GE Medical Systems

Technical Publications

Direction 2159496

Revision 4

GE 1.5T & 1.0T Cx
Active Shield Magnet
and Cryogens Subsystem

Operating Documentation

DAMAGE IN TRANSPORTATION

<u>All packages should be closely examined at time of delivery.</u> If damage is apparent, have notation "**damage in shipment**" written on **all** copies of the freight or express bill **<u>before</u>** 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.

Immediately complete **"Damage Loss Claim Form"** after damage is found. Form is available via MS Exchange Mail at **<u>Outlook/Public Folder/All Public Folders/Medical Systems/!Global Initiatives/Information Management/Forms/Common Forms/Damage Loss Claim Form.</u>** Send completed form to e–mail address listed on form.

For more information about the Transportation Claim Procedure, access the GE Medical Systems Intranet and enter the following URL address: **<u>ftp://3.87.40.2/globepro/qualsys/Docs/190016MF.PDF</u>**

REV 0, 11/17/2000

GE Medical Systems

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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。

REVISION HISTORY

REV	DATE	PRIMARY REASON FOR CHANGE
A	August 30, 1996	Preliminary Release
B	February 17, 1997	
C	April 18, 1997	
D	May 9, 1997	
0	July 25, 1997	
1	Sept. 26, 1997	
2	Mar 25, 1998	
3	July 31, 1998	
4	November 29, 2000	Safety Requirements, Safety Checklist and Safety Warning: Coldhead Motor Shield

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3–1	0
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5–1 to 5–4	0
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4–1 to 4–4	4
5–1	4
5–2 to 5–8	0
6–1 to 6–7	4
7–1 to 7–8	4
7–9 to 7–10	0
8–1	0
9–1	0
10–1 to 10–4	0
11–1 to 11–2	4
11–3 to 11–8	2
11–9	4
11–10 to 11–29	2
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3–1 to 3–2	2
3–3 to 3–4	3
3–5 to 3–8	2
3–9	3
4–1 to 4–2	2
4–3 to 4–18	0
4–19	2
4–20	3
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MR387	–
i	0
1–1 to 1–2	0
2–1 to 2–4	0
3–1 to 3–4	0
4–1 to 4–4	0
5–1	1
5–2	0
6–1 to 6–4	0
7–1 to 7–6	0
8–1 to 8–6	0
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SET UP AND CALIBRATION (continued)

SET UP AND CALIBRATION (continued)

FUNCTIONAL CHECKS

REPLACEMENT / MAINTENANCE

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INTRODUCTION

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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 2159496) ORGANIZATION

Note

Direction 2159496 – GE1.5T & 1.0T CX Active Shield Magnet and Cryogens Subsystem covers 1.5T and 1.0T Magnet Systems used on 1.5T and 1.0T 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
2142600 for 1.5T with compressor	2148633
2163097 for 1.5T without compressor	2148633
2183098 for 1.5T mobile with compressor	2148633
2155534 for 1.0T with compressor	2148633
2163096 for 1.0T without compressor	2148633
2183097 for 1.0T mobile with compressor	2148633

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 2159496) 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.

Note

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

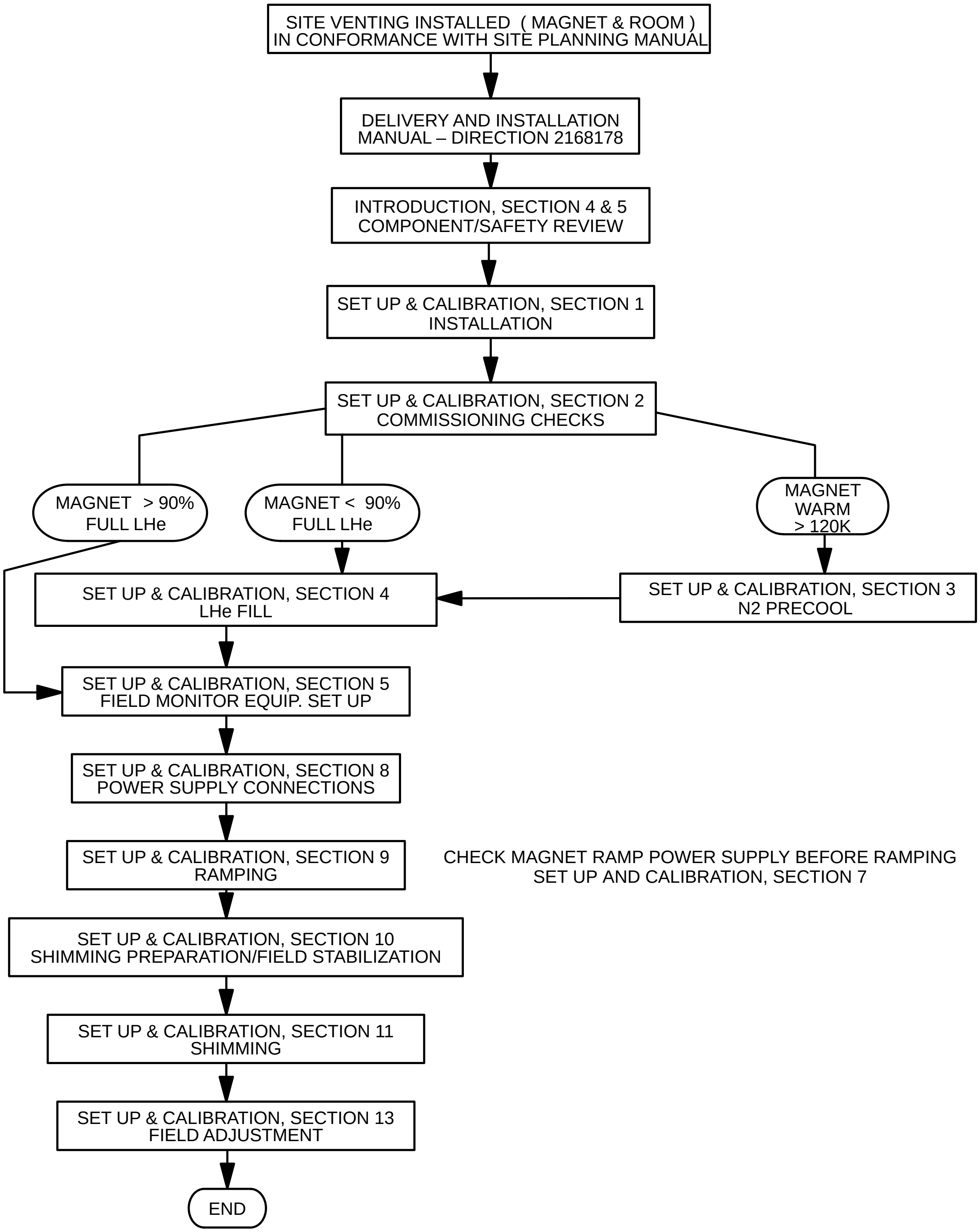
Note

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 2159496.*

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.



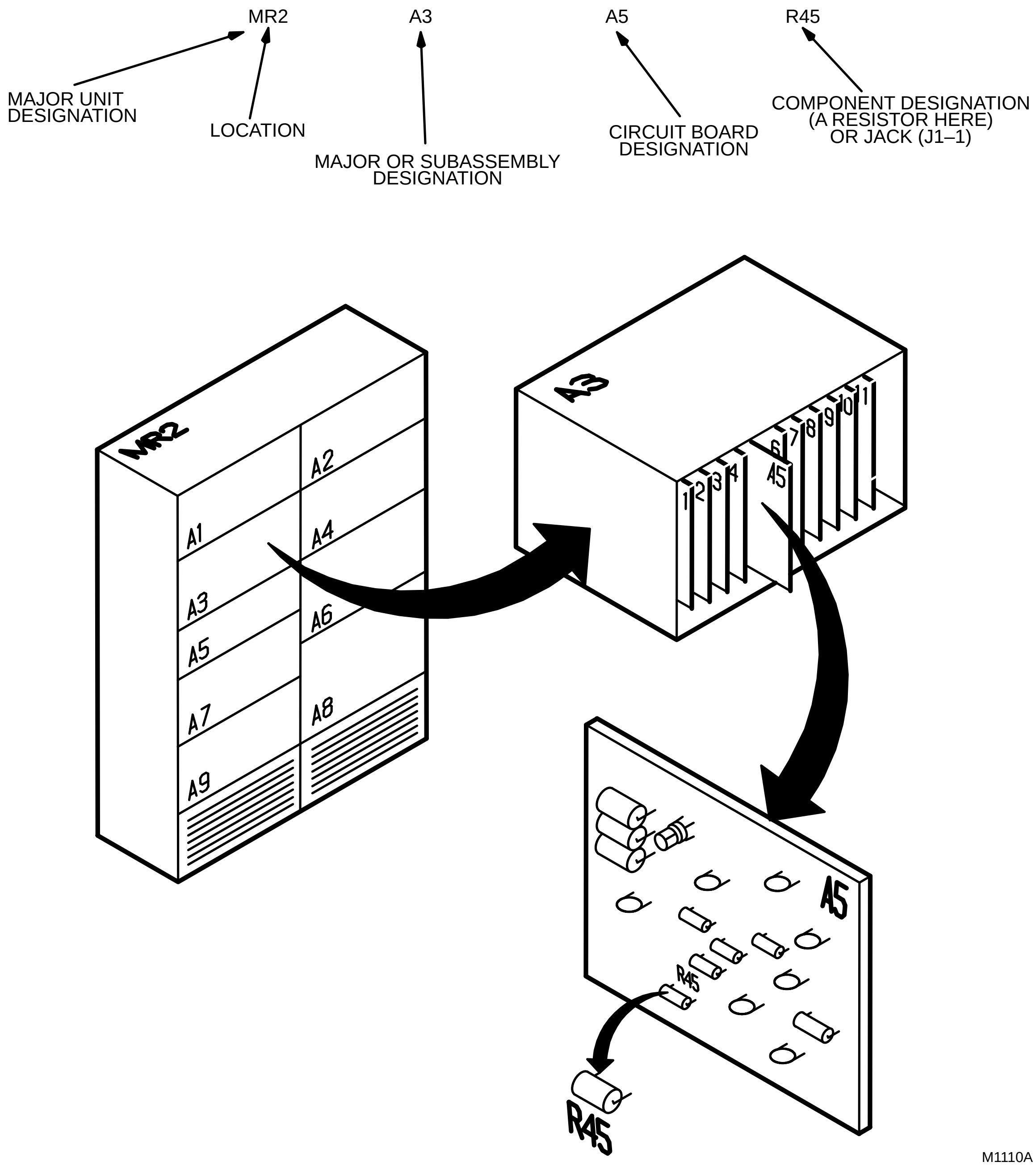
MAGNET COMMISSIONING FLOW DIAGRAM
ILLUSTRATION 1–1

SECTION 2 – VENDOR MANUAL MATRIX

EQUIPMENT	VENDOR	GE AND VENDOR MANUAL NUMBERS	GE AND VENDOR MODEL NUMBERS
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)	750 AMPS 46–294439P6 83–452–010 REV 4 04/03/92	750 AMPS 46–260776G3 EMI MODEL 452–62–1
		1,000 AMPS 46–294439P15 83–452–025 REV A	1,000 AMPS 46–260776G4 EMI MODEL 452–62–1–ESS
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 3 – 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

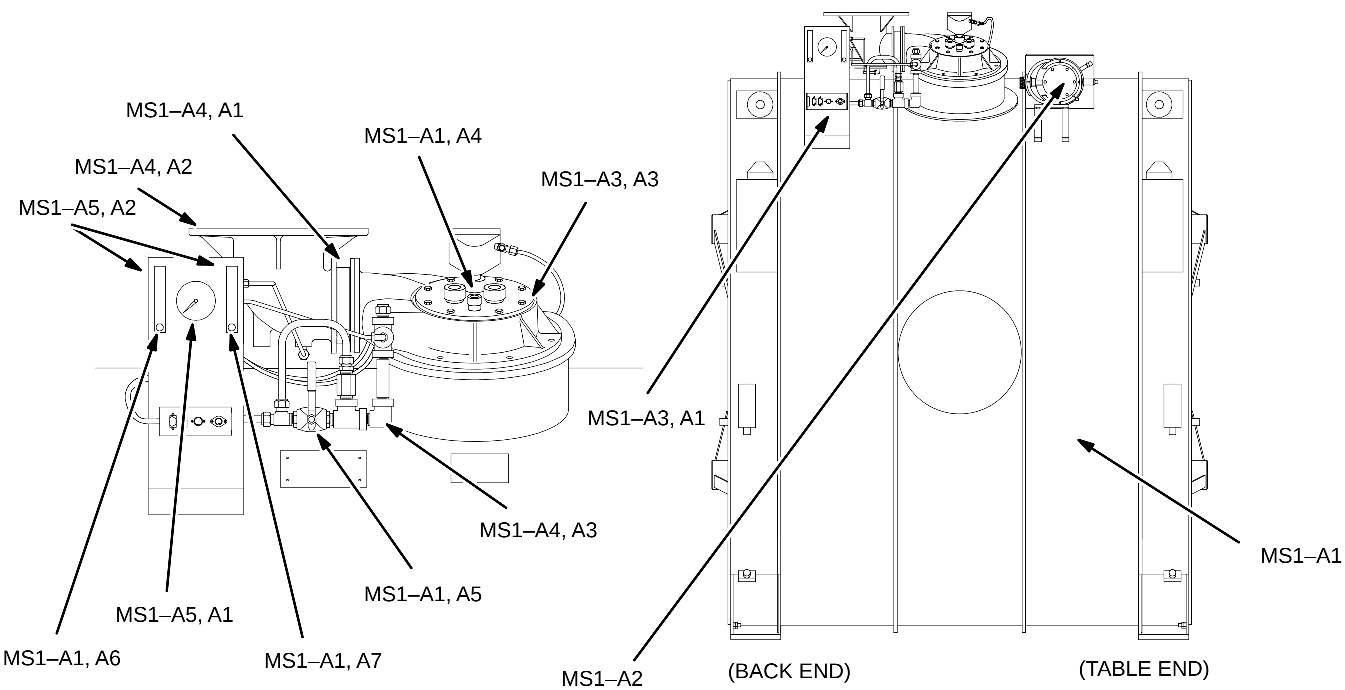


COMPONENT DESIGNATOR SYSTEM
ILLUSTRATION 3–1

SECTION 4 – COMPONENT IDENTIFICATION

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

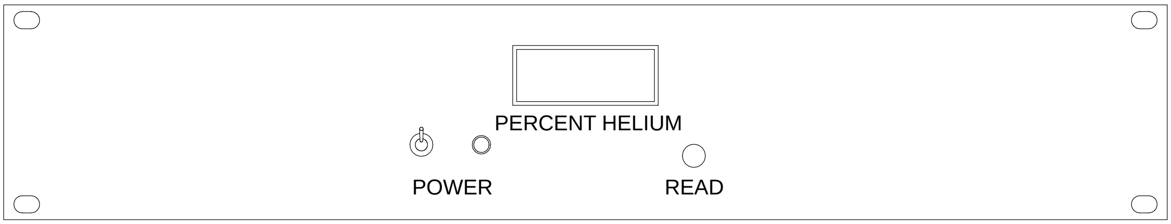
MS1 SUPERCONDUCTING MAGNET / CRYOSTAT

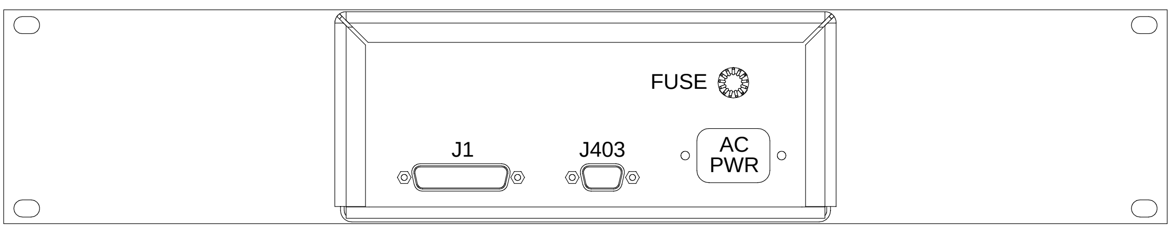


DESIGNATOR	DESCRIPTION	DESIGNATOR	DESCRIPTION
MS1–A1	CRYOSTAT		
		MS1–A3, A3	SERVICE TURRET
		MS1–A4	HELIUM VENTING
MS1–A1, A4	HELIUM FILL PORT (V1)	MS1–A4, A1	BURST DISC
MS1–A1, A5	HELIUM VENT VALVE (V2)	MS1–A4, A2	VENT ADAPTER
MS1–A1, A6	SHIM LEAD VENT VALVE (V3)	MS1–A4, A3	VENT PLUMBING
MS1–A1, A7	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		

SUPERCONDUCTING MAGNET / CRYOSTAT
COMPONENT DESIGNATIONS
ILLUSTRATION 4–1

MR2–A6 CRYOGEN MONITORING SYSTEM





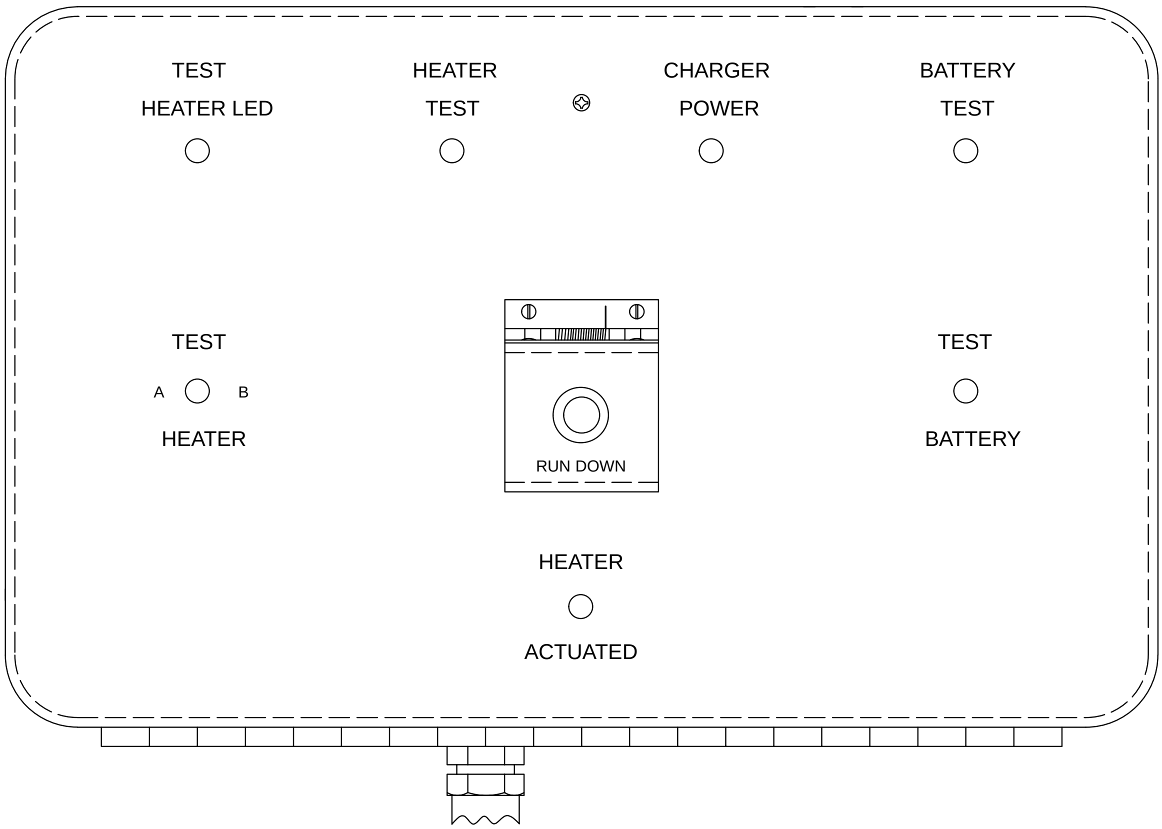
CRYOGEN MONITORING CABINET
MR2–A6,A 1

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

CRYOGEN MONITORING
COMPONENT DESIGNATIONS

ILLUSTRATION 4–2

MS4 MAGNET RUNDOWN UNIT (MRU)

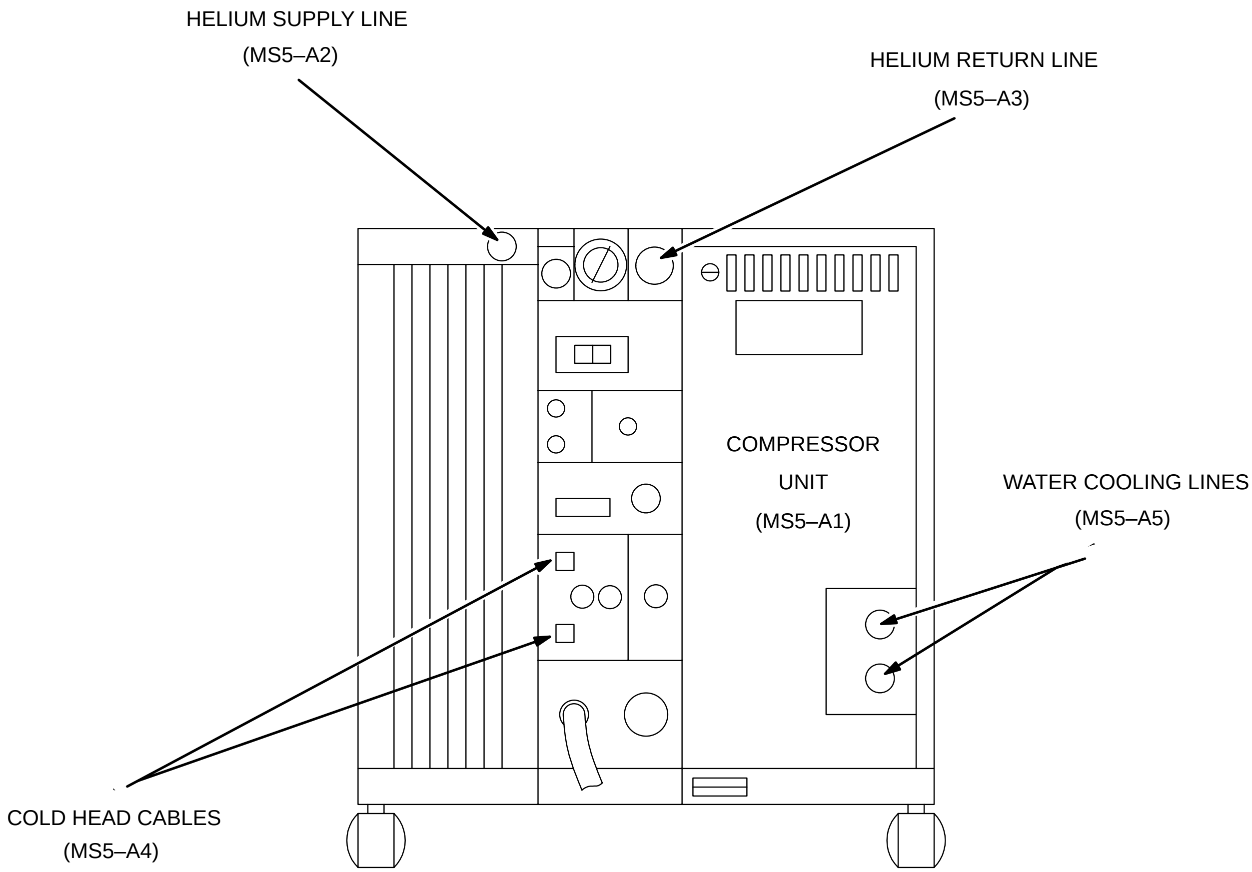


MAGNET RUNDOWN CABINET
(MS4A–A1)

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

MAGNET RUNDOWN UNIT (MRU)
COMPONENT DESIGNATIONS
ILLUSTRATION 4–3

MS5 SHIELD COOLER COMPRESSOR



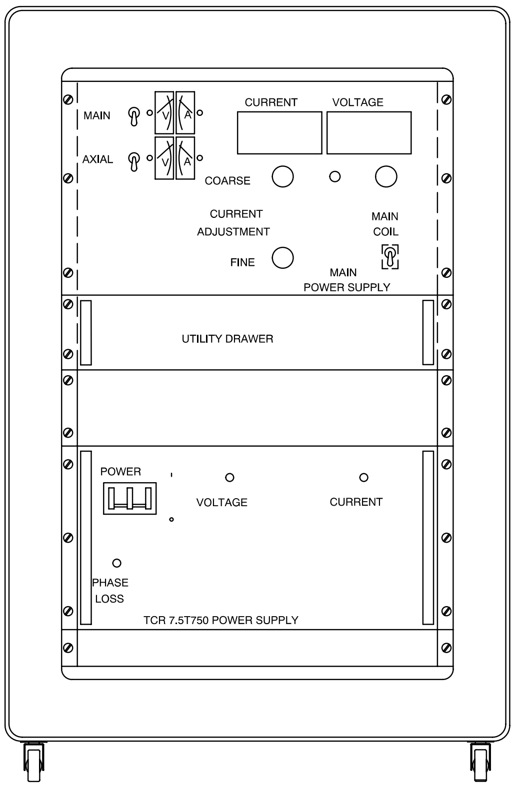
DESIGNATOR	DESCRIPTION
MS5–A1	* SHIELD COOLER COMPRESSOR
MS5–A2	HELIUM SUPPLY LINE
MS5–A3	HELIUM RETURN LINE
MS5–A4	COLD HEAD CABLES
MS5–A5	WATER COOLING LINES

SHIELD COOLER COMPRESSOR
COMPONENT DESIGNATIONS

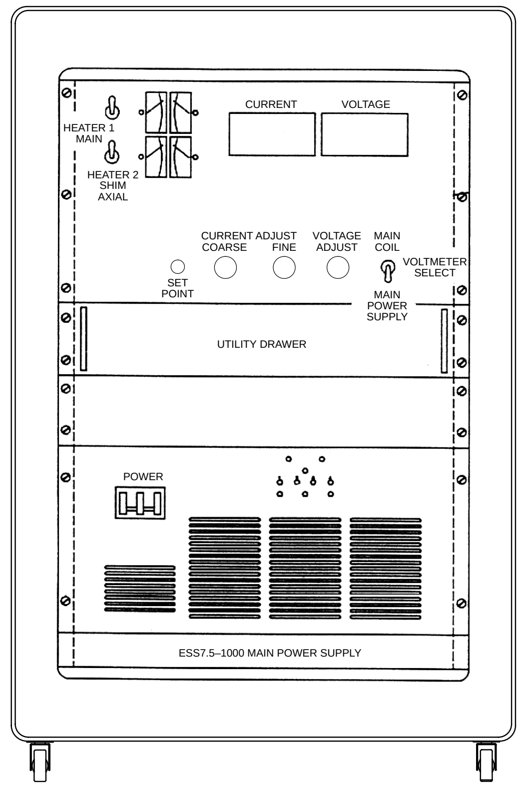
ILLUSTRATION 4–4

MS6 MAGNET SERVICE POWER SUPPLY CABINET

MS6 MAGNET SERVICE POWER
SUPPLY CABINET – 750 AMPS
(46–260776G3)



MS6 MAGNET SERVICE POWER
SUPPLY CABINET – 1,000 AMPS
(46–260776G4)

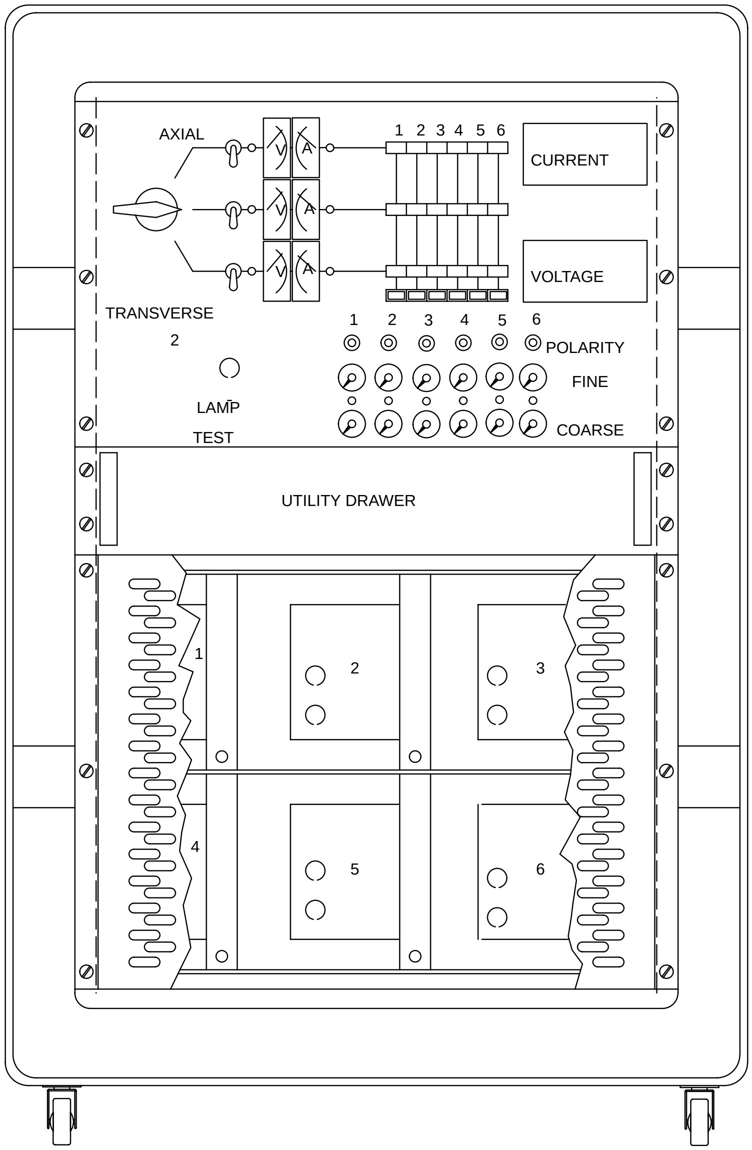


DESIGNATOR	DESCRIPTION
MS6–A1	MAGNET SERVICE POWER SUPPLY CABINET
MS6–A2	MAIN COIL POWER LEADS
MS6–A3	INPUT POWER CORD

MS6 MAGNET SERVICE POWER SUPPLY CABINET

ILLUSTRATION 4–5

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 4–6

SECTION 5 – SAFETY CONSIDERATIONS

5–1 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.
- 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

5–2 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 SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS

5–3–1 INTRODUCTION:

GE Superconducting magnets contain cryogenic liquids (liquid helium = –452°F, –269°C ; liquid nitrogen = –320°F, –196°C) and generate a three–dimensional magnetic field up to 60,000 times the strength of the earth's magnetic field. These conditions require safety precautions to be taken to prevent serious injury (cryogenic burns, asphyxiation, explosion, fire, shock, ferromagnetic projectiles or other magnetic field effects).

The following list of safety precautions / requirements must be reviewed, understood and implemented prior to performing any service on a GE Superconducting Magnet.

Make sure that trained and authorized personnel perform all magnet service and that all safety equipment is in place.

5–3–2 CRYOGEN SAFETY REQUIREMENTS:

1. SITE PRECAUTIONS:

   - Magnet room venting shall be installed, tested, and operating in conformance with site planning requirements. A portable floor fan and exhaust duct shall be used to remove the cold nitrogen gas that stratifies at floor level, from the room to the outside, during nitrogen pre–cool.
   - The magnet shall be vented in conformance with the site planning requirements. Magnet plumbing and vent system shall be inspected for leaks during magnet installation.
   - The door into the magnet room shall open outward and be secured in the open position prior to any service action that will result in the handling or release of cryogens from the magnet. The ceiling hatch and rear door shall be secured in the open position if in a mobile van.
   - Any service actions which release large quantities of cryogenic gas shall have provisions for exhausting the gas through the magnet vent system.
   - Make sure a second person (GE, contractor, or hospital personnel trained in these safety requirements) is present in the area and is scheduled to make routine checks during magnet service in case of emergency.
   - A working phone line to the outside shall be available to call (911) in case of emergency.
   - Post Authorized Personnel Only signs outside the magnet room door prior to bringing cryogens into the magnet room.
   - Ensure an O_2 monitoring device is calibrated and operating properly before beginning service. See Section 5–5, Safety Checklist, for a list of procedures where this device is required.

2. EQUIPMENT PRECAUTIONS:

   - Do not bring any ferromagnetic equipment, dewars or cylinders into the magnet room when the magnet is ramped. They will become dangerous projectiles in the presence of the magnetic field.
   - Helium gas cylinders are pressurized to 2400 psi. Secure each helium cylinder before removing the protective cap and open the main valve very slowly to prevent any possibility of a fatal release of explosive gas. Make sure gas cylinders are stored in a secured position.
   - Firmly hold the unattached end of the gas hose during a purge to prevent hose's "whipping" motion.
   - Keep dewars in the vertical position at all times. Dewars should have wheels mounted at the base for transport. If wheels are not present, use a low platform dolly which fully encompasses the dewar's base for moving. Do not slide or roll dewars. Use a suitable hand truck to move gas cylinders.

5–3–2 CRYOGEN SAFETY REQUIREMENTS: (continued)

2. EQUIPMENT PRECAUTIONS: (CONTINUED)

- Store dewars in a well ventilated area.
- Make sure that safety relief valves and regulators are operating properly.
- Check all equipment, dewars, and gas cylinders for leaks.
- Make sure the transportation route for dewars and gas cylinders is clear of obstacles and restrictions.

3. MAGNET PRECAUTIONS:

- **RAMP MAGNET DOWN TO ZERO FIELD** prior to any service requiring opening / exposure to the helium vessel and / or cryogenic gas / liquid, except for the removal of fill and ramp lead port caps, to prevent the possibility of a magnet quench and rapid expulsion of cryogenic helium gas and liquid.
- Make sure non–ferromagnetic fiber or composition safety shoes are worn in the magnet room.
- Observe helium vessel pressure gauge and vent the magnet down to < 0.5 psi before removing ramp / fill port caps or loosening component resulting in the release of cryogenic helium gas and liquid.
- Never allow a helium dewar to empty during a magnet fill resulting in a magnet quench from the introduction of warm helium gas.
- In case of a magnet cryogenic vent failure during a quench stay near the floor where the oxygen will be and immediately exit the magnet room.
- Use caution when inserting ramp leads or shim lead (LCC) into a ramped magnet to prevent a quench.

4. CRYOGEN HANDLING PRECAUTIONS:

- Contact of liquid cryogens or their vapors with the eyes can cause severe frostbite even when contact is too brief to affect the skin. Always wear safety goggles / face shield when handling cryogens.
- Never allow any unprotected part of the body to touch cold magnet plumbing.
- Protective clothing (long sleeve shirt, long pants, protective apron / jacket) and dry, non–absorbent gloves shall be worn when handling or being exposed to cryogens, to prevent cold burns from contact with the cryogenic liquid or gas.
- Make sure a calibrated, functioning oxygen monitor is installed in magnet room in conformance with the site requirements or that all personnel present in the magnet room have calibrated, functioning portable oxygen monitors on their person. See Section 5–5, Safety Checklist, for a list of procedures where this device is required.
- Smoking is prohibited in the magnet room and around cryogens. Liquid cryogens can liquify atmospheric oxygen producing a highly enriched oxygen liquid.
- When pluming a stinger, always point the stinger toward the ceiling and away from the face at a 45 degree angle.
- Do not bring over 1000 liters of cryogens into the magnet room.

5–3–2 CRYOGEN SAFETY REQUIREMENTS: (continued)

5. FIRST AID:

- Move persons suffering from a lack of oxygen immediately to an area with normal atmosphere and seek medical assistance. Self–contained breathing apparatus may be required to rescue workers from an oxygen–depleted area to prevent asphyxiation.
- Flush frostbitten or cold burn areas with large volumes of tepid water (105°F to 115°F; 41°C to 46°C)

5–3–3 MAGNETIC FIELD SAFETY REQUIREMENTS:

1. SITE PRECAUTIONS:

- Post warning signs outside the 5–gauss zone, including areas above and below the magnet room, prior to ramping the magnet to warn personnel with cardiac pacemakers, neurostimulators, steel plates or other conditions affected by a magnetic field not to proceed into the area.
- Post "ramped magnet" warning sign at magnet room entrance prior to ramping the magnet.
- Notify site administration before ramping the magnet.
- Remove all loose ferromagnetic material from the magnet room.
- Make sure that the Magnet Rundown Unit (MRU) is operating properly.
- Do not bring any ferromagnetic tools / objects into the magnet room when the magnet is ramped.
- Do not loosen any ferromagnetic components on a ramped magnet.
- Wear leather gloves when opening / closing the coldhead motor shield.
- Use caution when opening / closing top half of coldhead motor shield. Never put fingers / hand between motor shield and mounting bracket.

2. RAMPING PRECAUTIONS:

- A superconducting magnet at field is a high energy storage device capable of discharging rapidly (quenching), creating a high voltage across the main leads. Do not touch both main lead extensions at the same time or allow them to come in contact together.
- Allow main lead extensions to cool before fully inserting them into a ramped magnet to prevent any possibility of a quench.
- Make sure the power supply has passed all functional checks and the input power cable is disconnected before connecting it to the main power leads.
- Make sure the final magnet "parking" current and voltage polarity has been recorded and will be available to prevent a quench if a rampdown is required.
- Use the appropriate hold–down tool to properly secure ramp leads to the magnet.

3. EMERGENCY RAMPDOWN:

- Make sure the Magnet Rundown Unit (MRU) has been installed in conformance with the GE magnet service manual, the batteries have been charged for 24 hours and the MRU has passed the functional checks in conformance with the supplier manual before ramping the magnet.
- Make sure the rampdown methods covered in the introduction of the GE magnet service manual are fully understood by service and hospital personnel involved with the MR equipment.

5–3–3 MAGNETIC FIELD SAFETY REQUIREMENTS: (continued)

4. MAGNET QUENCH:
   - In case of a magnet quench where helium enters the magnet room, make sure magnet room exhaust vent is on, then immediately leave the room.
   - If the hospital has piped oxygen or air, know the location of it.

IMPORTANT !!!

All service and hospital personnel involved with the MR equipment need to be trained in the Superconducting Magnet Safety Requirements provided above. Good overall safety practice and training are essential. It is not the intent of this document to be a substitute for these requirements.

5–4 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.

5–5 SAFETY CHECKLIST

TABLE 5–1
SAFETY CHECKLIST
(X = REQUIRED ITEM FOR PROCEDURE)

Safety Checklist Item	Procedure												
	Conversion to Operating Configuration	Venting Installation	Nitrogen Precool	Helium Precool / Warm–Up	Helium Fill	Magnet Ramping	Magnet S/C Shim	Magnet P–Shim	Burst Disk / Plumbing Component Replacement	Magnet / Recondenser De–Icing	Shim Lead Replacement	Baffle / Instrumentation Lead Replacement	Crycooler Service
1. Cryogenic vent system installed per requirements	X	X	X	X	X	X	X	–	X	X	X	X	X
2. Mobile van ceiling hatch secured open	X	X	X	X	X	X	X	–	X	X	X	X	X
3. Room ventilation fan tested and running (room exhaust at ceiling)	X	X	X	X	X	X	X	–	X	X	X	X	X
4. Room ventilation fan tested and running (room exhaust at floor)	–	–	X	–	–	–	–	–	–	–	–	–	–
5. Vent magnet and inspect exhaust	X	X	X	X	X	X	X	–	–	X	X	X	X
6. Second person on site and trained in safety practices for procedure being performed	X	X	X	X	X	X	X	X	X	X	X	X	X
7. Magnet Room doors secured open to assist in room ventilation. Ensure cross ventilation to outside or other large volume non–workspace.	X	X	X	X	X	X	X	–	X	X	X	X	X
8. O_2 Monitor on site, tested and functional for both visual and audible alarms. Portable device P/N 2287000 for magnets up to and including 3.0T, For magnets greater than 3.0T, see you MAC team leader and refer to S/N 65051 for proper monitoring equipment.	X	X	X	X	X	X	X	–	X	X	X	X	X
9. Cryogen Safety Kit (P/N 46–271137G1) on site for use. Kit includes cryogen gloves, face shield and goggles.	X	X	X	X	X	X	X	–	X	X	X	X	X
10. Nonferrous safety shoes	X	X	X	X	X	X	X	X	X	X	X	X	X
11 Secure area and display signs alerting of intended process	X	X	X	X	X	X	X	X	X	X	X	X	X
12. Verify dewar transportation path is clear.	–	–	X	X	X	X	–	–	–	–	–	–	–
13. Dewars stored in a ventilated area.	–	–	X	X	X	X	X	–	–	–	–	–	–
14. Not–in–use gas cylinders secured to wall with protective cap in place.	–	–	X	X	X	X	X	–	X	X	X	X	X
15. Before removing protective cap on gas cylinder, secure to wall or nonmagnetic cart.	–	–	X	X	X	X	X	–	X	X	X	X	X
16. Move gas cylinders / dewars without wheels using had trucks designed for purpose.	–	–	X	X	X	X	X	–	X	X	X	X	X

17. Keep gas cylinders / dewars in upright position at all times.	–	–	X	X	X	X	X	–	–	–	–	–	–
18. Keep ferromagnetic equipment / objects out of magnet room when magnet is ramped.	–	–	–	–	X	X	X	X	X	X	X	X	X

5–5 SAFETY CHECKLIST (continued)

TABLE 5–1
SAFETY CHECKLIST (CONTINUED)
(X = REQUIRED ITEM FOR PROCEDURE)

Safety Checklist Item	Procedure: Conversion to Operating Configuration	Venting Installation	Nitrogen Precool	Helium Precool / Warm–Up	Helium Fill	Magnet Ramping	Magnet S/C Shim	Magnet P–Shim	Burst Disk / Plumbing Component Replacement	Magnet / Recondenser De–Icing	Shim Lead Replacement	Baffle / Instrumentation Lead Replacement	Crycooler Service
19. Wear long–sleeve shirt and apron designed for cryogenic servicing.	–	–	X	X	X	X	X	–	X	X	X	X	X
20. Inspect all pressure regulators for proper functioning.	–	–	X	X	X	X	X	–	X	X	X	X	X
21. Inspect all pressure relief valves and ensure proper configuration to achieve recommended pressure (e.g., 20 psi).	–	–	X	X	X	X	X	–	X	X	X	X	X
22. Inspect all valves and fittings for leaks.	–	–	X	X	X	X	X	–	X	X	X	X	X
23. MRU installed and tested prior to magnet ramp.	–	–	–	–	–	X	X	X	X	X	X	X	X
24. Post “Ramped Magnet” warning signs (P/N 46–258770G4 furnished with kit 46–282429G33).	–	–	–	–	–	X	–	–	–	–	–	–	–
25. Notify Hospital Administrator when magnet is ramping.	–	–	–	–	–	X	–	–	–	–	–	–	–
26. Remove all ferromagnetic material from Magnet Room before ramping or shimming magnet.	–	–	–	–	X	X	X	X	–	–	–	–	–
27. Use only single dewar connection (i.e., no daisy–chain connections)	–	–	X	X	X	X	X	–	–	–	–	–	–
28. Post “Authorized Personnel Only” signs at entrance to MR suite. signs are furnished with kit P/N 46–282429G33.	X	X	X	X	X	X	X	X	X	X	X	X	X
29. Identify and label dewars as full or empty; label dewar storage area.	–	–	X	X	X	X	–	–	–	–	–	–	–
30. Remove frost from valve operators on magnet after each dewar change.	–	–	X	X	X	X	–	–	–	–	–	–	–

SET UP AND CALIBRATION

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SECTION 1 – MAGNET SYSTEM INSTALLATION

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE SAFETY CHECKLIST SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

WARNING!

