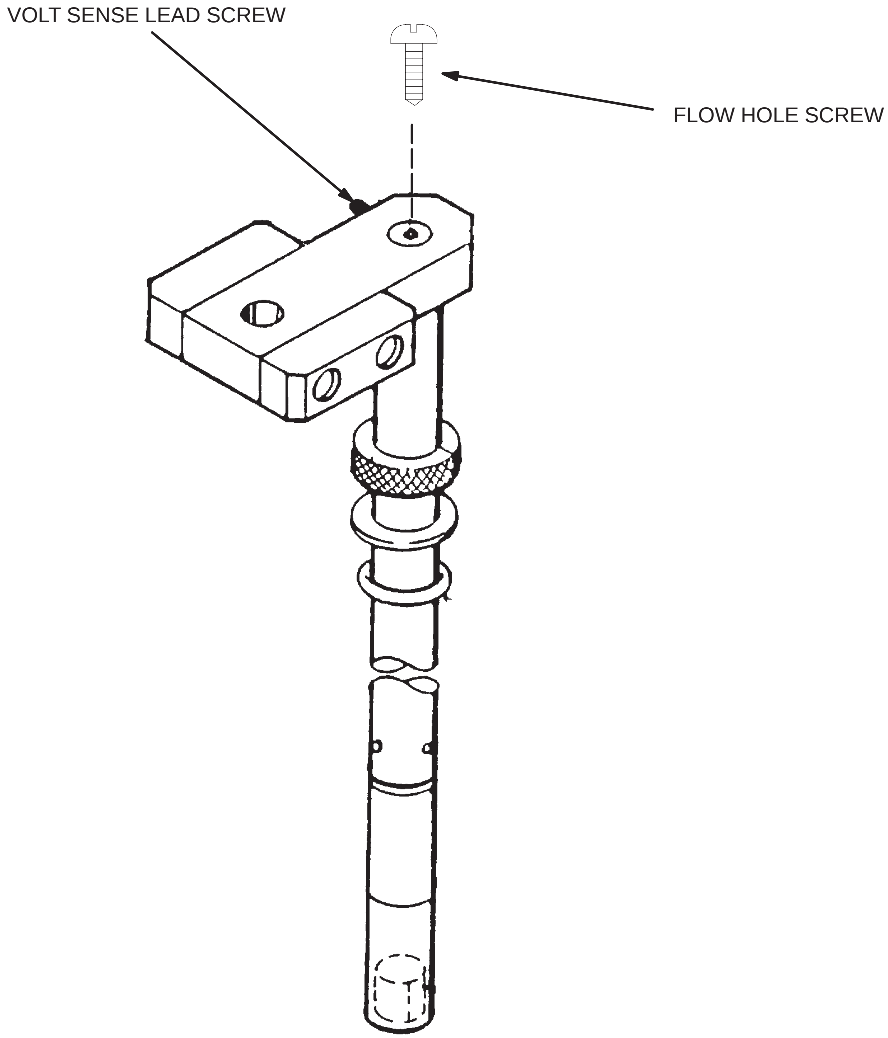
IF THE MAGNET IS RAMPED UP, WAIT FOR THE LEAD EXTENSIONS TO COOL SUFFICIENTLY (A FOG OR WATER VAPOR FORMS AROUND THE LEAD EXTENSIONS) BEFORE FULLY ENGAGING THEM, TO PREVENT THE RISK OF QUENCHING THE MAGNET.

7. When the Lead Extensions are sufficiently cooled, loosen the Compression Fittings and fully engage the Lead Extensions. Loosely screw the Compression Nut onto the Ramp Lead Ports.

CAUTION

Make sure gas flow holes in Lead Extension are not blocked and GHe is exiting holes.

9–5 MAIN COIL POWER SUPPLY CONNECTIONS (continued)



VOLT SENSE LEAD CONNECTIONS
ILLUSTRATION 8–7

CAUTION

During ramping, high currents in the power cables may cause movement of the cables due to magnetic forces. Excess motion may disrupt contact between the ramp probes and their contact pins causing a quench. Take the following steps to prevent lead motion.

8. After installing the ramp leads, secure the main power cables using Ty Wraps (field supplied item). The cables should be secured to each other and to convenient fixed points, such as the shroud rails or the magnet lifting rings, to prevent their movement.

9–5 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

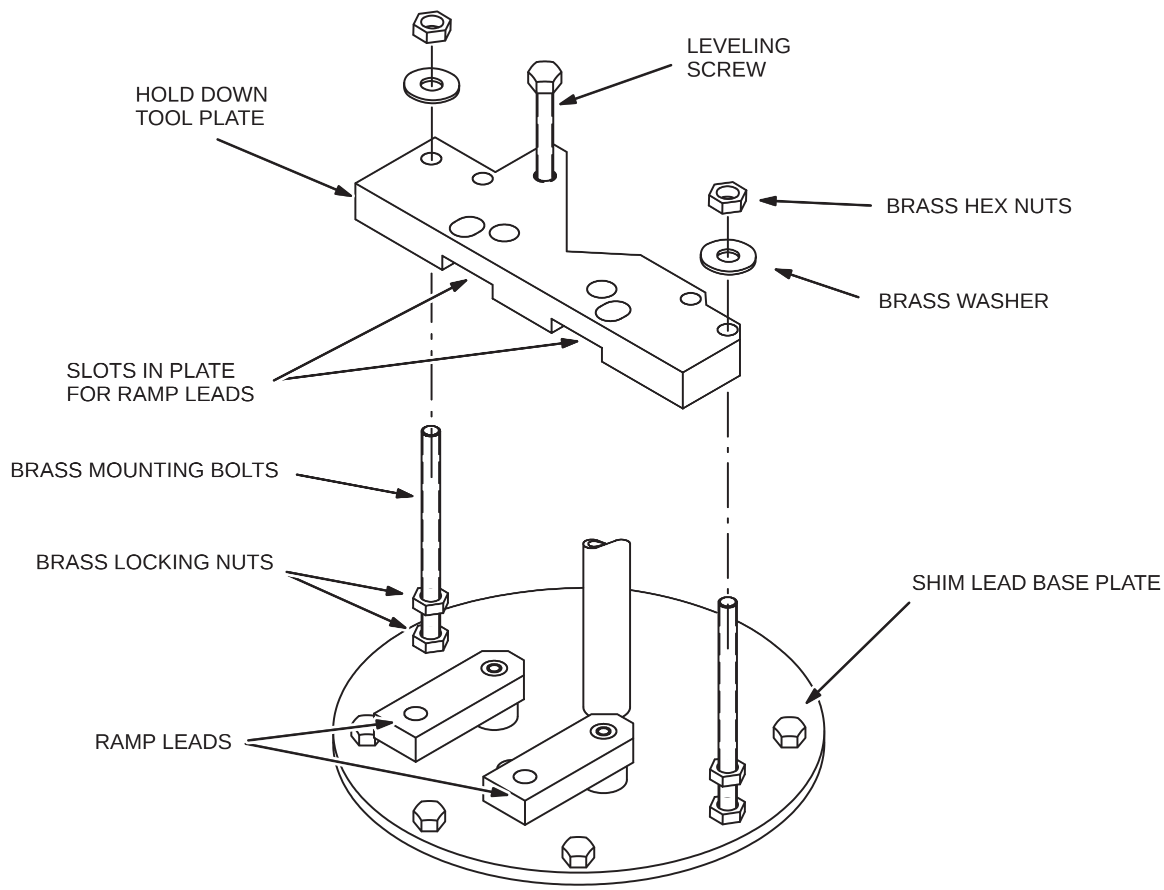
9. A Ramp Lead Hold Down Tool (2142687), is a mandatory tool which will minimize lead motion and aid in getting good contact resistance. Install the tool as follows: Remove two bolts from the Shim Lead Base Plate on top of the magnet (Save these bolts to be put back later). Screw the Mounting Bolts of the Hold Down Tool into these mounting holes. See Illustration 8–8.

10. Install the Hold Down Tool Plate onto the mounting bolts. Make sure that the ramp leads fit into the slots on the plate. See Illustration 8–8.

CAUTION

Make sure that the vent holes in the ramp leads are not blocked. This is necessary to minimize the Ramp Lead to Ramp Pin voltage drop, thereby, eliminating a quench potential.

11. Tighten the Nuts on top of the Hold Down Tool Plate to lock the plate firmly in place and prevent lead motion. While tightening the plate nuts, adjust the leveling screw to keep the plate level. See Illustration 8–8.



HOLD DOWN TOOL INSTALLATION
ILLUSTRATION 8–8

SECTION 9 – NITROGEN PURGE/PRECOOL

Description:

Liquid nitrogen is used to precool a warm cryostat when it is above 100K. The latent heat capacity of liquid helium is much lower than liquid nitrogen (21 VS. 198 KJ/KG); therefore, precooling with liquid nitrogen is more effective, economical and less time consuming.

Since all magnets are shipped from the factory with the cryostat full of liquid helium, precooling is not normally required. If precooling is deemed necessary, make sure that the temperature check in SET UP AND CALIBRATION, Section 7–2 is above 100K before proceeding with this Section. A cryostat with temperatures above 220K will require a Gaseous Nitrogen Purge (Section 9–1) before precooling with liquid nitrogen, to prevent the freezing of any latent moisture in the cryostat. If the cryostat temperature is 100K or less, proceed with LIQUID HELIUM FILL, Section 2.

WARNING!

NEVER BRING NITROGEN OR HELIUM DEWARS, GAS CYLINDERS, TOOLS OR EQUIPMENT MADE OF FERROMAGNETIC MATERIAL INTO THE EXAM ROOM WHEN THE MAGNET IS AT FIELD. FERROMAGNETIC OBJECTS BECOME DANGEROUS PROJECTILES IN A STRONG MAGNETIC FIELD.

CAUTION

Maintain Internal Cryostat Pressure below 5 psig at all times during precool and filling with Cryogens to prevent Relief Valve from activating and transfer efficiency from being reduced. Cryostat Pressure Gauge is located between the Service Turret and Exhaust Vent.

Procedure:

9–1 GASEOUS NITROGEN PURGE

WARNING!

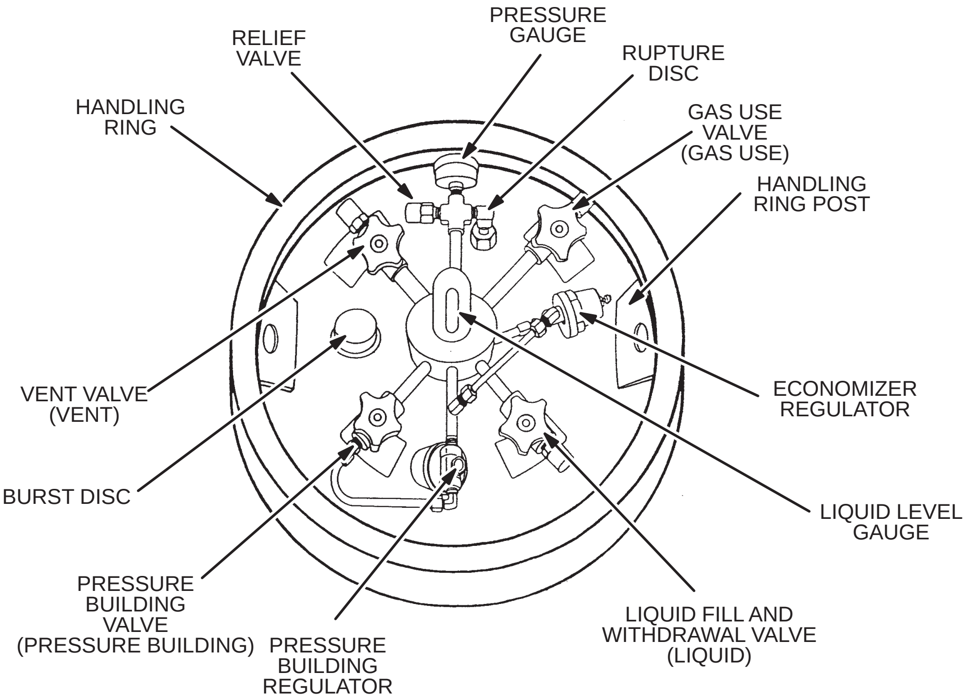
SKIN CONTACT WITH LIQUID CRYOGENS WILL CAUSE BURNS. WEAR PROTECTIVE CLOTHING, GLOVES (NONABSORBENT MATERIAL) AND GOGGLES OR FACE SHIELD WHEN TRANSFERRING CRYOGENS.

MAKE SURE SUFFICIENT VENTILATION EXISTS IN THE EXAM ROOM TO DISPEL THE LARGE AMOUNTS OF NITROGEN GAS WHICH WILL DISPLACE THE AIR (OXYGEN) AND COULD CAUSE ASPHYXIATION. VENT NITROGEN FROM ROOM DURING PURGING PROCEDURE.

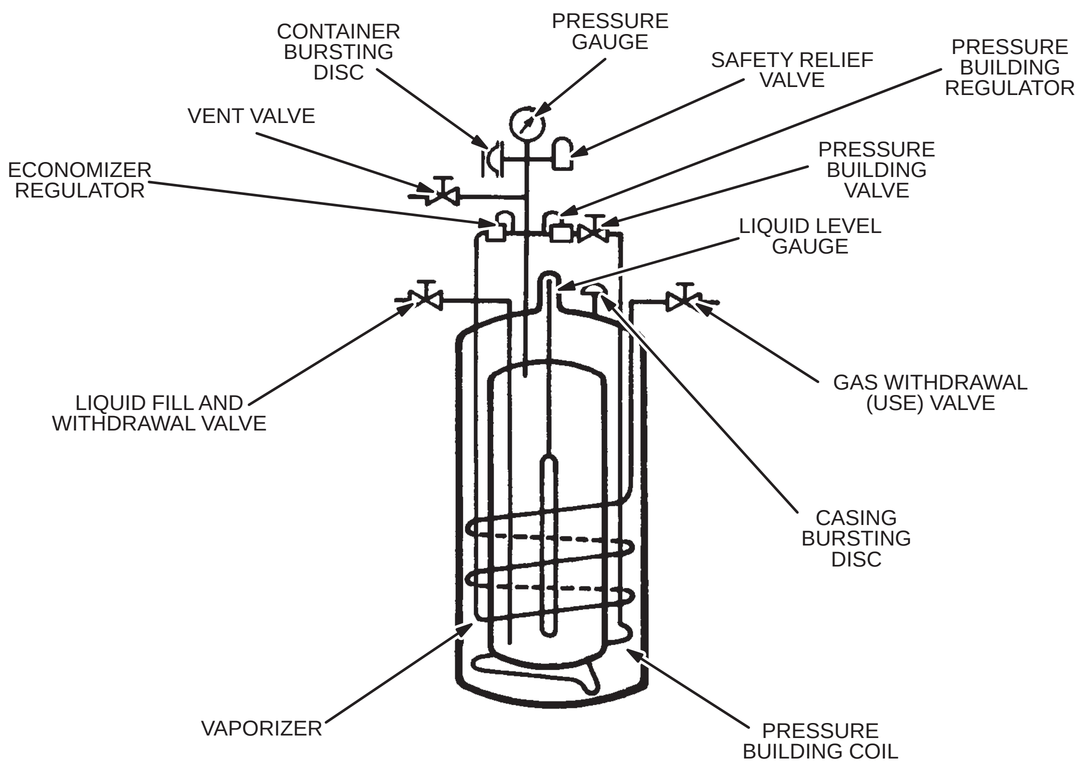
1. Obtain a full Liquid Nitrogen Dewar. Verify that all valves are in the closed position.

Note
Other sources of gaseous nitrogen may be used with appropriate setup apparatus.

2. Open PRESSURE BUILDING valve on dewar; verify that pressure gauge reading does not exceed 20 psig. See Illustration 3–1.



TOP VIEW OF NITROGEN DEWAR



TEXT IN PARENTHESIS REFERS TO THE IDENTIFICATION LABELS ON THE DEWAR.

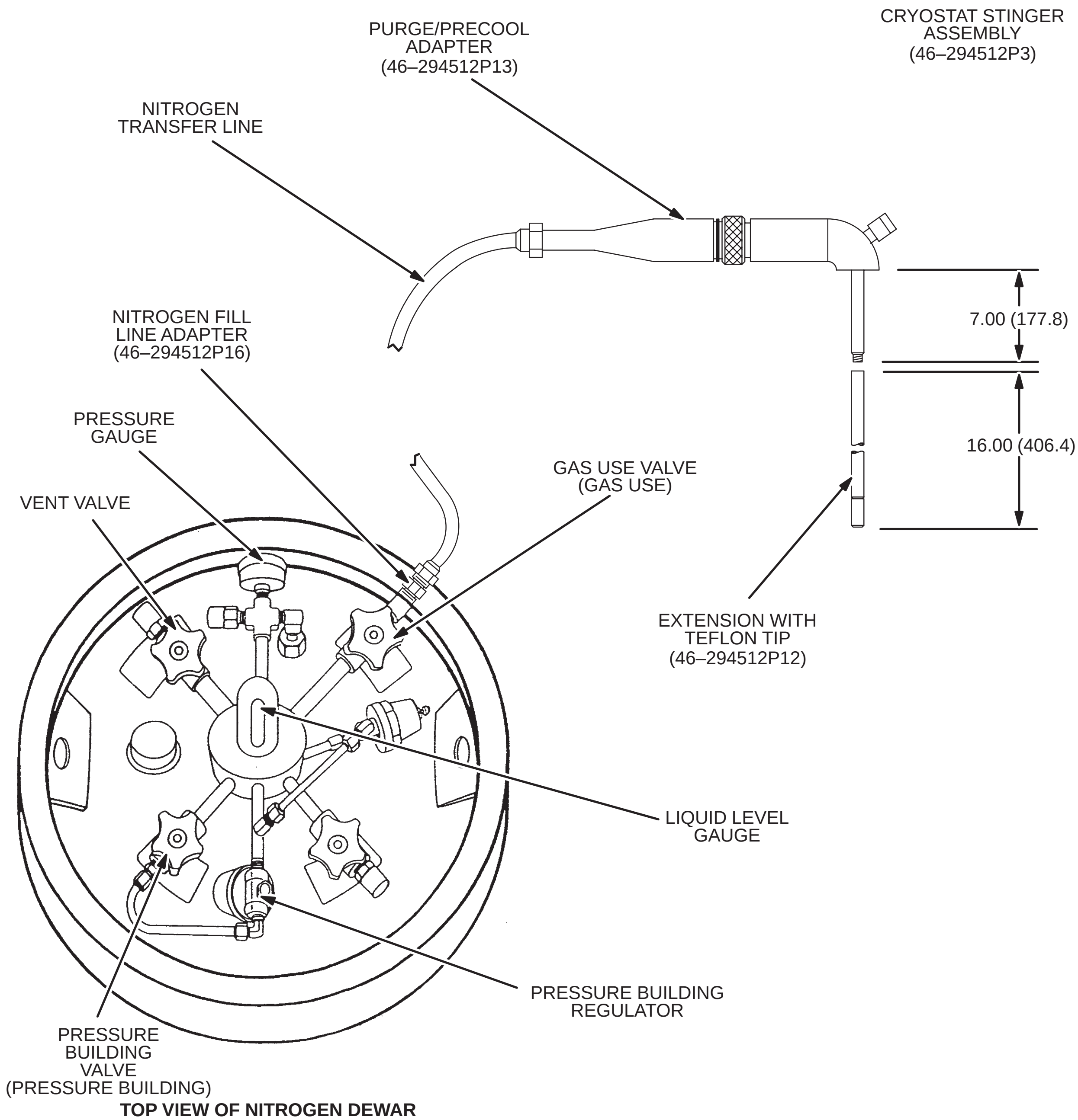
NITROGEN GAS/LIQUID DEWAR
ILLUSTRATION 3–1

9–1 GASEOUS NITROGEN PURGE (continued)

3. Connect Nitrogen Transfer Line to GAS USE valve on dewar using Nitrogen Fill line Adapter. See Illustration 3–2.

4. Connect Purge/Precool Adapter to opposite end of Nitrogen Transfer Line.

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



NITROGEN PURGE/PRECOOL ADAPTER
ILLUSTRATION 3–2

9–1 GASEOUS NITROGEN PURGE (continued)

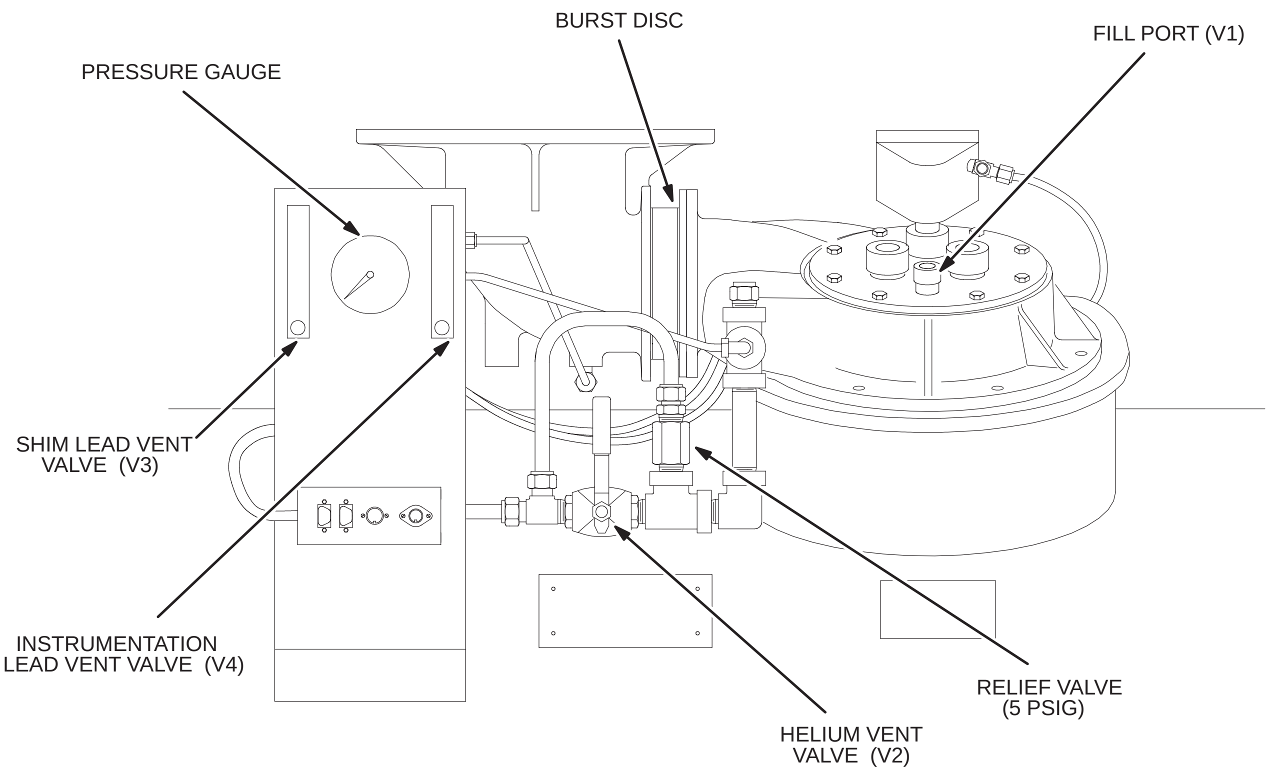
CAUTION

Make sure that Cryostat Stinger Extension (16 inch) and Teflon Tip are firmly secured during installation to prevent it from loosening and falling into magnet.

5. Screw 16 inch Cryostat Stinger Extension onto Cryostat Stinger Assembly. Make sure Teflon Tip is firmly attached to end of 16 inch Extension Tube.
6. Observe Cryostat Pressure Gauge. If pressure exceeds 0.5 psig, temporarily open Helium Vent Valve V2 allowing pressure to decrease to 0.5 psig. See Illustration 3–3.
7. Uncap Fill Port (V1). Remove Fill Port Plug.

Note

If ceiling height prevents insertion of Cryostat Stinger in Step 9, remove Extension from Cryostat Stinger and partially insert into Fill Port V1, before attaching it to the Cryostat Stinger. Grip extension firmly when inserting to prevent it from falling into magnet.



VALVE/VENT LOCATIONS
ILLUSTRATION 3–3

9–1 GASEOUS NITROGEN PURGE (continued)

8. Purge Nitrogen Transfer Line Assembly by partially opening GAS USE valve on dewar. Purge line for a minimum of 10 seconds, then connect Purge/Precool Adapter to Cryostat Stinger Assembly.

9. Fully insert Cryostat Stinger Assembly with Extension into Fill Port V1. Make sure that Extension is firmly seated then tighten Fill Port Compression Fitting.

10. Open Helium Vent Valve (V2).

11. Fully open GAS USE valve on dewar.

CAUTION

Do not allow cryostat pressure to exceed 5 psig in Step 12 to prevent any possible damage to the Burst Disc and Cryostat Pressure Gauge.

Note
Cycling Steps 12 and 13 are necessary to adequately purge Helium Vessel.

12. Close V2 allowing cryostat pressure to increase to 5 psig, observed on Cryostat Pressure Gauge. Then open V2 and allow pressure to decrease to 1 psig.

13. Repeat process in Step 12 continually for a 10 minute period.

14. Close GAS USE valve on dewar.

15. Close Helium Vent Valve V2.

16. Continue with Liquid Nitrogen Precool, Section 9–2.

9–2 LIQUID NITROGEN PRECOOL

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

SKIN CONTACT WITH LIQUID CRYOGENS WILL CAUSE BURNS. WEAR PROTECTIVE CLOTHING, GLOVES (NONABSORBENT MATERIAL) AND GOGGLES OR FACE SHIELD WHEN TRANSFERRING CRYOGENS.

SMOKING IS PROHIBITED IN THE EXAM AND CRYOGEN STORAGE ROOMS. LIQUID CRYOGENS CAN LIQUIFY ATMOSPHERIC OXYGEN, PRODUCING A HIGHLY COMBUSTION SUPPORTING FLUID.

1. Obtain a full liquid nitrogen dewar. Verify that all valves are in the closed position.

Note

Other sources of gaseous and liquid nitrogen may be used with appropriate setup apparatus.

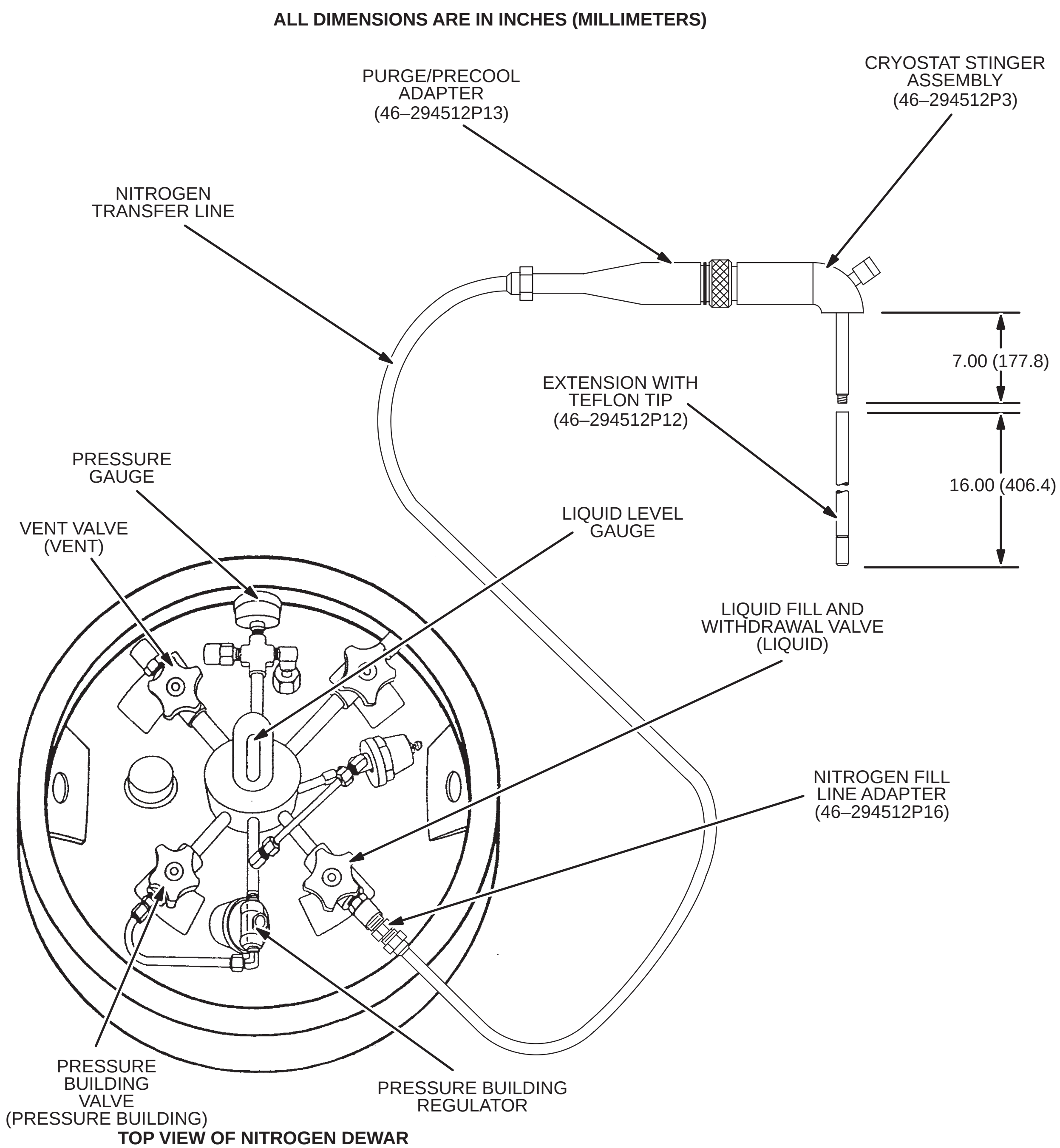
2. Open PRESSURE BUILDING valve on dewar; verify that pressure gauge reading does not exceed 20 psig. See Illustration 3–1.
3. Connect Nitrogen Transfer Line to LIQUID valve on dewar. Remove special Nitrogen Fill Line Adapter if attached to Transfer Line, before connecting. See Illustration 3–4.
4. Connect Purge/Precool Adapter to opposite end of Nitrogen Transfer Line. See Illustration 3–2.
5. Screw 16 inch Extension Tip onto Cryostat Stinger Assembly. Make sure Teflon Tip is firmly attached to end of 16 inch Extension Tube.
6. Observe cryostat pressure gauge. If pressure exceeds 0.5 psig, temporarily open Helium Vent Valve V2 allowing pressure to decrease to 0.5 psig. See Illustration 3–3.
7. Uncap fill port (V1).

Note

If ceiling height prevents insertion of Cryostat Stinger in Step 8, remove Extension Tip from Cryostat Stinger and partially insert into Fill Port V1, before attaching it to the Cryostat Stinger. Grip Extension firmly when inserting to prevent falling into magnet.

8. Purge Nitrogen Transfer Line Assembly by partially opening LIQUID valve on dewar.
9. Fully insert Cryostat Stinger Assembly with Extension Tip into Fill Port V1. Make sure that Extension Tip is firmly seated then tighten Fill Port Compression Fitting.

9–2 LIQUID NITROGEN PRECOOL (continued)



NITROGEN PRECOOL SET UP
ILLUSTRATION 3–4

9–2 LIQUID NITROGEN PRECOOL (continued)

10. Open Helium Vent Valve (V2).
11. Close LIQUID valve on dewar, then immediately connect Purge/Precool Adapter to Cryostat Stinger Assembly.
12. Open LIQUID valve and monitor Cryostat Pressure Gauge. Adjust valve as required to maintain 3 to 4 psig as displayed on Cryostat Pressure Gauge.

CAUTION

Do not allow cryostat pressure to exceed 5 psig, to prevent any possible damage to the Burst Disc and Cryostat Pressure Gauge.

13. Connect service readout equipment for the cryogen temperature diodes, e.g., Lakeshore 208 Thermometer, to the Diode Connector on the Magnet (MSI–A3, A1). See SET UP AND CALIBRATION, Section 1–4.
14. Record temperature readings at 1 hour intervals.

CAUTION

Do not cool cryostat below 90k with liquid nitrogen, to prevent liquid nitrogen from collecting in the helium vessel.

Observe ΔT between magnet diodes. If ΔT exceeds values shown in Table 3–1, temporarily suspend liquid nitrogen flow to allow diode temperatures to reach equilibrium.

TABLE 9–1
APPROXIMATE COOLDOWN RATES

FROM	TO	K/hr	*Diode ΔT
300K	200K	5	< 75K
200K	100K	3–4	< 50K
* TOP AND BOTTOM DIODE TEMPERATURES			

9–2 LIQUID NITROGEN PRECOOL (continued)

15. Continue precool until 95K reading is reached on either of the magnet diodes.

Note

It may take up to 48 hours (12 to 15 dewars) to precool the cryostat from room temperature (300k) to 95k.

16. When nitrogen dewar is empty, close all dewar valves, close V2, disconnect Purge/Precool Adapter from Cryostat Stinger Assembly and immediately install Brass Blanking Cap onto Cryostat Stinger Assembly. See Illustration 3–5.
17. Remove Nitrogen Transfer Line Assembly and repeat entire procedure (Steps 1 through 16) for each consecutive dewar.

CAUTION

A sudden drop in temperature to 77 – 80k during precool indicates that liquid nitrogen is collecting in the bottom of the helium vessel. Discontinue liquid nitrogen flow immediately and purge the collected liquid from the cryostat with gaseous nitrogen, in conformance with Section 9–1, until a temperature of 95k is indicated on both diodes.

18. Upon completion of Precool, close all dewar valves, close V2, disconnect Purge/Precool Adapter from Cryostat Stinger Assembly and immediately install Brass Blanking Cap onto Cryostat Stinger Assembly.
19. Remove Nitrogen Transfer Line Assembly and dewar from magnet room and proceed to Section 9–3, HELIUM PURGE.

9–3 HELIUM PURGE

WARNING!

WEAR PROTECTIVE SAFETY EYEWEAR (SAFETY GLASSES, GOGGLES OR FACE SHIELD) WHEN TRANSFERRING HELIUM GAS.

MAKE SURE SUFFICIENT VENTILATION EXISTS IN THE EXAM ROOM TO DISPEL THE LARGE AMOUNTS OF HELIUM GAS WHICH WILL DISPLACE THE AIR (OXYGEN) AND COULD CAUSE ASPHYXIATION. VENT HELIUM FROM ROOM DURING PURGING PROCEDURE.

1. Obtain 2, large (235 SCF), full, aluminum, gaseous helium cylinders.

9–3 HELIUM PURGE (continued)

WARNING!

SECURE CYLINDER BEFORE REMOVING PROTECTIVE VALVE CAP TO PREVENT CYLINDER FROM FALLING, WHICH COULD RESULT IN SHEARING VALVE OUTLET AND CAUSING HAZARDOUS HIGH PRESSURE GAS RELEASE.

2. Connect standard high pressure GHe regulator and hose assembly to valve outlet (CGA 580) on GHe cylinder.
3. Connect Helium Gas Line Adapter to Purge/Precool Adapter then connect Helium Gas Line to Adapter. See Illustration 3–5.
4. Make sure that regulator adjusting handle is fully backed out, then slowly open GHe Cylinder Valve.
5. Observe Regulator High Pressure Gauge. Make sure indicated pressure is approximately 2000 psig indicating full cylinder.

WARNING!

FIRMLY HOLD PURGE/PRECOOL ADAPTER WHILE PURGING REGULATOR AND GAS LINE ASSEMBLY TO PREVENT WHIPPING MOTION.

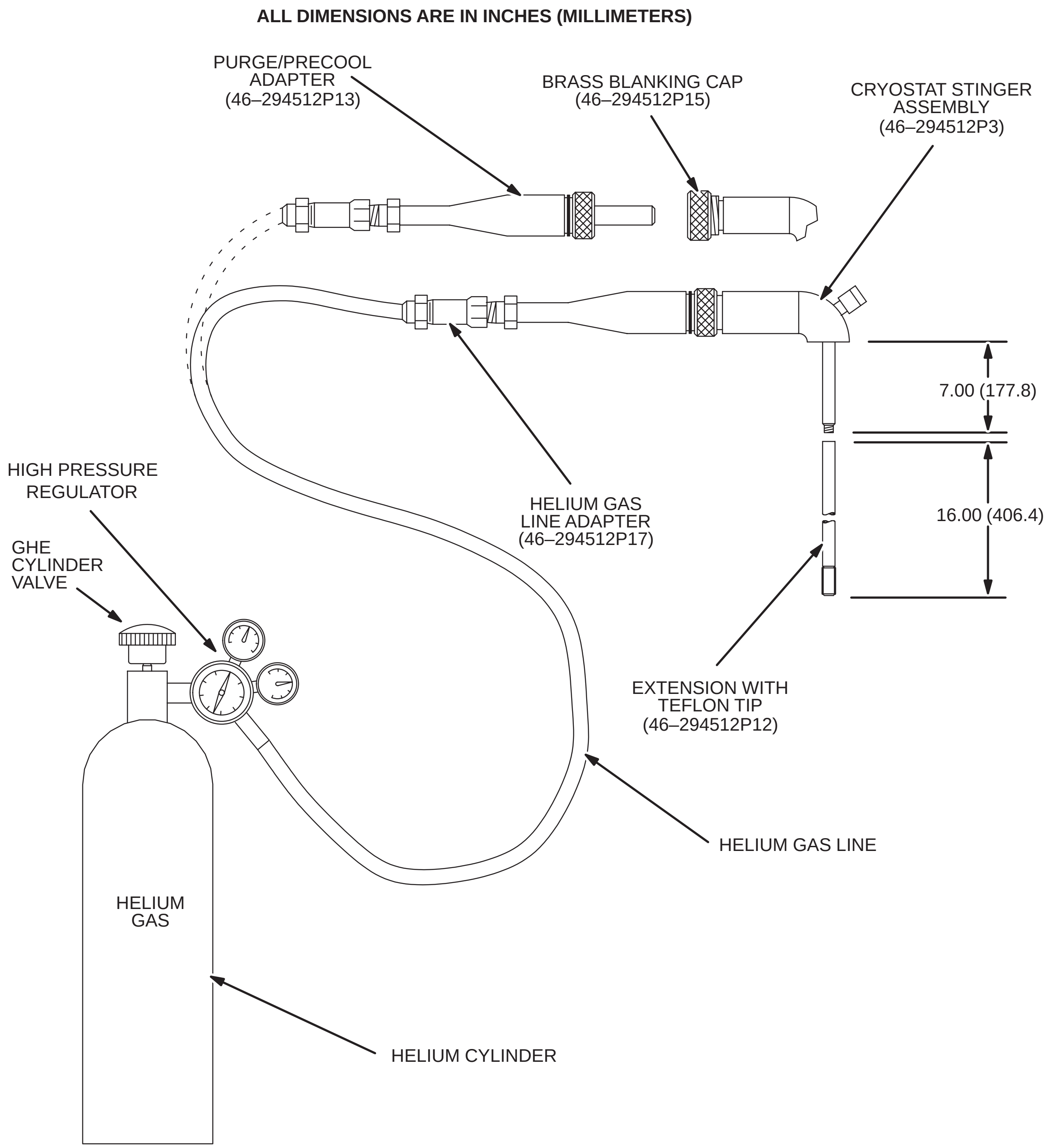
6. Purge regulator and gas line assembly by alternately turning regulator handle fully in and out 3 times. Upon completion of purge, back regulator out until minimal flow is felt exiting the Purge/Precool Adapter.
7. Remove Brass Blanking Cap from Cryostat Stinger Assembly and immediately connect Purge/Precool Adapter to Cryostat Stinger Assembly.
8. Open Helium Vent Valve (V2) on magnet.
9. Adjust regulator outlet pressure to 5 psig.
10. When GHe cylinder is empty, close V2, disconnect Purge/Precool Adapter from Cryostat Stinger Assembly and immediately install Brass Blanking Cap on Stinger Assembly.

Note

Helium purge is complete when second GHe cylinder is empty. Purging with more than 2 cylinders will cause unnecessary warming of the cryostat.

11. Repeat Steps 2 thru 9 for second GHe cylinder.
12. Continue with Section 2, LIQUID HELIUM FILL.

9–3 HELIUM PURGE (continued)



HELIUM PURGE SET–UP
ILLUSTRATION 3–5

SECTION 9 – 1.5T CRYOSTABLE MAGNET RAMPING PROCEDURE

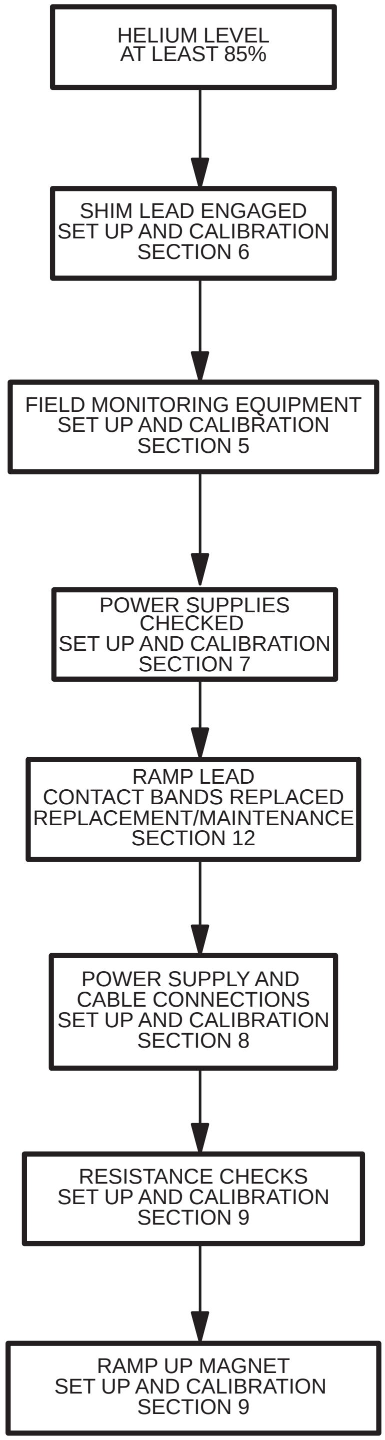
Description

The 1.5T Cryostable magnet Ramping current is approximately 705 amps. This procedure utilizes Voltage Control for ramping. If Ramp and Shim Cables were not ordered with the magnet, Ramp Cable Kit P/N 2135435 will be needed to Ramp the magnet and Shim Cable Kit P/N 2135558 will be needed to shim the magnet.

WARNING!

THE FOLLOWING REQUIRED SAFETY ACTIONS MUST BE TAKEN PRIOR TO RAMPING THE MAGNET:

1. **MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).**
2. **NOTIFY SITE ADMINISTRATION BEFORE RAMPING THE MAGNET THAT ALL MAGNETIC SAFETY PRECAUTIONS MUST BE TAKEN.**
3. **POST WARNING SIGNS OUTSIDE THE 5 GAUSS ZONE TO ALERT PERSONNEL WITH CARDIAC PACEMAKERS, NEUROSTIMULATORS AND OTHER BIOSTIMULATION DEVICES NOT TO PROCEED INTO THE DESIGNATED AREA. POST THESE SIGNS ON THE MAGNET ROOM LEVEL AS WELL AS AREAS BELOW THE MAGNET TO WHICH THE 5 GAUSS ZONE EXTENDS. SEE INTRODUCTION, SECTION 5.**
4. **POST “RAMPED MAGNET” WARNING SIGN AT THE MAGNET ROOM ENTRANCE PRIOR TO RAMPING THE MAGNET. WARNING TO ALERT PERSONNEL THAT NO FERROMAGNETIC MATERIAL OR INDIVIDUALS WITH CARDIAC PACEMAKERS, NEUROSTIMULATORS OR STEEL PLATES ARE ALLOWED IN THE MAGNET ROOM WHEN THE MAGNET IS RAMPED.**
5. **REMOVE ALL LOOSE FERROMAGNETIC MATERIAL FROM THE MAGNET ROOM. PULL THE POWER SUPPLIES AS FAR AWAY FROM THE MAGNET AS THE CABLES AND SITE GEOMETRY ALLOW. METAL OBJECTS CAN BECOME DANGEROUS PROJECTILES IN A MAGNETIC FIELD.**
6. **MAKE SURE THAT THE MAGNET RUNDOWN UNIT IS INSTALLED AND OPERATIONAL TO ENABLE THE MAGNETIC FIELD TO BE QUICKLY DISCHARGED IN CASE OF AN EMERGENCY. SEE SET UP AND CALIBRATION, SECTION 1–5.**
7. **MAKE SURE THAT THE MAGNET IS AT LEAST 85% FULL OF LIQUID HELIUM TO PREVENT THE LIQUID HELIUM LEVEL FROM DROPPING TO A POINT, DURING RAMPING, WHERE A QUENCH MAY OCCUR.**



RAMP FLOWCHART
ILLUSTRATION 9–1

9–1 PREPARATION

1. Set up the field monitoring equipment, Teslameter and Teslameter Probe, in conformance with SET UP AND CALIBRATION, Section 5.
2. Perform Magnet Electrical Checks in conformance with FUNCTIONAL CHECKS, Section 3.
3. Make sure the magnet is at least 85% full of helium before Ramping the magnet.

WARNING!

THE 1.5T MAGNET CAN BE QUENCHED IF THE MAGNET POWER SUPPLY EXPERIENCES LARGE OUTPUT VOLTAGE FLUCTUATIONS AND/OR EXCESSIVE RIPPLE. MAKE SURE THE POWER SUPPLY IS ROUTINELY CALIBRATED AT AN APPROVED FACILITY.

4. Make sure that the Main Power Supply is installed, checked and adjusted in conformance with the Vendor Manual supplied with the unit.
5. Make sure the Shim Lead Assembly is “Engaged” in conformance with SET UP AND CALIBRATION, Section 6.
6. Make sure that Input Power Cable to the Power Supply is disconnected.
7. Connect the Power Supply to the magnet by making all cable connections in conformance with SET UP AND CALIBRATION, Section 8. (“Electrical Connections For Ramping And Shimming”)
8. Record the Main Coil connection polarity in DATA SHEETS, Table 6–1.
9. Set all power supply heater switches to the OFF position. Set CURRENT ADJUST and VOLTAGE controls to 0 (full CCW).
10. Connect the Input Power Cable to the Main Power Supply.
11. Make sure He Vent Valve (V2) is closed.

9–2 RESISTANCE CHECKS

1. Check Switch Heater and Shim Coil resistances in conformance with FUNCTIONAL CHECKS, Section 3.
2. Make sure CURRENT ADJUST and VOLTAGE controls on the Main Power Supply are off (full CCW).

Note

All “Main Coil Driving Voltages” provided in this procedure will be equal in magnitude but opposite in polarity for “Reverse Ramped” magnets.

WARNING!

MAKE SURE MAIN HEATER SWITCH IS OFF DURING THE RESISTANCE CHECKS.

3. Set the MAIN POWER and POWER ON switches to ON (Switches located on both the front and back of the Main Power Supply).

9–2 RESISTANCE CHECKS (continued)

4. Set HEATER 2 SHIM AXIAL switch to 1 (on) and observe current rise in ammeter (800–820 mA) to verify circuit continuity. Make sure Main Heater Switch is off.
5. Connect a Digital Voltmeter (DVM) to the end of the Voltage Sense Leads.
6. Set CURRENT ADJUST controls on power supply to maximum (full CW).
7. Observe the Main Power Supply Ammeter and slowly turn the VOLTAGE control (CW) to set 750A current through the Main Power Leads, Lead Extensions and persistent Main Switch.
8. Record the voltage reading on the (DVM) in the DATA SHEET tab, Table 6–1.

WARNING!

A VOLTAGE READING GREATER THAN 150 MILLIVOLTS AT 750 AMPS INDICATES UNACCEPTABLE INTERNAL CONTACT RESISTANCE OF THE LEAD EXTENSIONS. HIGHER RESISTANCES WILL ADD MORE HEAT TO THE MAGNET INCREASING BOILOFF AND POSSIBLY CAUSING A QUENCH DURING RAMPING.

9. Perform one or more of the bulleted steps below, as necessary, if the DVM voltage is greater than 150mV.

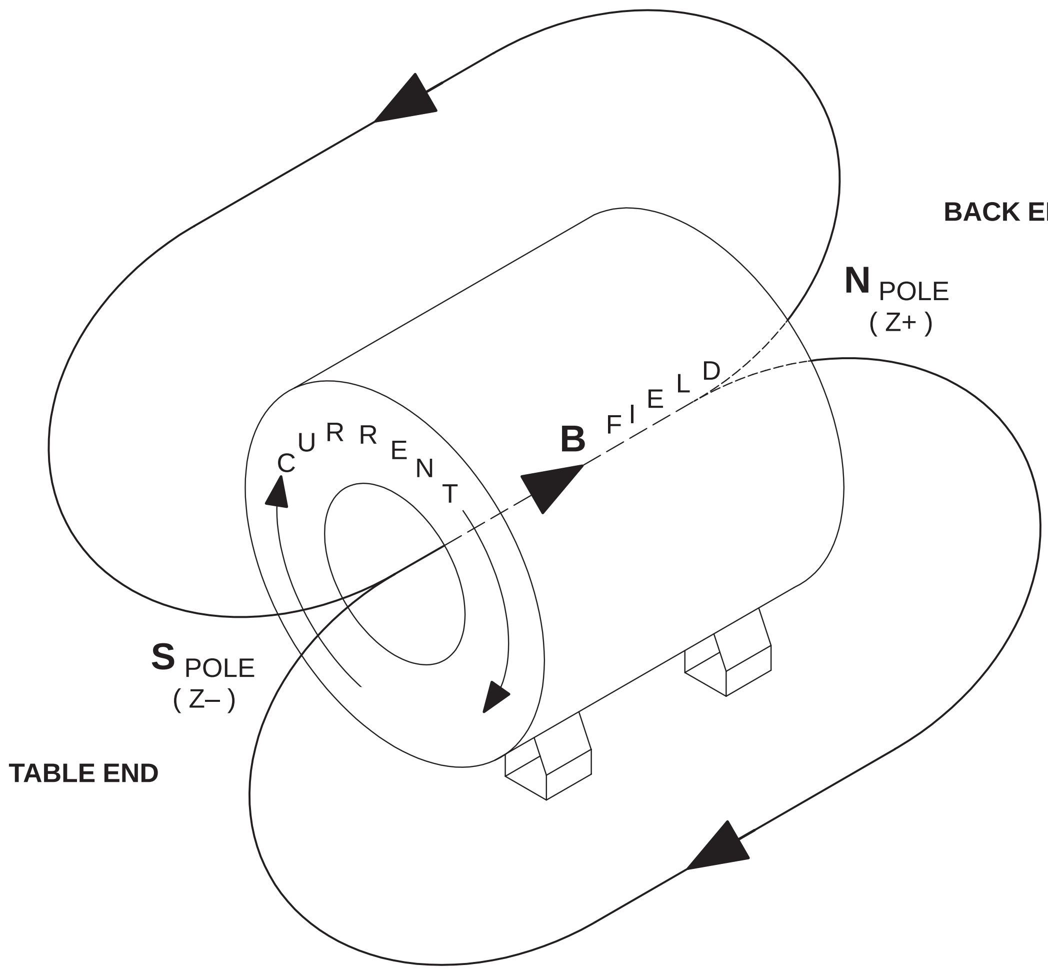
   - Wait approximately 1 minute with the current running, readings may drop as the Power Lead Extensions cool.
   - Tighten the nuts on top of the Hold Down Tool.
   - If the reading still exceeds 150 mV: turn the VOLTAGE and CURRENT ADJUST controls to zero (full CCW), turn off Magnet Power Supply input power, then check/tighten the bolts securing the Ramp Cables to the Power Supply and Ramp Leads Extensions. Lift and reseat the Ramp Leads. Repeat Steps 6 through 9.

10. Set the power supply VOLTMETER SELECT SWITCH to MAIN POWER SUPPLY position (This will display the output of the power supply monitored at the output lugs).

Note

A voltage less than 2.2V at 735A indicates acceptable system resistance. If the voltage exceeds 2.2V during the test, follow the procedures in Step 9 for adjusting contact resistance.

11. Gradually adjust the VOLTAGE ADJUST control to pass 735A through the Main Power leads, Lead Extensions and persistent Main Switch while observing the Power Supply Voltmeter. If the voltage exceeds 2.2V, then check/tighten the bolts securing the Ramp Cables to the Power Supply and Ramp Lead Extensions.
12. Turn the CURRENT ADJUST and VOLTAGE controls off (full CCW) and continue with the ramping procedure after completion of Step 11.



MAGNET POLARITY RAMPED NORMAL
ILLUSTRATION 9–2

9–3 RAMPING

Procedure:

CAUTION

If a Quench occurs during ramping, immediately turn VOLTAGE control and CURRENT control of the Main Coil Power Supply to zero (fully CCW). A quench is a rapid discharge of the magnetic field which will result in the rapid generation and expulsion of helium gas, rupturing the Burst Disc in the Vent System.

WARNING!

MAKE SURE THAT THE AXIAL SHIM SWITCH HEATER IS ON DURING RAMPING TO PREVENT COIL DAMAGE AND MAGNET QUENCH. GE POWER SUPPLIES HAVE PROTECTIVE CIRCUITRY TO PREVENT RAMPING VOLTAGE WITH THE AXIAL HEATER SWITCH IN THE "OFF" POSITION.

Note

Ice will form around the Ramp Lead Hold Down Tool Flow Holes during ramping. Remove ice as needed to maintain helium gas flow.

1. Make sure valve V2 is closed.
2. Make sure VOLTAGE ADJUST AND CURRENTS ADJUST controls are at zero (full CCW).
3. Set HEATER 2 SHIM AXIAL Switch, on the Main Power Supply, to 1 (ON).

9–3 RAMPING (continued)

4. Set Main Ramp Power Supply MAIN POWER Switch to ON.
5. Push and hold the SET POINT button then set CURRENT ADJUST controls for a reading of 710 amps on the power supply digital CURRENT meter. This sets the parking current.
6. Release SET POINT button.
7. Set HEATER 1 MAIN switch to 1 (on). Wait 3 minutes.
8. Set the power supply VOLTMETER SELECT SWITCH to MAIN COIL position.

RAMPING VOLTAGE VERSUS CURRENT

TABLE 9–1

MAIN COIL DRIVING VOLTAGE	MAIN COIL CURRENT
4.00 VOLTS	FROM 0 TO 100 AMPS
3.75 VOLTS	FROM 100 TO 200 AMPS
3.5 VOLTS	FROM 200 TO 300 AMPS
3.00 VOLTS	FROM 300 TO 400 AMPS
2.50 VOLTS	FROM 400 TO 500 AMPS
1.50 VOLTS	FROM 500 TO 600 AMPS
0.75 VOLTS	FROM 600 TO 650 AMPS
0.50 VOLTS	FROM 650 TO 675 AMPS
0.35 VOLTS	GREATER THAN 675 AMPS

9. Turn power supply VOLTAGE ADJUST control until a reading of 4.00 volts is observed on the power supply digital VOLTMETER.

Note

Measured inductance should be approximately 11 henrys. If the calculated value is between 14.5 – 16.5 Henries continue with the procedure. If the calculated value is outside this range, discontinue ramping and measure Main Coil Resistance (See FUNCTIONAL CHECKS, Section 3). Contact the Region MAC Team Representative.

10. Estimate the system inductance by measuring current change over a 10 second ramping interval:

L(inductance) = 10 x Voltage/Current Change

Note

This method will give inaccurate values of inductance when the current is less than 200 Amps.

Note

The Teslameter will lock on when magnet current rises between 350 to 400 amps (using a Range 5 Probe). This usually occurs between 0.6 and 0.7 Tesla (25.545900 MHz – 29.803550 MHz). If the teslameter has not locked on, after reaching a magnet current of 500 amps, slowly reduce Main Coil drive voltage to approximately 0.0v than select “MANUAL” position on magnetometer and adjust the “COARSE” vernier knob until the teslameter locks on to the field. Once the teslameter is locked on, select “AUTO” mode and continue with Ramping.

9–3 RAMPING (continued)

WARNING!

THE 1.5T MAGNET CAN BE QUENCHED IF LARGE CURRENT OR VOLTAGE CHANGES OCCUR NEAR PARKING. WHEN ADJUSTING THE VOLTAGE IN STEP 19 BELOW, TURN THE VOLTAGE CONTROL IN A SLOW, CONTINUOUS MOTION. BE CAREFUL NOT TO JERK THE VOLTAGE CONTROL.

Note

Allow Main Coil Driving voltage to decay between each of the steps below (e.g. in Step 11 adjust the Main Coil Driving voltage to 3.75V and do not readjust until Step 12).

11. When the magnet current reaches 100 amps, slowly adjust the VOLTAGE ADJUST control, counterclockwise, for 3.75 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter (Voltmeter Select Switch in the Main Coil position).
12. When the magnet current reaches 200 amps, slowly adjust the VOLTAGE ADJUST control for 3.50 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.
13. When the magnet current reaches 300 amps, slowly adjust the VOLTAGE ADJUST control for 3.00 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.
14. When the magnet current reaches 400 amps, slowly adjust the VOLTAGE ADJUST control for 2.50 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.
15. When the magnet current reaches 500 amps, slowly adjust the VOLTAGE ADJUST control for 1.50 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.
16. When the magnet current reaches 600 amps, slowly adjust the VOLTAGE ADJUST control for 0.75 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.
17. When the magnet current reaches 650 amps, slowly adjust the VOLTAGE ADJUST control for 0.50 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.
18. When the magnet current reaches 675 amps, slowly adjust the VOLTAGE ADJUST control for 0.35 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter
19. Check Teslameter and slowly adjust the VOLTAGE ADJUST controls, as required, to bring Magnetic Field between 1.4999 – 1.5001 Tesla (63.866 – 63.874 MHz). The total current will be approximately 705 amps. Allow final field to stabilize. The last two digits on the Teslameter should be the only digits changing.
20. Maintain field at final setting for 5 minutes before proceeding to Step 21.

Note

Observe voltage (read on Power Supply Voltmeter with toggle switch in MAIN COIL position). When field / current stabilizes the voltage across the magnet terminals will stabilize at 0.00.

9–3 RAMPING (continued)

21. Turn off Main Switch Heater. Wait a minimum of 15 minutes for the switch to fully cool and go “persistent”.
22. Record current, frequency and lead extension voltage values at which the switch went “persistent” in DATA SHEETS, Table 6–1.

WARNING!

MAKE SURE THAT THE CONNECTION POLARITY AND FINAL RAMPING CURRENT ARE RECORDED IN DATA SHEETS, TABLE 6–1. THIS INFORMATION IS ESSENTIAL FOR LATER CHANGING OF THE MAGNETIC FIELD. THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS TO AVOID A QUENCH WHEN TURNING ON THE MAIN SWITCH.

Note

Check that Teslameter does not decrease as the VOLTAGE ADJUST control knob is turned to Zero. Only the last two digits on the Teslameter should change. If the field decreases as the VOLTAGE control knob is turned, the main coil switch is not persistent and the VOLTAGE control must be slowly adjusted to return to Parking Field. The field will drop approximately 1 KHz when the power supply is being dialed down to zero amps.

23. When the switch goes “persistent”, slowly turn the power supply VOLTAGE ADJUST control to zero (full CCW) over a minimum of two minutes.
24. Gradually turn the CURRENT ADJUST control to zero (over a one minute period).
25. Set HEATER 2 SHIM AXIAL switch to 0 (off).
26. Set MAIN POWER AND POWER ON switches to OFF, on Main Power Supply and disconnect Input Power Cable.
27. Remove ramp lead hold down tool and replace bolts on lead assembly mounting plate.

CAUTION

Step 28 must be followed precisely in order to avoid an excessive heat load being applied to the magnet cartridge and a possible quench following a magnet ramp.

9–3 RAMPING (continued)

28. After parking the magnet and disconnecting main power supply, plug and remove one ramp extension at a time in the following sequence.

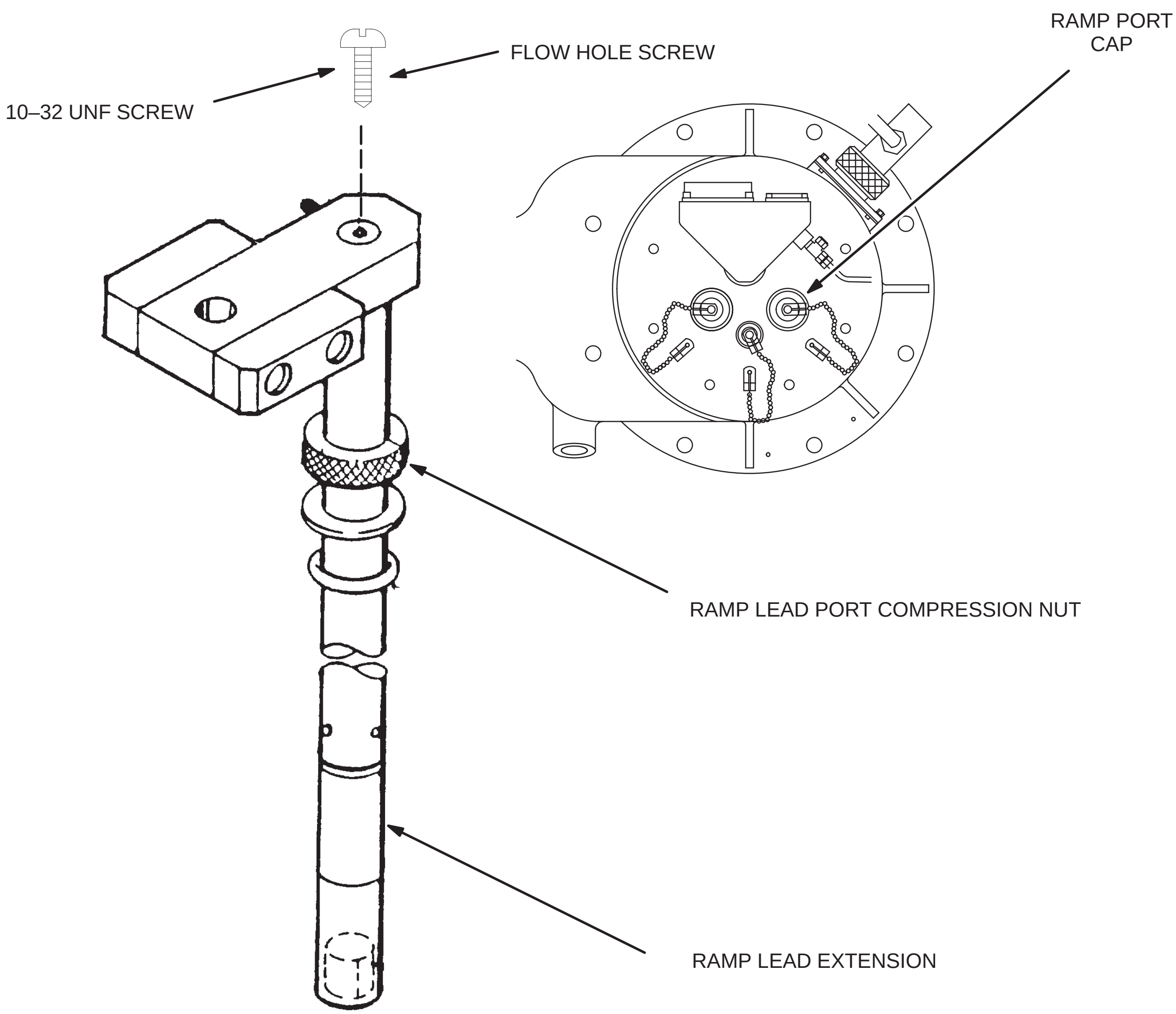
    a) Open valve (V2) to de–pressurize the cryostat to 0.25 psig. Close V2.

    b) Install a screw into the flow hole of only one of the ramp lead extensions. See Illustration 9–3.

    c) Remove all ice around the ramp lead port compression nut on the ramp lead extension that is being removed (i.e. the ramp lead extension that has the flow hole plugged in Step b). See Illustration 9–3.

    d) Unscrew the ramp lead port compression nut and remove the ramp lead extension from the magnet. Immediately replace the cap onto the ramp lead port.

    e) Repeat Steps b through e for the other ramp lead extension.



RAMP LEAD EXTENSION AND RAMP PORT COMPRESSION NUT
ILLUSTRATION 9–3

9–3 RAMPING (continued)

Note
Transverse coil currents will be removed in SET UP AND CALIBRATION, Section 10–2.

29. There may be small currents induced onto the Transverse Coils by the Ramping process. Make sure these currents are removed in conformance with SET UP AND CALIBRATION, Section 10–2 before Magnetic Probe Centering and Shimming the magnet.

CAUTION

Cryostat exhaust flow rates and pressure must be checked and adjusted as required after magnet installation, ramping and shimming to ensure that proper cooling conditions are maintained and no leaks are present in the Helium Exhaust System or Vent Valve (V2).

Note
Read all flow rates from the bottom of the float (ball) on the flow meters.

Note
Flow rates may be temporarily elevated after ramping. Do not adjust them until after the magnet has had time to stabilize (at least one day).

30. Make sure the following conditions are maintained. Re–check settings in three days and again after one week:

    INSTRUMENTATION LEAD FLOWMETER (F2) = 0.8 – 1.2 SCFH
    SHIM LEAD FLOWMETER (F1) = 1.8 – 2.2 SCFH
    CRYOSTAT GAUGE PRESSURE = 0.25 – 0.50 psig

Note
If flow rate through F2 is less than 0.8 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and "bubble test" all exhaust plumbing joints, relief valve and Shim Lead Connector. The vessel can be pressureized by either turning on the Correction Coil Heaters or turning off the Cold Head Compressor. Make sure V2 is fully closed. Repair any leaks.

31. Proceed to SET UP AND CALIBRATION, Section 10 ("Shimming Preparation/Field Stabilization").

SECTION 10 – SHIMMING PREPARATION / FIELD STABILIZATION

Description:

The preparations, covered in this procedure, are required before shimming the magnet. Allow the magnet to stabilize to < 0.1 ppm / hr (6.3 Hz / hr) main field drift before shimming. This will take from 4 to 12 hours. Other commissioning functions can be performed during this time. The minimum helium level for shimming is 65%.

Procedure:

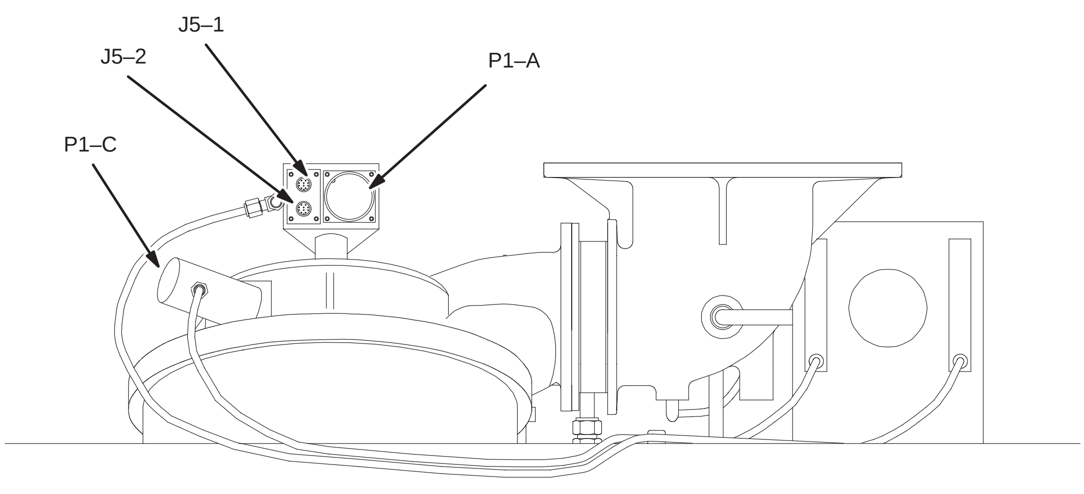
CAUTION

A minimum of 65% LHe is required for shimming. A "top off" of LHe is recommended to have a good residual LHe level for customer turnover. Moving articles or equipment in the magnet room may affect field readings.