MAKE SURE BOTH MAGNET AND ROOM VENTING SYSTEMS ARE INSTALLED IN THE MAGNET ROOM IN CONFORMANCE WITH THE APPLICABLE PREINSTALLATION MANUAL (ROOM VENTILATION AND CRYOGENIC VENTING) 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.

DO NOT STAND ON TOP OF MAGNET! INJURY MAY RESULT FROM FALLING. PERFORM ALL SERVICE ACTIONS REQUIRING ACCESS TO TOP OF MAGNET FROM THE PLATFORM LADDER (P/N 22656565) SUPPLIED WITH MAGNET.

IMPORTANT

Procedures for moving the magnet into the exam room and leveling the magnet are covered in the GE 1.5T & 1.0T Active Shield Magnet Delivery and Installation Manual (2168178) in Sections 5 and 6. 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.

A helium gas cylinder, regulator, gas hose and heat gun should be available at the site to use in case any ice / frost needs to be cleared in the magnet. Helium gas will be required later during cryogen fill.

1–1 SERVICE PLATFORM INSTALLATION AND ACCESS

Description:

The service platform (2195887) is shipped with the magnet and must be installed to allow access to top of magnet during shipping, rigging, functional checks, etc. and prior to performing installation functions on the top of the magnet (blanking plate removal, vent installation . . .).

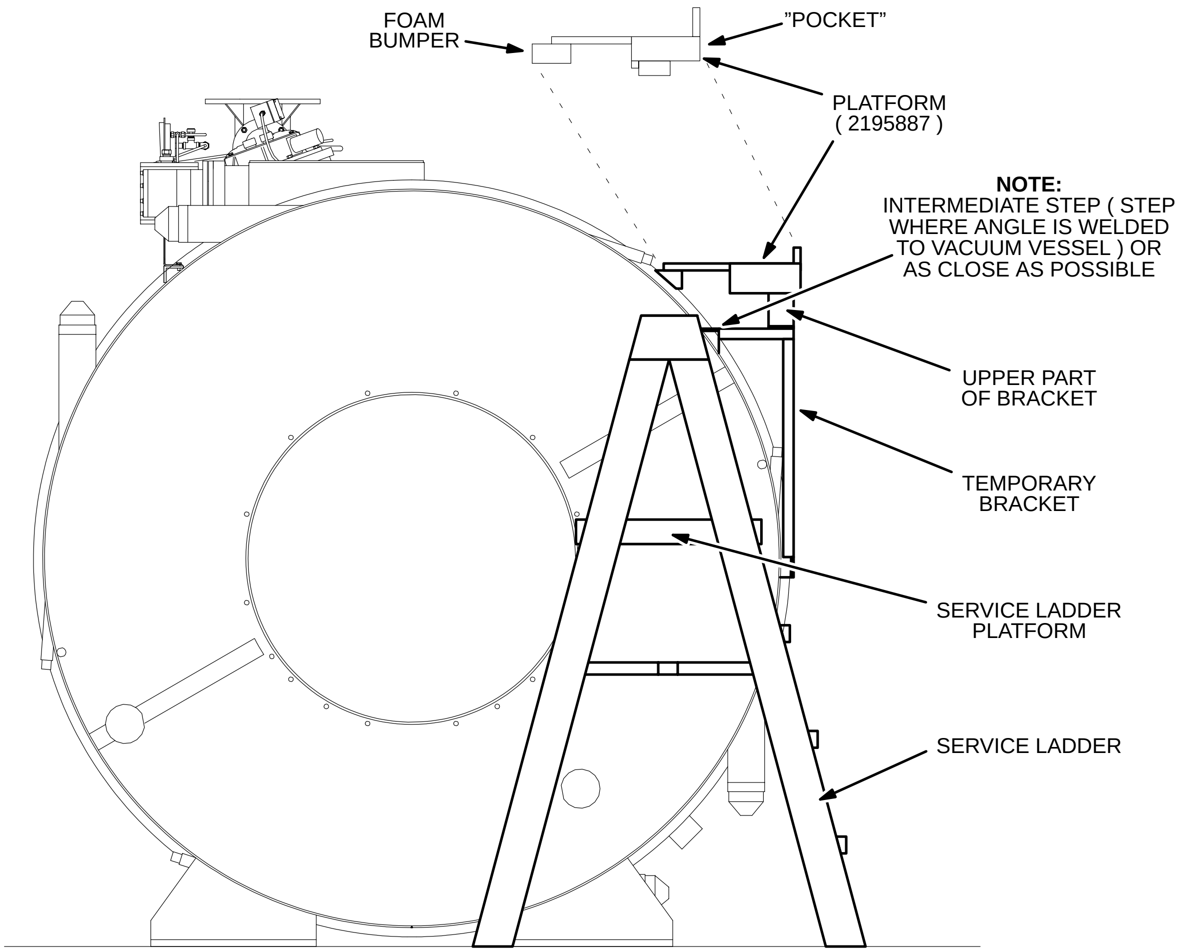
Remove platform before any lifting or moving operations are performed.

Install the platform after the magnet has been brought into the magnet room to prevent any interference problems from occuring during magnet lifting and moving into the room.

Procedure:

1. Locate and unpack (as required) the service platform (2195887) and ladder that was shipped with magnet.
2. Place platform on temporary brackets located on magnet. See Illustration 1–1. Make sure bracket upper part is fully enclosed in the “pockets” on underside of platform. If magnet is installed reversed from normal orientation, remove filler block (3 pieces) from platform (remove two .25–20UNC x 3.50” long hex head cap screws / nuts) and move to other end. See Illustration 1–1A.

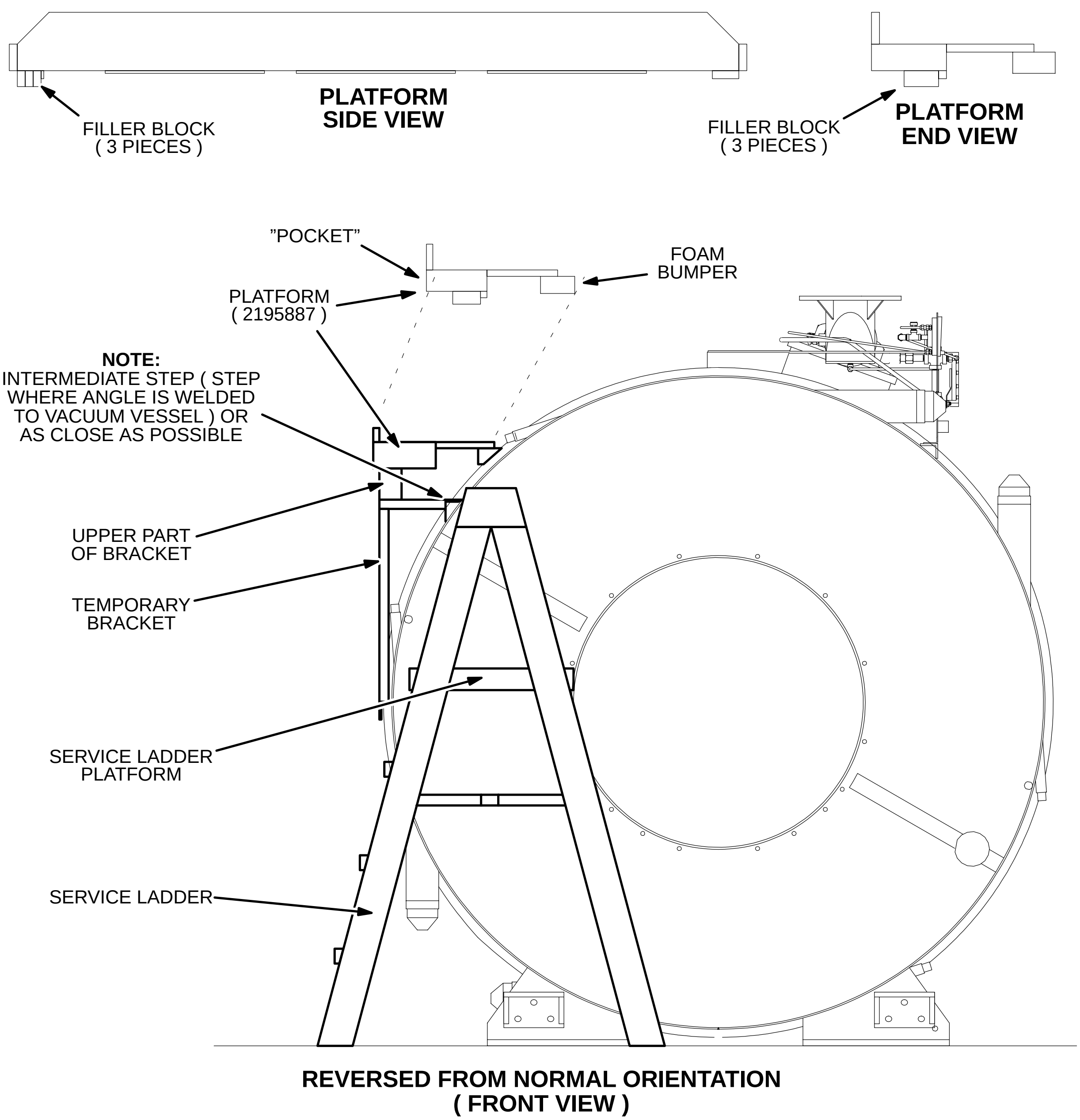
1–1 SERVICE PLATFORM INSTALLATION AND ACCESS (continued)



NORMAL MAGNET ORIENTATION
(FRONT VIEW)

SERVICE PLATFORM INSTALLATION
ILLUSTRATION 1–1

1–1 SERVICE PLATFORM INSTALLATION AND ACCESS (continued)



SERVICE PLATFORM INSTALLATION (continued)
ILLUSTRATION 1–1A

1–1 SERVICE PLATFORM INSTALLATION AND ACCESS (continued)

WARNING!

MAKE SURE SERVICE LADDER USED IN STEP 3 IS STABLE AND SECURE. EXTREME CARE MUST BE USED WHEN CLIMBING LADDER AND STEPPING ACROSS TO SERVICE PLATFORM. A SECOND PERSON TO STABILIZNG LADDER IS HIGHLY RECOMMENDED. SERIOUS BODILY INJURY CAN OCCUR SHOULD LADDER SLIP OR FALL.

3. Access the platform from the service ladder which must be positioned / located at the front or back end of the magnet. Use the intermediate step shown in Illustration 1–1 and 1–1A when moving from ladder to platform.

1–2 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 Valves 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 1–2.

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.

1–2 CONVERSION TO OPERATING CONFIGURATION (continued)

Procedure:

1. Make sure flowmeter and plumbing valves are left in factory–set positions. See Illustration 1–2. (V3 and V4 factory settings for shipment achieve maximum cooling efficiency during shipment.)

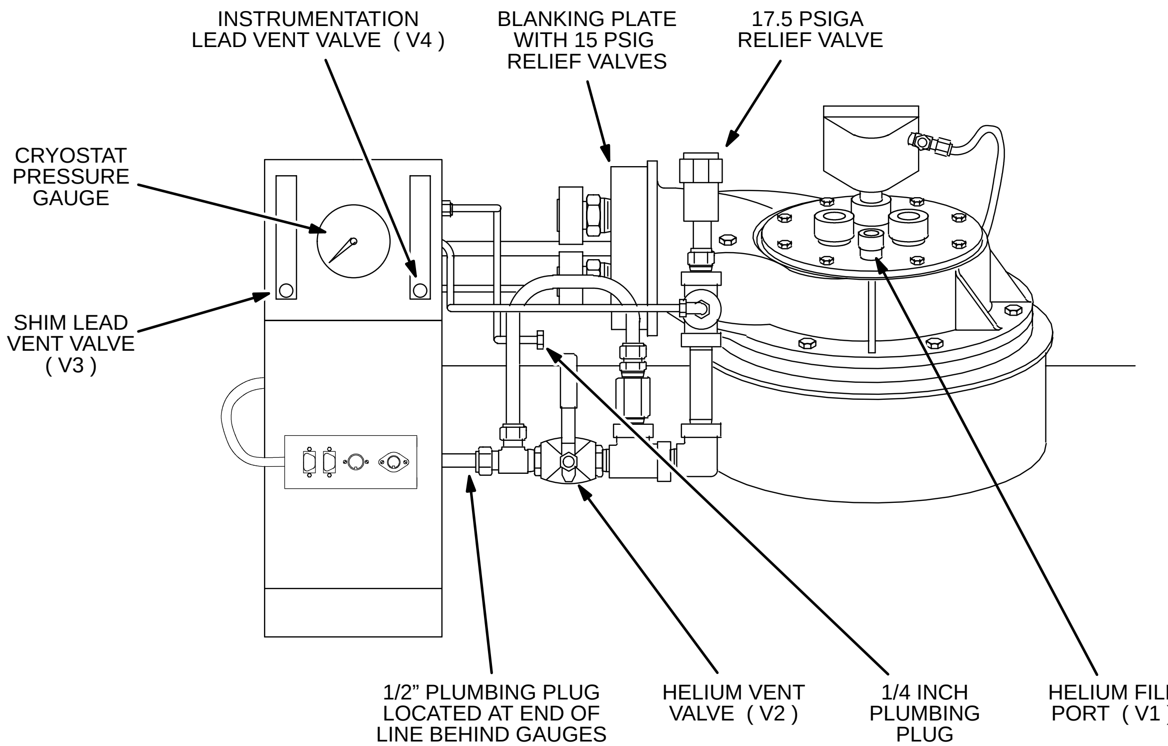
2. Record the Cryostat Pressure Gauge reading in the DATA SHEETS tab, Table 1–1. See Illustration 1–2.

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.

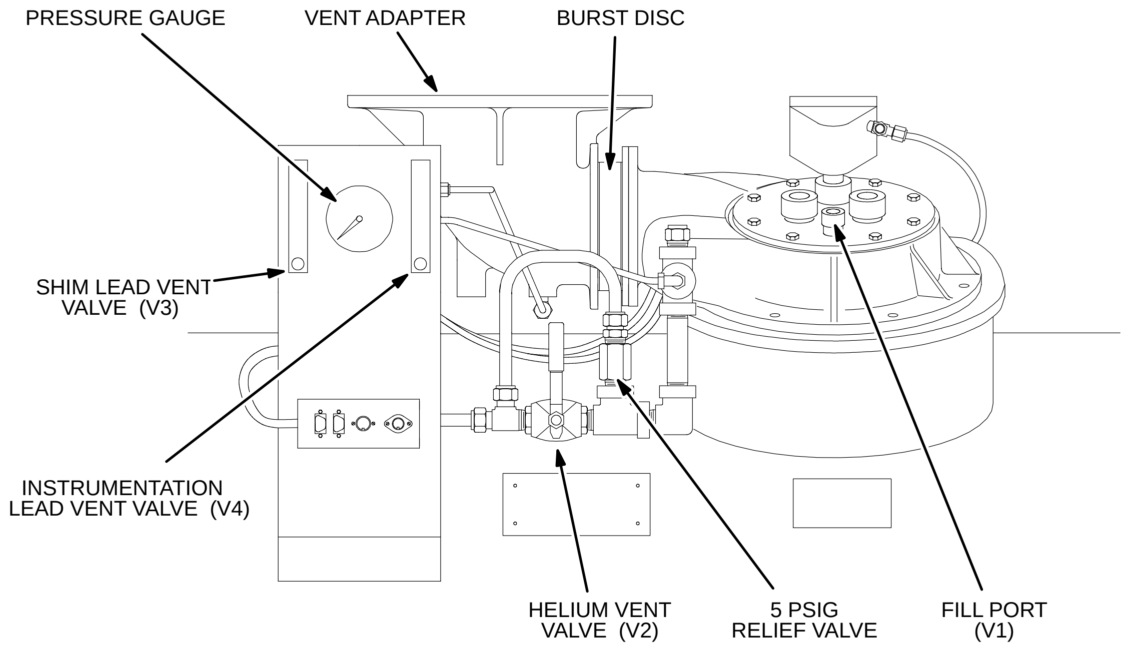
3. Remove the plug at the end of the 1/2 inch plumbing. See Illustration 1–2.

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



MAGNET AIR SHIPMENT CONFIGURATION
ILLUSTRATION 1–2

1–2 CONVERSION TO OPERATING CONFIGURATION (continued)



VALVE LOCATIONS
ILLUSTRATION 1–3

5. Close valves V3 and V4 at the base of the flow meters. See Illustration 1–3.

6. 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.

7. 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 (46–252552P4), shipped with the magnet, onto the Threaded Tee where the relief valve was removed.

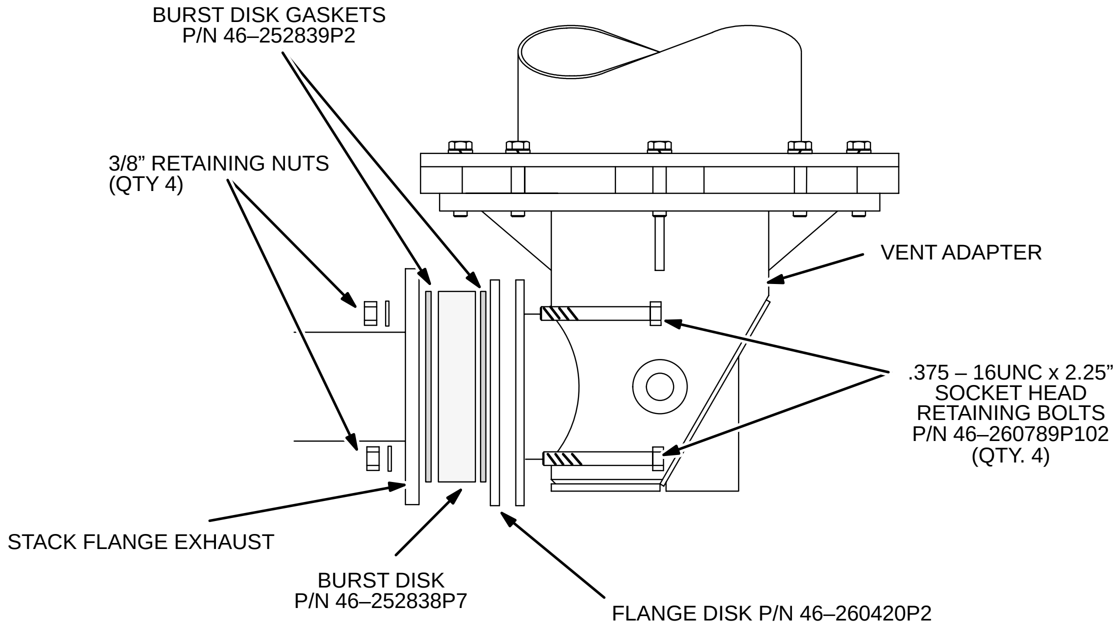
8. Unpack the 10 psi Burst Disc from its container, located in the Venting Hardware Kit. Inspect Burst Disc for visible damage (nicks / scratches). Make sure the Burst Disc has the proper part number (46–252838P7 *)* and rating plate marking of 10 psi.

9. Loosen the four Socket Head Retaining Bolts which secure the 15 psi Shipping Relief Valve and Blanking Plate to the Stack Flange Exhaust. 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 1–2.

10. Remove the 15 psi Shipping Relief Valves and Blanking Plate.

11. Install the burst disc and gaskets with the disc’s flat face facing out from the stack flange. See Illustration 1–4.

1–2 CONVERSION TO OPERATING CONFIGURATION (continued)



HELIUM VESSEL BURST DISC ASSEMBLY
ILLUSTRATION 1–4

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).

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

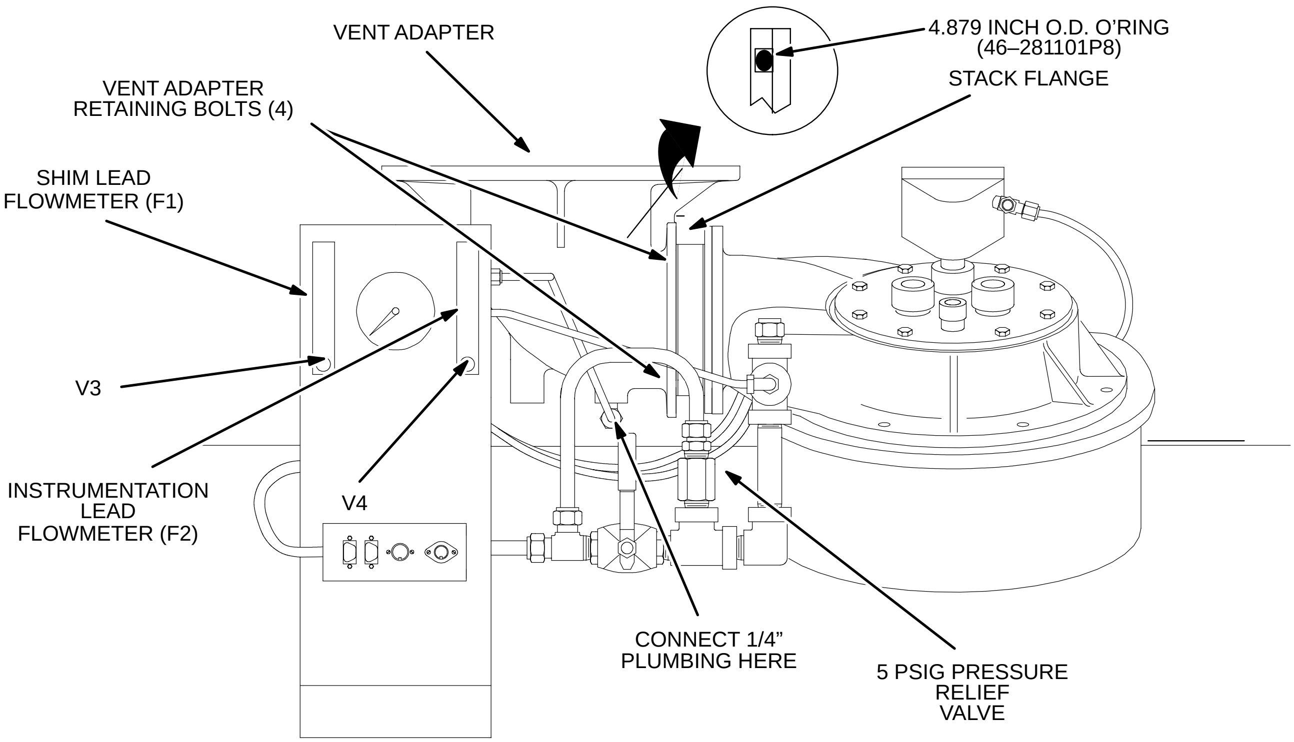
Note

See Illustration 1–5 for Steps 13 through 16.

13. Install the 4 inch O–ring (46–281101P8), located in the Venting Hardware Kit, in the groove of the Vent Adapter.
14. 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.
15. Connect the 1/2 inch Plumbing line, where the Plumbing Plug was connected, to the Vent Adapter.
16. Connect the 1/4 inch Plumbing from the Swagelok Fitting on the Flowmeter to the under side of the Vent Adapter.
17. Open valves V3 and V4 on Flowmeters F1 and F2.
18. Remove the four 15 psi Relief Valves 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

1–2 CONVERSION TO OPERATING CONFIGURATION (continued)



VENT ADAPTER & PLUMBING CONNECTIONS
ILLUSTRATION 1–5

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).

19. Open Vent Valve (V2) to depressurize helium vessel to 0.25 psig. Close V2.

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

20. Set Instrumentation Lead Vent Valve (V4) for a reading between 0.8 – 1.2 SCFH on Flowmeter F2.
21. Set Shim Lead Vent Valve (V3) for a reading between 1.8 – 2.2 SCFH on Flowmeter (F1) to maintain a Helium Vessel Pressure Gauge reading between 0.25 – 0.50 psig.
22. Make sure flow rate through F2 is equal or greater than 0.8 SCFH.
23. If the 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, the 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.

1–2 CONVERSION TO OPERATING CONFIGURATION (continued)

24. 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

25. Remove the Jacking Pads from the Magnet Feet and store onsite. Inform customer of storage requirements. Notify customer that jacking pads are part of magnet and need to be stored in an accessible place for future use.

1–3 VENTING INSTALLATION

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE SAFETY CHECKLIST SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

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).

CAUTION

Never place weight (objects) on the coldhead or sleeve as irreparable damage may result.

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.

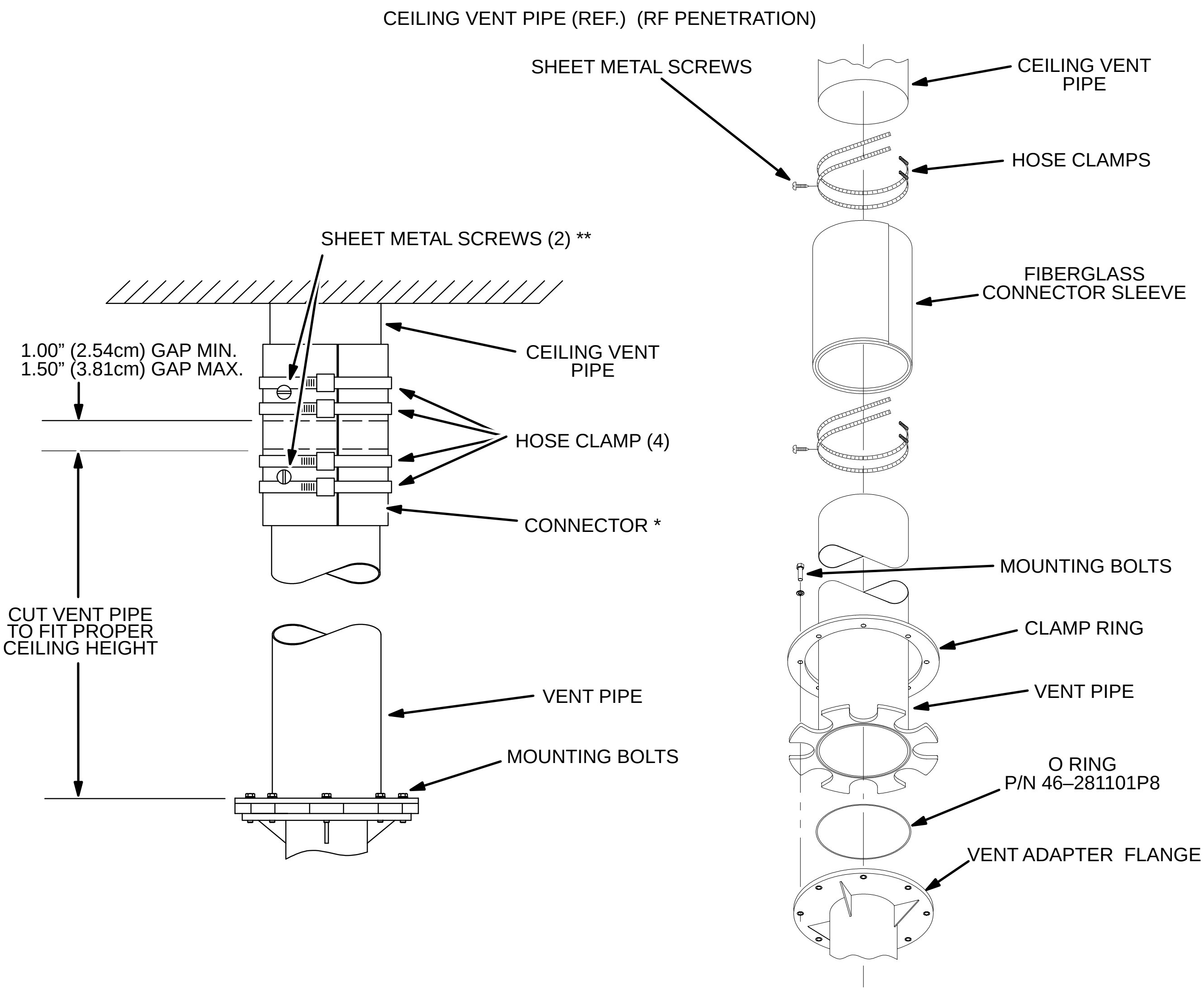
1–2 CONVERSION TO OPERATING CONFIGURATION (continued)

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 Vent Pipe before connecting Vent Pipe to Ceiling Vent Pipe.



* 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 1–6

1–3 VENTING INSTALLATION (continued)

2. Measure and cut the Vent Pipe for proper gap, at the Ceiling Vent Pipe, shown in Illustration 1–6.

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.

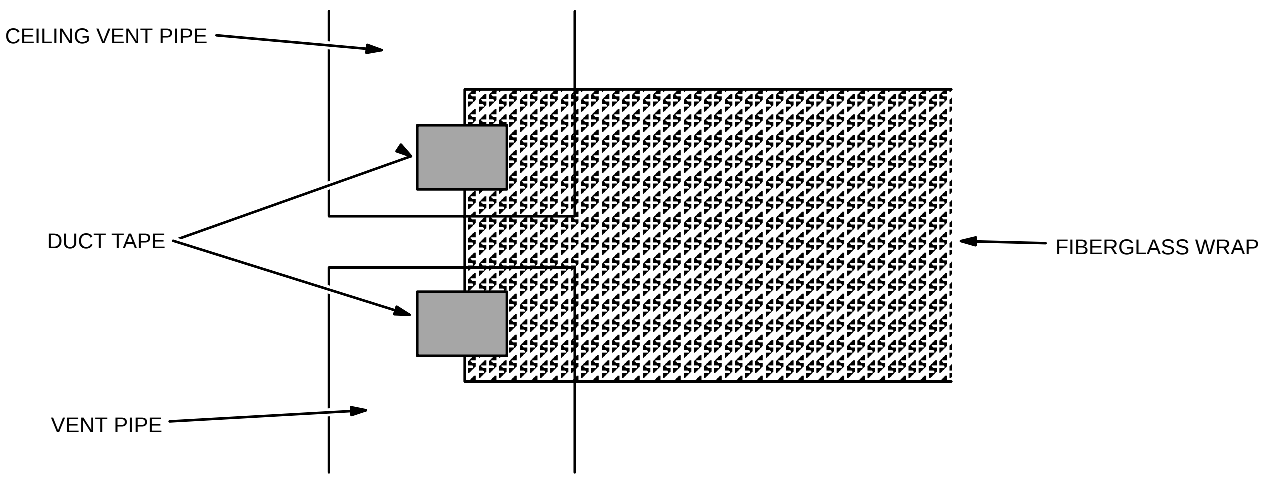
Note

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.

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 1–7.



FIBERGLASS WRAP INSTALLATION
ILLUSTRATION 1–7

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 1–6.

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 1–6.

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.

1–3 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 in. (mm)	DISTANCE OF VENT SYSTEM COMPONENT FROM MAGNET ft (m)	PRESSURE DROP FOR STRAIGHT VENT PIPE WITH SMOOTH INSIDE SURFACE psi/ft	(KPa/m)	STANDARD SWEEP 45° ELBOW psi	(KPa)	STANDARD SWEEP 90° ELBOW psi	(KPa)	LONG SWEEP 45° ELBOW psi	(KPa)	LONG SWEEP 90° ELBOW 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).

1–4 INSTALLATION OF INERTIA MASS DAMPENER KIT (REQUIRED ONLY FOR THE LEYBOLD COLDHEAD)

Note Inertia Mass Dampener Kit may not be required and therefore not shipped with all magnets. If kit is not present, move on to Subsection 1–5.

1–4–1 FIXED SITE – 2177596

WARNING!

THIS PROCEDURE REQUIRES THE HANDLING OF HEAVY PARTS (UP TO 33 POUNDS). MAKE SURE SERVICE LADDER IS FIRMLY IN PLACE AND USE CAUTION IN HANDLING PARTS TO AVOID DROPPING PARTS OR STRAINING MUSCLES. CARE MUST BE TAKEN WHEN INSTALLING THE HEAVY PLATES. PINCHED FINGERS OR OTHER SERIOUS BODILY INJURY CAN OCCUR.

Note The Inertia Mass Dampener Kit (2177596) is shipped separately with magnet as part of the shipping collector. It is to be installed on magnet prior to commissioning of the coldhead. Nuts on axial stops (typical 3 places) must be loosened on fixed site magnets before installation of the inertia mass dampener kit. See Illustration 1–8. Nuts MUST be re–tightened to original configuration if magnet is moved.
DO NOT LOOSEN ON MOBILE MAGNETS.

Procedure:

1. Loosen nuts on axial stops (typical 3 places). See Illustration 1–8. Re–tightened to original configuration if magnet is shipped to another location.

CAUTION

Do not remove the rubber isolators that are attached between the bellows flange and the cryostat. Removal of the isolators results in the collapse of the bellows assembly and potentially destroying the magnet. See Illustration 1–8.

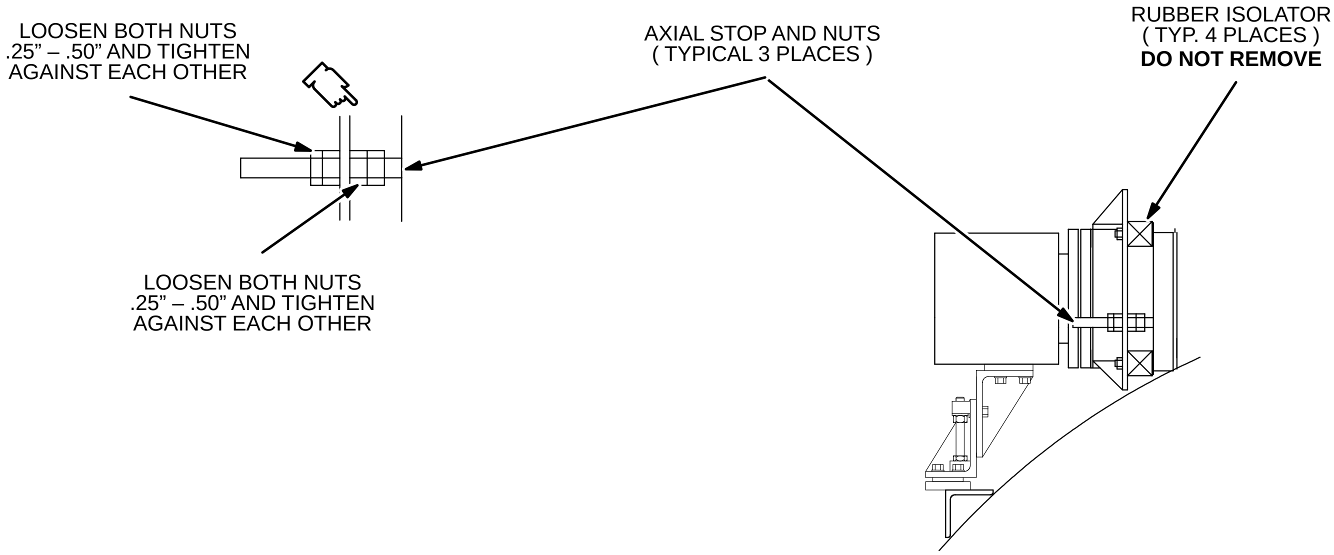
Be very careful when working near the coldhead sleeve bellows with tools. Damage to the bellows may result in the loss of the cryostat vacuum.

The magnet service procedures must be performed by trained personnel. Contact your MAC Team Leader for training prior to any servicing.

Note If you have any experience with coldhead set up on other magnet types and need to get this coldhead online before a MAC Team Leader can assist you onsite with training, you may connect the gas lines and start the coldhead without making any adjustments to the shipping hardware. The coldhead will operate okay with the flange locked in the shipping configuration.

2. Assemble the channel assembly to the pipe between the feet of the magnet using two “U” bolts, nuts and washers privided in the kit. Locations for channel alignment are already in place for some magnets either by taped in place “U” bolts or marked locations. See Illustration 1–9.

1–4–1 FIXED SITE – 2177596 (continued)



LOOSENING NUTS ON AXIAL STOPS
ILLUSTRATION 1–8

2. Place channel assembly in upright position. Align center of coldhead with vertical center of opening between channels. See Illustration 1–9.

3. Tighten "U" bolt nuts securely making sure channel assembly is firmly in position.

Note"U" bolts nuts may need to be loosened and adjustments made to the location of the channel assembly further along in this procedure.

CAUTION

Loosely add ty–wraps around top of frame and base of cryocooler motor shield bracket to secure channel assembly in the upright position to avoid injury during plate installation. See Illustration 1–9.

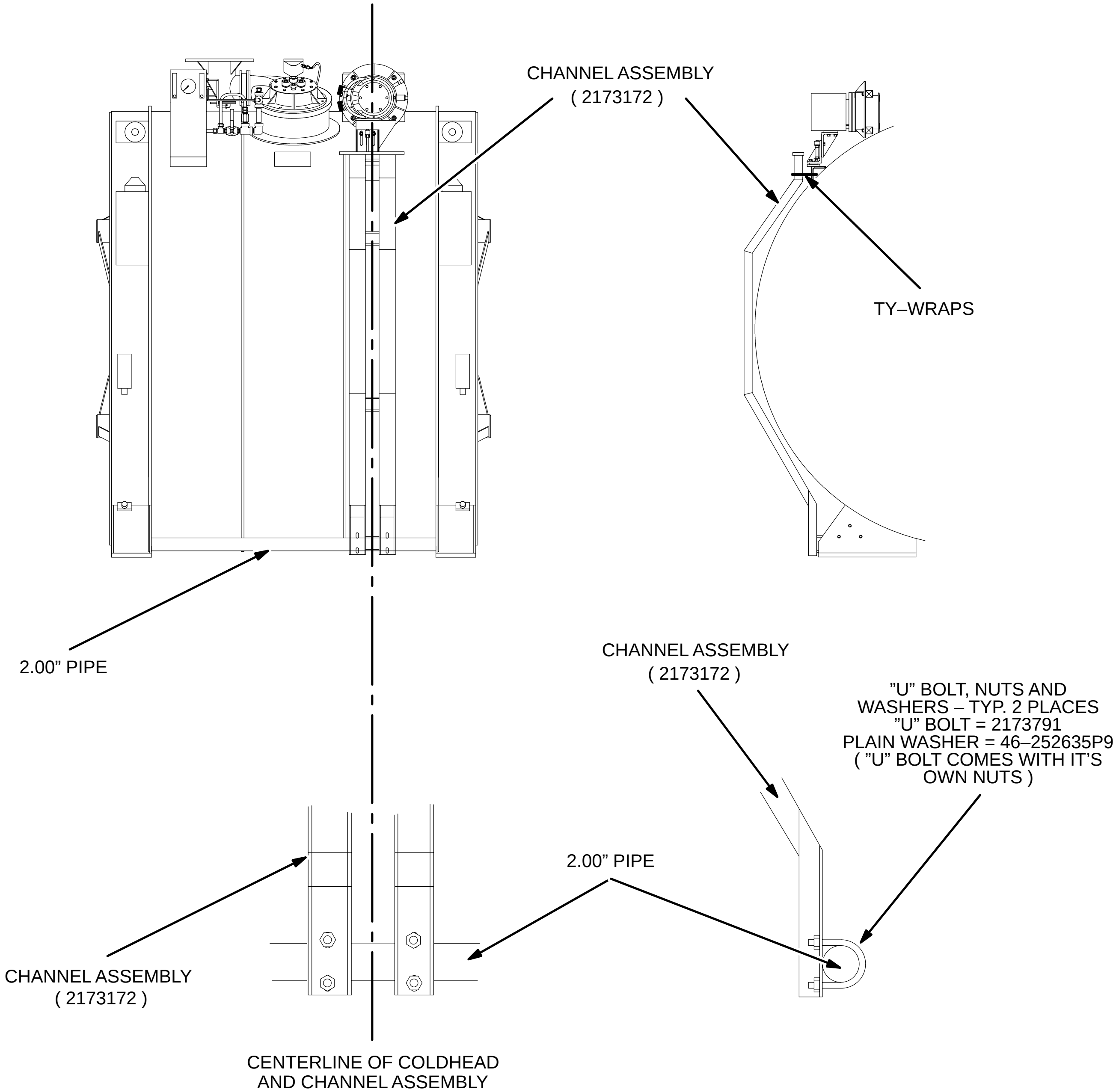
4. Attach pivot block to inside plate prior to assembly into yoke. See Illustration 1–10.