9–6 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS

1. Verify that the Shim Lead Pigtail Cable P/N 2135362 is connected to P1–A on the Shim Lead Assembly. See Illustration 10–1.

2. Make sure the Shim Lead Pigtail Cable is Ty–wrapped to a magnet lifting lug before connecting it to the Shim Cable to eliminate strain on the Shim Lead Assembly.



MAGNET ELECTRICAL CONNECTIONS
ILLUSTRATION 10–1

9–6 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)

Note

The cap on the Shim Lead Assembly Exhaust Male Run Tee must be removed before adding or dumping shim currents to prevent "Thermal Shock" which can damage the Shim Leads.

3. Make sure the Shim Lead Assembly is Engaged in conformance to SET UP AND CALIBRATION, Section NO TAG. The cap to the Shim Lead Exhaust Fitting must be removed to increase current carrying ability in the Shim Leads.

4. Connect power to Superconducting Shim Coil Power Supply and set Shim Heater Currents (Axial, T1, T2) at 810 mA. See Vendor Service Manual, Section 4 for details.

Note

The SV magnet does not have any correction coils for the following: T1–3, T1–5, T1–6, T2–3, T2–5, T2–6. Shim supplies will not operate when selecting any of these coils.

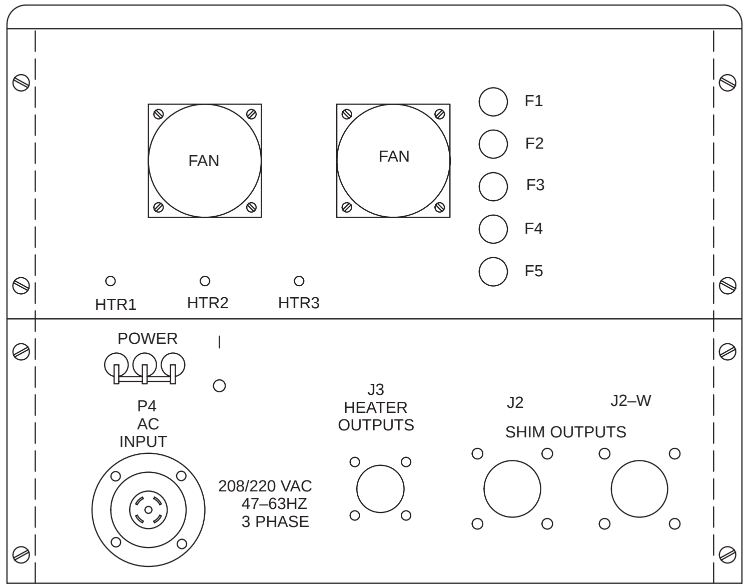
5. Verify all six Shim Power Supplies operate at both positive and negative polarities.

6. Disconnect the input power to the Superconducting Shim Coil Power Supply.

WARNING!

DO NOT CONNECT THE INPUT POWER TO OR TURN ON THE SUPERCONDUCTING SHIM COIL POWER SUPPLY UNTIL IT IS VERIFIED THAT ALL CURRENT CONTROLS ARE SET AT ZERO, FULLY COUNTERCLOCKWISE. TURNING THE SUPERCONDUCTING SHIM COIL POWER SUPPLY WHEN THE CURRENT CONTROLS ARE NOT AT ZERO MAY CAUSE IRREPARABLE DAMAGE TO THE VAPOR COOLED SHIM COIL LEADS.

7. Verify that (P2 & P2W) on the Superconducting Shim Coil Wire Harness (RUN #603) are connected to (J 2 & J 2–W) Shim Output Connectors on the back of the Power Supply Cabinet (MS7–A1). See Illustration 10–2.



SHIM POWER SUPPLY OUTPUT CONNECTIONS
ILLUSTRATION 10–2

9–6 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)

8. Verify that J 2 & J 2–W, on the other end of the Superconducting Shim Coil Cable (RUN #603), is connected to the Shim Lead Pigtail Cable.

9. Disconnect (P703) on Heater Wire Harness (RUN #604) from connector (J3) on the back of the Main Coil Power Supply Cabinet (MS6–A1) and connect (P703) to connector (J3) on the back of the Superconducting Shim Coil Power Supply Cabinet (MS7–A1).

10. Verify that connector (P5) on Heater Wire Harness (RUN #604) is connected to (J5–1 or J5–2) on the Shim Lead Assembly.

CAUTION

Only one Heater Wire Harness is to be connected to the Magnet Harness Terminal Box.

9–7 MAGNET STABILITY CHECK

1. Maintain probe setting at magnet physical center (R = 0, Z = 0).

Note

If Teslameter has been turned off, wait one hour for stabilization before performing the following steps.

WARNING!

BEFORE TURNING ON SUPERCONDUCTING SHIM COIL POWER SUPPLY, MAKE SURE THAT ALL CURRENT CONTROLS ARE SET TO ZERO, FULL COUNTERCLOCKWISE AND THAT THE HEATERS ARE IN THE “OFF” POSITION.

2. Connect input power on Superconducting Shim Coil Power Supply and turn on all Shim Coil Switch Heaters for one minute to dump any residual Shim Currents.

3. Turn off the Switch Heaters. Allow 3 to 5 minutes for switch heaters to go persistent before continuing with Step 4.

4. Disconnect heater cable (P703) from the Shim Power Supply.

5. Turn off Shim Power Supply and disconnect input power cable.

6. Monitor the magnetic field (center frequency) and verify the magnet has stabilized (max drift is 6.3 Hz/hr). Refer to FUNCTIONAL CHECKS, Section 2.

SECTION –12 POLARITY AND FUNCTIONAL CHECKS

Description:

Follow the procedures below if problems are encountered in shimming the magnet with the Superconducting Shim Coils. These procedures will help to identify: Shim Cable wiring error; Shim Coil Switch malfunction; Switch Heater malfunction; defective or misaligned S/C Shim Coil. See SCHEMATICS/INTERCONNECTS, Illustrations 2–1 and 2–2 ("Magnet System Wiring Diagram") and FUNCTIONAL CHECKS, Section 3 ("Magnet Electrical Checks") for troubleshooting if problems are encountered.

Note

If wiring problems are suspect, make sure the Shim Cables are not incorrectly wired before changing leads in the Magnet Connector Box.

12–1 AXIAL CORRECTION COIL

Description

The coil plots obtained in this section must be performed using the C6 mapping fixture set up.

1. Connect the Superconducting Shim Power Supply and Cable in conformance with SET UP AND CALIBRATION, Section 10.
2. Make sure the Field Monitoring Equipment is installed and aligned. See SET UP AND CALIBRATION, Section 5.
3. Turn on all Switch Heaters for 2 minutes, then turn heaters off to produce a virgin field.
4. Set the Teslameter probe to 0 cm radius and move it to the center of the magnet (i.e., axial = 0 cm and 0 degree rotation).
5. Record the virgin magnetic field at the magnet center (Z= 0cm) in Table 12–1.
6. Move the probe along the z–axis and record the virgin magnetic field at –20 cm and +20 cm.
7. Turn on the Axial and Transverse Switch Heaters. Allow the heaters to warm up for 2 minutes.

12–1 POLARITY AND FUNCTIONAL CHECKS (continued)

TABLE 12–1
AXIAL COIL DATA

S/C COIL	GAUSS READING (15,XXX.X)		
	Z = –20CM (TABLE END)	Z = 0CM (CENTER)	Z = +20CM (BACK END)
VIRGIN MAP			
AXIAL 1			
AXIAL 2			
AXIAL 3			
AXIAL 4			
AXIAL 5			
AXIAL 6			

WARNING!

DO NOT TURN ON THE MAIN MAGNET SWITCH HEATER. ACTIVATING THE MAIN MAGNET SWITCH HEATER WHILE THE MAGNET IS UP TO FIELD WILL RESULT IN A QUENCH.

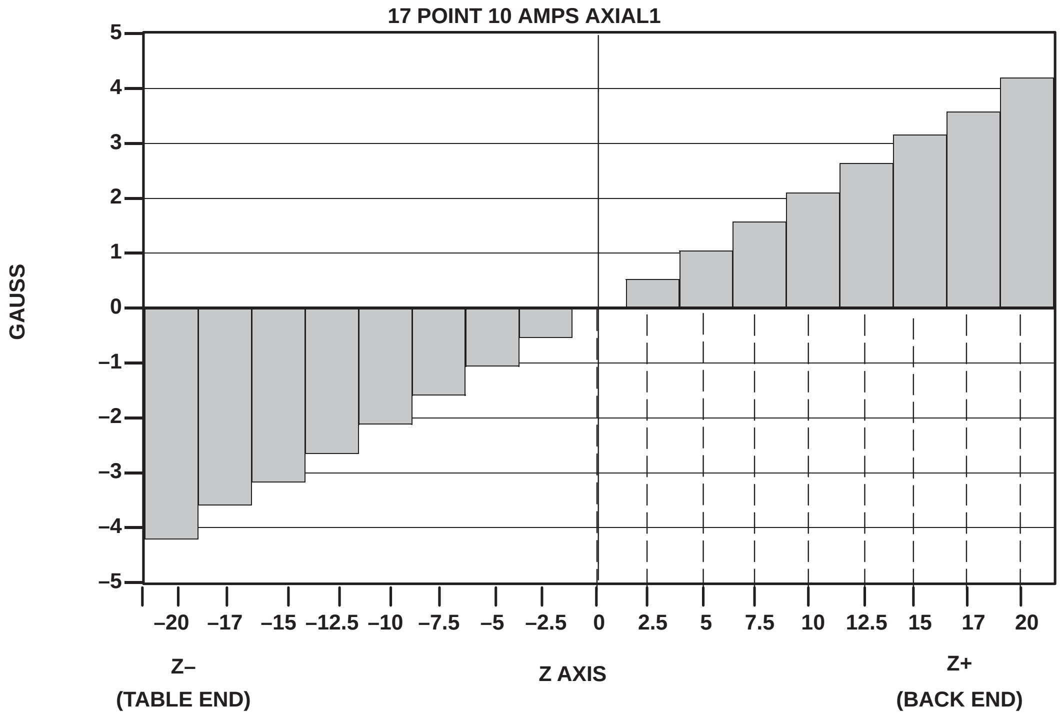
8. Apply 10 A to the Axial–1 coil (i.e. set Axial–1 Power Supply to 10 A).
9. Turn off the Axial and Transverse S/C Switch Heaters. Allow the heaters to cool for 2 minutes.
10. Ramp the Axial – 1 S/C Power Supply to 0 A after the Switch Heaters have cooled down for 2 minutes.
11. Move the probe to the –20 cm, 0 cm and +20 cm axial locations. Record the gauss values in Table 12–1.
12. Take the Axial 1 readings at –20 cm, 0 cm and +20 cm and subtract the corresponding point of the virgin map values from each.
13. Compare the gauss **difference** with the coil maps In Illustration 12–1.

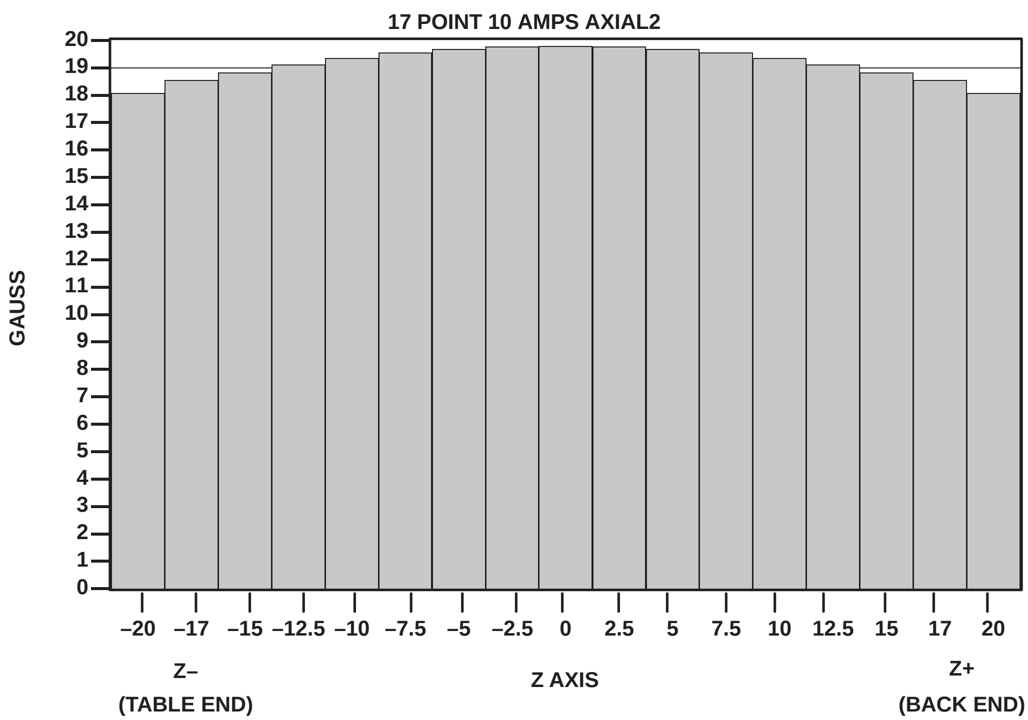
Note

If the polarity is correct for the Axial–1 Coil, the gauss value at the Table End (–20cm) will be approximately 4 gauss less than the –20cm virgin map value. However, the gauss value at +20cm along the z–axis is approximately 4 gauss greater than the +20cm virgin value.

14. Repeat Steps 6 through 13 for each of the Axial S/C Coils (Axial–2 through Axial–6). Compare the gauss differences with the plots in Illustrations 12–1 and 12–2. Rewire connectors on the Magnet Terminal Box (MS1–A3,A1) or change the Polarity Switch on the particular power supply as appropriate (i.e. when the collected data is opposite that in Illustrations 12–1 and 12–2).

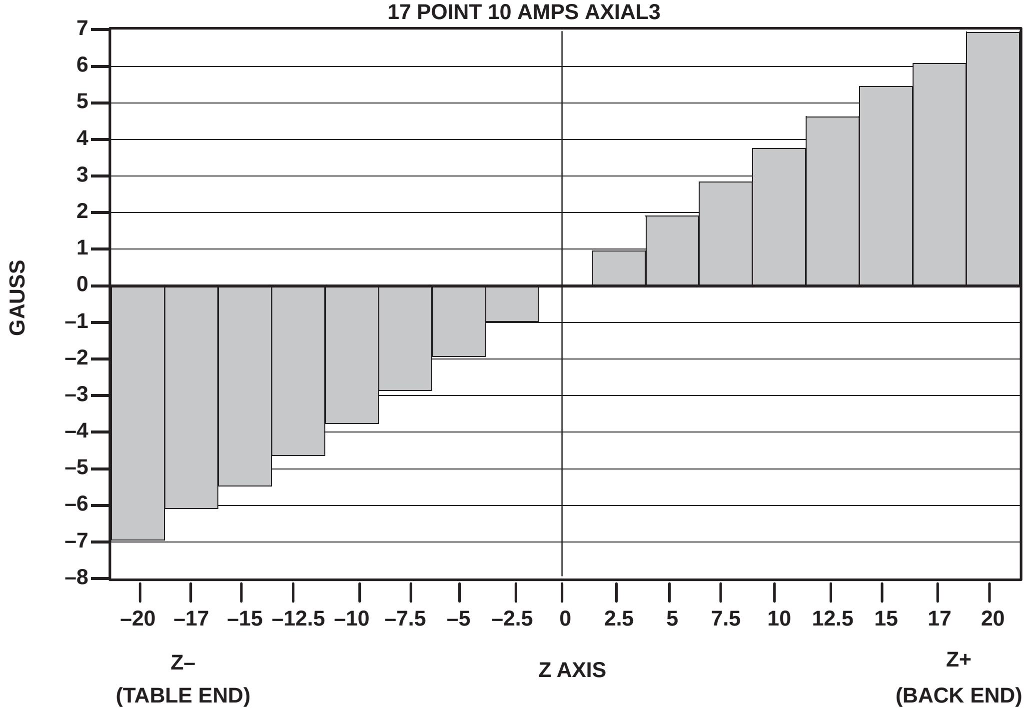
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS. C6 MAP.

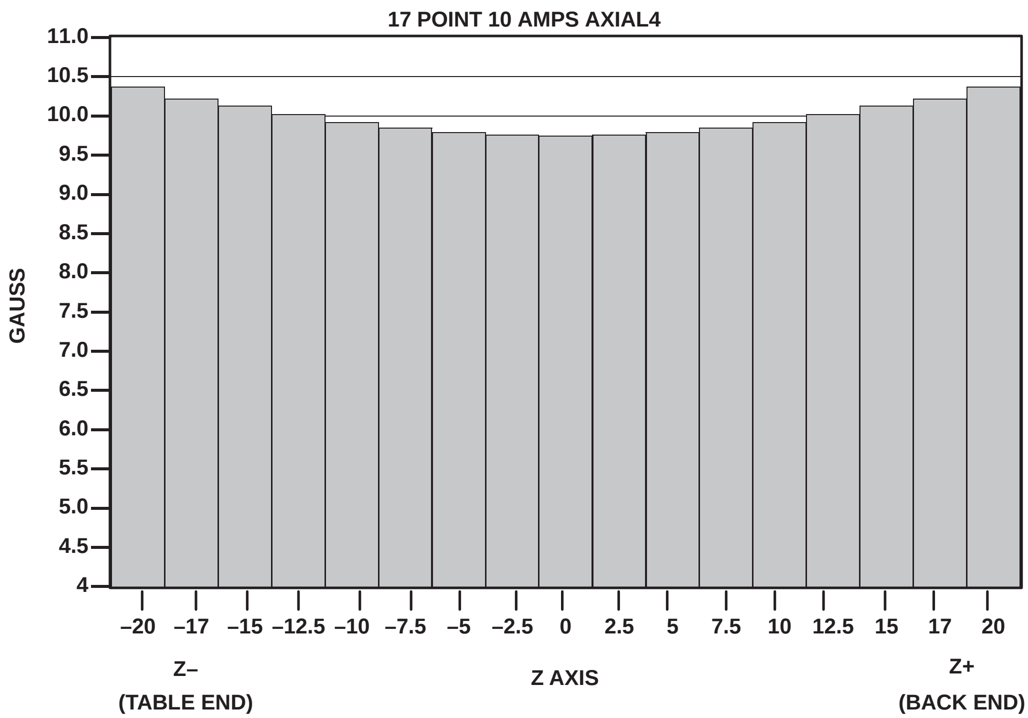




AXIAL 1 AND AXIAL 2 CORRECTION COIL PLOTS
ILLUSTRATION 12–1

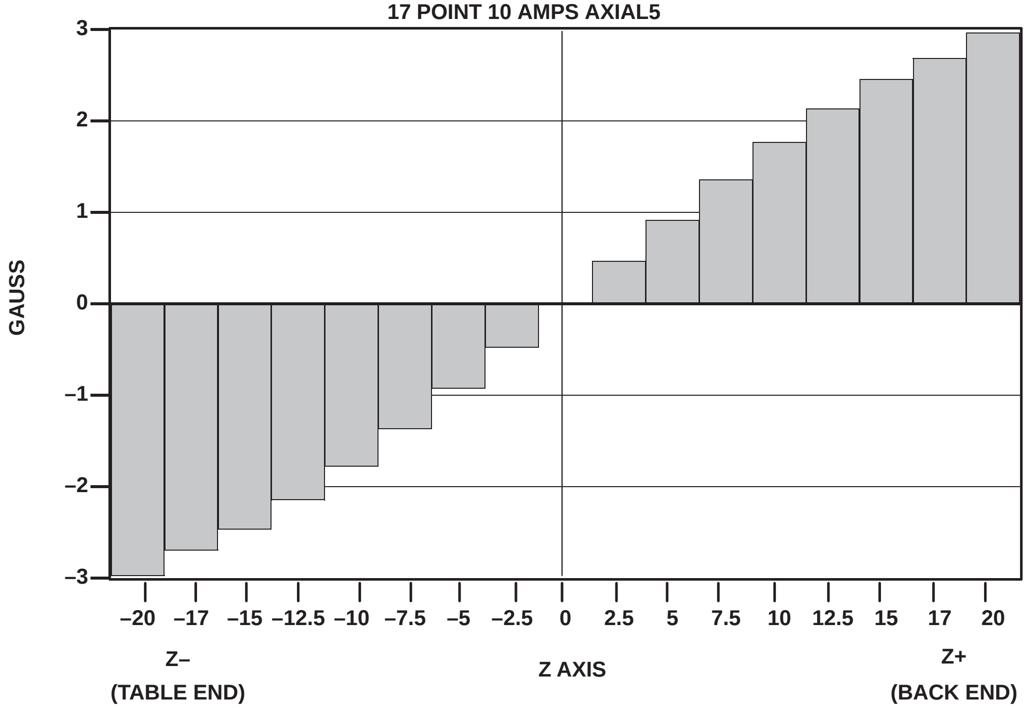
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.

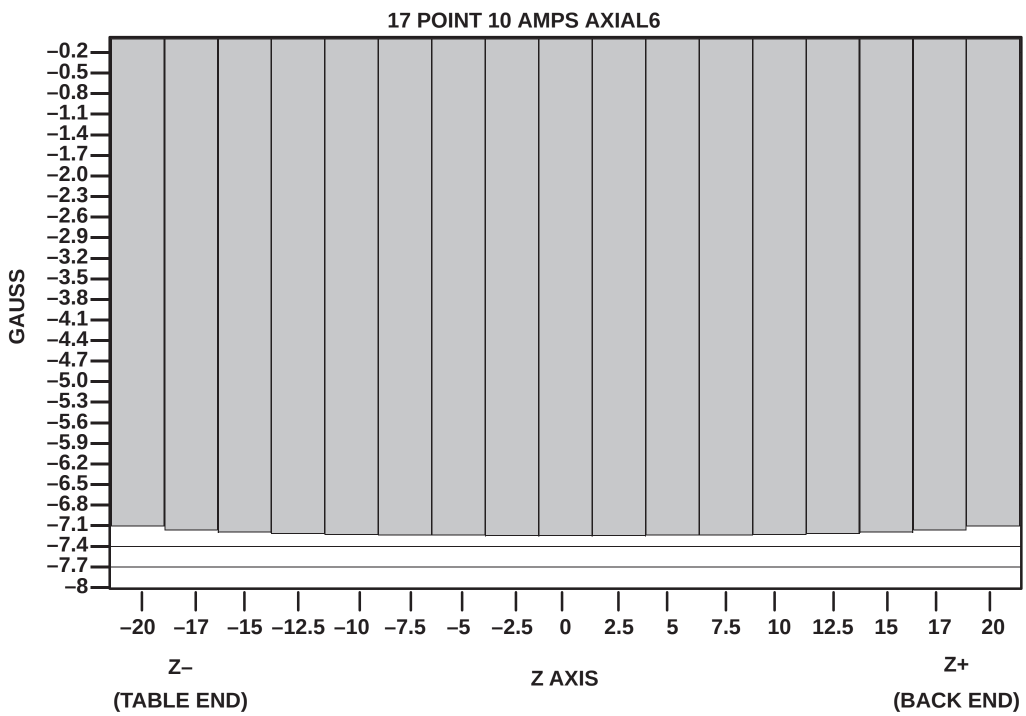




AXIAL 3 AND AXIAL 4 CORRECTION COIL PLOTS
ILLUSTRATION 12–2

NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS. C6 MAP





AXIAL 5 AND AXIAL 6 CORRECTION COIL PLOTS
ILLUSTRATION 12–3

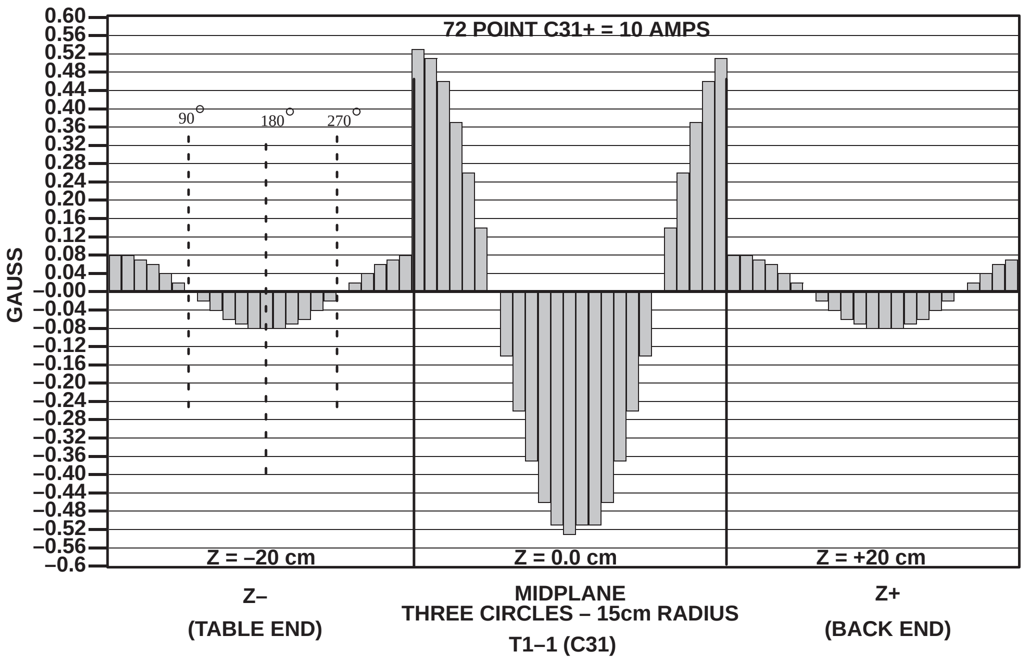
12–2 TRANSVERSE CORRECTION COILS

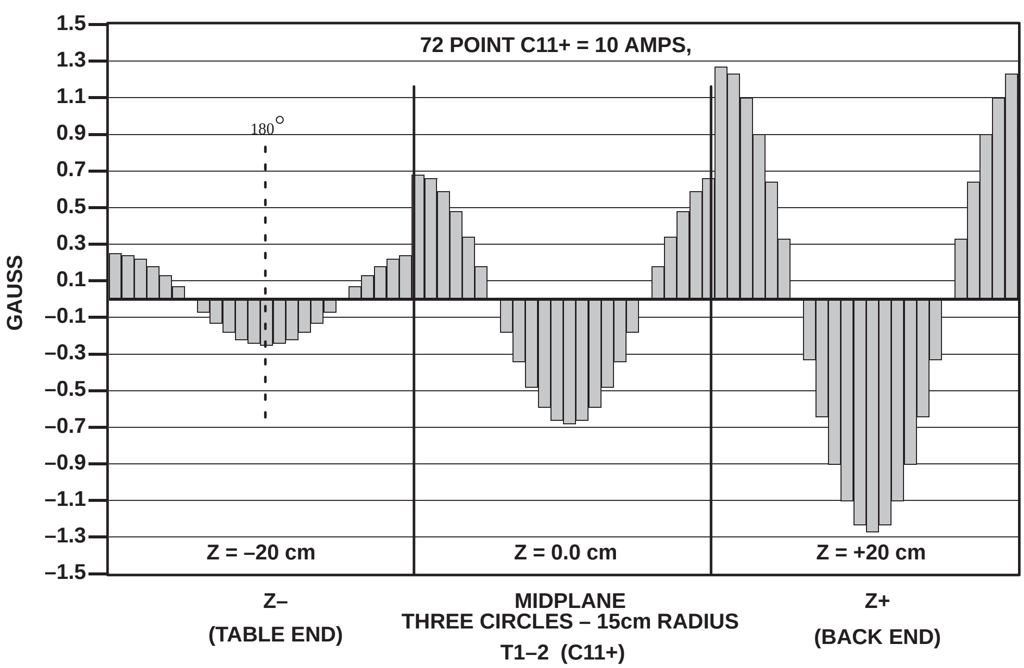
1. After completing the Axial Coil Checks, dump any remaining current in the Correction Coils by turning on both the Axial and Transverse Switch Heaters for one minute.
2. Adjust the probe to the 15cm radius position.
3. Move the probe positioner to –20cm (towards the Table End). Rotate the probe plotter clockwise (as viewed from the Table End). Record the virgin field values at 0, 45, 90, 135, 180, 225, 270 and 315 degrees. Record the data in Table 12–2.
4. Move the probe positioner to 0 cm. Obtain and record the virgin field values at 0, 45, 90, 135, 180, 225, 270 and 315 degrees.
5. Move the probe positioner to +20 cm. Obtain and record the virgin field values at 0, 45, 90, 136, 180, 225, 270 and 315 degrees.
6. After all virgin Held data in three planes (–20, 0 and +20cm) has been taken, turn-on the Transverse and Axial Switch Heaters.
7. Allow the heaters to warm up for two minutes.
8. Ramp the T1–2 (C11 +) Power Supply to 10A.
9. Turn off the Axial and Transverse Odd and Even Switch Heaters. Allow the heaters to cool two minutes.
10. Ramp down the T1–2 (C11 +) to 0 amps.
11. Move the probe (set to 15cm radius) to the –20cm axial location (Table End) and record data points at 0, 45, 90, 135, 180, 55, 270 and 315 degrees in Table 12–2.
12. Record the data at the same rotational degrees recorded in Step 11, with the probe at 0cm and then at +20cm along the z–axis.
13. Take the data collected at each of these points (i.e., 0, 45, 90, 135, 180, 225, 270 and 315 degrees) and subtract the corresponding virgin field value from each point.
14. Compare the gauss **differences** with the plots in Illustrations 12–4 through 12–6.
15. Turn on both the Axial and Transverse Switch Heaters and allow the heaters to warm up for 2 minutes.
16. Repeat steps 8 – 15 for each of the Correction Coil configurations. Use the ampere values in Table 12–2.

TABLE 12–2
TRANSVERSE COIL DATA

CORRECTION COIL (CURRENT INPUT)	**Z–AXIS**	**GAUSS READING (15.XXX.X)**							
		0	**45**	**90**	**135**	**180**	**225**	**270**	**315**
VIRGIN	+20cm								
(0AMPS)	0cm								
	–20cm								
	+20cm								
T1–1 (C31) = 10 AMPS	0cm								
	–20cm								
	+20cm								
T1–2 (C11+) = 10 AMPS	0cm								
	–20cm								
	–20cm								
	+20cm								
T1–4 (C11–) = 10 AMPS	0cm								
	–20cm								
	+20cm								
T2–1 (S31) = 10 AMPS	0cm								
	–20cm								
	+20cm								
T2–2 (S11+) = 10 AMPS	0cm								
	–20cm								
	+20cm								
T2–4 (S11–) = 10 AMPS	0cm								
	–20cm								

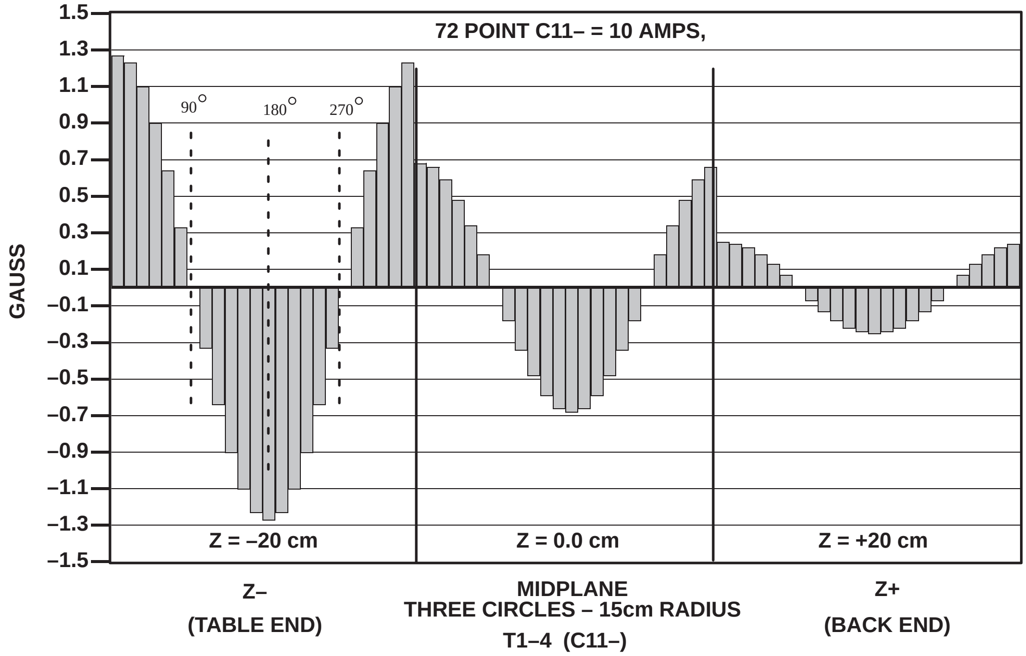
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.

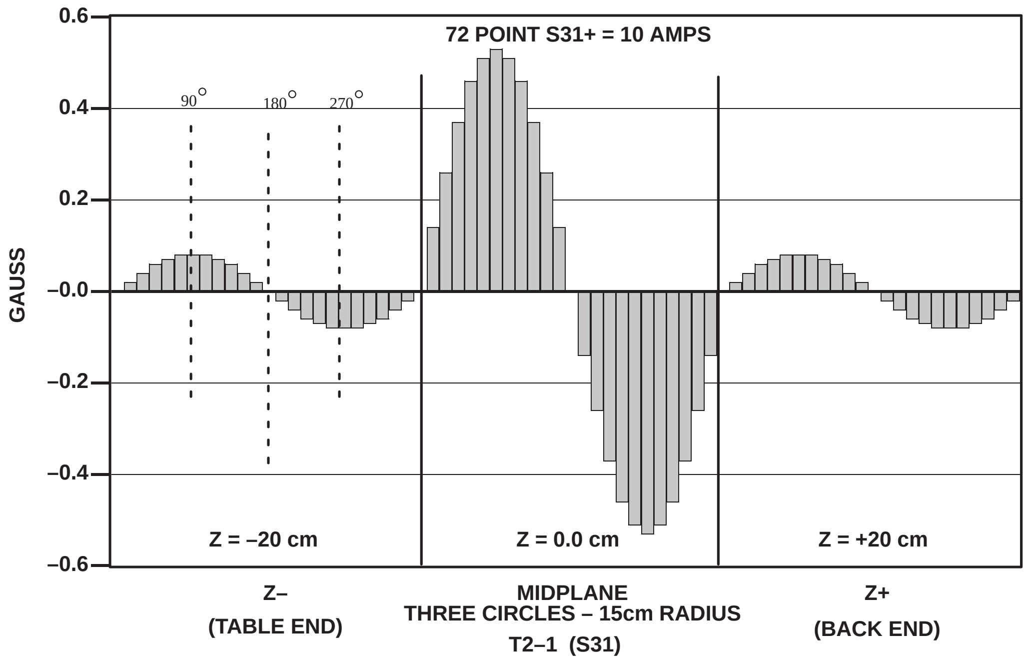




TRANSVERSE CORRECTION COIL PLOTS C31 AND C11+
ILLUSTRATION 12–4

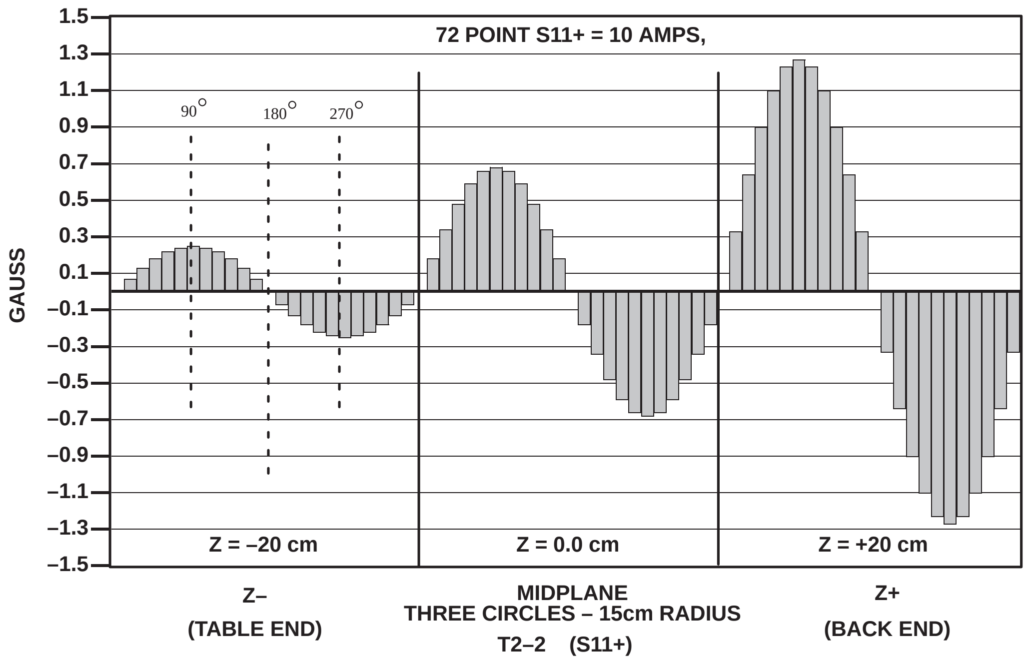
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.

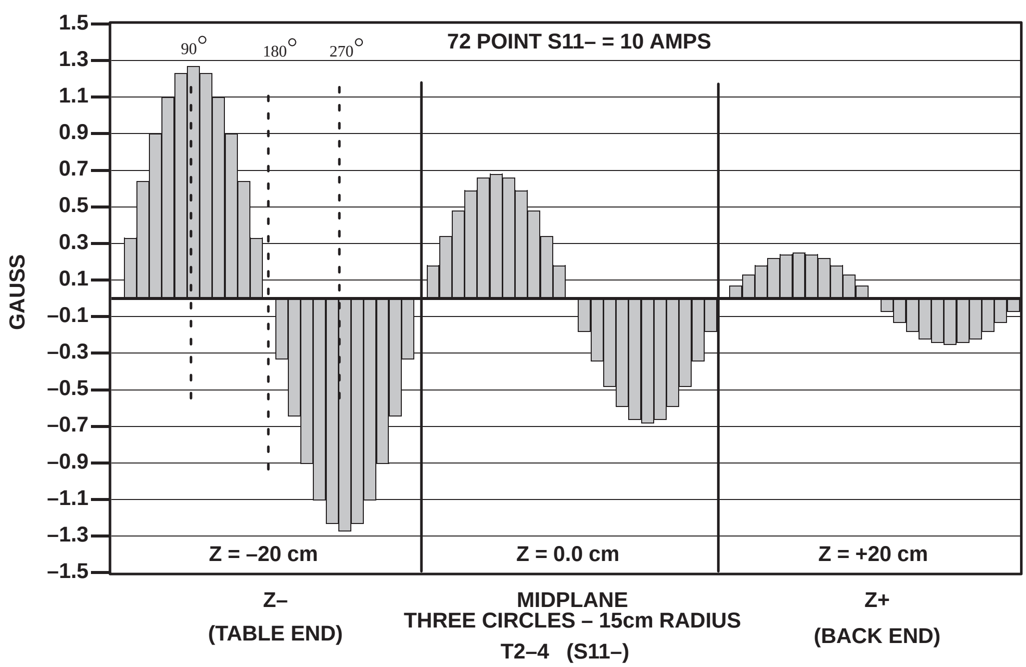




TRANSVERSE CORRECTION COIL PLOTS C11– AND S31
ILLUSTRATION 12–5

NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.





TRANSVERSE CORRECTION COIL PLOTS S11+ AND S11–
ILLUSTRATION 12–6

SECTION 13 – FIELD ADJUSTMENT AFTER SHIMMING

Description:

If the magnetic field is outside the range of 15000 gauss ± 7.5 gauss (63.864 MHz ± 31.932 KHz) after performing "Quickshim", the following field adjustment is required. If the field is in the specified range, adjust flow rates in conformance with Section 13–4 of this procedure.

If the Shim Supply can be powered simultaneously with the Ramp Supply, then the axial shim currents can be dialed in and held constant throughout the Field Adjustment procedure. In this case, Section 13–1 below can be skipped.

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

A SUPERCONDUCTING MAGNET IS AN ENERGY STORAGE DEVICE CAPABLE OF DISCHARGING RAPIDLY DURING A QUENCH AND CREATING A VOLTAGE OF 100V OR MORE ACROSS THE MAIN LEADS AND EXTENSIONS.

MAKE SURE INPUT POWER TO THE MAIN POWER SUPPLY IS DISCONNECTED WHEN CONNECTING MAIN POWER LEADS AND THE POSITIVE AND NEGATIVE POWER LUGS DO NOT MAKE CONTACT.

BEFORE CONTINUING THE FIELD ADJUSTMENT PROCEDURE, THE MAGNET CRYOGEN LEVEL SHOULD BE GREATER THAN 85% TO PREVENT A POSSIBLE QUENCH.

MAKE SURE THE SHIM LEAD VENT CAP IS REMOVED AND FROSTING IS VISIBLE ON THE SHIM LEAD CONNECTOR BOX BEFORE TURNING ON THE SHIM POWER SUPPLY.

13–1 REMOVING TRANSVERSE AND AXIAL SHIM CURRENTS

1. "Top" fill magnet, to greater than 85% helium level, before continuing with this procedure.

2. Replace Ramp Lead Extension Contact Bands in conformance with REPLACEMENT/MAINTENANCE, Section NO TAG.

13–1 REMOVING AXIAL AND TRANSVERSE SHIM CURRENTS (continued)

3. Make sure the Shim Lead Assembly is Engaged in conformance with SET UP AND CALIBRATION, Section 6.
4. Set up the field monitoring equipment Probe and Teslameter in conformance with SET UP AND CALIBRATION, Section 5.
5. Remove the Shim Lead Vent Cap and allow frost to appear on the Shim Lead Connector Housing before removing Shim Currents.
6. Make sure that the Magnet and Shim Power Supplies are checked and adjusted in conformance with the vendor manuals supplied with each unit. See vendor manuals for location and description of power supply controls.
7. Make sure the input power cables for the power supplies are disconnected.
8. Subtract the desired Center Frequency from the present Magnet Base Frequency. Record this "Delta Frequency: ______________________Hz.
9. Connect the Shim Power Supply to the magnet in conformance to SET UP AND CALIBRATION, Section NO TAG.
10. Connect the input power cable to the Shim Power Supply.
11. Switch on the main power to the Shim Power Supply.
12. Set the Shim Group Select Switch to the appropriate group (T1, T2, Axial). It is recommended that the Transverse Coils be ramped down first, then finally the Axial Coils.
13. Dial in all last recorded Shim Currents, from DATA Sheets Section 8, in the Shim Supply. Make sure the Current polarities are correct.
14. Turn on appropriate Switch Heater on the Shim Power Supply. Verify that the heater current is 810 mA. If it is not correct, adjust it with the adjustment screw located in the rear of the Shim Power Supply. <u>Allow five minutes for the heater to drive the switches resistive.</u>
15. Slowly adjust T1 Current controls to zero.
16. Turn off Transverse 1 Heater.
17. Repeat steps 12 through 16 for Transverse 2 and Axial Coils.
18. Disconnect Heater Cable from Shim Power Supply.
19. Turn off Shim Power Supply main power.

13–2 RESISTANCE CHECKS

1. Make sure that Input Power Cable for the Main Power Supply is disconnected.

13–2 RESISTANCE CHECKS (continued)

2. Connect the Main Power Supply and Main Lead Extensions to the magnet by making all cable connections in conformance with SET UP AND CALIBRATION, Section NO TAG. (“Electrical Connections For Ramping And Shimming”)

3. Set all power supply heater switches to the OFF position.

4. Set CURRENT ADJUST controls and VOLTAGE control to 0 (full CCW).

5. Connect the Input Power Cable for the Main Power Supply.

WARNING!

MAKE SURE MAIN HEATER SWITCH IS NOT TURNED ON DURING THE RESISTANCE CHECKS AS THIS WILL RESULT IN MAGNET QUENCH.

6. Turn on Main Power Supply Input Power.

7. Turn on Axial Shim Heater and observe current rise in ammeter (800–820mA) to verify circuit continuity. It the heater current is not correct, adjust it with the adjustment located on the rear of the power supply. Make sure the Main Heater Switch is set to OFF.

8. Connect a Digital Voltmeter (DVM) to the end of the Voltage Sense Leads.

9. Set the power supply voltmeter toggle switch to MAIN COIL position.

10. Set CURRENT ADJUST COARSE control on power supply to maximum (full CW).

11. Observe the Main Power Supply CURRENT meter and slowly turn the VOLTAGE control (CW) to set 750A current through the Main Power Leads, Lead Extensions and persistent Main Switch.

12. Record the voltage reading on the (DVM) in the DATA SHEET tab, Table 6–1.

WARNING!

A VOLTAGE READING GREATER THAN 150 MILLIVOLTS AT 750 AMPS INDICATES UNACCEPTABLE INTERNAL CONTACT RESISTANCE OF THE LEAD EXTENSIONS. HIGHER RESISTANCES WILL ADD MORE HEAT TO THE MAGNET INCREASING BOILOFF AND POSSIBLY CAUSING A QUENCH DURING FIELD ADJUSTMENT.

13–2 RESISTANCE CHECKS (continued)

13. Perform one or more of the bulleted steps below, as necessary, if the DVM voltage is greater than 150mV.

    - Wait approximately 1 minute with the current running, readings may drop as the Power Lead Extensions cool.
    - Repeated failing of the contact resistance check indicates a need to replace the Ramp Lead Extension Contact Bands. See REPLACEMENT/MAINTENANCE, Section NO TAG, or damaged Ramp Leads.
    - If the reading still exceeds 150 mV: turn the VOLTAGE and CURRENT controls to zero (full CCW), turn off Magnet Power Supply input power, then check/tighten the bolts securing the Main Power Cables to the Power Supply and Ramp Leads Extensions. Lift and reseat the Ramp Leads. Repeat Steps 6 – 13.

14. Upon passing the internal resistance check, continue with Step NO TAG.

15. Set the power supply voltmeter toggle switch to MAIN POWER SUPPLY position (This will display the output of the power supply monitored at the output lugs). A voltage less than 2.2V at 735 Amps indicates acceptable system resistance. If the voltage exceeds 2.2V during the test, follow the procedures in Step NO TAG for adjusting contact resistance.

16. Upon passing Step NO TAG, adjust the CURRENT ADJUST controls and VOLTAGE control to minimum (full CCW) and continue with the MAIN FIELD ADJUSTMENT procedure.

13–3 MAIN FIELD ADJUSTMENT

WARNING!

THE SV MAGNET CAN BE QUENCHED IF THE MAGNET POWER SUPPLY EXPERIENCES LARGE OUTPUT VOLTAGE FLUCTUATIONS AND/OR EXCESSIVE RIPPLE. MAKE SURE THE POWER SUPPLY IS REGULARLY CALIBRATED WITH AN APPROVED FACILITY.

WARNING!

AXIAL SHIM SWITCH HEATER MUST REMAIN ON DURING THE ENTIRE MAIN FIELD ADJUSTMENT PROCESS TO PREVENT IRREPARABLE SHIM COIL DAMAGE AND MAGNET QUENCH. THE POWER SUPPLY WILL NOT PASS CURRENT IN THE MAIN POWER LEAD CIRCUIT WITH THE AXIAL SHIM HEATER OFF.

WARNING!

MAKE SURE THAT THE CONNECTION POLARITY AND POWER SUPPLY CURRENT ARE THE SAME AS THE LAST RECORD IN TABLE 6–1 OF DATA SHEETS. THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS TO AVOID A QUENCH AND BURNING UP THE POWER SUPPLY WHEN TURNING ON THE MAIN SWITCH.

CAUTION

If a Quench occurs during change of magnetic field, immediately turn VOLTAGE control and CURRENT control to zero.

13–3 MAIN FIELD ADJUSTMENT (continued)

CAUTION

Make sure the polarity recorded in the DATA SHEET tab matches the configuration of the Ramp Polarity Plate on the Shim Lead Assembly. The "Normal" ramp polarity is "+" on the left and "–" on the right as viewed from the cold head side of the magnet. "Reversed" ramp polarity has "+" on the right and "–" on the left as viewed from the cold head side of the magnet. Call the National Support Center if the two do not match.

1. Retrieve the Main Coil Connection Polarity in the DATA SHEET Tab, Table 6–1.

Note

The Center Frequency will change by about 86 KHz per amp change in Main Coil current.

2. The main field will have either increased or decreased by the amount recorded in Step 8 of Section 13–1 (e.g. if the Delta Frequency is +21.288 KHz, then the Main Field is too high and will have to be decreased by this amount).
3. Make sure the Axial Shim Heater is on and Ramp Leads are connected with the polarity indicated in step NO TAG.
4. Set the power supply voltmeter toggle switch to MAIN COIL position.
5. Set CURRENT ADJUST controls on power supply to maximum (full CW).
6. Set VOLTAGE control to adjust power supply output current to the Parking Current value obtained in Step NO TAG above.
7. Turn on the Main Switch Heater. Leave the Axial Shim Switch Heater Supply on throughout the Main Field Adjustment procedure.
8. Allow approximately 3 minute for the Main Switch to go normal.
9. When the Main Switch is normal, slowly adjust VOLTAGE control until the main field is adjusted in conformance with Step 2 above.
10. Allow six minutes for field to stabilize before turning off Main Switch Heater.
11. Turn off Main Switch Heater. Wait a minimum of 8 minutes for the switch to fully cool and go "persistent".
12. Record current value at which the switch went "persistent" in DATA SHEETS, Table 6–1.

WARNING!

THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS TO AVOID A QUENCH WHEN TURNING ON THE MAIN SWITCH.

13–3 MAIN FIELD ADJUSTMENT (continued)

Note

Check that Teslameter does not decrease as the VOLTAGE control knob is turned to Zero. Only the last two digits on the Teslameter should change. If the field decreases as the VOLTAGE control knob is turned, the main coil switch is not persistent and the VOLTAGE control must be slowly adjusted to return to Parking Field.

13. When the switch goes "persistent", slowly turn the power supply VOLTAGE CONTROL to zero over a two minute period (Full CCW).
14. Turn off the Axial Shim Heaters.
15. Gradually turn the CURRENT ADJUST controls to zero (full CCW), over a one minute period.
16. Turn power supply off.
17. Disconnect Input Power Cable from the Main Power Supply.
18. Open Vent Valve (V2) to de–pressurize the Cryostat to 0.25 psig. Close V2.

CAUTION

Replace Ramp Port Caps immediately after removing Main Power Lead Extensions to prevent ice build up inside Vertical Stack.

Note

The steps below are performed after the magnet is ramped and the AC power has been disconnected from the Ramp Power Supply.

19. Install a screw into the Flow Hole of **only one** of the Ramp Lead Extensions. See Illustration 1.
20. Remove all ice around the Ramp Lead Port Compression Nut on the Ramp Lead Extension that is being removed. (i.e., the Ramp Lead Extension that has the Flow Hole plugged in Step 19).
21. Unscrew the Ramp Lead Port Compression Nut and remove the Ramp Lead Extension from the magnet. Immediately replace the cap onto the ramp lead port. Make sure all Ramp Port Caps are tight before leaving site.
22. Repeat Steps19 through 21 for the other Ramp Lead Extension.

13–4 INPUT SHIM CURRENTS

1. Reconnect the Shim Power Supply to the magnet in conformance to SET UP AND CALIBRATION, Section NO TAG.

2. Switch on the main power to the Shim Power Supply.

3. It is recommended that the Shim Currents be input in the following order:

   Transverse 1
   Transverse 2
   Axials

   For each of these groups, follow steps 4 through 11 below:

4. Set the Shim Group Select Switch to the appropriate group (T1, T2, or Axial).

5. Dial in all last recorded Shim Currents from DATA Sheets, Section 8 into the Shim Supply. Make sure the Current polarities are correct.

CAUTION

When the Switch Heaters are turned on, any currents existing in the Shim Coils will be discharged into the power supply. To prevent dumping excessive currents through the Shim Leads, match the existing shim currents with the power supply before turning on the heaters. The current will then be adjusted to the required new levels after the heaters are activated.

6. Turn on the appropriate Switch Heater. Verify that the heater current is 810 $\pm$10 mA. If it is not correct, adjust it with the adjustment screw located on the rear of the Shim Power Supply. Allow 5 minutes for the heater to drive the switches resistive. Make sure Shim Lead Extension is frosted.

7. After all the Correction Coil currents have been set, make sure each power supply is delivering the appropriate amount of current at the correct polarity.

8. Check the frequency reading on the Teslameter to make sure the Correction Coils are stable (i.e., there is no more than a 20 Hz change in the total magnetic field over a two minute period).

9. Once the field is stable (see Step 8), turn off Switch Heater and allow the heater to cool for 5 minutes.

10. Turn the Shim Power Supply back down to zero amperes (full CCW).

11. Repeat Steps 4 through 10 for Transverse 2 then Axial Coil Groups.

12. When all currents are set, turn off the power supply, then disconnect all leads between the magnet and Shim Power Supply.

13. Replace the Shim Lead Vent Cap.

13–4 INPUT SHIM CURRENTS (continued)

CAUTION

Make sure that the Shim Lead and Ramp Port Caps are replaced and does not leak and result in GHe loss and frosting.

14. Turn off input power to the Shim Power Supply and disconnect all Power Supply Cables.

Note
Read all flow rates from the bottom of the float (ball) on the flow meters.

15. Open Vent Valve (V2) to de–pressurize the Cryostat to 0.25 psig. Close V2.

16. Add liquid helium to magnet if necessary.

CAUTION

Cryostat exhaust flow rates and pressure must be checked and adjusted as required after magnet installation, ramping and shimming to ensure that proper cooling conditions are maintained and no leaks are present in the Helium Exhaust System or Vent Valve (V2).

Note
Flow rates may be temporarily elevated after ramping. Do not adjust them until after the magnet has had time to stabilize (at least one day).

17. Make sure the following conditions are maintained. Re–check settings in three days and again after one week:

INSTRUMENTATION LEAD FLOWMETER (F2) = 0.8 – 1.2 SCFH
SHIM LEAD FLOWMETER (F1) = 1.8 – 2.2 SCFH
CRYOSTAT GAUGE PRESSURE = 0.25 – 0.50 psig

Note
If flow rate through F2 is less than 0.8 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and “bubble test” all exhaust plumbing joints, relief valve and Shim Lead Connector. Make sure V2 is fully closed. Repair any leaks.

SECTION 1 – CRYOGEN BOIL–OFF RATE

1. An instantaneous boil off rate estimate can be calculated by using the following equations:

   BOIL OFF RATE (LITERS/HOUR), = F1+F2 x 0.10
   BOIL OFF RATE (SCFH) = F1+F2 x 2.70

   Where:

   F1 = Flow meter 1 reading (located on Shim Lead Venting)
   F2 = Flow meter 2 reading (located on instrumentation Lead Venting)

   Note

   Flow meter locations are shown in SET UP AND CALIBRATION, Illustration 1–4.

2. A more accurate, time averaged boiling rate is obtained by calculating helium boiling off rate, at periodic refill intervals, in DATA SHEETS, Table NO TAG of this manual (CRYOGEN LOG). Time periods less than one month give misleading values.

   Note

   Helium Meter Volumetric conversion is given in DATA SHEETS, Chart/Graph 5–1 of this manual.

3. Calibrate Cryogen Monitor at 12 month intervals in conformance with the vendor manual ; and whenever the helium boil off rate, calculated in Step 2. has shown a significant increase/ decrease.

SECTION 2 – MAGNET ELECTRICAL CHECKS

This section provides go/no go tests for internal magnet circuitry faults.

WARNING!

ELECTRICAL CHECKS CAN ONLY BE PERFORMED WITH THE COILS (MAIN & SHIM) RAMPED DOWN (0 AMPS). DO NOT MAKE CONTACT AT ANY CONNECTOR WITH COILS RAMPED UP.

Note
Resistance Table 3–1 is for cold superconducting coils (4.2K).

Shim Lead Assembly must be fully “Engaged” in conformance with SET UP AND CALIBRATION, Section NO TAG in order to obtain resistance data.

1. Place Shim Lead Assembly in the “Engaged” position in conformance with SET UP AND CALIBRATION, Section NO TAG.
2. Locate the Connector Pins using Table 3–1 and SCHEMATICS/INTERCONNECTS, Illustration NO TAG.
3. Use a digital meter to measure the resistance across the identified Connector Pins.
4. Measure the resistances and record them in Table 3–1, comparing them to “ACCEPTABLE RANGE”.

TABLE 3–1
MAGNET CIRCUITS RESISTANCE CHECK
COLD (4.2K)

FUNCTION	CONNECTOR	PIN #	RESISTANCE (OHMS) TYPICAL VALUES	RESISTANCE (OHMS) MEASURED
MAIN COIL	MAIN COIL POWER LUGS OR J5–1	+ – 9,10	< 4 OHMS	
SUPERCONDUCTING SHIM COILS	CANNON (P1–A) AT MAGNET VERTICAL STACK			
Z1		1,19	0.5	
Z2		2,20		
Z3		3,21		
Z4		4,22		
Z5		5,23		
Z6		6,24		
C11+		16,19		
C11–		17,20		
S11+		9,19		
S11–		10,20		
C31		13,23		
S31		11,23		
SUPERCONDUCTING SWITCH HEATERS MAIN SWITCH	J 5–1 & J 5–2 ON MAGNET TERMINAL BOX (MS1–A3,A1)	1,2	22 – 27	
AXIAL SHIMS		5,6	27.5 – 32.5	
TRANSVERSE 1		7,6	9 – 10	
TRANSVERSE 2		8,6	9 –10	

SECTION 1 – MAGNET FUNCTIONAL CHECKS

The commissioning and Operating Guidelines for the magnet system are provided in Table 1–1 ("Magnet Commissioning/Operating Guidelines") and serve as the basis for all functional checks, with the exception of the Magnet Rundown Unit Operation. Checking and maintaining the Guideline conditions, as recommended in the table, will ensure the optimum commissioning and operating of the magnet. The specific sections within Functional Checks cover the methodology and required apparatus for the individual checks.

TABLE 1–1
MAGNET COMMISSIONING/OPERATING GUIDELINES

ELEMENT	GUIDELINES	CHECK/SETTING REQUIREMENTS
MAIN FIELD	15000 gauss ± 7.5 gauss (63.864 MHz ± 31.932 KHz)	AFTER RAMPING & SHIMMING OR WHEN OUT OF GRADIENT AMP. BANDWIDTH.
DRIFT	< 0.1 PPM (6.3 HZ)/HR (12 Hrs AFTER RAMP)	BEFORE MECHANICAL SHIMMING
HOMOGENEITY	≤ 12 PPM ON 45CM DSV	ENVIRONMENTAL CHANGES MAKING LV SHIM UNACHIEVABLE
MAIN POWER SUPPLY	810 mA ± 10 mA MAIN HEATER 810 mA ± 10 mA AXIAL HEATER PASS VENDOR MANUAL CKS.	BEFORE RAMPING UP/DOWN
SHIM POWER SUPPLY	810mA ± 10 mA AXAIL, T1, T2 HEATER PASS VENDOR MANUAL CKS.	BEFORE SHIMMING
RAMPING CIRCUIT VOLTAGE @ 750A	< 2.00 V TOTAL < 150 mV RAMP LEADS	BEFORE RAMPING UP/DOWN
MAIN HEATER RESISTANCE	22–27 OHMS	AT START OF COMMISSIONING

SECTION 1 – MAGNET FUNCTIONAL CHECKS (continued)

TABLE 1–1 (CONTINUED)
MAGNET COMMISSIONING/OPERATING GUIDELINES

ELEMENT	GUIDELINES	CHECK/SETTING REQUIREMENTS
AXIAL HEATER RESISTANCE	25.5 – 31.0 OHMS	AT START OF COMMISSIONING
T1 & T2 HEATER RESISTANCE	10 OHMS	AT START OF COMMISSIONING
RAMP LEAD PREP	NEW CONTACT BANDS GAS FLOW OUT TOP HOLES	BEFORE RAMPING UP/DOWN
SHIM LEAD PREP	SHIM LEAD VENT CAP OFF LEAD FROSTED/SHIM LEAD ENGAGED	BEFORE SHIMMING
VENTING	PRESSURE DROP CALC. < 17 PSI	AT MAGNET INSTALLATION
CRYOSTAT PRES.	0.25 – 0.50 PSIG	AFTER INSTALLATION, CRYOSTAT VENTING, RAMPING, SHIMMING NOTE: SPEC VAULES ARE STEADY STATE AFTER PASSING LEAK CHECK
INST LEAD FLOW (F2)	0.8 – 1.2 SCFH	
SHIM LEAD FLOW (F1)	1.8 – 2.2 SCFH	
BOIL OFF	< 0.2 LITER/Hr. (AVE.)	
HELIUM LEVEL	85% FOR RAMP UP, RAMP DOWN OR FIELD ADJUSTMENT 50% MINIMUM OPERATING 65% MINIMUM FOR SHIMMING	BEFORE RAMP UP, RAMP DOWN, FIELD ADJUSTMENT ON GOING
FILL CONDITIONS	V2 OPEN, DEWAR < 3.5 CRYOSTAT < 1.5 PSIG	HELIUM FILL/REFILL
SHIELD COOLER	1ST STAGE 32 – 60K 2ND STAGE 7 – 17K	HIGH PRESSURE/BOIL OFF

SECTION 2 – MAGNET RUNDOWN UNIT (MRU)

WARNING!

PERFORM THE FOLLOWING CHECKS AT WEEKLY INTERVALS. IN THE EVENT OF ANY FAILURES, IMMEDIATELY CONTACT YOUR GENERAL ELECTRIC SERVICE REPRESENTATIVE.

MRU CHECKS:

1. Verify that the green “CHARGER POWER” LED is lit.
2. Depress the “TEST BATTERY” switch. Green ”BATTERY” LED should light.
3. Place “TEST HEATER” switch to “A” position. The green “HEATER” LED should light. Place “TEST HEATER” switch in “B” position. The green “HEATER” LED should light. If the “HEATER” LED does not light, depress “TEST HEATER” LED switch to verify that the LED is functioning.

See Functional Checks, Section 2 for Main Switch Heaters continuity check.

SECTION 3 – MAGNET QUENCHES

Description:
The following checks and operations have significant benefit in the prevention of and recovery from magnet quenches.

Procedure:

QUENCH PREVENTION

A. BEFORE RAMPING

1. Verify magnet is a minimum of 85% full of LHe.
2. Install new contact bands on the Ramping Lead Extensions.
3. Make sure Shim Lead is engaged
4. Make sure gas flow is visible from Top Flow Holes in Ramping Lead Extensions before starting ramp.
5. Verify ramping circuit voltage drops are in spec range, ensuring acceptable contact resistance.
6. Ramp magnet in conformance with service manual.

B. RAMPED MAGNET

1. Verify Cryostat Pressure and flows are in spec, ensuring adequate cooling of Shim Lead Assembly and Vertical Stack.
2. Maintain strict adherence to the ramp down requirements/prerequisites in the Replacement/Maintenance section of the service manual.
3. Do not insert any warm objects or blow warm gas into any entry port of the magnet (i.e. Vertical Stack, Fill Port, . . .).
4. Do not allow a Helium Dewar to empty and blow warm gas into the Fill Port of the magnet during LHe refill.
5. Keep the LHe level greater than 60% full at all times during magnet operation.

SECTION 3 – MAGNET QUENCHES (continued)

QUENCH RECOVERY

REPORT ALL QUENCHES TO YOUR MAC TEAM REPRESENTATIVE.

1. Check and replace Burst Disc and gaskets immediately.

2. Order and replace LHe ASAP.

Note

Steps 1 and 2 are essential to maintain positive Cryostat pressure and prevent cryopumping and ice build up. Before continuing to step 3, make sure positive Cryostat pressure is maintained. If necessary, helium gas can be used to pressurize the system.

3. Check for ice build up in Vertical Stack. Remove ice in conformance with service manual.

4. Inspect Vent System. Clear out any debris from a ruptured Burst Disc and/or disintegrated Shim Lead Baffles. Notify Site Administration of any damage to Vent System.

5. Order and replace Baffle Assembly (2133618) if baffles are disintegrated. Replace and return Shim Lead Assembly(2133617) only if damaged.

6. Check Pressure Gauge for damage. Replace if damage suspected. (46–281282P1)

7. Check Cryostat pressure and flows after LHe refill and stabilization.

Note

Do not adjust Cryostat flows / pressure at this time.

8. If a leak condition is suspect, check all external plumbing, relief valves and Shim Lead Assembly for leaks.

9. If pressure builds beyond 2 psig vent the Cryostat (V2) and check Cryostat and Shield Cooler temperatures. Continued pressure and flow build up could indicate Cryostat damage, if this is the case, contact the MAC Team Representative.

10. Ramp and Shim magnet in conformance to service manual.

11. Establish Cryostat pressure between 0.25–0.50 psig and check flow rates (F1) & (F2).

12. After the system has stabilized, the following conditions should be maintained:

CRYOSTAT PRESSURE = 0.25 – 0.50 PSIG
INSTRUMENTATION FLOW METER (F2) FLOW RATE = 0.8 – 1.2 SCFH
SHIM LEAD FLOW METER (F1) FLOW RATE = 1.8 – 2.2 SCFH

Note

Minimal adjustment, if any, should be required to maintain the conditions in Step 12. Slight variations will occur with changes in atmospheric pressure under steady state operating conditions.

SECTION 8 – MAGNET QUENCHES (continued)

QUENCH RECOVERY

TABLE 8–1
MAGNET QUENCH RECOVERY PARTS AND TOOL REQUIREMENTS

SV MAGNET QUENCH RECOVERY PARTS AND TOOLS			
PART	**GE NUMBER**	**TOOL**	**GE NUMBER**
Baffle Assembly	2133618	Magnetometer (Teslameter)	46–251865G2
Styrofoam Insulator Kit	2120128	Ramp Supply	46–260776G3
Shim Lead Assembly	2133617	Shim Supply	46–260777G3
Pressure Gauge	46–281282P1	Ramp Equipment	46–260703G2
Burst Disk	46–252838P6	Ramp Cable Kit	2135435
Burst Disk Gasket (2 Req'd.)	46–252839P6	Power Supply Calibration Kit	2101360
		Shim Cable Kit	2135558
		Universal Fill Line Kit	46–294705G1
		Dewar Stinger 250L	46–294511P1
		Dewar Stinger 500L	46–294511P2
		Transfill Line 12 ft.	46–294512P1
		Low Pressure Regulator Kit	46–306734G1
		Cryogen Safety Kit	46–271137G1

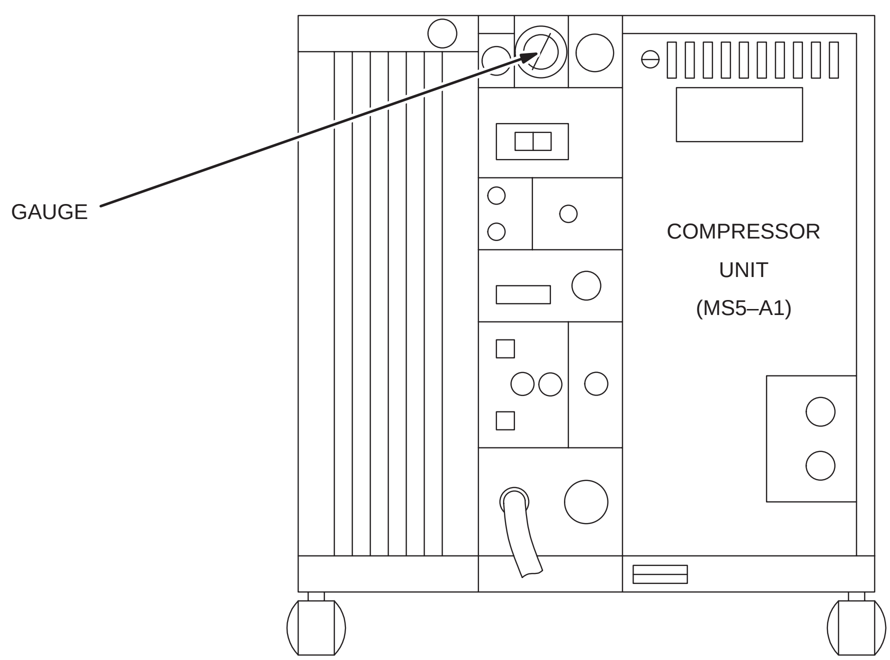
SECTION 4 – SHIELD COOLER CHECKS

Description:

The Shield Cooler System consists of a Shield Cooler Compressor, located in the Equipment Room, and a Cold Head thermally attached to the heat shields of the Cryostat. The Shield Cooler is designed to maintain a temperature on the Outside, “First Stage” Shield between 32K and 60K and the Inside, “Second Stage” Shield between 7K and 17K. Both the first and second stage interface points on the Shield Cooler Mounting Sleeve are equipped with temperature sensing silicon diodes for monitoring and troubleshooting purposes. Perform Shield Cooler Checks at installation, when Cryostat Pressure/ Boil off is out of specification and at the yearly Preventative Maintenance (PM) Interval if the check was not performed within the year interval.