NotePlate handling straps should be used to position plates to yoke assembly. Remove straps once plates are installed to prevent interference when tightening plates together. See Illustration 1–10.

5. Carefully slide inside brass plate onto yoke assembly and install pivot screws through yoke into pivot block. See Illustration 1–10.

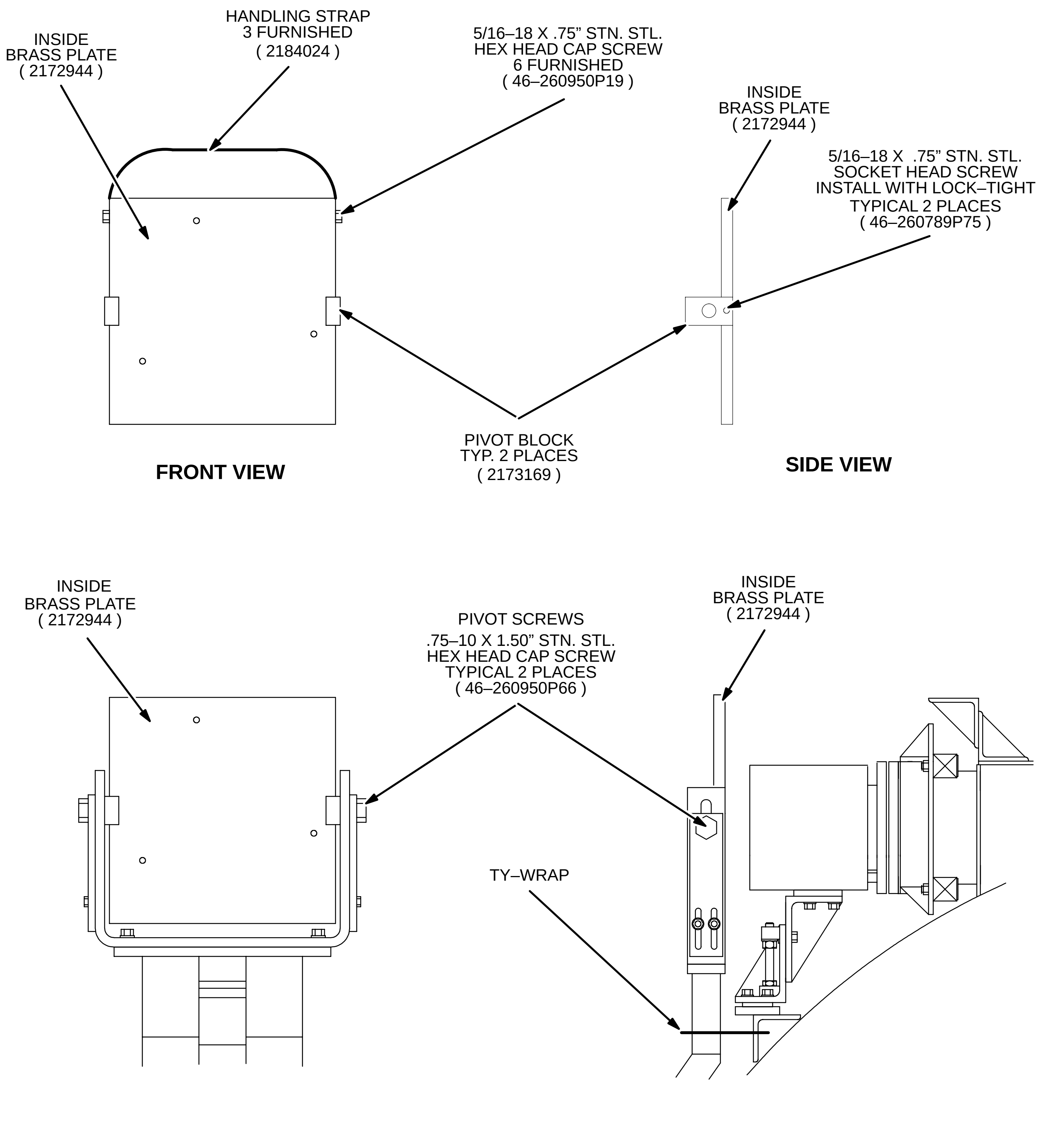
6. Install yoke assembly (and vertical adjustment bars) on top of frame. Secure yoke assembly to frame using two 5/16–18 x 1.25" long stn. stl. screws and washers. See Illustration 1–11.

1–4–1 FIXED SITE – 2177596 (continued)



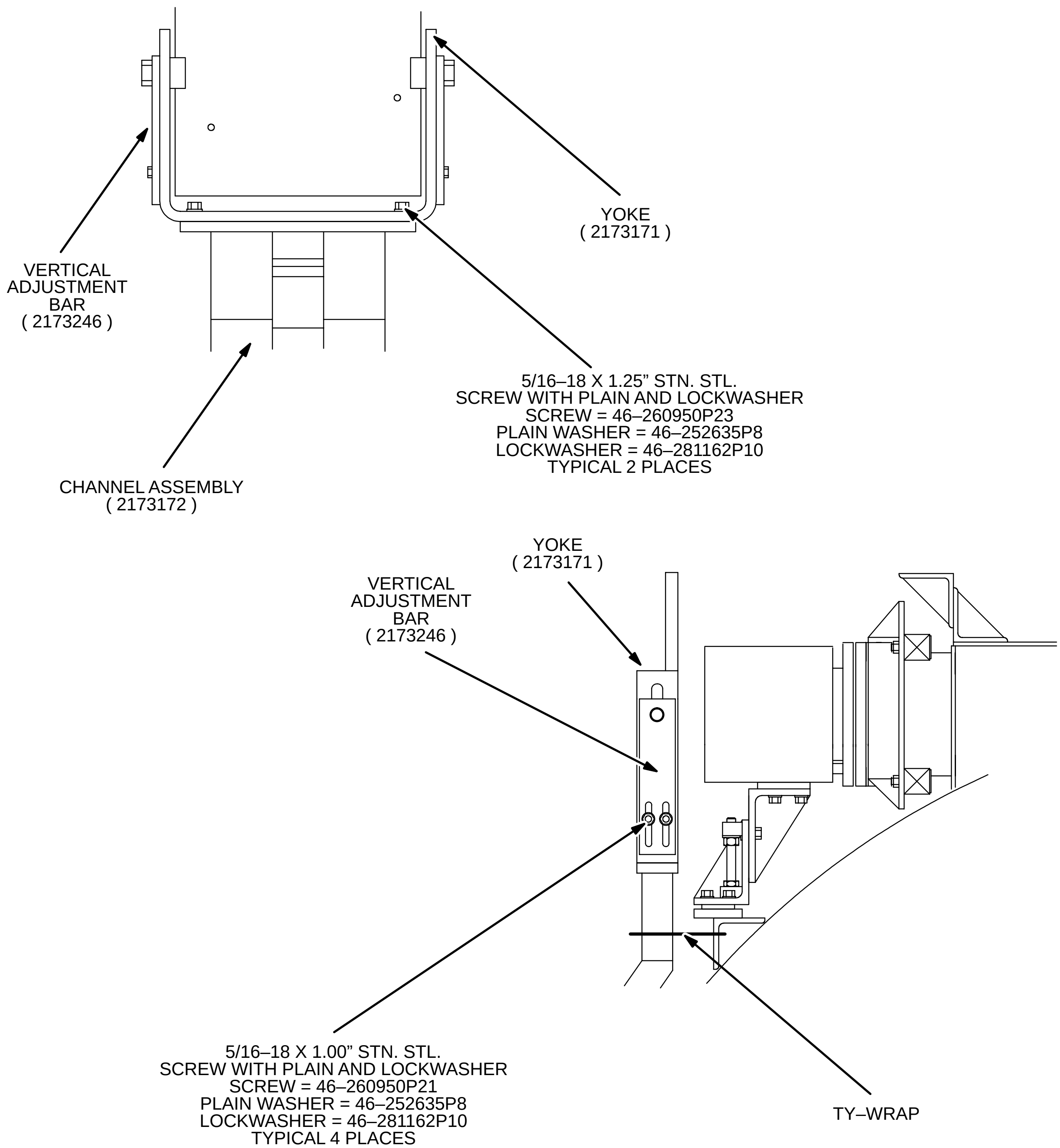
INSTALLATION OF CHANNEL ASSEMBLY
ILLUSTRATION 1–9

1–4–1 FIXED SITE – 2177596 (continued)



INSTALLATION OF INSIDE BRASS PLATE
ILLUSTRATION 1–10

1–4–1 FIXED SITE – 2177596 (continued)



INSTALLATION OF YOKE ASSEMBLY
ILLUSTRATION 1–11

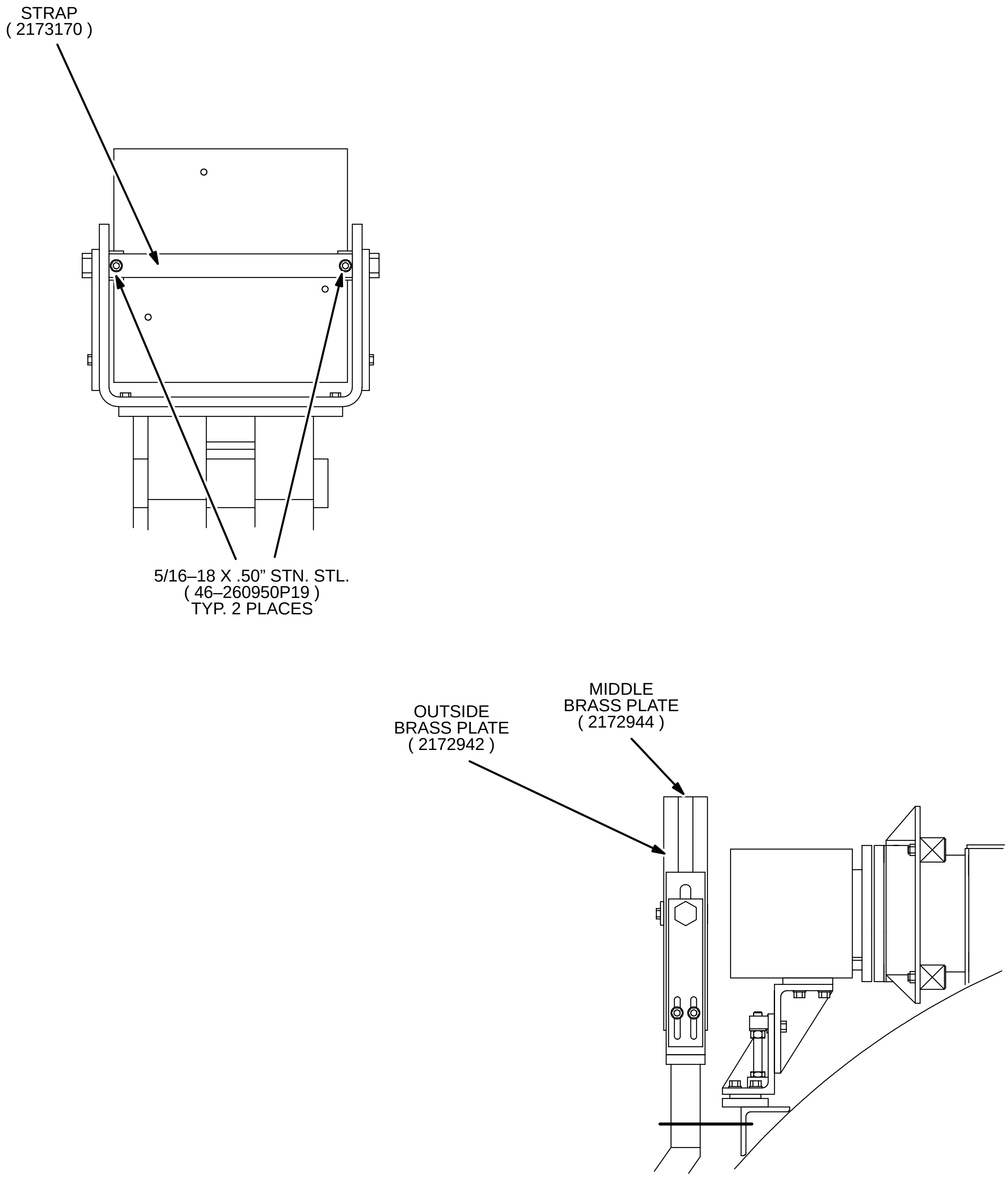
1–4–1 FIXED SITE – 2177596 (continued)

7. Carefully slide middle brass plate onto pivot blocks against inside plate. See Illustration 1–12.
8. Carefully slide outside brass plate onto pivot blocks against middle plate. See Illustration 1–12.
9. Install strap across outside face of plate stack and secure with two 5/16–18 x .50” long stn. stl. screws and washers. Tighten screws to compress plate stack. See Illustration 1–12.
10. Install 5/16–18 stn. stl. nuts on three guide rods to end of threaded portion of rod. Then thread the three guide rods into holes in the outside plate until 1/2” to 3/4” of the threads extend beyond the face of the plate. Secure with 5/16–18 stn. stl. nuts and lockwashers from the outside and tightening the nuts from the inside of the plates. See Illustration 1–13.
11. Thread 5/16” nuts and lockwashers fully onto the other end of each rod.
12. Check alignment of inertia mass / channel assembly by rotating the inertia mass towards coldhead and checking guide rod alignment to isolator bracket holes. Adjust left / right alignment sliding the channel on the pipe. Tighten the u–bolt hardware. Adjust height with hardware on frame.
13. Push plate stack / guide rods through holes in the isolator brackets until plates contact coldhead motor shield bracket or guide rods contact vacuum vessel.

Note“U” bolt nuts, installed in Step 3, may need to be loosened to allow movement of the assembly so that proper alignment can be achieved.

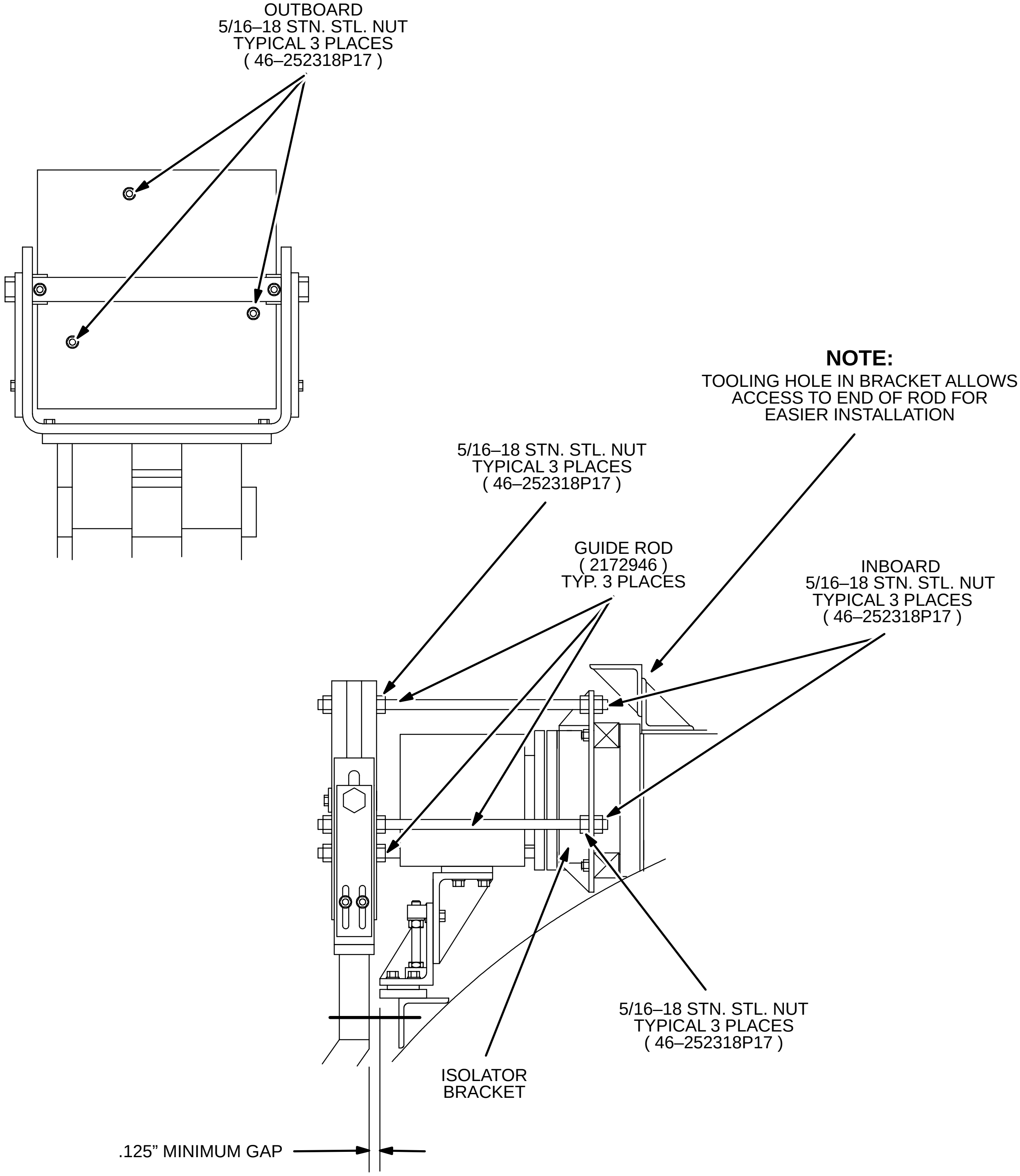
14. Install 5/16–18 nuts onto end of rods to capture on the isolator brackets.
15. Adjust nuts on guide rods to align plate stack along coldhead axis until 1/8” minimum gaps exist between the coldhead inertia assembly and the coldhead motor shield bracket, cryostat, shroud and frame. See Illustration 1–13.
16. When a minimum of 1/8” gap envelope exists around the coldhead inertia assembly, tighten outboard guide rod nuts and three jam nuts. See Illustration 1–13.
17. Manually push / pull plate stack with coldhead off (10 to 30 pound force) to confirm smooth motion. Any binding must be adjusted out.
18. Turn coldhead on and confirm minimum clearance of 1/8” around the coldhead inertia assembly.

1–4–1 FIXED SITE – 2177596 (continued)



INSTALLATION OF REMAINING BRASS PLATES
ILLUSTRATION 1–12

1–4–1 FIXED SITE – 2177596 (continued)



INSTALLATION OF THREADED RODS
ILLUSTRATION 1–13

1–4–2 MOBILE SITE – 2183100

NoteInertia Mass Dampener Kit may not be required and therefore not shipped with all magnets. If kit is not present, move on to Subsection 1–5.

WARNING!

THIS PROCEDURE REQUIRES THE HANDLING OF HEAVY PARTS (UP TO 33 POUNDS). MAKE SURE SERVICE LADDER IS FIRMLY IN PLACE AND USE CAUTION IN HANDLING PARTS TO AVOID DROPPING PARTS OR STRAINING MUSCLES. CARE MUST BE TAKEN WHEN INSTALLING THE HEAVY PLATES. PINCHED FINGERS OR OTHER SERIOUS BODILY INJURY CAN OCCUR.

DO NOT ALTER POSITIONS OF NUTS ON AXIAL STOPS. SEE ILLUSTRATION 1–18.

NoteThe Inertia Mass Dampener Kit (2183100) is shipped separately with magnet as part of the shipping collector. It is to be installed on magnet prior to commissioning of the coldhead.

Preparation:

1. Remove shroud and rail support brackets on cryocooler side of cryostat.
2. Check to make sure that support fame (2183102) is welded to wall of van by van supplier.

Yoke Assembly:

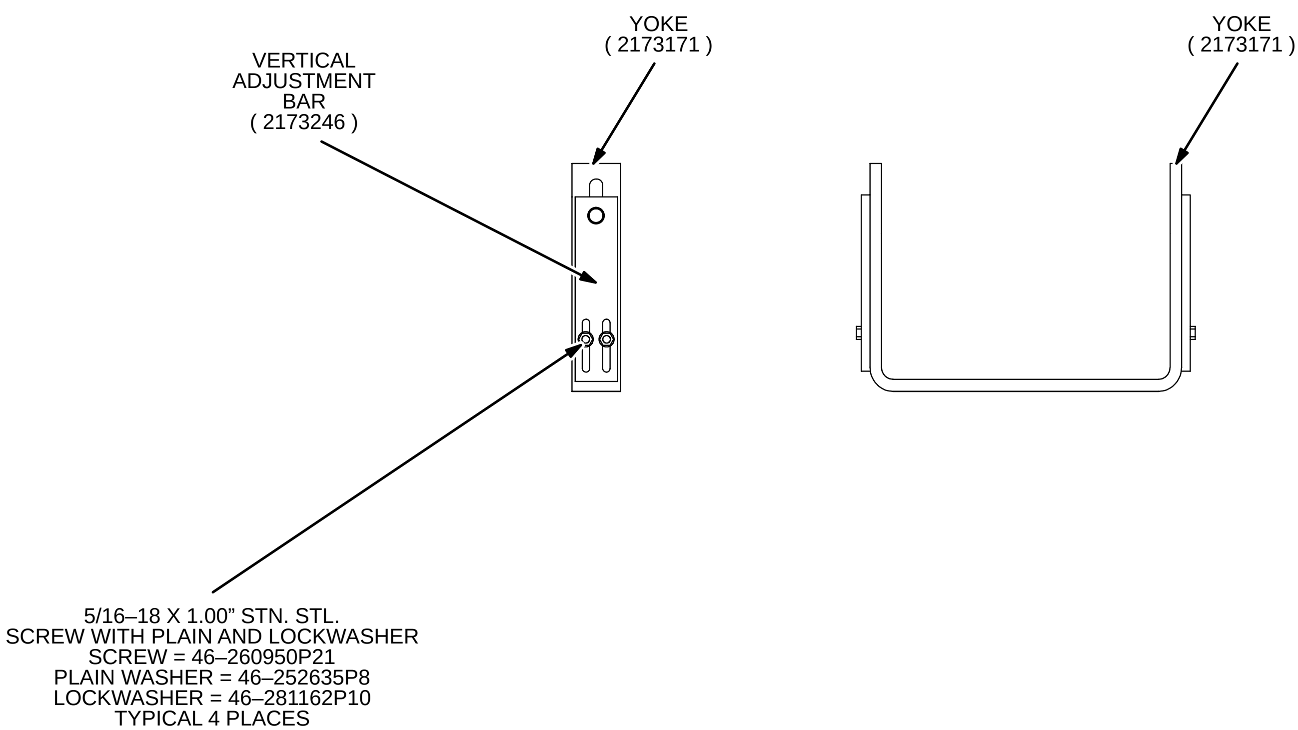
1. Attach two vertical adjustment bars (2173246) to outside of yoke (2173171) with 5/16–18 stainless steel screws x 1.00" long (46–260950P21) plus lockwashers (46–281162P10) and flatwashers (46–252635P8). See Illustration 1–14.
2. Attach two pivot blocks (2173169) to inboard plate (2184022) with 5/16–18 stainless steel socket head cap screws x .75" long (46–260789P75) and lock–tite. See Illustration 1–15.
3. Attach inboard plate / pivot blocks to yoke with 3/4–10 stainless steel hex head cap screws x 1.50" long (46–260950P66). See Illustration 1–15.

Installation and Alignment of Yoke Assembly:

1. Set yoke assembly on top of support frame being sure to orient 3 holes in plate with rod holes in isolator brackets. Secure with two 3/8–16 stainless steel screws x 2.00" long (46–318672P38) plus flatwashers (46–252635P9), lockwashers (46–281162P11) and nuts (46–252318P19). See Illustration 1–16.
2. Slide 3 rods (2184019) through holes in inboard plate until rods pass through holes in isolator brackets on cryocooler sleeve.

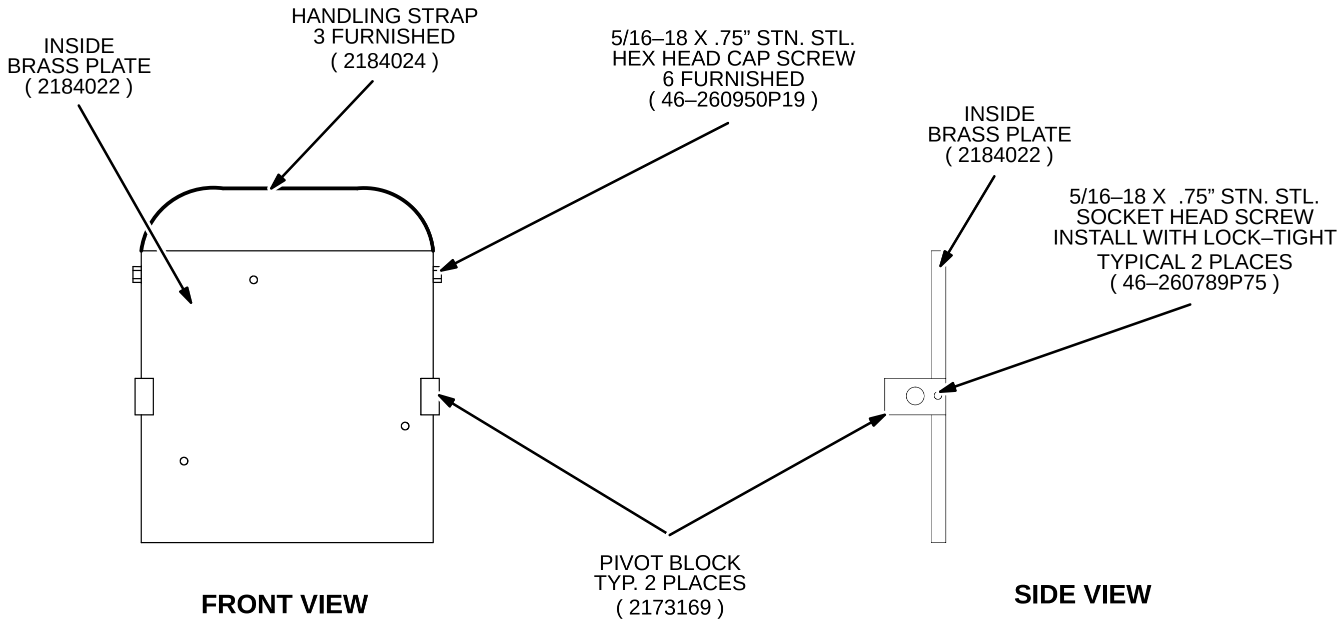
1–4–2 MOBILE SITE – 2183100 (continued)

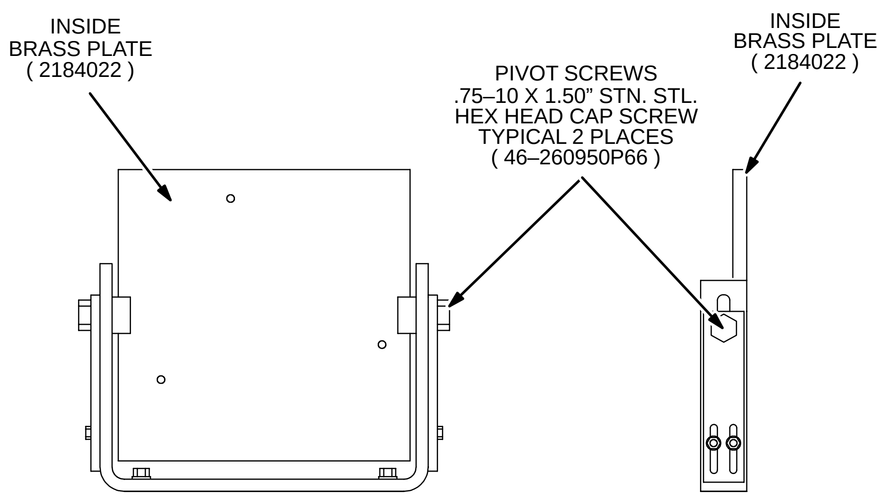
3. Align yoke to cryocooler using the following adjustments until the 3 rods pass through mating holes in the isolator brackets without binding.
   - Vertical adjustment = vertical adjustment bars
   - Horizontal adjustment = slotted holes in top of frame
   - Pitch (rotation about axis parallel to Z) = rotate plate on pivots
   - Yaw (rotation about vertical axis) = pair of screws attaching yoke to top of frame
   - Roll (rotation about axis aligned with coldhead) = vertical adjustment bars



YOKE ASSEMBLY
ILLUSTRATION 1–14

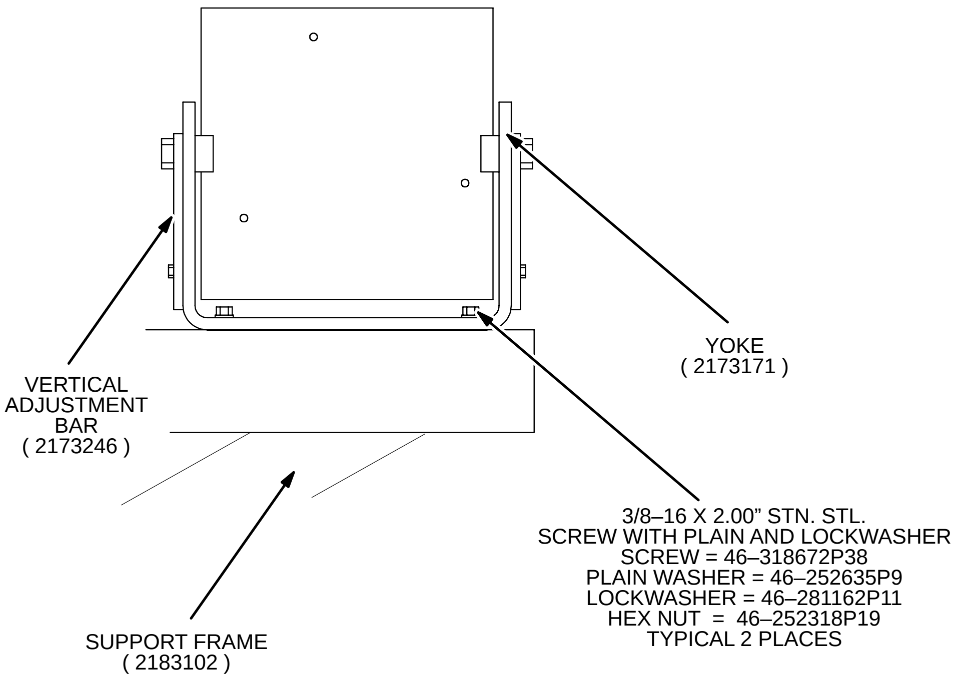
1–4–2 MOBILE SITE – 2183100 (continued)





INSTALLATION OF INSIDE BRASS PLATE
ILLUSTRATION 1–15

1–4–2 MOBILE SITE – 2183100 (continued)



INSTALLATION OF YOKE ASSEMBLY TO SUPPORT
ILLUSTRATION 1–16

4. When adjustment is complete, remove rods.

NotePlate handling straps may be used as required to position plates to yoke assembly. See Illustration 1–15.

5. Carefully slide middle brass plate onto pivot blocks against inside plate. See Illustration 1–17.
6. Carefully slide outside brass plate onto pivot blocks against middle plate. See Illustration 1–17.
7. Install strap across outside face of plate stack and secure with two 5/16–18 x .50" long stainless steel screws, flatwashers and lockwashers. Tighten screws to compress plate stack. See Illustration 1–17.
8. Install 1/2–13 brass nuts with lockwashers on three guide rods to end of threaded portion of rod. Then thread the 3 guide rods into holes in the outside plate until 1/2" to 3/4" of the threads extend beyond the face of the plate. Secure with 1/2–13 brass nuts and lockwashers from the outside and tightening the nuts from the inside of the plates. See Illustration 1–18.

1–4–2 MOBILE SITE – 2183100 (continued)

Installation and Alignment of Yoke Assembly: (continued)

9. Thread 5/16" nuts and lockwashers fully onto the other end of each rod.
10. Push plate stack / guide rods through holes in the isolator brackets until plates contact coldhead motor or guide rods contact vacuum vessel.
11. Install 5/16–18 nuts and lockwashers onto end of rods to capture on the isolator brackets.
12. Adjust nuts on guide rods to align plate stack along coldhead axis until 1/8" minimum gaps exist between the coldhead inertia assembly and the vacuum vessel, shroud and van wall. See Illustration 1–18.
13. When a minimum of 1/8" gap envelope exists around the coldhead inertia assembly, tighten outboard guide rod nuts and 3 jam nuts.

    NoteIf any gap between nuts on axial stops and isolator bracket have closed due to inertia assembly, then use 5/16" nuts on three rods to change alignment of isolator bracket with respect to plate assembly until bracket is centered between nuts on each side of each axial stop.

14. Use ty–wraps to support the weight of the gaseous helium lines from support frame in order to insure that their weight does not pull cryocooler away from it's free position.

    NoteGaseous helium lines must run between van wall and support frame so that their weight is carried by support frame and not cryocooler. Use ty–wraps to hold gaseous helium lines to support frame as currently stated.

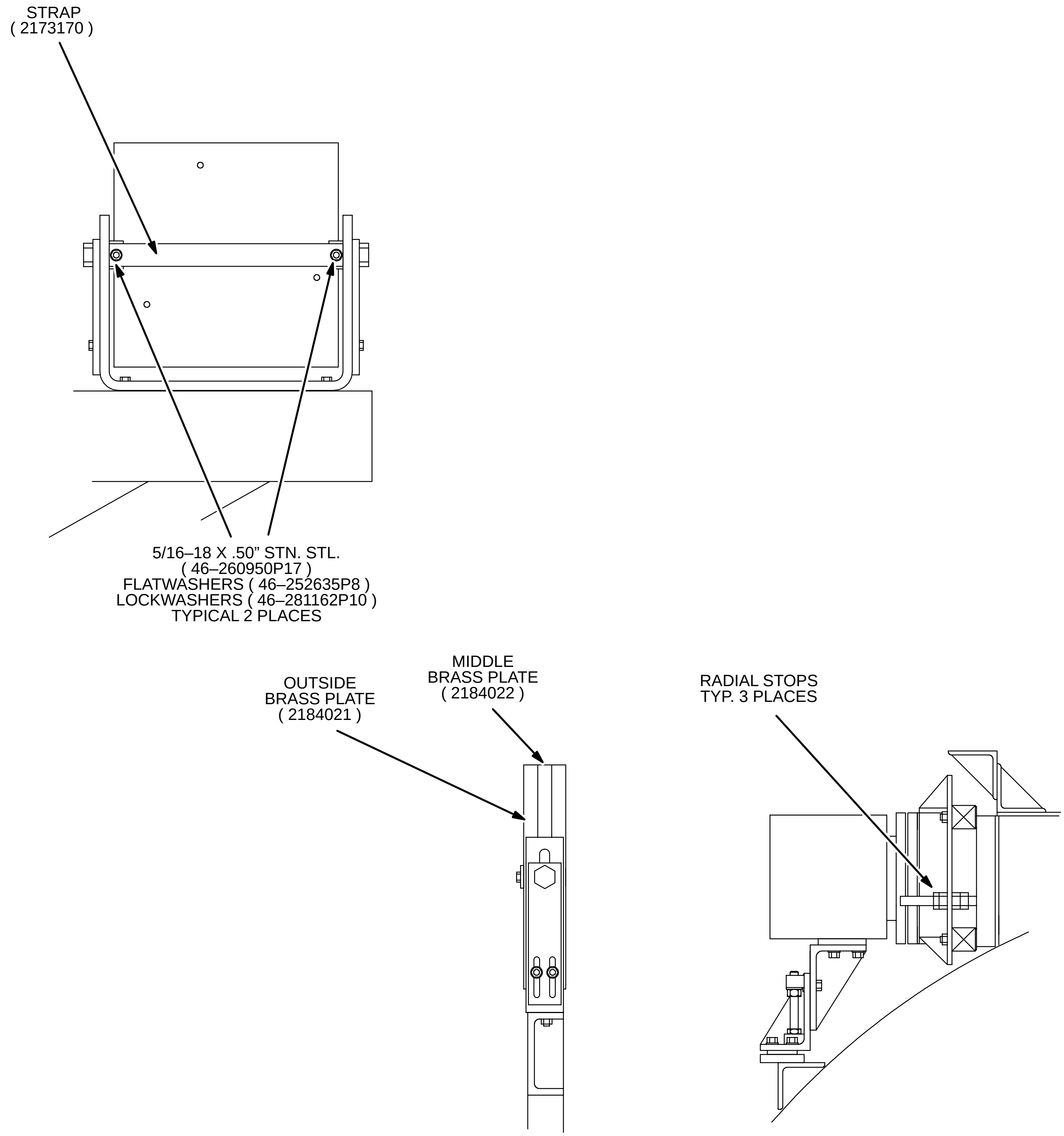
CAUTION

If Step 14 is not done, one or more of the 0.025" gaps set at the axial stops may be shorted and cryocooler operation will cause impacts which degrade image quality.

Final Check:

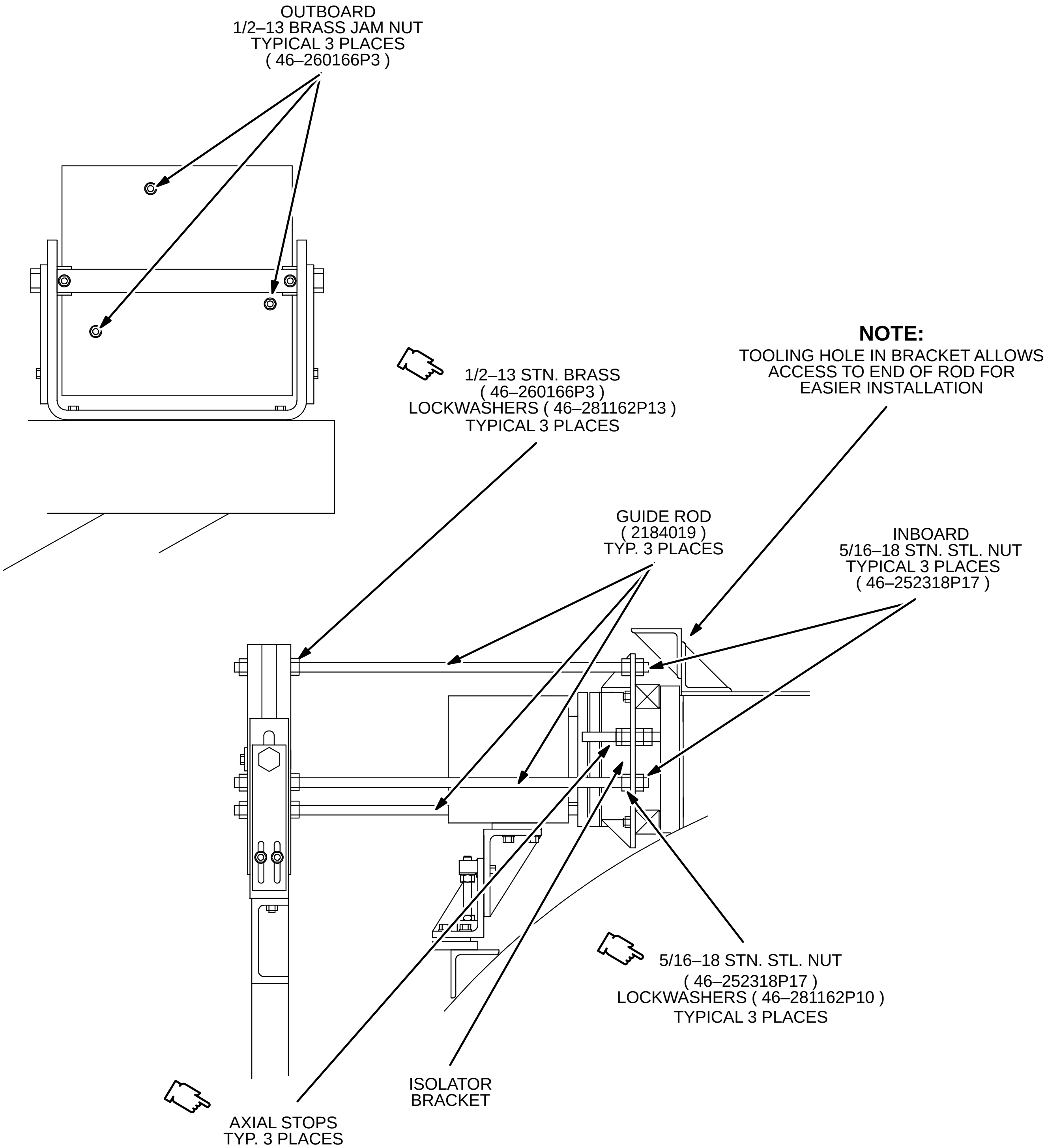
1. With cryocooler off, manually push / pull plate stack along axis of cryocooler to confirm smooth motion of isolator bracket at each axial stop. If isolator bracket fails to move in either direction or if it contacts nuts on axial stop studs, then use 5/16" nuts on three rods to change alignment of isolator bracket with respect to plate assembly until bracket is centered between nuts on each side of each axial stop.
2. Operate cryocooler and confirm:
    - Positive clearances not less than 1/8" between all parts of the inertia assembly, cryostat, shroud hardware and van wall (including support frame).
    - That there are no impacts between the isolator brackets and the axial stops.

1–4–2 MOBILE SITE – 2183100 (continued)



INSTALLATION OF REMAINING BRASS PLATES
ILLUSTRATION 1–17

1–4–2 MOBILE SITE – 2183100 (continued)



INSTALLATION OF THREADED RODS
ILLUSTRATION 1–18

1–5 SHIELD COOLER INSTALLATION AND CHECK OUT

CAUTION

Never place weight (objects) on the coldhead or sleeve as irreparable damage may result.