Procedure:

1. Turn the Shield Cooler Compressor off and allow the static gas pressure to equalize on the gauge on the front panel of the unit. See Illustration 7–1.



SHIELD COOLER COMPRESSOR PRESSURE GAUGE
ILLUSTRATION 7–1

SECTION 4 – SHIELD COOLER CHECKS (continued)

Note

If pressure is outside spec. range in Step 2, refer to vendor manual for troubleshooting instructions.

2. Read and record the gauge equalized pressure, in Table 1–1, DATA SHEETS Tab. The Static Pressure should be between 218 psig (15 bar) and 232 psig (16 bar). If the pressure is outside this range, refer to the vendor manual for troubleshooting instructions.

3. When static gas pressure is in the spec. range, turn on Shield Cooler Compressor.

4. Check the water flow to the Shield Cooler Compressor. Make sure that there is a minimum flow rate of 1.0 gallons per minute (gpm) available at the supply and the water temperature at the supply is between 40°F (5°C) and 80°F (27°C).

5. Check oil level glass inside the Compressor. The oil should completely fill the sight glass when the compressor isn't operating. When the Compressor is running, the oil level should be 1/2 to 3/4 full and must never fall below 1/5 full during operation.

6. Check Shield Cooler temperatures. See Set Up and Calibration, Section 1–4–7 (Monitoring Shield Temperatures) for the correct procedure.

7. Read and record "First Stage" and "Second Stage" Shield Temperatures in Table 1–1, DATA SHEETS Tab.

   GUIDELINES:

   First Stage Temperature (32K–60K).
   Second Stage Temperature (7K–17K).

8. Compare these readings to Guidelines and initial recorded readings obtained at equilibrium. Refer to SET UP AND CALIBRATION, Section 1–4–7.

9. If any Shield Temperature is out of range or differs drastically (> 10K First Stage, > 5K Second Stage) from the previous equilibrium temperatures, check the eight mounting bolts of the Shield Cooler Cold Head and ensure that they are not loose. See REPLACEMENT/MAINTENANCE, Section NO TAG (Shield Cooler Cold Head Replacement).

10. If gas pressure, oil level and water supply are in spec. and mounting bolts are tight when Shield Temperature is out of range, Shield Cooler Cold Head replacement may be necessary. Contact your MAC Team Representative before replacing Cold Head.

SECTION 5 – MAGNETIC FIELD STABILITY

Description:

The following check is made to determine "uncompensated" Main Field Drift of the magnet.

Procedure:

CAUTION

Moving equipment may effect the field readings.

1. Post signs indicating a magnetic drift test is in progress. Do not move or rearrange any articles or equipment in or near the exam room during the test.
2. Assemble the Field Mapping Fixture and Teslameter using the procedure in SET UP AND CALIBRATION, Section NO TAG, ("Field Monitoring Equipment Set–Up").
3. Locate the Teslameter Probe at the physical center of the Magnet Bore (R = 0, Z = 0). Make sure the radius of the probe holder is set to zero.
4. Set the Teslameter switch to NMR FREQUENCY (Hz), allow Teslameter to stabilize within 10 Hz band.
5. Connect Shim Power Supply to magnet in conformance with SET UP AND CALIBRATION, Section NO TAG.
6. Remove all Shim Currents in conformance with SET UP AND CALIBRATION, Section 11–,
7. Set all shim heater switches to 1 (on). After 3 minutes record the frequency as FREQUENCY 1 in the DATA SHEET TAB, Table 6–2.
8. Repeat Steps 5 through 7 after 24 hours. Record this frequency as FREQUENCY 2 in DATA SHEETS Tab, Table 6–2.

SECTION 5 – MAGNETIC FIELD STABILITY (continued)

9. Calculate the main field drift rate by using the following formula:

$$\text{Drift Rate (ppm/hr)} = \frac{(\text{Freg 1} - \text{Freg 2}) \times 10^6}{(\text{Freq 1}) \times (24)}$$

For the Initial drift rate use: Freq 1 = Initial reading
Freq 2 = reading after 24 hours

10. If the drift rate is greater than 6.3 Hz/hr, drift rate is outside guidelines, contact the MAC Team Representative. or the Regional Service Engineer. High drift rates will require frequent field adjustment and reshimming.

Note

The Teslameter has a resolution of ± 5 Hz; therefore, a month or more may be required to establish a significant frequency difference (drift rate).

SECTION 6 – CRYOSTAT VACUUM CHECK

WARNING!

MAKE SURE THAT THE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE STARTING CRYOSTAT VACUUM CHECK PROCEDURE.

CAUTION

Do not take leak detectors in the proximity of a magnetic field as irreparable damage will result.

1. Connect Valve Port Operator Vacuum Gauge Service Tool to the Vacuum Monitoring Port (MS1–A1,A3).
2. Connect Helium Leak Detector Vacuum Pump System to the Valve Port Operator. See illustration 4–1. Pump the internal area of the Valve Port Operator to 1 x 10^{-4} Torr. (approximately 15 minutes pumping time).
3. Connect Granville Phillips Gauge Controller and Combitron (C M330) to Valve Port Operator Vacuum Gauge Service Tool. See Illustration 4–1.
4. Turn on Combitron (CM330). Record reading _______________Torr.
5. Leak test Valve Port Operator and connections with Helium Leak Detector.
6. Turn valve off Helium Leak Detector from Valve Port Operator.

CAUTION

Leak test of Valve Port Operator must be performed prior to opening the Vacuum Port Valve.

7. Rotate operator handle 5–6 turns “CLOCKWISE”, then pull up on handle to open the Vacuum Port Valve.

SECTION – 6 CRYOSTAT VACUUM CHECK (continued)

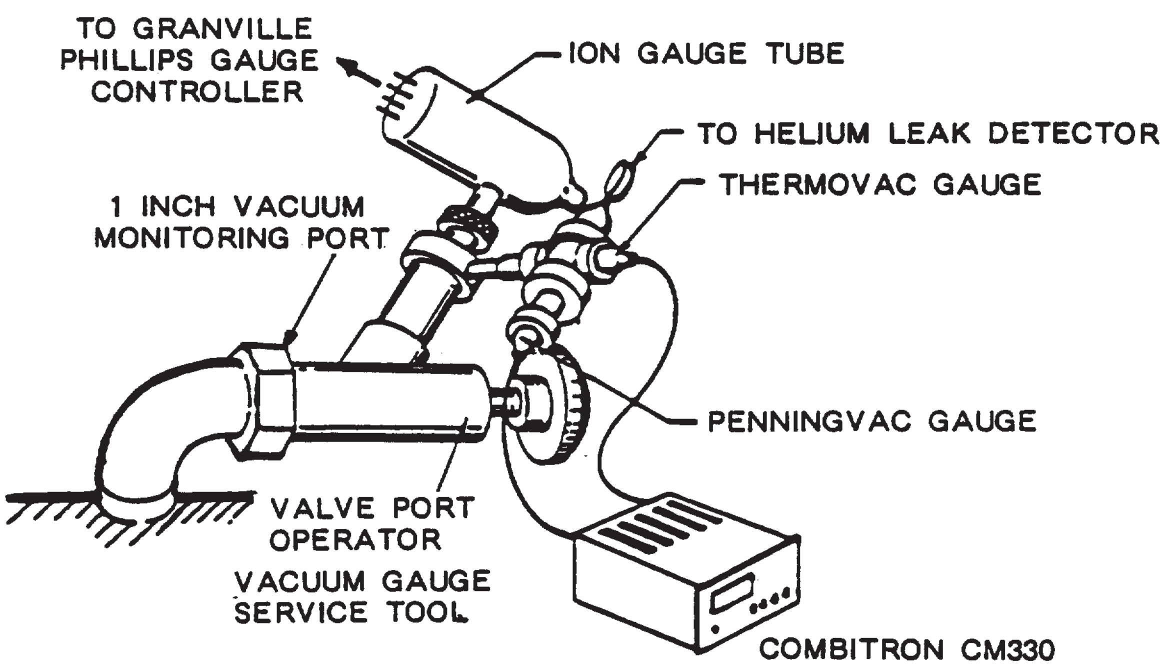
8. Turn on Gauge Controller power and thermocouple. Record reading __________Torr.

9. Select “AUTO” range on Gauge Controller and turn on Filament Controller.

Note
1–2 hours may be required for the Ion Gauge to settle out.

10. When gauge is settled out, record vacuum level reading __________ Torr.

Note
Vacuum level is dependent upon Cryostat temperature, < 1×10^{-6} Torr. should be achieved with diode temperature reading below 100K. At diode temperature readings above 150K, vacuum may be in the order of 1×10^{-1} ., (100 microns).



CRYOSTAT VACUUM MONITORING SET–UP
ILLUSTRATION 4–1

SECTION 3 – SHIM LEAD/BAFFLE ASSEMBLY REMOVAL / REPLACEMENT

WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

RAPID EXHAUSTING OF COLD HELIUM GAS MAY BE ENCOUNTERED DURING THE FOLLOWING PROCEDURES. WEAR NON ABSORBENT GLOVES AND GOGGLES OR FACE SHIELD WHEN PERFORMING THESE PROCEDURES.

MAKE SURE THAT THE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE REMOVING/REPLACING THE SHIM LEAD ASSEMBLY. A MAGNET QUENCH DURING REMOVAL/REPLACEMENT OF THE SHIM LEAD ASSEMBLY COULD RESULT IN THE RAPID EXPULSION OF LIQUID HELIUM OUT OF THE VERTICAL STACK.

Description:

The Shim Lead Assembly is designed with a replaceable Baffle Assembly. Following a Quench, the Shim Lead Assembly will have to be removed in order to replace the Baffle Assembly. The Shim Lead Assembly itself should only need replacing if it is determined that a fault exists.

Procedure:

3–1 SHIM LEAD ASSEMBLY REMOVAL

1. Make sure the Shim Lead Assembly is "Engaged" in conformance with SET–UP AND CALIBRATION, Section NO TAG.
2. Ramp magnet down to zero field in conformance with REPLACEMENT / MAINTENANCE, Section NO TAG.
3. Slowly open Vent Valve (V2) and vent magnet until internal pressure drops below 0.3 psi on the Cryostat Pressure Gauge. Close V2.
4. Disconnect connectors (J1–A & P5) from the Receptacle Box. See Illustration 5–1.
5. Disconnect 1/4 inch Exhaust Plumbing on the side of the Shim Lead Receptacle Box. Use 1/4 inch cap to blank off Port.
6. Disengage Shim Lead Assembly in conformance with SET–UP AND CALIBRATION, Section NO TAG.

CAUTION

Perform Steps 7 and 8 rapidly to prevent cryopumping of air into the Vertical Stack. Make sure that the Lexan Cover Plate P/N 46–294765G1 is on the service platform before removing the Shim Lead Assembly.

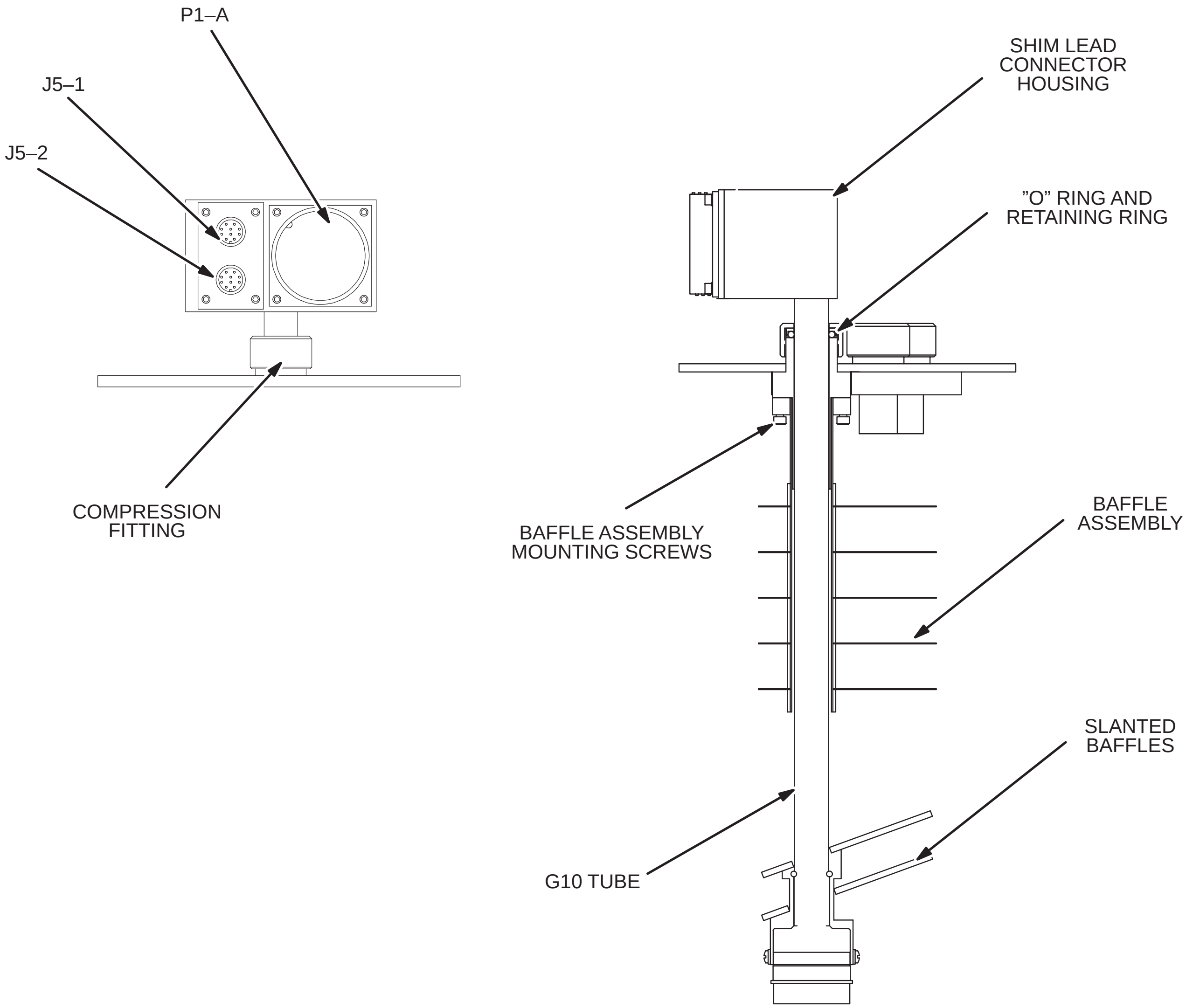
7. Loosen and remove the eight 1/4 – 20 Retaining Bolts and remove the Shim Lead Assembly.

Note

Make sure that the Shim Lead O–ring is in the groove of the Vertical Stack.

8. Immediately cover the Vertical Stack with the Lexan Cover Plate. Alignment of the Lexan Plate Scribe mark to the Vent Adaptor is not necessary for this procedure. See Illustration 5–2.
9. Secure the Lexan Cover Plate onto the Vertical Stack with the eight 1/4–20 Retaining Bolts removed in Step 7.
10. If the Baffle Assembly needs replacement, proceed to Section 3–3.

3–1 SHIM LEAD ASSEMBLY REMOVAL (continued)



SHIM LEAD ASSEMBLY
ILLUSTRATION 5–1

3–2 SHIM LEAD ASSEMBLY REPLACEMENT

1. Check for icing on the Sav Con Connector by shining a flashlight through the Lexan Cover Plate.
2. If any icing exists, remove the ice, by directing a flow of warm helium gas at 3–5 psig to affected areas. This is done by removing the 1/4 inch Pipe Plug in the Lexan Plate and inserting the Helium Gas Tube to the ice point.

Note
Step 3 is only necessary if the Shim Lead is being replaced.

Note
Wrap Teflon Tape on male threads of Male Run Tee before threading into Replacement Shim Lead Connector Housing.

3. Remove Male Run Tee from defective Shim Lead Assembly Connector Housing and remount to Connector Housing of Replacement Shim Lead Assembly. Place two 1/4 inch caps (if not already in place) to the open ends of the Male Tee Run. See Illustration 5–2 for Male Run Tee location.
4. Make sure that a functional Shim Lead Assembly is on the service platform and that the Shim Lead is in the retracted position.

CAUTION

Do not leave the Vertical Stack uncovered for any significant period of time as cryopumping and icing may result.

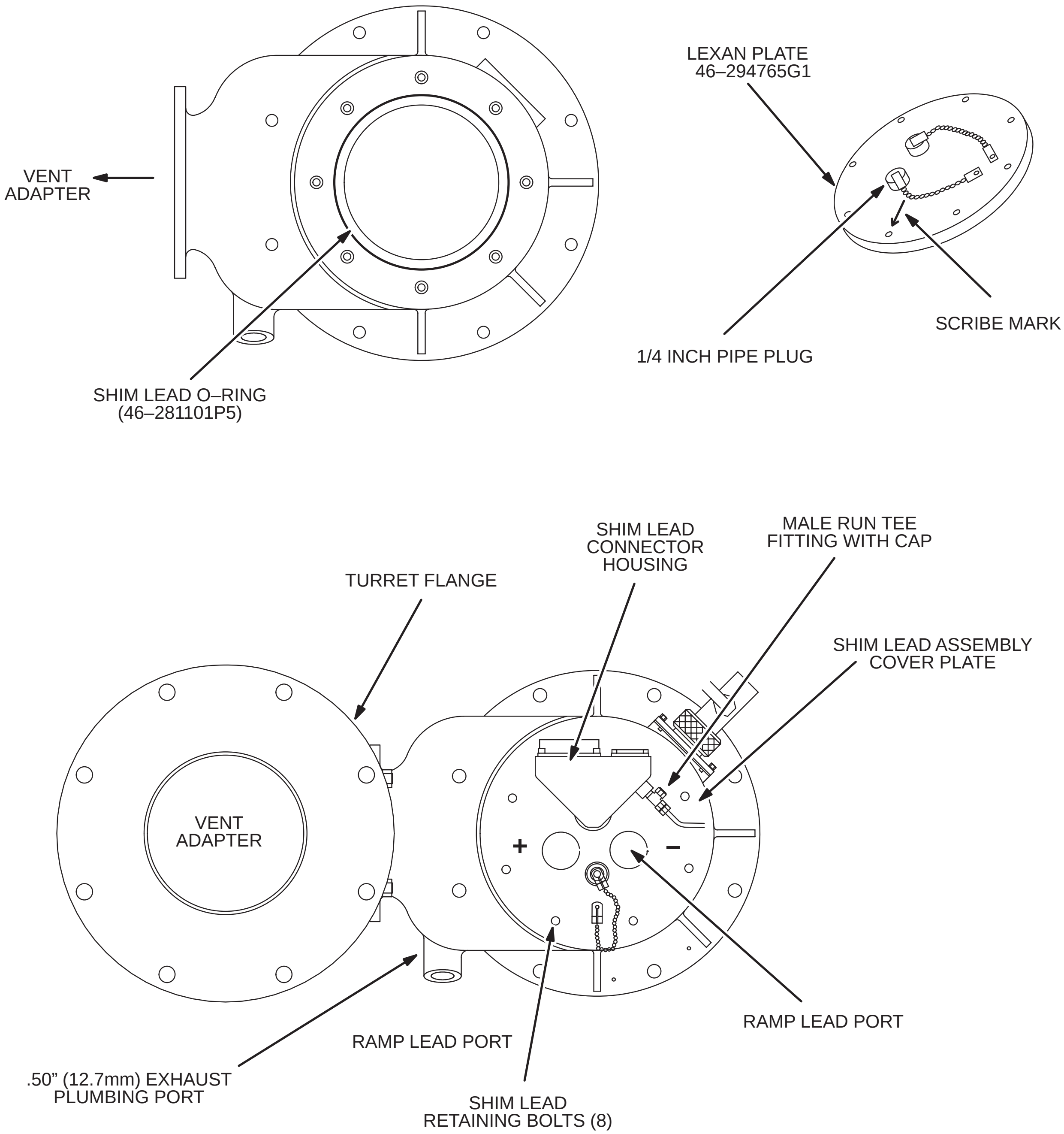
5. Loosen and remove the eight 1/4 – 20 Retaining Bolts and remove the Lexan Cover Plate.

CAUTION

Make sure the caps in Step 3 are in place and the Shim Lead is carefully inserted into the Vertical Stack to prevent ”cold shock” and possible permanent damage of the Shim Leads.

6. Inspect the Shim Lead O–ring at the top of the Vertical Stack. Replace if nicked, scratched or damaged.
7. Carefully replace the Shim Lead Assembly into the Vertical Stack. Make sure that the Shim Lead O–ring is in the Vertical Stack.
8. Align the scribe mark on the Shim Lead Assembly Cover Plate with the Vertical Stack Exhaust Plenum. See Illustration 5–2.

3–2 SHIM LEAD ASSEMBLY REPLACEMENT (continued)



SHIM LEAD ASSEMBLY ORIENTATION
ILLUSTRATION 5–2

3–2 SHIM LEAD ASSEMBLY REPLACEMENT (continued)

9. Secure the Shim Lead Assembly to the Vertical Stack with the 1/4 – 20 Retaining Bolts removed in Step 5. Use of Permatex (1 oz. tube – 2119594) or Bostik (4 oz. can – 46–294151P8) anti–sieze lubricant is recommended.

Note

The Shim Lead Connector is keyed and must be aligned to the key way of the Sav Con Connector in order to engage. When contact is felt between the Shim Lead and the Sav Con Connector, the Shim Lead will depress approximately 1/4 inch to fully seat connectors.

10. Loosen Compression Fitting and push the Shim Lead down to engage the connector.
11. Tighten Compression Fitting.
12. Open Helium Vent (V2) and vent Cryostat to reduce pressure to 0.2 – 0.3 psig.
13. Remove the Blank Off Cap and reconnect the 1/4 inch Shim Lead Exhaust Plumbing to the Male Run Tee on the Shim Lead Connector Housing. Tighten and leak test fitting.
14. Allow the Cryostat to build pressure of 1 psi. Then check for leaks around the O–ring in the Vertical Stack and at Shim Lead Compression Fitting. Repair any leaks found.
15. Engage the Shim Lead in conformance with SET–UP AND CALIBRATION, Section NO TAG.
16. Make sure the Connectors (J1–A and P5) are connected to the Shim Lead Receptacle Box.
17. Ramp the magnet to field in conformance with SET UP AND CALIBRATION, Section 9.

CAUTION

Cryostat exhaust flow rates and pressure must be checked and adjusted as required after magnet installation, ramping and shimming to ensure that proper cooling conditions are maintained and no leaks are present in the Helium Exhaust System or Vent Valve (V2).

18. Open Vent Valve (V2) to depressurize the Cryostat to 0.25 psig. Close V2.

Note

Read all flow rates from the bottom of the float (ball) on the flow meters. Flow rates may be temporarily elevated. Do not adjust until the magnet has had time to stabilize (> 1 day).

19. Set Instrumentation Lead Vent Valve (V4) for a reading between 0.8 and 1.2 SCFH on Flowmeter (F2).
20. Set Shim Lead Vent Valve (V3) for a reading between 1.8 and 2.2 SCFH on Flowmeter (F1) to maintain a Cryostat Pressure Gauge reading between 0.25 – 0.50 psig

3–2 SHIM LEAD ASSEMBLY REPLACEMENT (continued)

21. Make sure flow rate through F2 is between 0.8 and 1.2 SCFH.
22. If flow rate through F2 is less than 0.8 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and ”bubble test” all exhaust plumbing joints, relief valve and Shim Lead Connector. Make sure V2 is fully closed. Repair any leaks. If a 0.8 SCFH flow rate through F2 cannot be achieved, under the above conditions, contact your MAC Team Representative.
23. Make sure the following conditions are maintained. Recheck settings in three days and again after one week:

    INSTRUMENTATION FLOWMETER (F2) = 0.8 – 1.2 SCFH
    SHIM LEAD FLOWMETER (F1) = 1.8 – 2.2 SCFH
    CRYOSTAT GAUGE PRESSURE = 0.25 – 0.50 PSIG

3–3 BAFFLE ASSEMBLY REPLACEMENT

Note
Replacement of the Baffle Assembly is necessary after a Quench or if damaged when the Shim Lead Assembly is removed.

1. Remove Shim Lead Assembly in conformance with REPLACEMENT / MAINTENANCE, Section 3–1.
2. Place the Shim Lead Assembly in the “Engaged” position. This is necessary in order for the Baffle Assembly to clear the Stainless Guide Sleeve. See Illustration 5–3.
3. Remove the 3 hex head screws that secure the Baffle Assembly to the Shim Lead Assembly.
4. Remove the defective Baffle Assembly and discard.

CAUTION

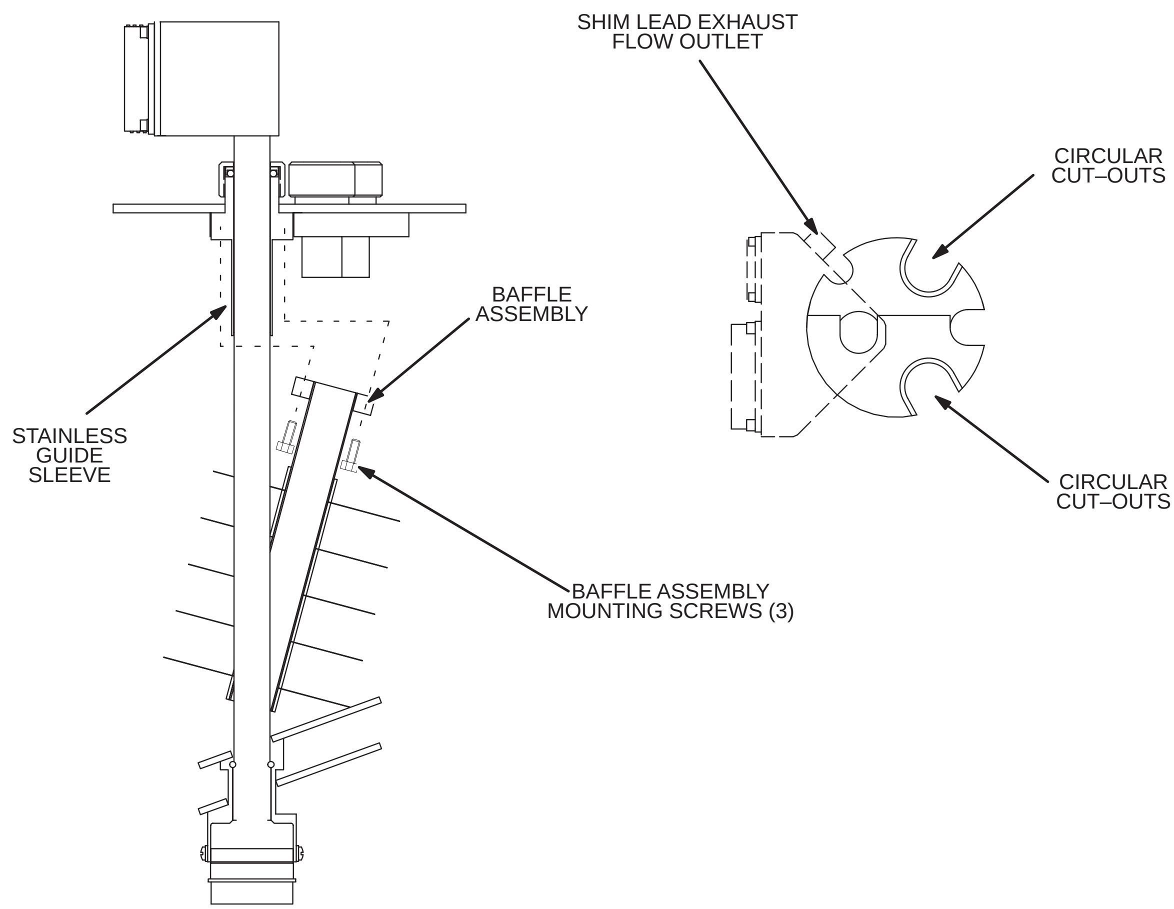
Care must be taken not to pinch the baffles between the Shim Lead G10 tube and the Baffle Assembly, while installing, to avoid damaging the baffles.

5. Install the Baffle Assembly (2133618) by carefully lifting up near the slit of each baffle while simultaneously pushing Baffle Assembly onto the Shim Lead Assembly, as in Illustration 5–3. Starting from the bottom of the Baffle Assembly and working towards the top; continue this process until the Baffle Assembly is attached to the Shim Lead Assembly G10 Tube.

3–3 BAFFLE ASSEMBLY REPLACEMENT (continued)

Note
Make sure the Baffle Assembly circular cutouts are aligned to the Rigid Baffle circular cutouts before securing to the Shim Lead.

6. Secure the Baffle Assembly to the Shim Lead Assembly using the three screws removed from step 3 above.
7. Place Shim Lead Assembly in the disengaged position. Tighten the Compression fitting on the Shim Lead Assembly.
8. Reinstall the Shim Lead Assembly in conformance to Section 3–2, REPLACEMENT / MAINTENANCE.
9. Ramp the magnet and check Flowmeters and Cryostat Pressure according to Section 9 in SET UP AND CALIBRATION.
10. After Magnet has been shimmed and is stable, and all Ramping and Shimming cables are removed from the Magnet, place the Shim Lead Assembly in the “Disengaged” position.



BAFFLE ASSEMBLY REPLACEMENT
ILLUSTRATION 5–3

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT

Description:

Shield Cooler Cold Heads require replacement for periodic maintenance and when out of spec, temperatures cannot be corrected by the actions in FUNCTIONAL CHECKS, Section 4 (Shield Cooler Checks).

It is recommended that the Cold Head replacement be performed by the "MAC" Team Representative in your district.

Make sure that the following parts and tools are on site before initiating this procedure:

- Reconditioned and Tested replacement Cold Head.
- Full Helium Gas Cylinder (99.9995% pure).
- Helium Transfer equipment indicated in RENEWAL PARTS, Section 3.
- Shield Cooler Maintenance Kit (46–281088G2).
- Heat Gun Kit (46–306830G1/G2)
- Field Vacuum Pump Kit (46–294047G1)

Make sure that the number of Indium Gaskets on the first and second stage stations of the removed cold head are determined and the same number are placed on the first and second stations of the new cold head before replacement; this will provide the proper spacing for the system.

WARNING!

THE MAGNET MUST BE RAMPED DOWN BEFORE BRINGING FERROMAGNETIC TOOLS OR EQUIPMENT INTO THE EXAM ROOM. FERROMAGNETIC OBJECTS BECOME DANGEROUS PROJECTILES IN A MAGNETIC FIELD.

RAMP MAGNET DOWN TO ZERO FIELD BEFORE STARTING THIS PROCEDURE.

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)

Note

Refer to the vendor manual for the identification and location of components and areas covered in the following procedure.

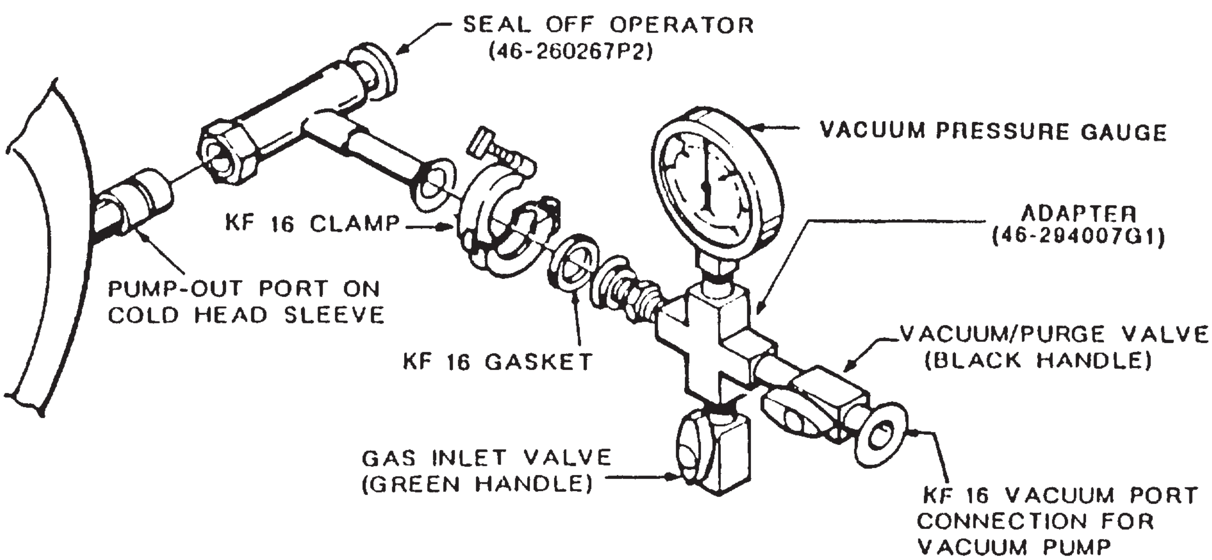
Procedure:

1. Turn off unit and disconnect the electrical cable from the Cold Head.
2. Disconnect the gas lines at the Cold Head with the wrenches provided in the Shield Cooler Maintenance Kit. See REPLACEMENT MAINTENANCE, Section NO TAG (CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS).
3. Signa Magnets have a magnetic shield around the Cold Head Motor. Remove the four bolts securing the shield and remove and save the shield and securing bolts.

Note

Clean all vacuum fittings on apparatus shown in Illustration 11–1 to make sure vacuum seals are tight.

4. Connect the Seal Off Operator (46–260267P2) to Adapter (46–294007G1).
5. Attach the Seal Off Operator and Adapter to the Pump Out Port on the Cold Head Sleeve. See Illustration 11–1. Tighten the Seal Off Operator to the Pump Out Port by holding the body of the operator and tightening the nut with a wrench.



COLD HEAD GAS/VACUUM SERVICE APPARATUS
ILLUSTRATION 11–1

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)

6. Connect Helium Gas Regulator (46–258151 P1) to the Helium Gas Cylinder (99.9995% pure) then to Flexible Hose (46–258152P1). Connect the hose to the Adapter Inlet Valve (green handle). See Illustration 11–2.

7. Make sure the Regulator Handle is backed out counterclockwise (CCW) to avoid regulator damage, then open the gas cylinder slowly, the high pressure gauge should indicate 2100–2400 psig if the cylinder is full.

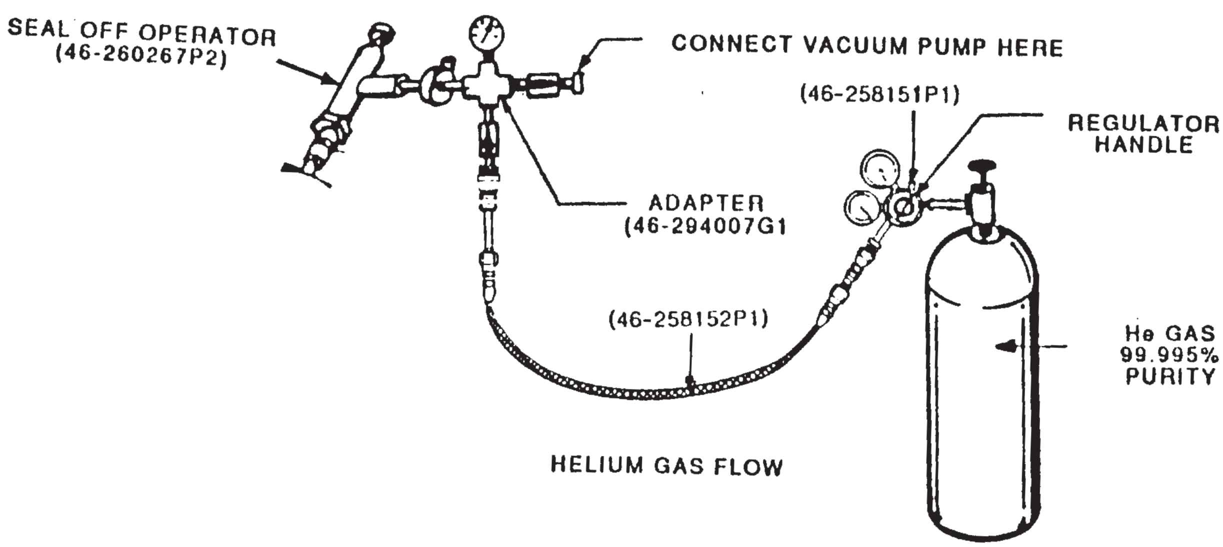
Note
A full gas cylinder is required for this procedure.

8. Open Inlet Valve and set a low pressure gas flow (1 psig) as indicated by the gauge on the Adapter.

9. Open the Vacuum Port Valve (black handle) on the Adapter and allow gas to flow out for one minute to purge the assembly of air.

10. Close the Vacuum Port Valve and Inlet Valve.

11. Push in and rotate the Black Handle of the Seal Off Operator clockwise (CW) to engage the plug in the Pump Out Port. When the handle is engaged, pull the handle out to open the Pump Out Port.



HELIUM GAS CONNECTION
ILLUSTRATION 11–2

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)

Note

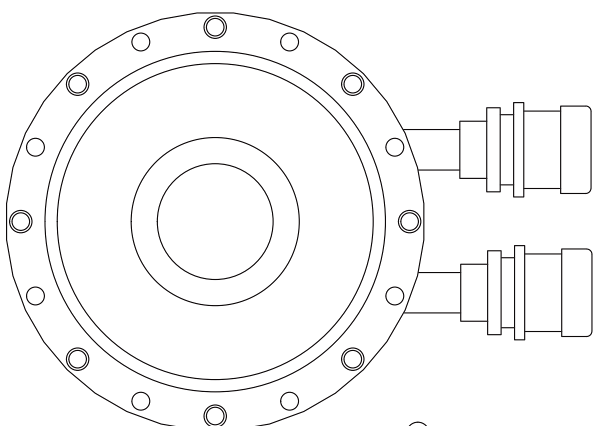
When the handle is pulled out, the gauge on the Adapter should indicate a vacuum.

12. Open the Gas Inlet Valve (green handle) and fill the vacuum space in the sleeve with Helium Gas at a small positive pressure (≈ 1 psig).

Note

Save the bolts and washers removed in Step 13, leaving the same number of washers on each bolt. These will be used to mount the new Cold Head and will make sure that the proper interface spacing is maintained.

13. Remove six of the eight Hex Head Bolts with Bellville Washers securing the Cold Head, leaving the remaining two bolts in to prevent the Cold Head from sliding out. See Illustration 11–3.



○ HEX HEAD COLD HEAD MOUNTING BOLTS (8)

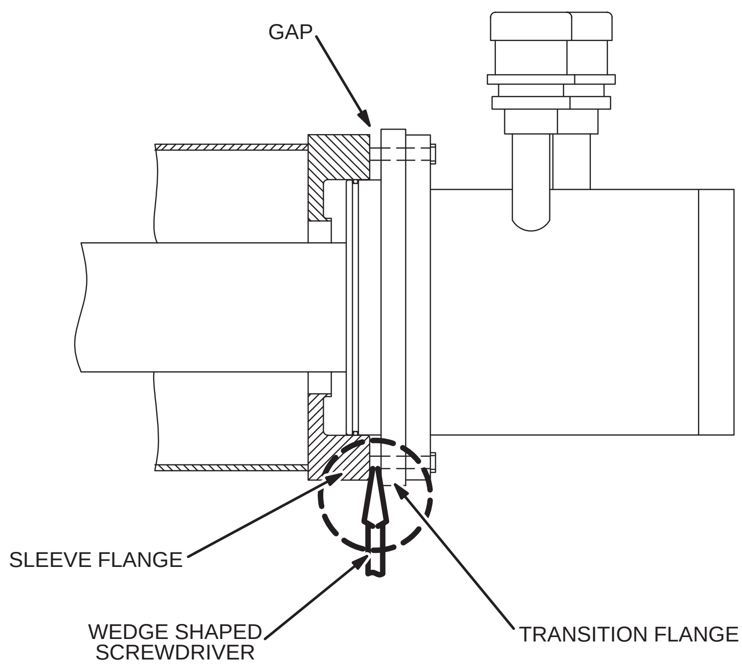
◎ TRANSITION FLANGE MOUNTING CAP SCREWS (8)

COLD HEAD MOUNTING
ILLUSTRATION 11–3

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)

14. Loosen the remaining two bolts to produce a 6mm (1/4 inch) gap under the bolt head.

15. Carefully insert a large screwdriver or other similar wedge shaped tool in the gap between the Cryostat Sleeve Flange and Transition Flange. Gradually pry the Transition Flange away from the Cryostat Sleeve Flange by tapping the end of a screwdriver or wedge while moving it around the circumference of the gap. See Illustration 11–4.



SEPARATION OF TRANSITION FLANGE–SLEEVE FLANGE
ILLUSTRATION 11–4

Note

It will be evident when the Cold Head "pops" away from the first stage contact in Step 15.

CAUTION

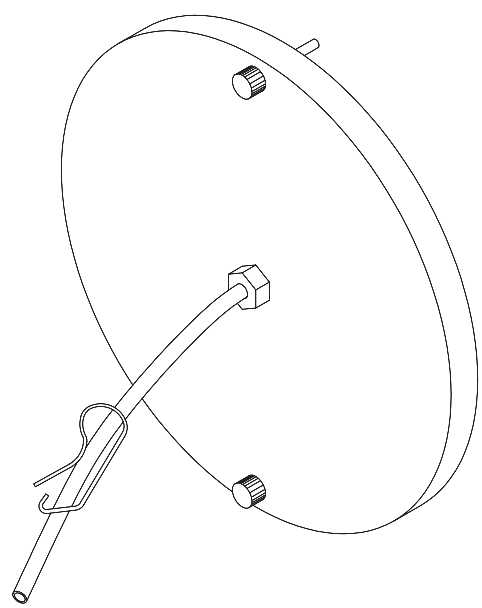
Make sure Helium Gas is flowing through the Pump–out Port connection and the Plexiglass Cover plate (46–294010G1) Is on hand before performing Step 16. When cold head is removed, Immediately cover hole with plexiglas cover plate to prevent contamination.

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)

CAUTION

The Cold Head weighs approximately 45 pounds and will require lifting straight out to prevent binding. Make sure there is adequate reach and support for its weight before lifting it out.

16. When the Cold Head “Pops” free, remove the remaining two bolts. Lift the Cold Head straight out of the Cold Head sump and place the Cold Head on padded surface for protection.
17. Immediately install the Plexiglas Cover Plate onto the Sleeve Flange of the Cryostat with the thumb screws provided on the cover. Make sure that Helium Gas is continuing to flow out of the slit in the tubing (1 psig) while the cover plate remains on Sleeve Flange. See Illustration 11–5.



PLEXIGLAS COVER PLATE (46–294010G1)
ILLUSTRATION 11–5

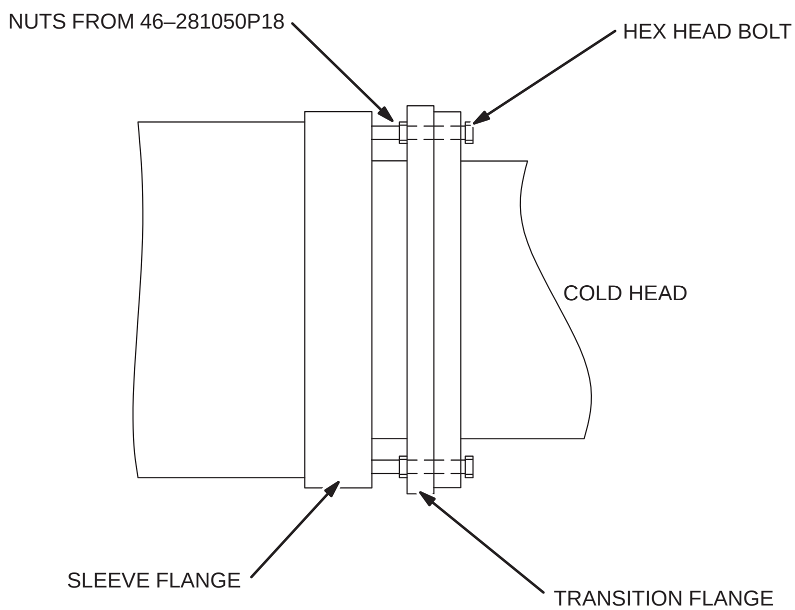
Note

If Cold Head does not pull free in Step 16, Perform Steps 18 through 21 to loosen the cold Head then repeat Step 16 and 17. If the Cold Head has been removed and the Plexiglas cover plate installed in Steps 16 and 17 go to Step 22.

18. Insert two Hex Head Bolts through the bolt holes in the Transition Flange, 180 degrees apart. Remove the Bellville Washers temporarily from two bolts before inserting them.
19. Remove the two nuts from the underside of the Plexiglas Cover Plate. Insert them into the gap between the Transition Flange and Cryostat Sleeve Flange and thread them onto the two Hex Head Bolts inserted in Step 18. See Illustration 11–6.

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)

20. Thread the Hex Head Bolts into the Threaded Holes in the Cryostat Sleeve Flange for approximately two turns.
21. Turn the nuts counterclockwise (CCW) on the Hex Head Bolt while holding the bolt head, turning each nut one turn at a time in succession, until the force of the nuts against the Transition Flange separates the second stage contact, then repeat Step 16.



NUT/BOLT MOUNTING FOR FLANGE SEPARATION
ILLUSTRATION 11–6

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)

22. Inspect the inside of the Sleeve Cylinder through the Plexiglas Cover Plate using a flashlight. Make sure that no Indium Gasket Material is present on the copper surfaces of the Heat Station. Determine the number of indium Gaskets on the First and Second Stage Stations of the removed Cold Head. This information is required for the gasket replacements in Steps 35 and 36.

CAUTION

If indium removal in Step 23 is required, do not keep the Sleeve Flange uncovered for an extended period of time (over 1 minute) to minimize icing.

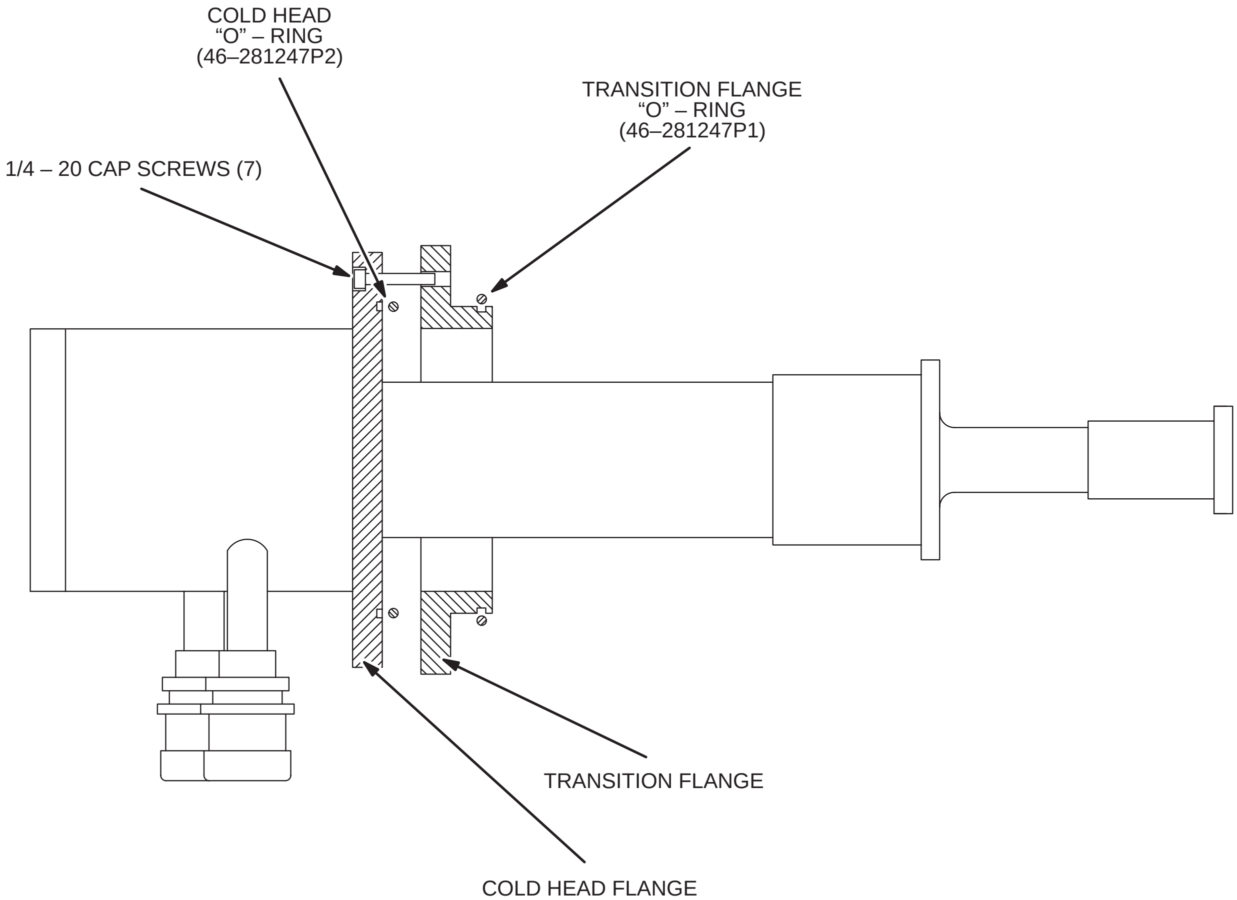
23. Continue the helium gas purge. If indium material is present, remove one of the thumb screws securing the cover plate and pivot the cover plate out on the remaining screw allowing access to the contaminated surface with a long handle screwdriver. Remove indium material with the screwdriver and pivot the cover plate over the Sleeve Flange.

Note

Wear cotton gloves (46–252065P64) when performing Steps 24 through 50.

24. Remove Heat Gun (46–306830G1/G2) for the Cold Head Sump and assemble in conformance with the instructions provided with the kit.
25. Clean all components of the Heat Gun with lint free cloth to make sure no contamination is present.
26. Loosen the thumb screws and remove the Lexan Cover Plate.
27. Carefully insert the Heat Gun into the Cold Head Sleeve and mount onto the Cold Head Sleeve Flange.
28. Close the Gas Inlet Valve (green handle) on the Pump Out Adapter and connect Helium Gas source to the Heat Gun.
29. Connect power and operate Heat Gun. Leave Heat Gun in place while preparing the new Cold Head.
30. Monitor Cold Head Diode temperatures while the Heat Gun is installed. Maintain the temperature between 285 and 300K. Do not allow the temperature to exceed 300K.
31. Remove the new Cold Head from the box and place in an upright position. Clean all surfaces to be placed into the sleeve with a lint free cloth/towel and Freon or other commercially available non–residue forming degreaser.
32. Remove “O” – Ring (46–281247P2) from the Poly–bag attached to the Cold Head and wipe with a dry, lint free cloth/towel. Inspect the “O” – Ring for nicks or cuts.

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)



COLD HEAD O – RING PLACEMENT
ILLUSTRATION 11–7

33. Coat the entire surface of the “O” – Ring with a thin film of Vacuum Grease and place the “O” – Ring into the groove on the Cold Head Flange. Apply a thin film of Vacuum Grease to the top surf ace of the “O” – Ring and groove. See Illustration 11–7.

34. Remove the Transition Flange (46–260938P1) from the removed Cold Head. See Illustrations 11–3 and 11–7. Save the seven Socket Head Cap Screws for installation of the flange on the new Cold Head.

35. Remove the “O” – Ring from the Transition Flange and clean the entire flange using the same materials as in Step 31.

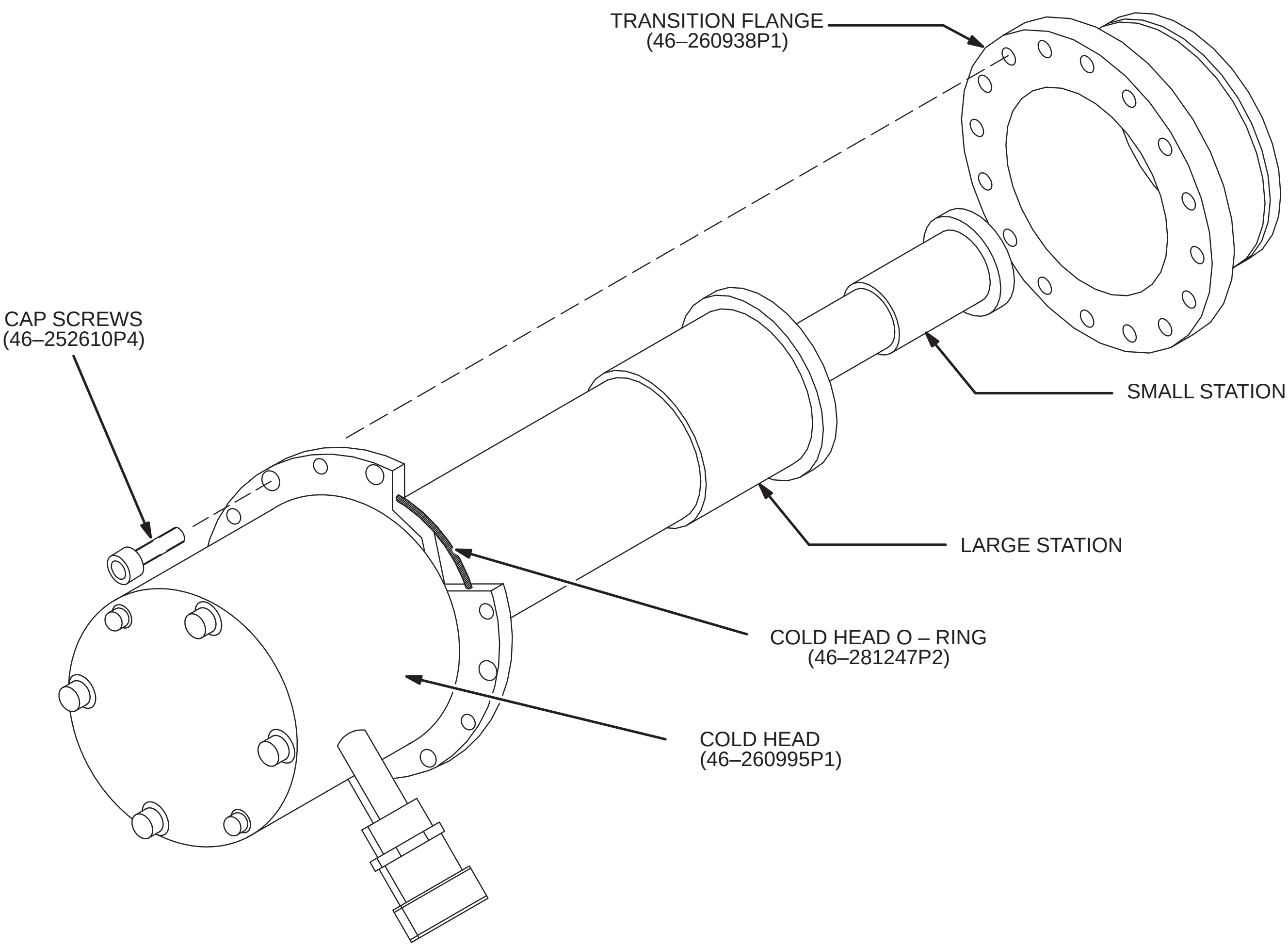
SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)

36. Apply a thin film of Vacuum Grease to the flat surface of the flange which contacts the "O" – Ring on the Cold Head Flange.

37. Slide the Transition Flange over the first and second stages of the Cold Head and rest the flange on the Cold Head "O" – Ring. See Illustration 11–8.

38. Align the bolt hole pattern of the Transition Flange and Cold Head Flange.

39. Insert the seven 1/4–20 Cap Screws (46–252610P4) through the bolt holes into Cold Head. Pull the Transition Flange flush to the Cold Head and hand tighten the Cap Screws until the Transition Flange is evenly sealed around the Cold Head "O" – Ring. Tighten each Cap Screw uniformity until the Transition Flange is tightly assembled against the Cold Head. See Illustration 11–8.



TRANSITION FLANGE MOUNTING
ILLUSTRATION 11–8

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)

Note

Cold Head “O” – Ring (46–281247P2) and Transition Flange “O” – Ring (46–281247P1) are approximately the same size. Make sure proper “O” – Ring (46–281247P1) is used in the following steps.

40. Inspect new “O” – Ring (46–281247P1) for cuts and nicks. Clean the “O” – Ring with a lint free cloth/towel and apply a thin film of Vacuum Grease to the entire surface of the “O” – Ring.

41. Slide the lubricated “O” – Ring over the two stations of the Cold Head and place in the groove of the Transition Flange. See Illustration 11–8.

Note

Assemble the same number of new Indium Gaskets on the First and Second stage stations of the Cold Head that were on the same stations of the removed Cold Head. See Step 22. Handle the gaskets only with clean hands or cloth gloves.

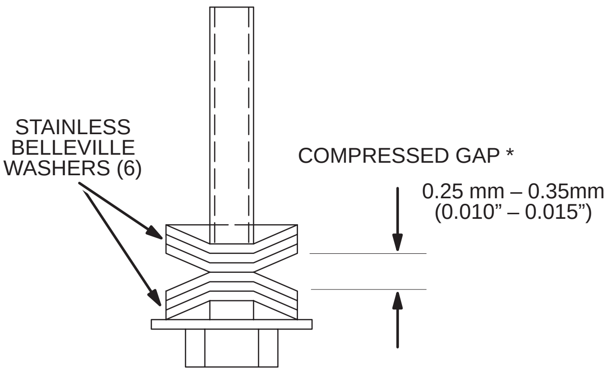
If number of gaskets are in question, consult the Acceptance Test Report included in the Data Sheet Section.

42. Place the required number of small Indium Gaskets (46–281241 P2) on the small Copper Station of the Cold Head. Fold the tabs on the gasket over the station to keep the gasket in place. See Illustration 11–9.

43. Place the required number of large Indium Gaskets (46–281241 P1) on the large Copper Station of the Cold Head. Secure the gaskets to the surface of the station by putting pressure on the gaskets forcing Indium into the small inside diameter of the station.

44. Apply a thin film of Anti–seize Compound to the eight Hex Head Bolts that were removed in Steps 13–16. Make sure that all bolts have the same number and orientation of the washers noted in Step 13. Generally, the number and orientation of washers will be as shown in Illustration 11–9.

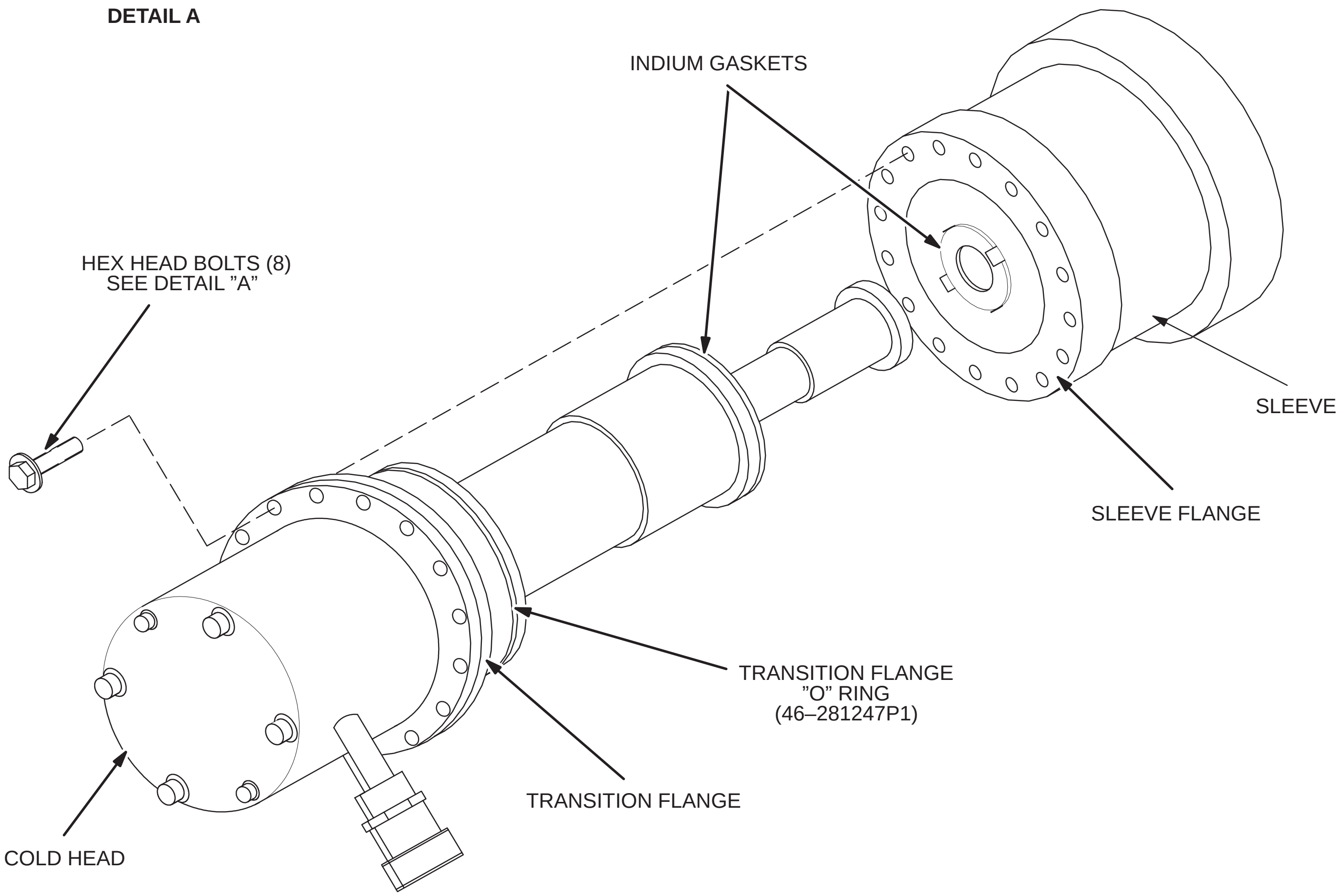
SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)



DETAIL A

NOTE:

SET COMPRESSION GAP WHILE TIGHTENING BOLT. DO NOT SET GAP WHEN LOOSENING BOLT.



COLD HEAD MOUNTING BOLT GAP SETTING
ILLUSTRATION 11–9

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)

45. Temporarily remove the Bellville Washers from three bolts, leaving the fiat washers on the bolts. These will be used to insert the new Cold Head.

46. After the Cold Head Sleeve Diodes have reached 285–300K, Discontinue Operation of the Heat Gun.

47. Detach and remove the Heat Gun from the Cold Head Heater to the Cold Head Flange.

48. When cool, return Heat Gun to case for future use.

49. Clean all surfaces within the Flange using a lint free cloth/towel and alcohol or other commercially available non–residue forming substance.

CAUTION

Do not rotate the Cold Head from its normal insertion position in Step 50 to prevent damaging the indium Gasket. Be careful not to damage or displace the indium Gaskets during Cold Head insertion.

50. Carefully insert the Cold Head into the sleeve on the Cryostat until the "O" – Ring contacts the opening of the sleeve.

CAUTION

Do not attempt to insert the Cold Head by hand beyond the point of "O" – Ring contact as "O" – Ring damage will result.

51. Insert the three bolts, with Bellville Washers removed in Step 45, equally spaced at 120 degree increments, in the mounting holes of the Cold Head Flange.

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)

52. Thread and lighten each bolt 1/2 turn at a time, in a rotational pattern, to evenly tighten until the “O” – Ring is fully captured into the sleeve.

53. Assemble and tighten the remaining 5 bolts with Bellville Washers. checked in Step 44, through the mounting holes in the Cold Head Flange.

54. Remove the three bolts inserted in Step 51; reassemble the Bellville Washers with the proper orientation; insert and tighten through the mounting holes in the Cold Head Flange.

55. Tighten all eight bolts evenly (hand tight).

56. Connect the Mechanical Vacuum Gauge on the Operator. Open the Vacuum Valve (black handle) and operate the Vacuum Pump for ten minutes to evacuate the sleeve space. Close the vacuum Valve. See illustration 11–1.

57. Observe the Vacuum Gauge on the operator for five minutes. If the vacuum reading remains steady, the sealing is “OK”.

Note

If sealing problem exists, a new Cold Head “O” – Ring (46–281247P2) is required and the Cold Head removal/replacement will have to be repeated using the same Cold Head.

58. When sealing “OK”, close the Pump Out Port Operator by pushing in on the knob and gently rotating it clockwise (CW). Then rotate the knob counterclockwise (CCW) until the Knob Extension is fully disengaged from the Pump Out Port and pull the knob out approximately 50mm (2 inches).

59. Turn off and remove Gas Supply, close Vacuum Valve (black handle), turn off Vacuum pump, open Gas Inlet Valve (green handle) to vent system and disconnect and remove apparatus.

60. Install Gas Flex Lines and Power Cable. Turn on Compressor and check out System. See SET UP AND CALIBRATION, Section 1–3.

61. Place the removed Cold Head in the New Cold Head Carton and return for servicing per instructions in carton. Make sure Cold Head is properly packaged and secure in the carton.

SECTION 4 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)

62. Monitor the Cold Head First and Second Stage Temperatures in conformance with the Magnet Service Manual, Section 1–4–7 of SET UP AND CALIBRATION ("Monitoring Cold Head Temperatures").

63. Liter the Cold Head has cooled down for approximately four hours, tighten the Cold Head Mounting Bolts hand tight in a "CW" rotational pattern.

64. Continue to hand tighten the Cold Head Mounting Bolts in the above manner, at approximately four hour intervals, until the First and Second Stage Temperatures have stabilized.

65. When temperatures have stabilized, tighten all Cold Head Mounting Bolts evenly, in a "CW" rotational pattern, to result in the Bellville Washer Gap Setting shown in Illustration 11–9.

Note

First and Second Stage Temperature may decrease farther, after setting the Bellville Washer Gap.

Note

Differences in diode mounting techniques and diode lead heat stationing used to intercept heat propagated down the leads from the outside the magnet, have produced increased variation in shield cooler diode temperature readings. Because of this condition, the acceptable diode temperature range (magnet operating with boil–off in specification) has exceeded the original temperature range established for field reference, for a small number of magnets. It is important to identify acceptable diode temperature readings which exceed the field reference range, as the "diagnostic threshold" for proper shield cooler operation. Diode temperature reading values are recorded on the Acceptance Test Report (ATR) sent with each magnet. Where the recorded value exceeds the field reference range documented in the above note, use the recorded value as the nominal value for proper shield cooler operation on the referenced magnet. Acceptable ranges around these nominal values are:
± 10 K FIRST STAGE ± 5 K SECOND STAGE
Starting March 1, 1993 all diode temperature reading values which exceed the field reference range will be recorded on a label attached to the coldhead sleeve, in addition to being recorded on the ATR.

66. Establish if the stabilized temperatures are within range (32–60K First Stage, 7–17K Second Stage). The temperatures that were found for your magnet in the factory are recorded in the Acceptance Test Report (ATR). If temperatures are higher than those values, perform the tests listed in FUNCTIONAL CHECKS, Section 4 of this manual.