Description:

The Shield Cooler System comes with a Coldhead 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 supplier manual supplied with your system to become thoroughly familiar with the configuration, site requirements and procedures before installation. Compressor installation instructions are covered in the supplier manual (Leybold or Sumitomo). The Shield Cooler Interconnect Diagram is shown in SCHEMATICS / INTERCONNECTS, Illustration NO TAG.

Leybold illustrations are used to depict common connections and settings.

1–5–1 COMPRESSOR INSTALLATION

1. Unpack and install the compressor in conformance with the supplier service manual. Note any visible damage and notify the shipper.

2. Position the compressor in the equipment room as required in the site plan. Refer to site planning manual.

3. Connect the input power cable in conformance with the supplier manual and local electrical code.

CAUTION

Do NOT connect flex lines until system gas pressure check is performed in Section 1–5–2 to prevent line contamination.

1–5–2 GAS PRESSURE ADJUSTMENT

1. Refer to the supplier manual (46–294439P4 for Leybold and 2210552 for Sumitomo) for compressor gas pressure requirements. If pressure is out of specification range, adjust as required using following procedures.

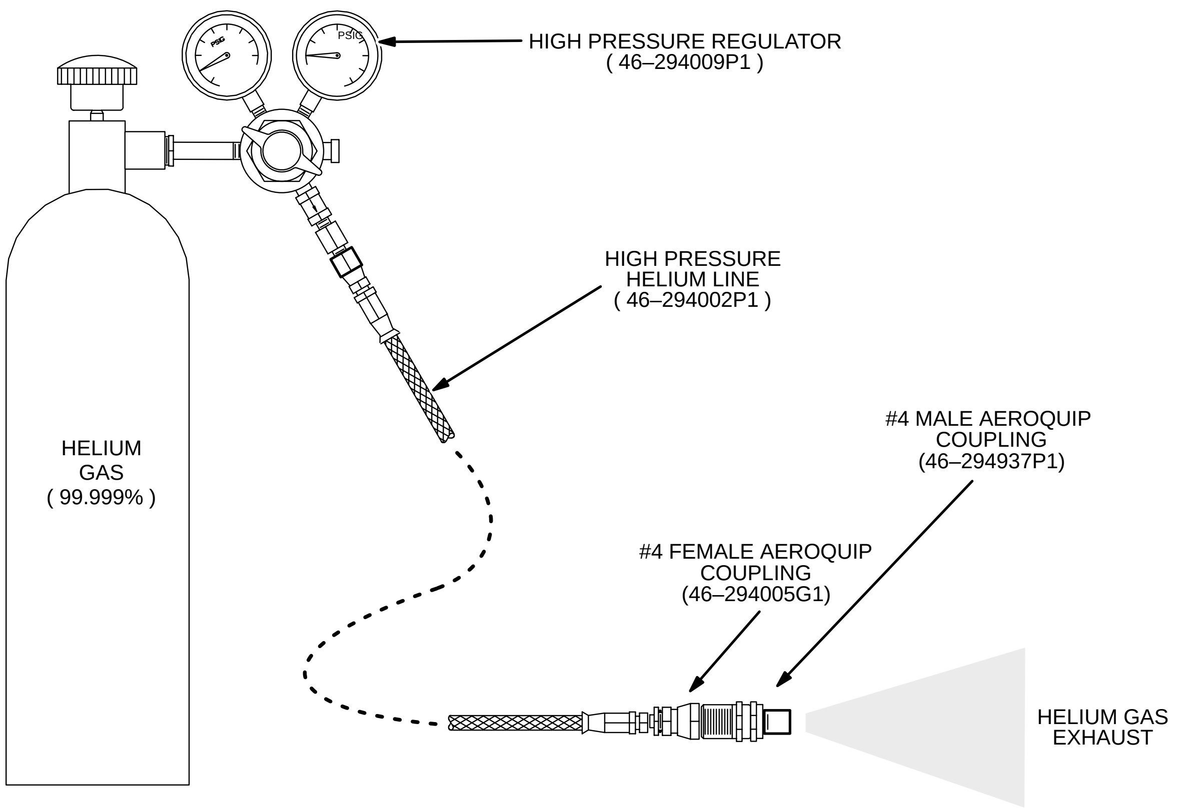
1–5–2–1 Preparation For Increasing Shield Cooler Gas Pressure

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.

1–5–2–1 Preparation For Increasing Shield Cooler Gas Pressure (continued)

1. Obtain a cylinder of 99.999% Helium Gas.
2. 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.
3. Attach high pressure helium line (46–294002P1) to regulator at shut off valve. See Illustration 1–19.
4. Attach the #4 Female Aeroquip Coupling (46–294005G1) to the end of the high pressure charging line. See Illustration 1–19.



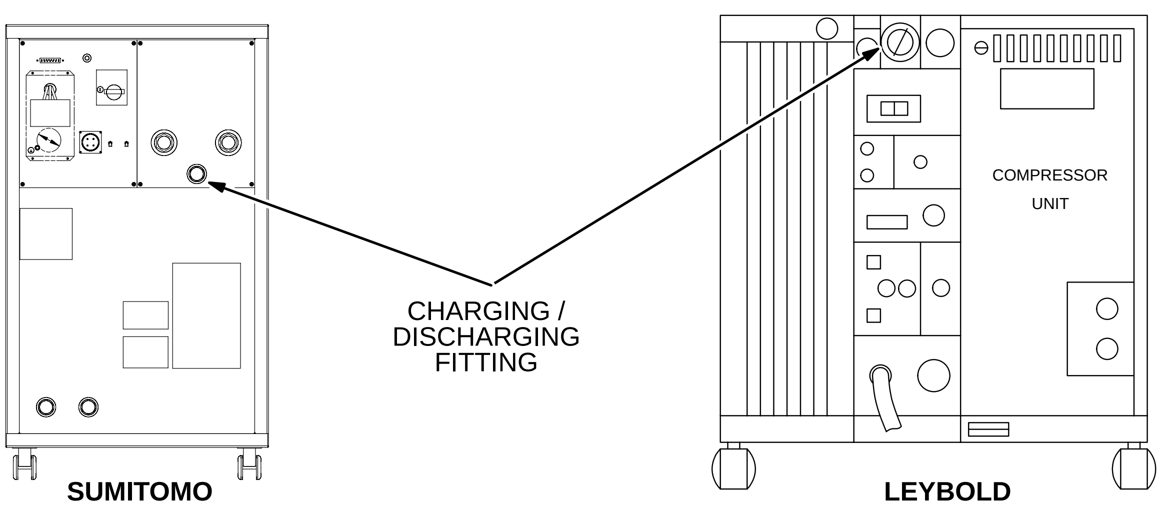
SET–UP FOR COMPRESSOR CHARGING
ILLUSTRATION 1–19

1–5–2–1 Increasing Shield Cooler Gas Pressure Preparation (continued)

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.

5. 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.
6. 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.
7. Allow Helium to purge out the assembly for 2 minutes.
8. Remove the male Aeroquip fitting coupling from the female coupling.
9. Close regulator. Shut off compressor power to let supply and return pressures equalize in compressor.
10. Fully open valve on gas cylinder.
11. Adjust regulator control valve to achieve a pressure of approximately 200 psig.
12. Attach purged charging line assembly with the female Aeroquip coupling to the charging fitting on the front of the compressor. See Illustration 1–20.



COMPRESSOR CHARGING FITTING LOCATION
ILLUSTRATION 1–20

1–5–2–2 Increasing Gas Pressure

1. Increase compressor Helium pressure by adjusting regulator until compressor's gauge reads static pressure within the specification range.
2. If too much helium gas has been added, refer to Section 1–5–3, Decreasing Shield Cooler Gas Pressure, to lower the helium pressure.

1–5–2–3 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 1–19.
3. Slowly tighten fitting until you hear gas escaping.
4. When pressure is decreased within specification range, immediately unscrew fitting and hose to prevent further gas removal.
5. Replace protective cap on front panel fitting.

1–5–2–4 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.

1–5–3 Flexible Gas Line Connections

NoteRefer to supplier manual for the procedure and sequence on connecting gas line and Aeroquip couplings.

1–5–3 Flexible Gas Line Connections (continued)

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 coldhead on the Magnet Cryostat.

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. Route the Flexible Gas Lines through the base pad of the magnet before connecting them at the coldhead. See Illustration 1–22.

4. Press lines in a gentle curve award the center of the magnet and adjust line slack and angles a minimize tension and noise (chirping). In mobile applications, use ty–wraps to support the weight of the gaseous helium lines from support frame in order to insure that their weight does not pull cryocooler away from it's free position.

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 Magnet 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.

5. Connect the flexlines to the compressor and coldhead Aeroquip fittings in the sequence and by the procedure shown in the supplier manual.

6. Install Safety Strap (2184023) and Ty–wraps (46–252283P58) around helium lines and attach to coldhead motor shield bracket bolt for Leybold coldhead or to bolt on side of motorshield bracket for SHI coldhead.. Straps are found in Acoustic Resonance Dampener Kit for Leybold and Compressor Kit for Sumitomo. See Illustration 1–22.

NoteStraps may be preattached to magnet.

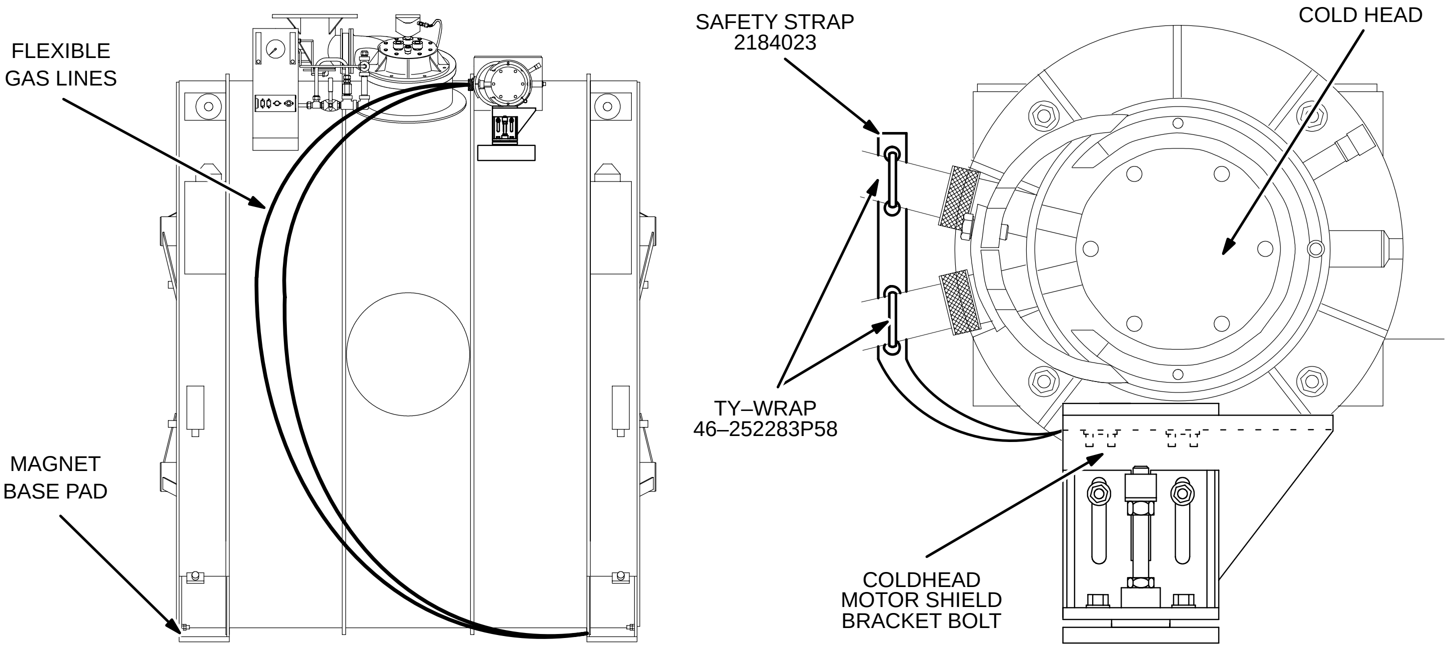
7. Observe the compressor pressure gauge reading after connecting the flex lines, the reading should remain constant.

NoteIf the reading is lower, this indicates that the flex lines were not fully charged when received, or that a leak may exist. Refer to the supplier manual for troubleshooting instructions.

1–5–3 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.



FLEXIBLE GAS LINE ROUTING AT MAGNET
ILLUSTRATION 1–22

1–5–4 Shield Cooler Electrical Cable Connections

Note

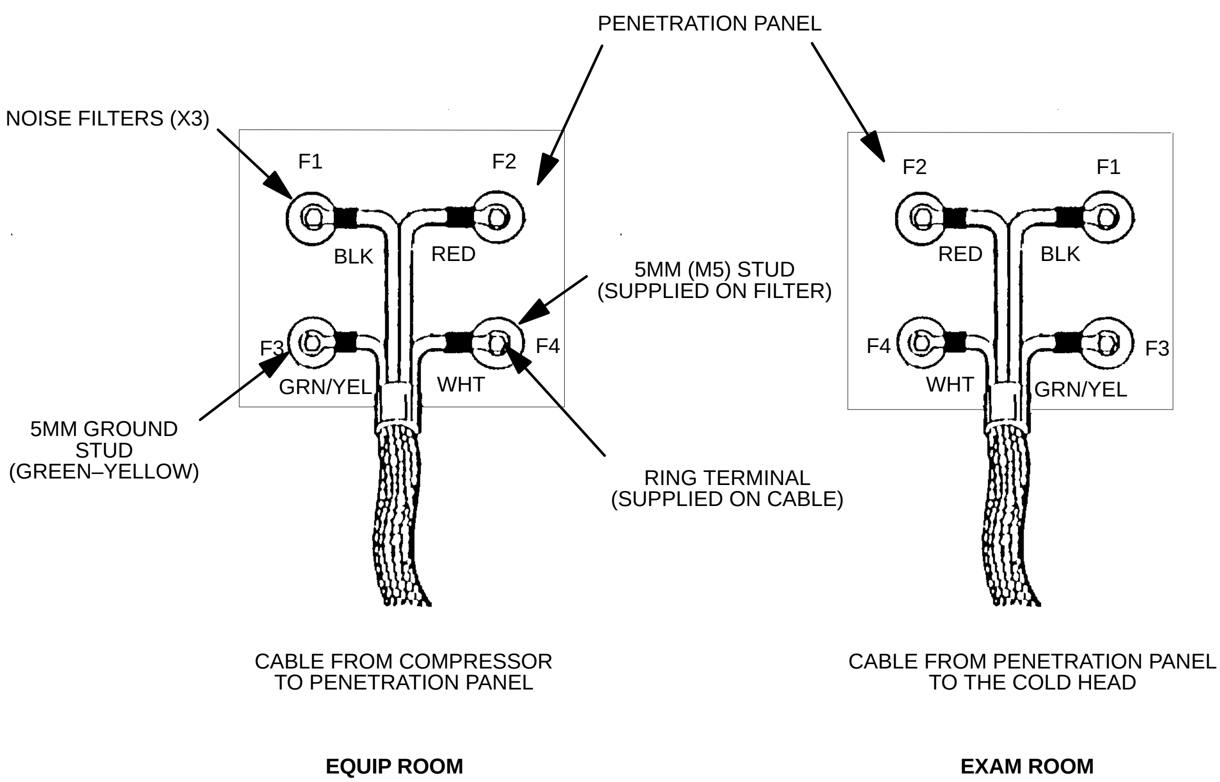
If shield cooler is installed prior to penetration panel installation, use a terminal block to connect four ring terminals on the two coldhead power cables. Make sure same color wires are connected.

1. Connect the four ring terminals on the end of the coldhead Electrical Cable (RUN #624) to the four studs of the Noise Filter on the inside the Penetration Panel. See Illustration 1–23.
2. Ty–wrap cable to motorshield for strain relief.
3. Connect the other end of the cable to the mating connector on the coldhead.
4. 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.

5. Connect the other end of this cable to the Coldhead Connector on the Compressor



SHIELD COOLER ELECTRICAL CABLE CONNECTIONS
ILLUSTRATION 1–23

1–5–5 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 1–24.

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

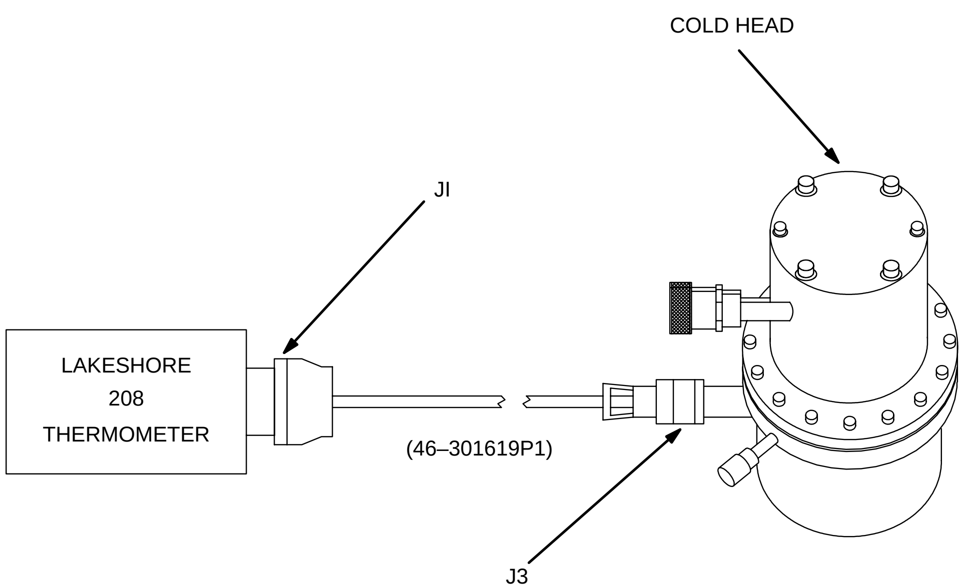
Note

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.

1–5–5 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:
± 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.



SHIELD COOLER TEMPERATURE MEASUREMENT SET–UP
ILLUSTRATION 1–24

1–5–6 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 1–6, 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.

   NoteSet 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 “star” pattern to achieve the Belleville Washer Gap setting shown in Illustration 1–25. 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 1–25.

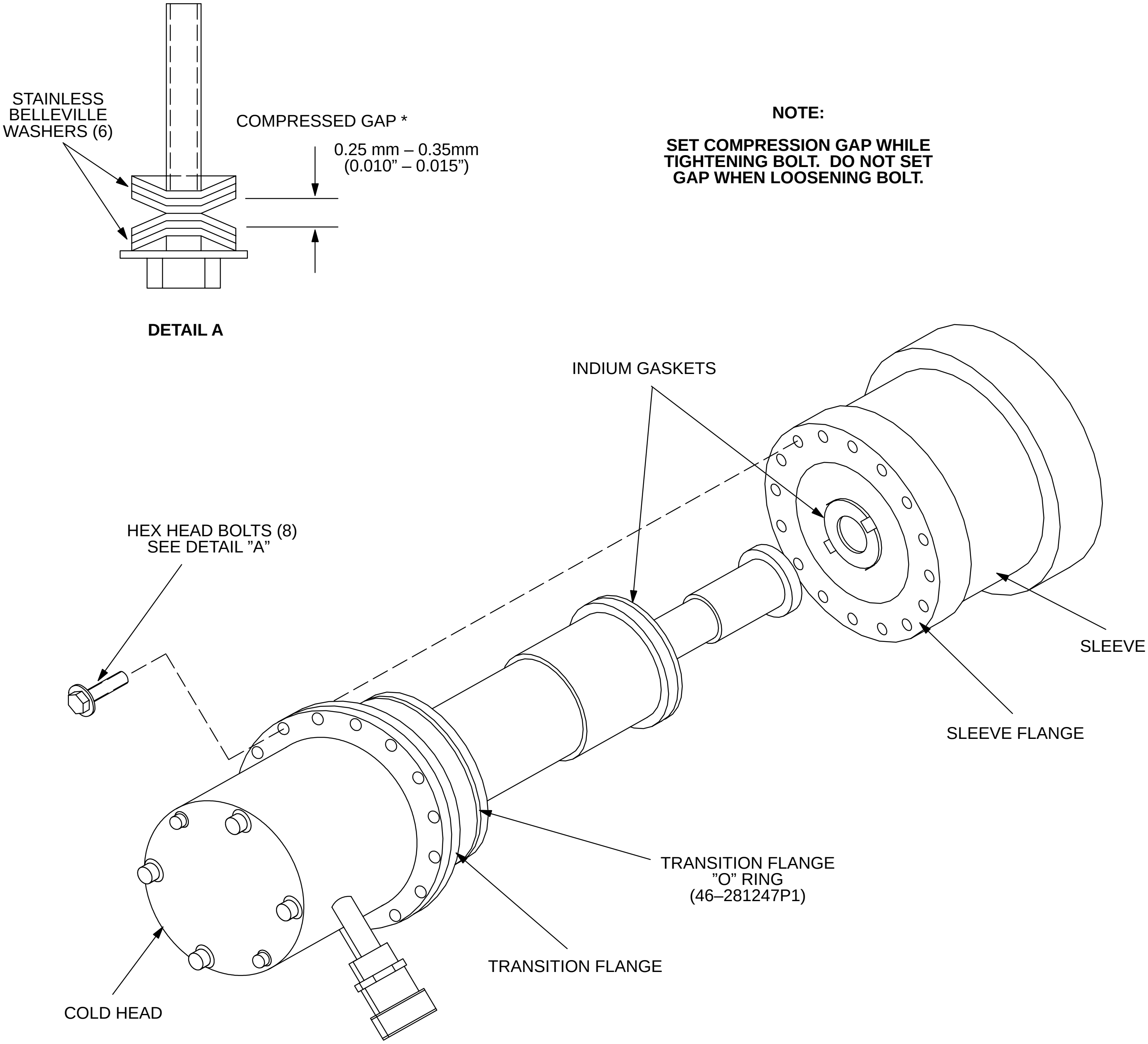
5. This process will continue from 1 to 4 days until the Cold Head reaches its ultimate operating temperature. At this time, the Belleville Washers will be set to the proper gap, but the temperatures will no longer decrease.

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 1 of this manual.



COLD HEAD MOUNTING BOLT GAP SETTING
ILLUSTRATION 1–25

1–5–7 RF Shielding

NoteThe 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.

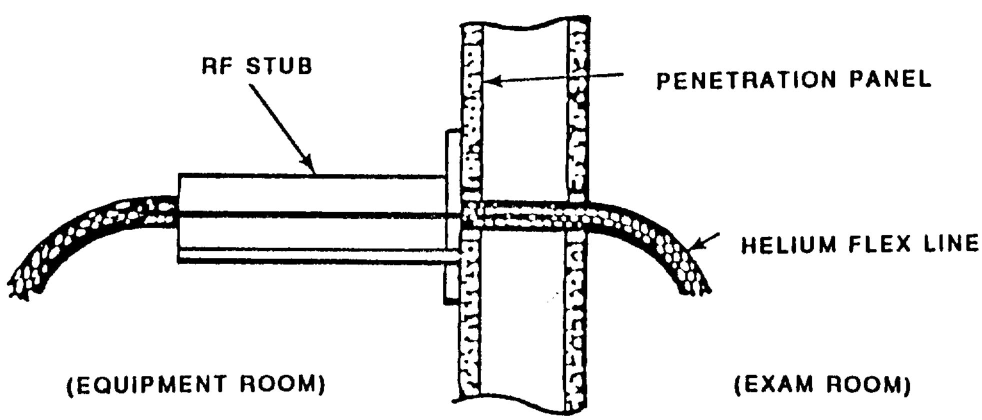
2. Position half of the RF Stub Assembly (46–260860G1*)* underneath the Helium Supply Line, with the flange end oriented toward the Penetration Panel. See Illustration 1–26.

NoteMake 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.



RF STUB ASSEMBLY MOUNTING
ILLUSTRATION 1–26

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.

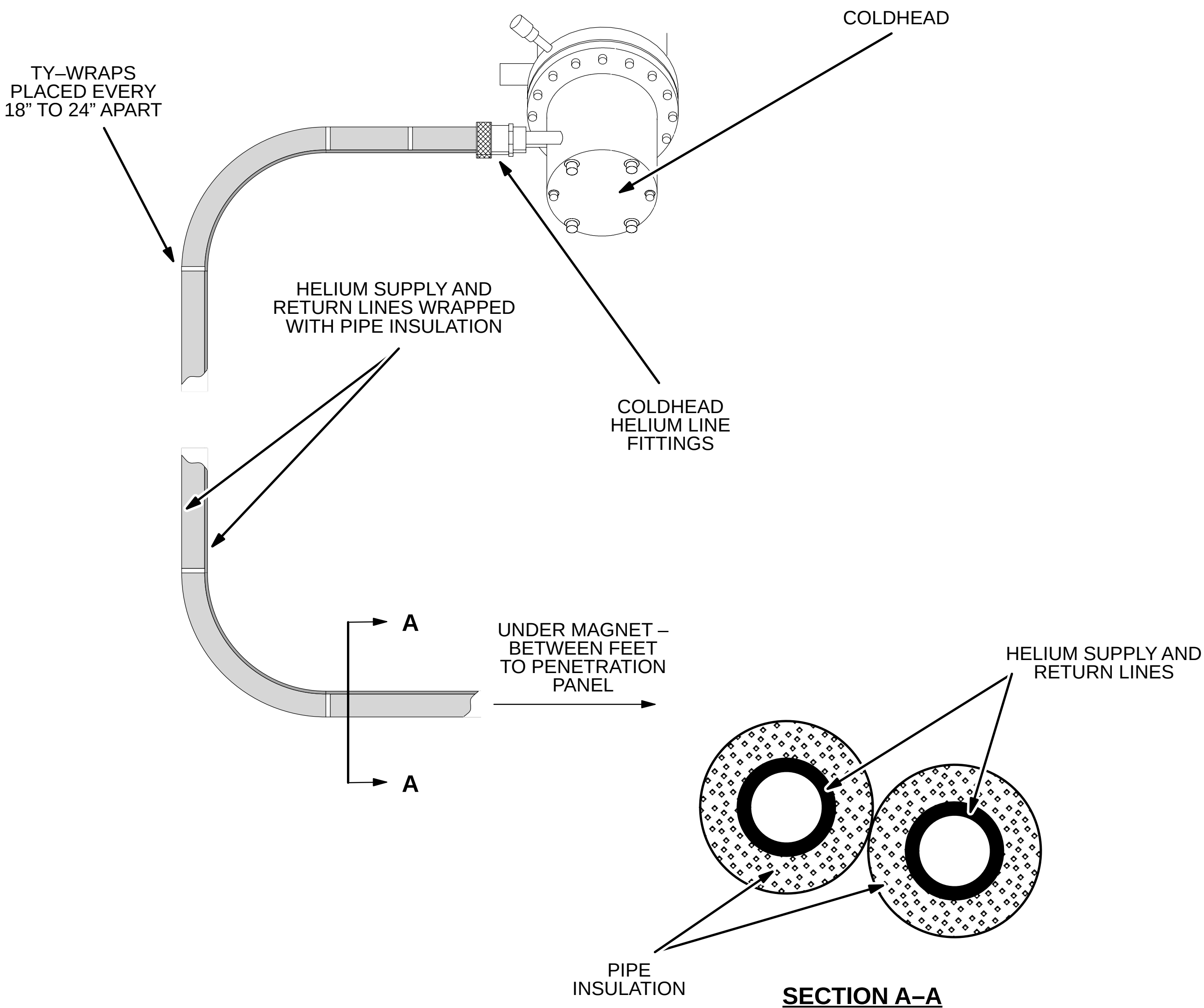
7. Repeat the procedure for the Helium Return Line.

1–5–8 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 1–22 for routing of helium lines.

1. Cover lines completely with insulation from the helium line fittings on the coldhead to the penetration panel where the lines exit the magnet room. See Illustration 1–27.



HELIUM INSULATION KIT
ILLUSTRATION 1–27

1–6 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

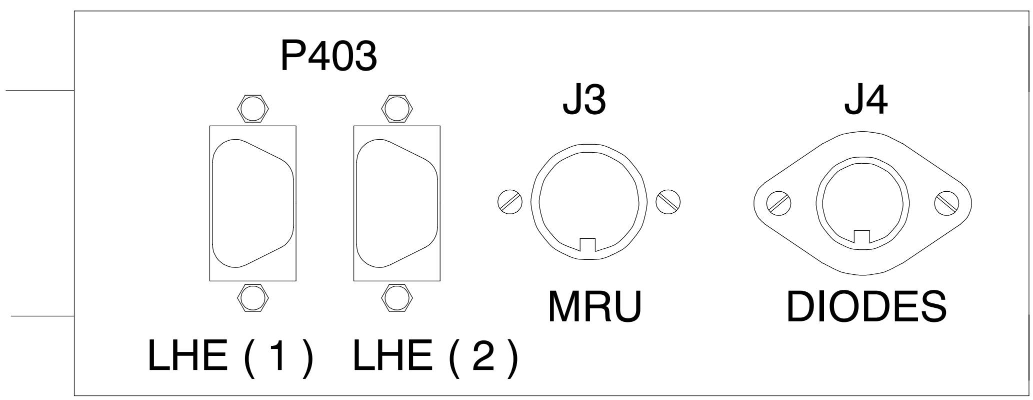
The MRU Cable is a shielded cable with the shield terminated at only the MRU end. It is essential that the cable be properly connected.

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 1–28 for (J3) Location.

1–6 MAGNET RUNDOWN UNIT (MRU) INSTALLATION (continued)



MAGNET HARNESS TERMINAL BOX
ILLUSTRATION 1–28

1–6 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 5 of this manual.

1–7 CRYOGEN MONITOR INSTALLATION

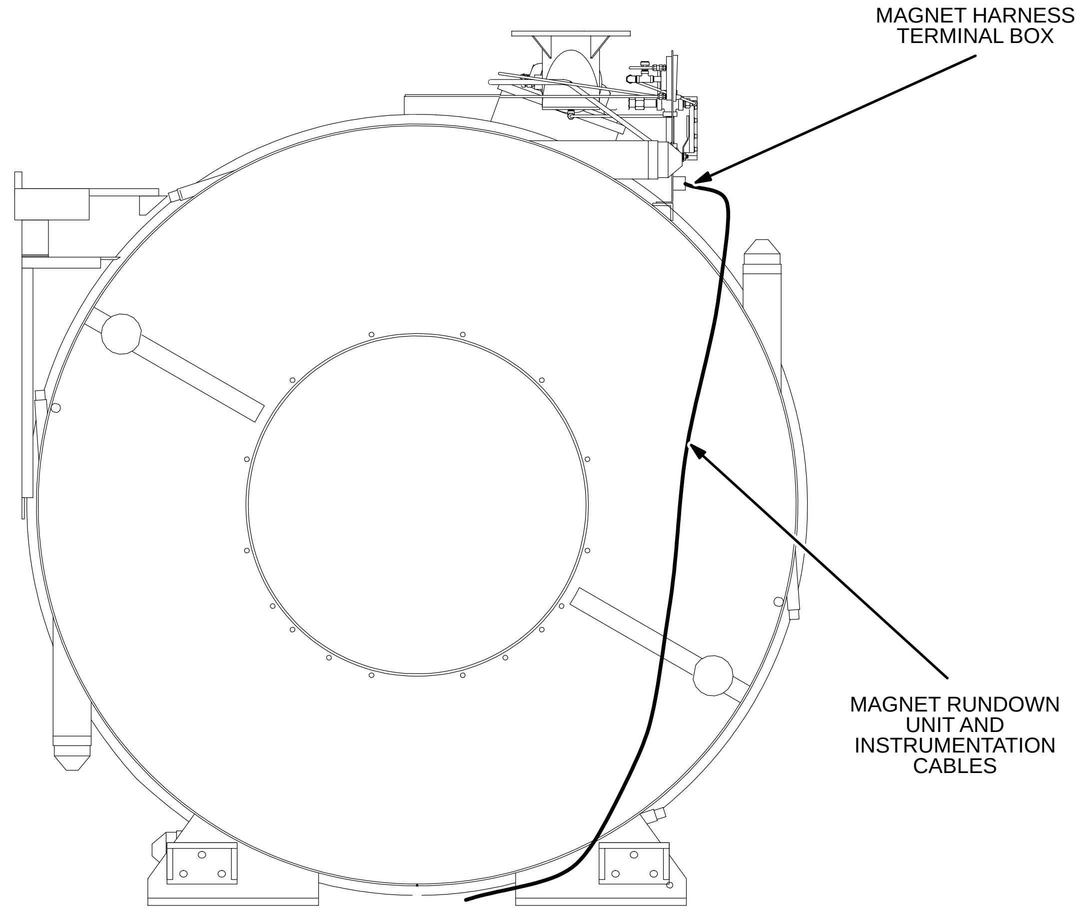
1. Install and inspect the Cryogen Monitor in conformance to the vendor service manual supplied with the unit. This unit is installed in the MR System Cabinet (MR2).

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 1–28 for (P403) location.
4. Ty–wrap MRU Cable (RUN #606) and Instrumentation Cable (RUN #605) to Back End, left Vertical Shroud Channel. See Illustration 1–29.

1–7 CRYOGEN MONITOR INSTALLATION (continued)



MRU & INSTRUMENTATION CABLE ROUTING
ILLUSTRATION 1–29

Note
Cryogen monitor calibration is covered in *Direction 15494,* Signa Advantage 1.5T & 0.5T PM Manual.

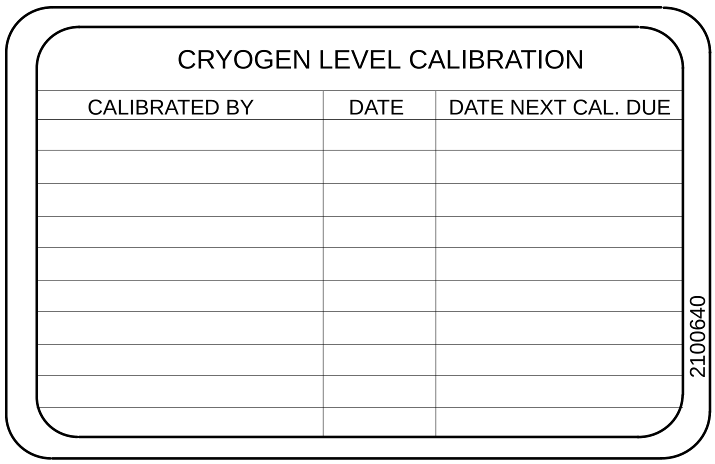
5. Perform the calibration procedure, covered in the PM manual, at least once every six months. Perform sensor length calibration.

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 1–30.

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.

1–7 CRYOGEN MONITOR INSTALLATION (continued)



CRYOGEN LEVEL CALIBRATION LABEL
ILLUSTRATION 1–30

8. Record the initial Liquid Helium level.

SECTION 2 – MAGNET COMMISSIONING CHECKS

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

2–1 MAGNET ELECTRICAL CHECK

Perform electrical checks called out in Functional Checks, Section NO TAG.

2–2 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:

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

1. Use the equipment referenced above to establish the Cryostat temperature.

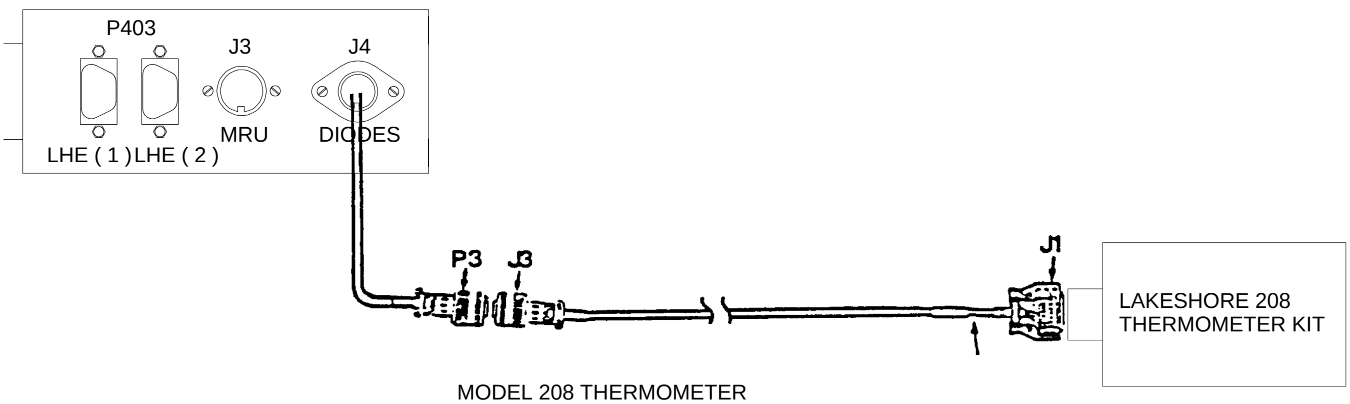
2. Connect the Lakeshore Cryotronics Digital Thermometer to the Diode Connector on the Magnet Connector Assembly (MS1–A3, A1) in conformance with Illustration 2–1. Select Curve 6 (equivalent of DT 470 Curve 10).

3. Select the Diode to be monitored as shown in Table 2–1.

2–2–1 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.

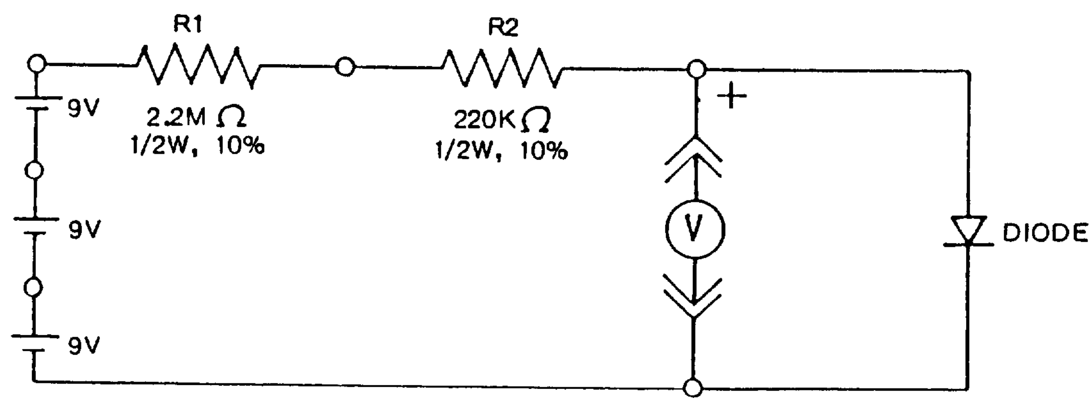
2–2–2 Diode Temperature Sensing Circuit

Description:

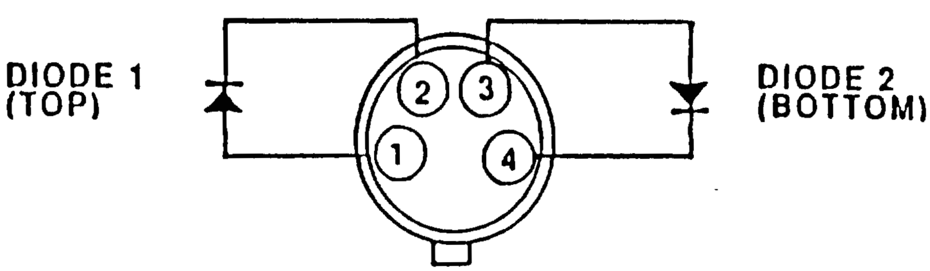
If the Lakeshore Cryotronics 208 Thermometer Kit is not available, the following temperature sensing circuit can be fabricated from commonly available components for temperature measurements.

Procedure:

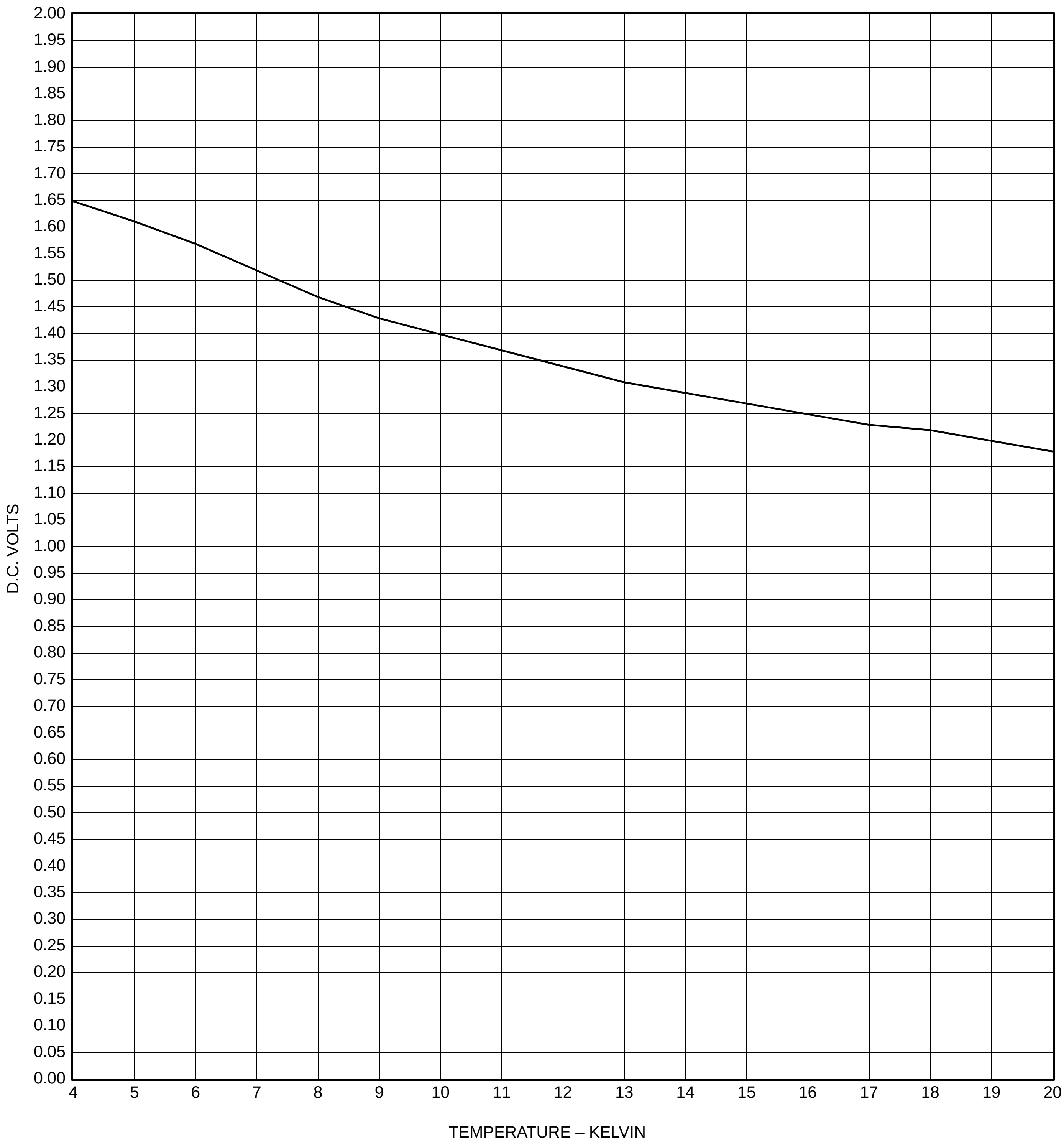
1. Assemble three 9 VDC Batteries and a series resistance of 2.4 to 2.7 Megohms, as shown in Illustration 2–2. Adjust resistance as required to obtain 10 ± 1 μ A current.
2. Connect a Digital Voltmeter (DVM) across the diode with the polarity shown in Illustration 2–2. See Illustration 2–3 for the pin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



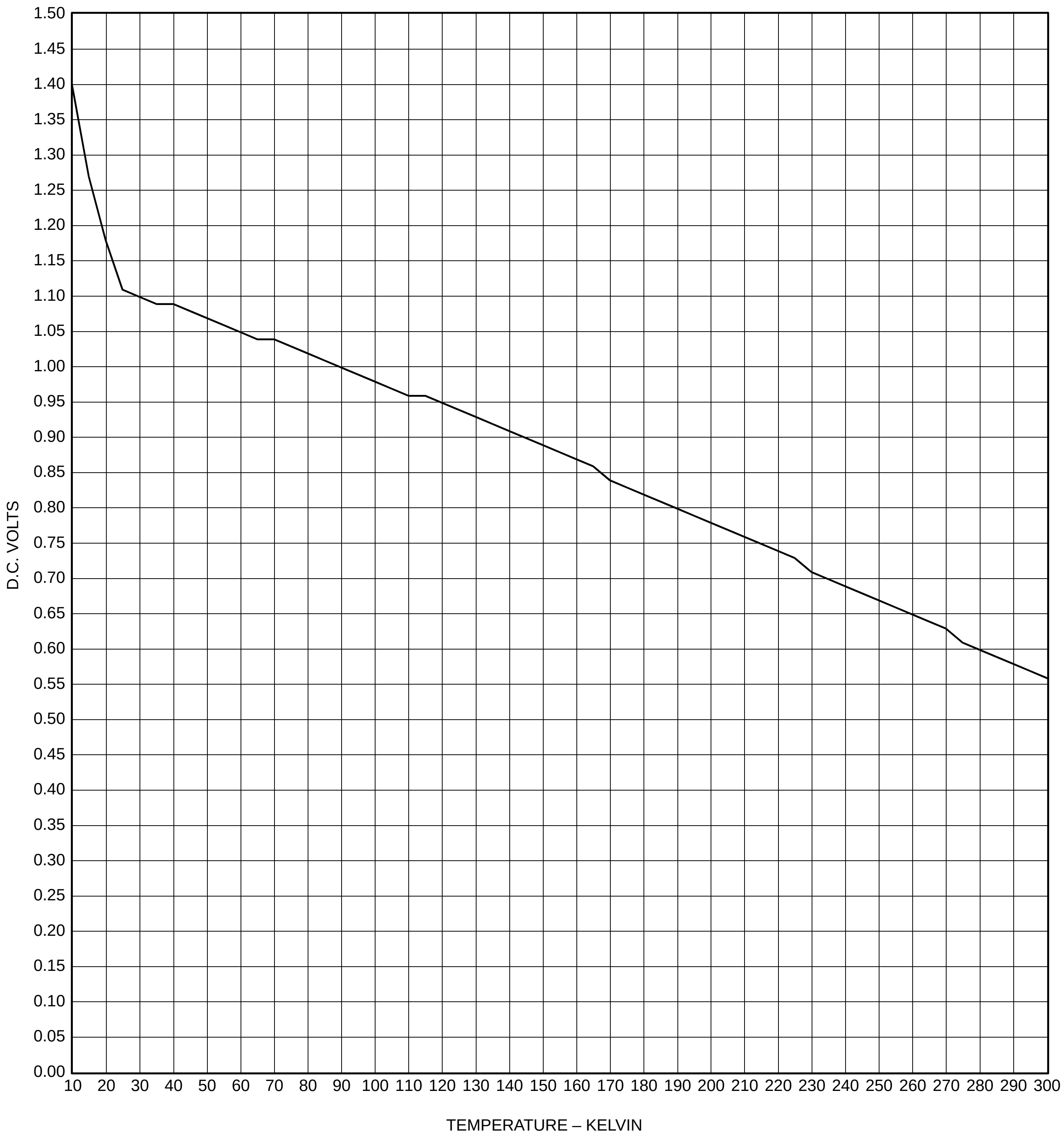
TEMPERATURE SENSING CIRCUIT
ILLUSTRATION 2–2



DIODE POLARITIES
ILLUSTRATION 2–3



GRAPH 2–1
SI410 DIODE VOLTAGE TO TEMPERATURE CONVERSION



GRAPH 2–2
SI410 DIODE VOLTAGE TO TEMPERATURE CONVERSION

2–2–3 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 NO TAG).

DIODE TEMPERATURE	CRYOSTAT COOLING/CRYOGEN FILLING REQUIREMENTS (MANUAL SECTIONS)
> 220K	FUNCTIONAL CHECKS, Sections 3 through 4 and SET UP AND CALIBRATION, Sections 3–1 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 3 through 4 or initiate magnet ramping, prior to establishing the Cryostat cooling/cryogen filling requirements in conformance with this Section.

2–3 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 3 – NITROGEN PURGE/PRECOOL

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE SAFETY CHECKLIST SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

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 2–2 is above 100K before proceeding with this Section. A cryostat with temperatures above 220K will require a Gaseous Nitrogen Purge (Section 3–1) 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 4.

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.

3–1 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.

CAUTION

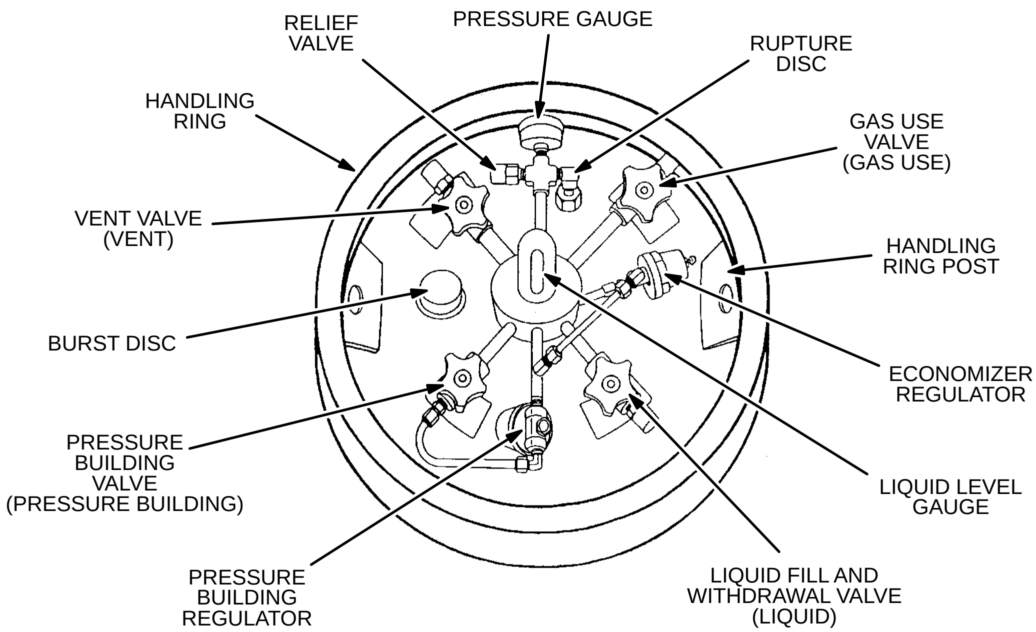
Never place weight (objects) on the coldhead sleeve as irreparable damage may result.

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

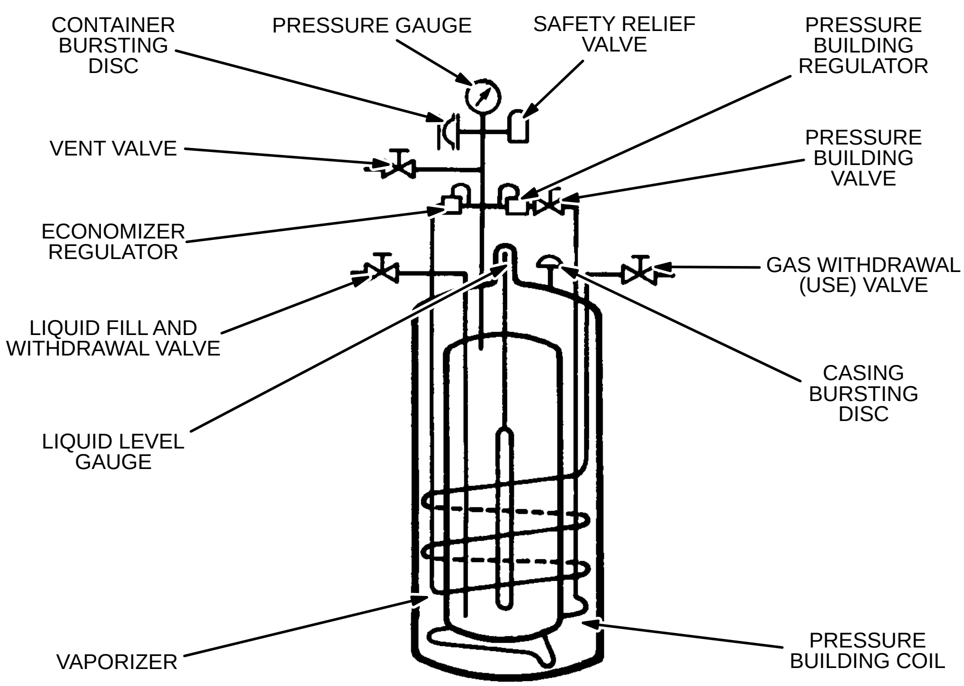
Note
Other sources of gaseous nitrogen may be used with appropriate setup apparatus.

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

3–1 GASEOUS NITROGEN PURGE (continued)



TOP VIEW OF NITROGEN DEWAR



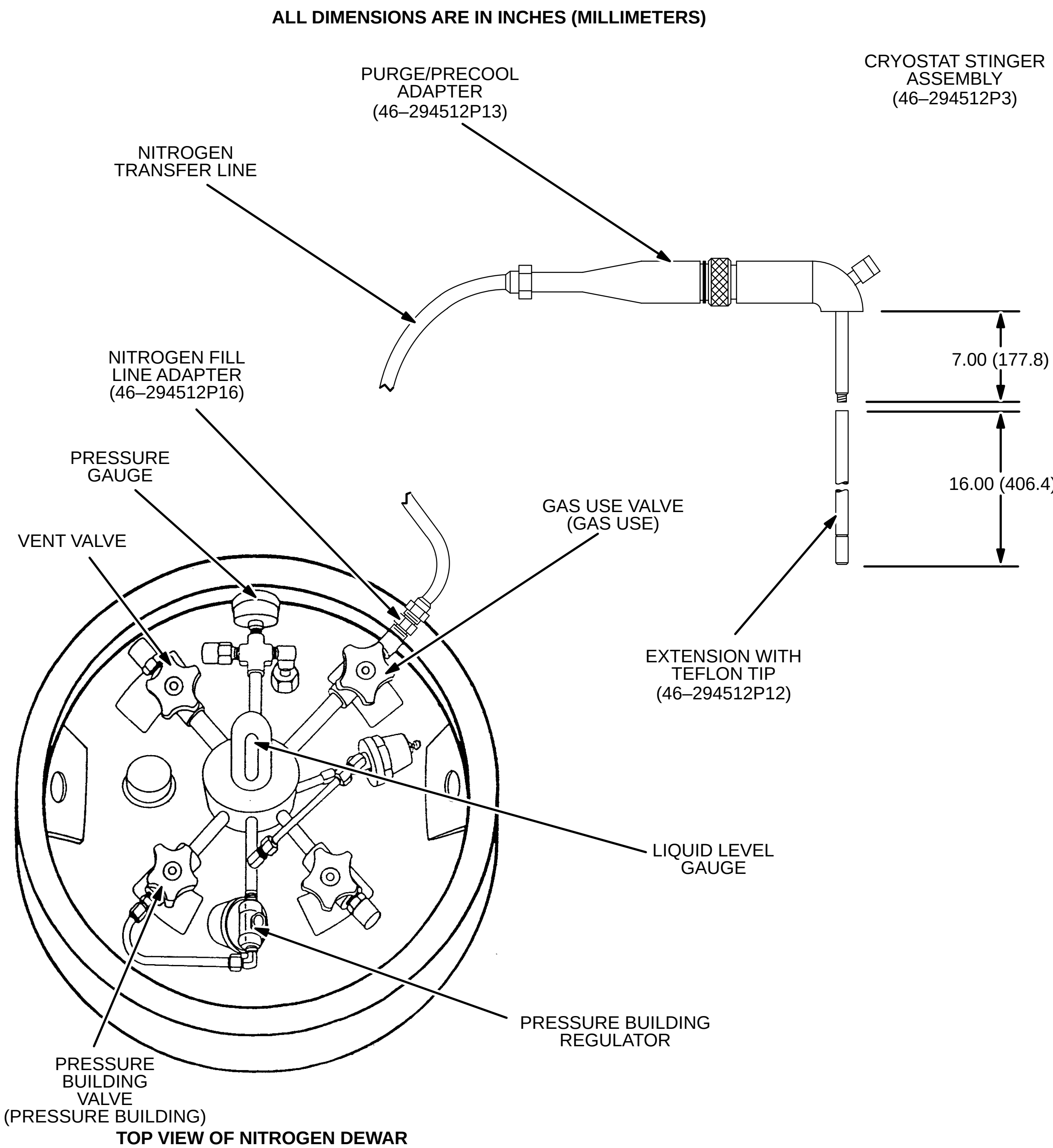
TEXT IN PARENTHESIS REFERS TO THE IDENTIFICATION LABELS ON THE DEWAR.

NITROGEN GAS/LIQUID DEWAR
ILLUSTRATION 3–1

3–1 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.



NITROGEN PURGE/PRECOOL ADAPTER
ILLUSTRATION 3–2

3–1 GASEOUS NITROGEN PURGE (continued)

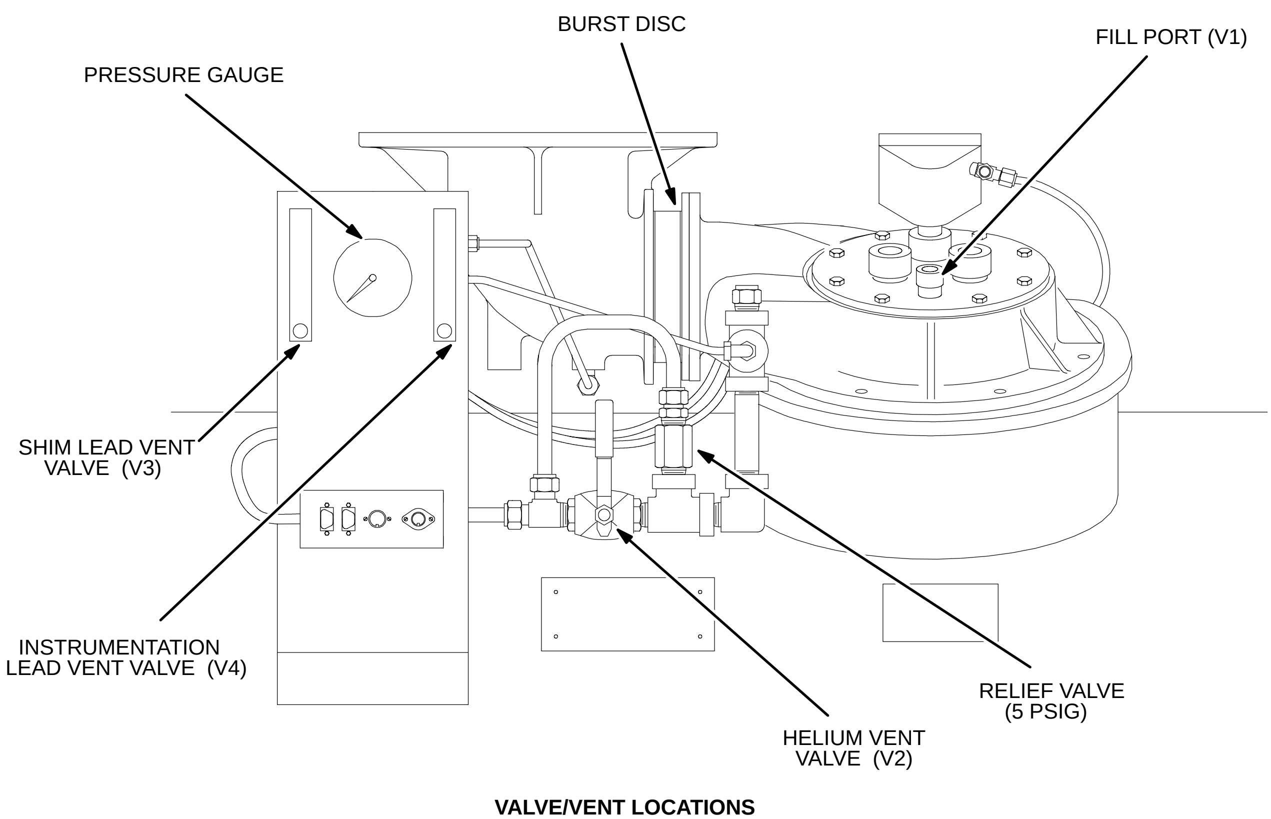
CAUTION

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

3–1 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 3–2.

3–2 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.

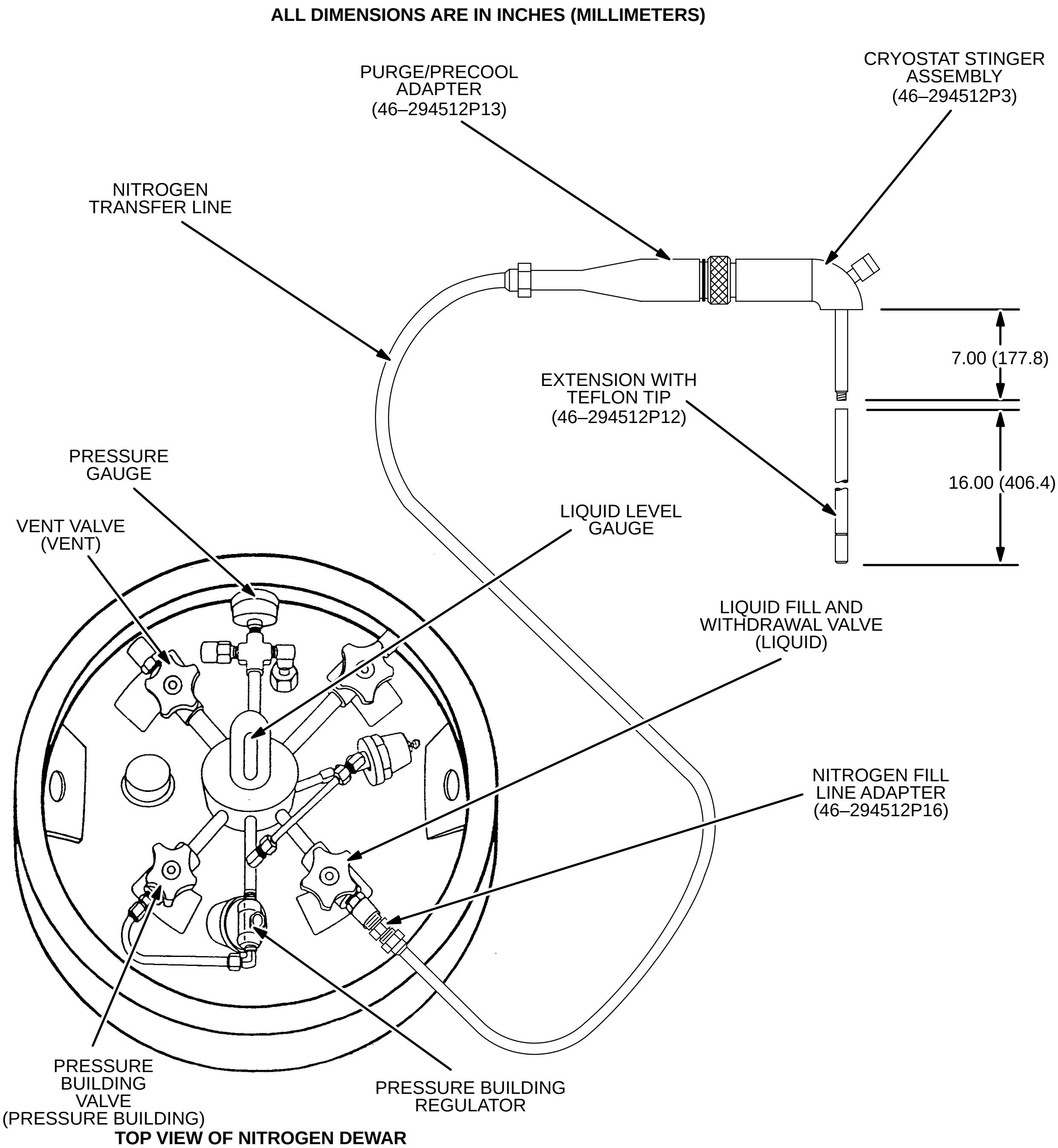
Note
Other sources of gaseous and liquid nitrogen may be used with appropriate setup apparatus.

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.

3–2 LIQUID NITROGEN PRECOOL (continued)



NITROGEN PRECOOL SET UP
ILLUSTRATION 3–4

3–2 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 3–1
APPROXIMATE COOLDOWN RATES

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

3–2 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 3–1, 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 3–3, HELIUM PURGE.

3–3 HELIUM PURGE

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE <u>SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS</u> SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE <u>SAFETY CHECKLIST</u> SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

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.

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.

3–3 HELIUM PURGE (continued)

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.

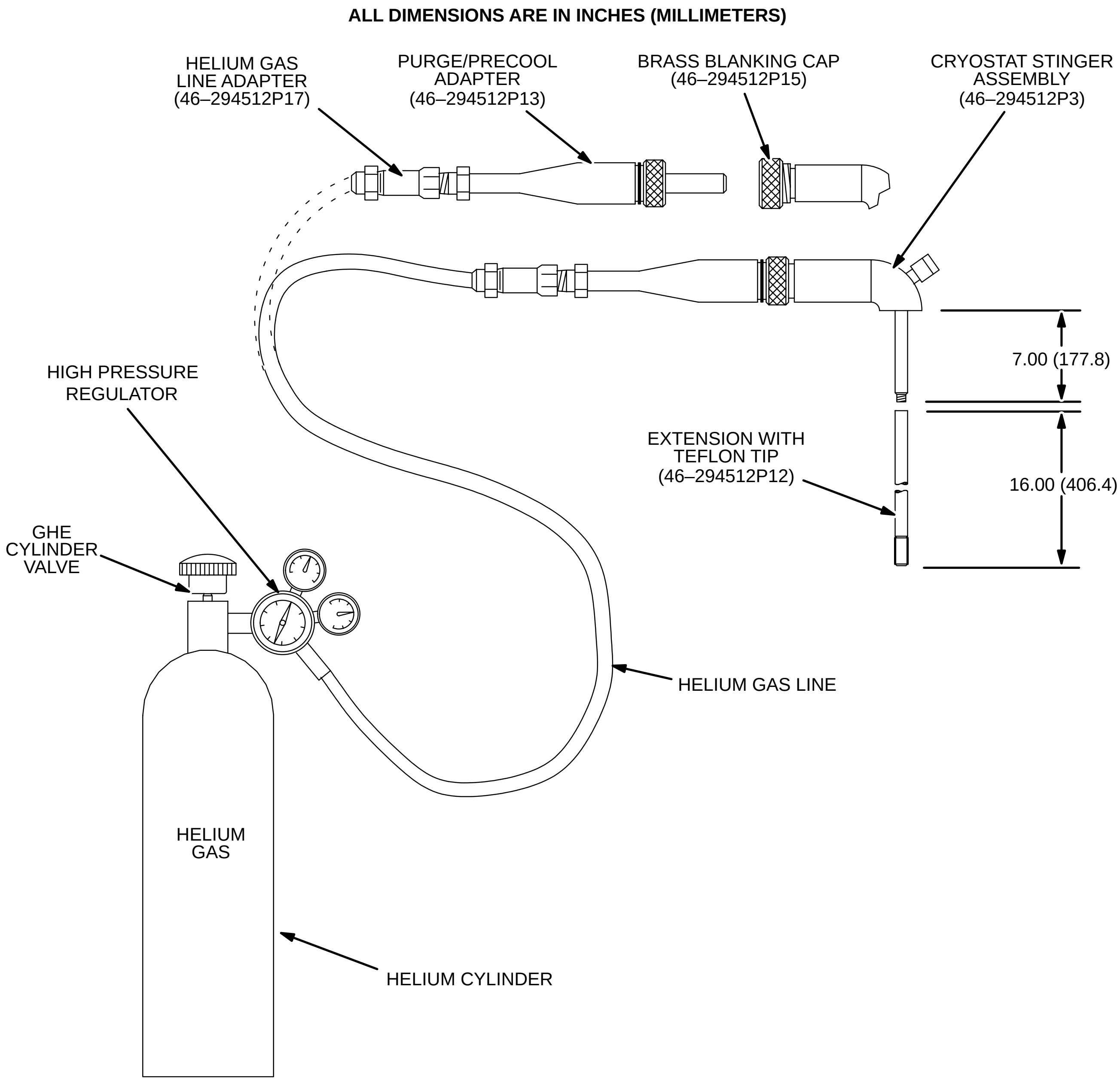
6. Purge regulator and gas line assembly by alternately turning regulator handle fully in and out 3 times. Upon completion of purge, back regulator out until minimal flow is felt exiting the Purge / Precool Adapter.
7. Remove Brass Blanking Cap from Cryostat Stinger Assembly and immediately connect Purge / 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 4, LIQUID HELIUM FILL.

3–3 HELIUM PURGE (continued)



HELIUM PURGE SET–UP
ILLUSTRATION 3–5

SECTION 4 – LIQUID HELIUM FILL

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE SAFETY CHECKLIST SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

NOTE

The following table should be used for determining minimum cryogen levels. Minimum cryogen levels are liquid volumns and NOT readings from level meters. Percentage (%) readings are taken on a cryogen monitor. Refer to Volumetric Conversion Chart 5–1 in Data Sheet section.

TABLE 4–1
MINIMUM CRYOGEN LEVELS

MAGNET	RAMP	SHIM	EMERGENCY FILL	FILL – 250 LITER DEWAR AT 90% FILL EFFICIENCY	
				3 DEWARS	4 DEWARS
1.0T CX 1.5T CX	90%	75%	42%	62% – 47%	47% – 42%
NOTE: LHe % values are liquid helium meter readings.					

CAUTION

Do not operate magnet below 28% liquid helium meter reading to avoid possible damage from a magnet quench.

Note:

See Volumetric Conversion Chart / Curve in Data Sheets, Sections 5–1 and 5–2 for volume conversions from liquid helium meter % readings.

“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 Online Center Magnet Support Team 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.

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

BOTTOM FILL: A Bottom Fill is performed only when there is very little liquid helium in the magnet such as after a quench. Generally, there will be some small amount of liquid helium left after a quench.

4–1 EQUIPMENT

Top Fill Equipment

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

Bottom Fill Equipment

- Liquid Helium Transfer Line 46–294512P1 x 12 feet (3658mm) or 46–294512P2 x 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

Mobile Fill Equipment

- Liquid Helium Transfer Line 2166440 x 20 feet (6096mm)
- 250 liter / 500 liter Dewar Stinger Assembly 46–294511P1 / P2

Note

Filling at relocatable sites must be performed from the front of the magnet. The relocatable module will not accommodate 500 liter dewars.

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.

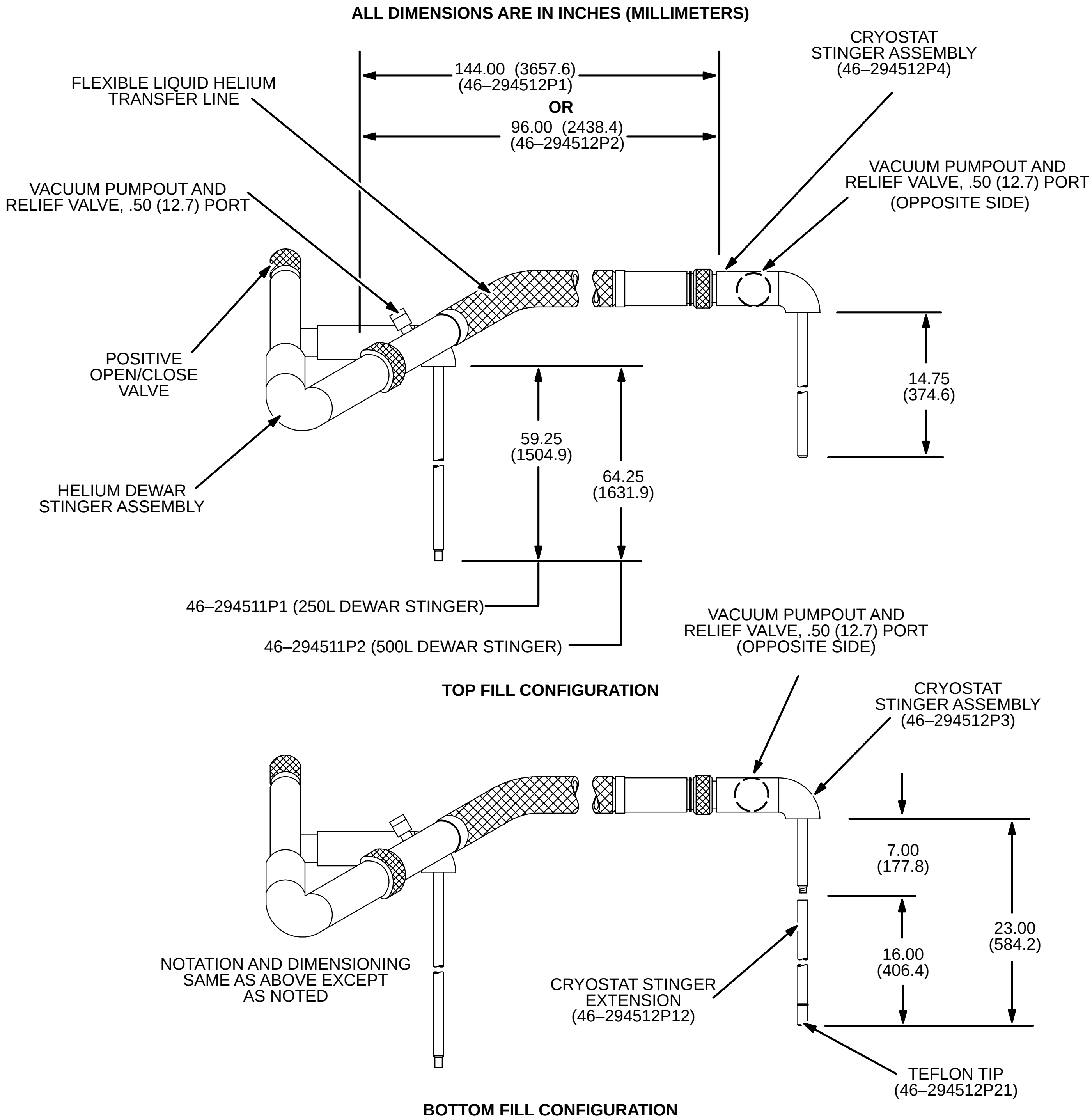
Other Equipment Needed

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

Note

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

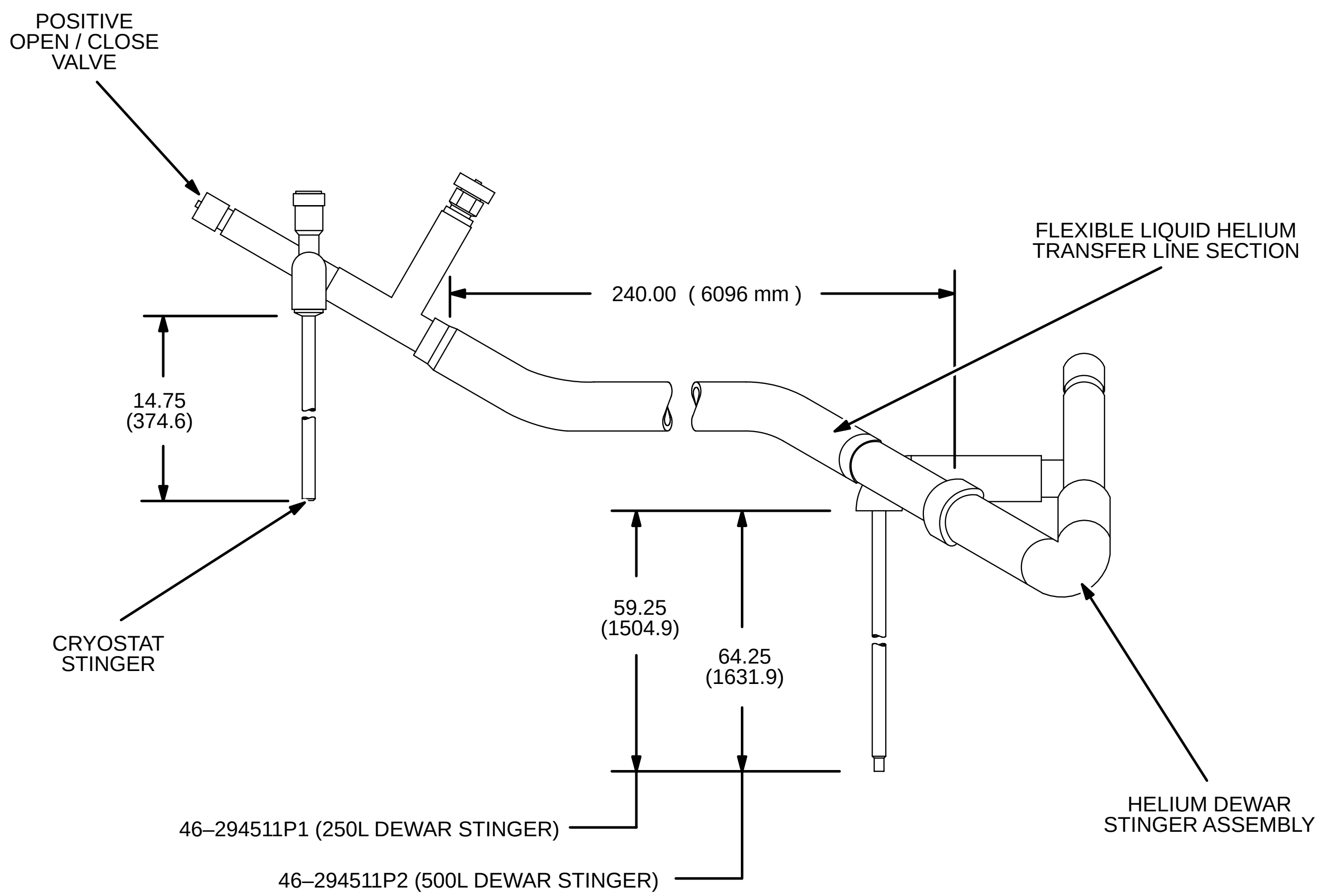
4–1 EQUIPMENT (continued)



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

4–1 EQUIPMENT (continued)

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



MOBILE FILL CONFIGURATION

VACUUM JACKETED HELIUM TRANSFER LINE AND DEWAR/CRYOSTAT STINGER ASSEMBLIES (con't.)
ILLUSTRATION 4–1

4–1 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:

4–2 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.

4–2 PREPARATION (continued)

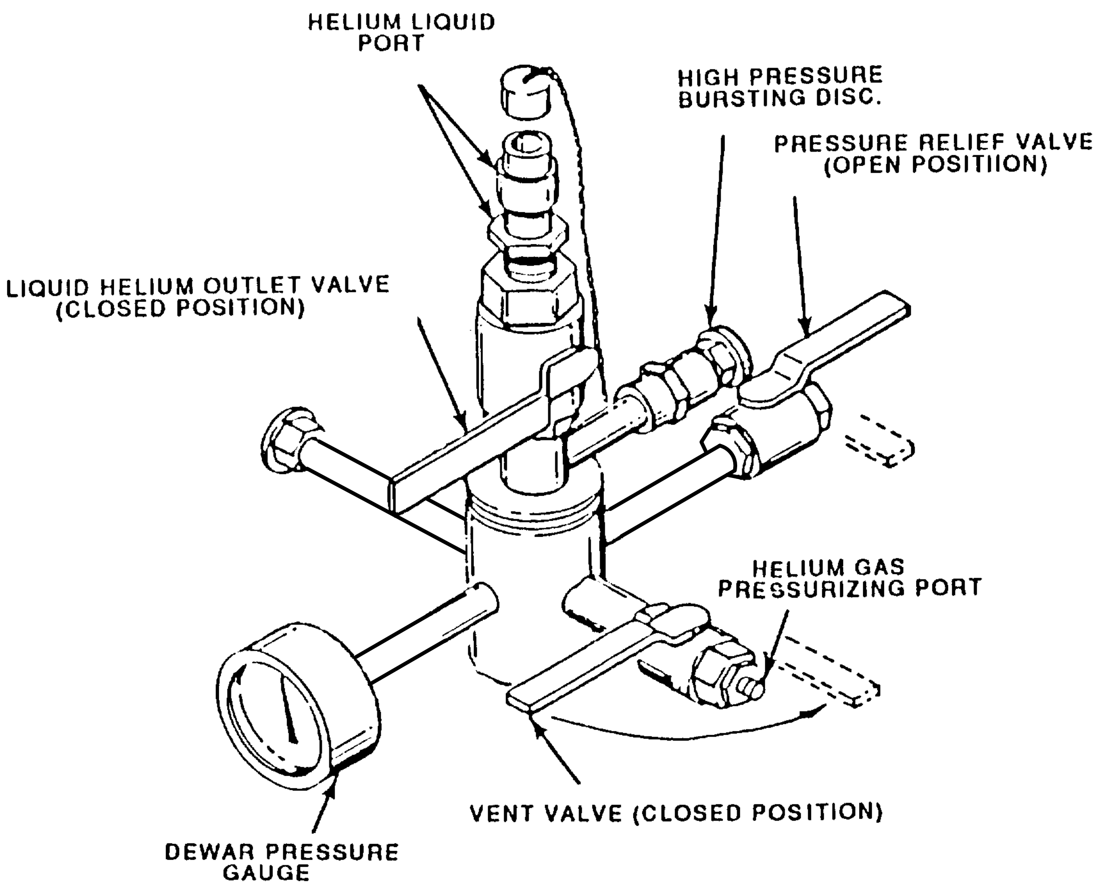
CAUTION

Never place weight (objects) on the coldhead sleeve as irreparable damage may result.

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 NO TAG, for instruction on checking the shield temperatures. If temperature is greater than 100K, refer to SET UP AND CALIBRATION, Section 2–2, 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

4–2 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.