SECTION 5 – SAV CON CONNECTOR REMOVAL / REPLACEMENT

WARNING!

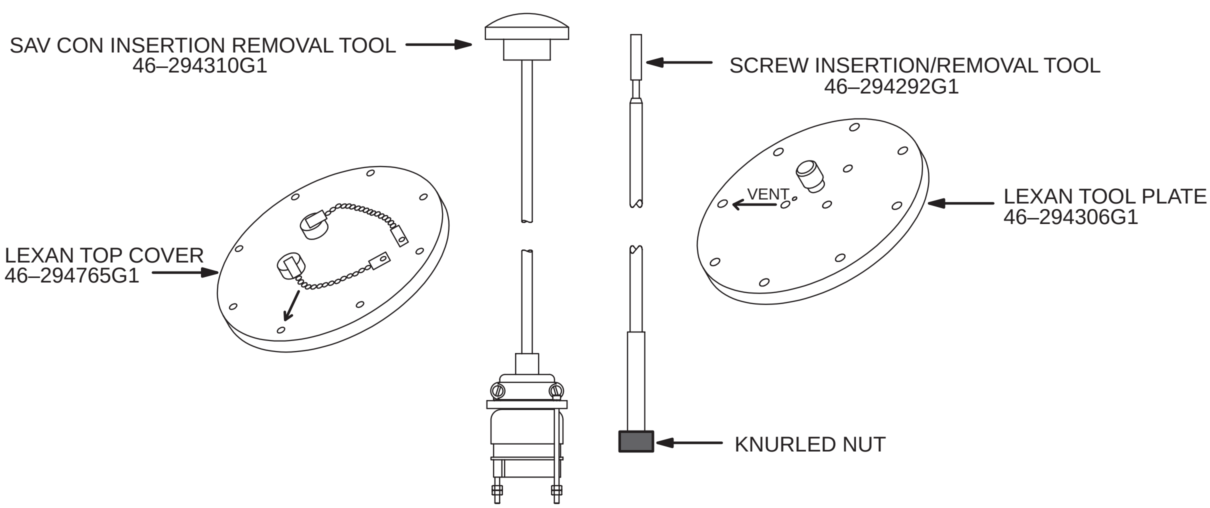
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

RAPID EXHAUSTING OF COLD HELIUM GAS MAY BE ENCOUNTERED DURING THE FOLLOWING PROCEDURES. WEAR NON ABSORBENT GLOVES AND GOGGLES OR FACE SHIELD WHEN PERFORMING THESE PROCEDURES.

MAKE SURE THAT THE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE REMOVING/REPLACING THE SHIM LEAD ASSEMBLY. A MAGNET QUENCH DURING REMOVAL/REPLACEMENT OF THE SHIM LEAD ASSEMBLY COULD RESULT IN THE RAPID EXPULSION OF LIQUID HELIUM OUT OR THE VERTICAL PENETRATION.

REMOVAL/REPLACEMENT OF THE SAV CON CONNECTOR MUST BE PERFORMED QUICKLY TO PREVENT CONDENSATION AND ICING IN THE VERTICAL PENETRATION AND ON THE ELECTRICAL CONNECTORS.

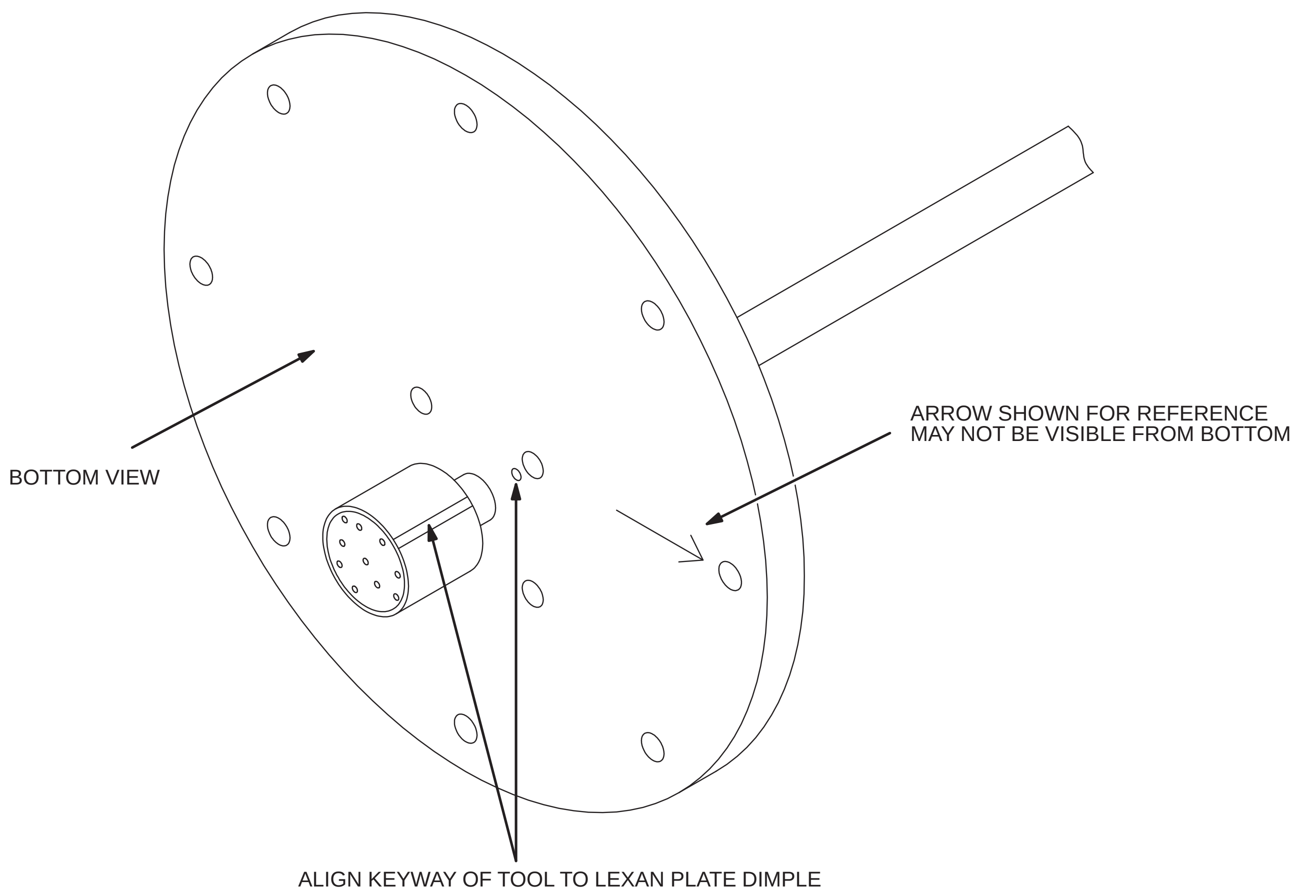
READ AND UNDERSTAND THIS PROCEDURE AND HAVE ALL REQUIRED TOOLS AND EQUIPMENT ON HAND INCLUDING: TOOL KIT P/N 46–294743G1, HELIUM GAS, HEAT GUN, WRENCHES, FLASHLIGHT, SNOOP, SAFETY FACE SHIELD AND GLOVES BEFORE STARTING.



SAV CON REPLACEMENT/REMOVAL TOOLS
ILLUSTRATION 6–1

5–1 SAV CON CONNECTOR REMOVAL

1. Ramp magnet down to zero field in conformance with REPLACEMENT / MAINTENANCE, Section NO TAG.
2. Slowly open Vent Valve (V2) and vent magnet until internal pressure drops between 0.20 and 0.3 psi on the Cryostat Pressure Gauge. Close V2.
3. Assemble the Sav Con Insertion/Removal Tool to Lexan Tool Plate (46–294306G1) by removing knob on the tool shaft and inserting shaft through center hole in Lexan plate.
4. Position connector end of tool towards the Lexan Tool Plate and align Sav Con Tool key way to dimple as shown in Illustration 6–2. Tighten knurled nut to hold in place. Reassemble knob to tool shaft.



SAV CON SET UP
ILLUSTRATION 6–2

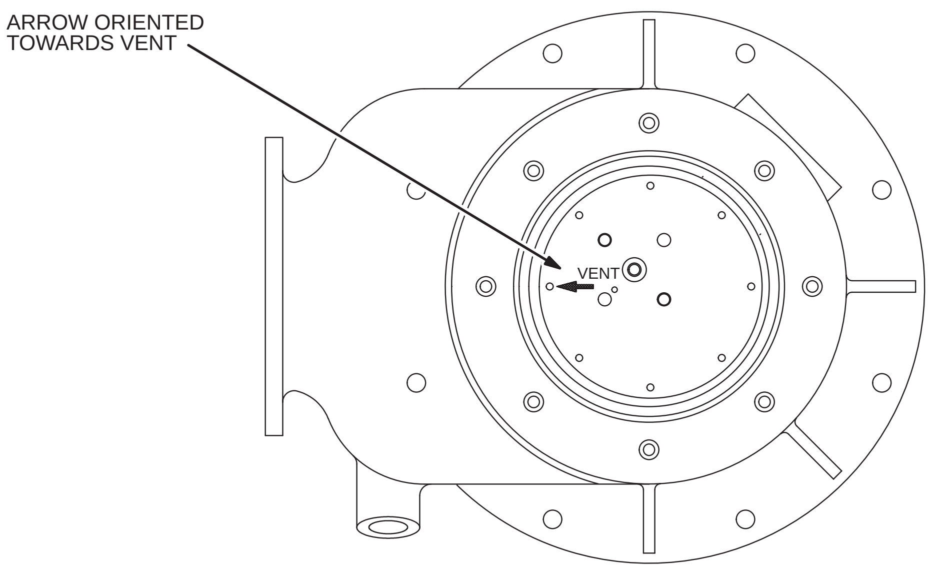
5–1 SAV CON CONNECTOR REMOVAL (continued)

Note

Quickly place this assembly onto the Vertical Penetration upon removal of Shim Lead Assembly to prevent icing. Always replace Shim Lead O–ring when performing this procedure.

5. Remove Shim Lead Assembly in conformance with REPLACEMENT / MAINTENANCE, Section 3 and store carefully.

6. Immediately position Lexan Tool Plate / Tool assembly onto Vertical Penetration; orient scribe mark as shown in Illustration 6–3.



SAV CON TOOL ASSEMBLY ALIGNMENT TO TURRET
ILLUSTRATION 6–3

7. Allow flow of helium gas exiting through holes in Lexan Tool Plate to subside.

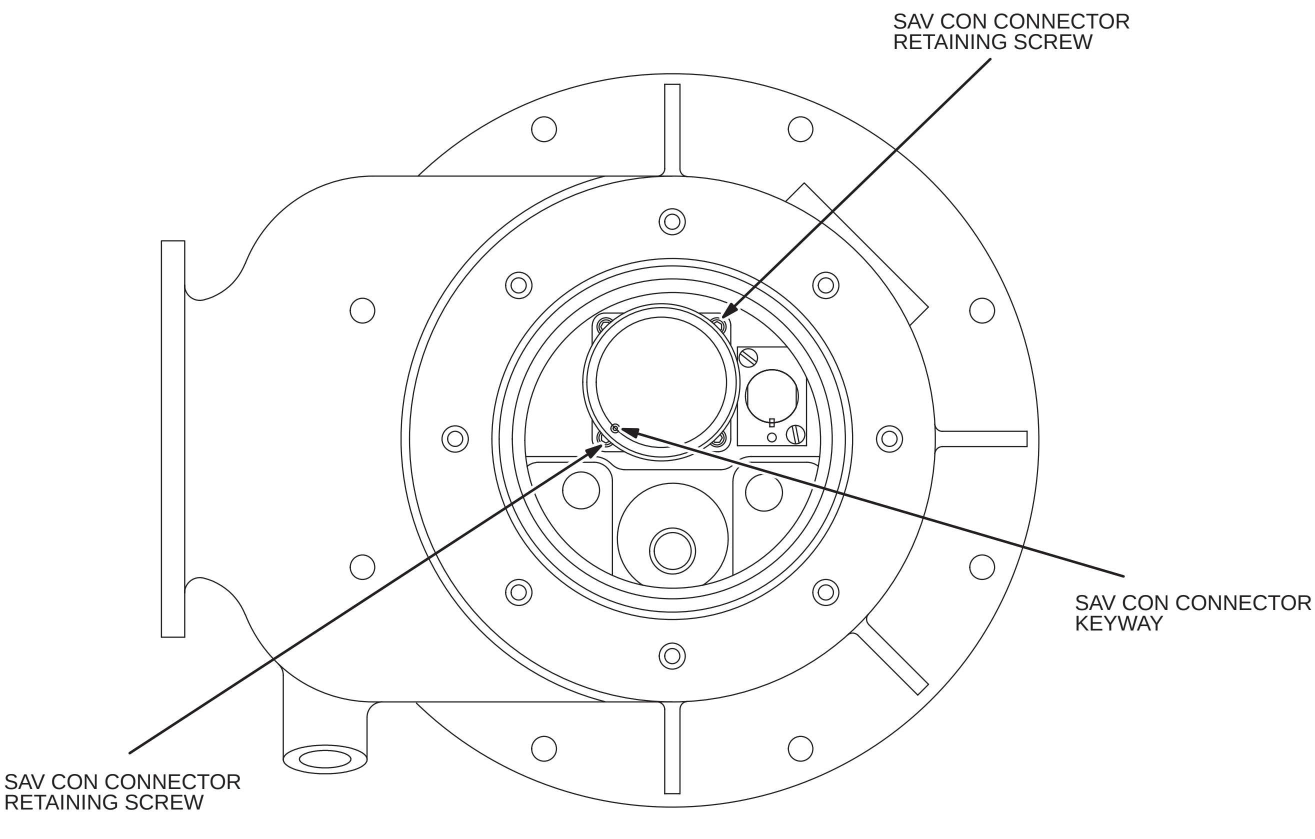
8. Make sure Shim Lead O–ring on top of Vertical Penetration is in its groove and firmly sandwiched between the Lexan Tool Plate and Vertical Penetration. Bolt Lexan Plate in place using bolts removed in step 5.

Note

If ice builds up on connector or associated hardware during procedure, Insert Helium Gas Tube through one of the holes in the Lexan Tool Plate to the ice point. Blow warm helium gas at 15 psi to remove ice, then allow flow of helium gas to subside.

5–1 SAV CON CONNECTOR REMOVAL (continued)

9. Shine flashlight through Lexan Tool Plate and locate Sav Con Connector and its Retaining Screws. Check for any ice build up.
10. Locate the two Sav Con Connector Retaining Screws, location should be directly below insertion holes on Lexan Tool Plate. See Illustration 6–4.



SAV CON CONNECTOR RETAINING SCREW LOCATION
ILLUSTRATION 6–4

Note
Sav Con Retaining Screws are captured by locking nut under Flange to prevent them from falling off the Sav Con Flange during removal.

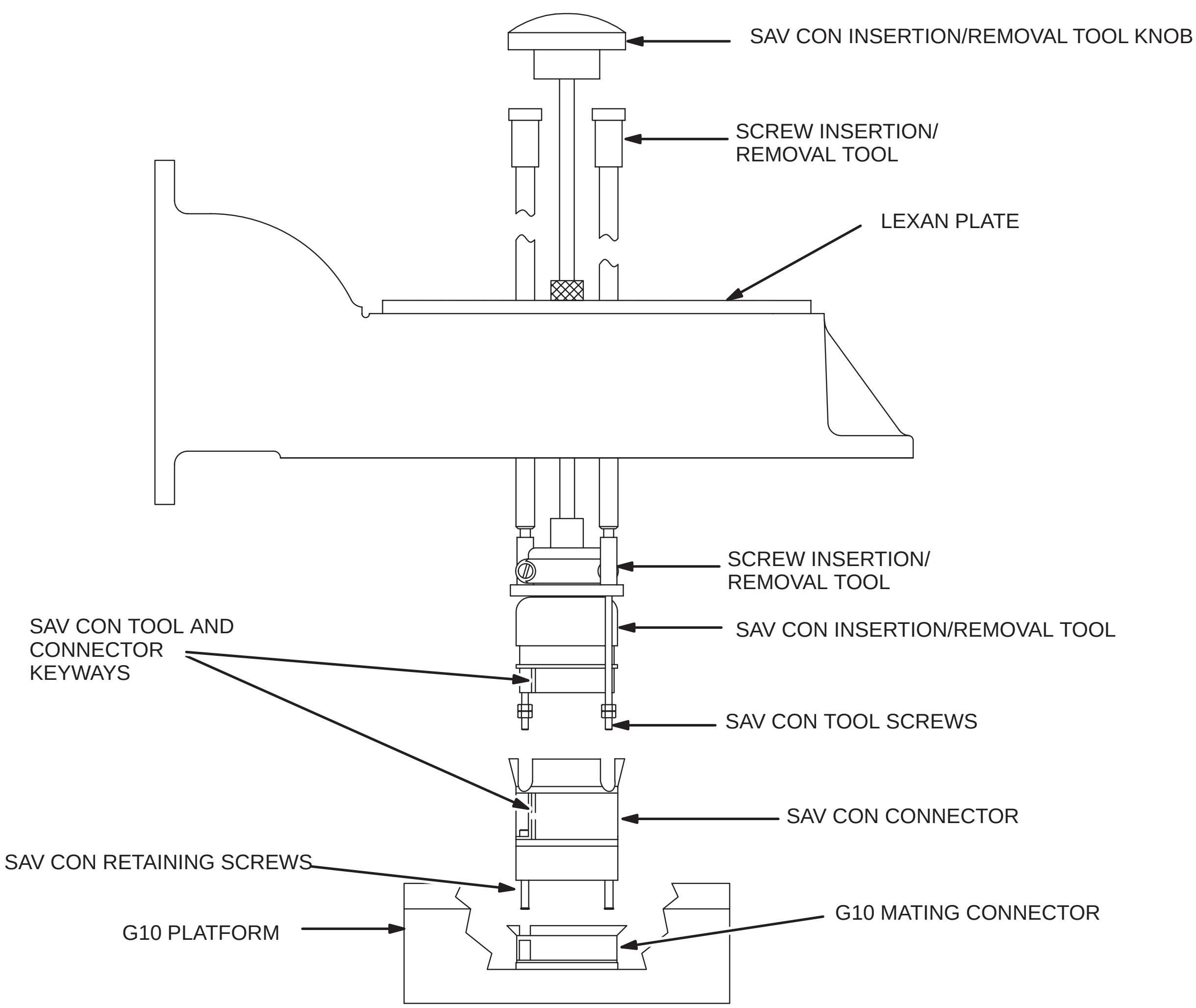
11. Lower the Screw Insertion Tool through one of the two appropriate holes to contact the Allen head on either Retaining Screw.
12. Push downward to engage Screw Insertion Tool with Sav Con Retaining Screw, loosen each screw.
13. Withdraw the Screw Insertion/Removal Tools.

5–1 SAV CON CONNECTOR REMOVAL (continued)

CAUTION

Make sure the key ways of the Sav Con Connector and the G10 mating connector are lined up before connecting the two together. Forcing the Sav Con Connector onto the G10 mating connector can result in bending of the G10 connector pins.

14. Loosen knurled nut holding the Sav Con Insertion / Removal Tool. Push downward and carefully align key ways of the two mating connectors, then seat the Sav Con Insertion/Removal Tool onto the Sav Con Connector. See Illustration 6–5.



SAV CON TOOL ASSEMBLY AND CONNECTOR MATING
ILLUSTRATION 6–5

5–1 SAV CON CONNECTOR REMOVAL (continued)

Note
The Sav Con Tool Screws are needed to grip the Sav Con Connector for easy removal.

15. Insert the Screw Insertion/Removal Tool through the appropriate holes in the Lexan Tool Plate and engage each screw on the Sav Con Connector Tool.
16. Carefully thread the Sav Con Tool Screws into the threaded bolt heads of the Sav Con Connector and tighten lightly. Remove Screw Insertion/Removal Tools.
17. Pull upward with the Sav Con Tool to remove the Sav Con Connector from the G10 Connector Platform. Tighten the knurled nut to secure tool.
18. Remove Lexan Tool Plate and Sav Con Tool Assembly. Quickly replace with Lexan Top Cover (46–294765G1).

5–2 SAV CON CONNECTOR REPLACEMENT

1. Remove old Sav Con Connector from tool and insert replacement Sav Con Connector onto the Sav Con Tool. Lightly tighten Sav Con Tool screws onto Sav Con threaded bolt head screws.
2. Remove Lexan Top Cover from Vertical Penetration and immediately position Sav Con Connector/Tool Assembly over Vertical Penetration. Orient scribe mark on Lexan Tool Plate towards Vent.
3. Repeat steps 7 through 9 in Subsection 5–1.

Note
Always be sure to align all key ways on all connectors.

4. Loosen knurled nut and lower Sav Con Connector / Tool Assembly. Carefully engage Sav Con Connector into mating G10 platform connector.
5. Locate Sav Con Connector Retaining Screws. Location should be directly below insertion holes on Lexan Plate.
6. Lower the Screw Insertion/Removal Tool to contact Allen head on Retaining Screws.
7. Engage and hand tighten Sav Con Retaining Screws. Withdraw Screw Insertion / Removal Tools.
8. Unscrew Sav Con Tool screws from the Sav Con Connector. Disengage, pull Sav Con Tool upward, and secure in place with knurled nut.
9. Remove Sav Con Tool Assembly from the Vertical Penetration and replace with Lexan Top Cover.
10. Check for ice and remove before reinstalling the Shim Lead Assembly.
11. Reinstall Shim Lead Assembly and Shim Lead Exhaust plumbing. Engage Shim Lead before Ramping.
12. Check Vertical Penetration and Shim Lead plumbing for leaks before Ramping.
13. Ramp Magnet in conformance with SET UP AND CALIBRATION, Section 9.

SECTION 6 – RE–EVACUATION OF CRYOSTAT

A Vacuum Pump Cart System has been developed for the re–evacuation of the Cryostat. Connection, monitoring and pumping procedures are supplied with the Vacuum Pump Cart System. Contact your MAC Team Representative for further information.

Note

The temperature of the magnet and all internal components must be greater than 273K to ensure adequate pumping of water vapor and prevent potential cryopumping.

SECTION 7 – WARMING UP CRYOSTAT

Description:
There will be very few situations that will require the magnet to be warmed up in the field (the removal of an internal ice block or field repairable vacuum leak requiring reevacuation). If a Magnet warm up is required, contact the Regional Mac Team Representative before proceeding.

CAUTION

Do not warm up the Magnet if it is to be shipped from the site!

Procedure:

WARNING!

WEAR PROTECTIVE CLOTHING, NON–ABSORBENT GLOVES AND GOGGLES OR FACE SHIELD, TO PROTECT AGAINST LIQUID CRYOGENS.

TURN ON EXAM ROOM EXHAUST FAN TO AID IN REMOVING CRYOGEN GASES. MAKE SURE PROPER VENTILATION EXISTS DURING WARM UP AS CONSIDERABLE QUANTITIES OF HELIUM AND NITROGEN GAS ARE RELEASED TO ATMOSPHERE.

SECURE EXAM ROOM DOORS IN THE OPEN POSITION BEFORE WARMING UP MAGNET.

MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD TO PREVENT ANY POSSIBILITY OF A QUENCH.

CAUTION

Make sure the MAC Team Representative is present and has determined that Magnet Warm Up is required before proceeding.

7–1 WARMING UP CRYOSTAT

1. Turn off Shield Cooler Compressor and disconnect power cable. Disconnect supply and return gas lines at the Cold Head.
2. Remove Helium Burst Disc and reconnect Vent Adapter. See REPLACEMENT/MAINTENANCE, Section NO TAG.
3. Connect the Lakeshore Cryotonic 208 Thermometer Kit (46–301477G1) to monitor silicon diode temperature in conformance with SET–UP AND CALIBRATION, Section 7–2–1.
4. Obtain 2 large (235 SCF) full aluminum helium cylinders.

WARNING!

SECURE CYLINDER BEFORE REMOVING PROTECTIVE VALVE CAP TO PREVENT CYLINDER FROM FALLING, WHICH COULD RESULT IN SHEARING VALVE OUTLET AND CAUSING HAZARDOUS HIGH PRESSURE GAS RELEASE.

5. Connect standard high pressure GHe regulator and hose assembly to valve outlet (CGA 580) on GHe cylinder.
6. Connect Helium Gas Line Adapter to Purge/Precool Adapter then connect Helium Gas Line to Adapter. See Illustration 3–1.
7. Make sure that regulator adjusting handle is fully backed out, then slowly open GHe Cylinder Valve.
8. Observe Regulator High Pressure Gauge. Make sure indicated pressure is approximately 2000 psig indicating full cylinder.

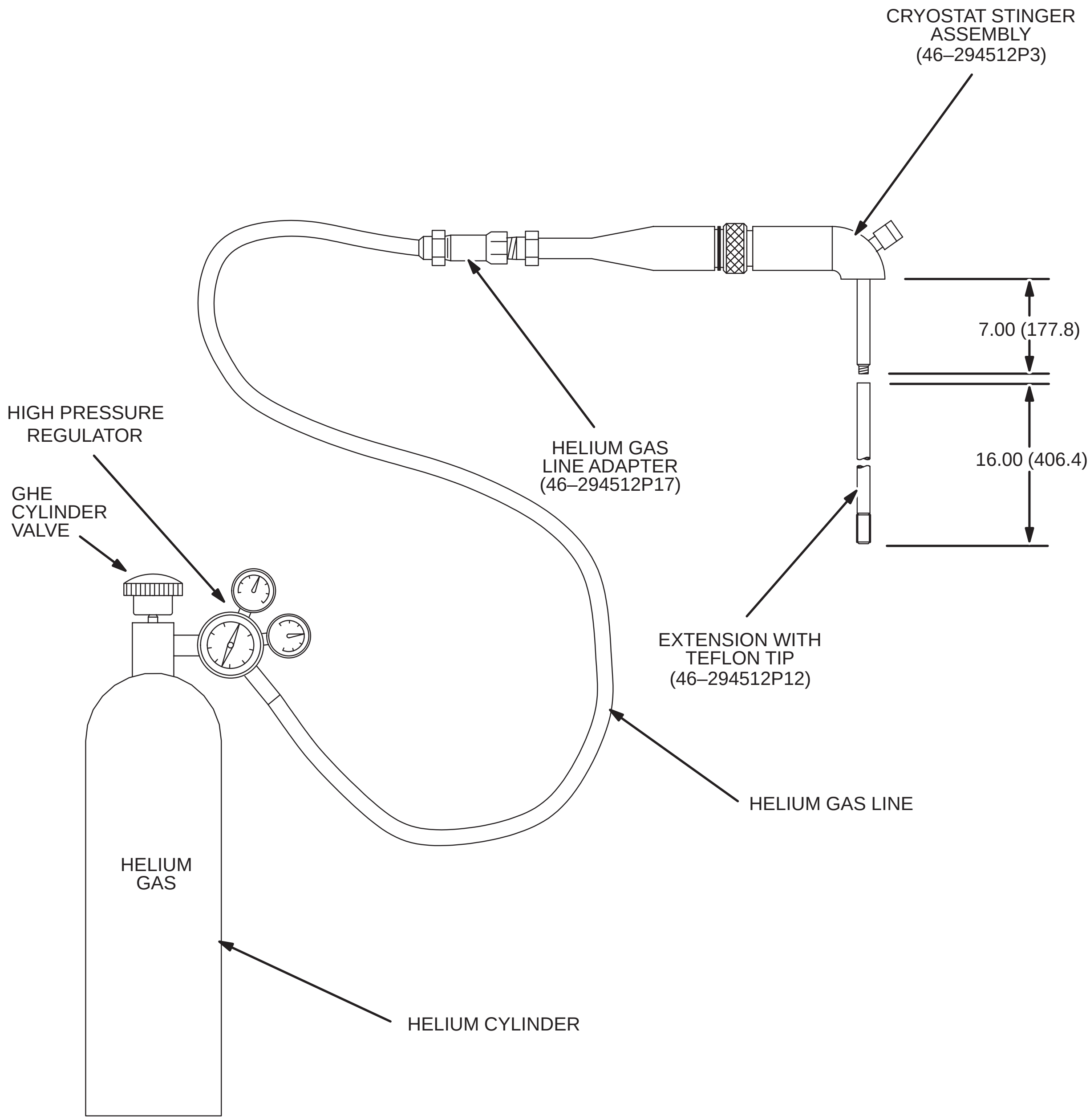
WARNING!

FIRMLY HOLD PURGE/PRECOOL ADAPTER WHILE PURGING REGULATOR AND GAS LINE ASSEMBLY TO PREVENT WHIPPING MOTION.

9. Purge regulator and gas line assembly by alternately turning regulator handle fully in and out 3 times. Upon completion of purge, back regulator out until minimal flow is felt exiting the Purge/Precool Adapter.
10. Adjust regulator outlet pressure to 5 psig.

7–1 WARMING UP CRYOSTAT (continued)

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



HELIUM PURGE SET–UP
ILLUSTRATION 3–1

7–1 WARMING UP CRYOSTAT (continued)

11. Position Helium Gas (99.995%) and Regulator Set–Up to the Helium Fill Port at V1.
12. Open Helium Vent Valve (V2).

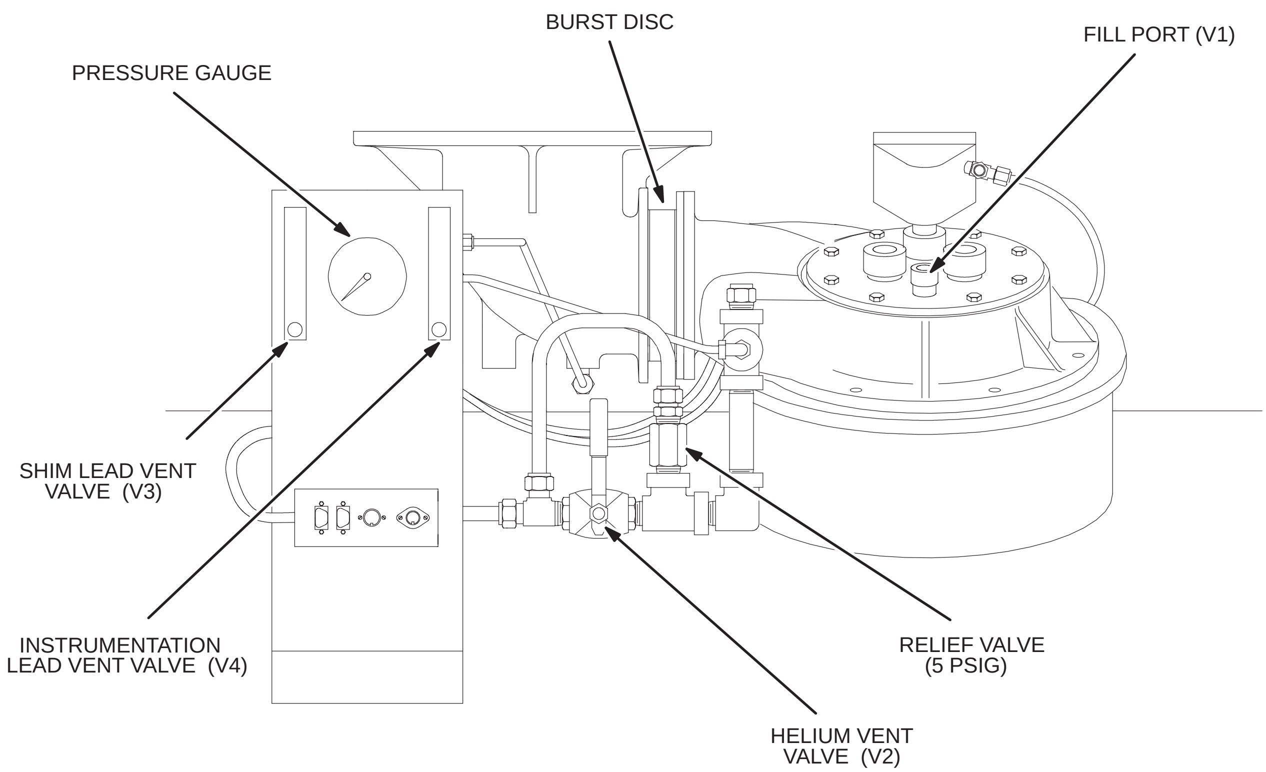
Note

If ceiling height prevents insertion of Cryostat Stinger in Step 13, remove Extension from Cryostat Stinger and partially insert into Fill Port V1, before attaching it to the Cryostat Stinger.

CAUTION

Maintain secure hold on Extension Tip when inserting in V1 to prevent it from falling into magnet.

13. Uncap Fill Port and insert Stinger until it "Bottoms Out" (approximately 22 inches or 559mm).



VALVE/VENT LOCATIONS
ILLUSTRATION 3–2

7–1 WARMING UP CRYOSTAT (continued)

14. Blow warm Helium Gas through the Cryostat, regulated at 4 to 6 psig, until silicon diode temperature readout exceeds 90K.
15. Shut off Helium Gas flow using Positive On/Off Valve.
16. Remove Helium Gas Setup and connect Nitrogen Gas Set–Up in its place.

WARNING!

SKIN CONTACT WITH LIQUID CRYOGENS WILL CAUSE BURNS. WEAR PROTECTIVE CLOTHING, GLOVES (NONABSORBENT MATERIAL) AND GOGGLES OR FACE SHIELD WHEN TRANSFERRING CRYOGENS.

MAKE SURE SUFFICIENT VENTILATION EXISTS IN THE EXAM ROOM TO DISPEL THE LARGE AMOUNTS OF NITROGEN GAS WHICH WILL DISPLACE THE AIR (OXYGEN) AND COULD CAUSE ASPHYXIATION. VENT NITROGEN FROM ROOM DURING PURGING PROCEDURE.

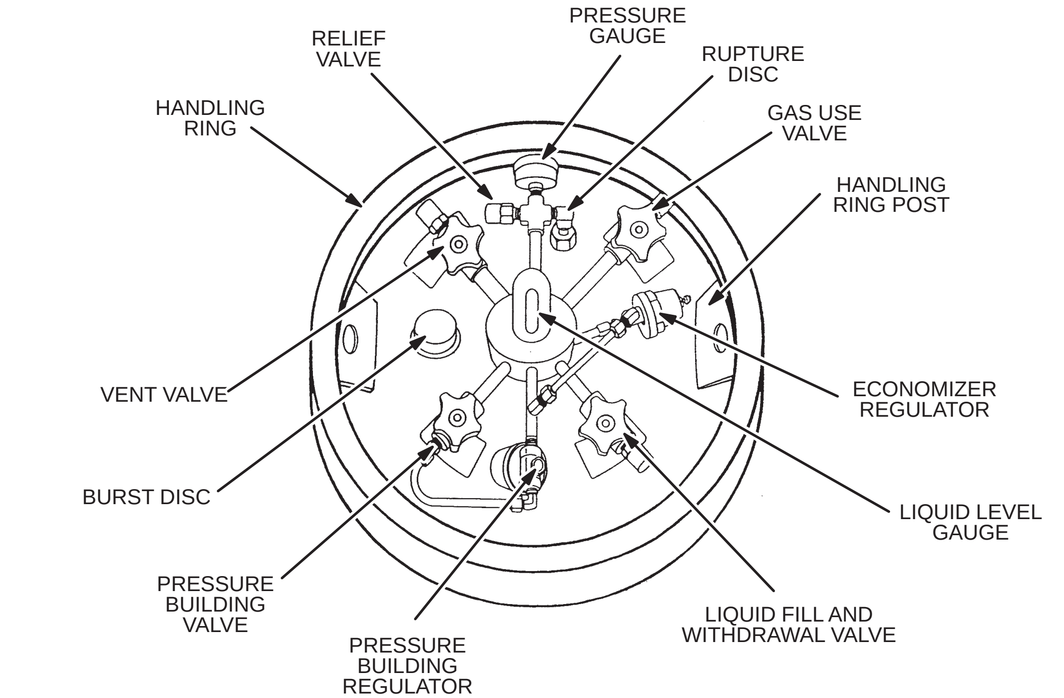
17. Obtain a full Liquid Nitrogen Dewar (PLC–230A). Verify that all valves are in the closed position.

Note

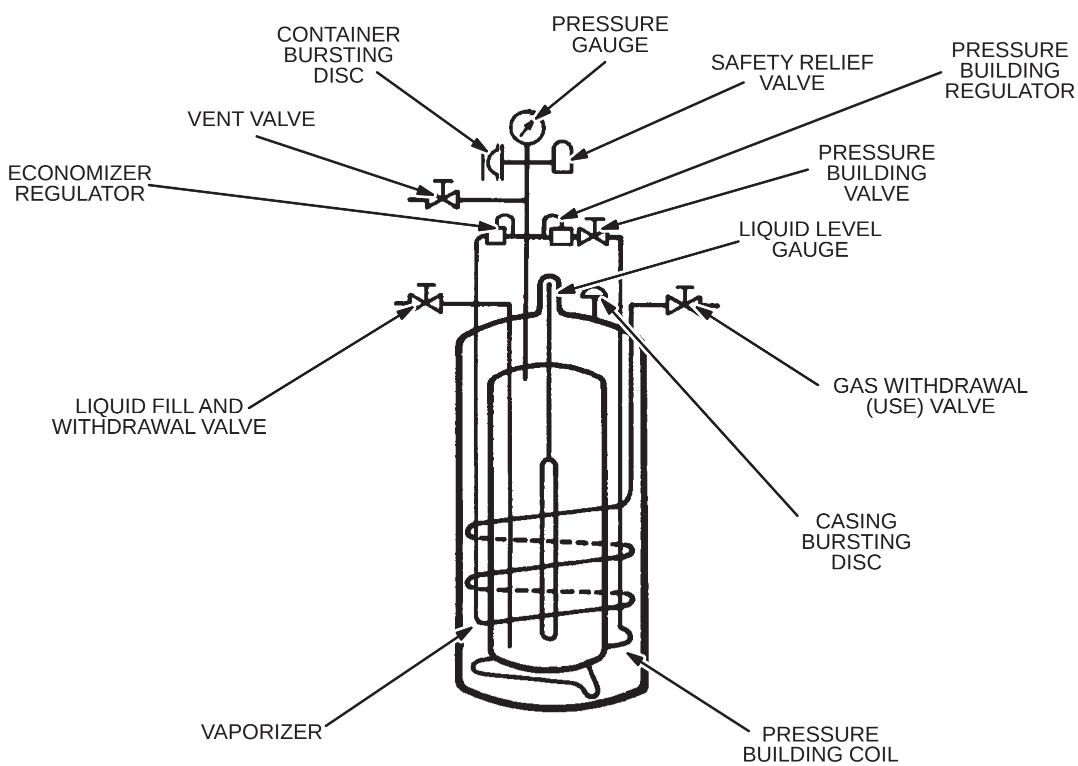
Other sources of gaseous nitrogen may be used with appropriate setup apparatus.

18. Open Pressure Building Valve on PLC–230A, verify that pressure gauge reading does not exceed 20 psig. See Illustration 3–3.

7–1 WARMING UP CRYOSTAT (continued)



TOP VIEW OF NITROGEN DEWAR

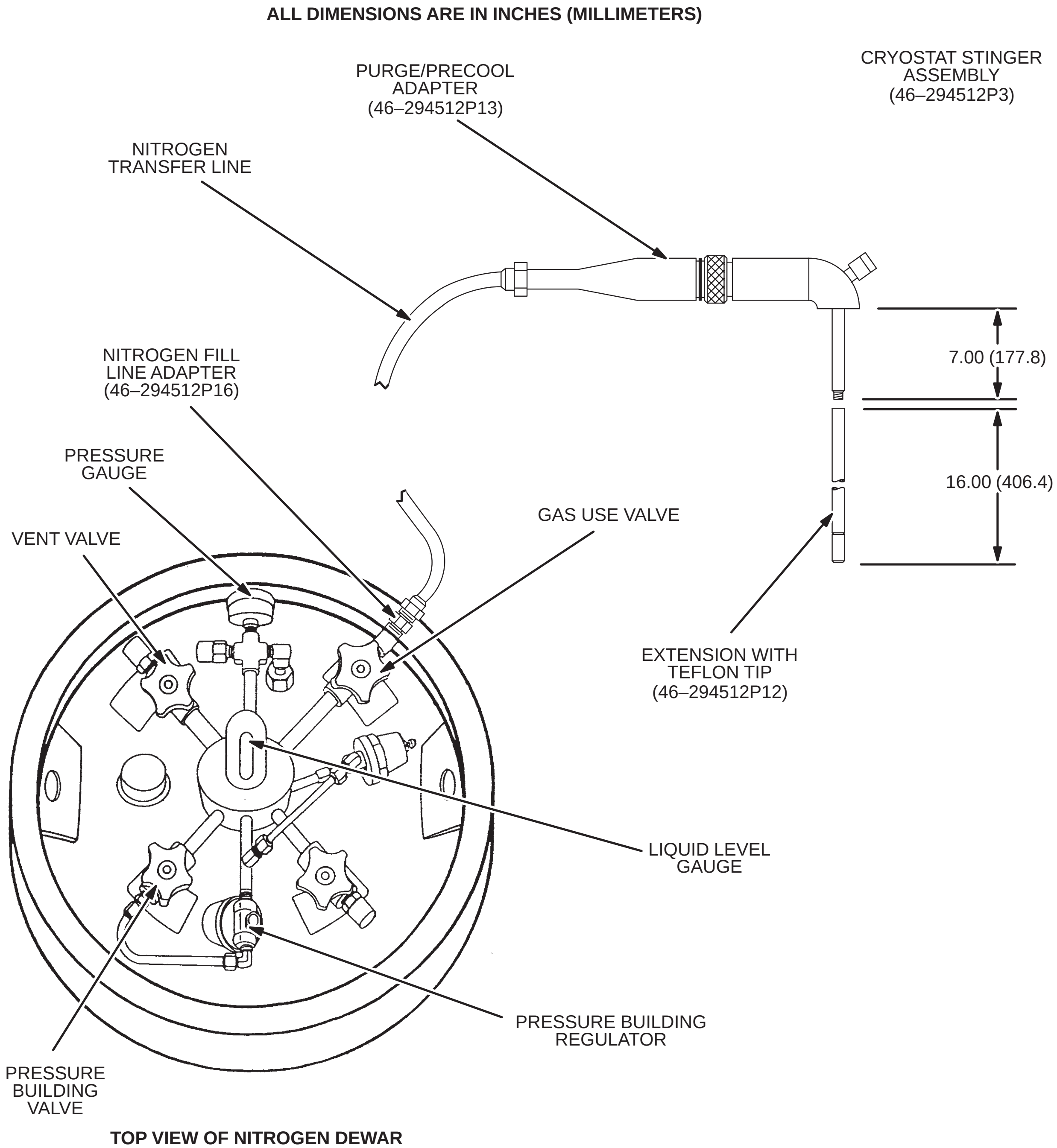


NITROGEN GAS/LIQUID DEWAR
ILLUSTRATION 3–3

7–1 WARMING UP CRYOSTAT (continued)

19. Connect Nitrogen Transfer Line to Gas Use Valve on PLC–230A dewar using Nitrogen Fill line Adapter.

20. Connect Purge/Precool Adapter to opposite end of Nitrogen Transfer Line. See Illustration 3–4.



NITROGEN PURGE/PRECOOL ADAPTER
ILLUSTRATION 3–4

7–1 WARMING UP CRYOSTAT (continued)

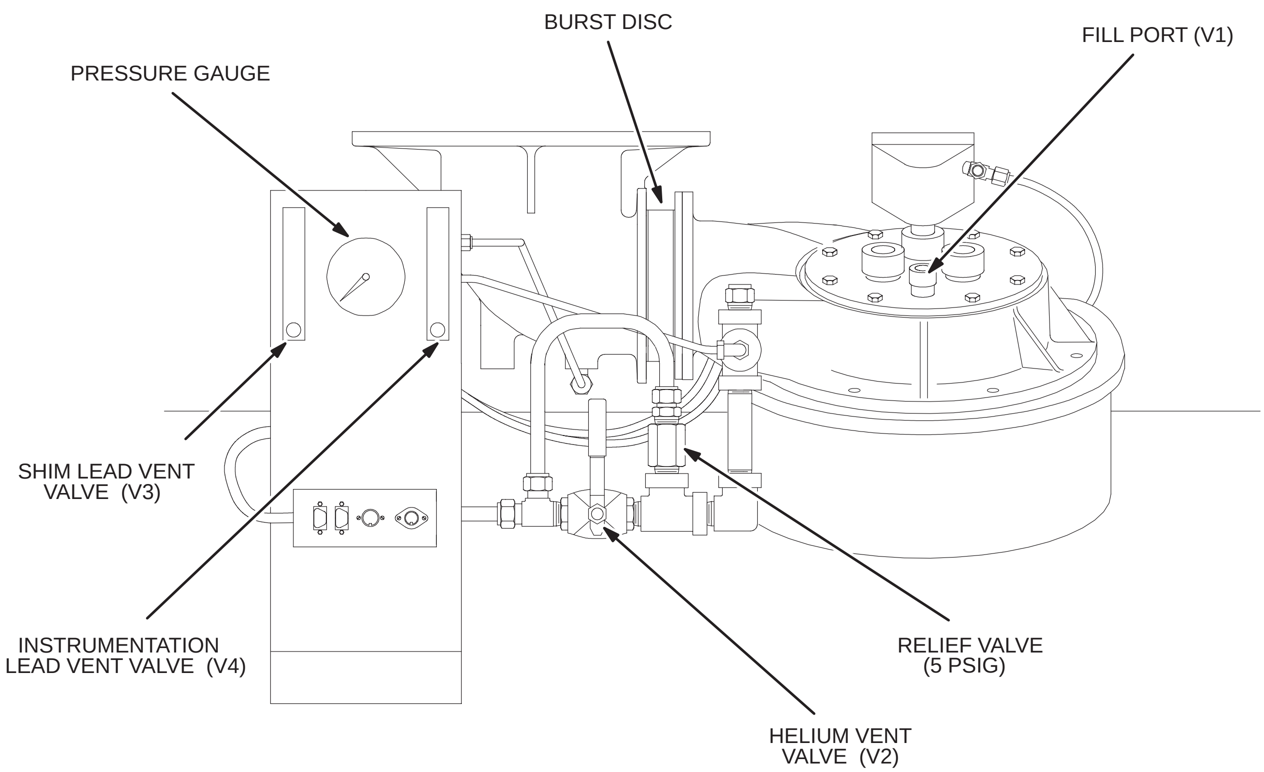
CAUTION

Make sure that Cryostat Stinger Extension (16 inch) and Teflon Tip are firmly secured during installation to prevent it from loosening and falling into magnet.

21. Screw 16 inch Cryostat Stinger Extension onto Cryostat Stinger Assembly. Make sure Teflon Tip is firmly attached to end of 16 inch Extension Tube.
22. Observe Cryostat Pressure Gauge. If pressure exceeds 0.5 psig, temporarily open Helium Vent Valve V2 allowing pressure to decrease to 0.5 psig. See Illustration 3–5.
23. Uncap Fill Port (V1). Remove Fill Port Plug.

Note

If ceiling height prevents insertion of Cryostat Stinger in Step 9, remove Extension from Cryostat Stinger and partially insert into Fill Port V1, before attaching it to the Cryostat Stinger.



VALVE/VENT LOCATIONS
ILLUSTRATION 3–5

7–1 WARMING UP CRYOSTAT (continued)

24. Fully insert Cryostat Stinger Assembly with Extension into Fill Port V1. Make sure that Extension is firmly seated then tighten Fill Port Compression Fitting.

CAUTION

Main secure hold on Extension when inserting in V1 to prevent it from falling into magnet.

25. Open Helium Vent Valve (V2).
26. Purge Nitrogen Transfer Line Assembly by cracking open Gas Use Valve on PLC–230A dewar. Purge line for a minimum of 10 seconds, then connect Purge/Precool Adapter to Cryostat Stinger Assembly.
27. Fully open Gas Use Valve on PLC–230A dewar.
28. Open Positive On/Off Valve.
29. Start and continue nitrogen gas flow, regulated at 4 to 6 psig, until silicon diode temperature readout exceeds 273K.
30. Upon completion of nitrogen gas flow, remove Stinger and cap Helium Fill Port. Close V2.
31. Close Positive On/Off Valve on Nitrogen Transfer Line. Turn off Gas Use and Pressure Building Valves on PLC–230A dewar.

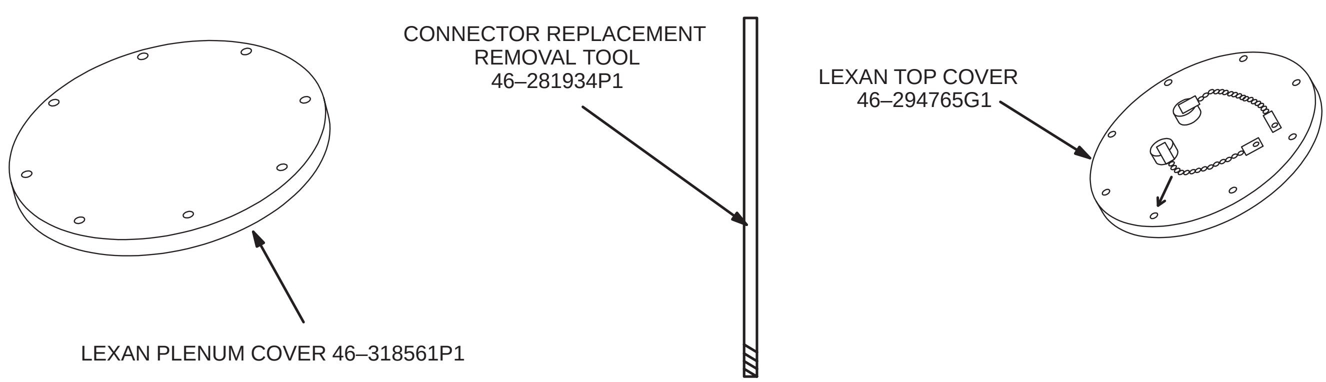
SECTION 8 – INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT

Description:

The Instrumentation Lead Assembly (2136078) must be replaced when opens or shorts in the lead assembly have resulted in the inability to read temperatures, activate main switch heaters or perform emergency rundown with the MRU.

Before initiating this replacement procedure, contact your MAC Team Representative and make sure that the following parts and tools are on site:

- Instrumentation Lead Assembly (2136078)
- Teflon O–ring (46–281101P9) – Instrumentation lead Connector Port
- Teflon O–ring (46–281101P5) – Shim Lead
- Teflon O–ring (46–281101P6) – Turret
- Teflon Tape (46–252065P19)
- Heat Gun (46–306830G3)
- Lexan Top Cover with 1/4 inch Pipe Plugs (46–294765G1)
- Lexan Plenum Cover (46–318561P1)
- Connector Removal Tool (46–281934P1)



INSTRUMENTATION REMOVAL / REPLACEMENT TOOLS
ILLUSTRATION 7–1

It is recommended that the Instrumentation Lead Assembly replacement be performed by the Mac Team Representative. The procedure must be performed quickly to avoid excessive Boiloff and frost / ice formation in the Vertical Penetration.

Ramp Magnet down to zero field in conformance with REPLACEMENT / MAINTENANCE, Section NO TAG, before starting this procedure.

8–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT

Procedure:

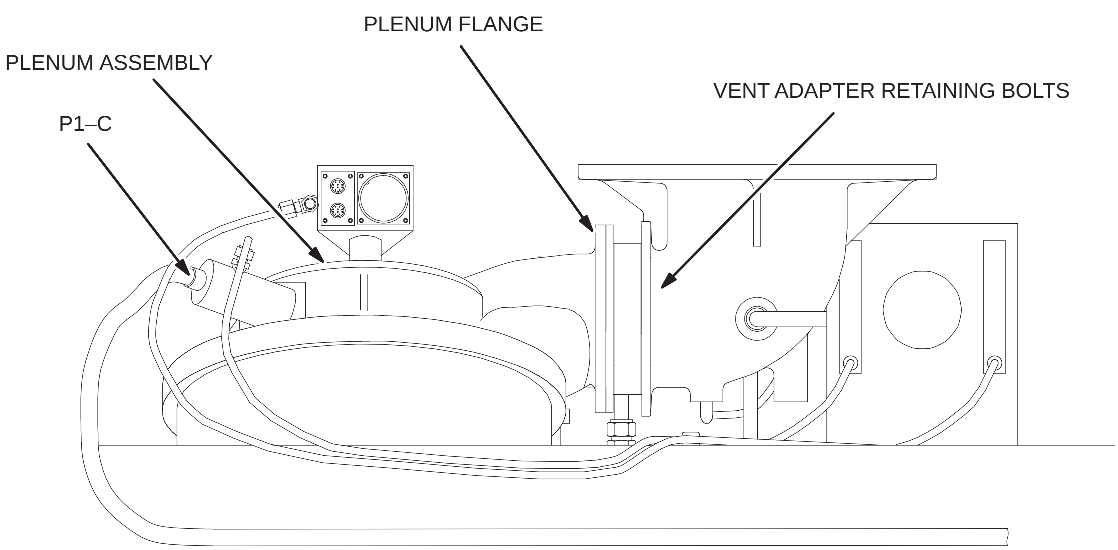
WARNING!

MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5–3 OF THE INTRODUCTION (CRYOGEN SAFETY).

RAPID EXHAUSTING OF COLD HELIUM GAS MAY BE ENCOUNTERED DURING THE FOLLOWING PROCEDURE. WEAR NON–ABSORBENT GLOVES AND GOGGLES OR FACE SHIELD WHEN PERFORMING THIS PROCEDURE.

MAKE SURE THAT THE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE STARTING THIS PROCEDURE. A MAGNET QUENCH DURING THE PROCEDURE COULD RESULT IN THE RAPID EXPULSION OF COLD HELIUM GAS / LIQUID OUT OF THE VERTICAL PENETRATION.

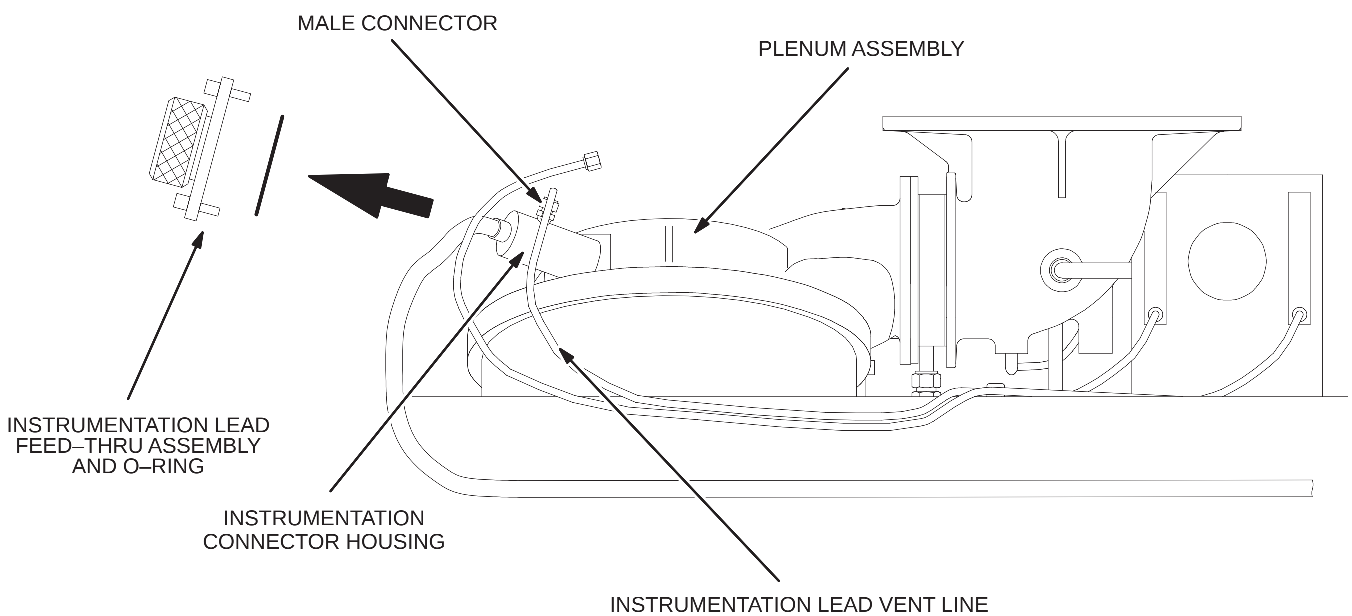
1. Turn off all level sensor, diode and main heater sources and disconnect P1–C. See Illustration 7–2.



INSTRUMENTATION LEAD CONNECTOR LOCATION
ILLUSTRATION 7–2

8–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)

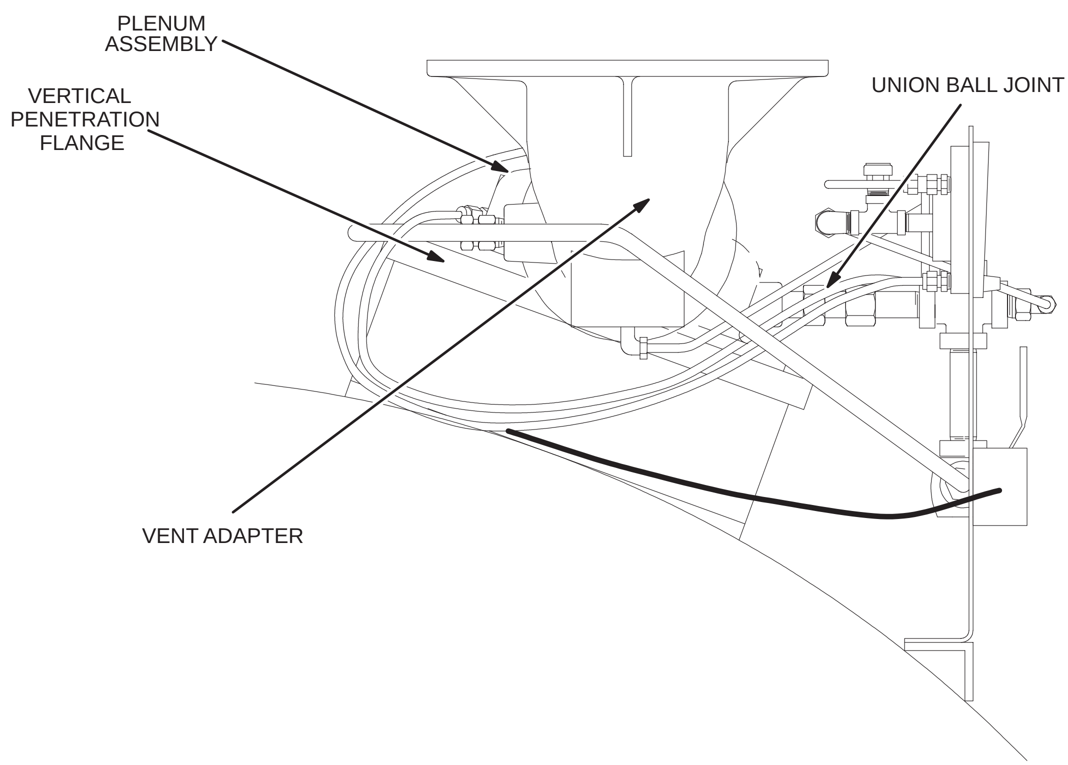
2. Make sure that the Lexan Top Cover (46–294765G1) is present, that 1/4 inch Pipe Plugs are installed and the cover is immediately accessible for mounting on the Plenum Assembly when the Shim Lead Assembly is removed.
3. Open Vent V2 to depressurize Cryostat between 0.25 and 0.30 psig. Close V2.
4. Unbolt and remove the four retaining bolts holding the Vent Adaptor to the Plenum Assembly. See Illustration 7–2.
5. Remove Shim Lead Assembly according to REPLACEMENT / MAINTENANCE, Section 3.
6. IImmediately place Lexan Top Cover over opening and secure with the eight bolts removed in Step 5. Tighten finger tight. Aligning Scribe Mark on Lexan Top Cover towards the Vent is not necessary for this procedure.
7. Disconnect 1/4” (5.1mm) Instrumentation Lead Vent Line from Male Connector on top of Instrumentation Connector housing. See Illustration 7–3.



INSTRUMENTATION LEAD MALE CONNECTOR LOCATION
ILLUSTRATION 7–3

8. Loosen and remove the Male Connector from the top of the defective Instrumentation Lead Assembly. See Illustration 7–3.
9. Loosen the compression fitting and remove the four socket head bolts holding the Instrumentation Lead Feed–thru Assembly to the Plenum Assembly. Remove Feed–thru and O–ring from assembly. See Illustration 7–3.
10. Disconnect “UNION BALL JOINT” on the 1/2 inch plumbing from the Plenum Assembly. See Illustration 7–4.

8–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)

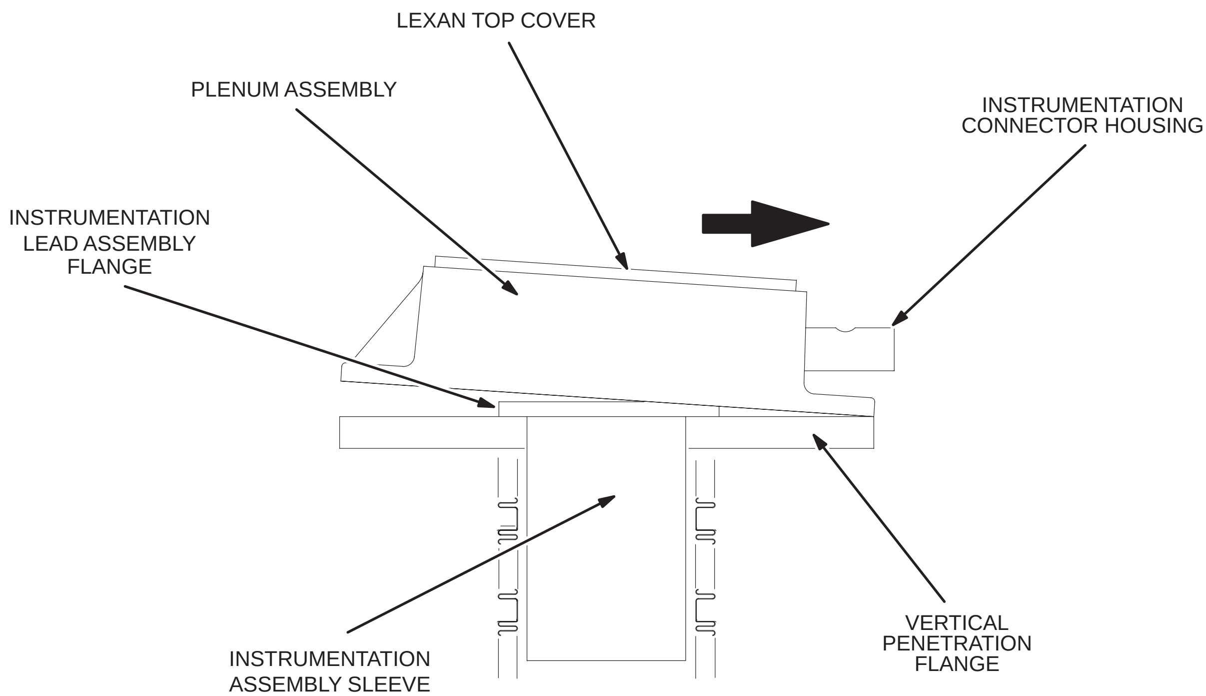


MAGNET PLUMBING END VIEW
ILLUSTRATION 7–4

Note
Make sure the Lexan Plenum Cover is Immediately accessible for mounting on the Vertical Penetration Flange when the Plenum Assembly is removed.

11. Remove the eight bolts securing the Plenum Assembly to the Vertical Penetration Flange. Remove the Plenum Assembly by carefully lifting the edge away from connector just enough to clear the flange of the Instrumentation Lead Assembly and slide it off the end of the Instrumentation Connector housing. See Illustration 7–5

8–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)



PLENUM ASSEMBLY REMOVAL
ILLUSTRATION 7–5

CAUTION

The following procedures must be performed rapidly to prevent cryopumping and frost build up.

12. Loosen and remove the four socket head bolts holding the Instrumentation Assembly Sleeve to the Vertical Penetration Flange. See Illustration 7–6

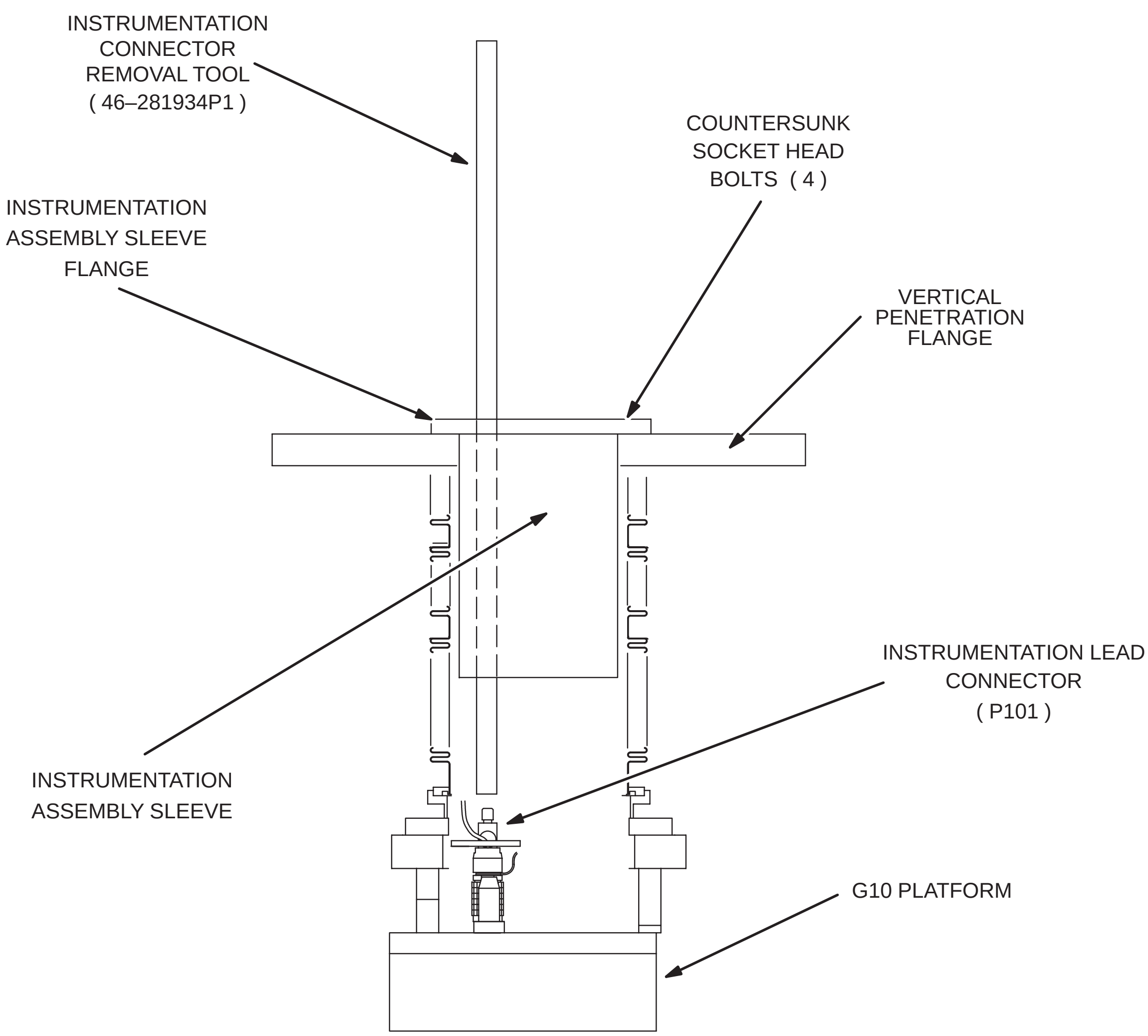
13. Locate the Connector Removal Tool (46–281934P1). Warm with heat gun to remove any moisture.

8–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)

CAUTION

Make sure there is no moisture or other contamination on the Connector Removal tool. Any moisture remaining on tool may result in the tool freezing to the connector.