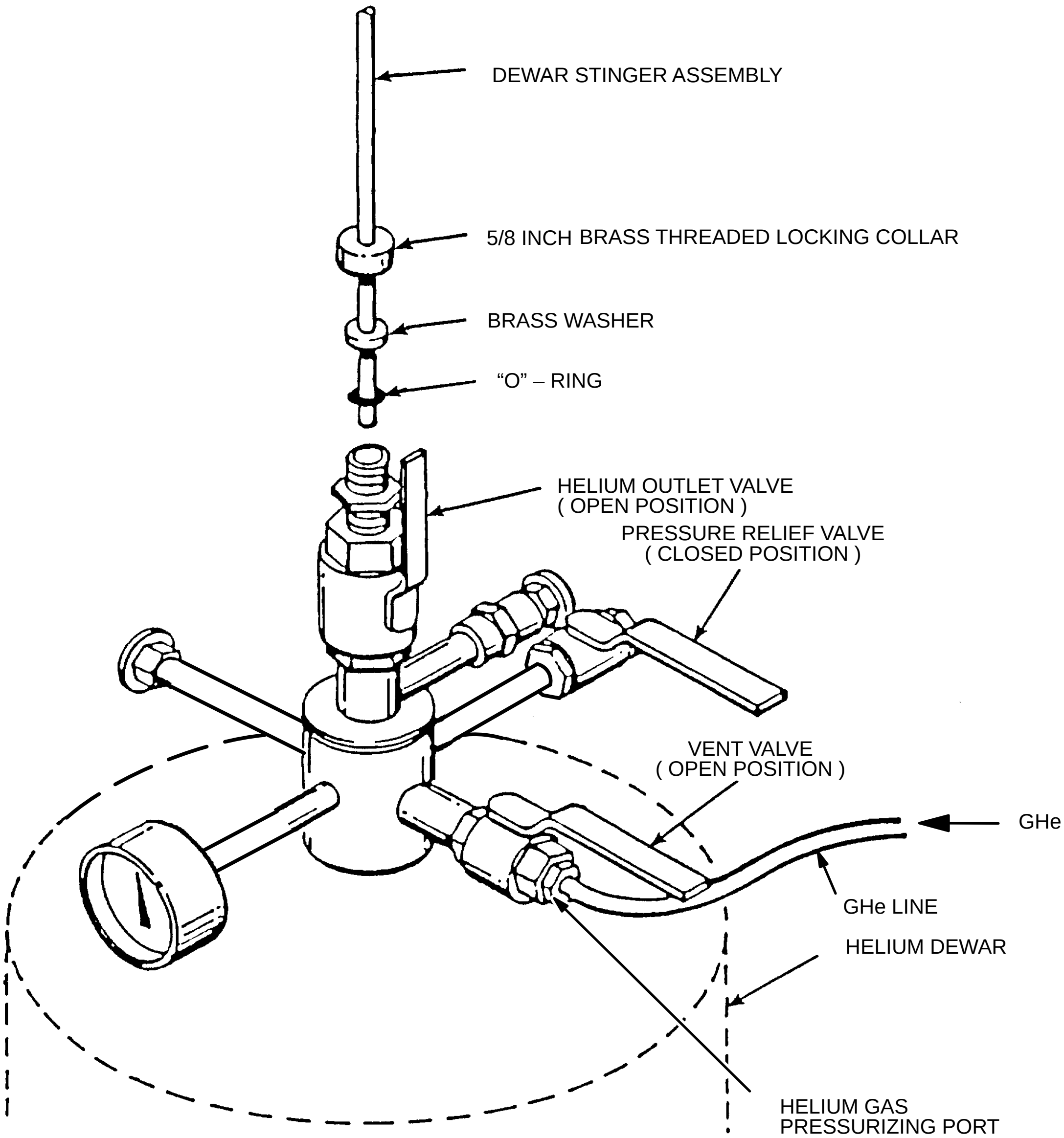
5. Connect standard GHe Cylinder Regulator And Hose Assembly to Valve Outlet (CGA 580) on GHe cylinder.
6. Make sure that Regulator Adjusting Handle is fully backed out, then slowly open GHe Cylinder Valve.
7. Observe Regulator High Pressure Gauge. Make sure indicated pressure is approximately 2000 psig 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.

4–3 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.

4–3 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

4–3 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.

4–3 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.

4–3 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.

4–3 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.

4–4 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.

4–4 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.

4–4 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 5 – 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 46–294060G4 to map the 45cm DSV (316 points).

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.

Refer to Illustration 9–2, “MAGNET POLARITY RAMPED NORMAL”, on page 9–5 in Set–Up and Calibration, Subsection 9–2, “RESISTANCE CHECKS”, for magnet polarity orientation.

5–1 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. 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.
7. Remove Rear Pedestal side trim covers.
8. Unlatch the Rear Cover and move cover to the side.
9. Remove front and rear bells. Refer to Magnet Enclosure Install Manual 2147666.

5–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G4)

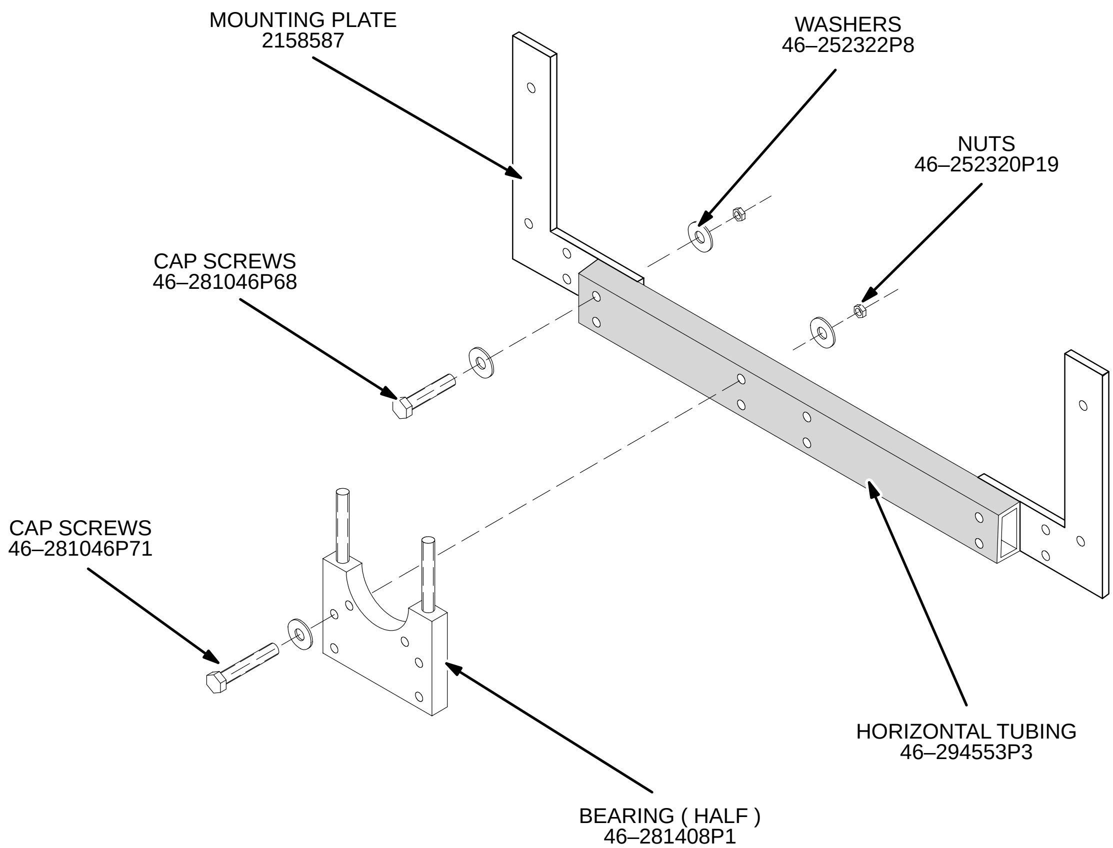
Note
The Magnet Bore should be clear for mounting and operating the Field Mapping Fixture.

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 Support Frame using 3.00 inch long 3/8–16 brass bolts, washers, and nuts. Install the horizontal member of the Support Frame as shown in the illustration below. See Illustration 5–1.



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

5–2 SERVICE TOOL MAPPING FIXTURE SETUP (MODEL #46–294060G4) (continued)

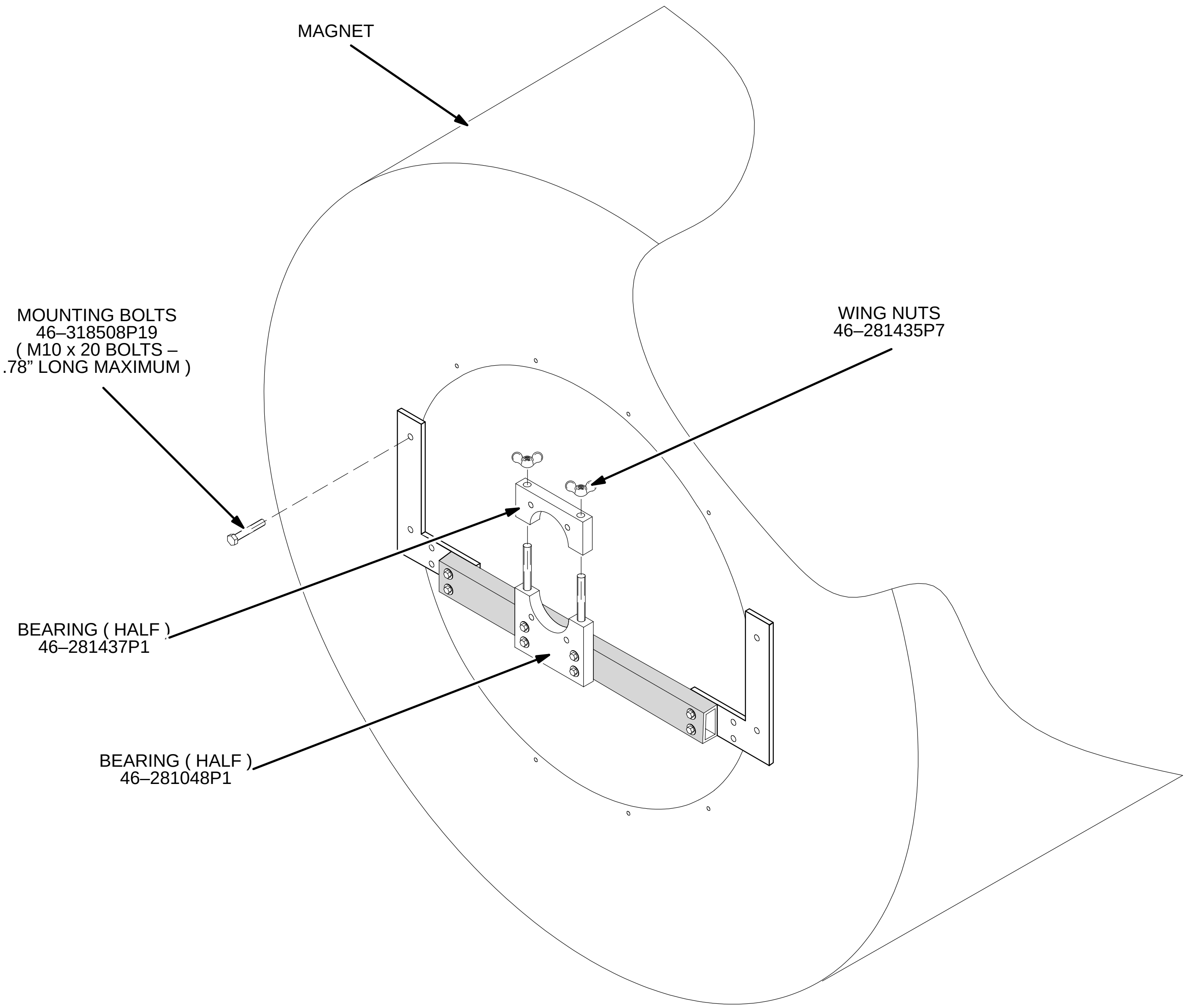
2. Attach the upper bearings to the Support Frame cross beam using 3.5 inch long cap screws, washers, and nuts. See Illustration 5–1.

3. Attach one of the Support Frames to the Back End of the magnet with four M10 x 20 bolts, at the required positions. See Illustration 5–2. Use of Permatex (1 oz. tube – 2119594) or Bostik (4 oz. can 46–294151P8) anti–seize lubricant is recommended.

CAUTION

Do not use mounting bolts any longer than the ones specified (46–318508P19 = M10 x 20). Damage to magnet end flange can occur. See Illustration 5–2

5–2 SERVICE TOOL MAPPING FIXTURE SETUP (MODEL #46–294060G4) (continued)

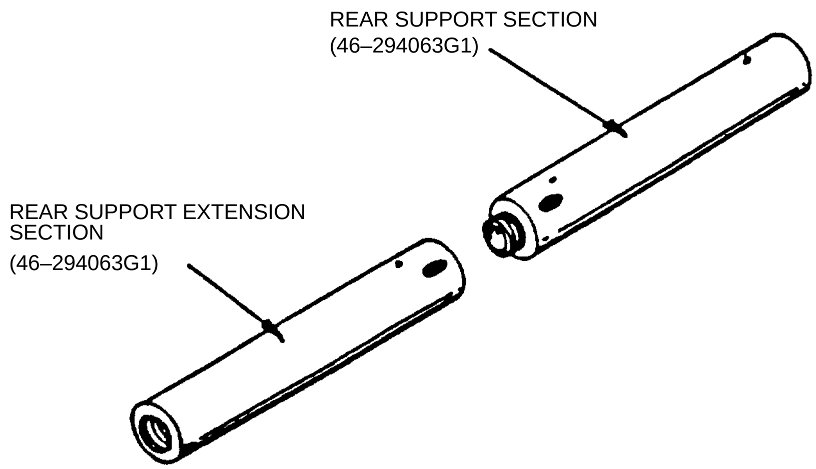


SUPPORT FRAME MOUNTING & HALF BEARING ATTACHMENT
ILLUSTRATION 5–2

5–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G4) (continued)

4. Loosely attach the lower half of the bearing to the upper half of the bearing on both Support Frames. Use the Wing Nuts to support the lower half of the bearing. See Illustration 5–2.

5. 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 5–3.



ATTACHMENT OF THE AXIAL TUBE EXTENSION SUPPORT SECTION
TO THE REAR SUPPORT SECTION
ILLUSTRATION 5–3

CAUTION

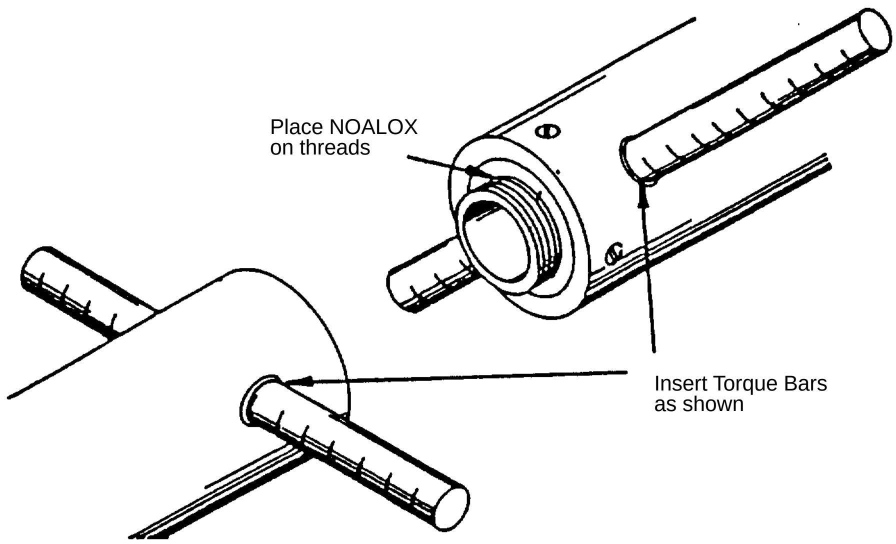
Stainless Steel Torquing Bars may be slightly magnetic. Do not use near the magnet bore.

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 5–4.

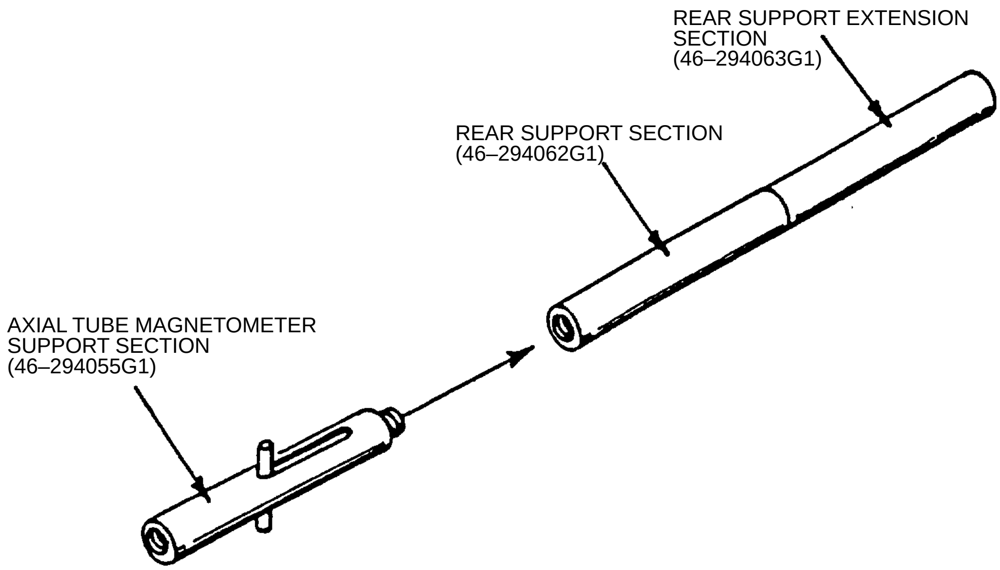
If it is difficult to align the tubes by hand, then use Torquing Bars as follows: All tubes have a pair of 3/4 inch diameter holes near each end. These holes should be used to insert Torquing Bars for leverage when torquing the tubes together. See Illustration 5–4.

5–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G4) (continued)



LUBRICATION POINTS
ILLUSTRATION 5–4

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

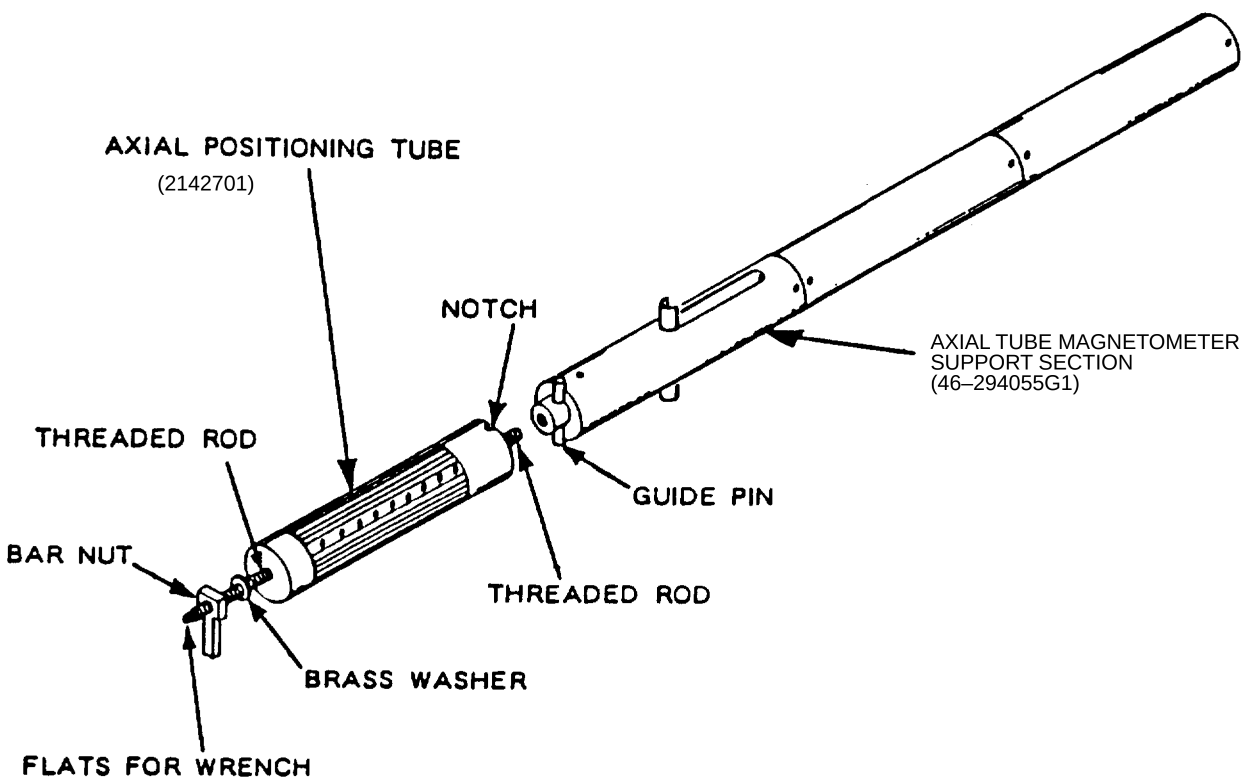


ATTACHMENT OF THE AXIAL TUBE MAGNETOMETER SUPPORT SECTION TO THE REAR SUPPORT SECTION AND THE REAR SUPPORT SECTION EXTENSION
ILLUSTRATION 5–5

5–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G4) (continued)

7. Join the Axial Positioning Tube (2142701), See Illustration 5–6, to the other assembled tubes as described below:

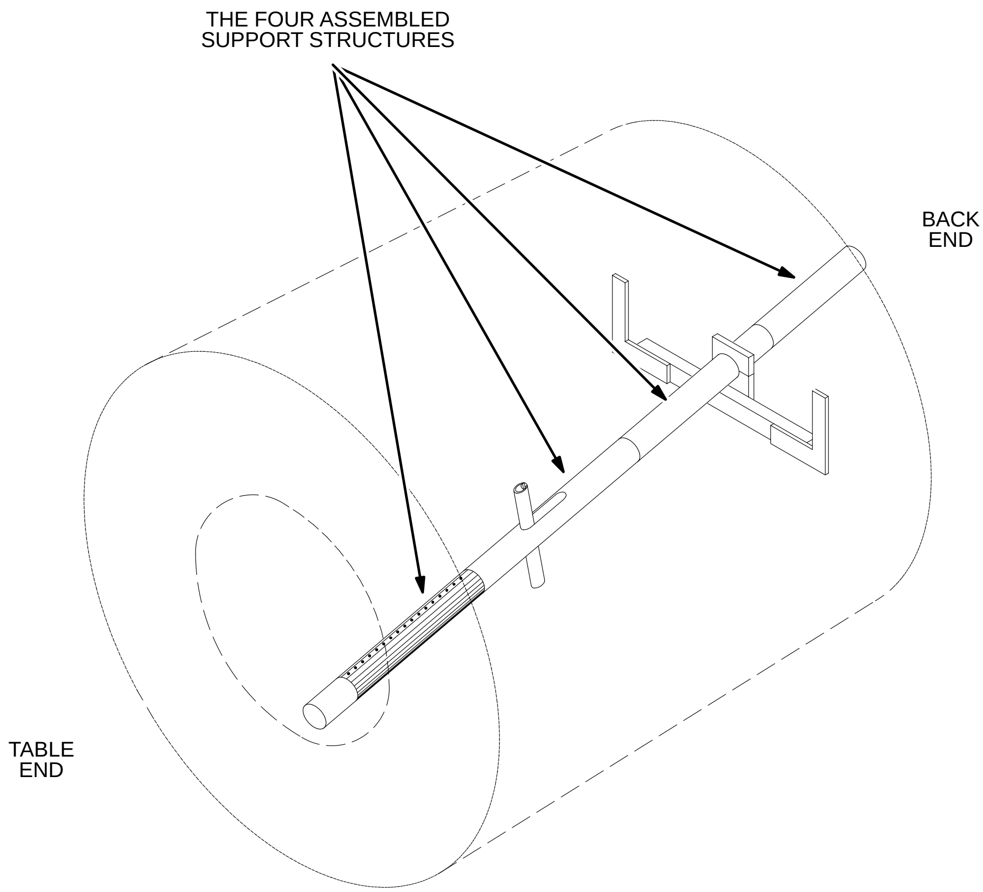
   - Line up the notch in the Axial Positioning Tube with the pin in the front of the Magnetometer Support Tube and slide the tubes together.
   - Using a 9/16 inch wrench on the “Flats” of the threaded brass rod, turn the rod until it engages the Magnetometer Support Tube (at least 4 turns).
   - Turn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



ATTACHMENT OF AXIAL POSITIONING TUBE
ILLUSTRATION 5–6

5–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G4) (continued)

8. 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 5–7.



INSERTION OF THE FOUR ASSEMBLED SUPPORT TUBES
ILLUSTRATION 5–7

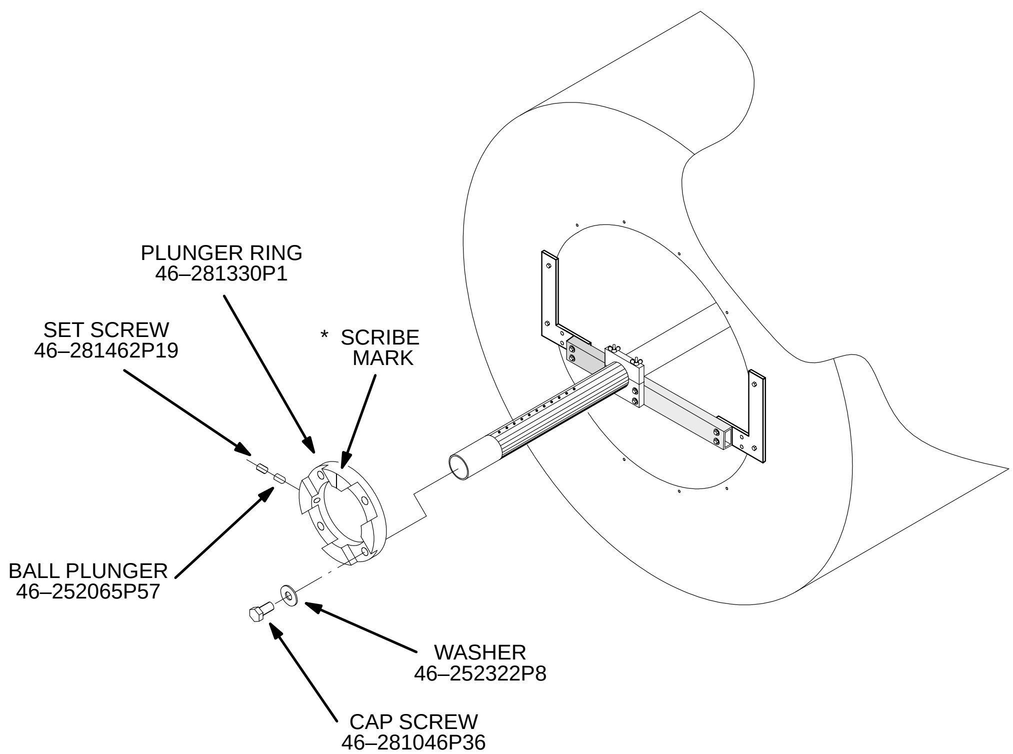
9. Attach the remaining Support Frame to the Table End of the magnet.

10. Lift and pull the tube assembly through the Table End bearing hole until the tube assembly is supported by the Support Frames. See Illustration 5–8.

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

12. 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 5–8.

5–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G4) (continued)



* SCRIBE MARK TO BE AT TOP, 0 DEG. POSITION

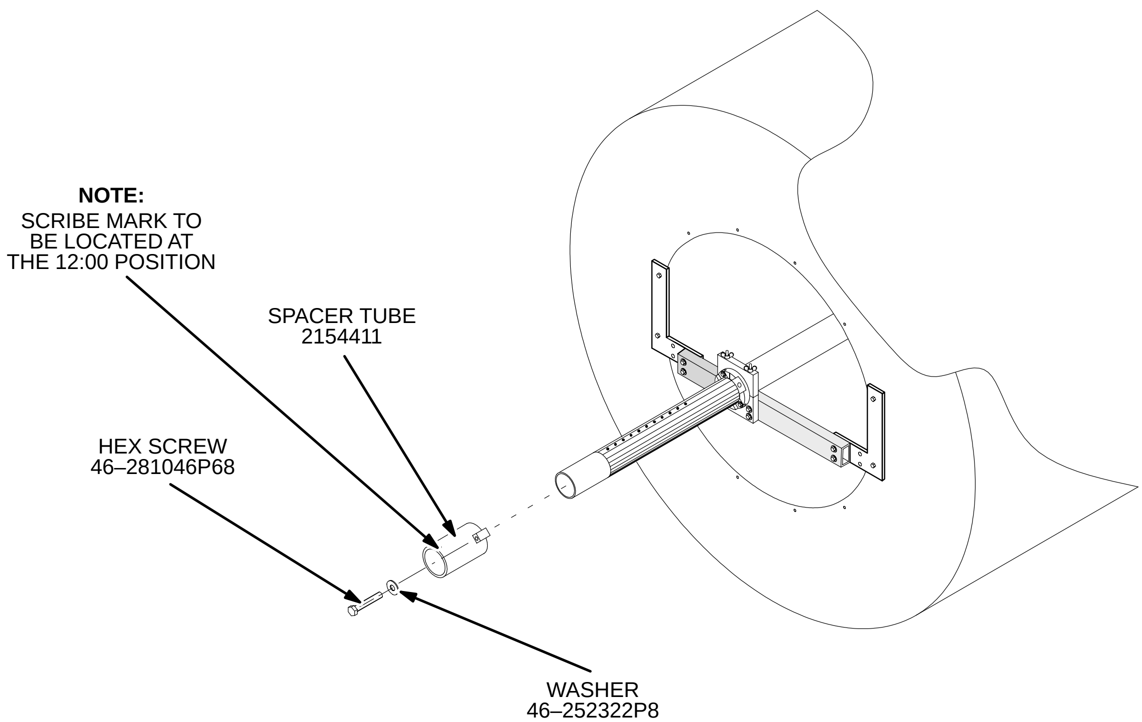
ATTACHMENT OF THE PLUNGER RING
ILLUSTRATION 5–8

IMPORTANT

There is a different Axial Positioning Ring (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.

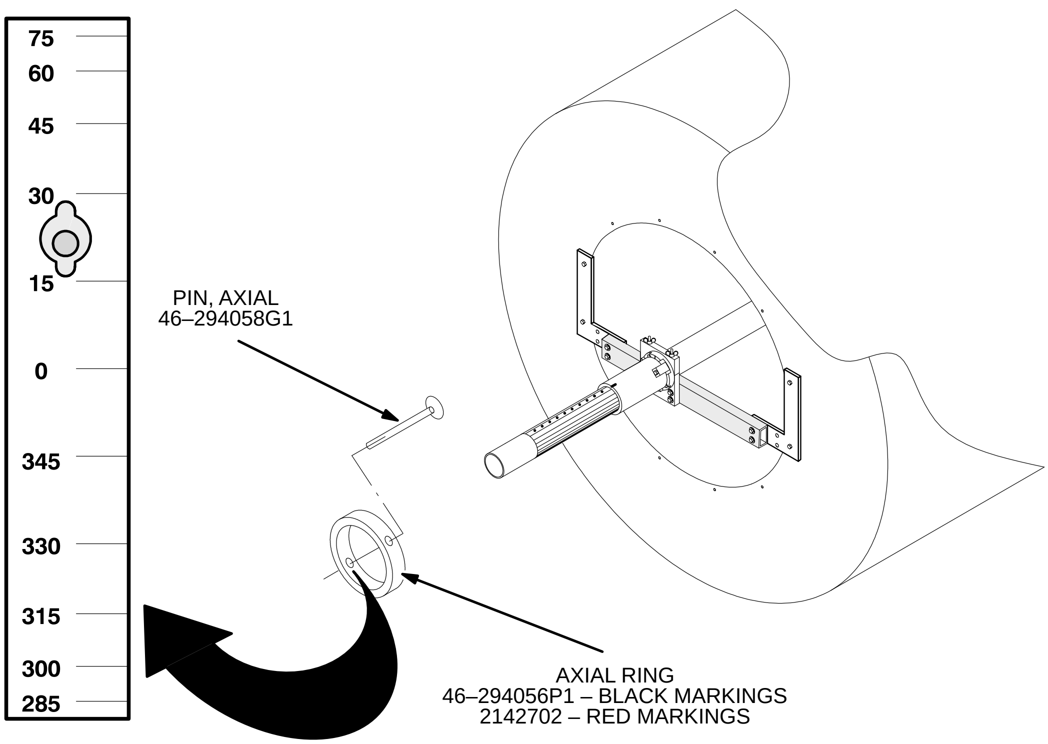
13. Slide the Axial Positioning Ring on the Axial Positioning Tube. Pin it at a convenient axial position. Make sure the Axial Positioning Ring is oriented with degree numbers advancing in a clockwise direction. See Illustration 5–10.

5–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G4) (continued)



ATTACHMENT OF THE SPACER TUBE
ILLUSTRATION 5–9

5–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G4) (continued)



ATTACHMENT OF AXIAL POSITIONING RING
ILLUSTRATION 5–10

5–2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46–294060G4) (continued)

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

CAUTION

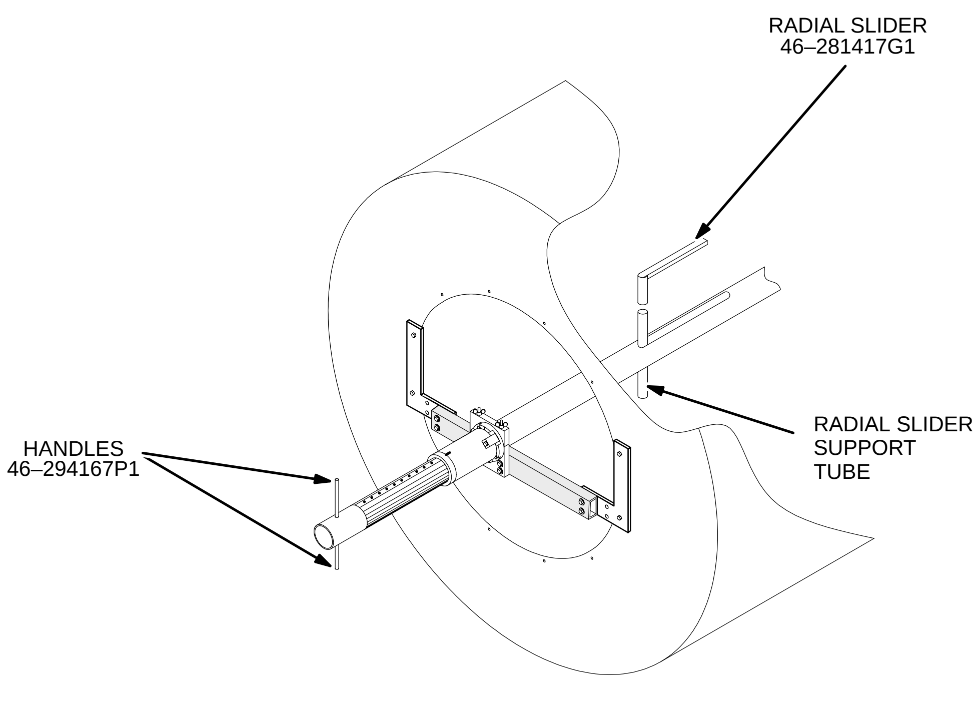
Do not overtighten Ball Plunger as damage could result. Back Set Screw out as far as possible to still maintain "detent action".

15. 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 5–8.

16. 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.

17. 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.



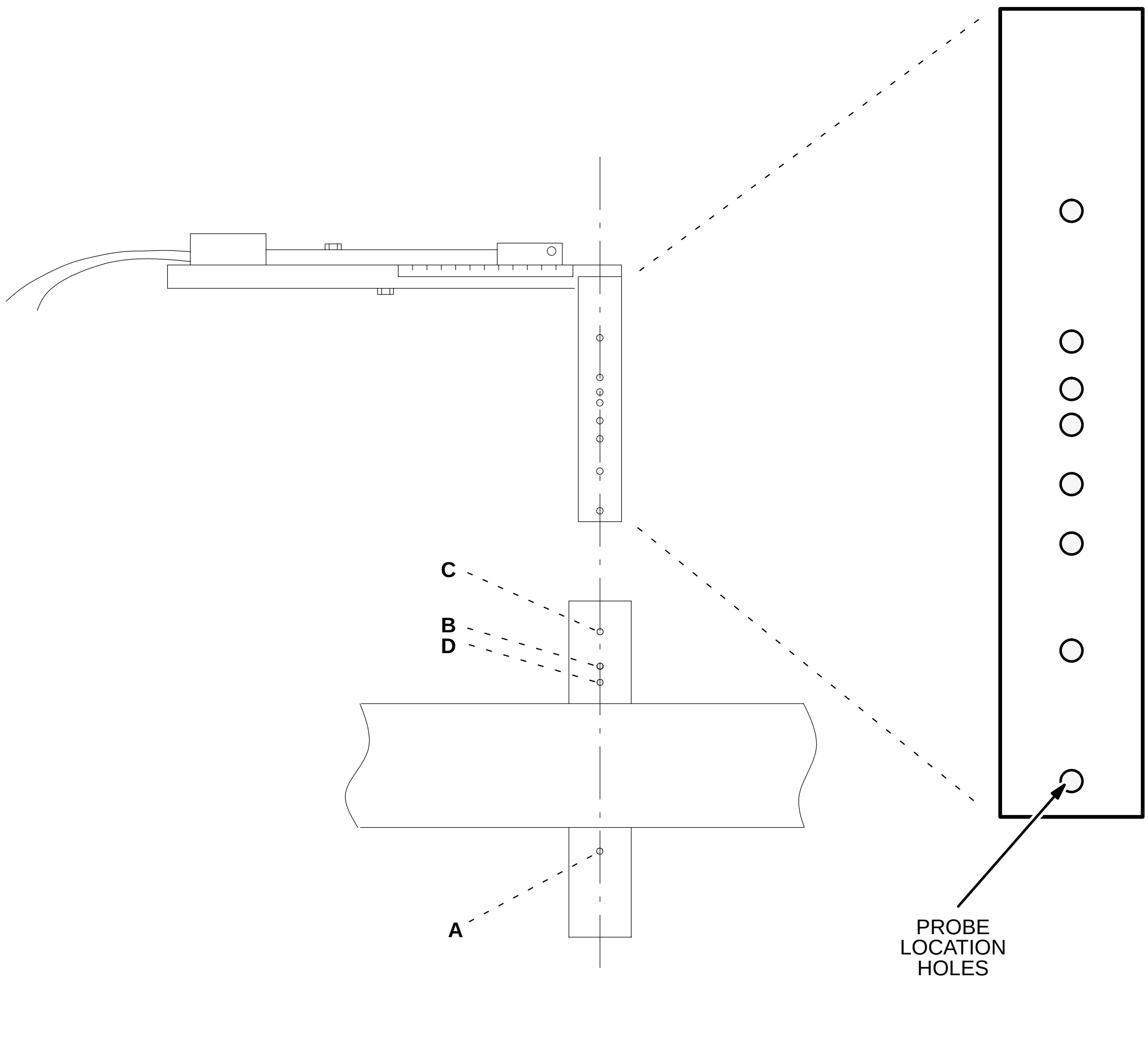
INSERTION OF THE RADIAL SLIDER AND ATTACHMENT OF HANDLES
ILLUSTRATION 5–11

5–3 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:

<u>MODEL #46–294060G4</u>

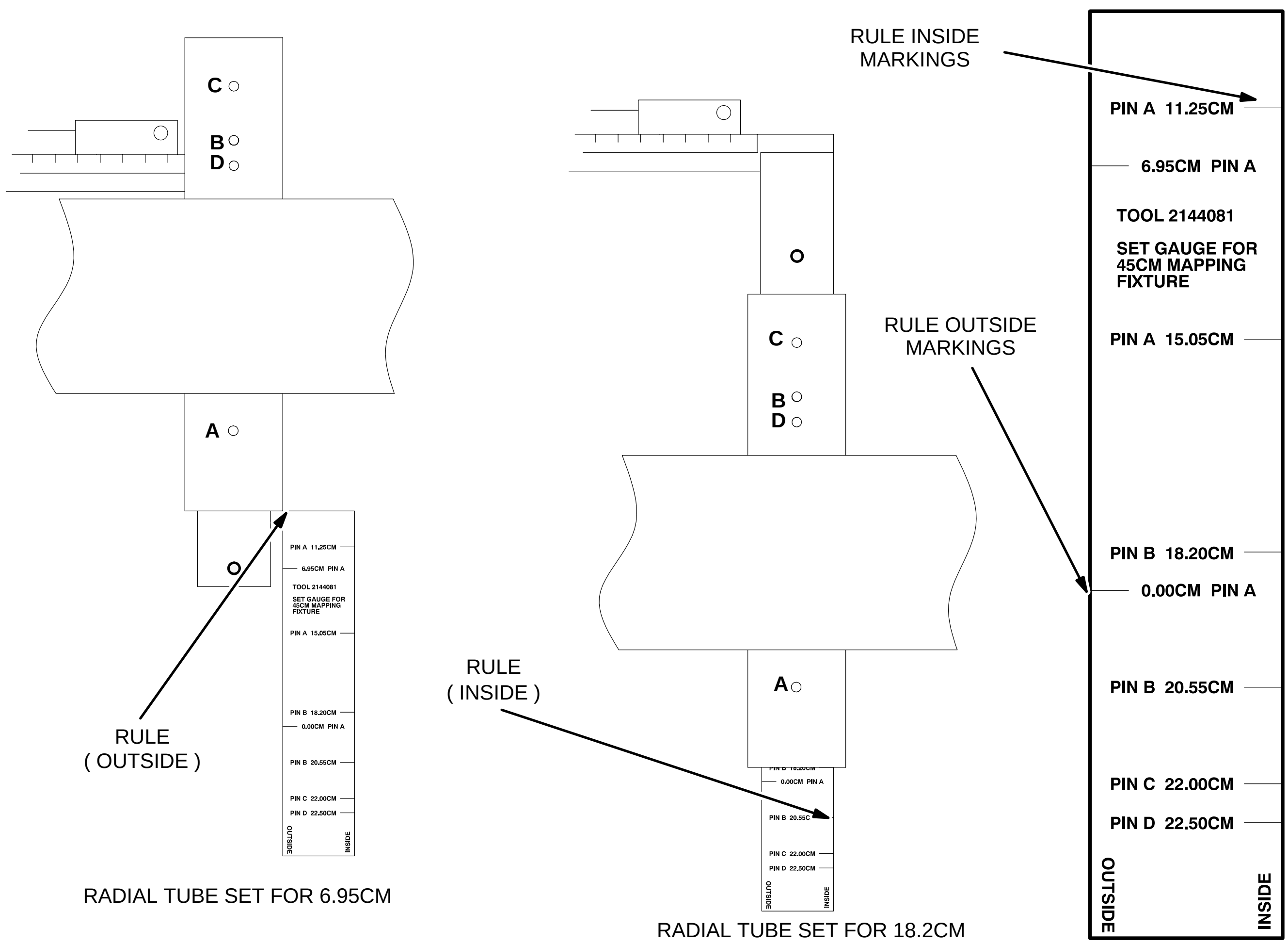
1. Radial Positioning: Adjust the Radial Slider Tube in the Radial Support Tube and pin through the desired position holes. See Illustration 5–12, 5–13 and Table 5–1 for correlation to Holes A, B, C and D. A ruler is available to help set the correct Radius. See Illustration 5–12.