14. Shine flashlight through Instrumentation Assembly Sleeve and inspect the Instrumentation Lead Connector for frost. Remove visible frost by inserting Helium Gas hose and blowing warm Helium Gas at 15 psi on location of frost.
15. Shine a flashlight through the Instrumentation Assembly Sleeve and align the end of the tool with the threaded top on the connector P101 at the bottom of the Vertical Stack. See Illustration 7–6.



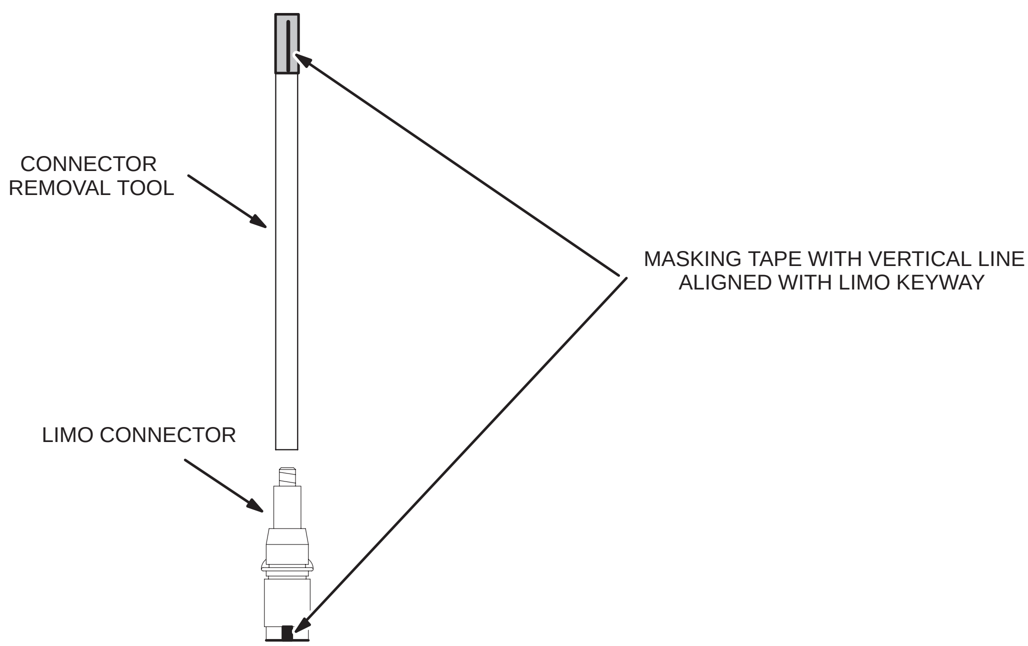
ATTACHING THE CONNECTOR REMOVAL TOOL
ILLUSTRATION 7–6

8–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)

Note

Repeated application of Helium Gas on the Instrumentation Lead Connector may be needed if excessive icing prevents the ability to disconnect the Instrumentation Lead Connector.

16. Thread the tool onto the connector (clockwise) until snug and back off 1/4 turn (counter clockwise). Pull upward on tool until connector disengages.
17. The connector tool and Instrumentation Lead Assembly can now be removed.
18. Immediately place Lexan Plenum Cover (46–318561P1) over Vertical Penetration Flange and secure with bolts removed in Step 11.
19. Wrap a piece of masking tape around the end of the Connector Removal Tool opposite the threaded end. The tape will be used to mark the location of the Limo Connector key way in Step 25.
20. Screw the Connector Removal Tool onto the new Limo Connector. Place a mark on the masking tape to indicate the location of the Limo Connector key way. See Illustration 7–7.
21. Remove Lexan Plenum Cover that was installed in Step 18.



LIMO CONNECTOR KEYWAY IDENTIFICATION
ILLUSTRATION 7–7

22. Install new O–ring (46–281101P10) on Vertical Penetration Flange for new Instrumentation Lead Assembly. Use Vacuum Grease when installing new O–ring.
23. Warm the insertion end of the Instrumentation Lead Assembly and the Extraction Tool to remove any moisture.

8–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)

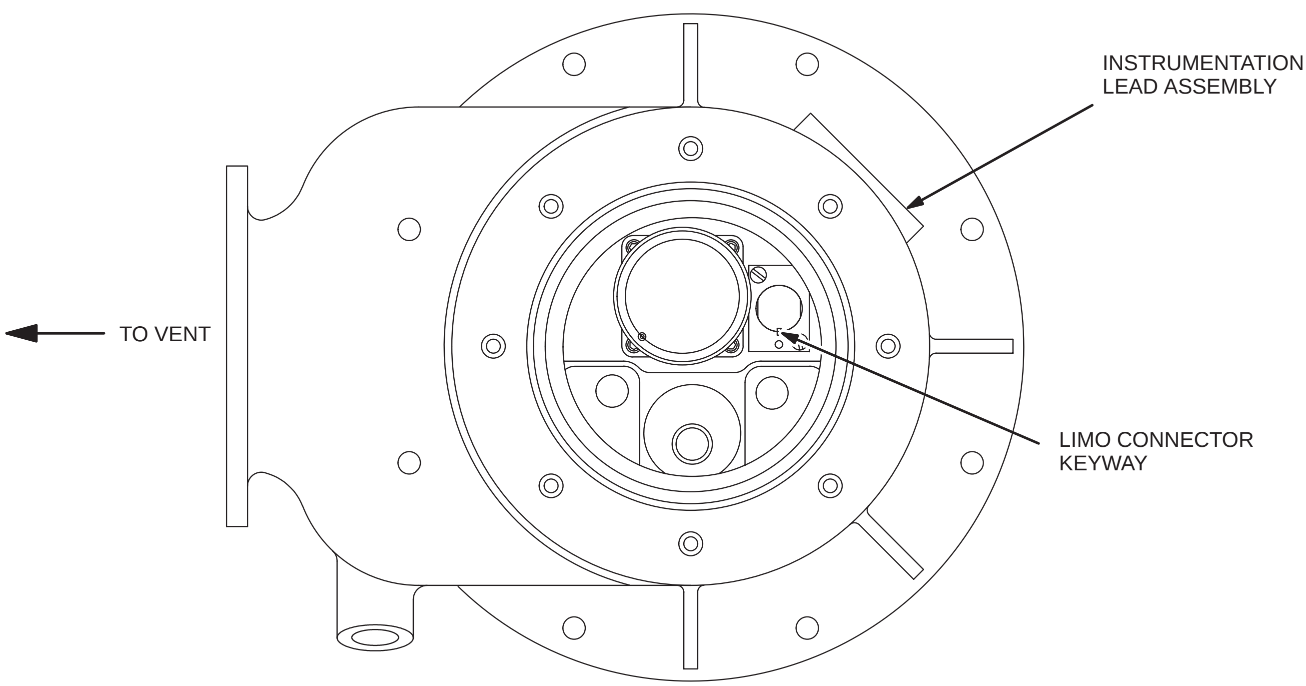
24. Insert the new Instrumentation Lead Assembly into the Penetration Flange.

25. Secure the new Instrumentation Lead Assembly to the Penetration Flange with the four hex bolts removed in Step 12.

Note
Before connecting P101, make sure there is no ice buildup on J101.

Note
Study the location of the key ways on the Instrumentation Lead Limo Connector and J101 for easy installation.

26. Shine a flashlight into the Vertical Penetration and using the Connector Removal Tool, previously attached to the connector, position the Instrumentation Connector at the bottom of the Vertical Penetration and insert into J101 until properly seated. See Illustration 7–8 for alignment of key ways.



POSITION OF LIMO CONNECTOR KEY WAY
ILLUSTRATION 7–8

27. Unscrew tool from connector and remove.

28. Quickly replace Plenum O–ring and Mount Plenum Assembly with new Instrumentation Lead Assembly onto Vertical Penetration Flange using bolts remove from Step 21.

8–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)

Note
Apply Vacuum grease to O–ring before replacement.

29. Install new O–ring and Instrumentation Lead Feed–thru Assembly that was removed in Step 9. Tighten compression nut.

30. Clean the threads of the Male Connector (removed in Step 8) and wrap with Teflon Tape. Install Male Connector on new Instrumentation Lead Assembly and tighten until snug. Attach the 1/4" (5.1 mm) Vent Line removed in Step 7.

31. Reconnect Union Ball Joint.

32. Reconnect the Vent Adaptor to the Plenum Assembly with the bolts removed from Step 4.

33. Remove Lexan Top Cover that was installed in Step 6.

34. Prepare the Shim Lead Assembly by removing old O–ring and installing new O–ring (46– 281101P5). Use Vacuum Grease when installing O–ring.

CAUTION

Lower Shim Lead Assembly into Vertical Stack carefully to prevent damage to baffles.

Note
Shim Lead Assembly must be in the "Retracted" position.

Note
Check for ice buildup on the Shim Lead Assembly mating connector J100, before installing Shim Lead Assembly.

35. Immediately install Shim Lead Assembly into Vertical Stack with scribe mark on Shim Lead Cover Plate oriented as shown in Section 5–2, REPLACEMENT /MAINTENANCE. Secure with the eight 1/4–20 screws and washers removed previously.

36. Reconnect 1/4 inch Exhaust Plumbing to side of the Shim Lead Receptacle Box.

37. Perform a "Leak " Test, using Snoop Liquid Leak Detector (P/N 46–252065P71), on Instrumentation Lead/Shim Lead Assembly Mountings, and all plumbing connections. Correct any leaks.

38. Reconnect P1–C to J1–C and perform checks as outlined in Section 2, FUNCTIONAL CHECKS.

39. Reengage Shim Lead Assembly according to Section NO TAG, REPLACEMENT MAINTENANCE.

40. Ramp Magnet back up to field as described in Section 9, SET UP AND CALIBRATION.

8–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL/REPLACEMENT (continued)

41. Re–shim the Magnet in conformance with Section NO TAG, SET UP AND CALIBRATION.

42. Adjust flow rates.

    INSTRUMENTATION LEAD FLOWMETER (F2) = 0.8 – 1.2 SCFH
    SHIM LEAD FLOWMETER (F1) = 1.8 – 2.2 SCFH
    CRYOSTAT GAUGE PRESSURE = 0.25 – 0.5 PSIG

SECTION 8 – CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS

Note

Refer to Illustrations 10–1 and 10–2 for this procedure.

CONNECTING

1. The system gas connections are shipped with caps and plugs to keep the fittings clean and free from damage. Remove the caps and plugs and thread them together for storage.

2. Wipe the faces of the couplings with a lint free cloth to insure they are clean and free of chips and dust.

3. Insure that the face seal is in place on the inside periphery of the male coupling and is not damaged.

Note

Excessive gas will escape if the fittings are not aligned properly during connection or disconnection.

4. To make the connection, start the hose side union nut onto the male connector by hand. Then, with the wrenches supplied, hold the stationary part of the female coupling while turning the union nut with the other wrench.

5. As the poppet begins to open there will be a slight venting of gas from the fitting, continue to tighten the connection until the female coupling is firmly seated against the face seal on the male coupling. The required torques are:

   35 ft–lbs (47.5 N–m) for the 1/2 inch connection

   45 ft–Lbs (61.0 N–m) for the 3/4 inch connection

DISCONNECTING

1. To disconnect the gas line at the cold head, first use one wrench to turn the female coupling union nut about 1/8 turn, while holding the male coupling with the other wrench. This will overcome the initial torque required to break the connection without loosening the male connector from its adapter.

2. Make sure the hose is free to rotate, to avoid a torsional force on the hose.

3. Place the second wrench on the stationary part of the female coupling and continue to unthread the union nut. Be sure the male connector does not rotate when disconnecting.

SECTION 8 – CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS (continued)

4. To disconnect the gas line at the compressor, turn the union nut on the female coupling while holding the stationary part of female coupling with a second wrench. Since the male coupling is mounted to compressor front panel with a lock washer, the male coupling should not rotate from its adapter while removing.

5. Make sure the male coupling jam nut is secure and the male coupling does not rotate when removing the gas line.

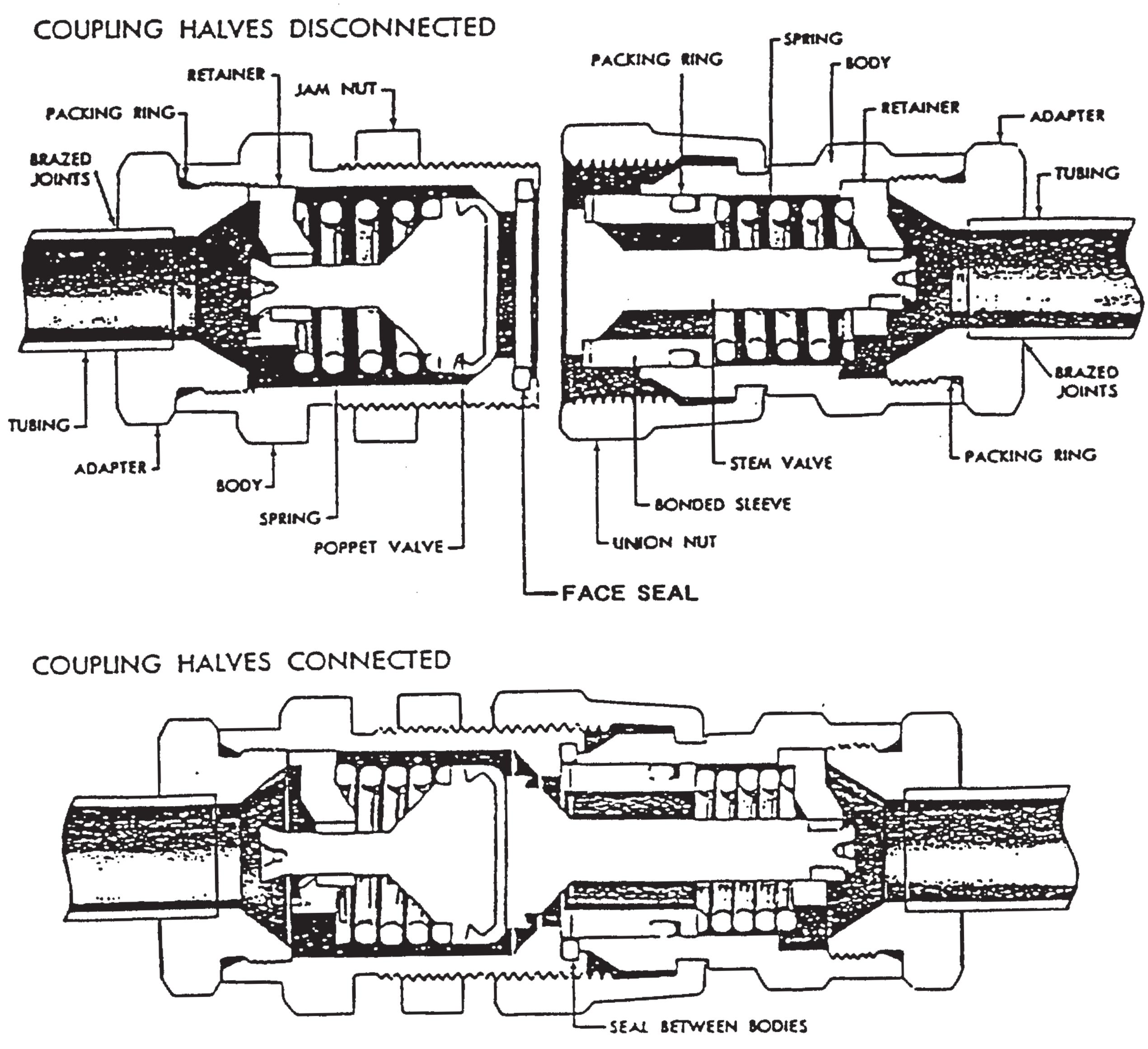
6. When the hoses are disconnected check each male coupling to ensure the face seal is in place.

Note

Many times. while the hose is venting during disconnection, the face seal will be blown out of its gland and into the female coupling. Failure to remove the seal from the female coupling will cause the connection to leak when reconnected, with or without another face seal installed.

7. If all seals are in place, replace the dust caps and plugs to the coupling halves.

SECTION 8 – CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS (continued)

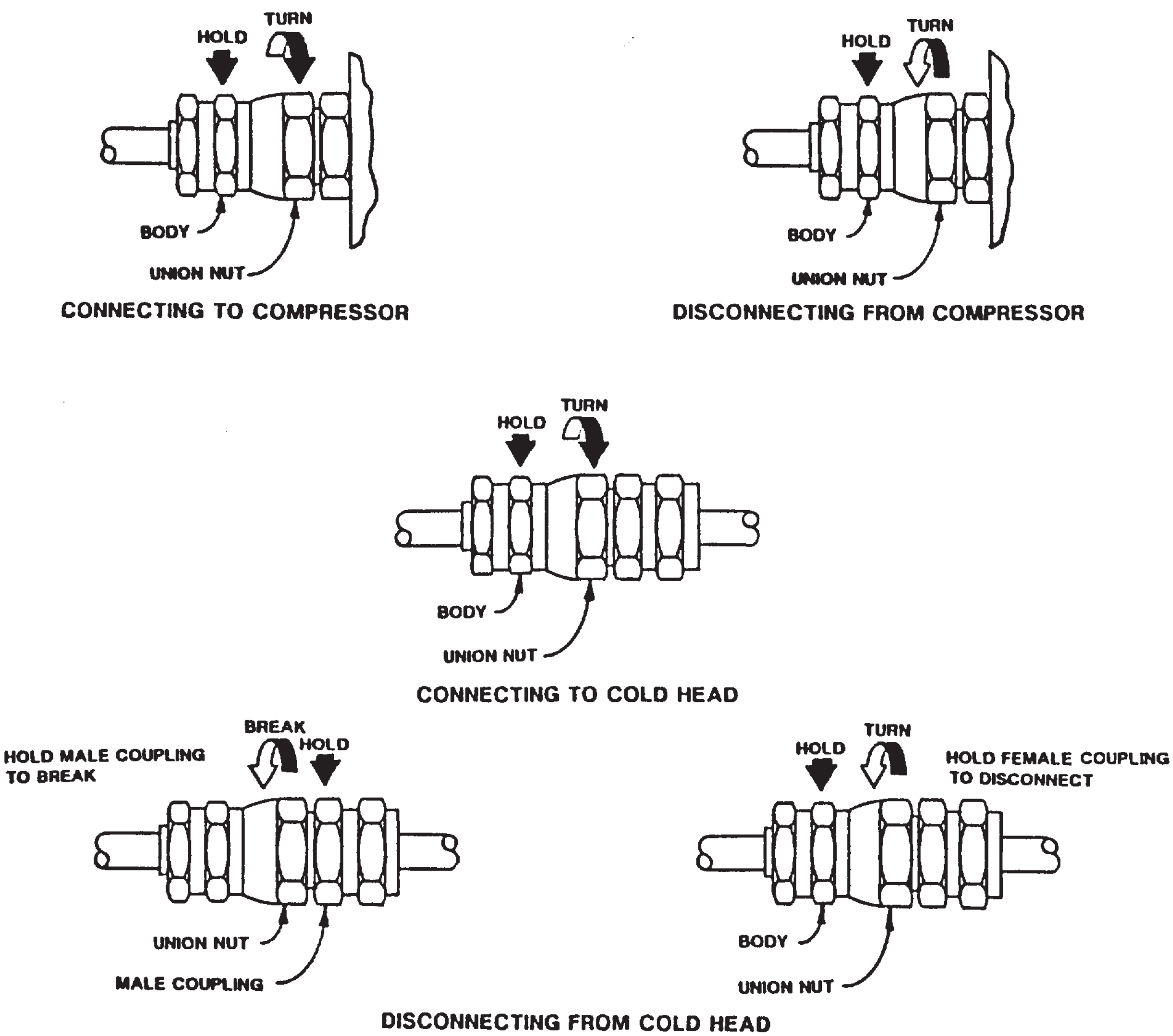


VIEW OF DISCONNECTED AND CONNECTED SELF–SEALING (AEROQUIP)
ILLUSTRATION 10–1

SECTION 8 – CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS (continued)

NOTES:

1. **INSURE THE MALE COUPLINGS AT THE COMPRESSOR AND COLD HEAD DO NOT ROTATE WHEN DISCONNECT ING LINES.**
2. **AVOID TORSIONAL FORCES ON THE FLEX SECTIONS.**



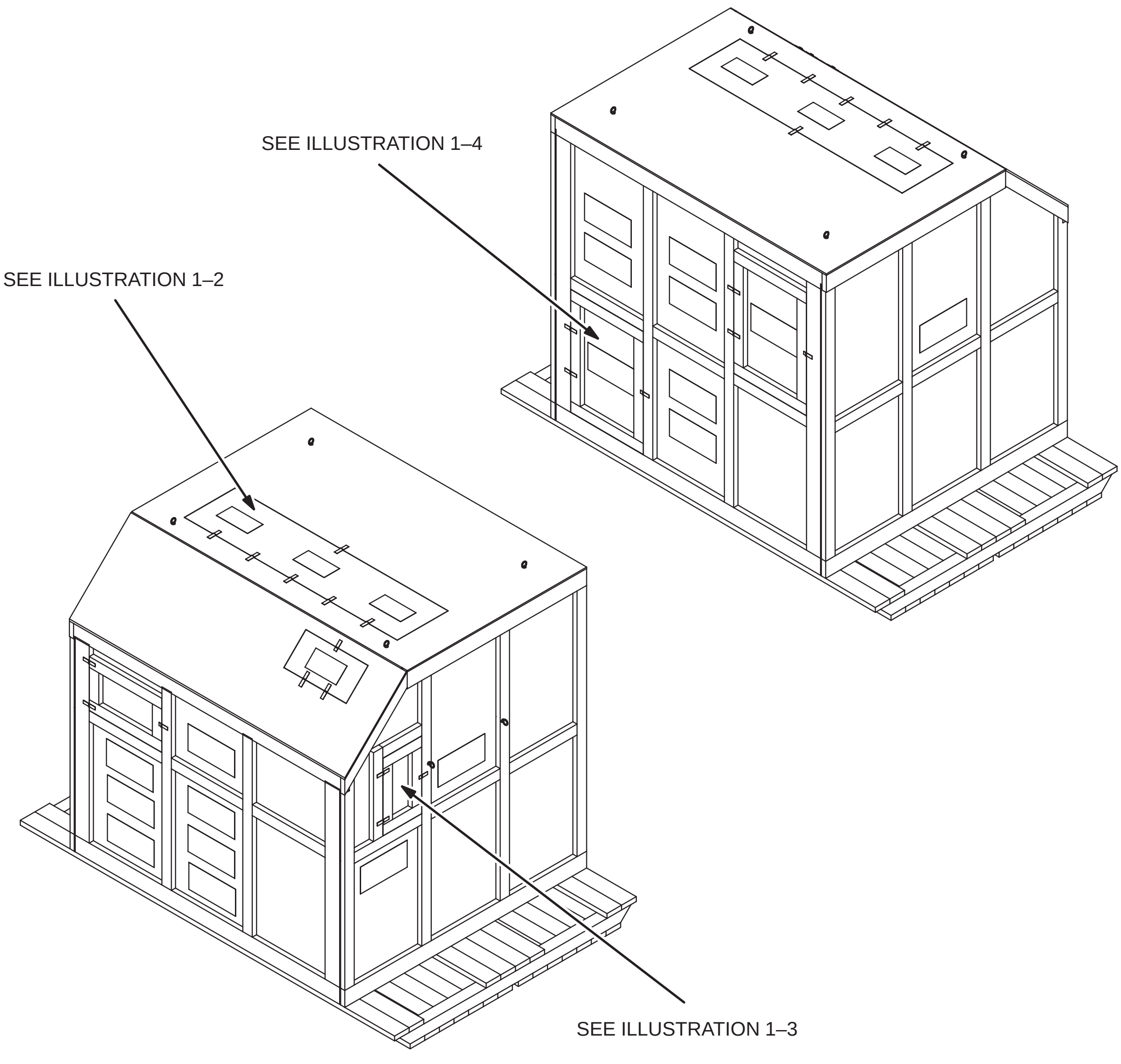
VIEW OF DISCONNECTED AND CONNECTED SELF–SEALING (AEROQUIP)
ILLUSTRATION 10–2

SECTION 1– SHIPPING / DELIVERY INSTRUCTIONS

1–1 INTRANSIT SERVICE

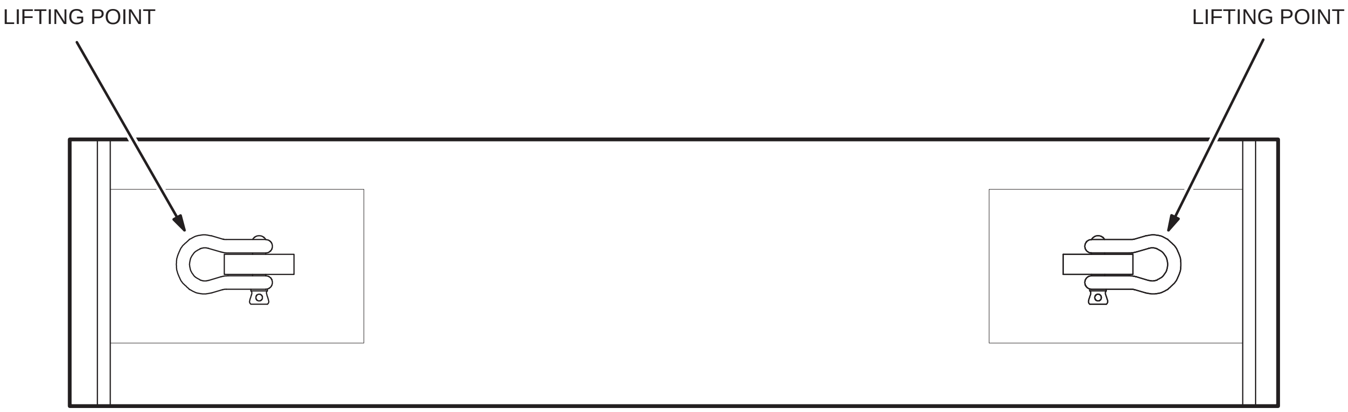
Note

The following information outlines provisions for filling and electrical / temperature checks while magnet is still in shipping crate. This will enable required service to be performed in transit based upon magnet shipping date. The following Illustrations (1–1 through 1–3) show the magnet configuration behind each shipping crate access door. Access doors and hinges not shown for clarity.



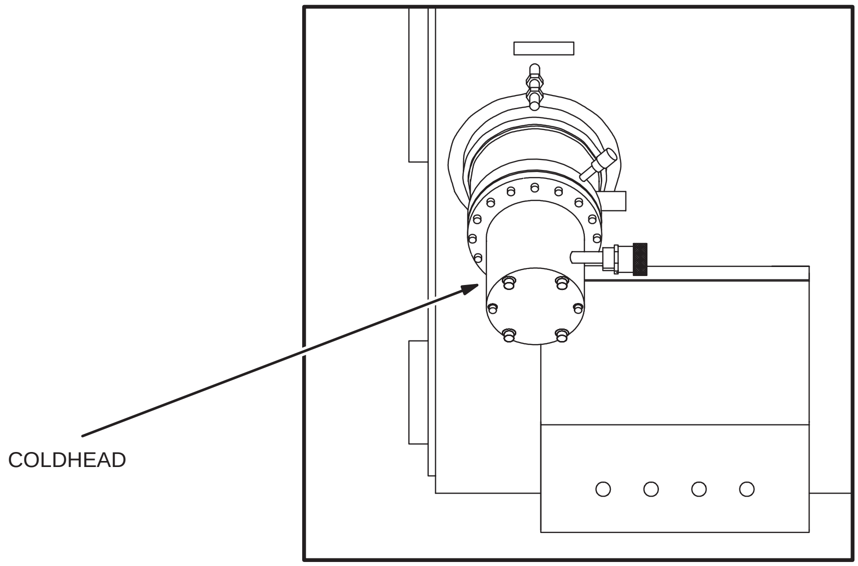
ACCESS DOOR LABELING ON CRATE
ILLUSTRATION 1–1

1–1 INTRANSIT SERVICE (continued)



TOP ACCESS DOOR LABELED “LIFTING POINT”
ILLUSTRATION 1–2

1–1 INTRANSIT SERVICE (continued)



LEFT SIDE ACCESS DOOR LABELED "COLD HEAD ACCESS"
ILLUSTRATION 1–3

1–2 SHIPPING / HANDLING

CAUTION

Shipping and handling guidelines are provided in Table 1–1.

These guidelines must be followed to prevent any potential damage to the magnet during shipping and handling.

Review guidelines with Shipper / Riggers prior to transporting magnet.

TABLE 1–1
MAGNET SHIPPING AND HANDLING INFORMATION

MAGNET	* MAXIMUM WEIGHT	** MAXIMUM TILT	(1) ALLOWABLE SHIPPING MODES	(2) FORKLIFT CAPABILITY
SV	SV = 18,000 lbs.	30 deg.	A, T, Tr, B	Yes

MAGNET	SHIPPING CAPABILITY	(3) MAXIMUM TRANSIT TIME	MAXIMUM SHOCK LOADS	COMMENTS
SV	Cold	21 days	2 G's	See Notes

* Includes weight of Shipping Crate (2,200 lbs.)

** Tilt allowed when suspended by Lifting Shackles.

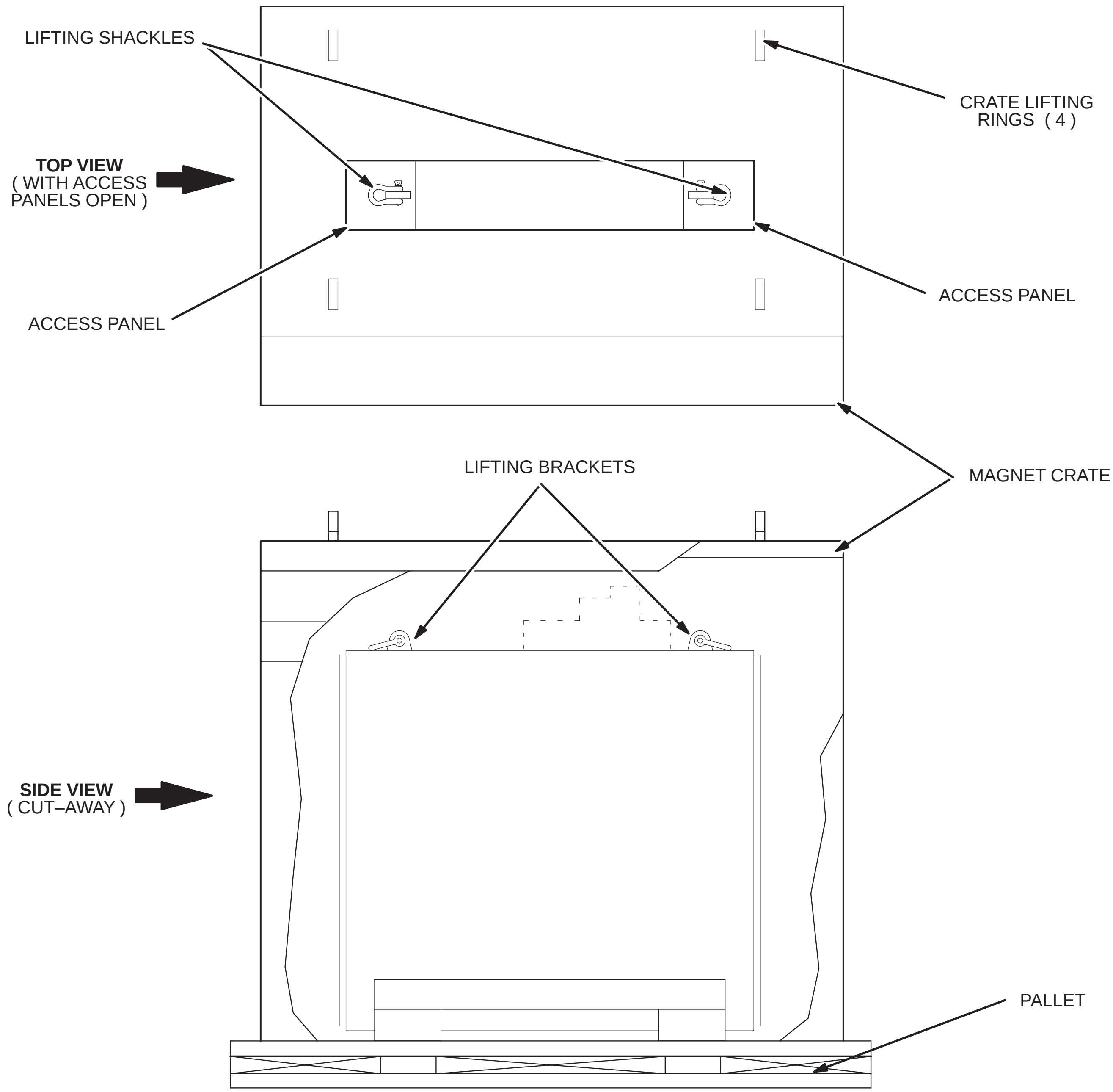
Notes:

1. Key for Shipping mode symbols:
   "A" Airplane (including any plane that has fuselage openings large enough to accept a magnet)
   "T" Air ride Trailer (Any magnet transported on a non–air ride trailer must be identified and never used in a Mobile trailer.)
   "Tr" Train
   "B" Boat or ocean going ship
2. Extreme care must be exercised during forklift operations. The magnet pallet / crate must be picked up from the sides only. The forks MUST be placed directly under the four (4) feet of the magnet. The magnet feet can be identified by the steel plates attached to the pallet.
3. The elapsed time begins when the magnet leaves the Florence loading dock.

1–3 UNLOADING / LOADING MAGNET AND CRATE

Note

Lifting Shackles and Brackets are provided for magnet unloading / loading. See Illustration 1–4. Shackle / Bracket access panels are provided, as shown in Illustration 1–4, for crated magnets.

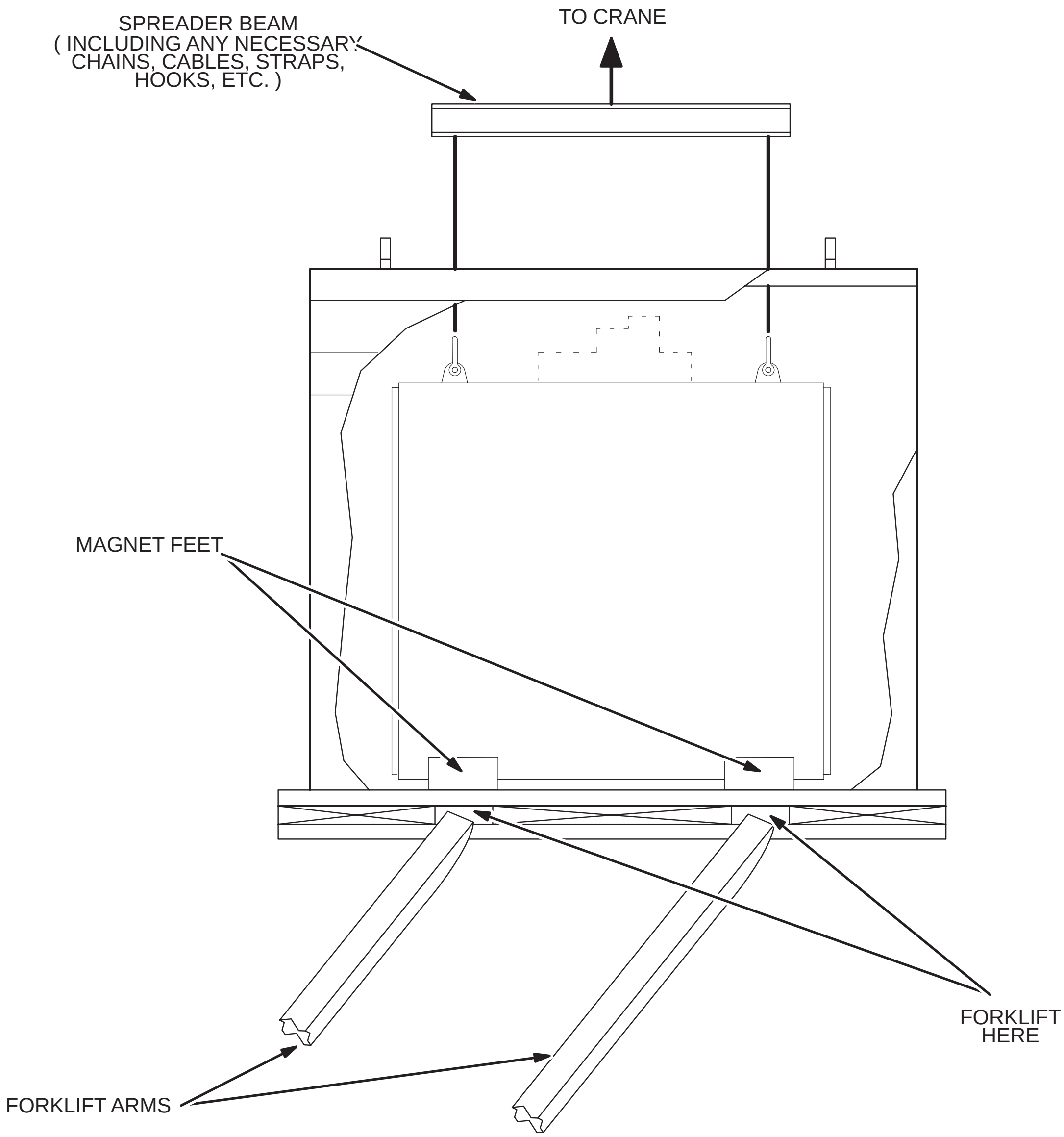


ACCESS PANEL, SHACKLE AND BRACKET LOCATIONS
ILLUSTRATION 1–4

1–3 UNLOADING / LOADING MAGNET AND CRATE (continued)

CAUTION

Extreme care must be exercised during forklift operations. The magnet crate must be picked up from the sides only. The forks MUST be placed directly under the four (4) feet of the magnet. The magnet feet can be identified by the steel plates attached to the pallet. Do not lift crate with straps fed through the pallet. This will crush the crate.



FORKLIFT / CRANE LIFTING OPERATIONS
ILLUSTRATION 1–5

1–3 UNLOADING / LOADING MAGNET AND CRATE (continued)

1. Position the Crane Hook centrally over the crated magnet to ensure a vertical lift force on the Lifting Brackets.

CAUTION

It is important to lift the magnet smoothly to avoid impact or jolts to the system which may damage the magnet.

2. Attach the rigging to the lifting shackles at each end of the crated magnet.

Note

Any combination of spreader beam, shackles and / or slings, 6 foot (1829 mm) minimum length, which can support a minimum of 18,000 pounds (8,163 Kg) may be used.

3. Lift crated magnet with crane to clear trailer.
4. Lower the crated magnet onto a flat surface.

1–4 PRE–DELIVERY INSTRUCTIONS

CAUTION

Make sure ALL site requirements / conditions, identified for the magnet in the site planning manual, are met before scheduling magnet delivery.

This will prevent installation delays, cryogen loss and resultant ongoing magnet quenches, potential damage, environmentally related problems and increased costs.

WARNING!

THE OXYGEN MONITOR MUST BE INSTALLED AND FUNCTIONAL BEFORE BRINGING THE MAGNET INTO THE EXAM ROOM. THIS MONITOR MUST GIVE AN AUDIO AND VISUAL WARNING WHEN THE OXYGEN LEVELS IN THE ROOM FALLS BELOW 18% TO NOTIFY PERSONNEL OF ANY POSSIBILITY OF ASPHYXIATION. REFER TO DIRECTION 15336 FOR OXYGEN MONITOR INSTALLATION INSTRUCTIONS.

1. Visit magnet site with rigging foreman before magnet delivery to plan the move.
2. Caution rigger that the magnet is extremely fragile. Sudden jolts can damage the magnet. Riggers aware of the cost of a magnet and its replacement usually use more care while handling magnet.
3. Make sure all roads and paths leading to exam room are level and free from obstacles and holes. Rigger will be required to construct platforms where needed.
4. If Roller Dollies are to be used, have rigger bring eight steel plates, 96in. x 24in. x 0.50 in. (2438mm x 610mm x 12.7mm), to place along delivery route.
5. Mark the magnet location on the floor before delivery. Refer to architectural drawings.

SECTION 2 – UNCRATING MAGNET SYSTEM

1. Remove all subsystem crates, except the Magnet Crate, from low–boy trailer using a crane or forklift. Inspect all crates for visible damage.
2. Move subsystem crates to a receiving location protected from the weather, preferably in proximity of the examination room and on the same level.

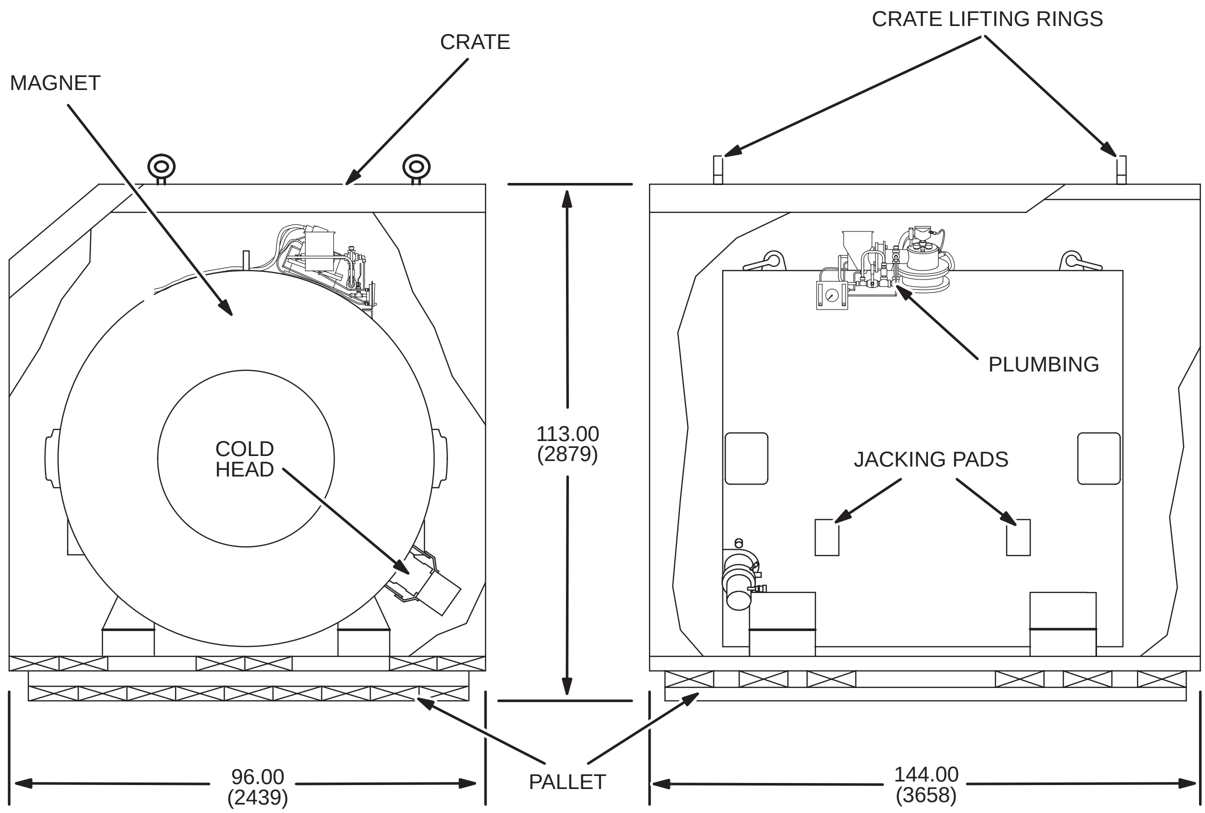
Note

Domestic shipments are made with a tarp covering on the magnet instead of a crate. See Illustration 2–1 for magnet weight (domestic and international shipements). For domestic shipments, skip to RIGGING, Section 3.

3. Inspect the crate containing the magnet and identify the crate side marked, “REMOVE THIS SIDE FIRST”. This designated side is to be removed first. See Illustration 2–1 for crate dimensions.
4. Position crane centrally over this designated crate side.
5. Connect crane to the two lifting rings located near the top of the crate side marked ”Remove This Side First” using a sling and shackles supplied by riggers. Tighten the sling snug. See Illustration 2–2.
6. Remove lag screws securing the face of the crate marked “REMOVE THIS SIDE FIRST” See Illustration 2–2.
7. Lift crate side with crane and clear from the area.
8. Secure four one ton (900 Kg) working load slings, minimum 6 foot length (1829mm), to four lifting rings assembled to the top corners of crate. Using one ton (900 Kg) anchor shackles.
9. Position crane centrally over top section of the crate and attach slings to crane hook.
10. Remove lag screws only from the bottom portions of the three remaining crate sides. See Illustration 2–3.
11. Lift crate carefully using crane and clear crate from shipping skid containing magnet.

CAUTION

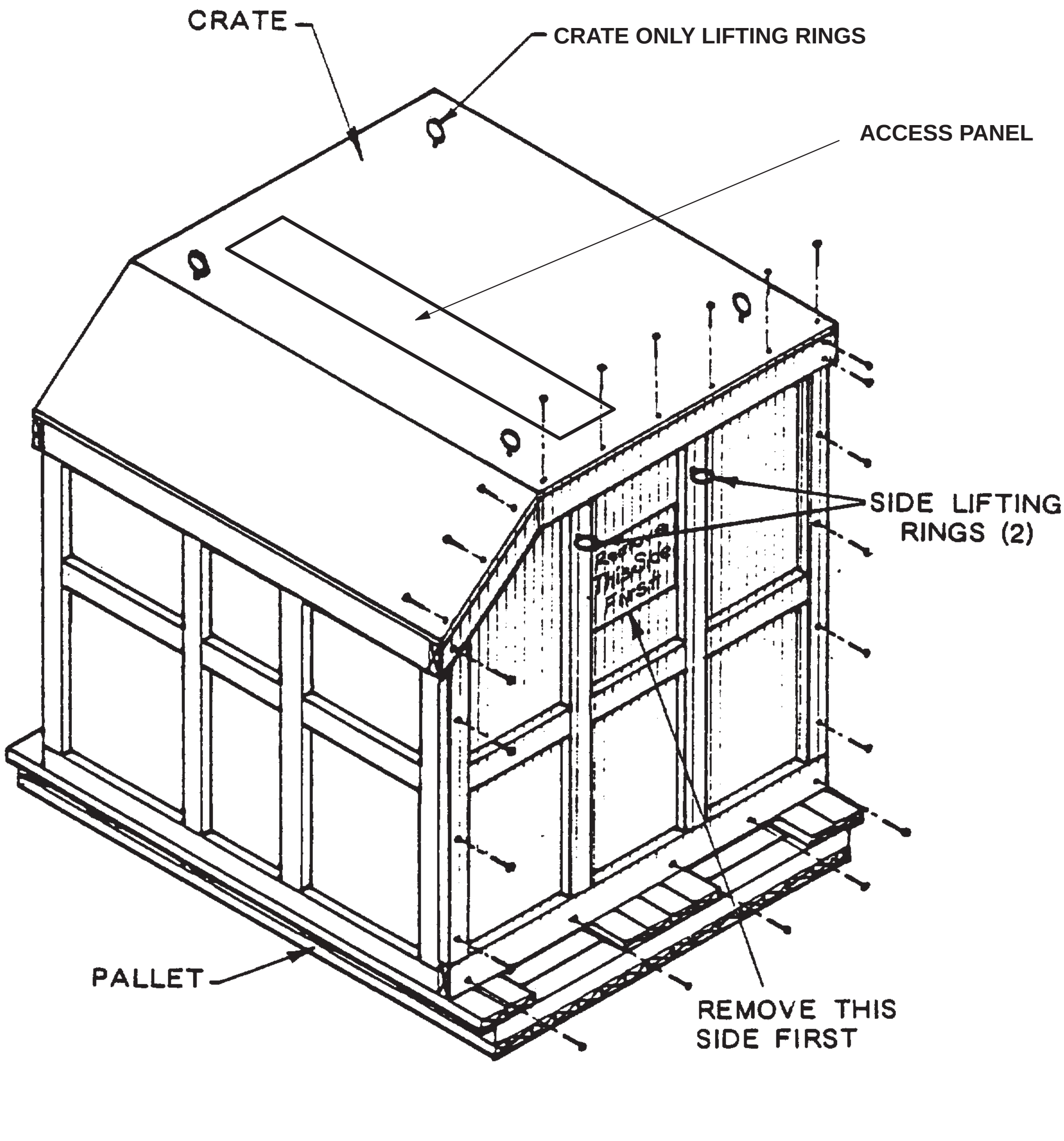
Make sure that the crate does not swing and hit the Magnet Cold Head, Vertical Penetration or Plumbing during the lifting process.



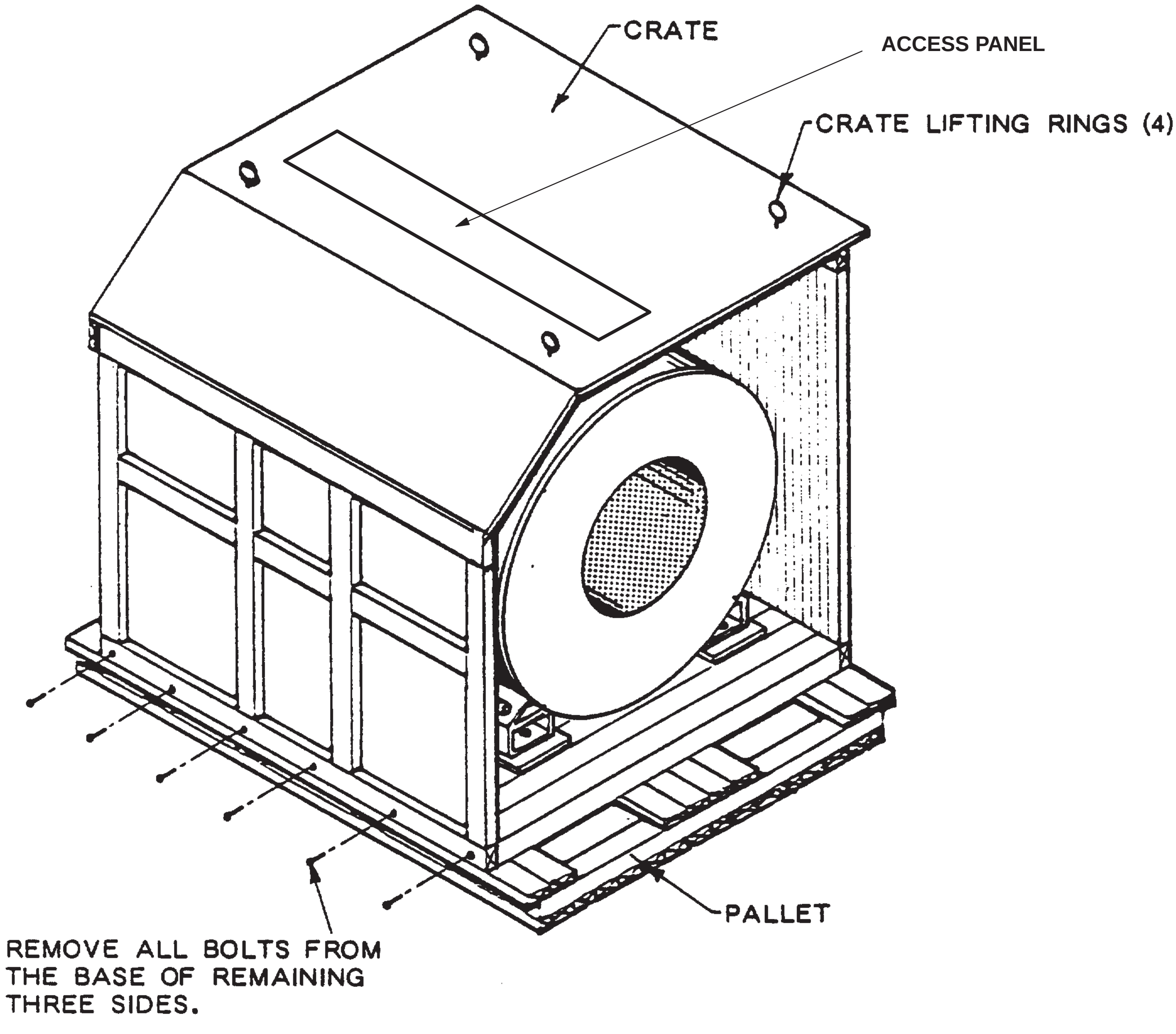
MAGNET CRATE
ILLUSTRATION 2–1

NOTE:

MAGNET LIFTING SHACKLES ARE LOCATED UNDER THE ACCESS PANEL DOOR



MAGNET CRATE FACE LAG SCREW REMOVAL
ILLUSTRATION 2–2



MAGNET CRATE BOTTOM LAG SCREW REMOVAL
ILLUSTRATION 2–3

SECTION 3 – MAGNET SYSTEM COMPONENT CHECK

Note

Shipment of magnet system components to the installation site may occur as a complete system or a drop shipment of major system components. Verify that all required magnet system components are present at the site to assure a complete and timely installation.

1. Locate the Pre–Delivery Information Package shipped with the magnet which contains the (Bill of Material) for the magnet system delivered. Check that all boxes indicated are present.
2. Check the contents of each box against its packing list when the boxes are brought into the MR Site.
3. Inspect the magnet for physical damage and icing/condensation on the body. If no problem found, unload magnet.

Note

Because of the higher Boiloff and helium gas flow through the vertical penetration, some frost on the Vertical Penetration is normal during periods when cold head has been shut off.

4. If icing or condensation present on the body or the bore of the magnet, check Liquid Helium level before unloading. See Set Up and Calibration, Section 1–6 for Cryogen Monitor set up.

Note

If magnet has been sitting for a period of time with the Cold Head inoperative, the Magnet may be depleted of Cryogens.

5. Refer to SET UP AND CALIBRATION, Section NO TAG for Cryostat Cooling /Filling Requirements. If pressure in vacuum cavity is greater than 1 x 10^{-6} Torr., contact MAC Team Leader before installing magnet.
6. Make sure the Shim Lead is “Engaged” in conformance with SET UP AND CALIBRATION, Section 6.

CAUTION

It is important to establish if any damage was sustained by the magnet or its system components during delivery or if any components are missing. This will result in the fast, proper follow–up of any problems and a timely installation.

7. Perform the Magnet Circuits Resistance Checks identified in Table 3–1, “MAGNET CIRCUITS RESISTANCE CHECK COLD (4.2 K)” and Table 3–2 “SHIM LEAD CHECKS”. If any problems are found the Shim Lead can be “retracted” to isolate the shorts from the shim coils.
8. Report any damage found in compliance with the “Damage In Transportation” note on the back side of the Service Manual Title Page.
9. Report all problems found to the Regional Magnet & Cryogenics (MAC) Team Leader. Report all missing components to the person identified on the Magnet Component Bill of Material.

TABLE 3–1
MAGNET CIRCUITS RESISTANCE CHECK
COLD (4.2K)

			RESISTANCE (OHMS)	
FUNCTION	**CONNECTOR**	**PIN #**	**TYPICAL VALUES**	**MEASURED**
MAIN COIL	MAIN COIL POWER LUGS OR J5–1	+ – 9,10	< 4 OHMS	
SUPERCONDUCTING SHIM COILS	CANNON (P1–A) AT MAGNET VERTICAL STACK			
Z1		1,19	0.5	
Z2		2,20		
Z3		3,21		
Z4		4,22		
Z5		5,23		
Z6		6,24		
C11+		16,19		
C11–		17,20		
S11+		9,19		
S11–		10,20		
C31		13,23		
S31		11,23		
SUPERCONDUCTING SWITCH HEATERS MAIN SWITCH	J 5–1 & J 5–2 ON MAGNET TERMINAL BOX (MS1–A3,A1)	1,2	22 – 27	
AXIAL SHIMS		5,6	27.5 – 32.5	
TRANSVERSE 1		7,6	9 –10	
TRANSVERSE 2		8,6	9 –10	

SECTION 4 – REMOVING THE MAGNET FROM THE SHIPPING SKID

CAUTION

The magnet must be moved as smoothly as possible at all times. If severe jolting is encountered, internal damage may result.

1. Unbolt and remove the four 1 inch bolts which secure the base frame to the magnet. For magnets used on Sierra systems (YMS), remove the 1.5 inch steel plates by removing 4 bolts on each foot. See Illustration 4–1.
2. Position the Crane Hook centrally over the magnet to ensure a vertical lift force on the Lifting Brackets.

CAUTION

It is important to lift the Magnet smoothly to avoid impact or jolts to the system which may damage the magnet. The magnet cannot be tipped by more than 30 degrees during any lifting operation using the lifting shackles/brackets.

3. Attach the rigging to the lifting shackles at each end of the magnet.

Note

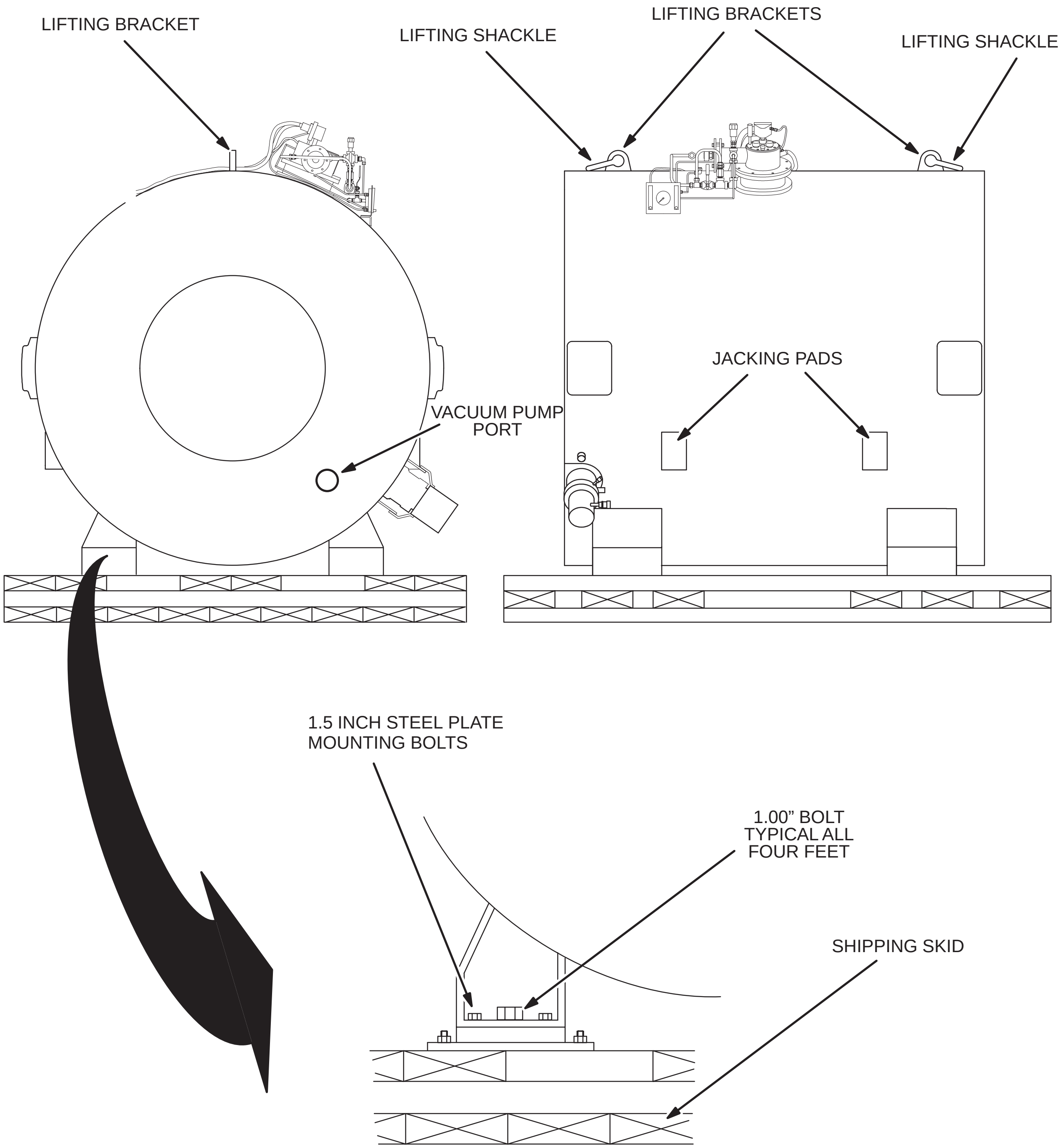
Any combination of spreader beam, shackles and/or slings, 6 foot (1829mm) minimum length, which can support a minimum of 15,500 pounds (7,029 Kg) may be used.

4. Lift magnet with crane to clear shipping skid and trailer.

CAUTION

When lowering the magnet, be careful not to shock the magnet which could result in over stressing the internal magnet support members.

5. Lower the magnet onto a flat surface.



MAGNET MOUNTING ON SHIPPING SKID
ILLUSTRATION 4–1

SECTION 5 – MOVING MAGNET TO EXAM ROOM

Description

Before moving magnet to exam room (fixed sites), make sure mounting holes, anchors and washers are installed as per Magnet Bolt Down Kit instructions. For normal installations use Magnet Bolt Down Kit R–Cat #R4391CA.

Note

Roller Dollies are recommended for moving magnet into the examination room as shown in Illustration 5–1. If Roller Dollies are used, place steel floor plates along the magnet delivery route.

CAUTION

Use the Jacking Pads located on the magnet to raise the magnet for Roller Dolly installation.

Use shims when rolling magnet with Roller Dolly over door thresholds and other inclines.

Note

The magnet location in the examination room must be marked. Use tape to mark the four corners of magnet on the examination room floor. Refer to architectural drawings to determine the exact location of magnet within the examination room.

1. Push magnet to exam room. If using a motorized tow vehicle, attach chains around the magnet base support pads and pull magnet.
2. If there are turns in the delivery route, adjust Roller Dollies to appropriate positions to negotiate turns.
3. Move Magnet into the Exam Room. If there is not enough vertical clearance for the Magnet, remove the 1.5 inch plates from the bottom of the magnet or the Vent Adapter from the Vertical Penetration to obtain additional clearance. If more clearance is still needed call the MAC Team Representative for further removal of Vertical Penetration components.
4. Position magnet on the examination room floor. If ceiling is in place, drop a plumb bob from the center of the vent hole and mark the floor at the location where the plumb bob points. This corresponds to the location of the center of the Vent Adapter on the Magnet.

Note

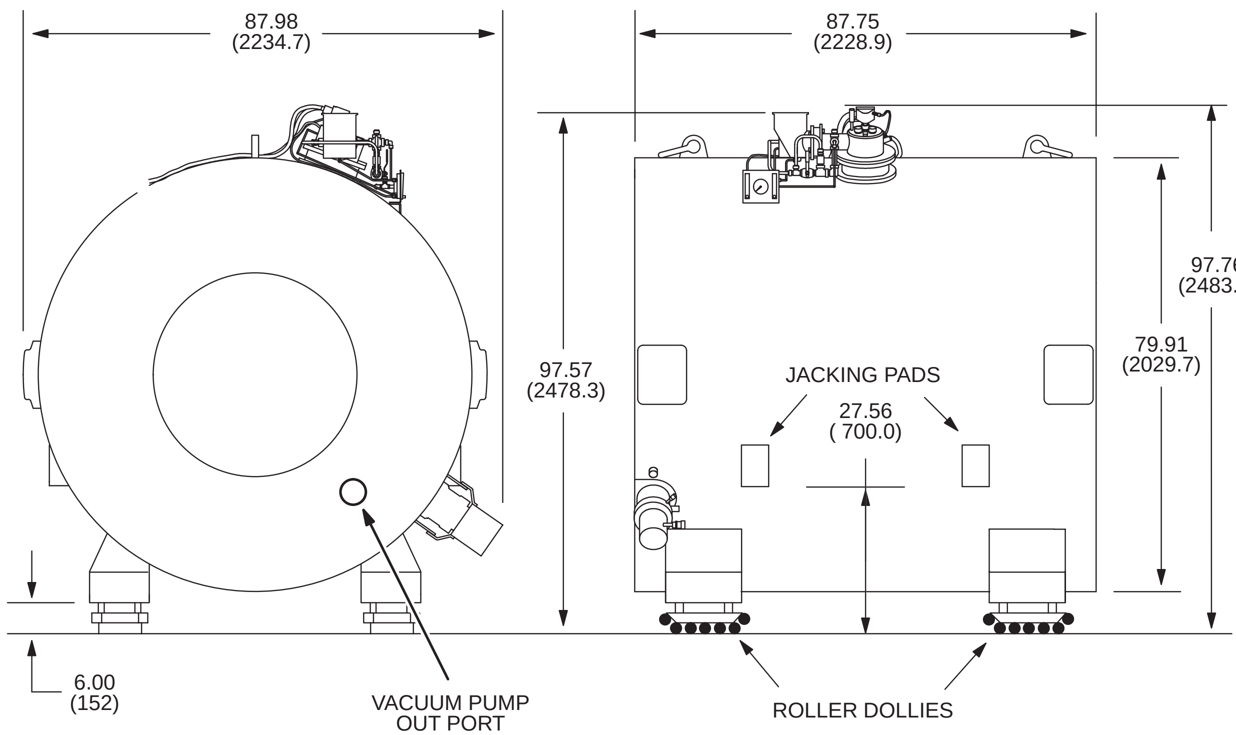
Table end of magnet (See Introduction, Illustration 4–1) must be oriented away from rear wall of exam room.

CAUTION

Keep magnet level at all times. Uneven jacking of corners could result in shifting of magnet on jacks.

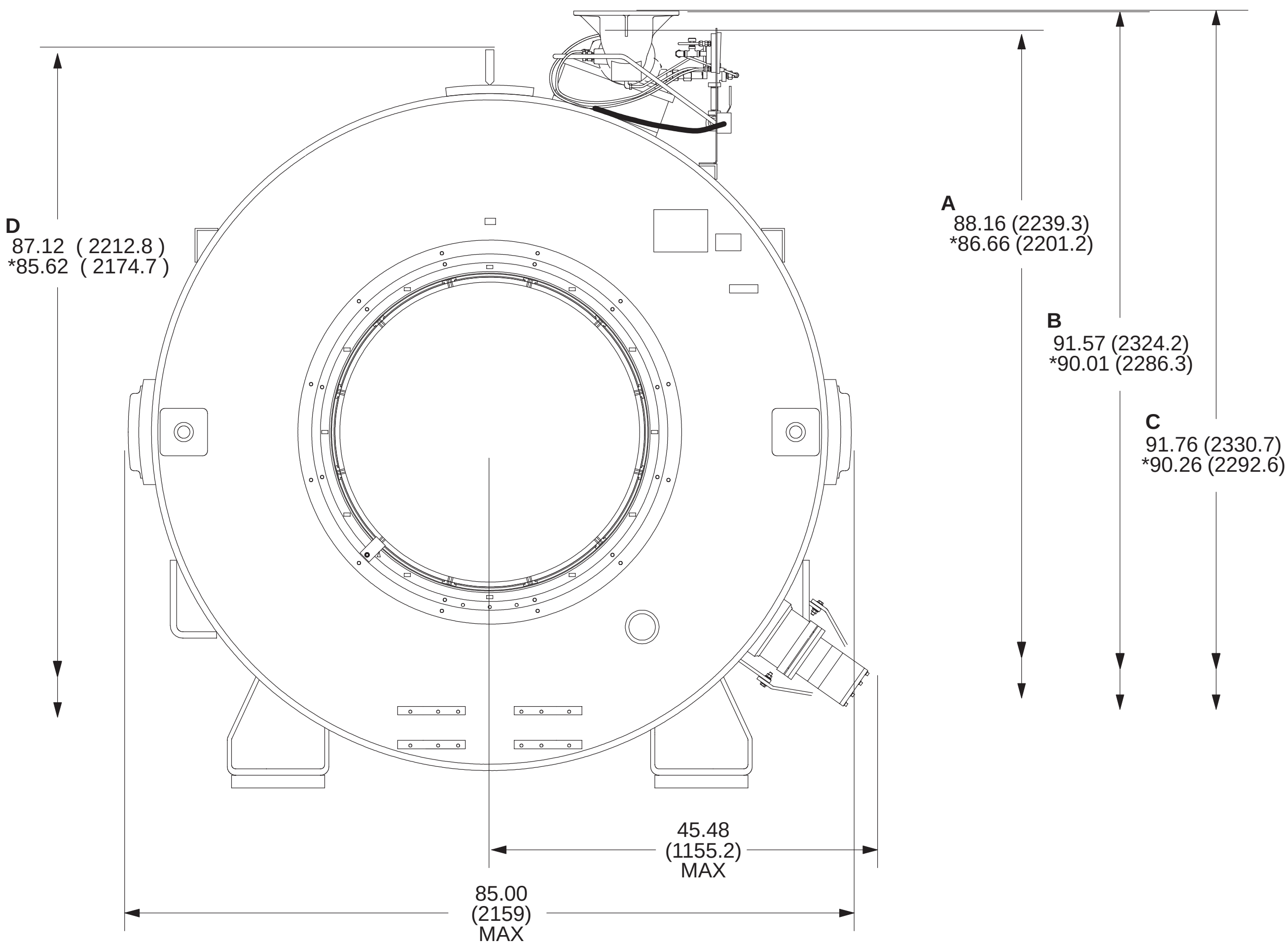
5. Jack the magnet up sufficiently, at the 4 jacking pads, and remove the 4 Roller Dollies.
6. Slowly lower magnet onto the exam room floor.

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)
* DIMENSIONS INCLUDE 1.50 (38.1) PLATES ON BOTTOM OF EACH FOOT.



MAGNET WITH ROLLER DOLLIES ATTACHED
ILLUSTRATION 5–1

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)
* DIMENSIONS SHOWN WITHOUT FOOT BLOCKS ATTACHED TO MAGNET FEET.



A: DISTANCE TO UPPERMOST POINT ON TURRET COVER PLATE.
B: DISTANCE TO TOP OF VENT ADAPTER.
C: DISTANCE TO TOP OF SHIM LEAD CONNECTOR BOX.
D: DISTANCE TO TOP OF LIFTING LUG

Note

Minimum height for service clearance is 102.68 inches (2608mm). This clearance is needed for Ramp Lead, Shim Lead, and Fill Line installation.

MAGNET CLEARANCE DIMENSIONS
ILLUSTRATION 5–2

SECTION 6 – LEVELING MAGNET

1. Fill a 25 foot (7.6m) x 0 .5 inch (12.7mm) section of transparent tubing 3/4 full with water.
2. Position the ends of the tube adjacent to the 3mm deep grooves, located on the end flanges of the magnet, at the horizontal center. Assure that there is sufficient water in the tube so that the water level is above the groove height. See Illustration 6–1.
3. Measure the difference between the groove and water level height in the tube. There should be no more than 0.04 inch (1 mm) difference between any of the four measurements (four corners of the magnet).
4. If there is more than a 0.04 inch (1 mm) difference, jack up magnet and insert an aluminum shim plate under the appropriate corner of the Magnet Base Frame.

Note

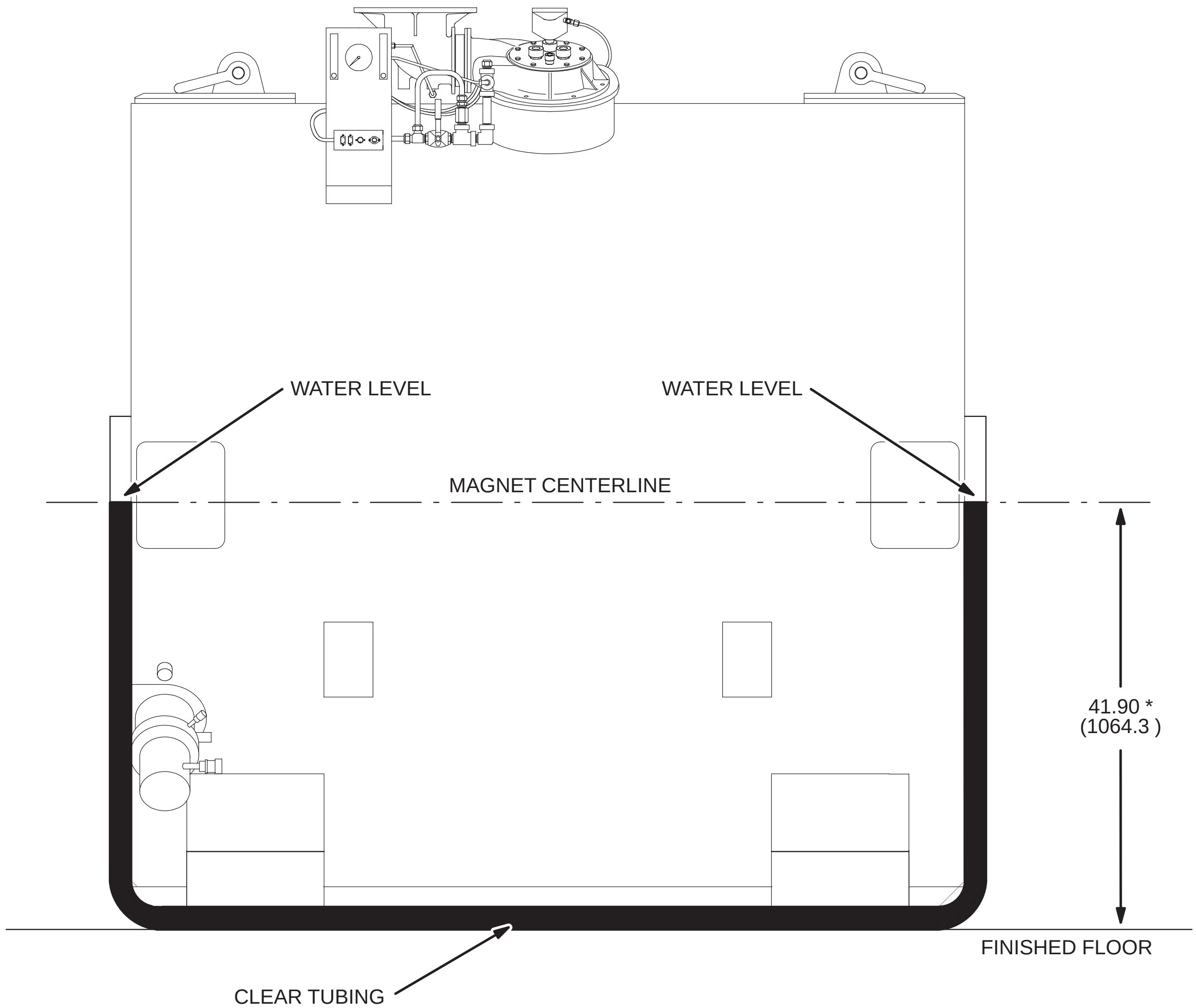
A Magnet Leveling Kit (46–260888G1), containing 12 – 0.062 inch (1.57mm) and 8 – 0.020 inch (0.5mm) shim plates, is shipped with the magnet.

5. Lower magnet onto shim plate and recheck the level.

Note

Repeat Steps 2 through 5 until the magnet is level (i.e., there is no more than a 0.04 inch (1mm) difference between any of the four measurements.

6. Allow magnet to settle on exam room floor for approximately 12 hours and recheck magnet level.
7. After 12 hours, bolt the magnet to the floor using the appropriate bolt down kit. If the magnet is in a Seismic Zone it will require the Magnet Bolt Down Installation Kit (P/N 2105959). All other SV installations require the Magnet Bolt Down Installation Kit (P/N 2104219) for reduced vibration sensitivity.



* MINIMUM DISTANCE BETWEEN MAGNET CENTERLINE AND FINISHED FLOOR IS 41.90 (1064.3) FOR FRONT AND REAR SHROUD CLEARANCE.

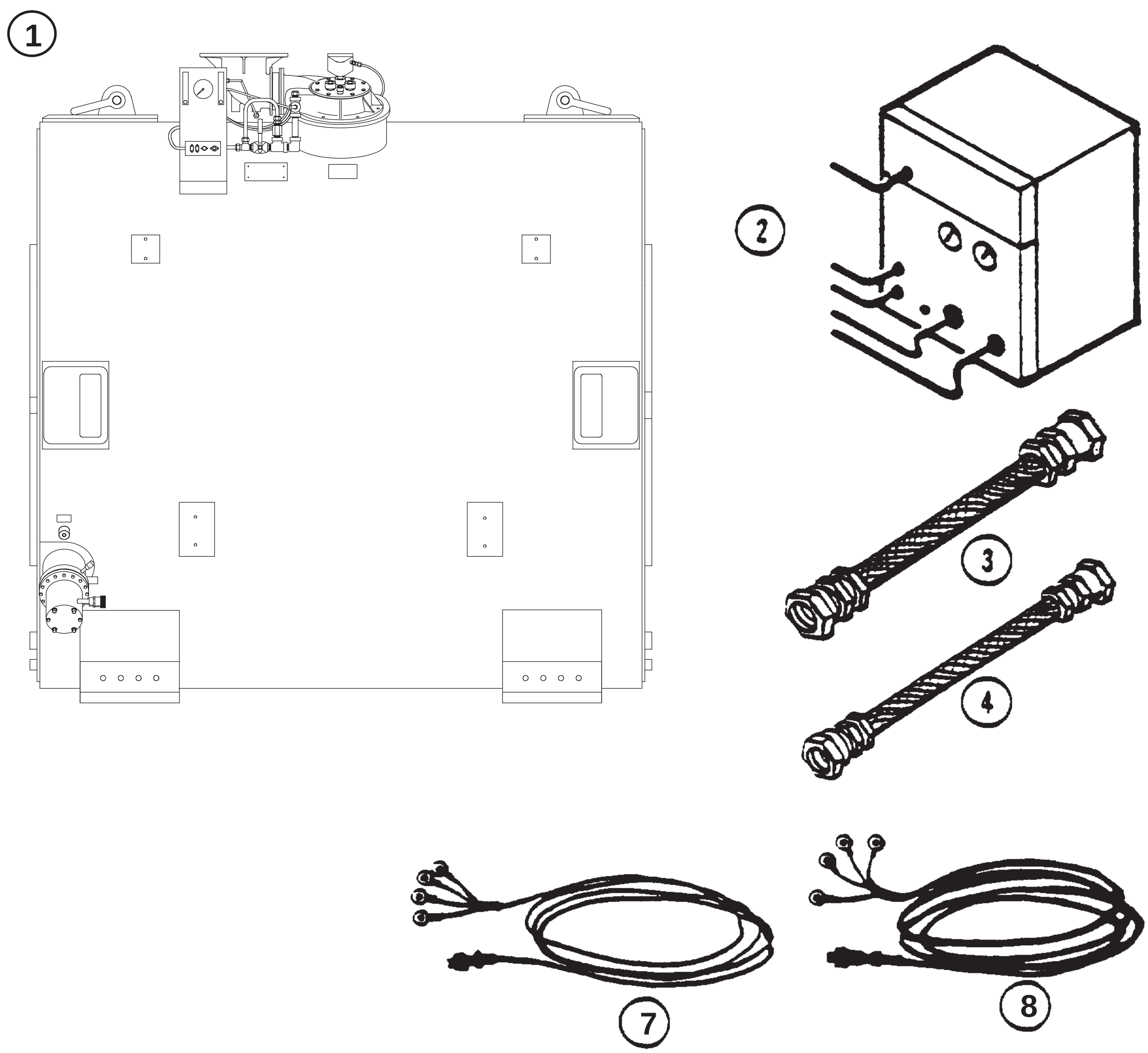
CHECKING MAGNET LEVEL
ILLUSTRATION 6–1

SECTION 1 – MAGNET SYSTEM

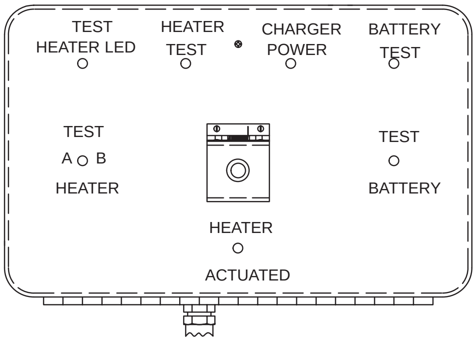
TABLE 1–1
MAGNET MODEL / ASSEMBLY NUMBERS

MAGNET MODEL NUMBER	MAGNET ASSEMBLY NUMBER
2131600	2131604

1–1 MAGNET SYSTEM



1–1 MAGNET SYSTEM (continued)



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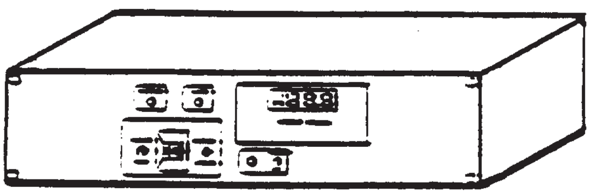

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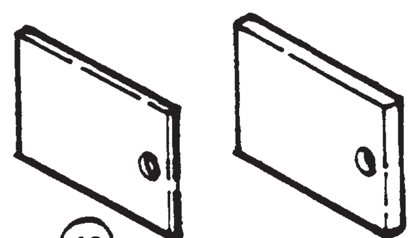

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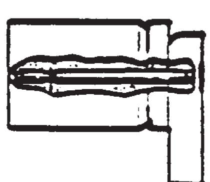

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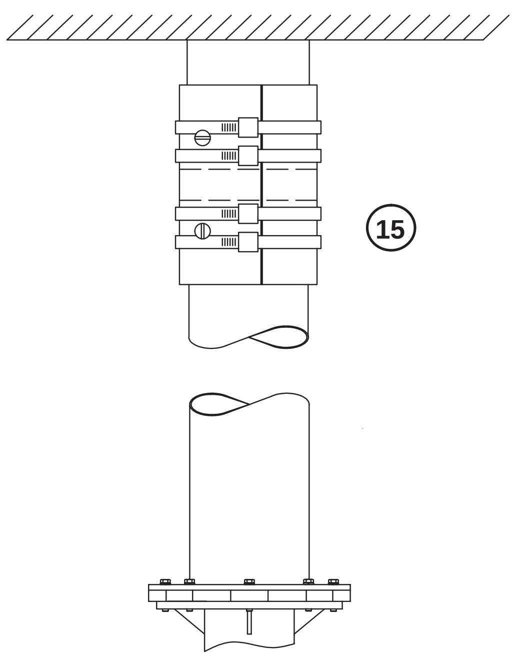

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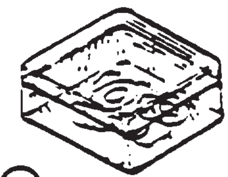
1–1 MAGNET SYSTEM (continued)



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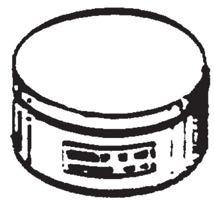

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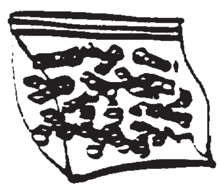

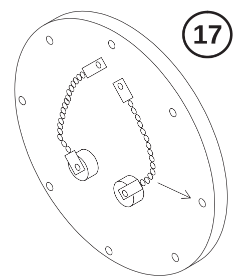

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1–1 MAGNET SYSTEM (continued)

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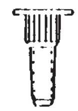

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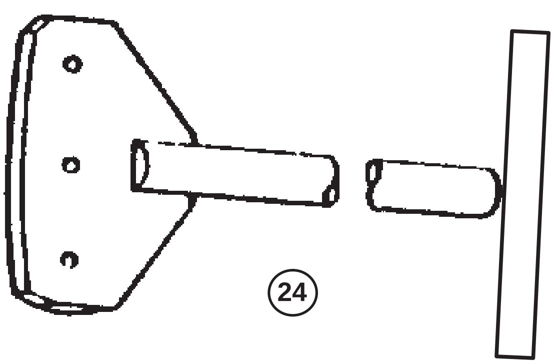
20 21 27 28 29 30



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1–1 MAGNET SYSTEM (continued)

1–1 MAGNET SYSTEM 2131604 SV 1.5T MAGNET SYSTEM

Item	Part Number	FRU	Name	Quantity	Description (Remarks)
1	2131600	N	MAGNET	1	GE SV 1.5T MAGNET / CRYOSTAT ASSEMBLY
2	46–294141G1	1	COMPRESSOR	1	LEYBOLD SHIELD COOLER COMPRESSOR
3	46–294142P2	1	He GAS LINE	1	LEYBOLD HELIUM SUPPLY LINE (70' LONG)
4	46–294143P2	1	He GAS LINE	1	LEYBOLD HELIUM RETURN LINE (70' LONG)
6	46–318068P1	2	WOOL	1	BRONZE WOOL
7	2104829	1	CABLE	1	COLD HEAD TO PENETRATION PANEL (50' LONG)
8	46–294144P2	1	CABLE	1	COMPRESSOR TO PENETRATION PANEL (50' LONG)
9	46–294231G1	1	MRU	1	MAGNET RUNDOWN UNIT
10	2128699	1	CABLE	1	FOR MAGNET RUNDOWN UNIT
11	46–260725G3	1	CABLE	2	FOR CRYOSTAT INSTRUMENTATION (80' LONG)
12	2122498	N	MONITOR	1	CRYOGEN MONITOR ASSEMBLY
13	46–260888G1	1	KIT	1	MAGNET LEVELING KIT
14	46–260852G3	1	TOOL	1	VACUUM TOOL
15	46–318057G1	1	KIT	1	HELIUM VENTILATION KIT
16	46–294744G3	N	KIT	1	FIELD SPARE PARTS KIT
17	46–294765G1	N	FLANGE	1	TURRET COVER FLANGE ASSEMBLY
19	46–258770G4	N	KIT	1	WARNING SIGN AND LABEL KIT
20	46–294126P201	1	SHIM	75	CARBON STEEL – .200" WIDE X .001" THICK
21	46–294126P401	1	SHIM	75	CARBON STEEL – .400" WIDE X .001" THICK
24	46–318765G1	N	TOOL	1	SHIM DRAWER PULLER TOOL
27	46–294126P901	1	SHIM	75	CARBON STEEL – 1.00" WIDE X .001" THICK
28	46–294126P903	1	SHIM	75	CARBON STEEL – 1.00" WIDE X .003" THICK
29	46–294126P910	1	SHIM	50	CARBON STEEL – 1.00" WIDE X .010" THICK
30	46–294127P1	N	SHIM	5	CARBON STEEL – 1.00" WIDE X .040" THICK
31	46–294128P2	1	COVER	50	ALUMINUM SHIM COVER – 1.00" WIDE X .062" THICK
32	46–294125P3	1	FASTENER	100	#6 – 32 UNC BROACHING TYPE X .44" LONG
33	46–252320P9	1	NUT	100	#6 – 32 UNC, BRASS
35	2163409	2	SPACER	200	MYLAR SPACER
37	46–318042P1	1	CABLE	1	METER CABLE, COLD HEAD SLEEVE TO REAR PEDESTAL
38	2114744–3	2	LADDER	1	SERVICE LADDER
39	2156980	2	KIT	1	SPIKE NOISE INSULATION KIT

1–2 MANUALS 46–294589G7 GE & VENDOR SERVICE MANUALS

Item	Part Number	FRU	Name	Quantity	Description (Remarks)
1	2141548	N	MANUAL	1	SV 1.5T MGT / CRY SUBSYSTEM SERVICE MANUAL
2	2120209	N	MANUAL	1	HELIUM LEVEL MONITOR OPER / MAINT MANUAL
3	46–318393	N	MANUAL	1	MAGNET RUNDOWN UNIT (MRU) SERVICE MANUAL
4	46–318394	N	MANUAL	1	MAGNET RUNDOWN UNIT (MRU) OPERATION MANUAL
5	46–294439P4	N	MANUAL	1	LEYBOLD COLD HEAD & COMPRESSOR MANUAL

SECTION 2 – MAGNET ACCESSORIES

2–1 LEYBOLD SHIELD COOLER COMPRESSOR 46–294141G1
* (VENDOR RENEWAL PARTS CROSS REFERENCE)

Item	Vendor Part #	FRU	Description	GE Part Number
1	200–20–179	2	POWER LEAD PLASTIC COVER	46–294147P1
2	200–19–805	2	POWER LEAD CLUSTER CONNECTOR	46–294148P1
3	200–19–816	1	COMPRESSOR ABSORBER	46–294156P1
4	200–19–850	2	SWIVEL CASTOR	46–294150P2
5	725–52–421	2	FLAT WASHER (AEROQUIP P/N 22008–4)	46–281034P13
6	725–52–216	2	DUST CAP	46–294150P1
7	200–19–900	2	BRACKET	46–294150P3
8	200–19–854	2	LOCK SCREW	46–294150P4
9	200–80–380	2	HIGH POWER VOLTAGE MODULE	46–294150P5
10	200–80–260	2	LOW VOLTAGE MODULE	46–294150P6
11	200–19–460	2	HOSE NIPPLE	46–294150P7
12	200–19–775	2	SPRING RING	46–294150P8
13	212–12–117	2	RETAINING NUT	46–294150P9
14	722–78–037	2	LEYBOLD SERVICE MANUAL	46–294439P4
■ 15	200–80–418	2	.6A CIRCUIT BREAKER	46–294150P20

* VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL.

2–2 FIELDSPARE KIT 46–294744G3

Item	Part Number	FRU	Name	Quantity	Description
1	2133618	1	BAFFLE ASM	1	SHIM LEAD BAFFLE ASSEMBLY
2	46–252838P6	1	BURST DISK	1	20 PSI BURST DISK 4 INCH (FOR 4 INCH CAST PLENUM)
3	46–252839P2	1	GASKET	2	4.25” ID X 5.25” OD NEOPRENE
4	46–281101P9	1	O–RING	2	1.487” ID X 0.103” THK. #2–137
5	46–281101P5	1	O–RING	2	5.737” ID X 0.103” THK. #2–162
6	46–281101P6	1	O–RING	2	9.487” ID X 0.103” #2–177
8	46–260389P1	1	O–RING	4	SILICONE, PARKER #2–116
9	46–260389P2	1	O–RING	2	SILICONE, PARKER #2–014
10	46–294104P1	2	NUT	2	QUICK COUPLING VACUUM NUT
11	46–294105P1	2	RING	2	QUICK COUPLING RETAINING RING
12	46–281101P10	1	O–RING	1	TEFLON O–RING, 6.237” I.D. X .103” THK.

2–3 MAGNET RUNDOWN UNIT 46–294231G1

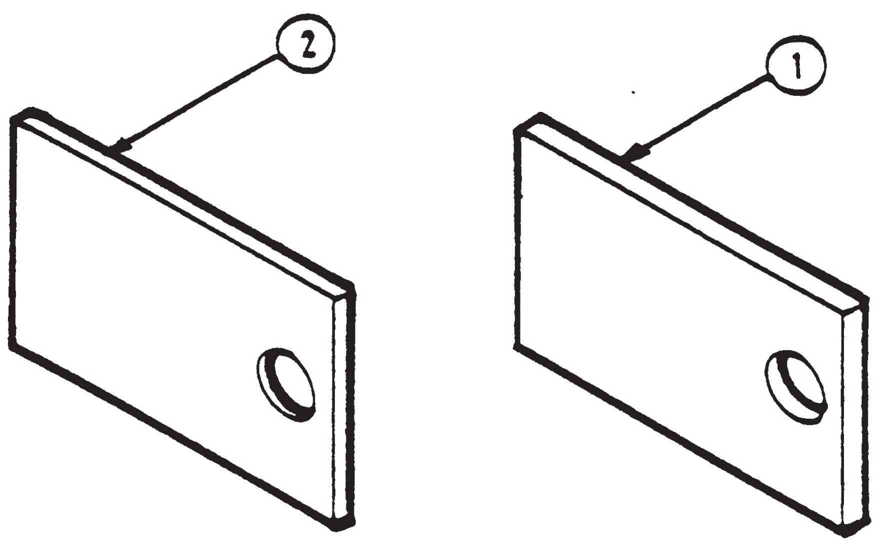
Item	Vendor Part #	FRU	Description	GE Part Number
1	EF1001	1	FUSE, F1, 110VAC .400 GDCTIME LAG	46–294231P1
2	EF1002	1	FUSE, F1, 220VAC .125GDC TIME LAG	46–294231P2
3	EF1008	1	FUSE, F2, 2.5A GDC TIME LAG	46–294231P3
4	GS4063	1	FUSE, F3/F4, 1.25A GDB	46–294231P4
5	GS4063	1	BATTERY, GEL CEL 6V 1.2AH YUSA NP1.2–6	46–294231P5
6	EC1140	1	CAPACITOR, CI, 470uF, 50V,	46–294231P6

2–4 CRYOGEN MONITOR 2122498

Item	Vendor Part #	FRU	Description	GE Part Number
1	EF–1000	1	FUSE, 0.3A, 250V, 3AG, 100–115 VAC	2122500–2
2	EF–1002	1	FUSE, 0.2A, 250V, 3AG, 200–230 VAC	2122500–3
3	BM / 111GE / PCB	2	MAIN PRINTED CIRCUIT BOARD	2122500–4
4	EM–1015	2	DISPLAY METER	2122500–5

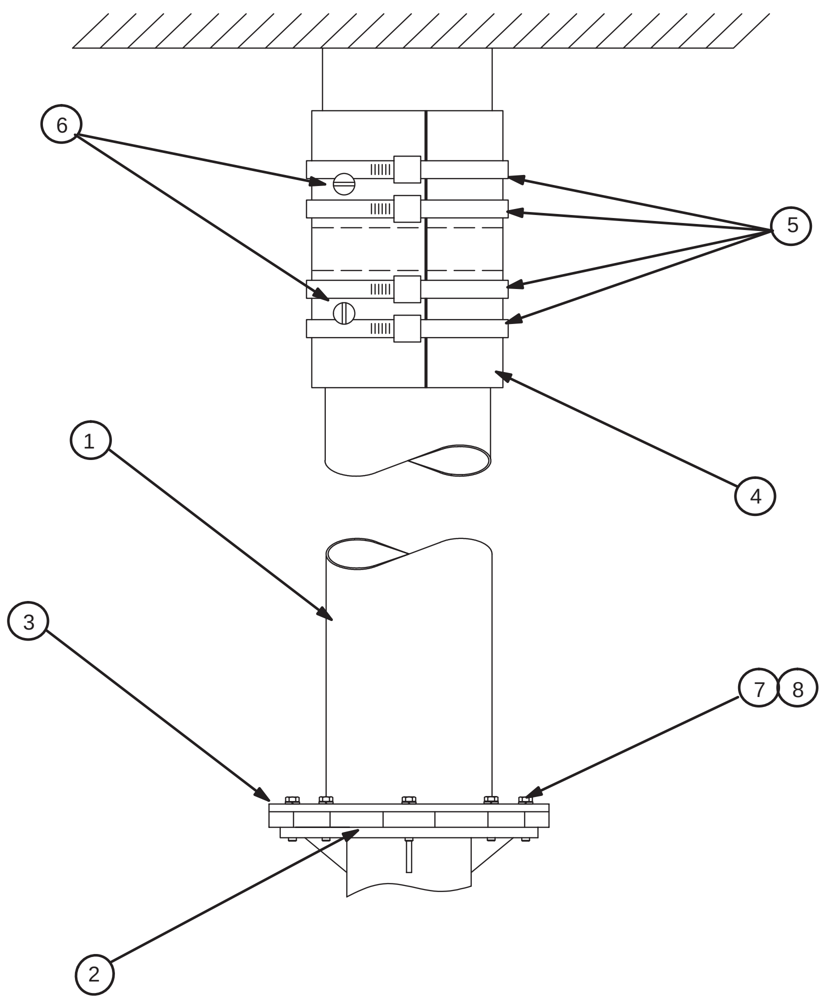
2–5 MAGNET LEVELING KIT 46–260888G1

Item	Part Number	FRU	Name	Quantity	Description
1	46–260886P2	2	SHIM PLATE	12	.062” THICK AL. ALLOY PLATE
2	46–260886P3	2	SHIM PLATE	8	.020” THICK AL. ALLOY PLATE



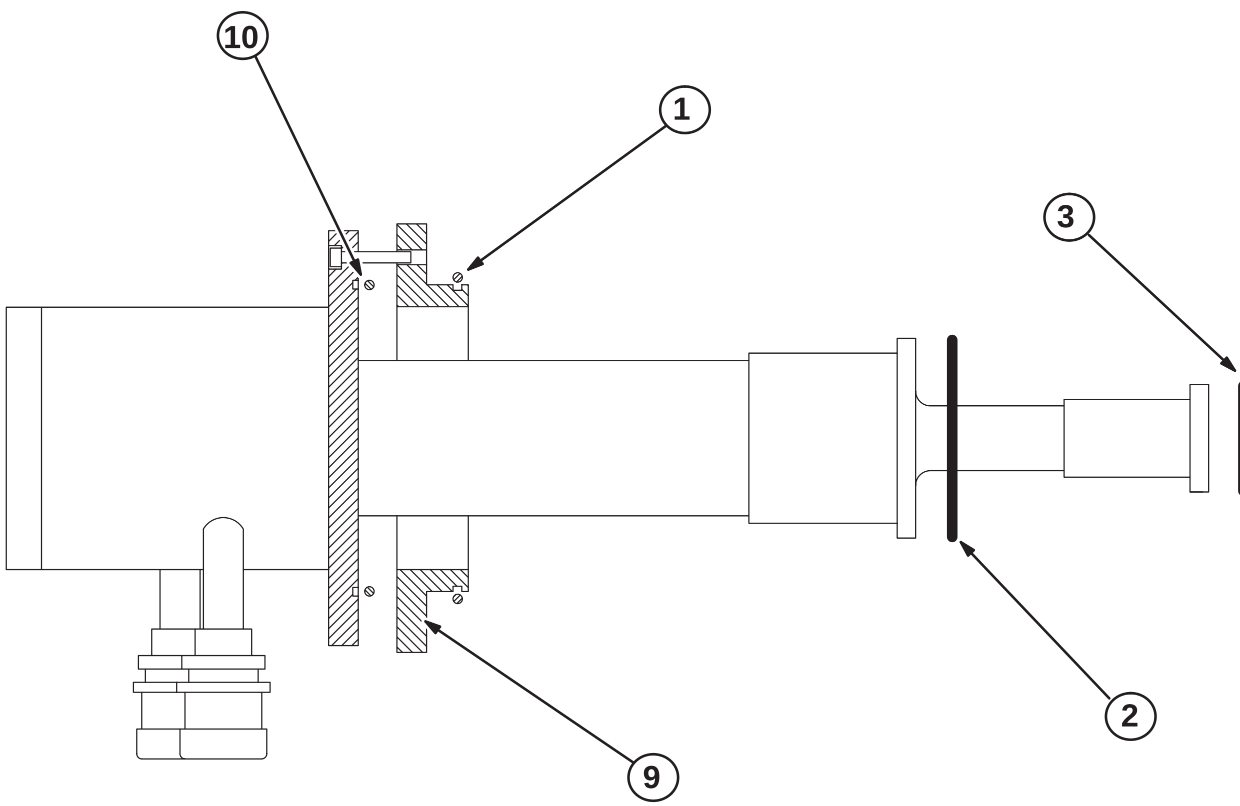
2–6 HELIUM VENT KIT 46–318057G1

Item	Part Number	FRU	Name	Quantity	Description
1	46–318051G1	N	PIPE	1	8" O.D. VENT PIPE ASSEMBLY
2	46–281101P2	1	O–RING	1	TEFLON O–RING, 8.237 I.D. X .103 THICK
3	46–318043P1	2	RING	1	304 STN. STL. CLAMP RING
4	46–281971P2	1	CONNECTOR	1	FIBERGLASS CONNECTOR SLEEVE 80.00" X 8.00"
5	46–281972P2	2	CLAMP	4	STN STL. HOSE CLAMP
6	46–318057P1	N	SCREW	2	#10 X 1.00" LG PAN HEAD, SELFTAPPING, STN. STL.
7	46–252635P9	2	WASHER	8	.375 NOM. PLAIN STN. STL. WASHER
8	46–281046P38	N	SCREW	8	.375–16 X 1.75 LG. BRASS, HEX HD. CAP SCREW



2–7 SHIELD COOLER COLD HEAD ASSEMBLY COMPONENT (SLEEVE MOUNT) LEYBOLD (2100832)

Item	Part Number	FRU	Name	Quantity	Description
1	46–281247P1	1	O–RING	1	BUNA, 4.987 I.D. X .103 THICK
2	46–281241P1	1	GASKET	2	INDIUM GASKET, 3.37 O.D.
3	46–281241P2	1	GASKET	2	INDIUM GASKET, 1.75 O.D.
4	46–281387P1	1	WASHER	48	.25 I.D. BELLEVILLE WASHER, STN. STL.
5	46–294151P7	N	COMPOUND	1	ANTI–SIEZE COMPOUND, 4 OZ. CAN
6	46–252065P24	N	GREASE	1	VACUUM GREASE
7	46–252065P64	N	GLOVES	1	COTTON, ONE PAIR
8	NOT USED				
9	46–260938P1	2	FLANGE	1	TRANSITION FLANGE
10	46–281247P2	1	O–RING	1	BUNA, 5.237 I.D. X .103 THICK

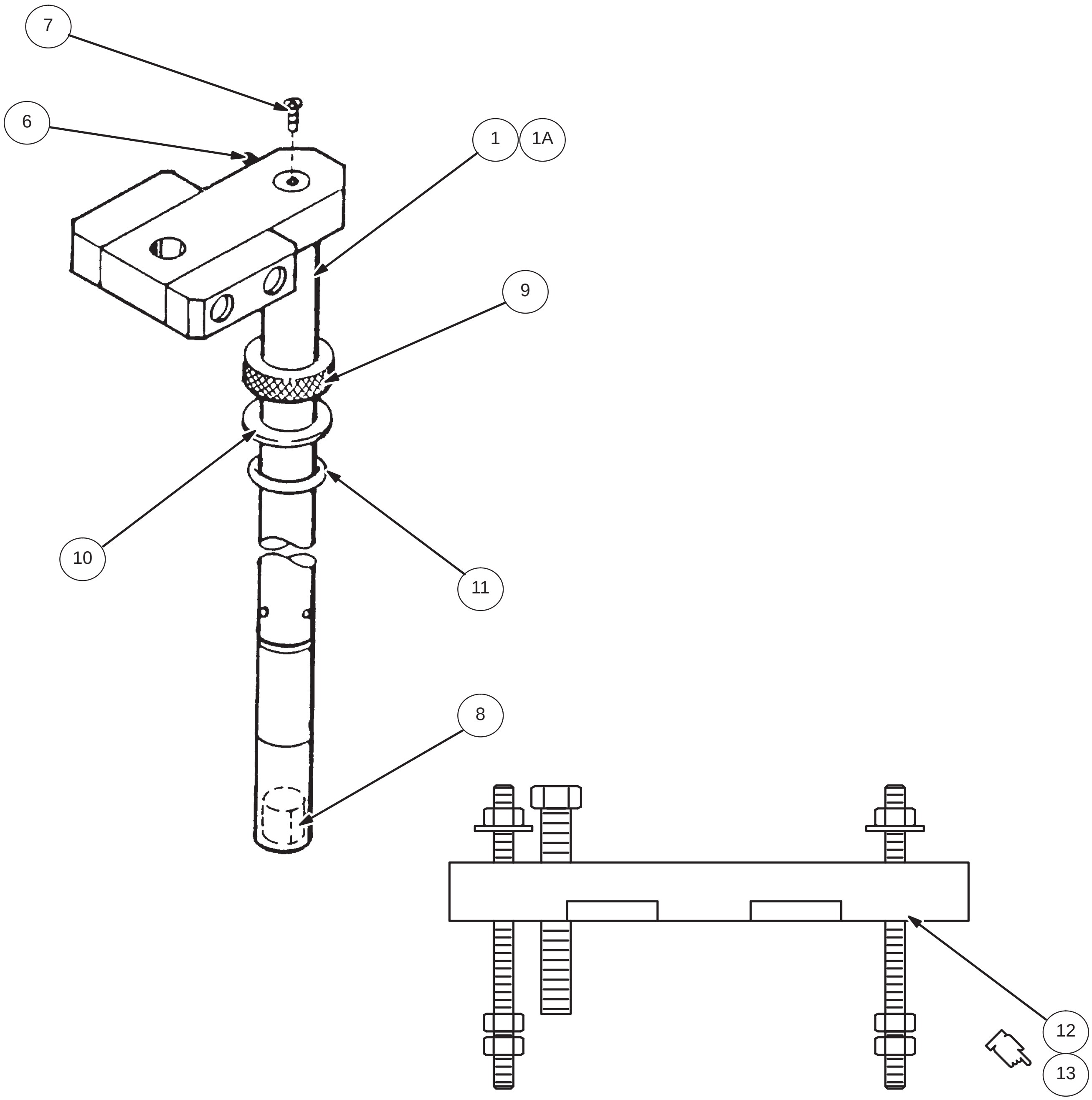


SECTION 3 – SERVICE TOOL KITS / COMPONENTS

Note

The Service Tools Section contains tools used on different GE magnets. Please refer to Magnet Tool Matrix, Section 4–27, to determine which tools are used for each magnet type.

3–1 MAGNET RAMPING EQUIPMENT KIT 46–260703G3



3–1 MAGNET RAMPING EQUIPMENT KIT 46–260703G3

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–260817G3	SII, SIII, & MAX MAIN LEADS	2	VAPOR COOLED MAIN LEAD EXTENSIONS
1A	46–294204G1	SIV AS MAIN LEADS	2	VAPOR COOLED MAIN LEAD EXTENSIONS
2	46–252366P4	CAP SCREW	3	3/8–16 X 1.00 CAP SCREW
3	46–252320P19	NUT	6	3/8–16 BRASS NUT
4	46–252322P8	WASHER	12	3/8 BRASS WASHER
5	46–281046P35	CAP SCREW	3	3/8–16 X 1.250 BRASS CAP SCREW
6	46–252351P2	#10 SCREW	4	BRASS SCREW RD HD #10–24 X .500
7	46–252351P51	#10 SCREW	4	BRASS SCREW RD HD #10–32 X .438
8	46–281256P1	CONTACT BAND	20	CONTACT BANDS FOR MAIN LEAD EXTENSIONS
9	46–294104P1	RETAINING NUT	4	KNURLED BRASS RETAINING NUT
10	46–294105P1	RETAINING RING	4	S/S RETAINING RING
11	46–260389P1	“O” RING	8	SILICON “O” RING
12	2142687	RAMPING FIXTURE	1	HOLD DOWN TOOL FOR RAMP LEADS (1.0T & 1.5T)
13	2152359	RAMPING FIXTURE	1	HOLD DOWN TOOL FOR RAMP LEADS (0.5T ACTIVE SHIELS)
14	46–294236G1	CASE/FOAM	1	CASE FOR RAMPING ITEMS

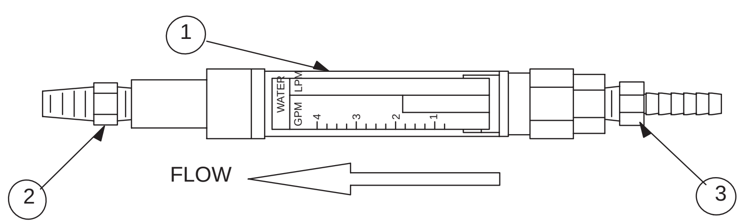
3–2 POWER SUPPLIES

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–260776G3	MAIN P/S	1	MAIN COIL POWER SUPPLY
2	46–260777G3	SHIM P/S	1	SHIMMING POWER SUPPLY

3–3 RAMP CABLE HOLDER 46–318314G2

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–260723G1	POWER CABLE	2	MAIN, POSITIVE 4 / 0
2	46–260723G2	POWER CABLE	2	MAIN, NEGATIVE 4 / 0
3	46–318373G1	POWER CABLE	2	AC CORD FOR POWER SUPPLIES
4	46–318314G1	CABLE HOLDER	1	RAMP CABLE HOLDER

3–4 WATER FLOW METER KIT 46–294052G1



Item	Part Number	Name	Quantity	Description (Remarks)
1	46–294052P1	FLOW METER	1	INLINE FLOW METER
2	46–294052P2	HEX NIPPLE	1	BRASS, .50 NPT X .50 NPT
3	46–294052P3	HOSE CONNECTOR	1	BRASS, .50 NPT X .50 I.D. HOSE

3–5 RAMPING SUPPLY AND EQUIPMENT 46–294998G1

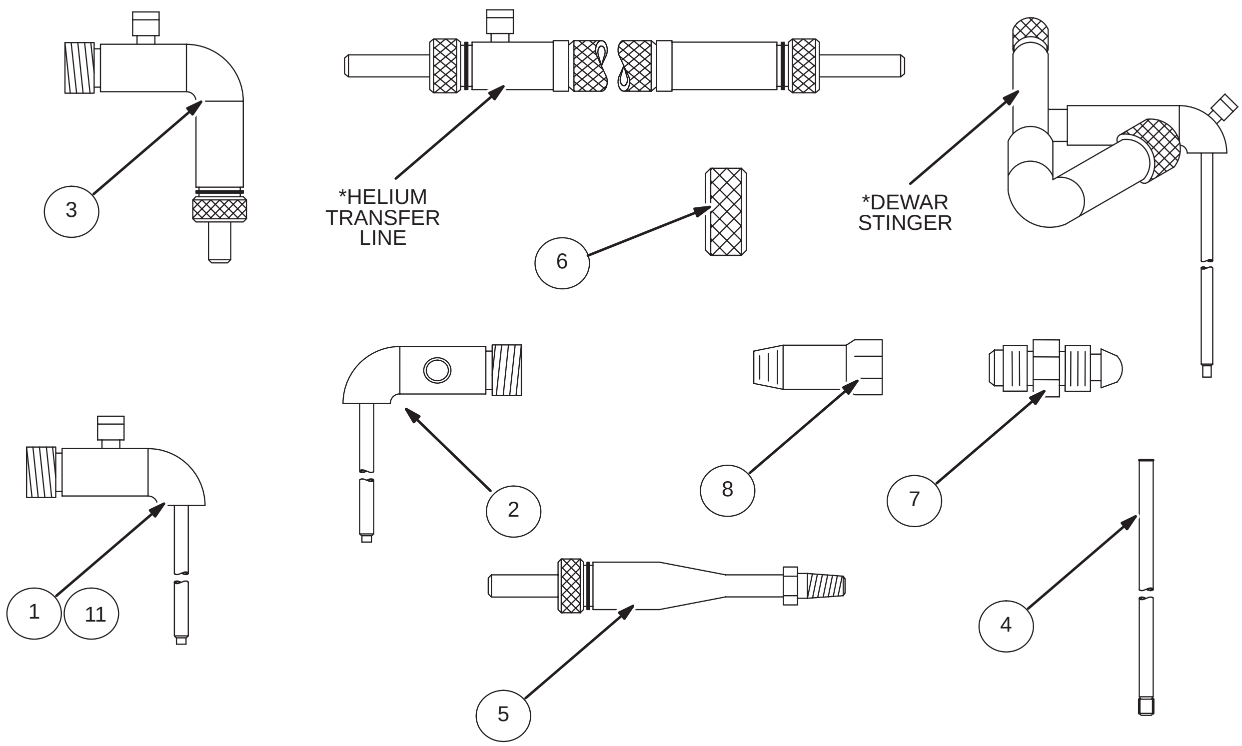
Item	Part Number	Name	Quantity	Description (Remarks)
1	46–260703G2	RAMP EQUIPMENT	1	MAIN FIELD RAMPING
2	46–260776G3	MAIN P/S	1	MAIN COIL POWER SUPPLY

3–6 SERVICE POWER SUPPLY RENEWAL PARTS 46–260776G3 & 46–260777G3
* (VENDOR RENEWAL PARTS CROSS REFERENCE)

Item	Vendor Part Number	Description (Remarks)	GE Part Number
1	12–452–028	PANEL, CONTROL ASSEMBLY	46–281468P1
2	12–452–026	HEATER, P/S, HEATER & 24 VDC PS	46–281468P2
3	25–611–000	PANEL, INPUT/OUTPUT CONNECT	46–281468P3
4	00–467–498	TCR 7.5T750, MAIN COIL PS	46–281468P4
5	51–001–001	FAN, 3.12”, 115V	46–260219P12
6	58–005–010	FUSE, MDA, 4A, 250V	46–281468P5
7	20–292–002	PWB, PRINTED CIRCUIT ASSY	46–281468P6
8	20–230–000	PWB, +24 & ±15 PS ASSY	46–281468P7
9	71–024–000	DIAL TURNS COUNTING	46–260219P27
10	66–065–006	VOLTMETER, ANALOG, 0–36 VDC	46–281468P8
11	62–062–009	AMMETER, ANALOG, 0–1 ADC	46–281468P9
12	66–082–007	VOLMETER, DIGITAL 3.5 DIGIT	46–281468P10
13	66–082–008	AMMETER, DIGITAL 5.5 DIGIT	46–281468P11
14	67–055–007	POT, 10 TURN, 5K, WW	46–281468P12
15	68–012–005	SWITCH, PUSH BUTTON, MOM, WHT	46–260219P33
16	68–004–001	SWITCH, DPDT TOGGLE	46–281468P13
17	68–008–003	SWITCH, DPDT, LOCKING TOGGLE	46–281468P14
18	20–354–000	PWP, PCB P–SET AMPLIFIER	46–281468P15
19	58–006–010	FUSE, MDV, 0.125A, 250V	46–281468P16
20	58–001–008	FUSE, AGC, 2A, 250V	46–281468P17
21	20–137–087	PCB, A100, CONTROL	46–281468P18
22	54–072–002	CAPACITOR, 350 KMF/10V	46–281468P19
23	61–011–001	SCR, DUAL PACK	46–281468P20
24	56–069–004	BREAKER, 3 POLE, 30A	46–281468P21
25	51–002–002	FAN, 468” SQ, 220V	46–260219P2
26	67–023–005	RESISTOR, 3 OHM, 25W	46–281468P22
27	63–004–001	INDICATOR, LED, RED 46–281468P23	
28	51–009–001	FAN, BISCUIT	46–281468P24
29	51–002–001	FAN, 4.68 SW. 115V	46–260219P20
30	56–001–002	BREAKER, 3 POLE, 30A	46–281468P25
31	12–452–027	PANEL, CONTROL ASSEMBLY	46–281469P1
32	58–005–013	FUSE, MDA, 6.25A, 250A	46–281469P2
33	12–452–025	SUPPLY SWITCH HEATER & INTERNAL POWER	46–281469P3
34	25–612–000	PANEL, INPUT/OUTPUT	46–281469P4
35	00–452–084	MODULE, SHIM P/S #1 THRU #6	46–281469P5
36	58–005–006	FUSE, MDA, 1A, 250V	46–281469P11
37	60–010–001	DIODE, DUAL PAK, 600V, 15A	46–281469P12
38	20–292–001	PWB, A700, PCB ASSY	46–281469P13
39	65–047–001	RELAY, DPDT, 24VDC	46–281469P14
40	66–082–012	VOLTMETER, DIGITAL, 4 1/2 DIGIT	46–281469P15
41	66–082–011	AMMETER, DIGITAL, 4 3/4 DIGIT	46–281469P16
42	68–037–007	SWITCH, *8PL, 6STN, SELECT	46–281469P17
43	67–055–011	POT, 2000 OHM, 10 TURN	46–281469P18
44	65–024–007	RELAY, 4PDT, 25A	46–281469P19
45	68–008–001	T’STAT N/O 195 DEGREES F	46–281469P20
46	62–005–020	TRANSISTOR, 2N5685	46–281469P21
47	62–005–014	TRANSISTOR, MJ2955	46–281469P22
48	68–002–002	T‘STAT N/C, 210 DEGREES F	46–281469P23
49	20–350–001	PWB, A100 ASSY	46–281469P24
50	67–055–005	POT, 20K, 10 TURN, 2W	46–281469P25

*** VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL**

3–7 UNIVERSAL FILL LINE KIT 46–294705G1

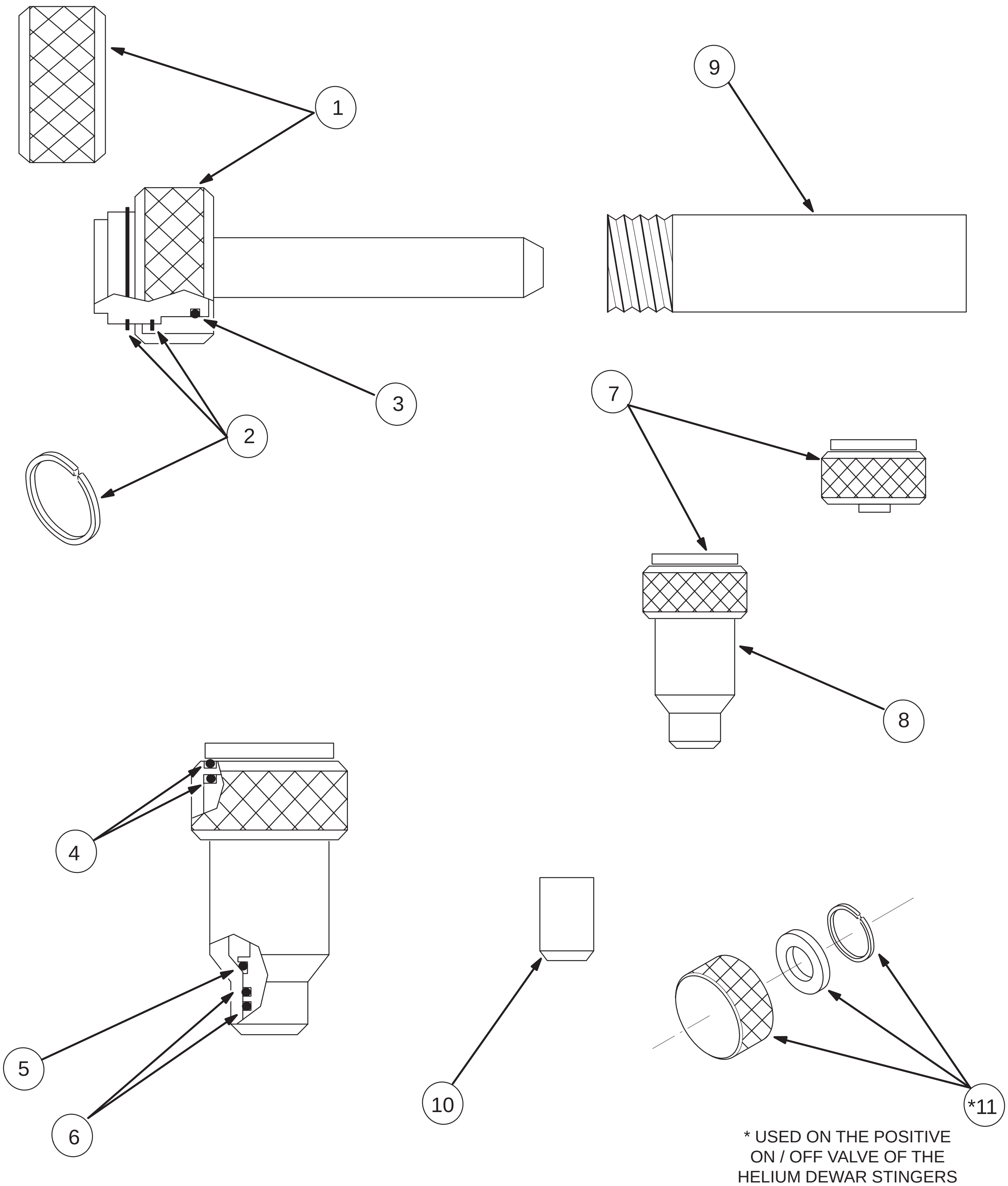


* ITEMS ARE NOT INCLUDED IN UNIVERSAL FILL LINE KIT

3–7 UNIVERSAL FILL LINE KIT 46–294705G1

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–294512P3	7” STINGER	1	7” CRYOSTAT STINGER AIR PRODUCTS# CSA–7
2	46–294512P4	14.75” STINGER	1	14.75 CRYOSTAT STINGER AIR PRODUCTS #CSA–14
3	46–294512P5	3” MALE BAYONET	1	.50” X 300” MALE BAYONET AIR PRODUCTS #MBR–6–3
4	46–294512P12	16” STINGER EXT. TIP	1	16” CRYOSTAT STINGER AIR PRODUCTS #CSE–16
5	46–294512P13	ADAPTER	1	PURGE/PRECOOL ADAPTER AIR PRODUCTS #PPA–1
6	46–294512P15	BLANKING CAP	1	BRASS BLANKING CAP 1.5” OD AIR PRODUCTS #BBC–1.5
7	46–294512P16	NITROGEN ADAPTER	1	NITROGEN FILL LINE ADPTR AIR PRODUCTS #FLA–1
8	46–294512P17	HELIUM ADAPTER	1	HELIUM FILL LINE ADPTR AIR PRODUCTS #GLA–1
9	46–294512P14	CASE/FOAM	1	BLACK CARRYING CASE AIRPRODUCTS #PCC–27
10	46–294512P25	17” STINGER	1	17” MAGNET STINGER AIR PRODUCTS #CSE–17

3–8 HELIUM TRANSFER LINE KIT RENEWAL PARTS



3–8 HELIUM TRANSFER LINE KIT RENEWAL PARTS

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–294512P6	COUPLING NUT	1	MALE BAYONET COUPLING NUT AP#BCN–1
2	46–294512P7	RETAINER RING	1	MALE BAYONET NUT RETAINER RING AP#BRR–1
3	46–294512P8	O–RING	1	MALE BAYONET O–RING AP#BOR–1
4	46–294512P9	O–RING	2	VAC PORT AND RELIEF VALVE O–RING AP#VPOR–1
5	46–294512P10	O–RING	1	VAC PORT AND RELIEF VALVE O–RING AP#VPOR–2
6	46–294512P11	O–RING	2	VAC PORT AND RELIEF VALVE O–RING AP#VPOR–3
7	46–294512P18	CAP	1	VAC PORT CAP AP#VPC–1
8	46–294512P19	VALVE	1	VAC PORT VALVE AP#VPV–1
9	46–294512P20	PROTECTOR	1	BAYONET PROTECTOR AP#BP–PVC
10	46–294512P21	TEFLON TIP	1	TEFLON TIP AP#STT–1
11	46–294512P22	VALVE STEM REP	1	VALVE STEM AP#VSC–K

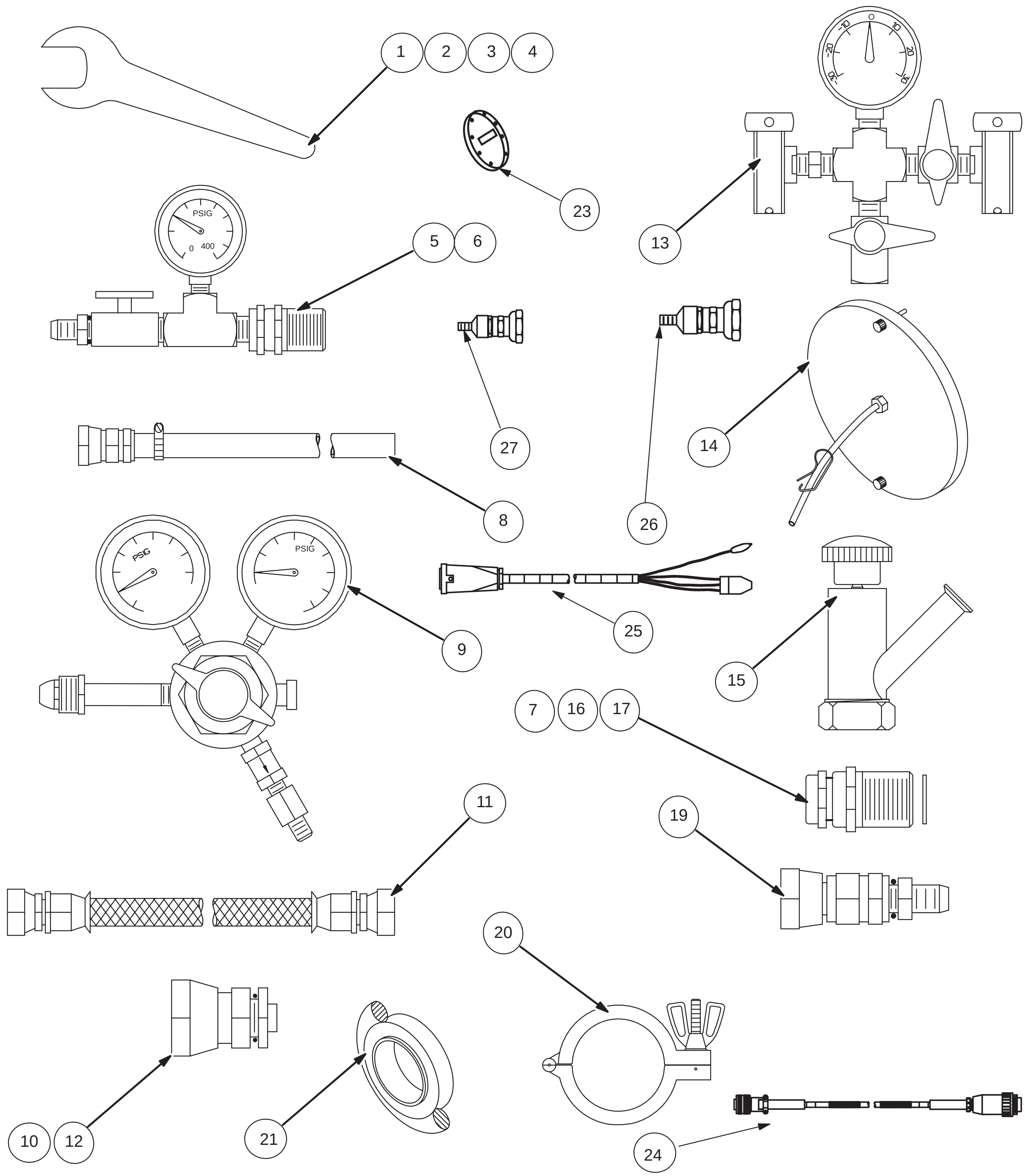
3–9 DEWAR STINGERS, HELIUM AND NITROGEN TRANSFER LINES

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–294511P1	DEWAR STINGER	1	250 LITER DEWAR STINGER AIR PRODUCTS #DSA–59
2	46–294511P2	DEWAR STINGER	1	500 LITER DEWAR STINGER AIR PRODUCTS #DSA–64
3	46–294512P1	TRANSFER LINE	1	12’ HELIUM TRANSFER LINE AIR PRODUCTS #FS–12–2B6
4	46–294512P2	TRANSFER LINE	1	8’ HELIUM TRANSFER LINE AIR PRODUCTS #FS–8–2B6
5	46–252805P2	TRANSFER LINE	1	10’ NITROGEN TRANSFER LINE
6	46–252805P3	TRANSFER LINE	1	15’ NITROGEN TRANSFER LINE
7	46–271135P1	FLEX HOSE	1	FLEX HOSE WITH NPT FITTINGS FOR HE BOTTLE

3–10 OTHER HELIUM TRANSFER SERVICE ITEMS

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–271137G1	SAFETY KIT	1	SAFETY FACE SHIELD KIT AIR PROD. #295–A–MRK500
2	46–265286G1	HEL. RES. BOX	1	GE MAGNET HELIUM RES BOX
3	46–306734G1	REGULATOR KIT	1	HELIUM HIGH PRESS. REG.AND HOSE KIT
4	46–258150P1	HELIUM CART	1	NON–MAGNETIC CYLINDER CART

3–11 COLD HEAD / COMPRESSOR INSTALLATION / MAINTENANCE KIT 46–281088G3



3–11 COLD HEAD/COMPRESSOR INSTALLATION/MAINTENANCE KIT 46–281088G3

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–294150P14	WRENCH	2	1 3/16” WRENCH LEYBOLD #722–81–019
2	46–294150P13	WRENCH	1	1” WRENCH LEYBOLD #72281018
3	46–294150P15	WRENCH	1	1 3/8” WRENCH LEYBOLD #72281020
4	46–294150P16	WRENCH	2	1 5/8” WRENCH LEYBOLD #72281021
5	46–317904P1	PURGE TOOL	2	#8(1/2”) AEROQUIP MALE PURGE TOOL
6	46–317904P2	PURGE TOOL	2	#12(3/4”) AEROQUIP MALE PURGE TOOL
7	46–294937P1	#4 MALE AEROQUIP	1	#4 MALE AEROQUIP COUPLING WITH TUBE ADAPTER
8	46–294003P1	#4 FITTING	1	#4 CHARGING TOOL
9	46–294009P1	HIGH PRESS. REG.	1	HIGH PRESSURE HELIUM REGULATOR FOR CHARGING
10	46–294936P1	#8 FEM. AEROQUIP	1	#8 FEMALE AEROQUIP COUPLING WITH TUBE ADAPTER
11	46–294002P1	LINE ADAPTER	1	LINE ADAPTER HOSE
12	46–294006G1	DISCHARGE TOOL	1	#12 DISCHARGE FITTING
13	46–294007G1	ADAPTER	1	COLD HEAD BACKFILL PMPDWN ADAPTER
14	46–294010G1	COVER PLATE	1	PLEXIGLASS PURGE COVER PLATE
15	46–260267P2	SEAL OFF OPER.	1	SLEEVE SEAL OFF OPERATOR
16	46–294000G1	#12 COUPLING	1	#12 MALE FITTING
17	46–281999G1	#8 COUPLING	1	#8 MALE FITTING
18	46–252065P63	WIRE BRUSH	1	WELDER’S BRUSH
19	46–294005G1	#4 ADAPTER ASM	1	#4 AEROQUIP
20	46–294026P1	KF 16 CLAMP	1	KF 16 CLAMP
21	46–294030G1	CENTERING RING	1	O–RING CENTERING RING
22	46–294939G50	CASE/FOAM ASM.	1	CARRYING CASE FOR TOOLS
23	46–281989G1	COVER ASSEMBLY	1	COLD HEAD PORT COVER
24	46–318911P1	POWER CABLE	1	BALZER’S COMPRESSOR TO COLDHEAD
25	46–318910P1	POWER CABLE	1	LEYBOLD COMPRESSOR TO COLDHEAD
26	2100316	LG. ADAPTER FIT.	1	AEROQUIP FITTING TO HELIUM LINE
27	2100317	SM. ADAPTER FIT.	1	AEROQUIP FITTING TO HELIUM LINE
28	2102476DDW	INSTRUCTIONS	1	KIT UPGRADE INSTRUCTIONS
29	2102181	LABEL	1	SHIELD COOLER TOOL KIT LABEL UPGRADE

3–12 EXTRA EQUIPMENT NEEDED TO SERVICE COLD HEAD AND COMPRESSOR

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–306734G1	HELIUM TANK	1	REGULATOR KIT REGULATOR AND HOSE
2	46–294047G1	PUMP KIT	1	SHIELD COOLER VACUUM PUMP KIT

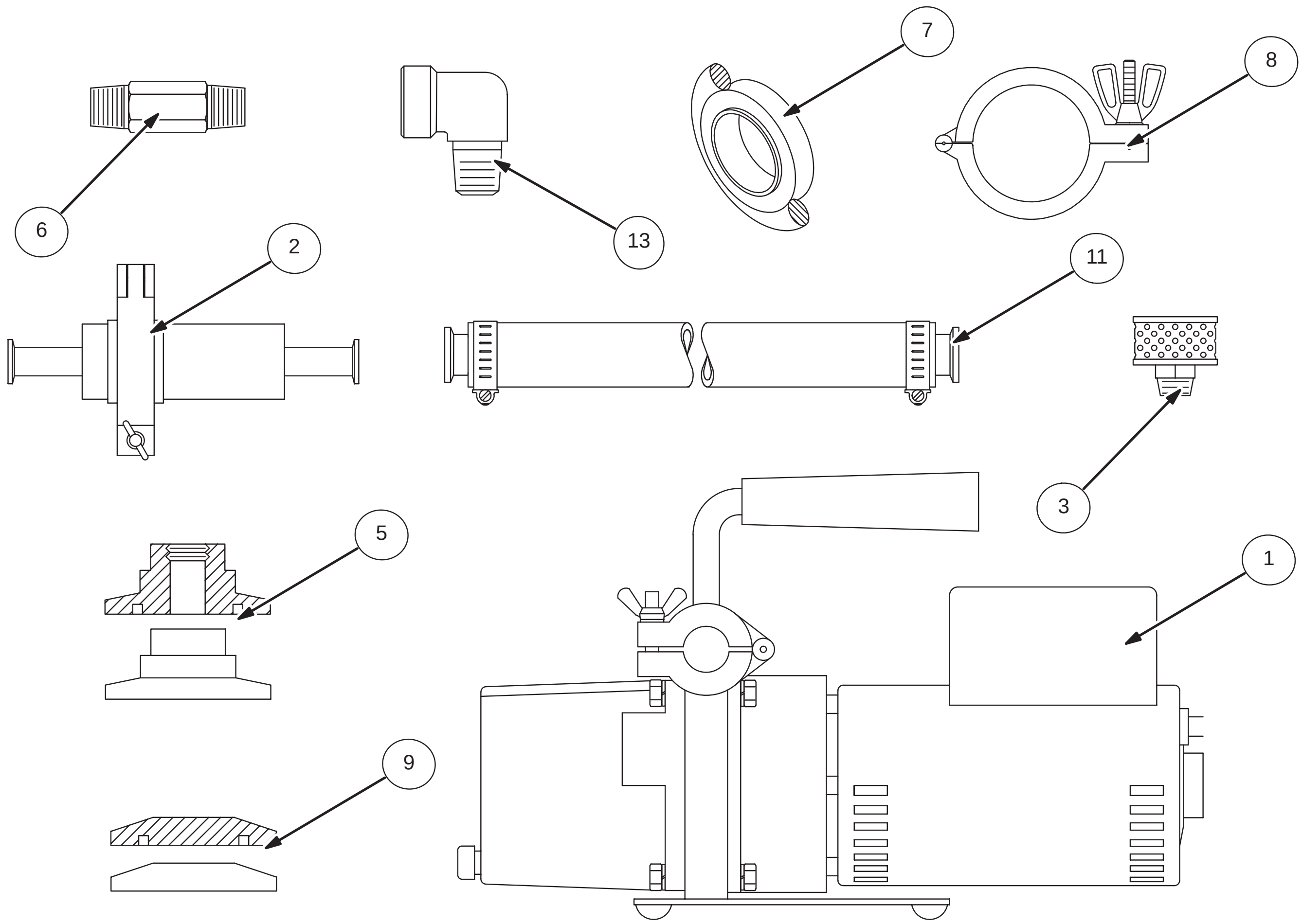
3–13 LAKESHORE 208 THERMOMETER KIT 46–301477G1

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–301453P6	CASE	1	14 X 103/4 X 53/4
2	46–301618P1	INSERT, FOAM	1	TOP – CONVOLUTING FOAM
3	46–301618P2	NSERT, FOAM	1	BOTTOM – 2 LAYERS
4	46–301478P1	THERMOMETER	1	LAKESHORE MODEL 208
5	46–301619P1	CABLE, DIODES	1	INTERCONNECT TO DIODES
6	46–301620P1	CABLE, MAGNET	1	INTERFACE TO GE MAGNET
7	46–301621P1	LABEL	1	“GE MEDICAL SYSTEMS LAKESHORE THERMOMETER AND INTERFACE CABLE 46–301477G1”

3–14 LOW COST SHIELD TEMPERATURE DIODE BOX 46–317543G1

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–317537P1	METER	1	CURRENT SOURCE METER
2	46–317537P2	CABLE	1	METER CABLE
3	46–317537P3	CASE	1	CARRYING CASE

3–15 SHIELD COOLER VACUUM PUMP KIT 46–294047G1



3–15 SHIELD COOLER VACUUM PUMP KIT 46–294047G1

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–294041P1	VAC. PUMP	1	SARGENT–WELCH PUMP
2	46–294041P3	OIL TRAP(INLET)	1	INLET FORELINE TRAP
3	46–294041P2	EXHAUST FILTER	1	EXHAUST FILTER
4	46–294041P4	CARTRIDGE FOR OIL	1	TRAP REPLACEMENT TRAP
5	46–294027P1	INLET ADAPTER	1	KF16 TO .25 NPT ADAPTER
6	46–294029P1	NIPPLE	1	2”NIPPLE
7	46–294030G1	CENTERING RING	1	CENTER AND O RING

3–15 SHIELD COOLER VACUUM PUMP KIT 46–294047G1 (continued)

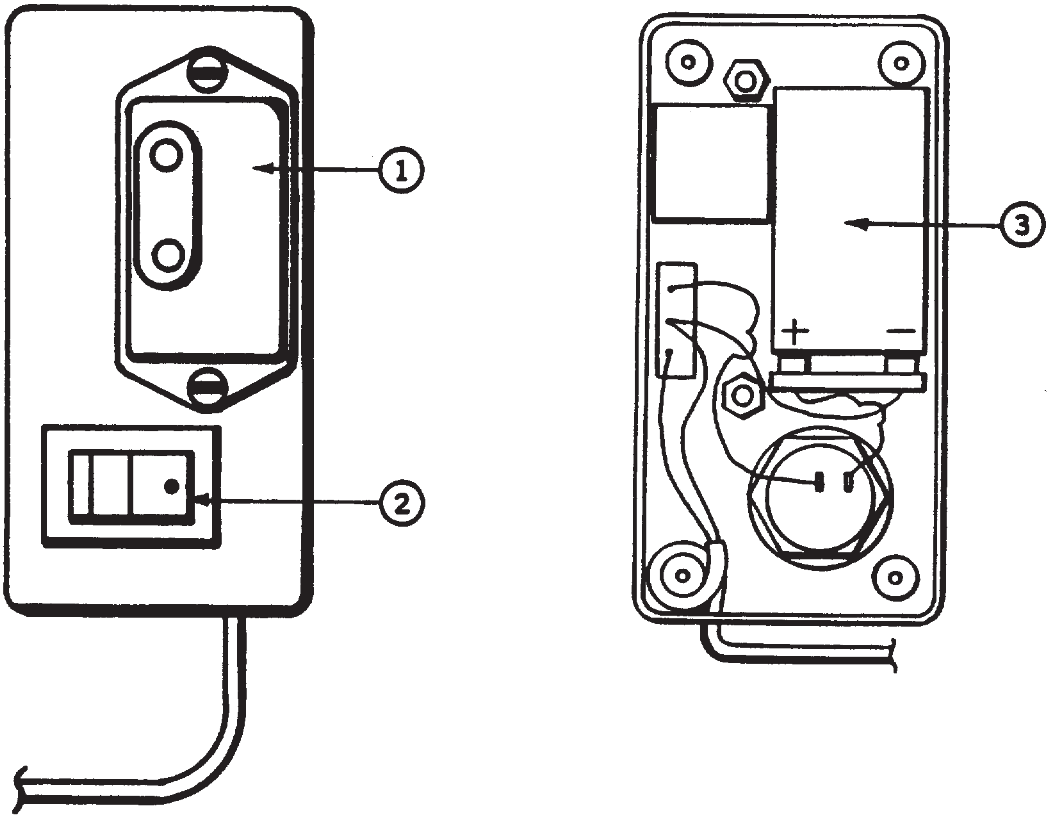
Item	Part Number	Name	Quantity	Description (Remarks)
8	46–294026P1	KF 16 CLAMP	1	KF 16 HOSE CLAMP
9	46–294028P1	BLANK KF FLANGE	1	KF 16 BLANKING FLANGE
10	46–294041P5	OIL FOR VAC PUMP	1	ONE QUART OIL
11	46–294040G1	HOSE FOR PUMP	1	HOSE AND KF 16 ADAPTERS
12	46–294837G50	CASE AND FOAM		
13	46–252557P2	90 ELBOW		
* 14	46–XXXXXXX	CAP FOR EXHAUST		

*Parts in development

3–16 VACUUM MAINTENANCE EQUIPMENT

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–252210P1	VALVE OPERATOR	1	3” PORT VALVE OPERATOR
2	46–265273G1	HELIUM METER	1	HELIUM LEVEL METER
3	46–265387G1	He GAGE ASM	1	HELIUM GUAGE ASSEMBLY
4	46–251867G1	PUMPDOWN KIT	1	MAGNET VAC. PMPDWN KIT
5	46–260201P1	N2 PRECOOL SYPH.	1	N2 PRECOOL SYPHON
6	46–260267P2	SEAL–OFF OPER.	1	1” INSTR. PORT OPERATOR

3–17 TAO MONITOR 46–281406G1

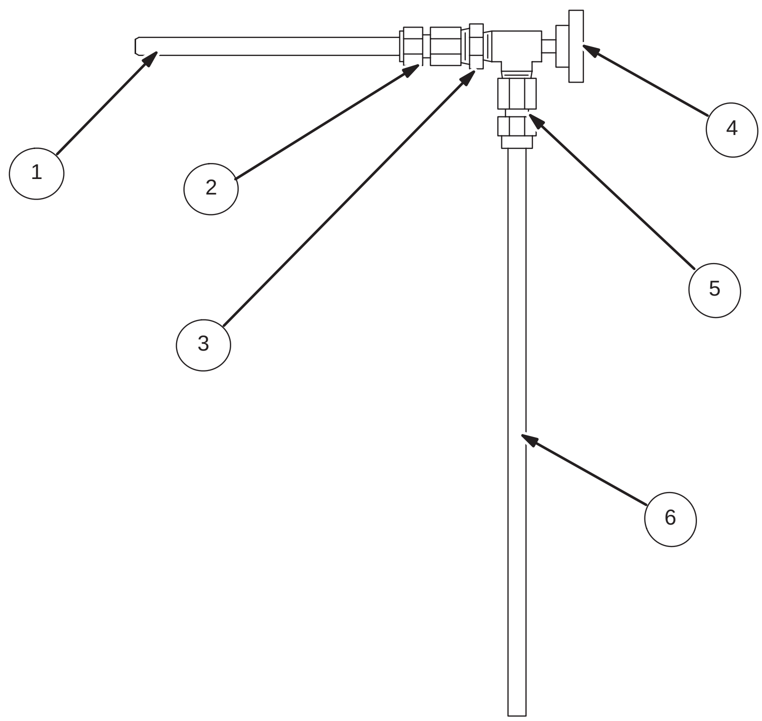


3–17 TAO MONITOR 46–281406G1

	Item	Part Number	Name	Quantity	Description (Remarks)
*	1	46–281406P2	TRANSDUCER	1	TRANSDUCER, LOW PRESSURE DIFFERENTIAL TYPE, RANGE 0–27.68 INCHES H20 OMEGA NO. PX162–027D5V
*	2	46–281406P5	SWITCH	1	SWITCH, ROCKER TYPE, SPST, 6 AMP AT 125VAC, RADIO SHACK NO. 275–690
*	3	46–281406P7	BATTERY	1	BATTERY, 9V RECT. RADIO SHACK NO. 23–464 OR EQUAL

* PARTS ARE NOT AVAILABLE AS INDIVIDUAL ITEMS, ONLY AS ASSEMBLED PART.