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

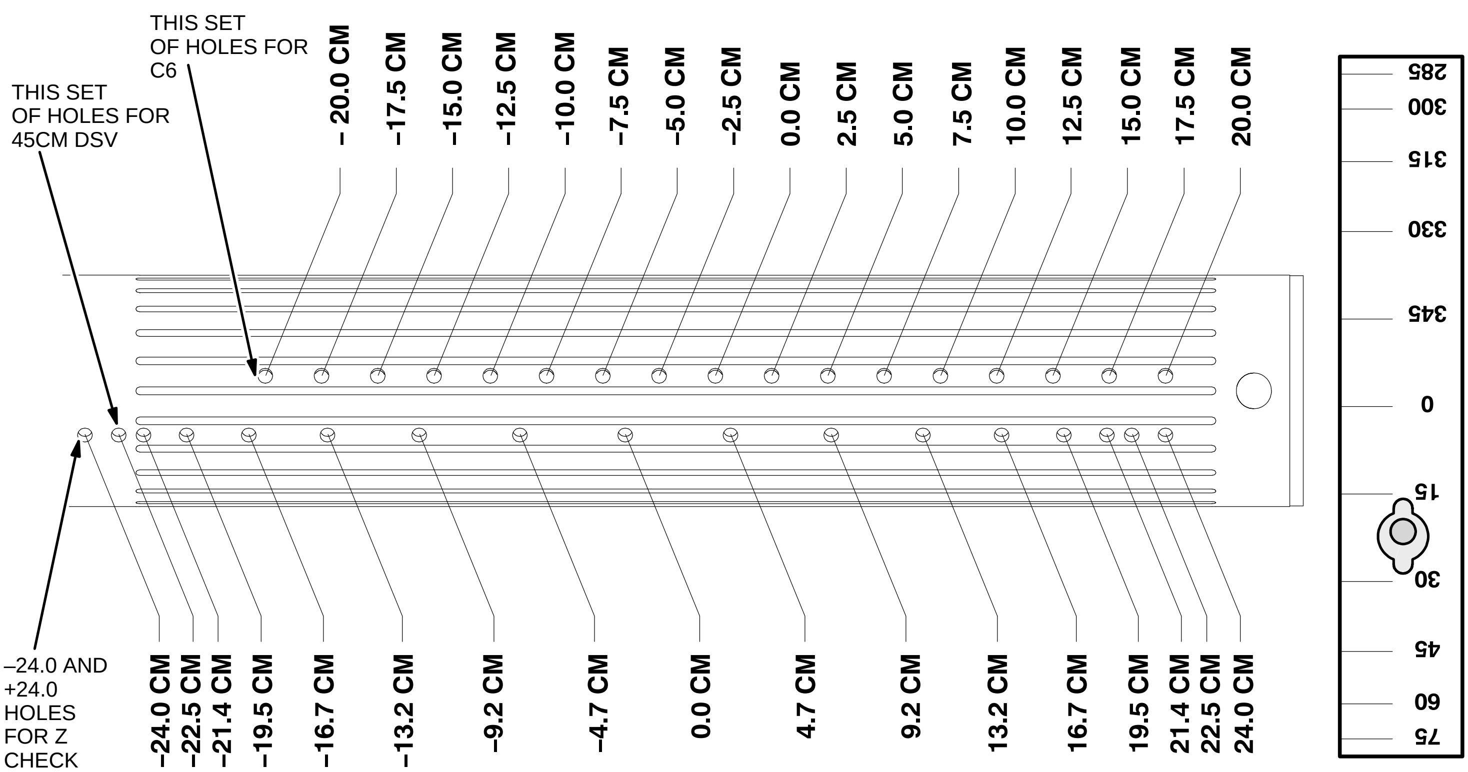


RADIAL ARM PINNING LOCATIONS
ILLUSTRATION 5–13

5–3 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. 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. See Illustration 5–14.



USE RED MARKINGS AND GROOVES ON TUBE AND RED MARKED AXIAL POSITIONING RING FOR 45 CM DSV.

ANGULAR / AXIAL POSITIONING
ILLUSTRATION 5–14

5–4 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.

5–4 TESLAMETER PROBE MECHANICAL CENTERING

Procedure:

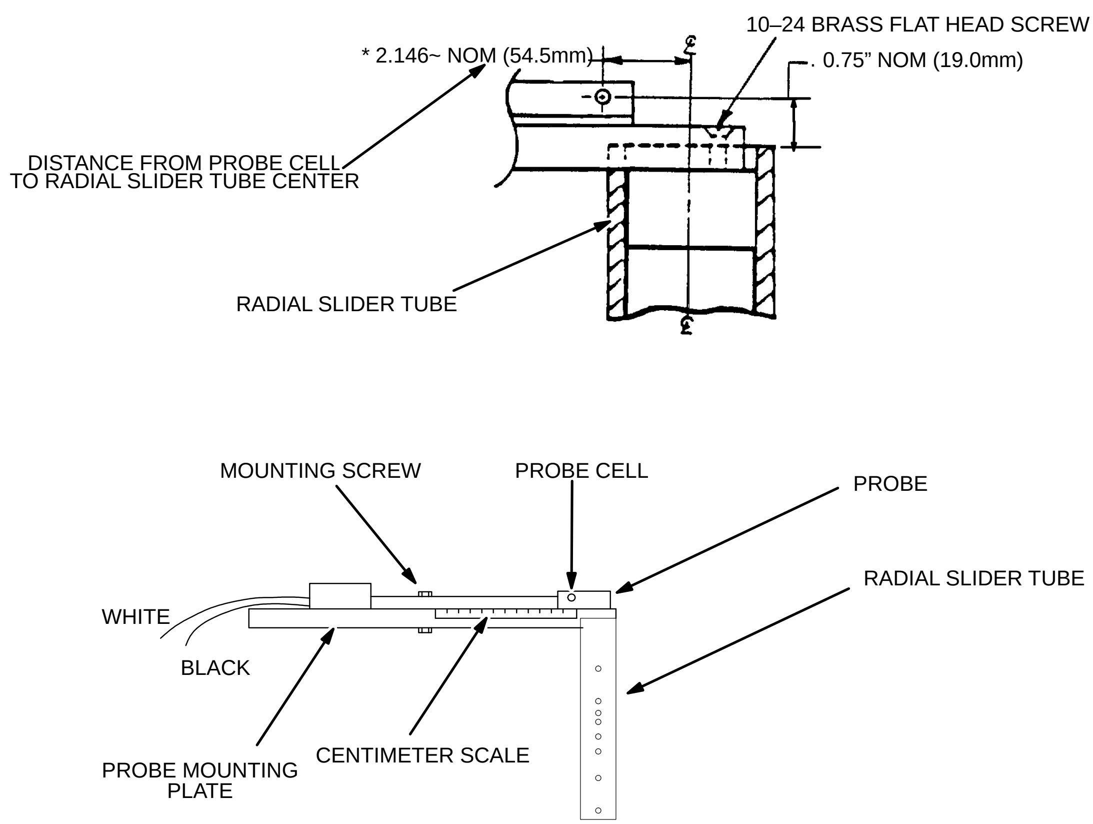
1. Attach the Probe to the probe mounting plate with brass machine screws as shown in illustration 5–15.

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 (46–294060G4). 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

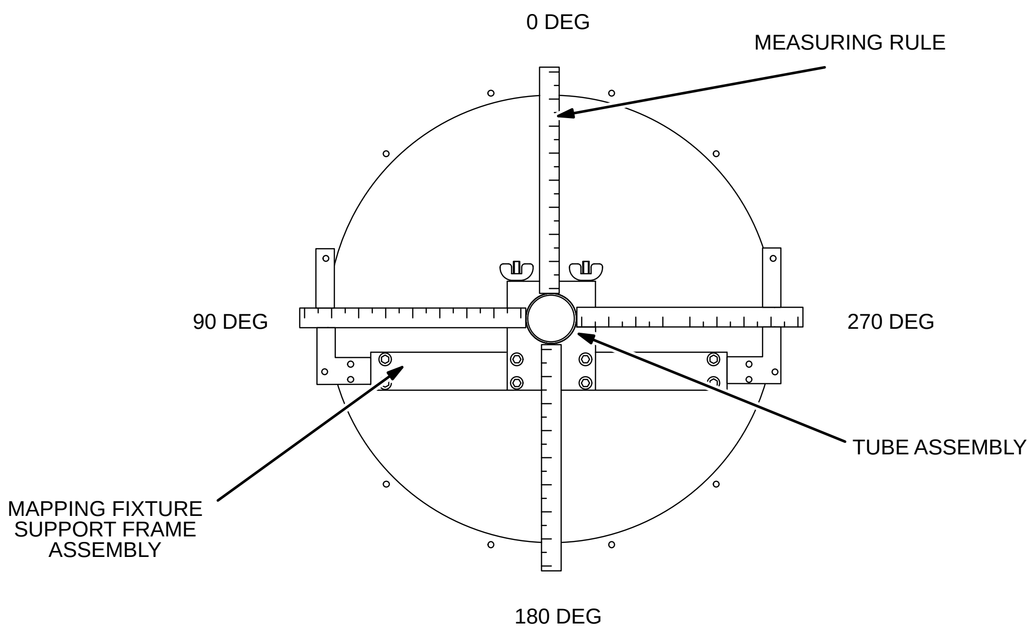
5–4 TESLAMETER PROBE MECHANICAL CENTERING (continued)

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 Support Frame Mounting Bolts on the appropriate Support Frame slightly and adjust the Support Frame in the appropriate direction to bring the distances within the ± 1 mm tolerance.

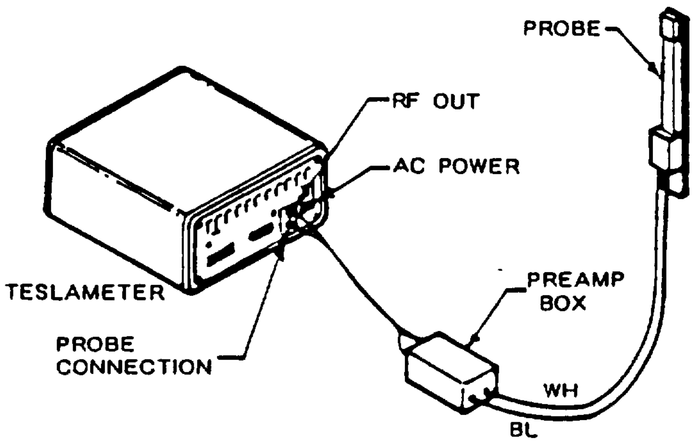
7. Repeat Steps 3 through 5 for both sides of the Mapping fixture.



TRANSVERSE MECHANICAL CENTERING OF MAPPING FIXTURE
ILLUSTRATION 5–16

5–5 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).

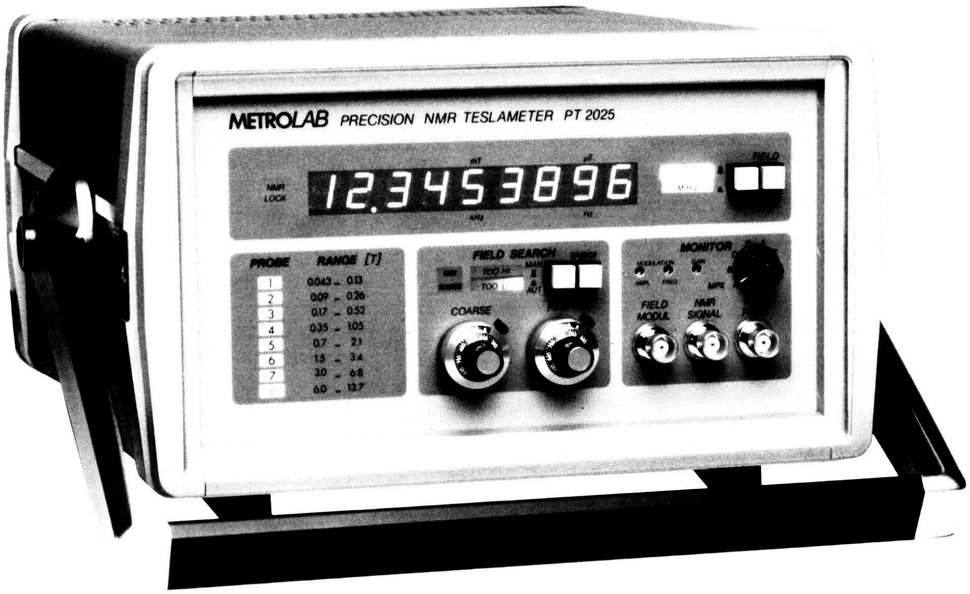


TESLAMETER INTERCONNECTIONS
ILLUSTRATION 5–17

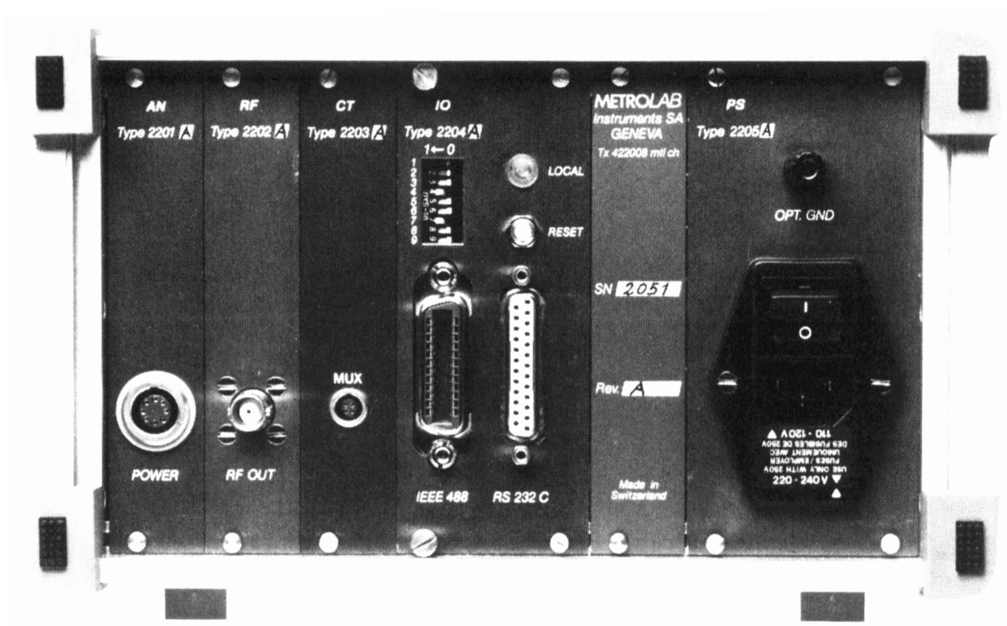
4. Turn on AC power to the meter. See Illustration 5–18 rear view.
5. Place the “LOCK / MANUAL’’ switch in the MANUAL position.

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 Coldhead 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.

5–6 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.

5–7 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.

5–8 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 6 – SHIM LEAD ENGAGE/DISENGAGE

Description:

Make sure the Shim Lead Assembly is in the “Engaged” position before Ramping or Shimming the Magnet.

The Shim Lead Assembly should only be placed in the “Disengaged” position for troubleshooting purposes only.

Procedure:

6–1 SHIM LEAD ENGAGE

1. Loosen Shim Lead Compression Fitting.
2. Carefully push downward on Shim Lead Connector Housing until Shim Lead contacts the Sav Con Connector.

Note

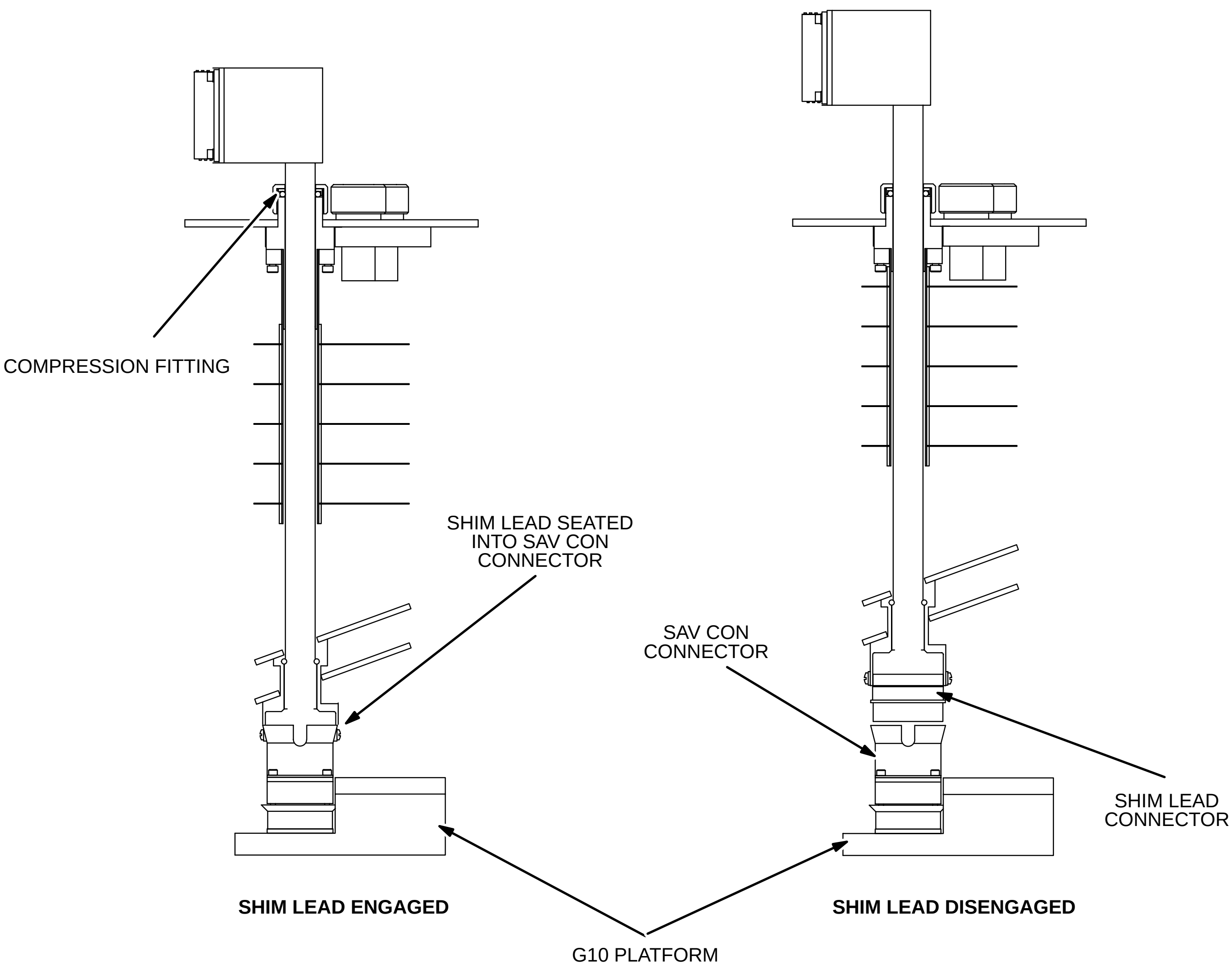
Shim Lead Connector and G10 mating connector are keyed and can only mated in one position.

3. Seat Shim Lead fully, after contact is felt, by continuing to push on the Shim Lead Connector Housing with moderate pressure. Shim Lead should move down approximately 1/4 inch, after contact is felt, to fully engage.
4. Tighten the Shim Lead Compression Fitting.
5. Refer to Sections 9 through 11, SET UP AND CALIBRATION for Ramping and Shimming respectively.

6–2 SHIM LEAD DISENGAGE

1. Remove ice, with Heat Gun, around Shim Lead Assembly and Shim Lead Compression Fitting.
2. Loosen Shim Lead Compression Fitting.
3. Pull up firmly from underside of the Shim Lead Connector Housing until the Shim Lead Assembly unseats. See Illustration 6–1.
4. Hand tighten Shim Lead Compression Fitting.

6–2 SHIM LEAD DISENGAGE (continued)



SHIM LEAD POSITION
ILLUSTRATION 6–1

SECTION 7 – TCR 7.5T750 MAIN POWER SUPPLY TEST

Description

The Power Supply Checkout procedure should always be done before Ramp Up, Ramp Down, Or Readjusting The Magnet Field After Shimming. The Heater Current checkout only need to be performed when the Heater 1 Main, or the Heater 2 Shim Axial currents are outside the specified range (810 mA $\pm$ 10 mA). The Main Power Supply must be repaired, if any of the checks in Section 7 fail, before attempting to Ramp Up, Ramp Down, or Readjusting the Magnet Field After Shimming.

750A power supply model TCR 7.5T750 normally used. If magnet Acceptance Test Report (ATR) indicates ramping current > 750 amps or site has steel in floor / ceiling, use 1000 amp power supply model ESS 7.5–1000–2–D–1236.

7–1 POWER SUPPLY CHECK OUT

DESCRIPTION:

All TRC7.5T750 Power Supplies should be checked in conformance with this procedure at least once a year. In addition, it could be used when a TRC7.5T750 Power Supply is suspect of faulty operation and the supply cannot be sent to an approved calibration / repair facility before it is needed. This document is intended only for MAC team members who have been trained by a member of the “Power Supply Team”.

EQUIPMENT:

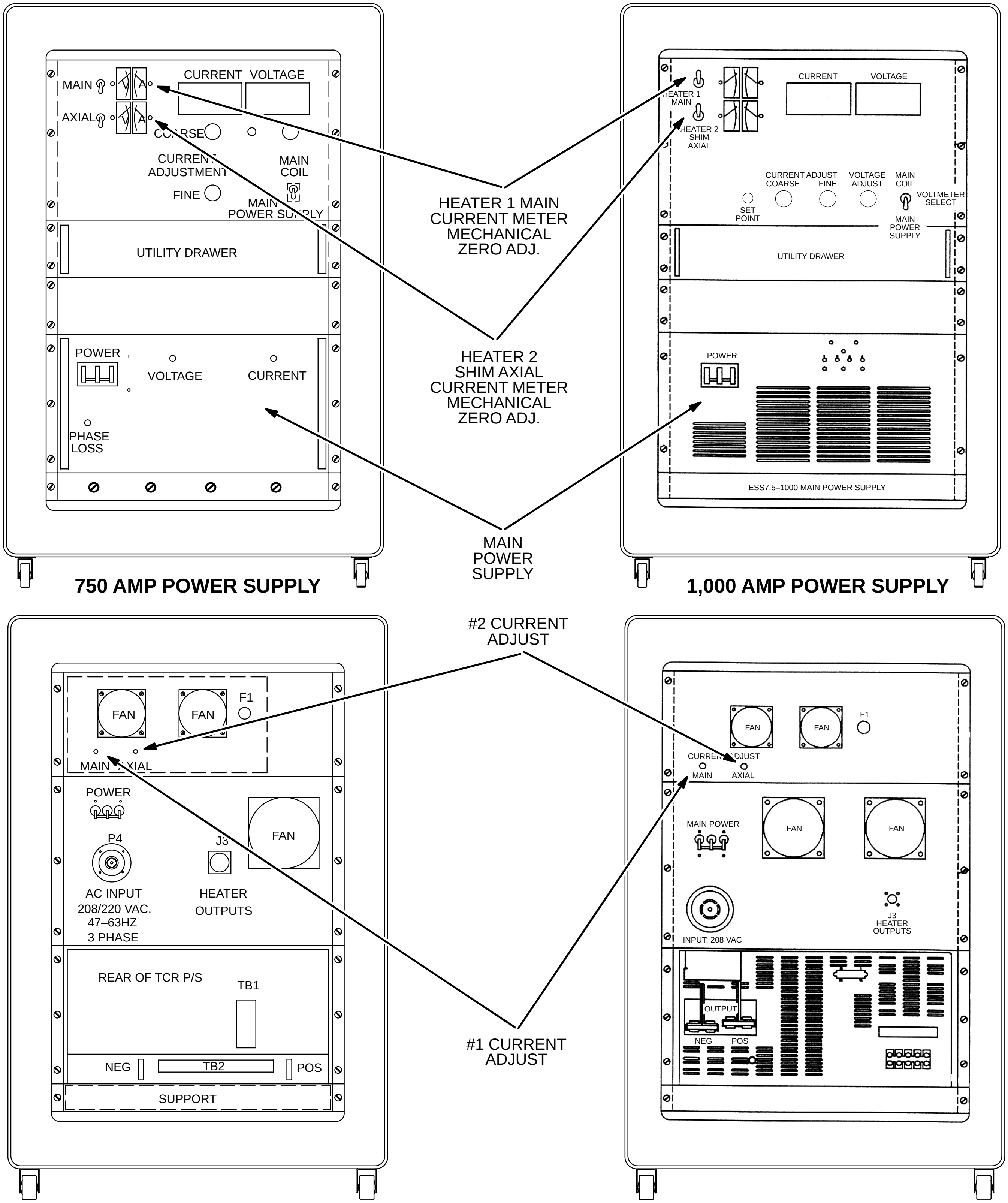
- 4 1/2 Digit True RMS Voltmeter (Fluke 87 or equivalent)
- Oscilloscope
- Set of Ramping Cables – 2 each for 750 amp power supply or 3 each for 1,000 amp power supply.
- Power Supply Checkout Kit P/N 2101360
- Non metallic Tuning Tool

7–1–1 HEATER CURRENT METER ZERO CALIBRATION

1. Disconnect input power cable to power supply under test.
2. Remove cover plates for meter mechanical zero adjustment screw (located adjacent to each meter). See Illustration 7–1.
3. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL switches to 0 (off).
4. Adjust each meter’s Mechanical Zero Adjustment screw to position meter indicator needle at “0” (zero).
5. Replace cover plates.

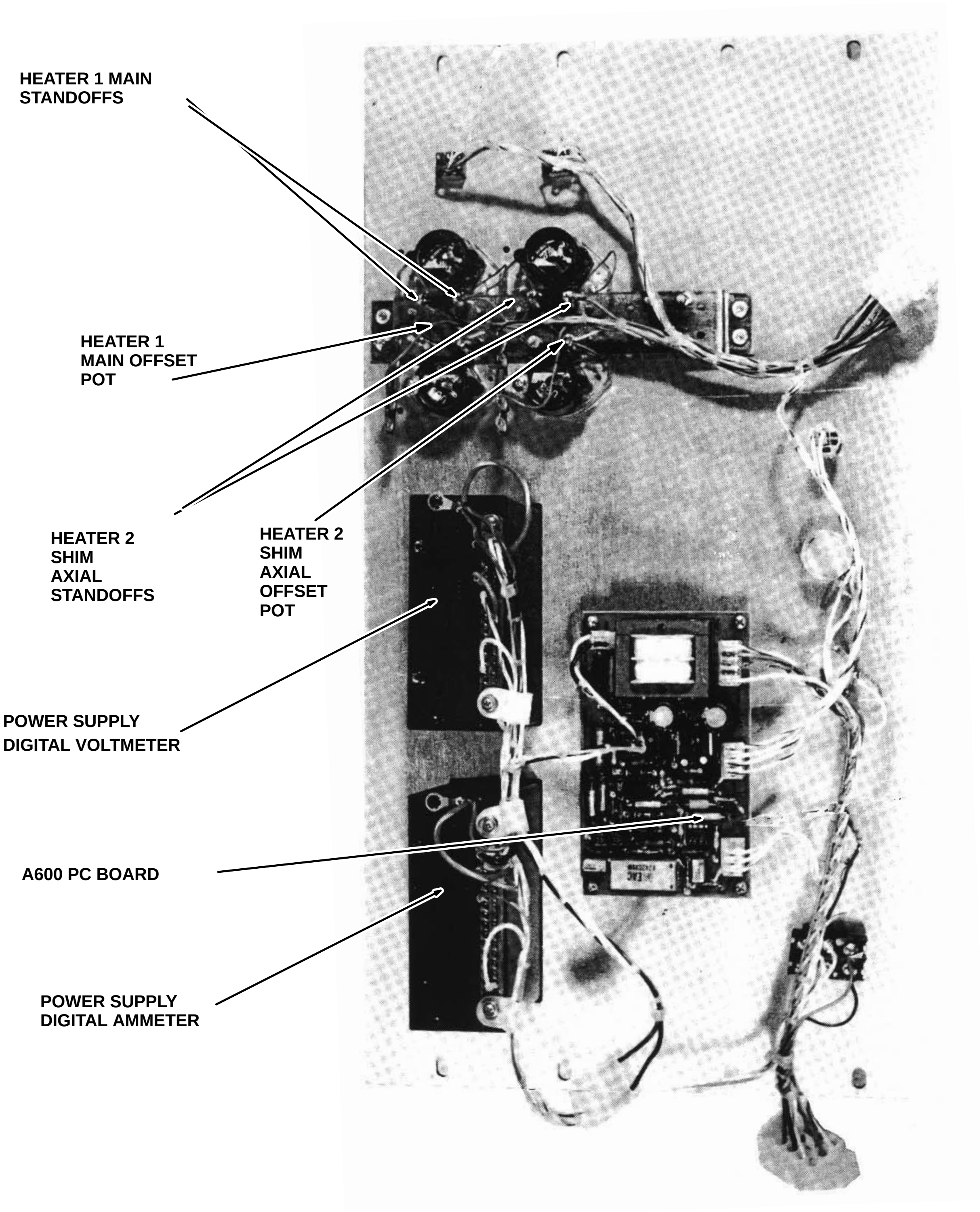
7–1–2 HEATER CALIBRATION

1. Disconnect input power cable to power supply under test.
2. Connect P3 test connector to J3 located on the rear of power supply.
3. Remove eight, Control Panel to Power Supply, mounting screws. See Illustration 7–1.
4. Pull out the UTILITY drawer, then place the Control Panel face down on the UTILITY drawer to expose the component side of the Control Panel.
5. Connect external DVM (set to DC VOLTS) to the Heater 1 Main Standoffs located on the component side of the control panel. Use the set of standoffs located nearest the heater Voltmeter. See Illustration 7–2.
6. Connect 208 VAC to AC input connector. Set MAIN POWER and POWER ON switches to ON.
7. Set HEATER 1 MAIN switch to 1 (on).
8. Adjust #1 Current Adjust pot (located on rear of power supply) for 24.3 VDC indication on the external voltmeter. See Illustration 7–1.
9. Adjust Heater 1 Main Meter Offset Pot, located on component side of the Control Panel, until Heater 1 Main Current Meter reads 810 mA DC. See Illustration 7–2.
10. Set HEATER 2 SHIM AXIAL switch to 1 (on).
11. Connect external DVM (set to DC VOLTS) to the Heater 2 Shim Axial Standoffs located on the component side of the control panel. See Illustration 7–2.
12. Adjust #2 current adjust pot (located on rear of power supply) for 24.3 VDC indication on the external voltmeter.
13. Adjust Heater 2 Shim Axial Meter Offset Pot, located on component side of the Control Panel, until Heater 2 Shim Axial Current Meter reads 810 mA DC. See Illustration 7–2.
14. Set both heater switches to 0 (off).
15. Set MAIN POWER and POWER ON switches to OFF.



SUPERCONDUCTING MAIN COIL SERVICE POWER SUPPLY CABINET
ILLUSTRATION 7–1

7–1–2 HEATER CALIBRATION (continued)



REAR VIEW CONTROL PANEL
ILLUSTRATION 7–2

7–1–3 VOLTAGE CALIBRATION

Note

Voltage Calibration and Voltage Adjust Potentiometer Noise Test are to be performed under no load condition (i.e., ramp cables not connected together).

1. Turn off Power supply then disconnect power supply input power cable.
2. Remove TB2 Access Cover Plate. See Illustration 7–4.
3. Make sure the P3 test connector is connected to J3 located on the rear of the power supply.
4. Set DVM to DC Volt scale.
5. Connect DVM to TB2 pin 1 (positive) and TB2 pin 7 (negative).
6. Adjust VOLTAGE ADJUST pot to minimum (full CCW), and adjust CURRENT ADJUST pots to maximum (full CW).

DANGER!!

FATAL ELECTRIC SHOCK HAZARD!! WITH THE TB2 ACCESS COVER PLATE REMOVED, 208 VAC 3 PHASE ON TB1 IS EXPOSED. BE EXTREMELY CAREFUL NOT TO COME INTO CONTACT WITH TB1.

7. Connect Power Supply Input Power Cable to power supply.
8. Set MAIN POWER and POWER ON switches to ON.
9. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL switches to 1 (on).

Note

The ideal DVM reading in Step 9 is 7.5 Volts. Voltages lower than 7.5 volts could increase ramp up time. Voltages greater than 8.0 Volts could damage output capacitors. If the voltage is outside the range, indicated in Step 9, return the power supply for repair.

10. Adjust VOLTAGE ADJUST pot to maximum (full CW). The DVM should display within the range of 7.0 VDC and 8.0 VDC.
11. Adjust CURRENT COARSE ADJUST pot to minimum (full CCW).

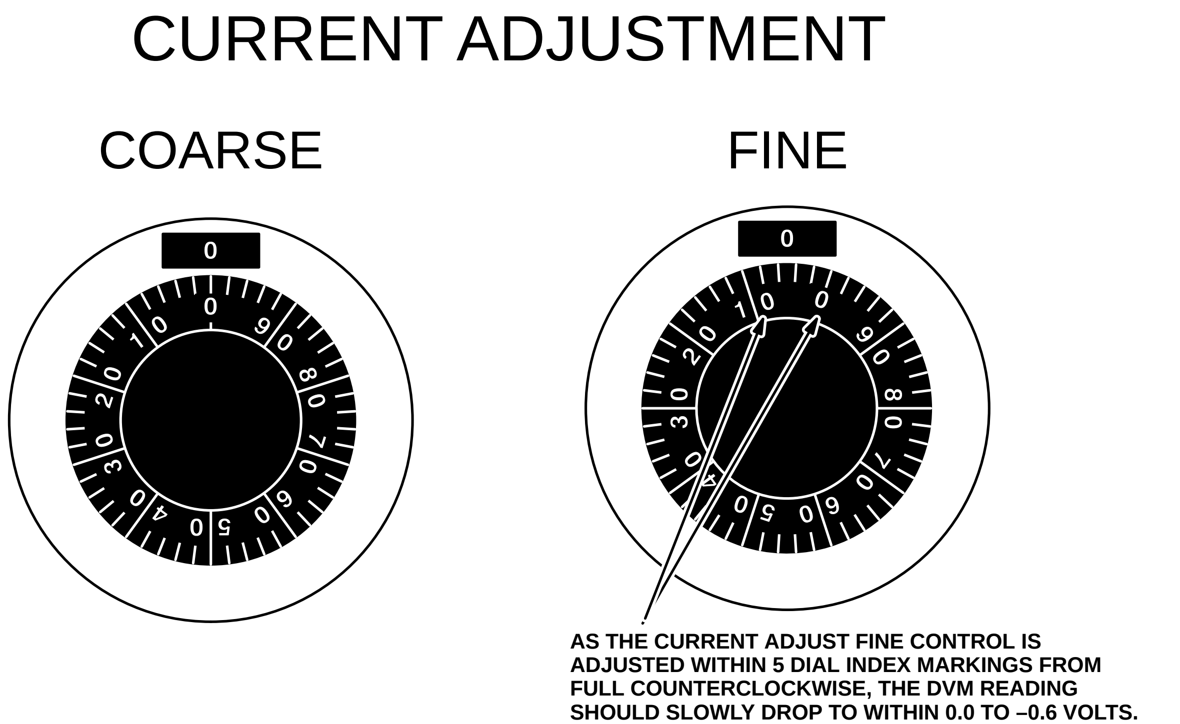
Note

The adjustment in Step 11, below, is a Step Function. The DVM reading will not vary continuously as R605 is adjusted. The function of R605 is to set the threshold at which no voltage is available at the power supply output when the Current Adjust controls are set to minimum. If R605 is adjusted much beyond the threshold point, there will be a delay between the point at which the CURRENT ADJUST controls are adjusted, from minimum, until there is a noticeable current output of power supply.

7–1–3 VOLTAGE CALIBRATION (continued)

Note

It takes approximately 2 minutes for the DVM reading, in Step 11, to decay to a value between 0.0 and –0.6 Volts. A few trials of adjusting the CURRENT ADJUST FINE pot must be done in order to insure power supply output voltage drops and rises as the CURRENT FINE ADJUST pot is adjusted in and out of the range shown in Illustration 7–3.



CURRENT ADJUST POTENTIOMETERS
ILLUSTRATION 7–3

12. Adjust CURRENT FINE ADJUST pot to minimum (full CCW). As the CURRENT FINE ADJUST pot is adjusted to within 5 Dial Index Markings from full counterclockwise, as shown in Illustration 7–3, the DVM reading should drop to within the range of 0.0 VDC and –0.6 VDC. If necessary, adjust pot R605, located on the A600 PC board behind the power supply control panel, to the point at which the DVM drop occurs. See Illustration 7–2.

13. Adjust CURRENT ADJUST FINE pot in and out of the range shown in Illustration 7–3 to insure proper adjustment of R605.

Note

The Control Panel will have to removed later on in this procedure. It is only necessary to replace a couple of the control panel mounting screws at this time.

14. Reinstall the control panel if removed in Step 10.

7–1–4 VOLTAGE ADJUST POTENTIOMETER NOISE TEST

Description

The VOLTAGE ADJUST Potentiometer is checked under no load condition. Make sure the Ramp Leads are disconnected for this test.

Procedure:

1. Disconnect input power cable to Main Coil Power Supply.

Note

2. Measure resistance, using an ohmmeter, from the Negative Buss Bar to any point on the power supply chassis. The resistance will increase, to well within the Megohm range, as the output capacitor is being charged by the Ohmmeter. Send the power supply to repair facility if the resistance check indicates a shorted or leaky output capacitor.
3. Remove mounting screws on cover plate located between the output buss bars on bottom rear of power supply. The cover plate protects a fan and terminal board TB2. See Illustration 7–4.
4. Connect the X1 Probe to the Oscilloscope.

Note

TB2 is numbered from left to right.

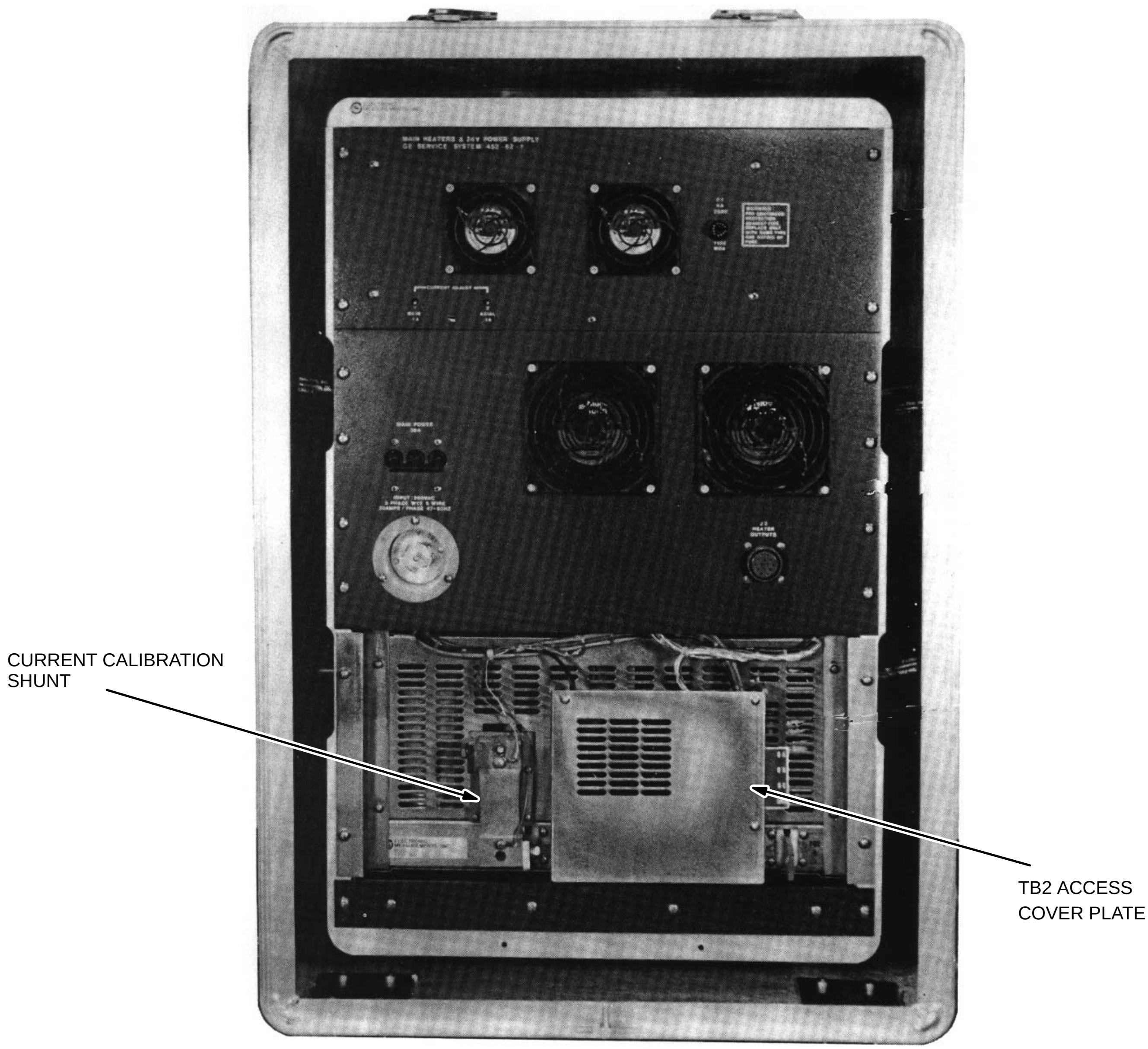
5. Connect the X1 Probe ground lead to TB2 pin 7 and the signal lead on TB2 pin 3.
6. Set the Oscilloscope TIME BASE control to 5 msec/div (X1 PROBE).
7. Set the Oscilloscope VOLT/DIV to 5 mV / div.
8. Set the input coupling to AC.
9. Connect Oscilloscope power cable plug into AC outlet and turn on Oscilloscope power switch.
10. Connect input power to the Main Coil Power Supply and turn on all power supply breaker switches.