3–18 FILL LINE ADAPTER FOR TAO MONITORING 46–281232G1

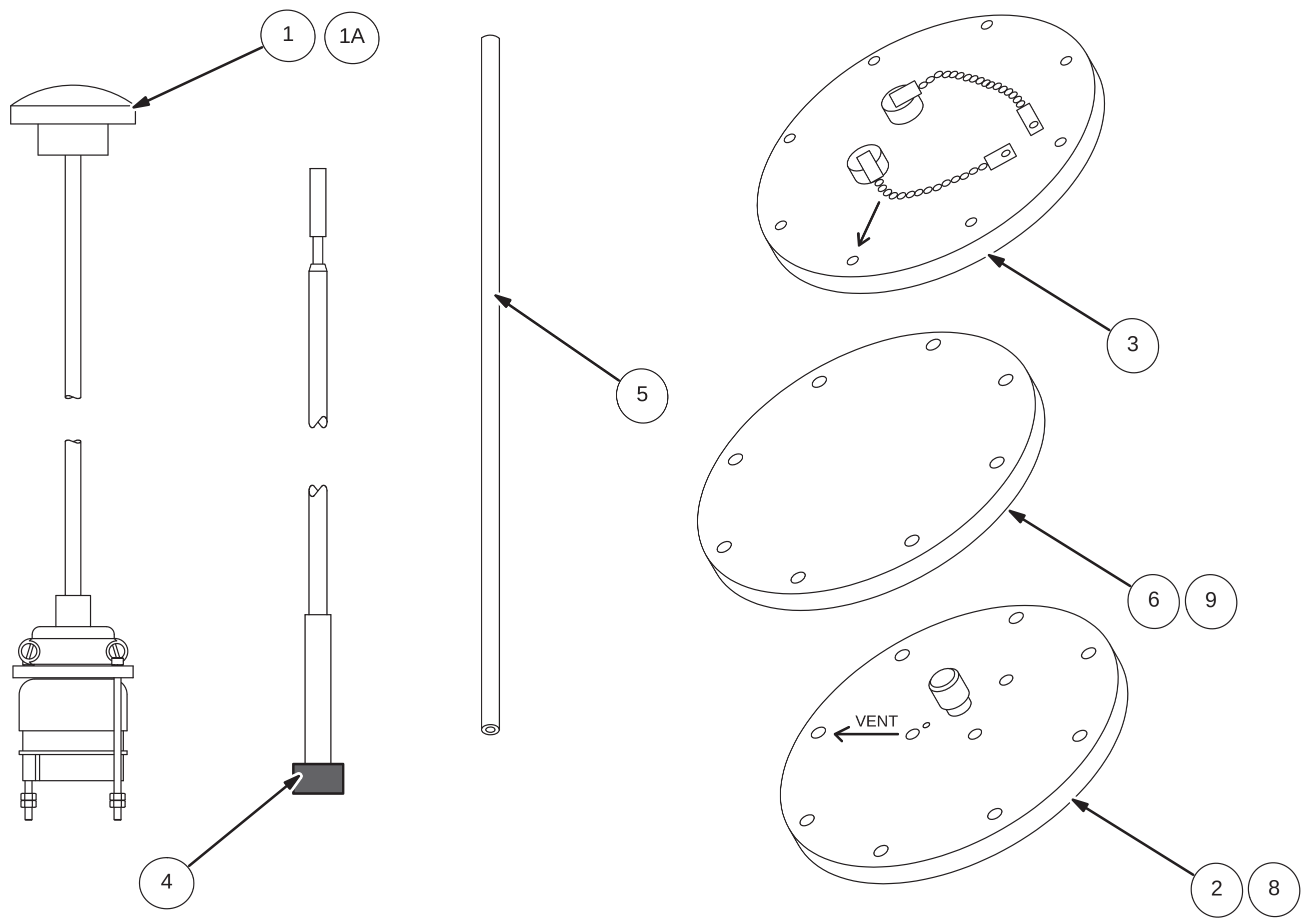


3–18 FILL LINE ADAPTER FOR TAO MONITORING 46–281232G1

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–281232P1	TUBE	1	STN. STL. TUBING .5 OD X .049 WALL THICK
2	46–260912P1	CONNECTOR	1	1/2 OD X 1.5 NPT BRASS FEMALE CONNECTOR
3	46–252204P3	BUSHING	1	2” – 1” NPT BRASS REDUCTION BUSHING
4	46–281109P1	VALVE	1	ANGLE – FILL LINE DAMPENER VALVE
5	46–281169P1	CONNECTOR	1	.25 ODT X .25 NPT BRASS FEMALE CONNECTOR
6	46–252065P45	TUBING	1	TUBING POLYETHYLENE, 1/4 OD X .040 WALL, IMPERIAL CAT. # 44–P NATURAL

** AVAILABLE AS AN ASSEMBLY ONLY

3–19 SAV–CON AND INSTRUMENTATION LEAD INSTALLATION / REMOVAL KIT 46–294872G2

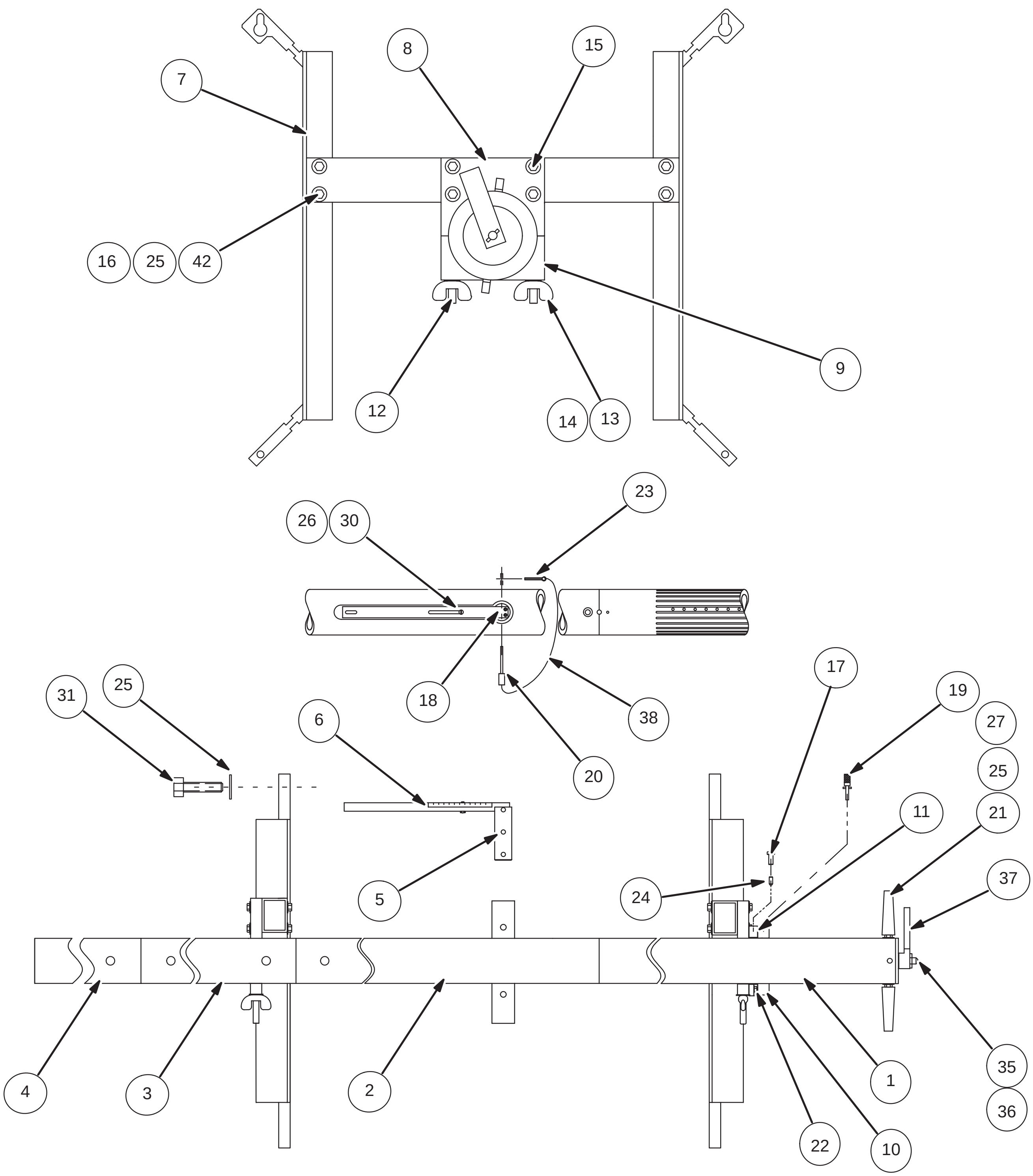


3–19 SAV–CON AND INSTRUMENTATION LEAD INSTALLATION / REMOVAL KIT 46–294872G2

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–294310G1	SAV CON TOOL	1	SAV CON INSTALLATION/REMOVAL TOOL
1A	46–294310G2	SAV CON TOOL	1	SAV CON INSTALLATION/REMOVAL TOOL
2	46–294306G1	LEXAN PLATE	1	CLEAR PLATE TO GUIDE TOOLS (SIV)
3	46–294765G1	LEXAN PLATE	1	PLATE FOR PURGING VERT. PEN. WITH HE GAS (SIV)
4	46–294292G1	EXTENDED ALLEN	1	TOOL TO REMOVE ALLEN HEAD SCREWS IN SAV CON
5	46–281934P1	TAPPED G–10 ROD	1	INSTR. LEAD REMOVAL TOOL
6	46–318561P1	TURRET COVER	1	VERT. PENETRATION COVER–SIV
7	46–318612G50	CASE/FOAM	1	CASE AND FOAM ASSEMBLY
8	46–318241G1	LEXAN PLATE	1	PLATE TO GUIDE TOOLS *
9	46–260963P2	LEXAN PLATE	1	LEXAN TURRET COVER *

* MAX AND SIGNA III ONLY

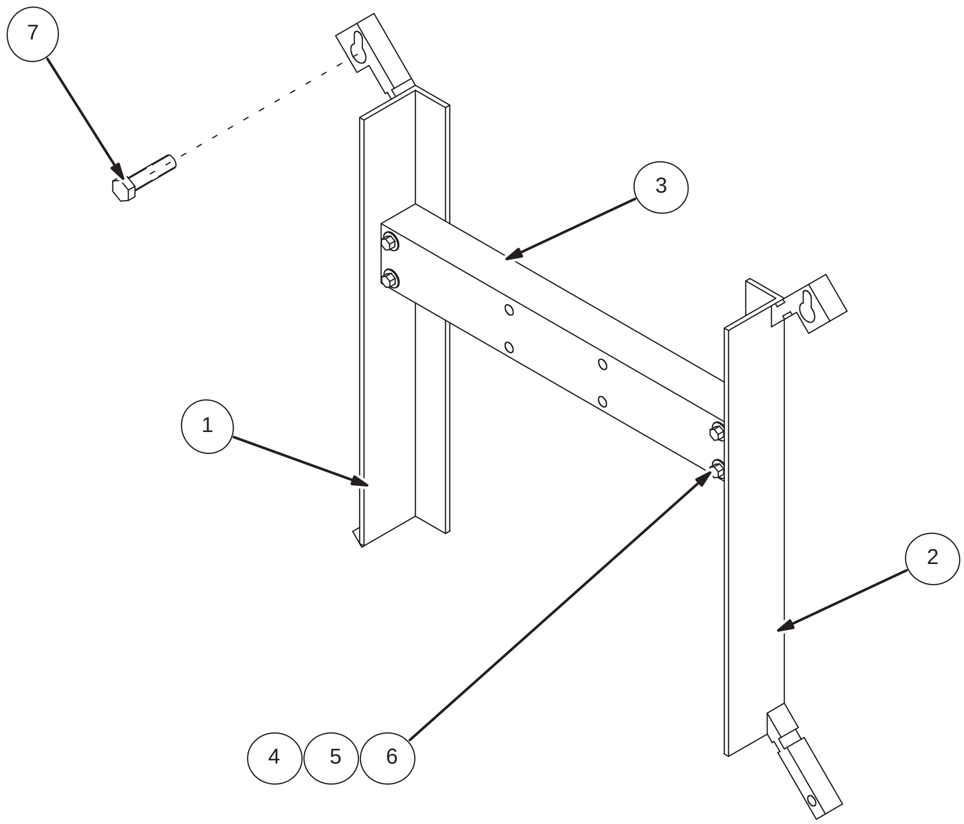
3–20 SERVICE TOOL MAPPING FIXTURE 46–294060G3



3–20 SERVICE TOOL MAPPING FIXTURE 46–294060G3

Item	Part Number	Name	Quantity	Description (Remarks)
1	2142701	TUBE SUPPORT	1	FRONT TUBE SUPPORT
2	46–294055G1	TUBE SUPPORT	1	MAGNETOMETER SUPPORT
3	46–294062G1	TUBE SUPPORT	1	REAR TUBE SUPPORT
4	46–294063G1	TUBE SUPPORT	1	REAR TUBE EXTENSION
5	2142703	RADIAL SLIDER	1	RADIAL SLIDER
6	46–281418P1	MAGT. SUPPORT	1	MAGNETOMETER SUPPORT
7	46–294553G2	H–FRAME ASSM.	2	H–FRAME ASSEMBLY
8	46–281408P1	BEARING	2	TOP HALF BEARING
9	46–281437P1	BEARING	2	BOTTOM HALF BEARING
10	2142702	AXIAL POS. RING	1	AXIAL POSITIONING RING
11	46–281330P1	PLUNGER RING	1	PLUNGER RING
12	46–252188P7	BRASS ROD	4	BRASS THREADED ROD
13	46–281435P7	WING NUT	5	.5–13 WING NUT
14	46–252322P10	BRASS WASHER	5	BRASS WASHER
15	46–281046P71	CAP SCREW	10	3/8–16 X3.5 BOLT
16	46–252320P19	BRASS NUT	12	3/8–16 BRASS NUT
17	46–281046P31	CAP SCREW	1	3/8–16 X .74 BRASS SCREW
18	46–252338P9	#6 SCREW	3	6–32 X .812 LONG FLAT HEAD
19	46–294058G1	PIN	2	PIN
20	46–281334P2	RADIAL PIN	1	RADIAL POSITIONING PIN
21	46–294167P1	HANDLE	2	TUBE HANDLE
22	46–281046P36	CAP SCREW	6	3/8–16 CAP SCREW
23	46–260422P3	COTTER PIN	1	.078 DIA COTTER PIN
24	46–252065P57	BALL PLUNGER	1	STN ST BALL PLUNGER
25	46–252322P8	WASHER	30	WASHERS
26	46–252320P13	BRASS NUT	1	10–24 BRASS HEX NUT
27	46–252188P6	THREADED RODS	2	3/8–16 X 2 IN THREADED ROD
28	46–281464P1	CENTER LABEL	1	CENTER LINE LABEL
29	46–281465P1	SCALE LABEL	1	SCALE LABEL
30	46–252352P24	SCREW	1	10–24 X 2IN SCREW
31	46–281046P37	BRASS SCREW	10	3/8–16 X 1.50 BRASS SCREW
32	46–294019P1	BAR	2	TORQUING BARS
33	46–252065P65	NOALOX	1	8 OZ. BOTTLE NOALOX
34	46–294059P1	SPACER RINGS	5	.010 THICK NYLON RINGS
35	46–294057P1	THREADED ROD	1	.75 BRASS THREADED ROD
36	46–252322P12	BRASS WASHER	1	.750 BRASS WASHER
37	46–294072P1	BARNUT	1	.75–10 BARNUT
38	46–294167P2	STRETCH CORD	1	.042 DIA STRETCH CORD
39	46–294048G1	CRATE	1	CRATE
40	46–294059P2	SPACER	8	NYLON SPACER SHIM
41	46–294168P1	ASSEMBLY INST.	1	ASSEMBLY INSTRUCTIONS
42	46–281046P70	BRASS SCREW	2	3/8 X 2.75IN BRASS SCREW
43	46–252320P19	BRASS NUT	2	3/8–16 BRASS NUT
44	46–252322P8	WASHER	2	WASHER

3–21 MAPPING FIXTURE H–FRAME 46–294553G2



3–21 MAPPING FIXTURE H–FRAME 46–294553G2

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–294553P1	H–FRAME	1	LEFT MOUNTING BAR
2	46–294553P2	H–FRAME	1	RIGHT MOUNTING BAR
3	46–294553P3	H–FRAME	1	CROSS BAR
4	46–281046P70	BRASS SCREW	4	CROSS BAR SCREW 375 X 2.75 LG BRASS
5	46–252320P19	BRASS NUT	4	.375–16 BRASS NUT
6	46–252322P8	WASHER	8	WASHER
7	46–281046P37	BRASS SCREW	4	3/8–16 X 1.5LG BRASS SCREW

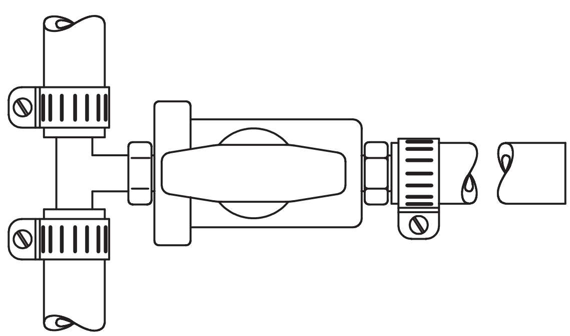
3–22 SPECIALTY TOOLS FOR SPECIFIC MAGNET TYPES

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–281847G1	3” VALVE OPERATOR	1	ADD 0N SHIELD EXTENDED 3” VALVE OPERATOR
2	46–281050P4	COLD HEAD TOOL	1	SECOND STAGE ASSEMBLY TOOL FOR WELDED IN COLD HEAD
3	46–281967G1	CENTERING KIT	1	ADD ON SHIELD CENTERING KIT
4	46–281935P1	LEXAN PLATE	1	LEXAN COVER FOR INSTRUMENTATION LEAD FOR COMPACT MAGNET
5	46–281936G1	LEXAN PLATE	1	LEXAN COVER FOR VERTICAL STACK OF COMPACT MAGNET
6	46–260705G1	SAV CON TOOLS	1	SAV CON TOOLS FOR SI MAGNET
7	46–260705G1	LEXAN PLATE	1	LEXAN COVER FOR P3 PLUG
8	46–252065P29	THREADED RODS	3	THREADED RODS FOR P3 PLUG REMOVAL
9	46–281432G1	TAO DAMPER KIT	1	TAO DAMPER KIT FOR SI MAGNET
10	46–294052G1	WATER FLOW KIT	1	WATER FLOW METER KIT

3–23 MAGNET CENTERING / VERIFICATION KIT 46–281967G1

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–281962P1	SCALE	1	12” STAINLESS STEEL STARRET CAT. NO. 1604R–12
2	46–281965P1	RATCHET	1	1/2” DRIVE RATCHET MCMASTER CARR NO. 5523A23
3	46–281964P1	EXTENSION	1	5 1/2” EXTENSION MCMASTER CARR NO. 5523A28
4	46–281966P1	SOCKET	1	1 1/8” SOCKET MCMASTER CARR NO. 5545A65
5	46–281966P2	SOCKET	1	1 1/2” SOCKET MCMASTER CARR NO. 5545A94
6	46–294182G1	CASE	1	TOOL CASE WITH LABEL

3–24 WATER TEE ASSEMBLY 46–318696G1

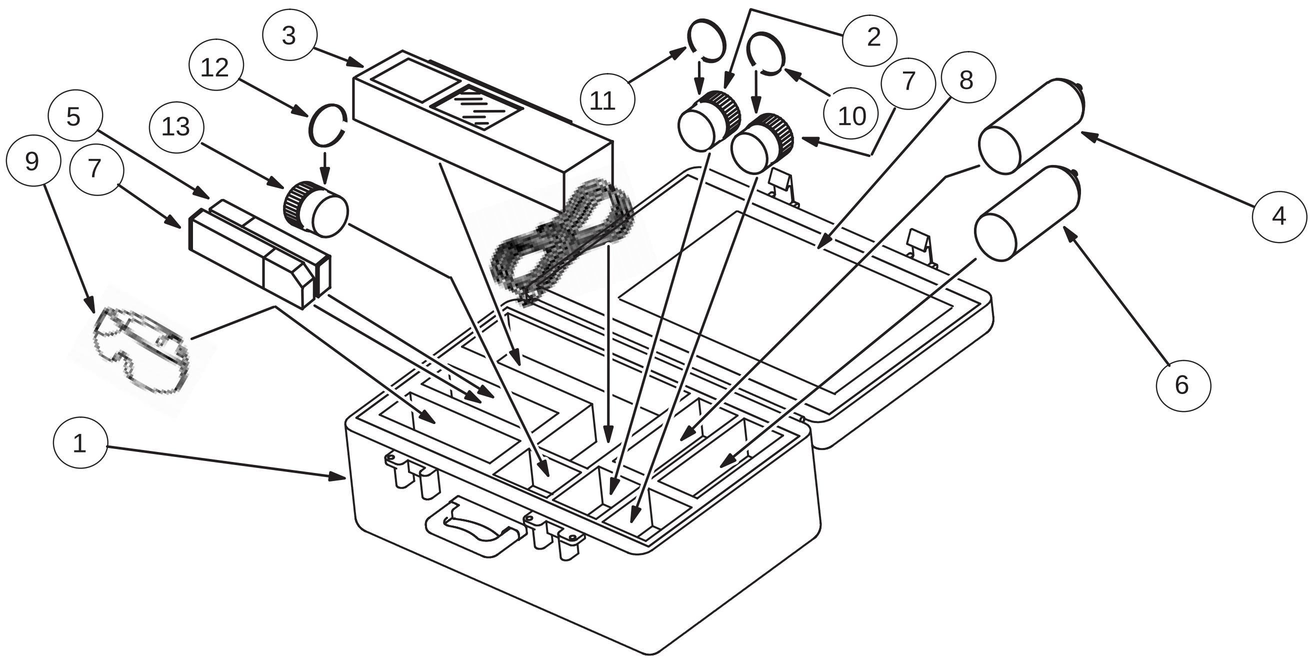


Item	Part Number	Name	Quantity	Description (Remarks)
1	46–318696G1	WATER TEE	1	WATER TEE ASSEMBLY

3–25 REGION SHIM KIT 2181921

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–318830P1	CASE	1	CASE FOR KIT ASSEMBLY
2	46–294126P201	SHIM	75	.200” WIDE X .001” THICK, CARBON STEEL
3.	46–294126P401	SHIM	75	.400” WIDE X .001” THICK, CARBON STEEL
4	46–294126P901	SHIM	75	1.00” WIDE X .001” THICK, CARBON STEEL
5	46–294126P903	SHIM	75	1.00” WIDE X .003” THICK, CARBON STEEL
6	46–294126P910	SHIM	50	1.00” WIDE X .010” THICK, CARBON STEEL
7	46–294128P2	SHIM COVER	25	1.00” WIDE X .062” THICK, ALUMINUM
8	46–294125P3	FASTENER	100	#6–32UNC BROACHING TYPE X .44” LONG
9	46–252320P9	HEX NUT	100	#6–32UNC, BRASS
10	46–294410P1	SET SCREW	12	.25–20UNC CONE POINT

3–26 SHIELD COOLER TEST KIT 46–318784G2



Item	Part Number	Name	Quantity	Description (Remarks)
1.	2100644	CASE ASSEMBLY	1	KIT CASE ASSEMBLY
2.	2100660	CONTAINER	1	SPECIMEN CONTAINER
3.	2100976	UV LIGHT	1	UV LIGHT & LABEL
4.	2100661	SOLUTION	1	FOR SOLIDS
5.	46–318649P1	TESTER	1	DISSOLVED SOLIDS
6.	2100662	SOLUTION	1	FOR PH
7.	46–318648P1	METER	1	PH METER
8.	2101994APR	INSTRUCTIONS	1	KIT OPERATING
9.	46–318649P1	GOGGLES	1	UV LIGHT SAFETY
10.	2101986	LABEL	1	SAMPLE, ADHESIVE BACKING
11.	2101987	LABEL	1	SOLIDS, ADHESIVE BACKING
12.	2101988	LABEL	1	PH, ADHESIVE BACKING
13.	2100660	SAMPLE	1	EMPTY – FOR SAMPLES

4–27 MAGNET TOOL MATRIX

SERVICE TOOLS	SIII	SIV SX	MR MAX 0.5T	VECTRA	VMX	MRT
MAGNET RAMPING EQUIPMENT KIT 46–260703G3	X	X	X	X	X	
MAIN POWER SUPPLY 46–260776G3	X	X	X	X	X	
SHIM POWER SUPPLY 46–260777G3	X	X	X			
RAMPING SUPPLY AND EQUIPMENT 46–294998G1	X	X	X	X	X	
UNIVERSAL FILL LINE KIT 46–294705G1	X	X	X	X	X	
250 LTR DEWAR STINGER 46–294511P1	X	X	X	X	X	
500 LTR DEWAR STINGER 46–294511P2	X	X	X	X	X	
DEWAR LEVEL TOOL KIT 46–306812G1	X	X	X	X	X	
12 FT He TRANSFER LINE 46–294512P1	X	X	X	X	X	
8 FT He TRANSFER LINE 46–294512P2	X	X	X	X	X	
10 FT NITROGEN TRANSFER LINE 46–252805P2	X	X	X	X	X	
15 FT NITROGEN TRANSFER LINE 46–252805P3	X	X	X	X	X	
SAFETY KIT 46–271137G1	X	X	X	X	X	
He RESISTANCE BOX 46–265286G1	X	X	X	X	X	
HIGH PRESSURE REGULATOR KIT 46–306734G1	X	X	X	X	X	
NONMAGNETIC HELIUM CART 46–258150P1	X	X	X	X	X	
SHIELD COOLER INST. / MAINT. KIT 46–281088G3	X	X	X	X	X	
SHIELD COOLER VACUUM PUMP KIT 46–294047G1	X	X	X	X	X	
LAKESHORE THERMOMETER KIT 46–301477G1	X	X	X	X	X	

4–27 MAGNET TOOL MATRIX (continued)

SERVICE TOOLS	SIII	SIV SX	MR MAX 0.5T	VECTRA	VMX	MRT
LOW COST SHIELD TEMP BOX 46–317543G1	X	X	X	X	X	
3 IN. VALVE OPERATOR 46–252210P1	X	X	X	X	X	
3 IN. VALVE OPERATOR 46–281847G1	MAGNI-SHIELD					
He LEVEL METER 46–265273G1	X	X	X	X	X	
MAIN VACUUM PUMP DOWN KIT 46–251867G1	X	X	X	X	X	
N_2 PRECOOL SYPHON 46–260201P1	X	X	X	X	X	
TAO MONITOR 46–281406G1	X	X	X	X	X	
FILL LINE ADAPTER FOR TAO MONITORING 46–281232G1	X	X	X			
MAPPING FIXTURE 46–281420G2	X		X			
MAPPING FIXTURE 46–294238G1				X	X	
SERVICE MAPPING FIXTURE 46–294060G2	X	X	X			
H–FRAME ADAPTER KIT 46–294842G1 (UPGRADES 46–294060G1 TO G2)	X	X	X			
SAV–CON / INSTRUMENTATION LEAD SERVICE KIT 46–294872G2	X	X	X			
LEXAN / ALUMINUM BELLOWS COVER 2119965					X	
LEXAN COVER VERT STACK 2117683				X	X	
LEXAN COVER VERT. STACK 46–281936G1				X	X	
LEXAN COVER FOR P3 PLUG 46–260192P1						
ENMET OXYGEN MONITOR KIT 2107184	X	X	X	X	X	
CONNECTICUT ANALYTICAL PORTABLE OXYGEN MONITOR – 2106236	X	X	X	X	X	
McNEIL INTERNATIONAL PORTABLE OXYGEN MONITOR – 2106237	X	X	X	X	X	

4–27 MAGNET TOOL MATRIX (continued)

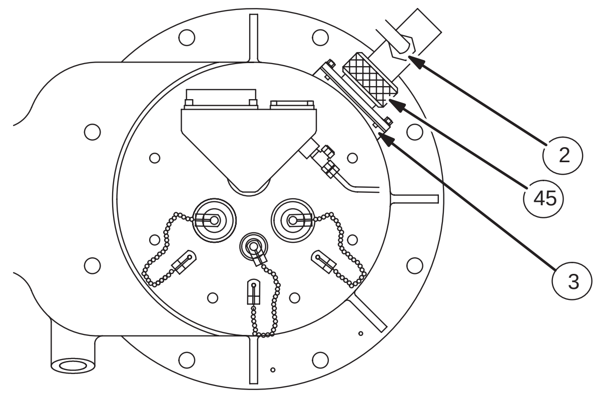
SERVICE TOOLS	SIII	SIV	MR MAX 0.5T	VECTRA	VMX	MRT
LEXAN COVER INSTR. LEAD 46–281935P1				X		
SECOND STAGE ASSEMBLY TOOL 46–281050P4 (FOR WELDED IN COLD HEAD)			X			
MAGNISHIELD CENTERING KIT 46–281967G1	X					
SAV–CON KIT 46–260705G1						
THREADED RODS 46–252065P29						
TAO DAMPER KIT 46–281432G1						
RAMP CABLE HOLDER 46–318314G2	X	X	X	X	X	
RAMP CABLE HOLDER 46–318833G1	X	X	X	X	X	
WATER FLOW METER KIT 46–294052G1	X	X	X	X	X	
MAGNET CENTERING / VERIFICATION KIT 46–281967G1	MAGNI– SHIELD					
WATER TEE ASSEMBLY 46–318696G1	X	X	X	X	X	
SIV REGION SHIM KIT 46–318832G1		X				
SHIELD COOLER TEST KIT 46–318784G2	X	X	X	X	X	
WRENCH KIT (FERROUS) 2103333	X	X	X	X	X	
WRENCH KIT (NON–FERROUS) 46–294804G1	X	X	X	X	X	
BELL GAUSSMETER KIT 46–306801G1	X	X	X	X	X	
1.00” VACUUM CHECK TOOL 46–228192P1	MAGNI- SHIELD					
50 Hz HEAT GUN 46–306830G11	X	X	X	X	X	X
60 Hz HEAT GUN 46–306830G12	X	X	X	X	X	X

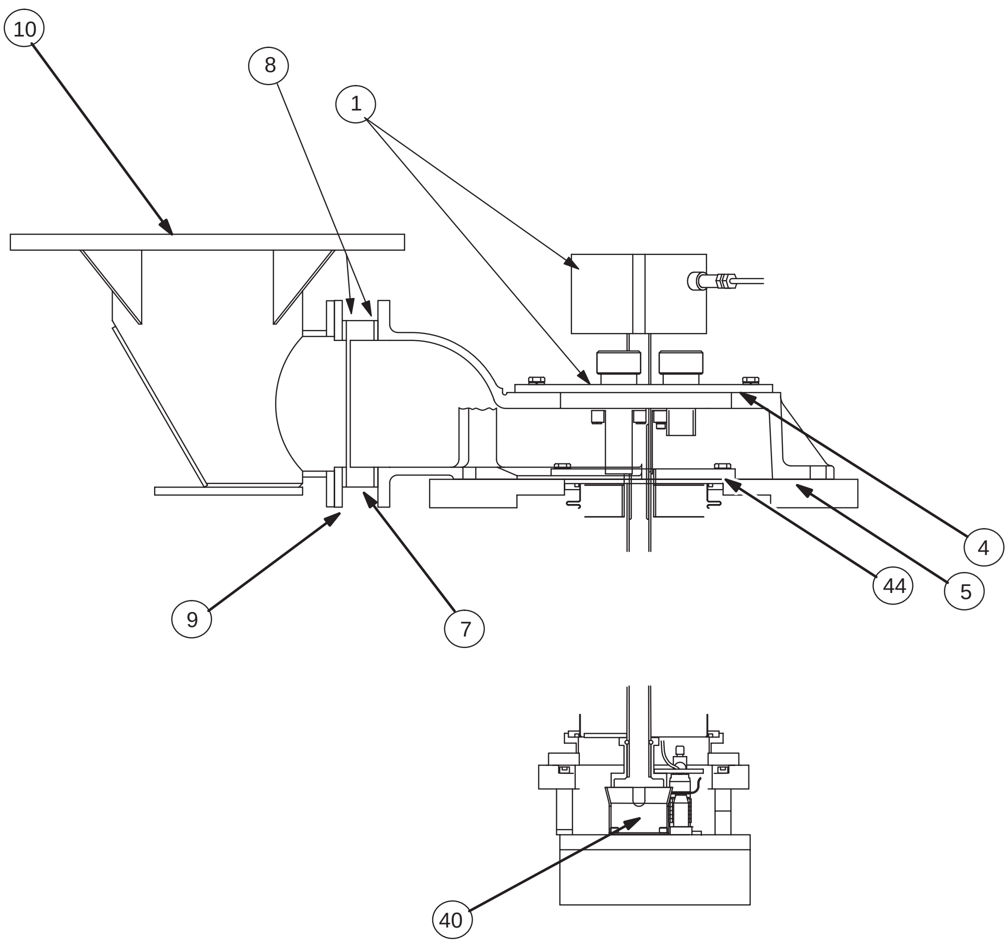
4–27 MAGNET TOOL MATRIX (continued)

SERVICE TOOLS	SIII	SIV SX	MR MAX 0.5T	VECTRA	VMX	MRT
METROLAB TESLAMETER KIT 46–251865G2	X	X	X	X	X	
He DEWAR ADAPTER KIT 46–271136G1	X	X	X	X	X	
He MECHANICAL GAS FLOWMETER 46–306781G1	X	X	X	X	X	
ALUMINUM PLATFORM LADDER 46–307476G1	X	X	X	X	X	
ENMET OXYGEN MONITOR CALIBRATION KIT 46–328021G1	X	X	X	X	X	
LARGE SHIM LEAD CAPS 42102831	X	X	X			
SMALL SHIM LEAD CAPS 2102832		X				
COMPACT REGION SHIM KIT 46–318831G1				X		
TESLAMETER 46–251865G2	X	X	X	X	X	
THERMOCOUPLE ADAPTER AND K PROBE 46–194427P285	X	X	X	X	X	
POWER SUPPLY CALIBRATION 2101360	X	X	X	X	X	
ADAPTER FITTING 2122261						X
HEAT EXCHANGER COUPLING 2115923						X
TEST PLUG – DB25 PIN 2122539						X
TEST PLUG – DB9 PIN 2122540						X
VACUUM ASSEMBLY COMPONENTS 2123165	X	X	X	X	X	X
PORTABLE TEMPERATURE INDICATOR 2125073						X
1.00” VALVE OPERATOR 2135559	X	X	X	X	X	X
MAPPING FIXTURE 2115039						X
HEAT EXCHANGER COVER PLATE 2132223						X

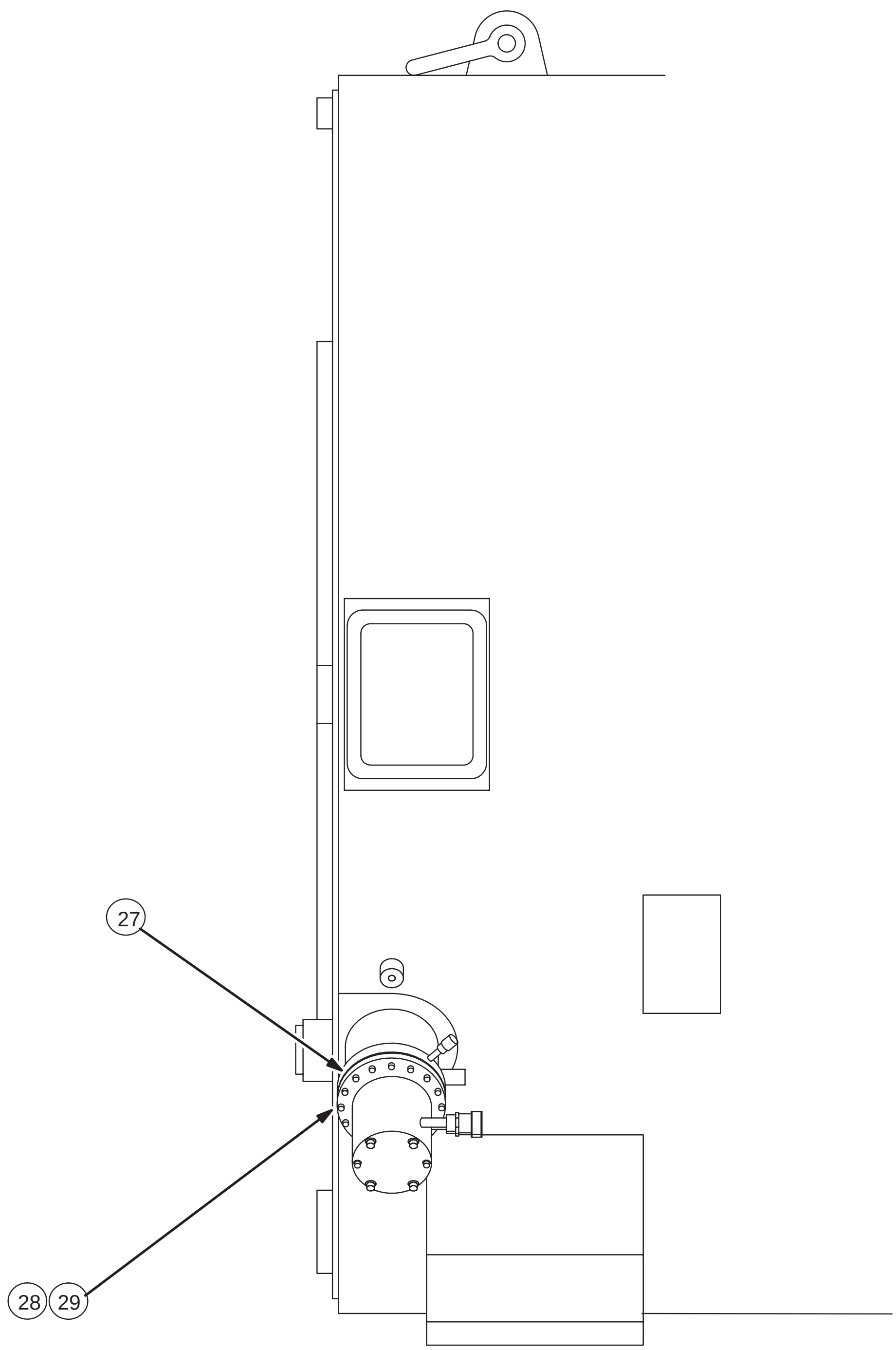
SECTION 4 – MAGNET COMPONENTS

4–1 MAGNET COMPONENTS

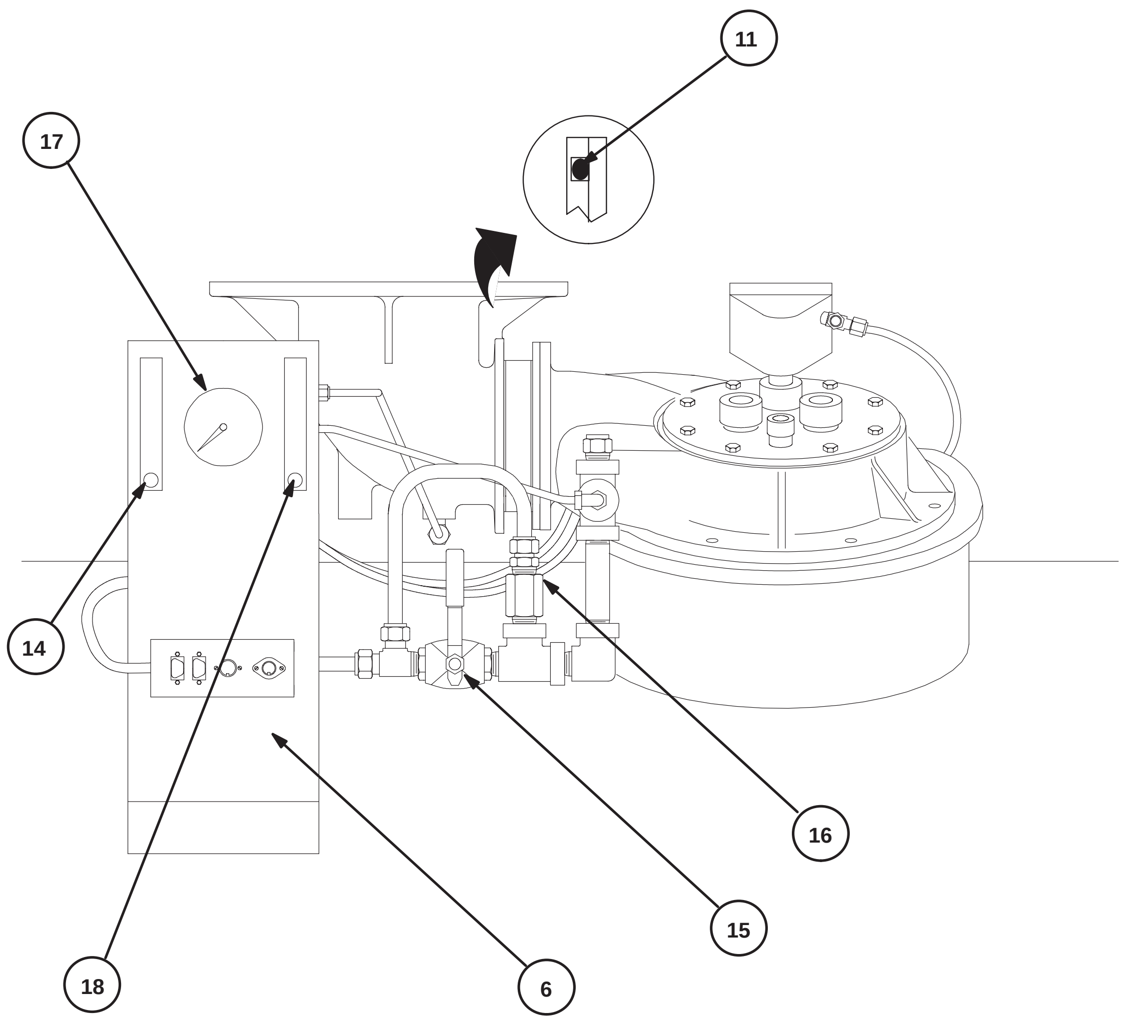




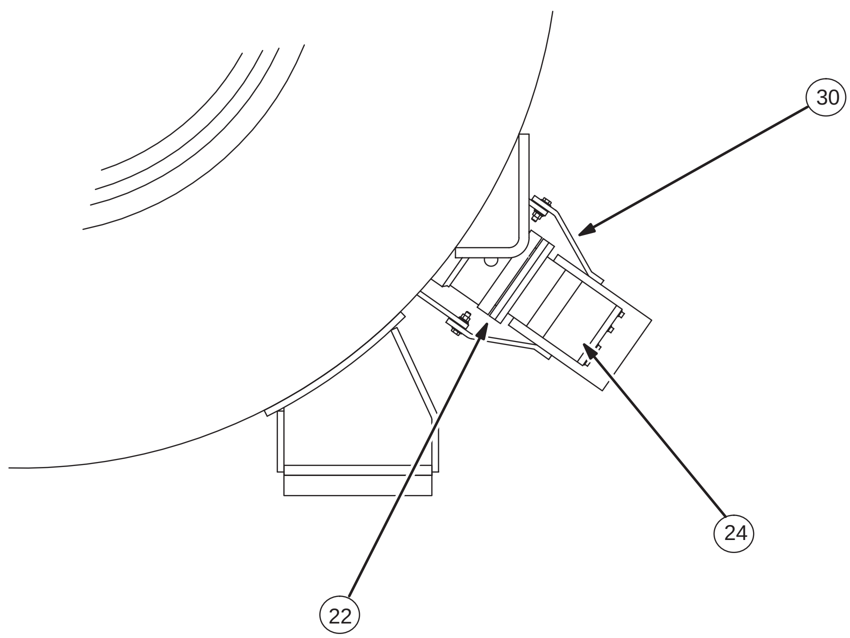
4–1 MAGNET COMPONENTS (continued)

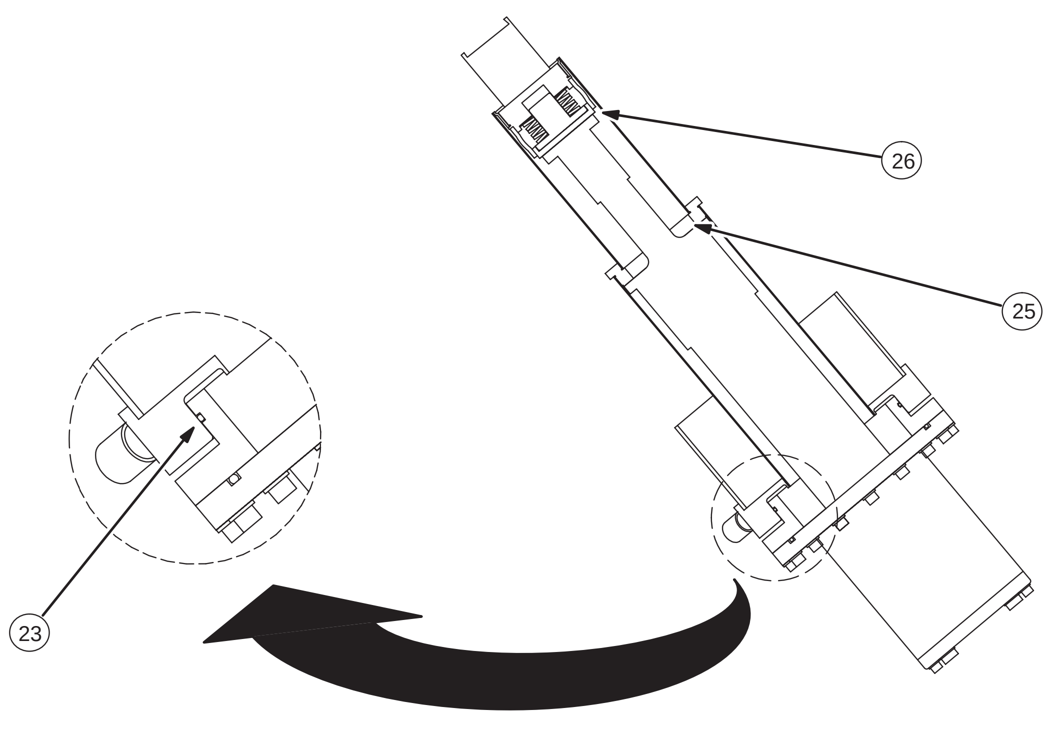


4–1 MAGNET COMPONENTS (continued)

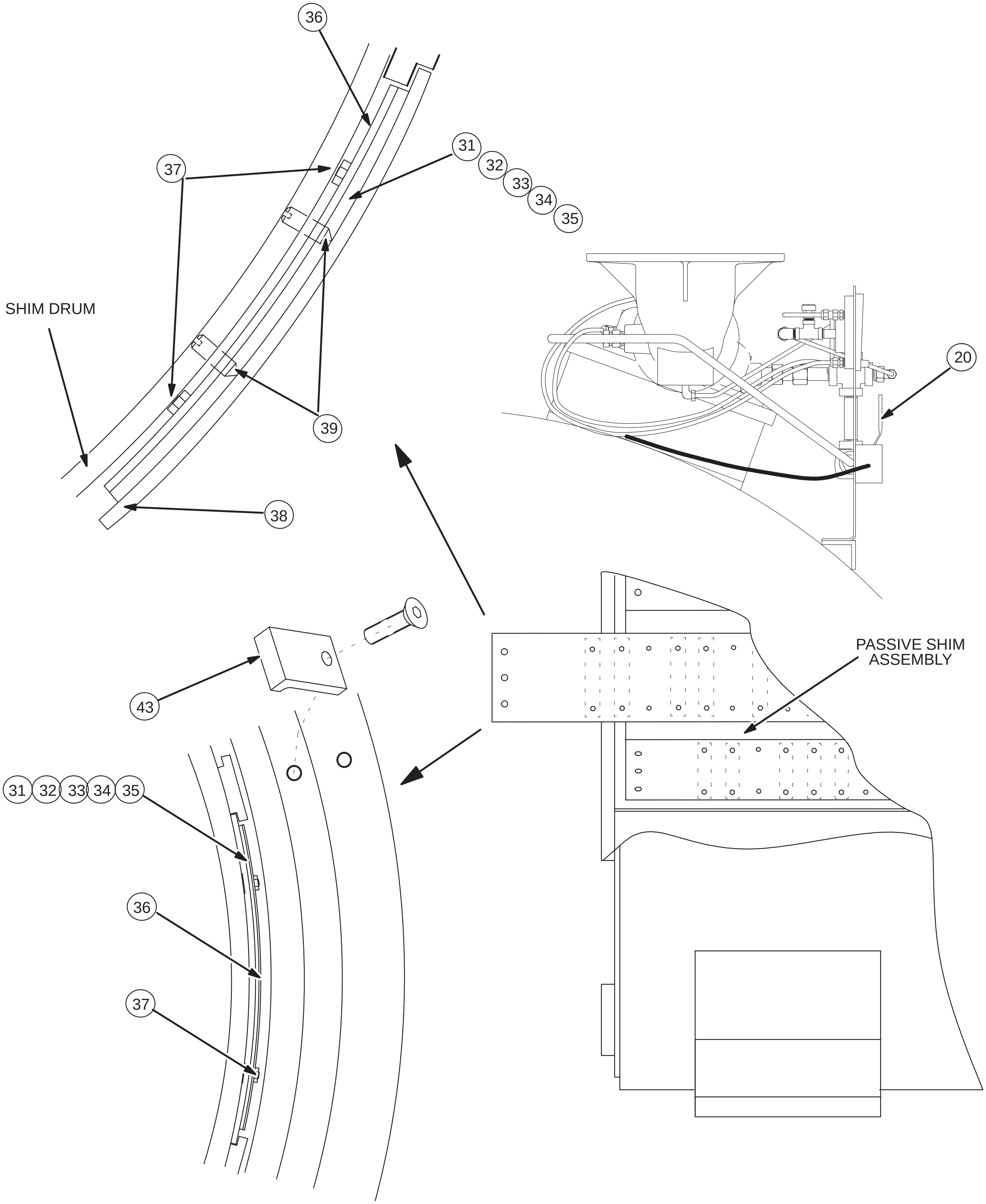


4–1 MAGNET COMPONENTS (continued)





2–1 MAGNET COMPONENTS (continued)



4–1 MAGNET COMPONENTS (continued)

MAGNET COMP. 2131604 SV 1.5T MAGNET COMPONENTS

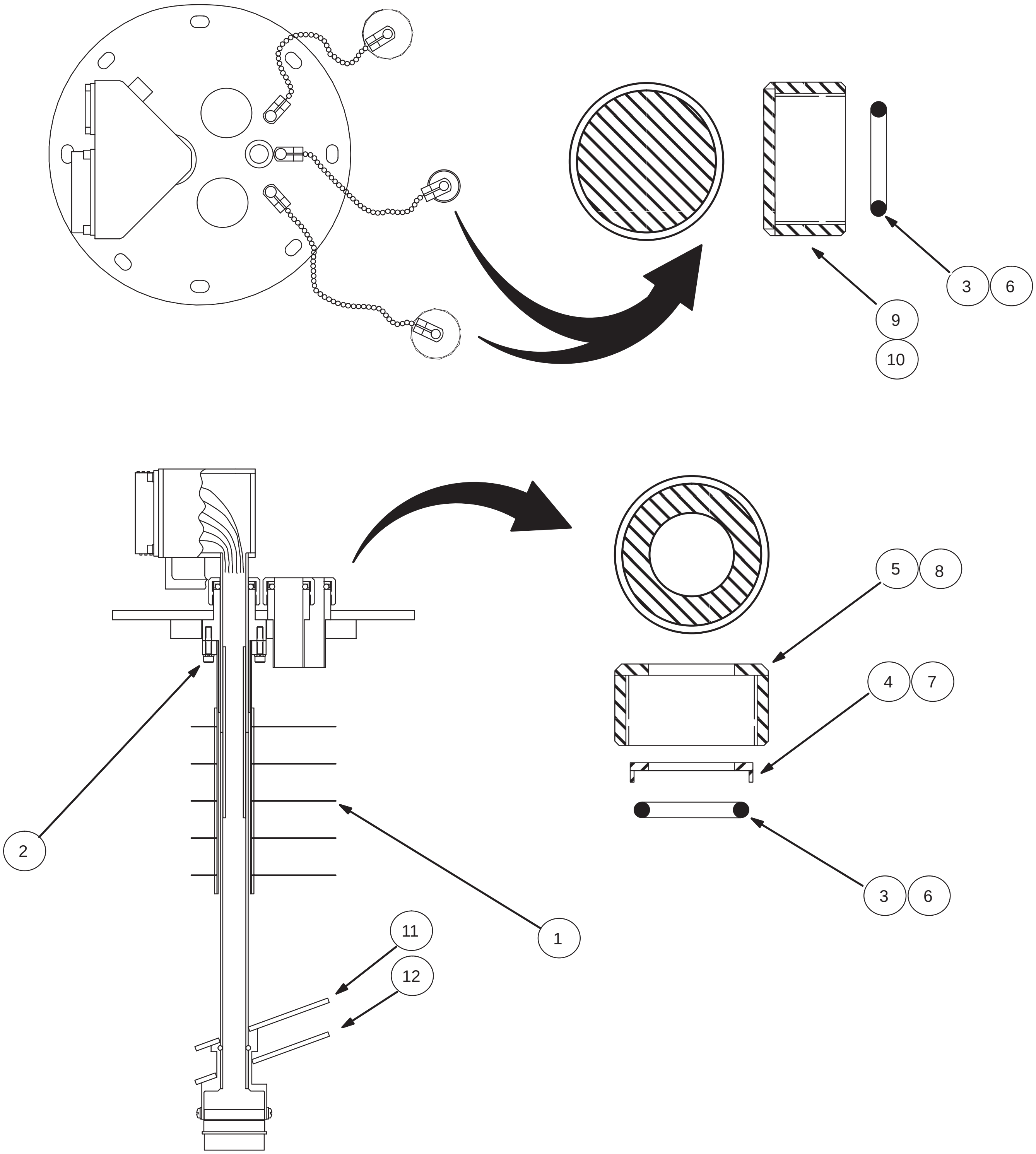
Item	Part Number	FRU	Name	Quantity	Description (Remarks)
1	2133617	1	SHIM LEAD	1	SHIM LEAD AND TOP PLATE ASSEMBLY
2	2136078	1	LEAD ASSY.	1	INSTRUMENTATION AND ELECTRICAL LEAD ASSEMBLY
3	46–281101P9	1	O–RING	1	TEFLON O–RING, 1.487” I.D. X .103” THK.
4	46–281101P5	1	O–RING	1	TEFLON O–RING, 5.737” I.D. X .103” THK.
5	46–281101P6	1	O–RING	1	TEFLON O–RING, 9.487” I.D. X .103” THK.
6	2134437	2	ENCLOSURE	1	INSTRUMENT AND MAGNET WIRING ASSEMBLY
7	46–252838P6	1	BURST DISC	1	20 PSIG 4 INCH BURST DISC (USED WITH CAST PLENUM)
8	46–252839P2	1	GASKET	2	NEOPRENE GASKET, 4.25” I.D. X5.25” O.D.
9	46–260420P2	N	FLANGE DISC	1	USED WITH BURST DISC
10	46–318712G1	N	VENT ADP. ASSY.	1	VENT ADAPTER ASSEMBLY 4 INCH
11	46–281101P8	2	O–RING	1	TEFLON O–RING, 4.739” I.D. X .070” THK.
14	46–294352P2	2	FLOWMETER	1	FOR SHIM LEAD, 0.5 – 5.0 SCFH AIR
15	46–252223P1	2	BALL VALVE	1	.50” NPT CRYOGENIC BALL VALVE
16	46–252405P1	2	RELIEF VALVE	1	.50” NPT BRASS, 5 PSIG RELIEF VALVE
17	46–281282P1	2	GAUGE	1	.25” NPT DUAL SCALE, 0 – 5 PSI / KPA
18	46–294352P3	2	FLOWMETER	2	FOR INSTRUMENTATION LEAD, 0.20 – 2.00 SCFH AIR
20	46–260829P2	2	RELIEF VALVE	1	.25” NPT, 5 PSIG RELIEF VALVE
22	46–260938P1	2	FLANGE	1	COLD HEAD TRANSITION FLANGE
23	46–281247P1	1	O–RING	1	BUNA O–RING, 4.987” I.D. X .103” THK.
24	2100832	1	COLD HEAD	1	LEYBOLD SHIELD COOLER COLD HEAD ASSEMBLY
25	46–281241P1	1	GASKET	1	3.37” O.D. INDIUM GASKET
26	46–281241P2	1	GASKET	1	1.75” O.D. INDIUM GASKET
27	46–252610P4	2	CAP SCREW	8	STN. STL. SOC. HD., .25–20UNC X .75” LG.
28	46–252361P11	2	BOLT	8	STN. STL. HEX HD., .25–20UNC X 1.75” LG.
29	46–281387P1	1	WASHER	48	.25” NOM. STN. STL. BELLEVILLE WASHER
30	46–318789G1	2	GUARD	1	LEYBOLD COLD HEAD MOTOR GUARD
31	46–294126P201	1	SHIM	200	CARBON STEEL, .200” WIDE X .001” THICK
32	46–294126P401	1	SHIM	200	CARBON STEEL, .400” WIDE X .001” THICK

4–1 MAGNET COMPONENTS (continued)

MAGNET COMP. 2131604 **SV 1.5T MAGNET COMPONENTS**

Item	Part Number	FRU	Name	Quantity	Description (Remarks)
33	46–294126P901	1	SHIM	300	CARBON STEEL, 1.00” WIDE X .001” THICK
34	46–294126P903	1	SHIM	200	CARBON STEEL, 1.00” WIDE X .003” THICK
35	46–294126P910	1	SHIM	120	CARBON STEEL, 1.00” WIDE X .010” THICK
36	46–294128P2	1	SHIM COVER	200	ALUMINUM, 1.00” WIDE X .062” THICK
37	46–294125P3	1	FASTENER	300	PHOS. BRNZ., #6–32UNC BROACHING TYPE X .44” LG.
38	2106085	2	DRAWER	12	FIBER RE–INFORCED PLASTIC SHIM DRAWER
39	46–294123P2	2	SET SCREW	48	.50–13UNC BRASS SET SCREW X .625” LONG
40	46–318060P1	1	CONNECTOR	1	SAV–CON CONNECTOR
43	2139593	2	STOP	24	SHIM DRUM / DRAWER STOP
44	46–281101P10	1	O–RING	1	TEFLON O–RING, 6.237” I.D. X .103” THK.
45	2142318	2	COUPLING	1	INSTRUMENTATION LEAD ASSEMBLY COUPLING

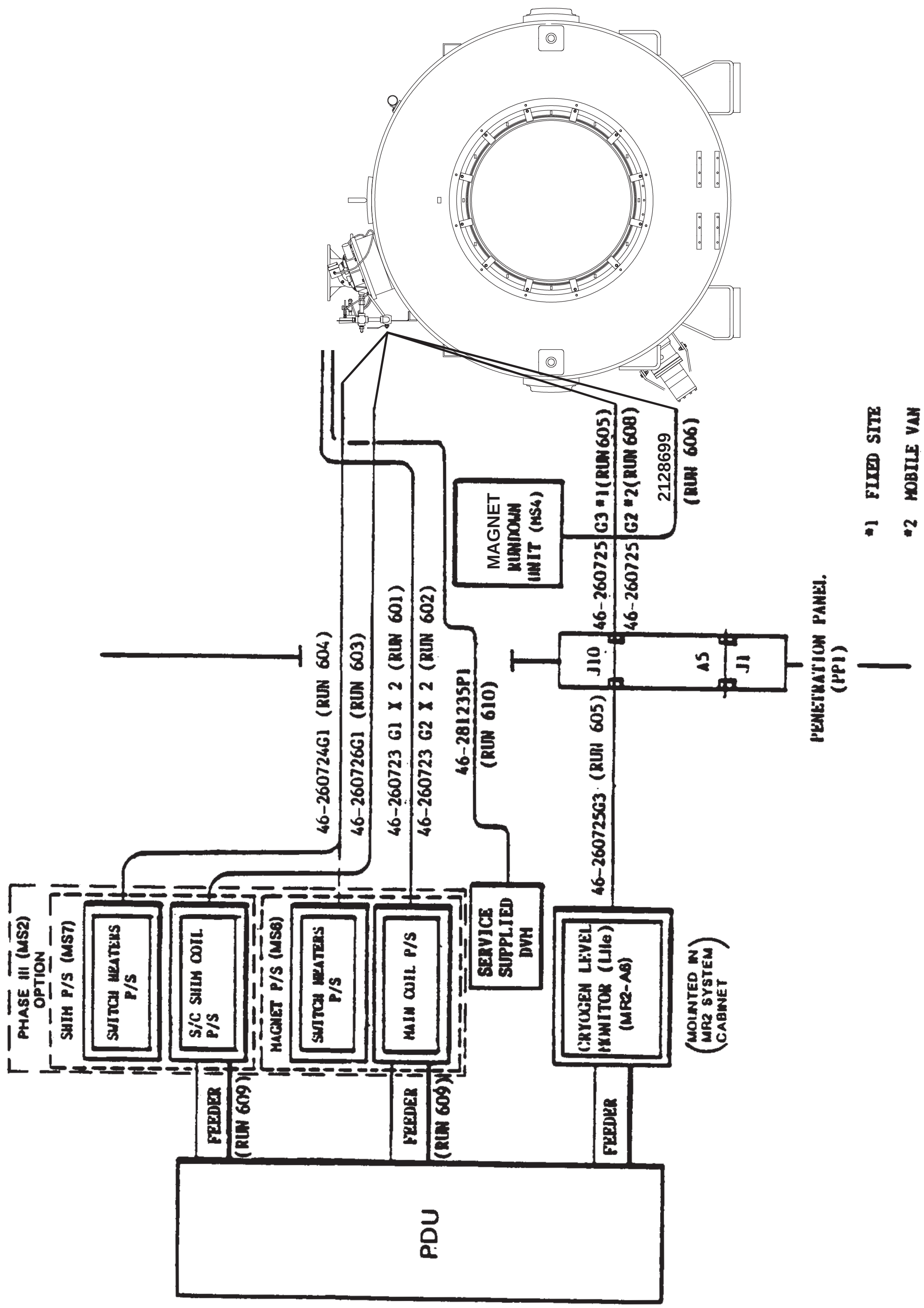
4–2 SHIM LEAD COMP. 2133617 SHIM LEAD AND TOP PLATE ASSEMBLY



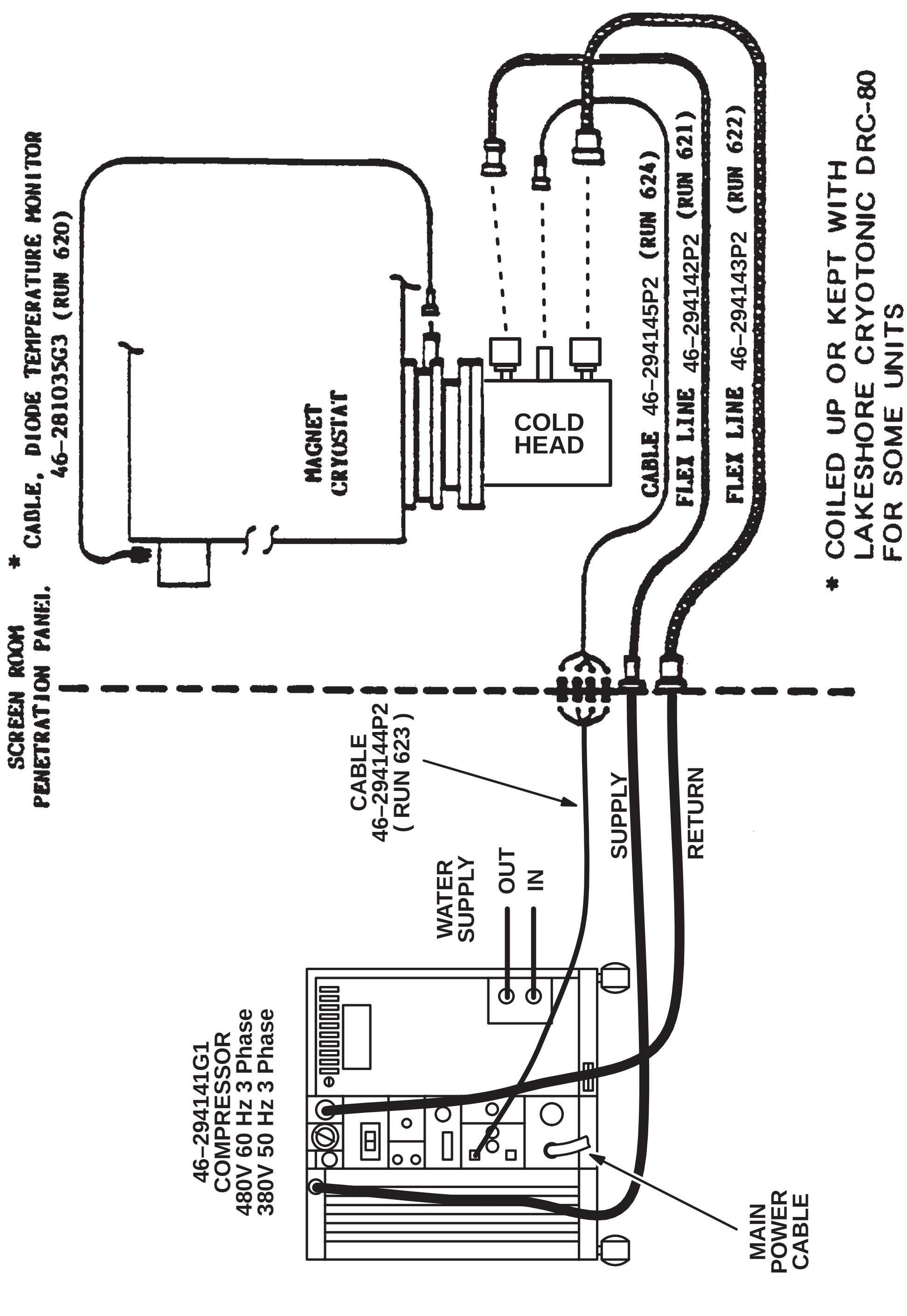
4–2 SHIM LEAD COMPONENTS (continued)

4–2 SHIM LEAD COMP. 2133617 SHIM LEAD AND TOP PLATE ASSEMBLY

Item	Part Number	FRU	Name	Quantity	Description (Remarks)
1	2133618	1	BAFFLE ASSY.	1	REMOVABLE BAFFLE ASSEMBLY
2	46–252546P6	2	SCREW	3	BRASS, SOC. HD., #8–32UNC X .62” LG.
3	46–260389P3	1	O–RING	4	BUNA–N O–RING, .736” I.D. X .103” THK.
4	46–294105P1	2	RING	3	BRASS RETAINING RING X 1.109” O.D.
5	46–294104P1	2	NUT	3	KNURLED BRASS 1.187–20UNC COUPLING NUT
6	46–260342P9	1	O–RING	2	BUNA–N O–RING, .489” I.D. X .625” O.D.
7	46–260272P1	2	RING	1	STN. STL. RETAINING RING X .687” O.D.
8	46–318619P1	2	NUT	1	KNURLED BRASS .75–20UNEF COUPLING NUT (EXTENDED)
9	46–294769P33	2	CAP	2	BRASS .75” TUBE CAP
10	46–318618P1	2	CAP	1	BRASS .50” TUBE CAP (EXTENDED)
11	2133937	2	BAFFLE	1	TOP, SLANTED BAFFLE
12	2134793	2	BAFFLE	1	BOTTOM, SLANTED BAFFLE

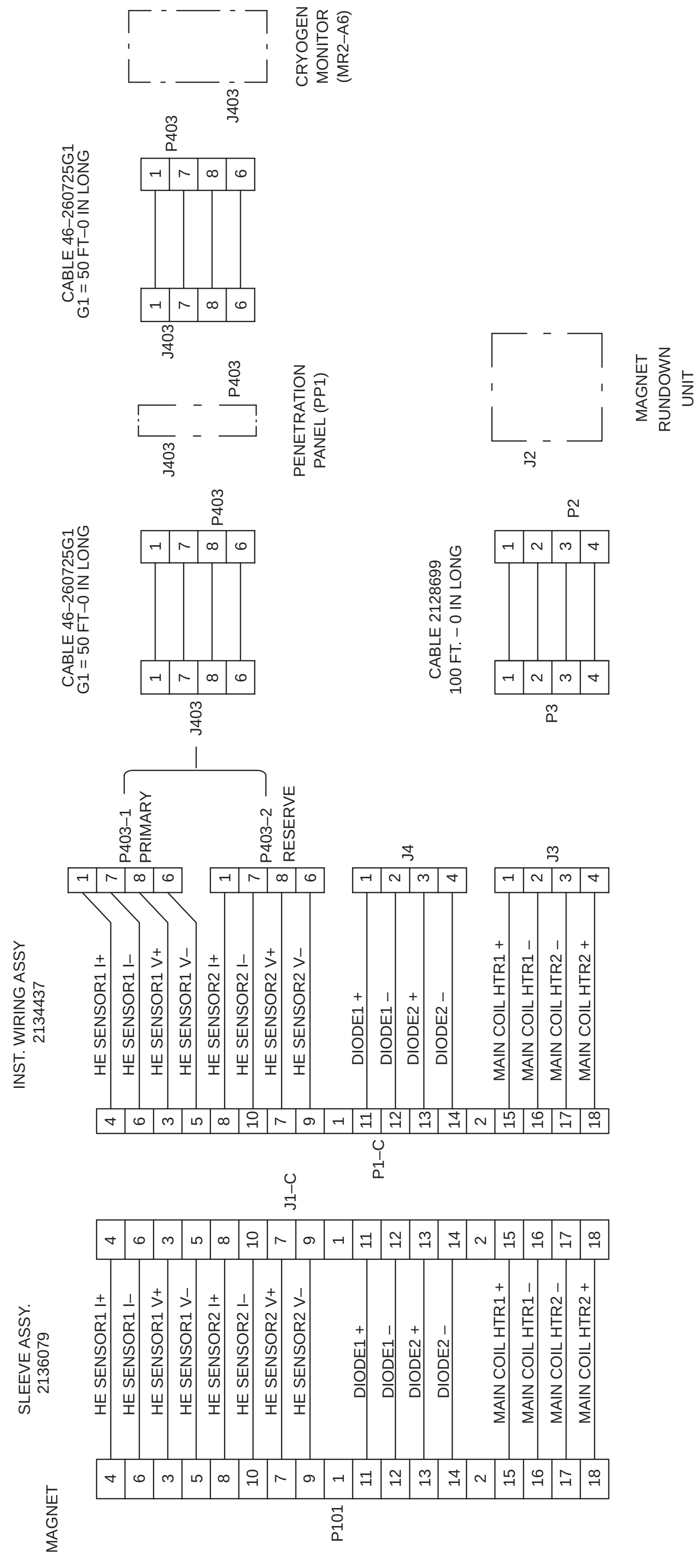


MAGNET SYSTEM INTERCONNECT DIAGRAM
ILLUSTRATION 1–1

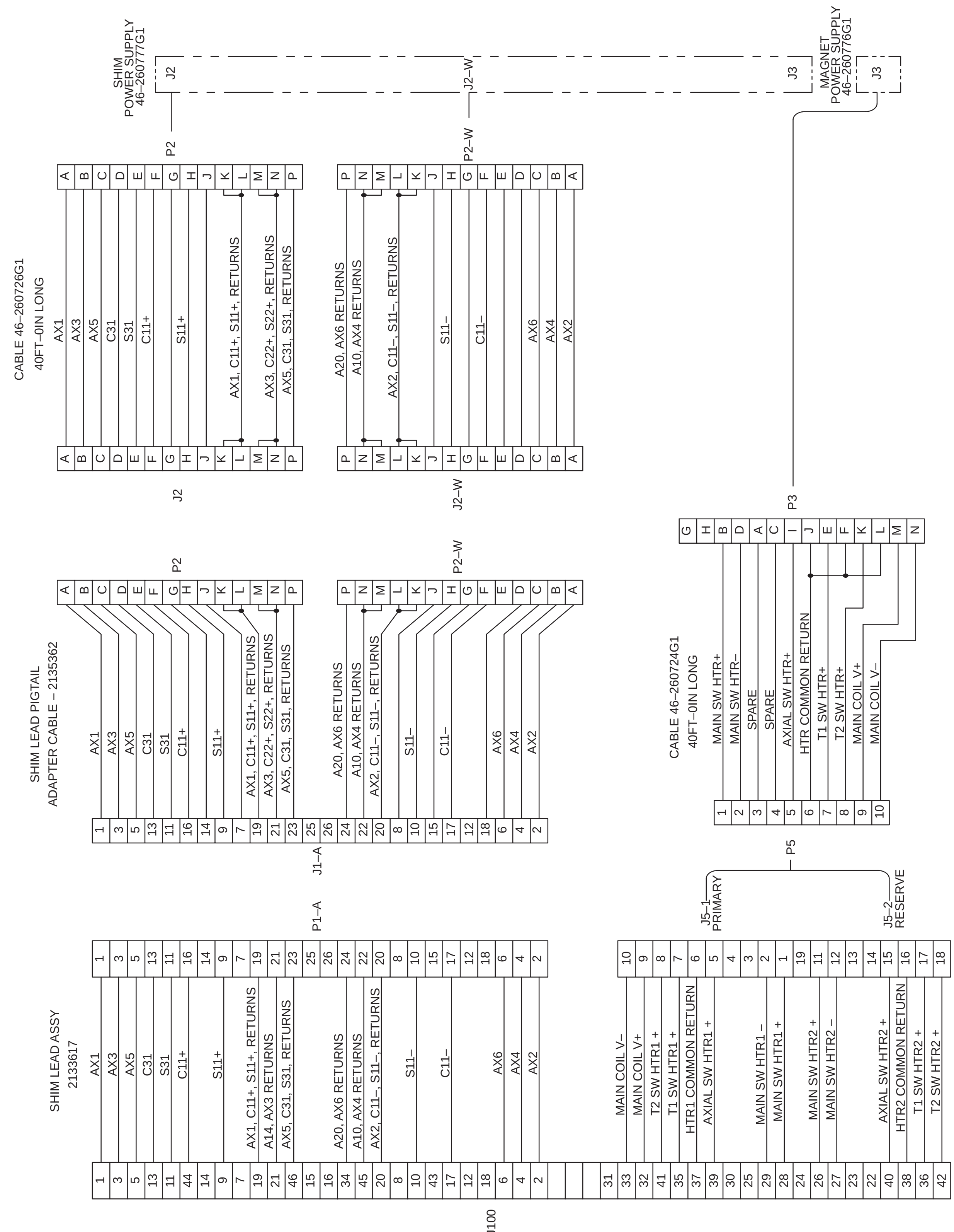


MAGNET SHIELD COOLER INTERCONNECT DIAGRAM

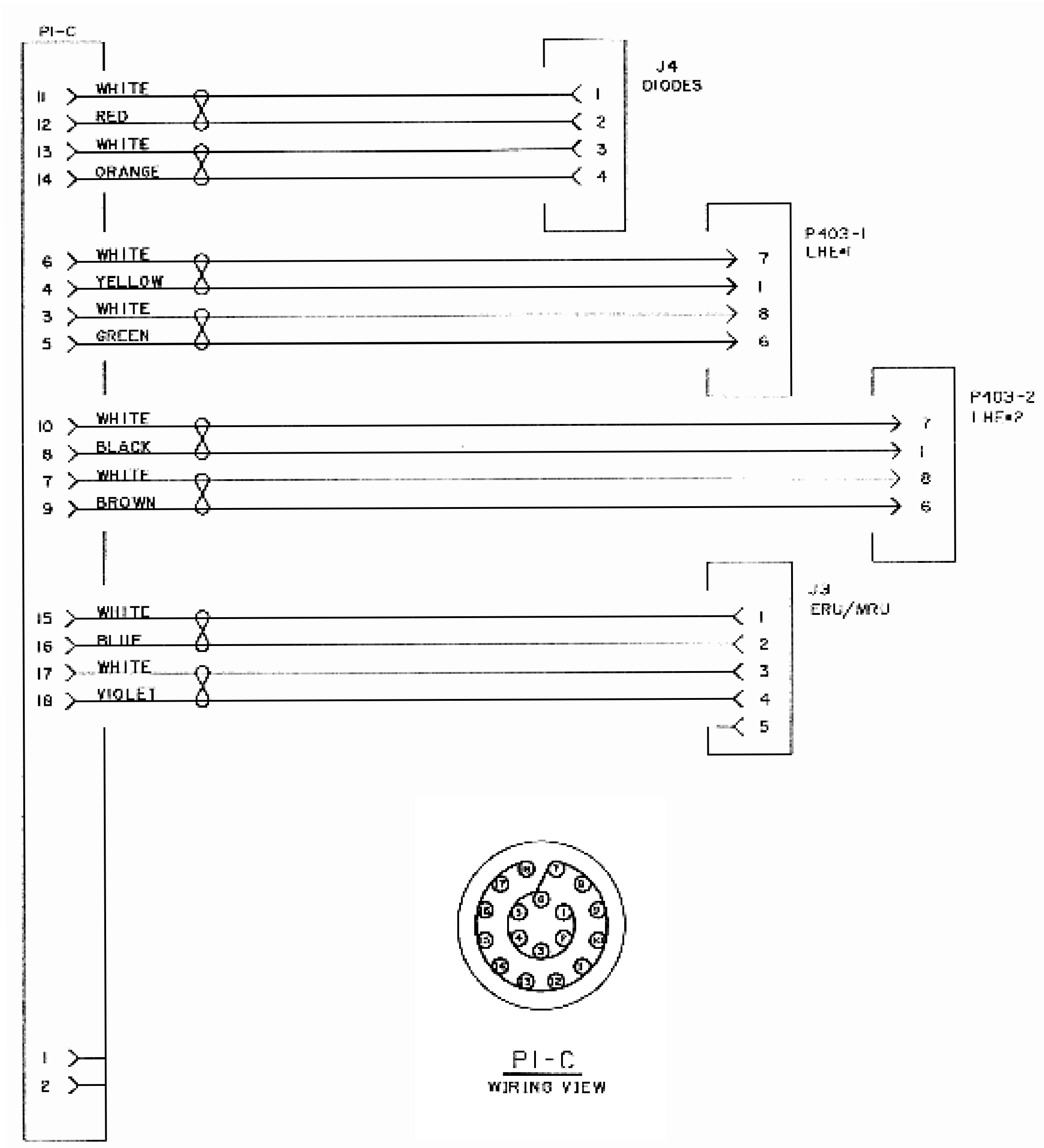
ILLUSTRATION 1–2



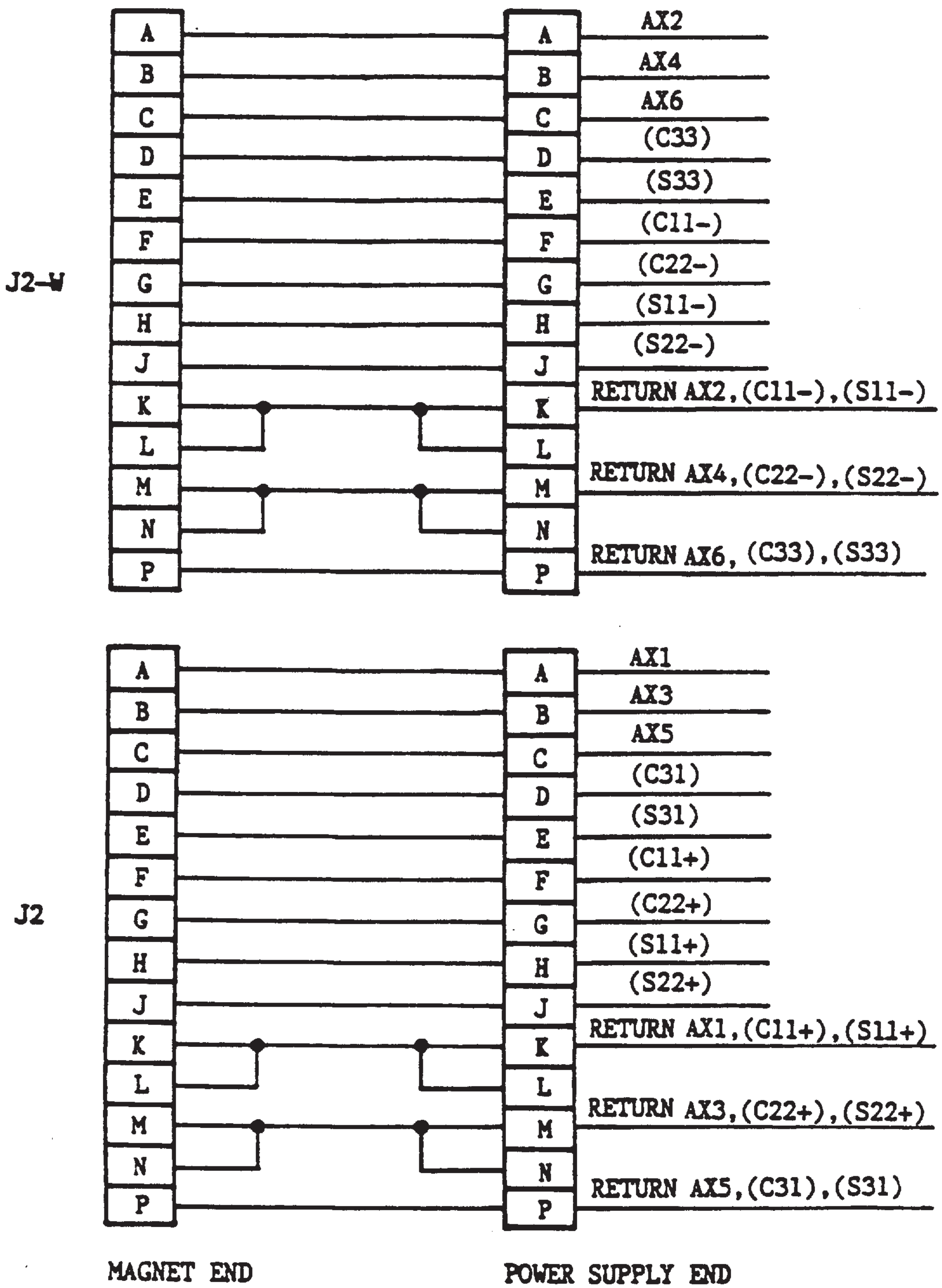
MAGNET SYSTEM WIRING DIAGRAM
ILLUSTRATION 2–1



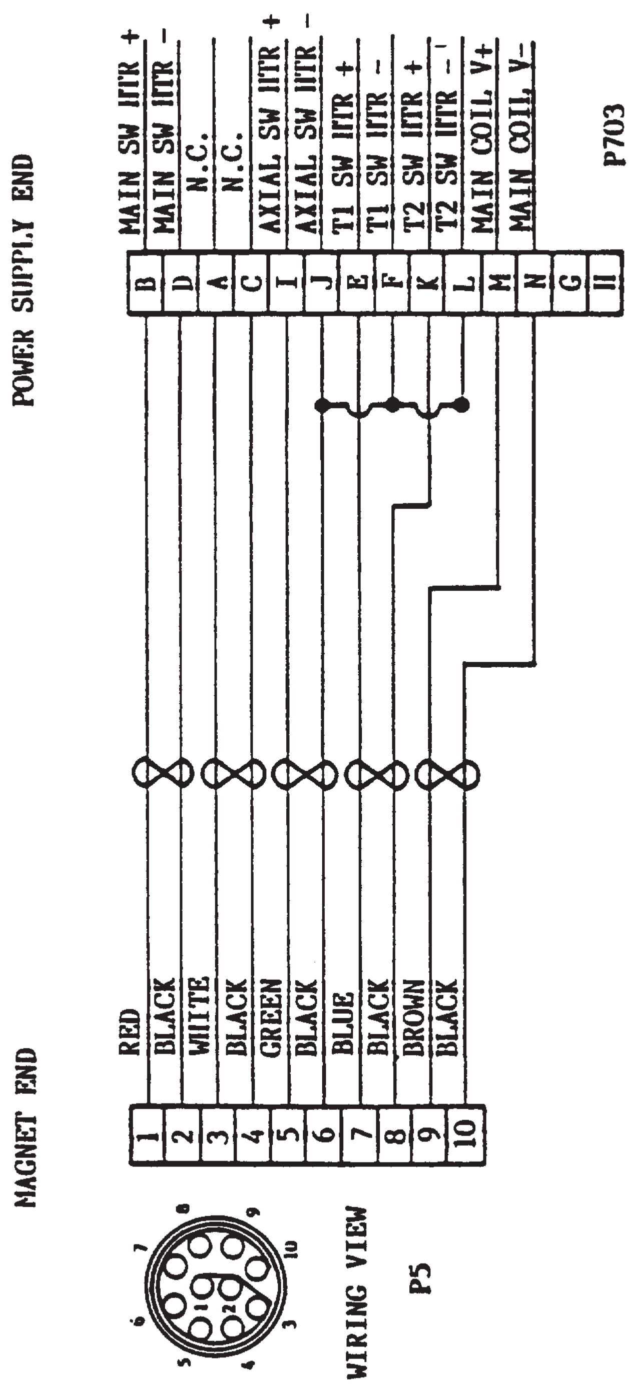
MAGNET SYSTEM WIRING DIAGRAM (continued)
ILLUSTRATION 2–2



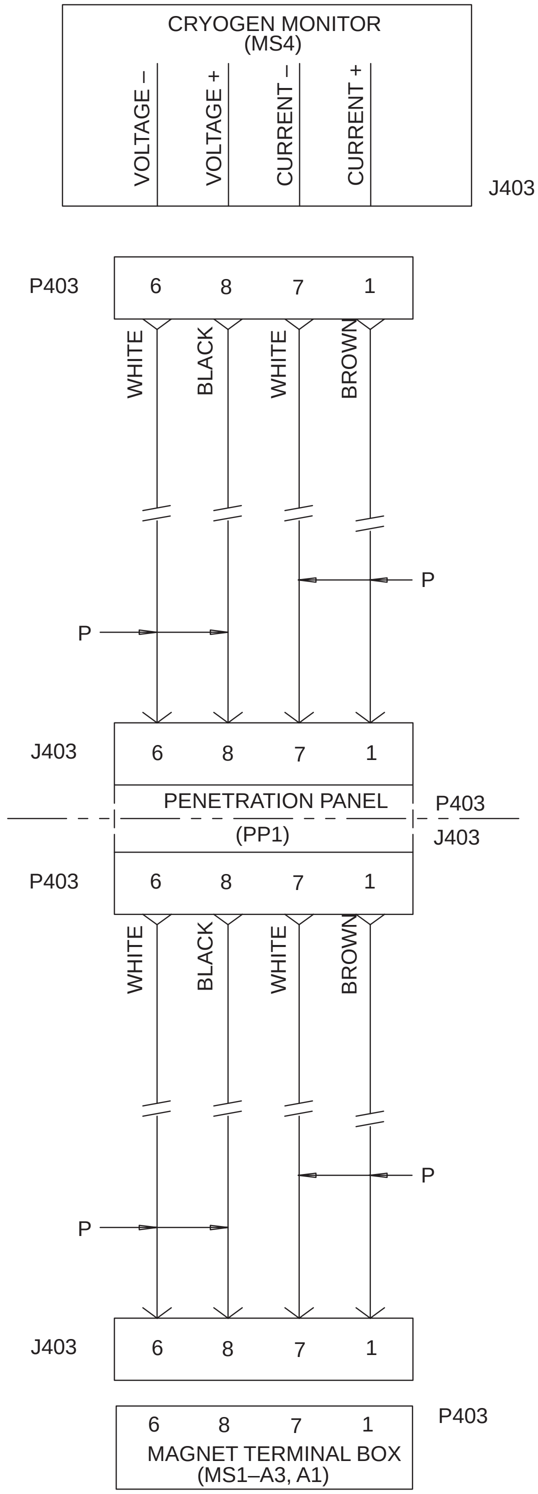
WIRING DIAGRAM
MAGNET CABLE 2134437
ILLUSTRATION 2–3



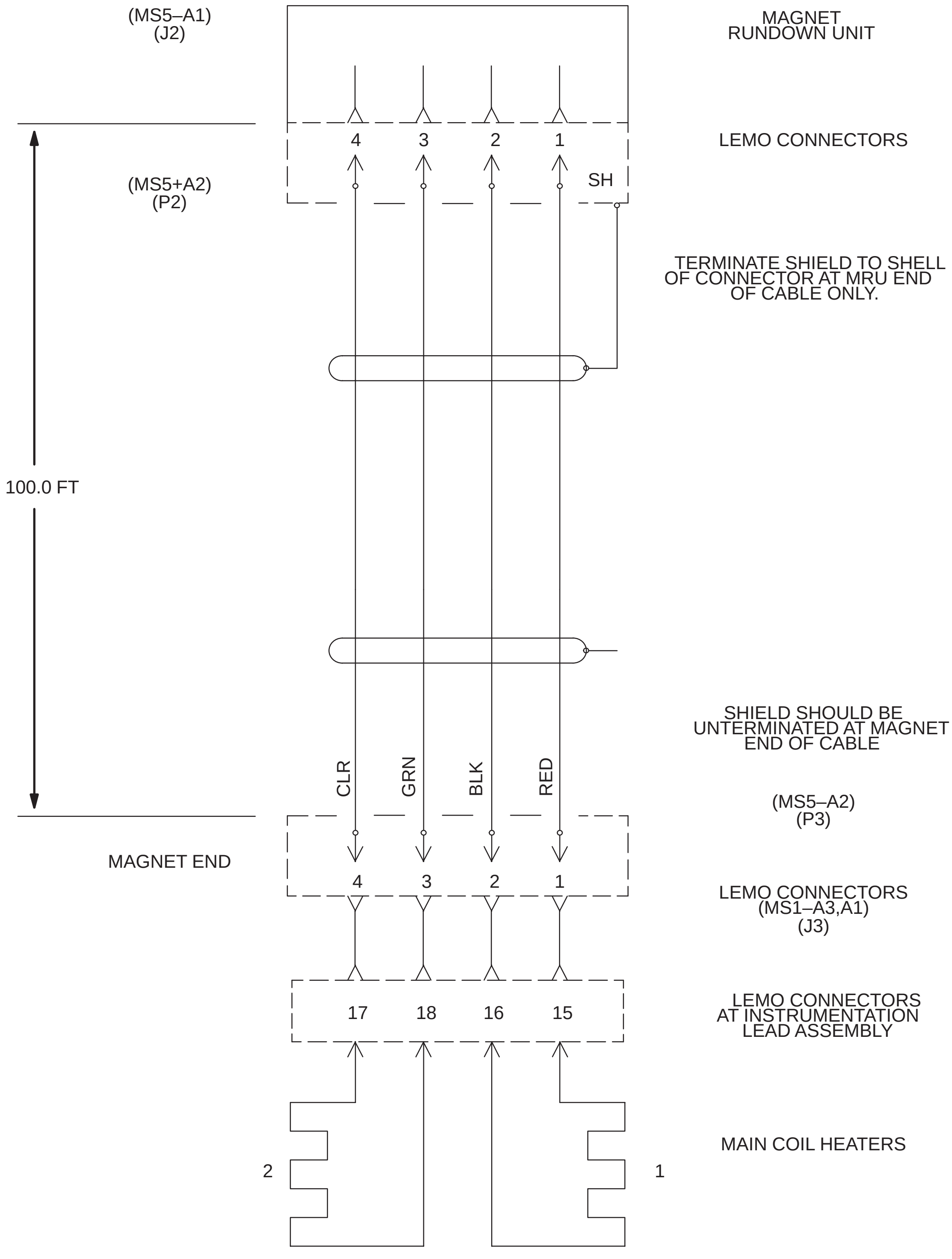
WIRING DIAGRAM
S/C SHIM COIL CABLE 46–260726G1
ILLUSTRATION 2–4



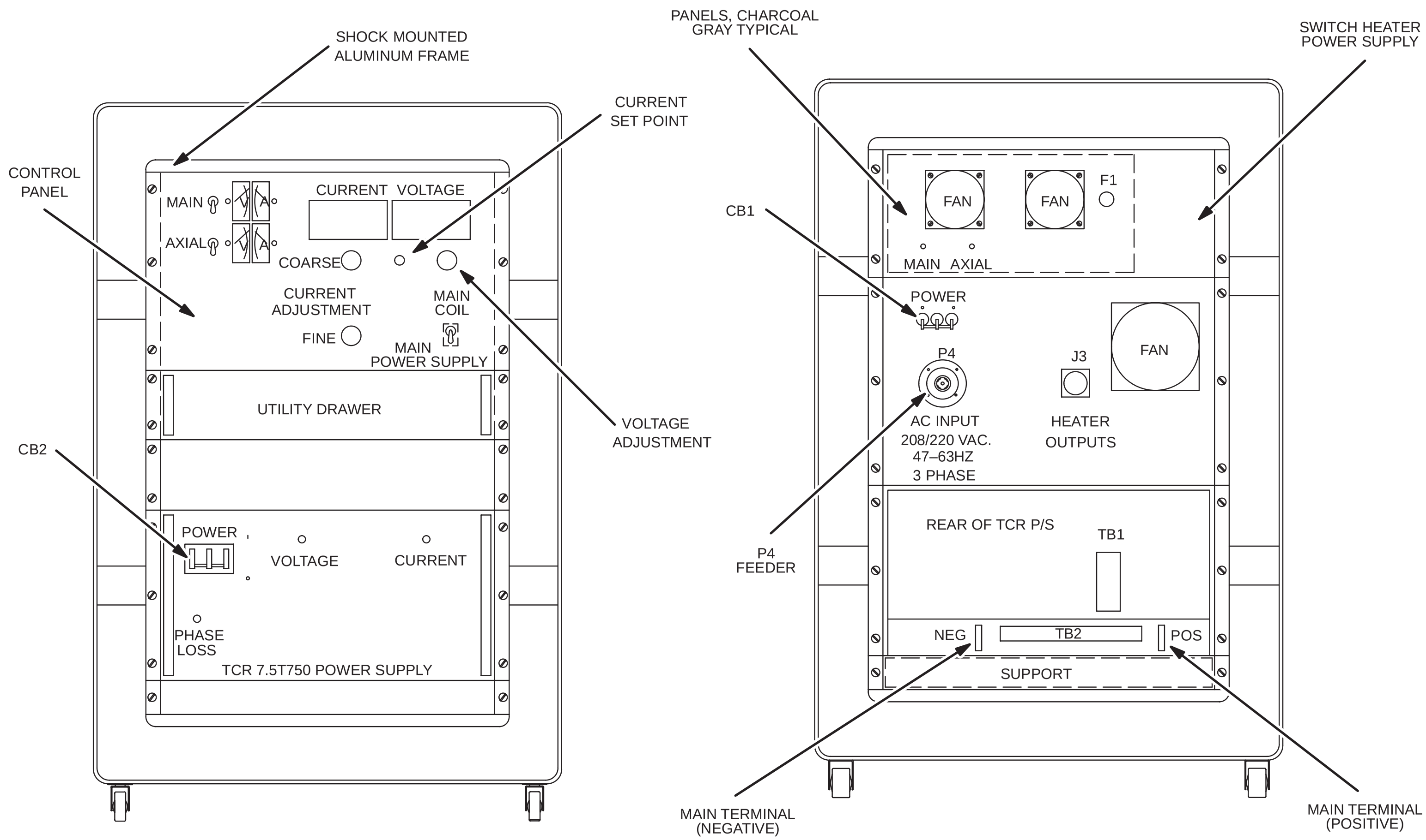
WIRING DIAGRAM
VOLTAGE MONITOR & SWITCH HEATERS CABLE 46–260724G1
ILLUSTRATION 2–5



WIRING DIAGRAM
LIQUID HELIUM MONITOR CIRCUIT
ILLUSTRATION 2–6



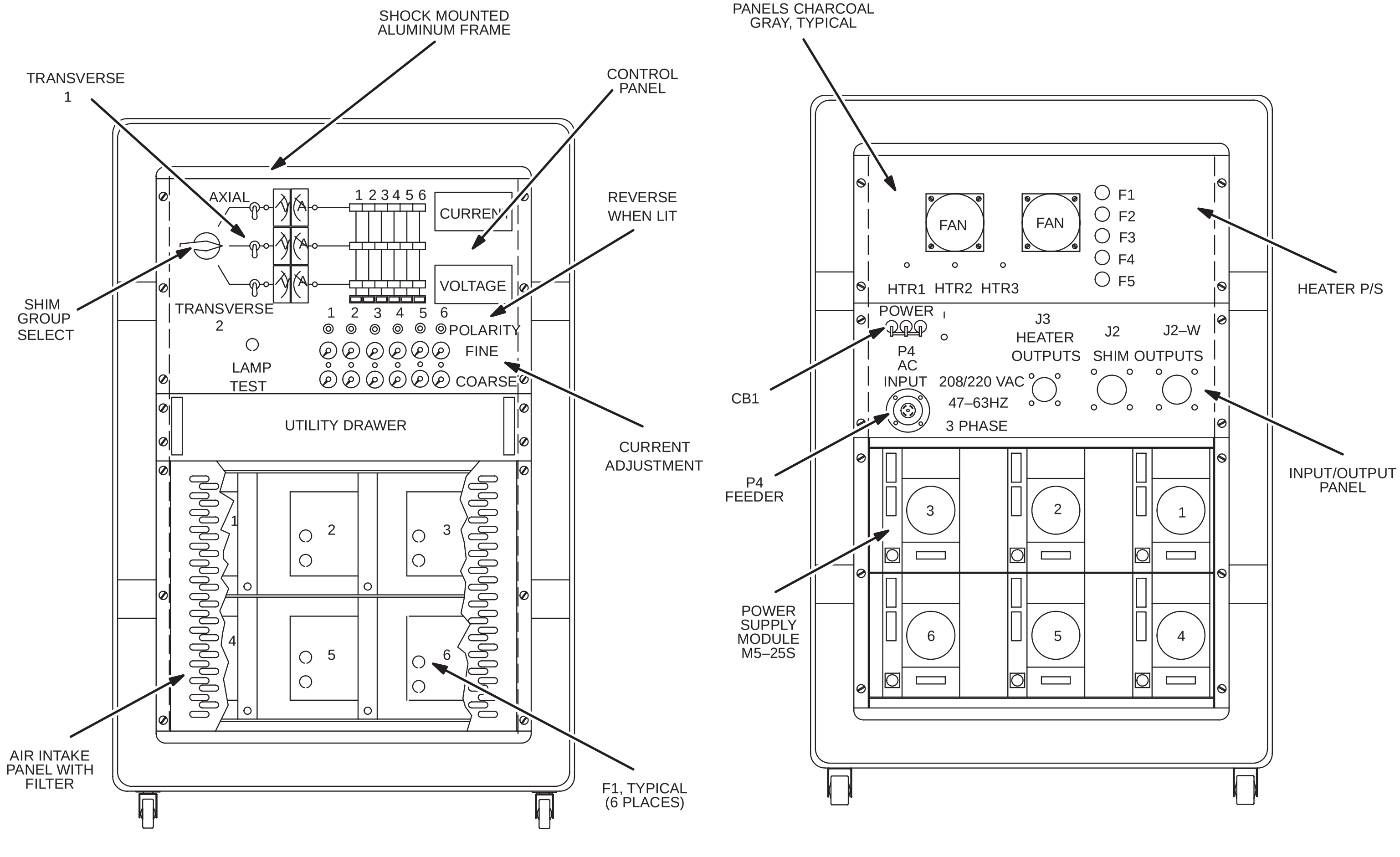
WIRING DIAGRAM
MAGNET RUNDOWN SYSTEM FOR MAIN COIL HEATERS
ILLUSTRATION 2–7



FUSES AND CIRCUIT BREAKERS	
DESIGNATOR	RATING AND TYPE
CB1 CABINET	3 POLE, 25 A, 250 VAC
CB1 SUPPLY	3 POLE, 25 A, 250 VAC
F1	4 A, 250 V, MDA

INPUT POWER		
DESIGNATOR	RATING AND TYPE	CONNECTION
P4	208/220 VAC, 50–60 HZ	
TB1	30 AMP, 602Y	AC INPUT MAIN POWER SUPPLY
OUTPUT CONNECTION		
DESIGNATOR	RATING AND TYPE	CONNECTION
MAIN TERMINAL POS.	750 A BUS BAR	RED/POS. MAIN POWER LEADS (MS3–A2)
MAIN TERMINAL NEG.	750 A BUS BAR	BLACK/NEG. MAIN POWER LEADS (MS3–A2)
J3	1 AMP, MS3106A20–27P	HEATER WIRE HARNESS (MS3–A5) P3

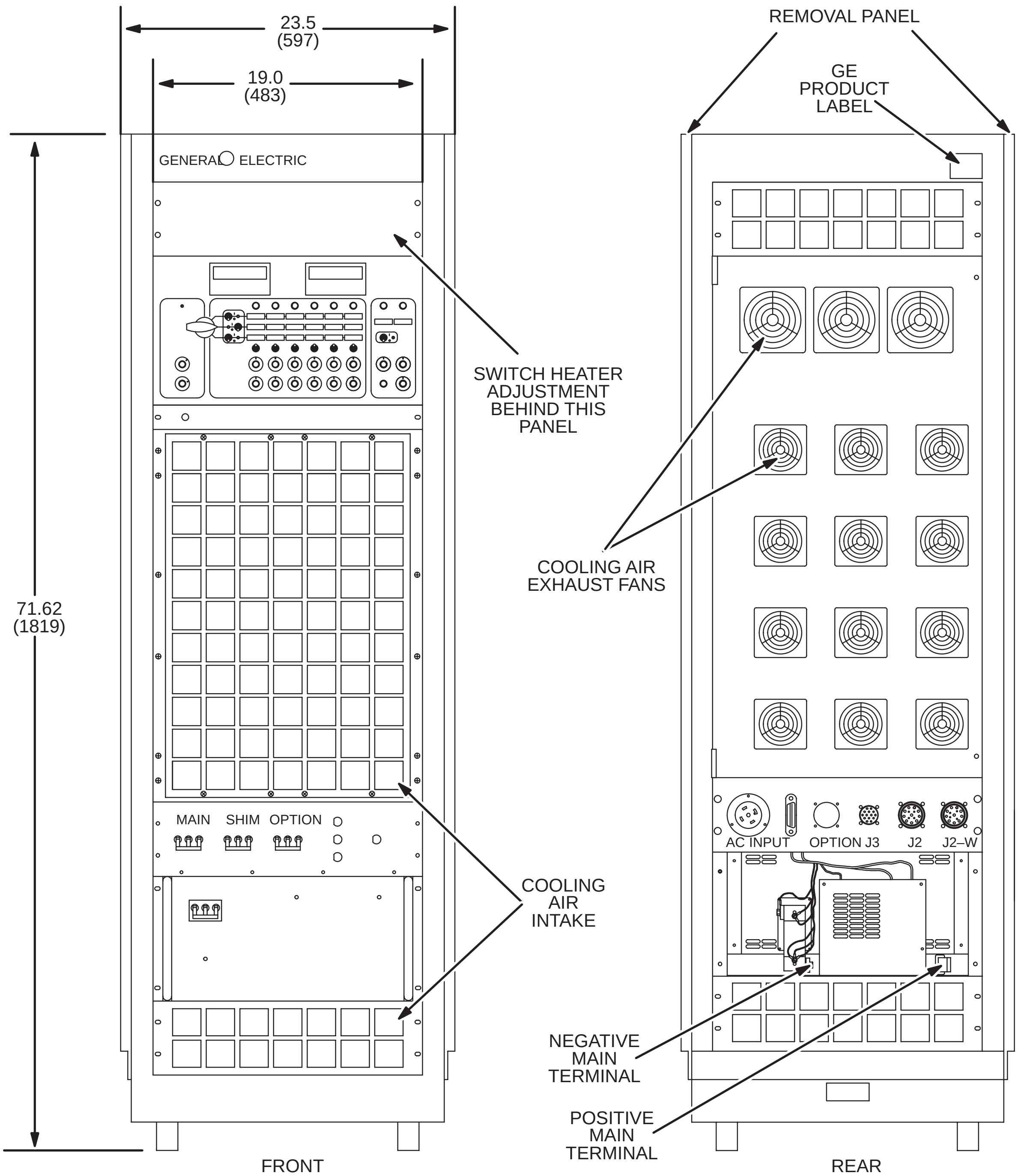
SUPERCONDUCTING MAIN COIL SERVICE POWER SUPPLY CABINET
ILLUSTRATION 3–1



FUSES AND CIRCUIT BREAKERS	
DESIGNATOR	RATING AND TYPE
CB1	3 POLE, 25 A, 250VAC
F1 (TYP. 6 PLACES)	6.25 A, 250 V. MDA
F1, F5	4 A, 250 V. MDA
F2, F3, F4	1 A, 250 V. MDA

INPUT POWER		
DESIGNATOR	RATING AND TYPE	
P4	208/220 VAC, 50/60 HZ.	
OUTPUT CONNECTIONS		
DESIGNATOR	RATING AND TYPE	CONNECTION
J2	25 A, MS3012A28–20S	S/C SHIM COIL WIRE HARNESS (MS3–A4) P1
J2–W	25 A, MS3012A28–20SW	S/C SHIM COIL WIRE HARNESS (MS3–A4) P2
J3	1 A, MS3106A20–27P	HEATER WIRE HARNESS (MS3–A5) P3

SUPERCONDUCTING SHIM COIL SERVICE POWER SUPPLY CABINET
ILLUSTRATION 3–2



SPECIFICATIONS

WEIGHT: 750 LBS MAX

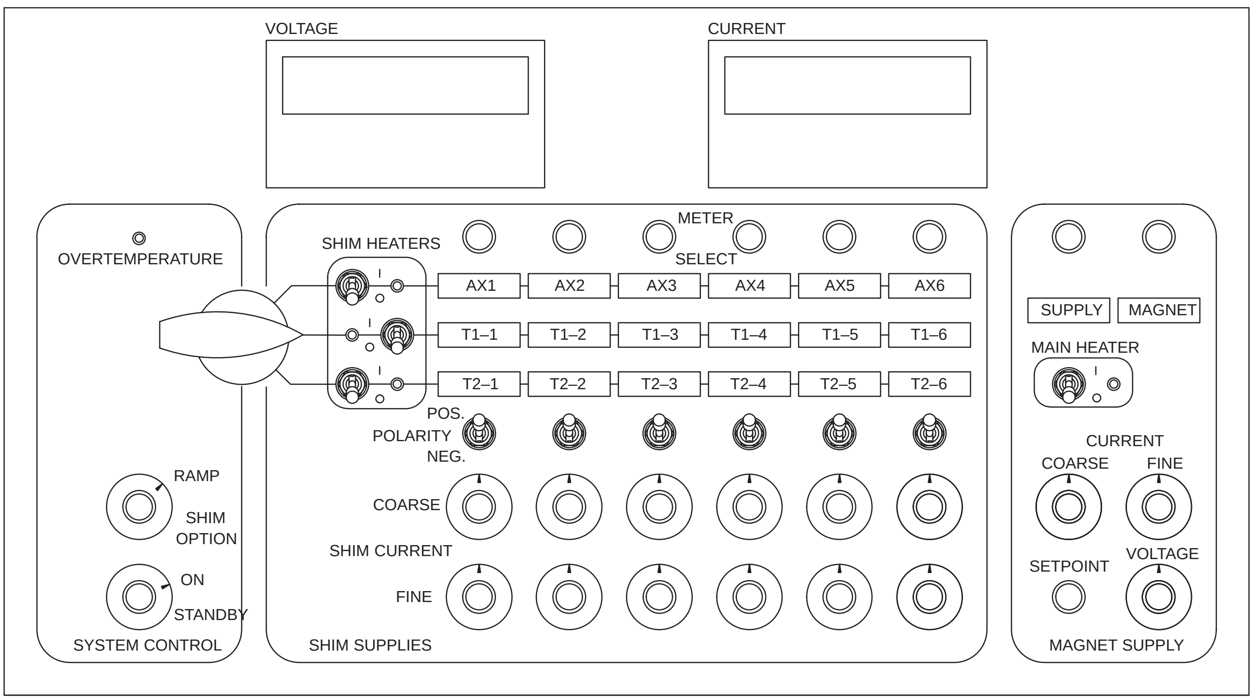
AC – INPUT REQUIREMENTS: 208 VAC +/– 10%
30 A
55 +/– 8 HZ
THREE PHASE /Y

SYSTEM COMPONENTS:

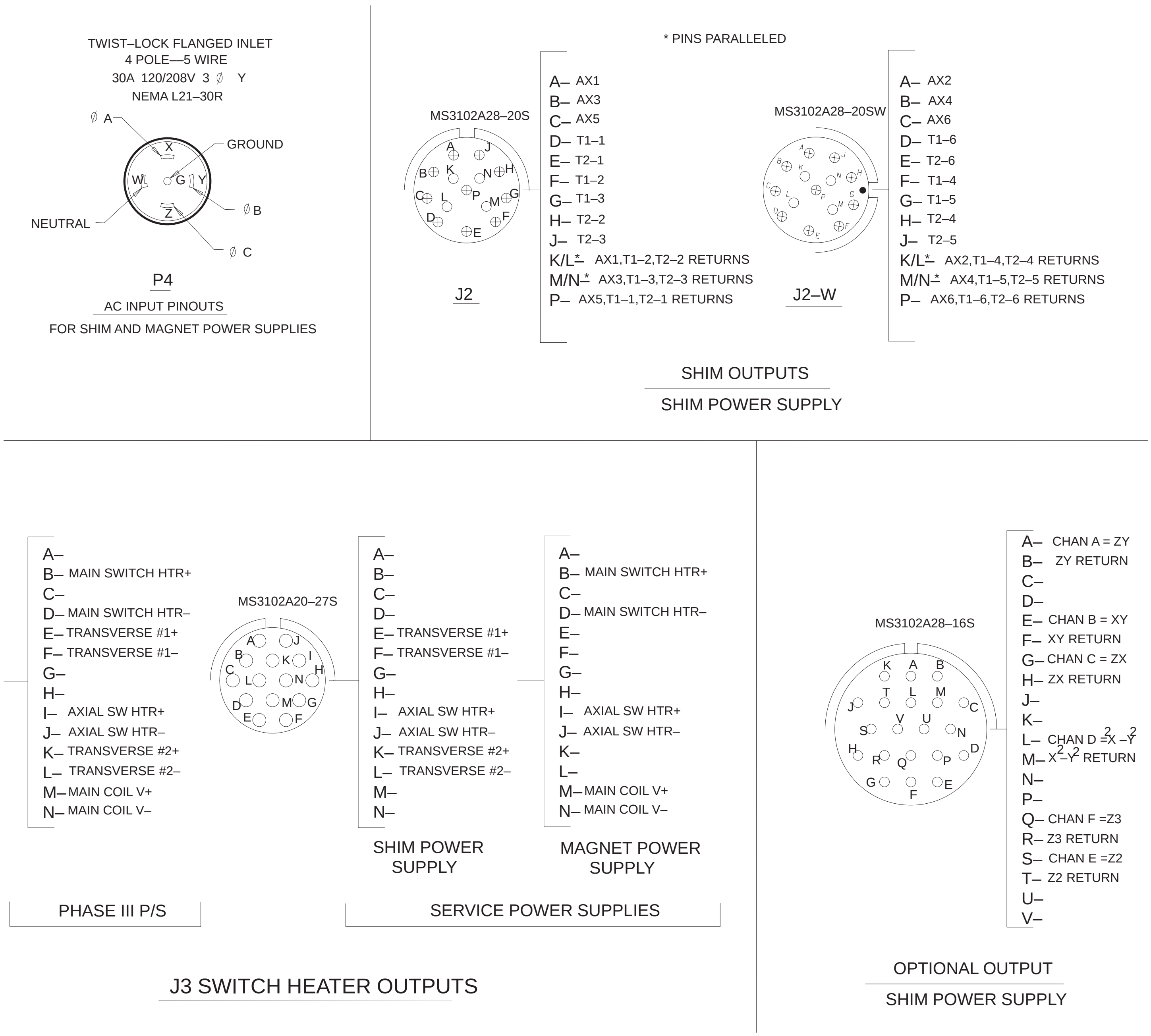
MAGNET SUPPLY 0 – 7.5 VDC, 0 – 75 A
SHIM SUPPLY (6) 5 VDC, 0 – 25 A

MAGNET/SHIM PHASE III–A POWER SUPPLY SYSTEM

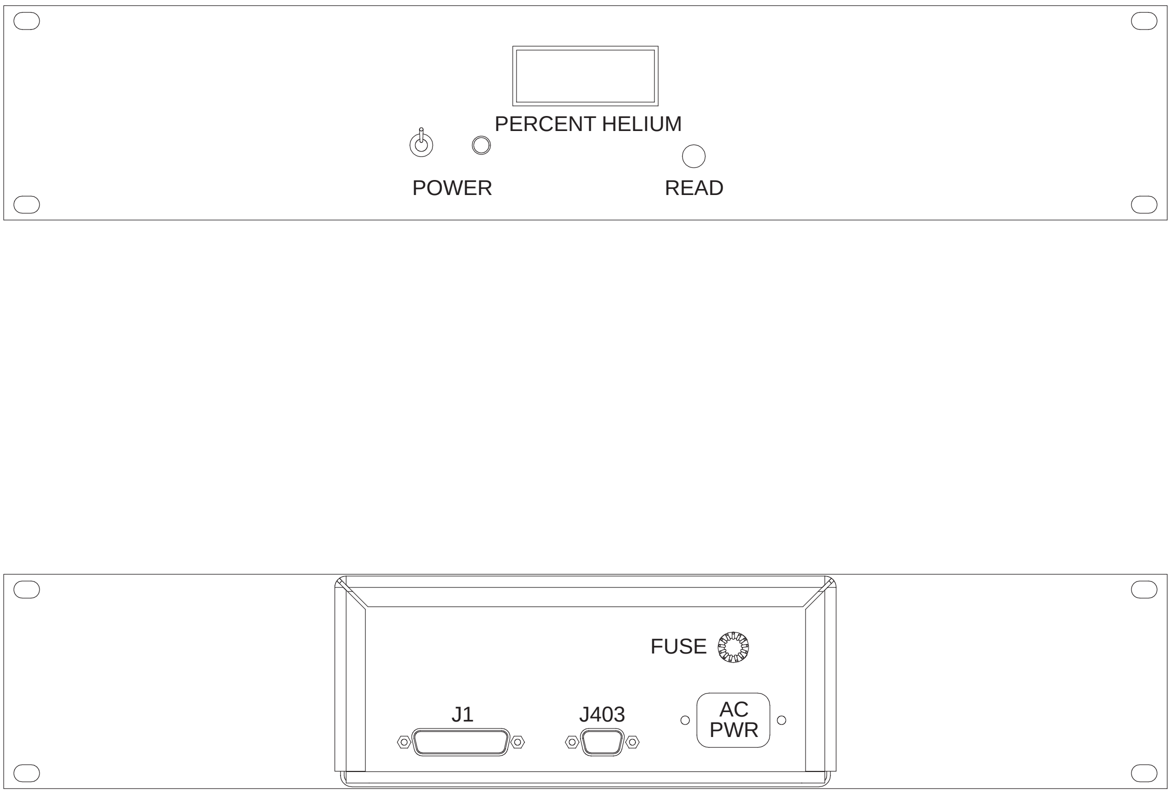
ILLUSTRATION 3–3



MAGNET/SHIM PHASE III–A POWER SUPPLY CONTROL PANEL
ILLUSTRATION 3–4



POWER SUPPLY INPUT/OUTPUT CONNECTOR PINOUTS
ILLUSTRATION 3–5



CRYOGEN MONITOR PANEL
ILLUSTRATION 4–1

TABLE 8–1
CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS

DATE:______________________MAGNET SERIAL #:_________________________PLOT #:_________________________OUTPUT FILE:____________________

POWER SUPPLY # (NAME)	**TOTAL CURRENT(AMPS)**	+ **Δ CHANGE (AMPS)**	= **TOTAL CURRENT(AMPS)**	+ **Δ CHANGE (AMPS)**	= **TOTAL CURRENT(AMPS)**	+ **Δ CHANGE (AMPS)**
T1–1(C31)						
T1–2(C11+)						
T1–4(C11–)						
T2–1(S31)						
T2–2(S11+)						
T2–4(S11–)						
AX1						
AX2						
AX3						
AX4						
AX5						
AX6						
GRADIENT OFFSETS						
X						
Y						
Z						
PREDICTED						
INHOMOGENEITY						

TABLE 8–1

CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS

DATE:____________________MAGNET SERIAL #:______________________PLOT #:______________________OUTPUT FILE:__________________

POWER SUPPLY # (NAME)	**TOTAL CURRENT(AMPS)** +	**Δ CHANGE (AMPS)** =	**TOTAL CURRENT(AMPS)** +	**Δ CHANGE (AMPS)** =	**TOTAL CURRENT(AMPS)** +	**Δ CHANGE (AMPS)**
T1–1(C31)						
T1–2(C11+)						
T1–4(C11–)						
T2–1(S31)						
T2–2(S11+)						
T2–4(S11–)						
AX1						
AX2						
AX3						
AX4						
AX5						
AX6						
GRADIENT OFFSETS						
X						
Y						
Z						
PREDICTED						
INHOMOGENEITY						

TABLE 8–1
CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS (continued)

DATE:______________________MAGNET SERIAL #:_________________________PLOT #:_________________________OUTPUT FILE:____________________

POWER SUPPLY # (NAME)	TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)	= TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)	= TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)
T1–1(C31)						
T1–2(C11+)						
T1–4(C11–)						
T2–1(S31)						
T2–2(S11+)						
T2–4(S11–)						
AX1						
AX2						
AX3						
AX4						
AX5						
AX6						
GRADIENT OFFSETS						
X						
Y						
Z						
PREDICTED						
INHOMOGENEITY						

TABLE 8–1
CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS (continued)

DATE:______________________MAGNET SERIAL #:_________________________PLOT #:_________________________OUTPUT FILE:____________________

POWER SUPPLY # (NAME)	**TOTAL CURRENT(AMPS)**	+ **Δ CHANGE (AMPS)**	= **TOTAL CURRENT(AMPS)**	+ **Δ CHANGE (AMPS)**	= **TOTAL CURRENT(AMPS)**	+ **Δ CHANGE (AMPS)**
T1–1(C31)						
T1–2(C11+)						
T1–4(C11–)						
T2–1(S31)						
T2–2(S11+)						
T2–4(S11–)						
AX1						
AX2						
AX3						
AX4						
AX5						
AX6						
GRADIENT OFFSETS						
X						
Y						
Z						
PREDICTED						
INHOMOGENEITY						

TABLE 8–1
CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS (continued)

DATE:____________________MAGNET SERIAL #:______________________PLOT #:______________________OUTPUT FILE:__________________

POWER SUPPLY # (NAME)	TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)	= TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)	= TOTAL CURRENT(AMPS)	+ Δ CHANGE (AMPS)
T1–1(C31)						
T1–2(C11+)						
T1–4(C11–)						
T2–1(S31)						
T2–2(S11+)						
T2–4(S11–)						
AX1						
AX2						
AX3						
AX4						
AX5						
AX6						
GRADIENT OFFSETS						
X						
Y						
Z						
PREDICTED						
INHOMOGENEITY						

TABLE 3–1
CRYOGEN LOG

DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL– OFF RATE ($\Delta l \div \Delta t$)	DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL– OFF RATE ($\Delta l \div \Delta t$)
				Δ t	Δ l						Δ t	Δ l	

TABLE 3–1
CRYOGEN LOG (continued)

DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL– OFF RATE ($\Delta l \div \Delta t$)	DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL– OFF RATE ($\Delta l \div \Delta t$)
				Δt	Δl						Δt	Δl	

TABLE 3–1
CRYOGEN LOG (continued)

DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL– OFF RATE (Δl ÷ Δt)	DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL– OFF RATE (Δl ÷ Δt)
				Δ t	Δ l						Δ t	Δ l	

TABLE 3–1
CRYOGEN LOG (continued)

DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL– OFF RATE ($\Delta l \div \Delta t$)	DATE	TIME (t)	METER %	AMT (L)	CHANGE FROM PREVIOUS READING		BOIL– OFF RATE ($\Delta l \div \Delta t$)
				Δt	Δl						Δt	Δl	

TABLE 2–1
LIQUID HELIUM REFILL CHART

DATE_______________

FILLED BY____________________

DEWAR SERIAL#	TIME		DEWAR WEIGHT (LBS)		LITERS HELIUM USED (L_U) (Δ LBS x 3.63)	HELIUM LEVEL (L_I)				TRANSFER EFFICIENCY (Δ L_I/L_U)
						START		FINISH		
	START	FINISH	START	FINISH		METER %	AMT (L)	METER %	AMT (L)	

TABLE 2–1
LIQUID HELIUM REFILL CHART (continued)

DATE______________

FILLED BY___________________

DEWAR SERIAL#	TIME		DEWAR WEIGHT (LBS)		LITERS HELIUM USED (L_U) (Δ LBS x 3.63)	HELIUM LEVEL (L_I)				TRANSFER EFFICIENCY (Δ L_I/L_U)
						START		FINISH		
	START	FINISH	START	FINISH		METER %	AMT (L)	METER %	AMT (L)	

TABLE 2–1
LIQUID HELIUM REFILL CHART (continued)

DATE_______________

FILLED BY____________________

DEWAR SERIAL#	TIME		DEWAR WEIGHT (LBS)		LITERS HELIUM USED (L_U) (Δ LBS x 3.63)	HELIUM LEVEL (L_I)				TRANSFER EFFICIENCY (Δ L_I/L_U)
						START		FINISH		
	START	FINISH	START	FINISH		METER %	AMT (L)	METER %	AMT (L)	

TABLE 2–1
LIQUID HELIUM REFILL CHART (continued)

DATE_______________

FILLED BY_____________________

DEWAR SERIAL#	TIME		DEWAR WEIGHT (LBS)		LITERS HELIUM USED (L_U) (Δ LBS x 3.63)	HELIUM LEVEL (L_I)				TRANSFER EFFICIENCY (Δ L_I/L_U)
						START		FINISH		
	START	FINISH	START	FINISH		METER %	AMT (L)	METER %	AMT (L)	

TABLE 1–1
MAGNET COMMISSIONING LOG

DATE	CRYOSTAT PRESSURE	SHIM LEAD FLOW	INSTRUMENTA-TION LEAD FLOW	STATIC PRES-SURE READING (SPEC 218 PSIG TO 232 PSIG)	COLD HEAD TEMPERATURES	
					FIRST STAGE	SECOND STAGE

TABLE 1–1
MAGNET COMMISSIONING LOG

DATE	CRYOSTAT PRESSURE	SHIM LEAD FLOW	INSTRUMENTATION LEAD FLOW	COLD HEAD TEMPERATURES	
				FIRST STAGE	SECOND STAGE

TABLE 6–1
MAGNET RAMPING & PARKING CURRENT LOG

MAGNET: MODEL NO.____________________________ SERIAL NO.____________________

SERVICE ENGINEER____

DATE	TIME	CONNECTION POLARITY NORMAL (+/–) REVERSE (–/+)	LEAD EXTENSION VOLTAGE DROP mV	PARKING CURRENT (A)	MAGNETIC FIELD BEFORE SHIMMING HZ (GAUSS)	MAGNETIC FIELD AFTER MECHANICAL SHIMMING HZ (GAUSS)	MAGNETIC FIELD WITH SHIM CURRENTS REMOVED BEFORE RAMPING DOWN OR REPARKING HZ (GAUSS)

TABLE 6–1
MAGNET RAMPING & PARKING CURRENT LOG

MAGNET: MODEL NO.__________________________ SERIAL NO.___________________

SERVICE ENGINEER_____________________________________

DATE	TIME	CONNECTION POLARITY NORMAL (+/–) REVERSE (–/+)	LEAD EX-TENSION VOLTAGE DROP mV	PARKING CURRENT (A)	MAGNETIC FIELD BEFORE SHIM-MING HZ (GAUSS)	MAGNETIC FIELD AFTER MECHANI-CAL SHIMMING HZ (GAUSS)	MAGNETIC FIELD WITH SHIM CUR-RENTS REMOVED BEFORE RAMPING DOWN OR REPARK-ING HZ (GAUSS)

TABLE 6–2
MAGNET UNCOMPENSATED DRIFT LOG

MAGNET: MODEL NO.__________________________ SERIAL NO.___________________

SERVICE ENGINEER______________________________________

DATE	TIME	FREQUENCY 1	FREQUENCY 2

TABLE 6–2
MAGNET UNCOMPENSATED DRIFT LOG

MAGNET: MODEL NO.___________________________ SERIAL NO.___________________

SERVICE ENGINEER_______________________________________

DATE	TIME	FREQUENCY 1	FREQUENCY 2

TABLE 9–1
SHIM SIZE/LOCATION (MILS)

Z	ROTATION (DEGREES)											
(NO)	0	30	60	90	120	150	180	210	240	270	300	330
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												

TABLE 9–1
SHIM SIZE/LOCATION (MILS) (continued)

Z	ROTATION (DEGREES)											
(NO)	0	30	60	90	120	150	180	210	240	270	300	330
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												

TABLE 9–1
SHIM SIZE/LOCATION (MILS) (continued)

Z	ROTATION (DEGREES)											
(NO)	0	30	60	90	120	150	180	210	240	270	300	330
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												

TABLE 9–1
SHIM SIZE/LOCATION (MILS) (continued)

Z	ROTATION (DEGREES)											
(NO)	0	30	60	90	120	150	180	210	240	270	300	330
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												

TABLE 7–1
SHIM PLOT DATA

DATE:______________________MAGNET:______________________LOCATION:_________________________PLOT#:________________________________

POINT 1 (R = 0, Z = –22.5cm):____________________________POINT 2 (R = 0, Z = +22.5cm):____________________________BASE FREQ:____________

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz)

TABLE 7–1
SHIM PLOT DATA

DATE:______________________MAGNET:______________________LOCATION:_________________________PLOT#:______________________________

POINT 1 (R = 0, Z = –22.5cm):____________________________POINT 2 (R = 0, Z = +22.5cm):____________________________BASE FREQ:____________

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz)

TABLE 7–1
SHIM PLOT DATA

DATE:______________________MAGNET:______________________LOCATION:_________________________PLOT#:______________________________

POINT 1 (R = 0, Z = –22.5cm):____________________________POINT 2 (R = 0, Z = +22.5cm):____________________________BASE FREQ:____________

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz)

TABLE 7–1
SHIM PLOT DATA

DATE:______________________MAGNET:______________________LOCATION:_________________________PLOT#:_______________________________

POINT 1 (R = 0, Z = –22.5cm):____________________________POINT 2 (R = 0, Z = +22.5cm):____________________________BASE FREQ:____________

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz)

TABLE 7–1
SHIM PLOT DATA

DATE:______________________MAGNET:______________________LOCATION:_________________________PLOT#:______________________________

POINT 1 (R = 0, Z = –22.5cm):____________________________POINT 2 (R = 0, Z = +22.5cm):____________________________BASE FREQ:____________

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz)

CHART 5–1
VOLUMETRIC CONVERSION OF LIQUID HELIJM LEVEL

LEVEL PERCENTAGE TO LIQUID LITERS CORRELATION

PERCENT	LITERS	PERCENT	LITERS
0	243	51	987
1	265	52	1000
2	287	53	1012
3	308	54	1025
4	330	55	1038
5	371	56	1051
6	374	57	1064
7	396	58	1076
8	417	59	1089
9	439	60	1102
10	461	61	1114
11	476	62	1127
12	490	63	1140
13	505	64	1152
14	520	65	1165
15	539	66	1177
16	549	67	1190
17	564	68	1202
18	579	69	1214
19	593	70	1227
20	608	71	1244
21	620	72	1256
22	632	73	1269
23	644	74	1282
24	656	75	1294
25	672	76	1308
26	681	77	1321
27	693	78	1335
28	705	79	1349
29	717	80	1363
30	729	81	1378
31	741	82	1393
32	753	83	1409
33	765	84	1426
34	777	85	1445
35	789	86	1461
36	802	87	1471
37	814	88	1496
38	826	89	1519
39	838	90	1542
40	850	91	1562
41	862	92	1586
42	874	93	1609
43	887	94	1632
44	890	95	1654
45	912	96	1675
46	924	97	1696
47	937	98	1716
48	949	99	1735
49	962	100	1753
50	974		

GRAPH 5–1

VOLUMETRIC CONVERSION OF LIQUID HELIUM LEVEL