Note

The oscilloscope beam will move upward and downward as the Voltage Adjust Control is adjusted.

11. Adjust the VOLTAGE ADJUST potentiometer through its full range of operation while observing the Oscilloscope. The signal should be free from spikes. A bad potentiometer will display large spikes, intermittently, as the potentiometer is adjusted through its full range. See Illustration 7–5 for an example of a bad pot. Do not confuse Spikes, or noise seen while the pot is <u>not</u> being turned with potentiometer noise.

7–1–4 VOLTAGE ADJUST POTENTIOMETER NOISE TEST (continued)



MAIN POWER SUPPLY REAR VIEW
ILLUSTRATION 7–4

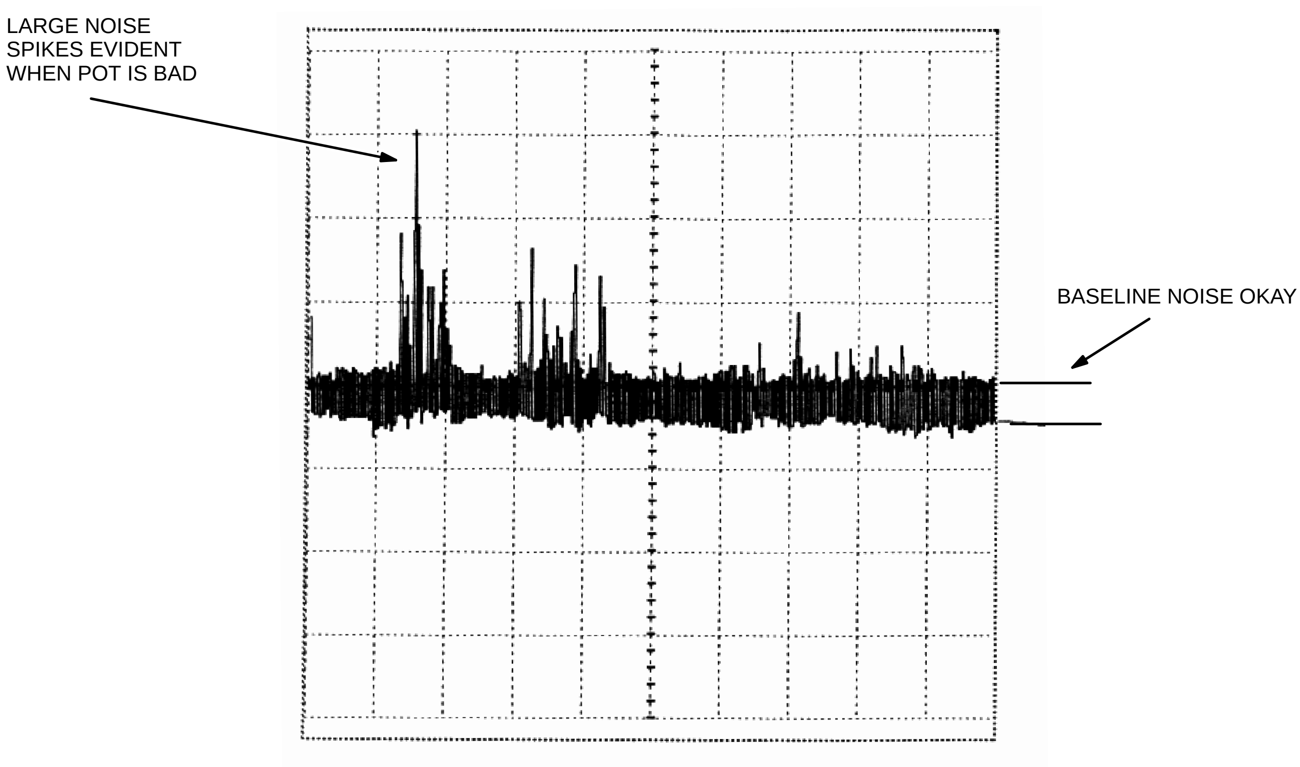
7–1–4 VOLTAGE ADJUST POTENTIOMETER NOISE TEST (continued)

Note

A storage type oscilloscope, if properly used, will greatly aid in determining if a pot is excessively noisy.

Note

Spikes seen, riding on the baseline, at regular intervals are caused by switching circuits in the main power module. Do not confuse these spikes as potentiometer noise.



POTENTIOMETER NOISE
ILLUSTRATION 7–5

12. If the potentiometer fails this test, turn off and disconnect power supply input power and replace the pot. The VOLTAGE ADJUST pot is a 5K 10 turn pot (P/N 46–281468P12).

13. Adjust the VOLTAGE ADJUST potentiometer to minimum (CCW).

14. Set the Power Supply MAIN POWER and POWER ON switches to OFF.

7–1–5 CURRENT CALIBRATION AND CURRENT POT NOISE CHECK

Description

The External Current Shunt, P/N 2101358, should be replaced or calibrated at least once a year. If dropped, it could be forced out of tolerance and should be replaced. The resistance tolerance of the Shunt is $\pm$0.1%. This means that the power supply output, at rated current, could be 750 $\pm$ 0.75 amps. The DVM used in the following section should be a 4 1/2 digit Digital Voltmeter (DVM) Fluke 87 or equivalent.

1. Connect Oscilloscope power cable into AC outlet and turn on Oscilloscope power switch.
2. Connect P3 test connector to J3 located on the rear of the power supply.
3. Set MAIN POWER and POWER ON switches to ON.
4. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL toggle switches to “1” (on).
5. Adjust CURRENT ADJUST and VOLTAGE ADJUST pots to minimum (full CCW)
6. Remove the “snap on” Cover Plate from the power supply CURRENT meter.

Note
Step 7 must be performed with no load (i.e., ramp cables disconnected).

7. Adjust Meter Zero “trim Pot” on the lower left corner of the meter to 000.0 Amps. This pot is located behind the “snap on” Cover Plate from the power supply digital CURRENT meter. See Illustration 7–6.

CAUTION

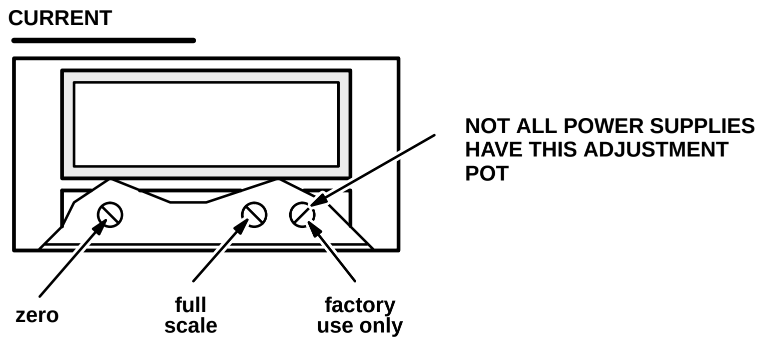
Heat in excess of 60 watts could be present at the Ramp Cable/1000 amp 100mV Current Shunt junction if the cables in Steps 11 and 12 are not tightly connected to the Current Shunt.

Because of the high current capacity of the power supply, jewelry, such as rings, should not be worn during this section of the checkout procedure as a potential burn hazard exists.

Place Current Shunt on brick or ceramic to avoid damage to tile or carpet from heat.

8. Set both heater switches to 0 (off).
9. Set MAIN POWER and POWER ON switches to OFF.
10. Connect positive and negative ramp cables to the magnet power supply output buss bars.
11. Bolt, tightly, the other end of the Positive Ramp Cables to one side of the 1000 amp 100mV Current Shunt. See Illustration 7–7.
12. Bolt, tightly, the other end of the Negative Ramp Cables to the other side of the 1000 amp 100mV Current Shunt.

7–1–5 CURRENT CALIBRATION AND CURRENT POT NOISE CHECK (continued)



POWER SUPPLY CURRENT METER ADJUSTMENT POTS
ILLUSTRATION 7–6

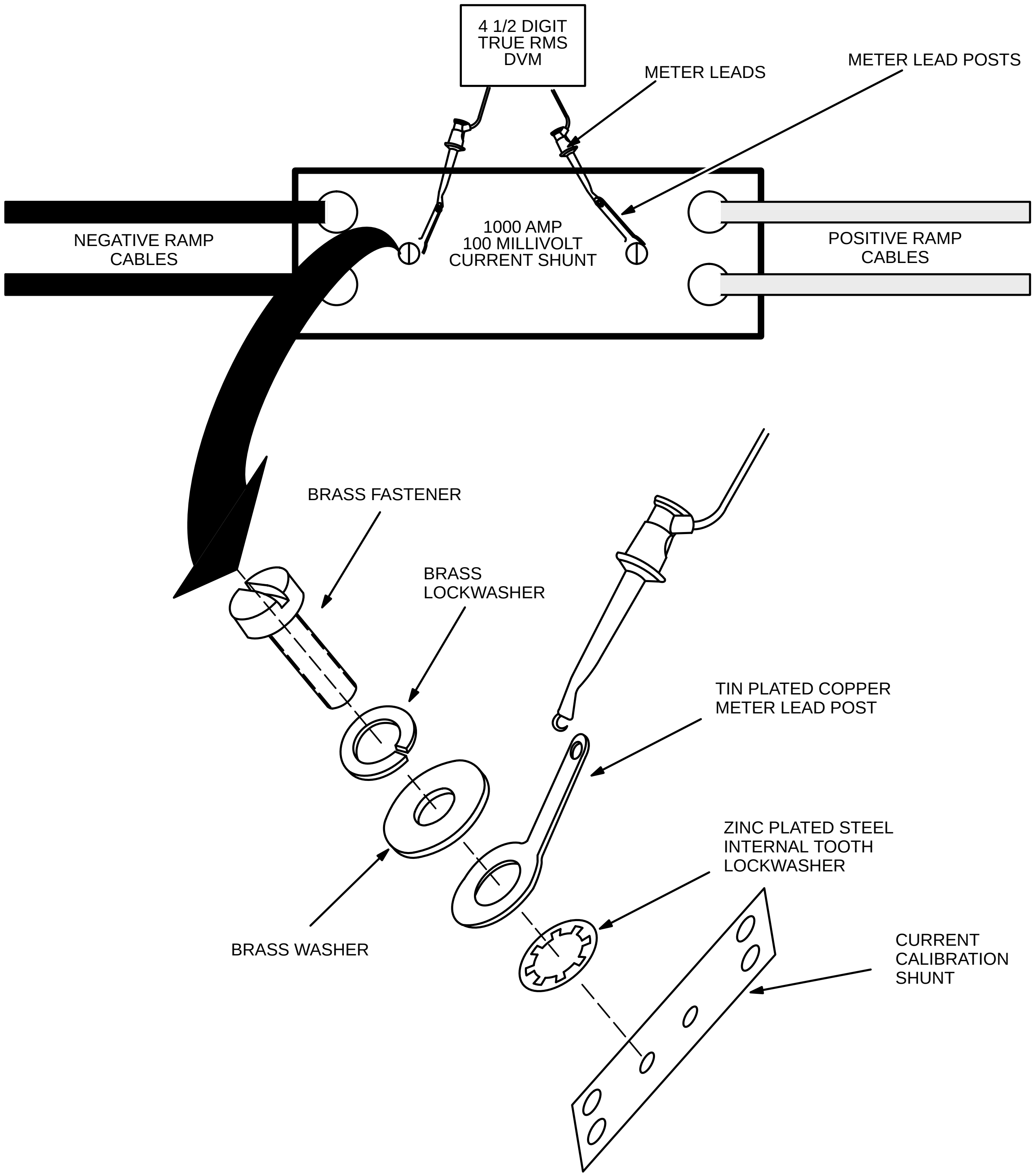
13. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL toggle switches to “0” (off).
14. Adjust VOLTAGE CONTROL pot to maximum (full CW). Make sure CURRENT ADJUST pots are set to minimum (full CCW).

Note

Erroneous readings will result, in Steps 24 through 26 below, if the Meter Lead Post Fasteners are not tight. All materials used for the Meter Lead Posts, Fasteners, and washers were chosen to avoid the possibility of thermocouple action.

15. Install Meter Lead Posts, Fasteners and Washers to External Current Shunt as shown in Illustration 7–7. Make sure Meter Lead Post Fasteners are tight.
16. Connect a 4 1/2 digit “True RMS” Digital Voltmeter (DVM) to the Meter Lead Posts on the Current Calibration Shunt. See Illustration 7–7.
17. Set DVM to read DC millivolts.
18. Connect Oscilloscope to TB2 pins 9 (+) and 7 (–).
19. Set the Oscilloscope TIME BASE control to 5 msec/div.
20. Set the Oscilloscope VOLT / DIV to 5 mV / div.
21. Set the input coupling to AC.
22. Set power supply MAIN POWER and POWER ON switches to ON.
23. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL toggle switches to “1” (on).

7–1–5 CURRENT CALIBRATION AND CURRENT POT NOISE CHECK (continued)



CURRENT SHUNT CONNECTIONS
ILLUSTRATION 7–7

7–1–5 CURRENT CALIBRATION AND CURRENT POT NOISE CHECK (continued)

Note

Each millivolt increment on the DVM corresponds to 10 amps. Make sure the meter used, in this procedure, is capable of reading to three decimal places.

24. Adjust CURRENT ADJUST controls to maximum (full CW). The external DVM should indicate a minimum of 75.0 mVDC. If this voltage is low, maximum rated current (750 amps) will not be achievable and the power supply should be returned for repair. Returned power supplies should have a written description of the problem.

25. Adjust CURRENT ADJUST FINE/COARSE controls to obtain a reading of 75.0 mVDC on the external DVM. This corresponds to a power supply output of 750 amps. Adjust R613, located on the A600 board, to display a reading of 750 amps on the Power Supply Digital Current Meter. If a reading of 750 amps cannot be achieved, perform Step 26 below.

Note

Perform Step 26 only if a reading of 750 amps on the Power Supply Digital Current Meter cannot be achieved by adjusting R613.

26. Adjust power supply Current Meter “Full Scale” Trim Pot for 750 Amps. See Illustration 7–6.

27. Adjust the CURRENT ADJUST potentiometers through the full range of operation while observing the Oscilloscope. The signal should be free from spikes. See Illustration 7–5 for an example of a bad pot.

28. If either Potentiometer fails this test, turn off and disconnect power supply input power and replace the pot. The CURRENT ADJUST pot is a 5K 10 turn pot. The CURRENT ADJUST FINE pot is a 100 ohm 10 turn pot. Extra potentiometers are included in the Power Supply Checkout Kit P/N 2101360.

29. Adjust all CURRENT and VOLTAGE ADJUST pots to minimum (full CCW).

30. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL switches to 0 (off).

31. Set POWER ON and MAIN POWER switches to OFF.

32. Reinstall power supply control panel.

7–1–6 VOLTAGE RIPPLE CHECK

Description:

Typical values of ripple, using this procedure, range between 30mV – 55mV RMS. The power supply under test must be warmed up for at least 15 minutes, before checking and/or adjustment, to achieve the lowest voltage ripple reading. This test is to be performed using a True RMS Voltmeter.

Procedure:

1. Connect the positive and negative ramp cables to the Main Power Supply output buss bars.
2. Connect P3 test connector to J3 located on the rear of the power supply.

WARNING!

THE RAMP CABLES COULD CAUSE A SLIGHT BURN AT THE POSITIVE TO NEGATIVE CABLE JUNCTION (WHERE THE TWO CABLES ARE BOLTED TOGETHER). MAKE SURE THE CONNECTION IS TIGHT TO AVOID RESISTANCE WHICH CAN CAUSE EXCESSIVE HEAT.

3. Bolt the other end of the Positive and Negative Ramp Cables together.
4. Set a True Voltmeter to the AC millivolt scale.
5. Connect the True RMS Voltmeter to the Main Power Supply Buss bars.
6. Set MAIN POWER and POWER ON switches to ON.
7. Set HEATER 2 SHIM AXIAL toggle switches to “1” (on).
8. Adjust CURRENT ADJUST and VOLTAGE ADJUST pots to maximum (full CW).
9. Monitor the True RMS Volmeter, after at least 15 minutes to allow power supply to sufficiently warm up, for a “Voltage Ripple” indication.
10. If the Voltage Ripple is greater than 55 millivolts, send the Main Power Supply for repair.
11. Adjust the VOLTAGE and CURRENT ADJUST Potentiometers to minimum (CCW).
12. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL switches to 1 (off).
13. Set the Power Supply MAIN POWER and POWER ON switches to OFF.

7–2 ESS7.5–1000–2–D–1236 MAIN POWER SUPPLY TEST

DESCRIPTION:

All ESS7.5–1000–2–D–1236 Power Supplies should be checked in conformance with this procedure at least once a year or when a fault condition is suspected.

EQUIPMENT:

4 1/2 Digit True RMS Voltmeter (Fluke 87 or equivalent)

Oscilloscope

Set of Ramping Cables – 2 each for 750 amp power supply or 3 each for 1,000 amp power supply

Power Supply Checkout Kit P/N 2101360

Non metallic Tuning Tool

Note

Use 3 each (red and black) ramp cables when testing power supply to 1,000 amps.

7–2–1 HEATER CURRENT METER ZERO CALIBRATION

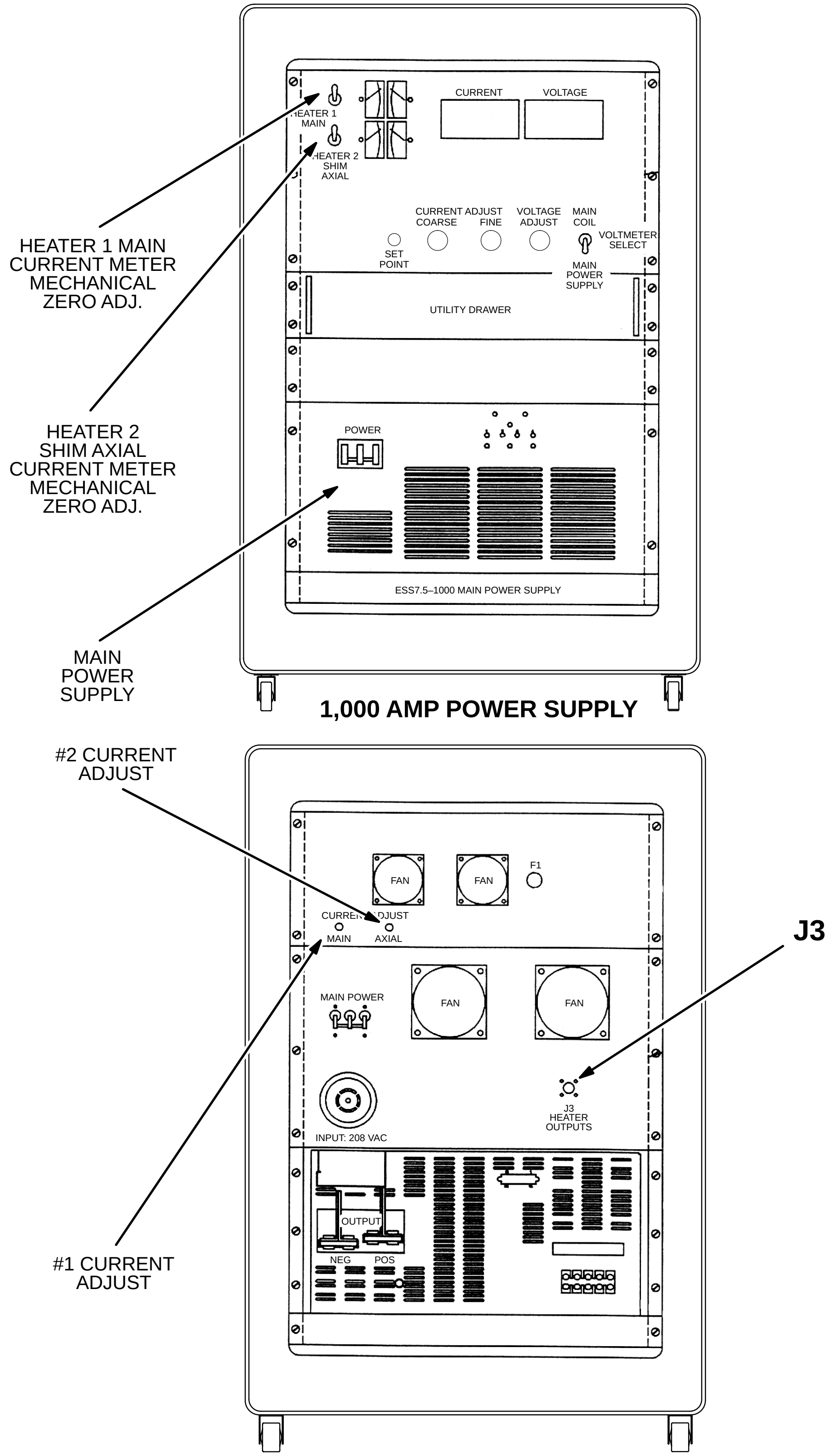
1. Disconnect input power cable to power supply under test.
2. Remove cover plates for meter mechanical zero adjustment screw (located adjacent to each meter). See Illustration 7–8.
3. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL switches to 0 (off).
4. Adjust each meter’s Mechanical Zero Adjustment screw as required to position meter indicator needle at “0” (zero).
5. Replace cover plates.

7–2–2 HEATER CALIBRATION

1. Disconnect input power cable to power supply under test.
2. Connect P3 test connector to J3 located on the rear of power supply.
3. Pull out the UTILITY drawer.
4. Remove eight, Control Panel to Power Supply, mounting screws. Place the Control Panel face down on the UTILITY drawer to expose the component side of the Control Panel. See Illustration 7–8.
5. Connect external DVM (set to DC VOLTS) to the Heater 1 Main Standoffs located on the component side of the control panel. Use the set of standoffs located nearest the heater Voltmeter. See Illustration 7–9.
6. Connect 208 VAC to AC input connector. Set MAIN POWER and POWER ON switches to ON.
7. Set HEATER 1 MAIN switch to 1 (on).
8. Adjust #1 Current Adjust pot (located on rear of power supply) as required for 24.3 VDC indication on the external voltmeter. See Illustration 7–8.
9. Adjust Heater 1 Main Meter Offset Pot, located on component side of the Control Panel, until Heater 1 Main Current Meter reads 810 mA DC. See Illustration 7–9.
10. Set HEATER 2 SHIM AXIAL switch to 1 (on).
11. Connect external DVM (set to DC VOLTS) to the Heater 2 Shim Axial Standoffs located on the component side of the control panel. See Illustration 7–9.
12. Adjust #2 current adjust pot (located on rear of power supply) as required for 24.3 VDC indication on the external voltmeter.
13. Adjust Heater 2 Shim Axial Meter Offset Pot, located on component side of the Control Panel, until Heater 2 Shim Axial Current Meter reads 810 mA DC. See Illustration 7–9.
14. Set both heater switches to 0 (off).
15. Set MAIN POWER and POWER ON switches to OFF.
16. Re–install Control Panel.

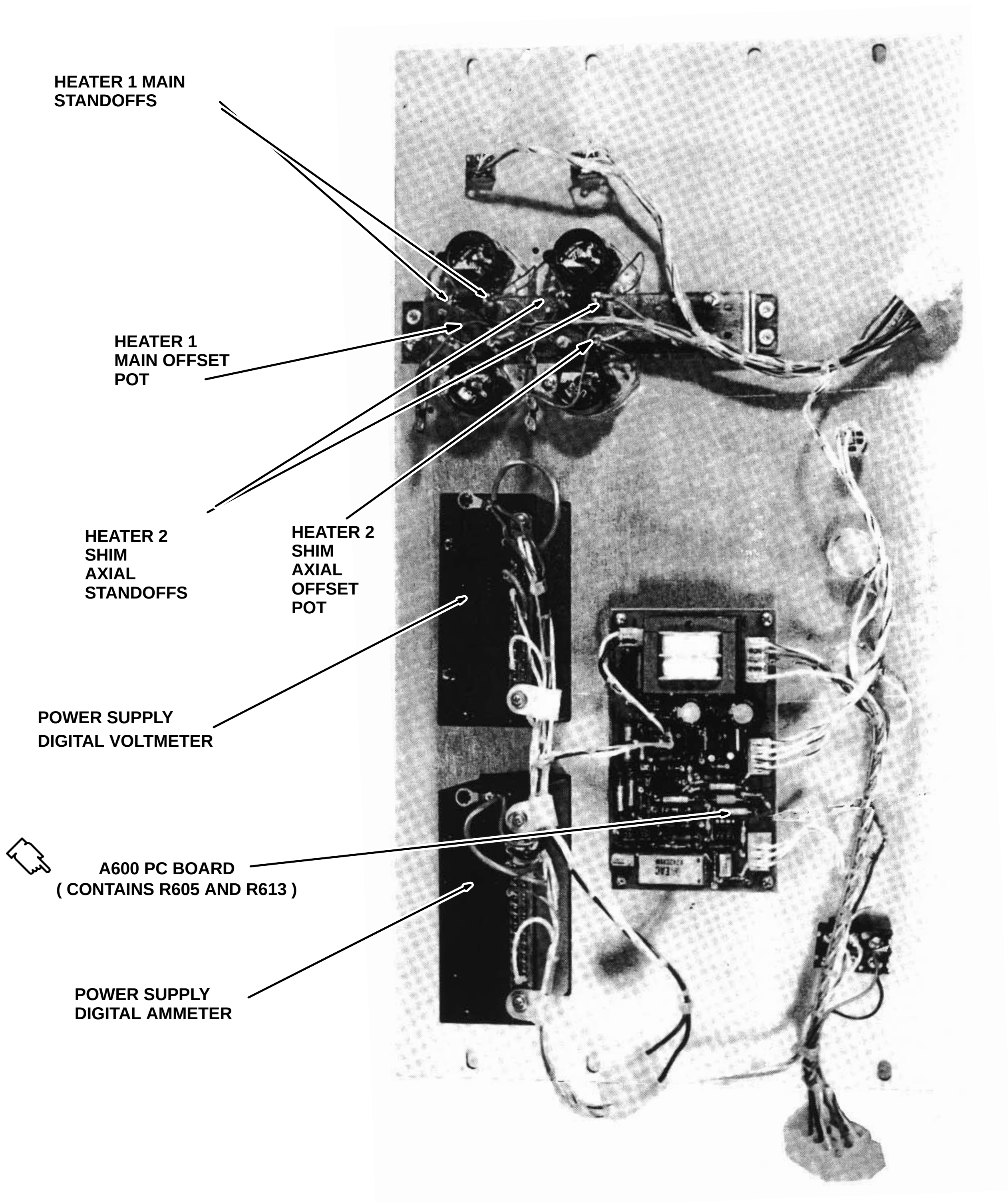
Note

The Control Panel will have to removed later on in this procedure. It is only necessary to replace a couple of the control panel mounting screws at this time.



SUPERCONDUCTING MAIN COIL SERVICE POWER SUPPLY CABINET
ILLUSTRATION 7–8

7–2–2 HEATER CALIBRATION



REAR VIEW CONTROL PANEL
ILLUSTRATION 7–9

7–2–3 VOLTAGE CALIBRATION

Note
Voltage Calibration and Voltage Adjust Potentiometer Noise Test are to be performed under no load condition (i.e., ramp cables not connected together).

1. Turn off Power supply then disconnect power supply input power cable.
2. Make sure the P3 test connector is connected to J3 located on the rear of the power supply.
3. Set DVM to DC Volt scale.
4. Connect DVM to the positive (+) and negative (–) terminals of the supply.
5. Adjust VOLTAGE ADJUST pot to minimum (full CCW), and adjust CURRENT ADJUST pots to maximum (full CW). See Illustration 7–8.

DANGER!!

FATAL ELECTRIC SHOCK HAZARD!! WITH THE TB2 ACCESS COVER PLATE REMOVED, 208 VAC 3 PHASE ON TB1 IS EXPOSED. BE EXTREMELY CAREFUL NOT TO COME INTO CONTACT WITH TB1.

6. Connect Power Supply Input Power Cable to power supply.
7. Set MAIN POWER and POWER ON switches to ON.
8. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL switches to 1 (on).

Note
The ideal DVM reading in Step 9 is 7.5 Volts. Voltages lower than 7.5 volts could increase ramp up time. Voltages greater than 8.0 Volts could damage output capacitors. If the voltage is outside the range, indicated in Step 9, return the power supply for repair.

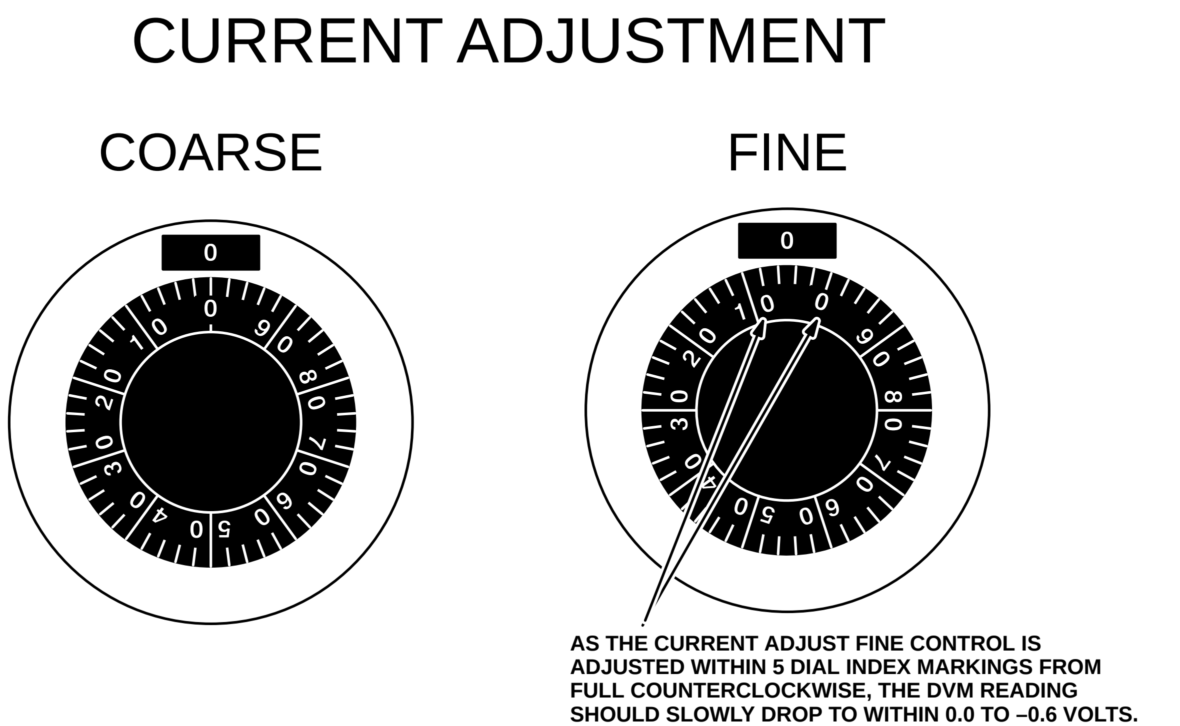
9. Adjust VOLTAGE ADJUST pot to maximum (full CW). The DVM should display within the range of 7.0 VDC and 8.0 VDC.
10. Adjust CURRENT COARSE ADJUST pot to minimum (full CCW).

Note
The adjustment in Step 11, below, is a Step Function. The DVM reading will not vary continuously as R605 is adjusted. The function of R605 is to set the threshold at which no voltage is available at the power supply output when the Current Adjust controls are set to minimum. If R605 is adjusted much beyond the threshold point, there will be a delay between the point at which the CURRENT ADJUST controls are adjusted, from minimum, until there is a noticeable current output of power supply.

7–2–3 VOLTAGE CALIBRATION (continued)

Note

It takes approximately 2 minutes for the DVM reading, in Step 11, to decay to a value between 0.0 and –0.6 Volts. A few trials of adjusting the CURRENT ADJUST FINE pot must be done in order to insure power supply output voltage drops and rises as the CURRENT FINE ADJUST pot is adjusted in and out of the range shown in Illustration 7–10.



CURRENT ADJUST POTENTIOMETERS
ILLUSTRATION 7–10

Note

CURRENT FINE ADJUST is very sensitive.

11. Adjust CURRENT FINE ADJUST pot to minimum (full CCW). As the CURRENT FINE ADJUST pot is adjusted to within 5 Dial Index Markings from full counterclockwise, as shown in Illustration 7–10, the DVM reading should drop to within the range of 0.0 VDC and –0.6 VDC. If necessary, adjust pot R605, located on the A600 PC board behind the power supply control panel, to the point at which the DVM drop occurs. See Illustration 7–9.

12. Adjust CURRENT ADJUST FINE pot in and out of the range shown in Illustration 7–10 to insure proper adjustment of R605.

Note

The Control Panel will have to removed later on in this procedure. It is only necessary to replace a couple of the control panel mounting screws at this time.

13. Reinstall the control panel if removed in Step 10.

7–2–4 VOLTAGE ADJUST POTENTIOMETER NOISE TEST

Description

The VOLTAGE ADJUST potentiometer is checked under no load condition. Make sure the Ramp Leads are disconnected for this test. Test plug J3 needs to be connected.

Procedure:

1. Disconnect input power cable to Main Coil Power Supply.

Note

2. Measure resistance, using an ohmmeter, from the Negative Buss Bar to any point on the power supply chassis. The resistance will increase, to well within the Megohm range, as the output capacitor is being charged by the Ohmmeter. Send the power supply to repair facility if the resistance check indicates a shorted or leaky output capacitor.
3. Connect oscilloscope X1 probe to the oscilloscope.
4. Connect X1 probe ground lead to output negative terminal buss bar and the signal lead to the positive output terminal.
5. Set the oscilloscope TIME BASE control to 5 msec/div (X1 PROBE).
6. Set the oscilloscope VOLT / DIV to 100 mV/div.
7. Set the input coupling to AC.
8. Connect input power to oscilloscope and turn on oscilloscope power switch.
9. Connect input power to the Main Coil Power Supply and turn on all power supply breaker switches.

Note

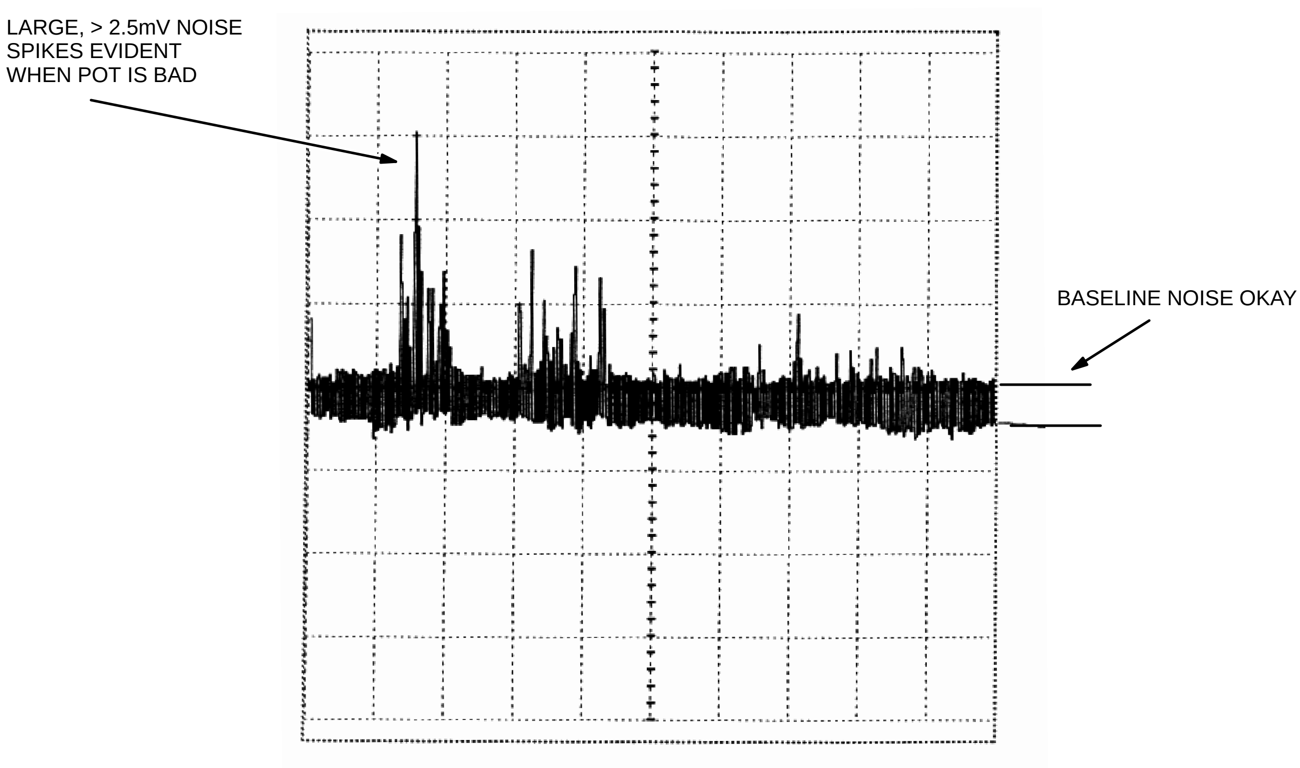
The oscilloscope beam will move upward and downward as the Voltage Adjust Control is adjusted.

10. Adjust the VOLTAGE ADJUST potentiometer through its full range of operation while observing the oscilloscope. The signal should be free from spikes. A bad potentiometer will display large spikes, intermittently, as the potentiometer is adjusted through its full range. See Illustration 7–11 for an example of a bad pot.

7–2–4 VOLTAGE ADJUST POTENTIOMETER NOISE TEST (continued)

Note
A Storage type Oscilloscope, if properly used, will greatly aid in determining if a pot is excessively noisy.

Note
Spikes seen, riding on the baseline, at regular intervals are caused by switching circuits in the main power module. Do not confuse these spikes as Potentiometer noise. Make probe and ground length as short as possible to isolate noise spikes less than a volt.



POTENTIOMETER NOISE
ILLUSTRATION 7–11

11. If the Potentiometer fails this test, turn off and disconnect power supply input power and replace the pot. The VOLTAGE ADJUST pot is a 5K 10 turn pot.

Note
The 1,000 amp Power Supply (46–260776G4) has oil filled pots. They are designed to eliminate wire corrosion and resultant noise.

7–2–5 CURRENT CALIBRATION AND CURRENT POT NOISE CHECK

Description

The External Current Shunt, P/N 2101358, should be replaced or calibrated at least once a year. If dropped, it could be forced out of tolerance and should be replaced. The resistance tolerance of the Shunt is ± 0.1%. This means that the power supply output, at rated current, could be 750 ± 0.75 amps. The DVM used in the following section should be a 4 1/2 digit Digital Voltmeter (DVM) Fluke 87 or equivalent.

1. Connect Oscilloscope power cable into AC outlet and turn on Oscilloscope power switch.
2. Connect P3 test connector to J3 located on the rear of the power supply.
3. Set MAIN POWER and POWER ON switches to ON.
4. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL toggle switches to “1” (on).
5. Adjust CURRENT ADJUST and VOLTAGE ADJUST pots to minimum (full CCW)
6. Remove the “snap on” Cover Plate from the power supply CURRENT meter.

Note
Step 7 must be performed with no load (i.e., ramp cables disconnected).

7. Adjust Meter Zero “trim Pot” on the lower left corner of the meter to 000.0 Amps. This pot is located behind the “snap on” Cover Plate from the power supply digital CURRENT meter. See Illustration 7–12.

CAUTION

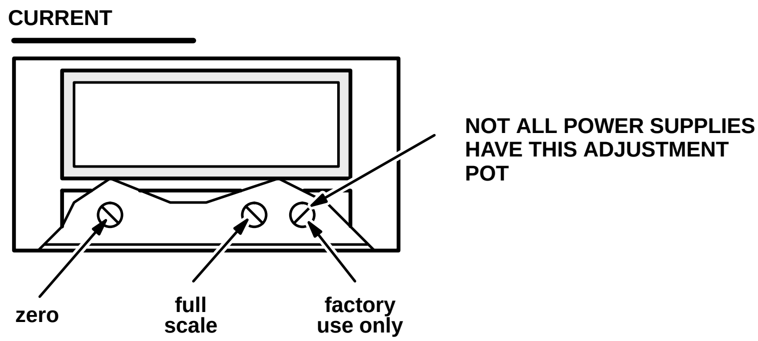
Heat in excess of 60 watts could be present at the Ramp Cable/1000 amp 100mV Current Shunt junction if the cables in Steps 11 and 12 are not tightly connected to the Current Shunt.

Because of the high current capacity of the power supply, jewelry, such as rings, should not be worn during this section of the checkout procedure as a potential burn hazard exists.

Place Current Shunt on brick or ceramic to avoid damage to tile or carpet from heat.

8. Set both heater switches to 0 (off).
9. Set MAIN POWER and POWER ON switches to OFF.
10. Connect positive and negative ramp cables to the magnet power supply output buss bars.
11. Bolt, tightly, the other end of the Positive Ramp Cables to one side of the 1000 amp 100mV Current Shunt. See Illustration 7–13.
12. Bolt, tightly, the other end of the Negative Ramp Cables to the other side of the 1000 amp 100mV Current Shunt.

7–2–5 CURRENT CALIBRATION AND CURRENT POT NOISE CHECK (continued)



POWER SUPPLY CURRENT METER ADJUSTMENT POTS
ILLUSTRATION 7–12

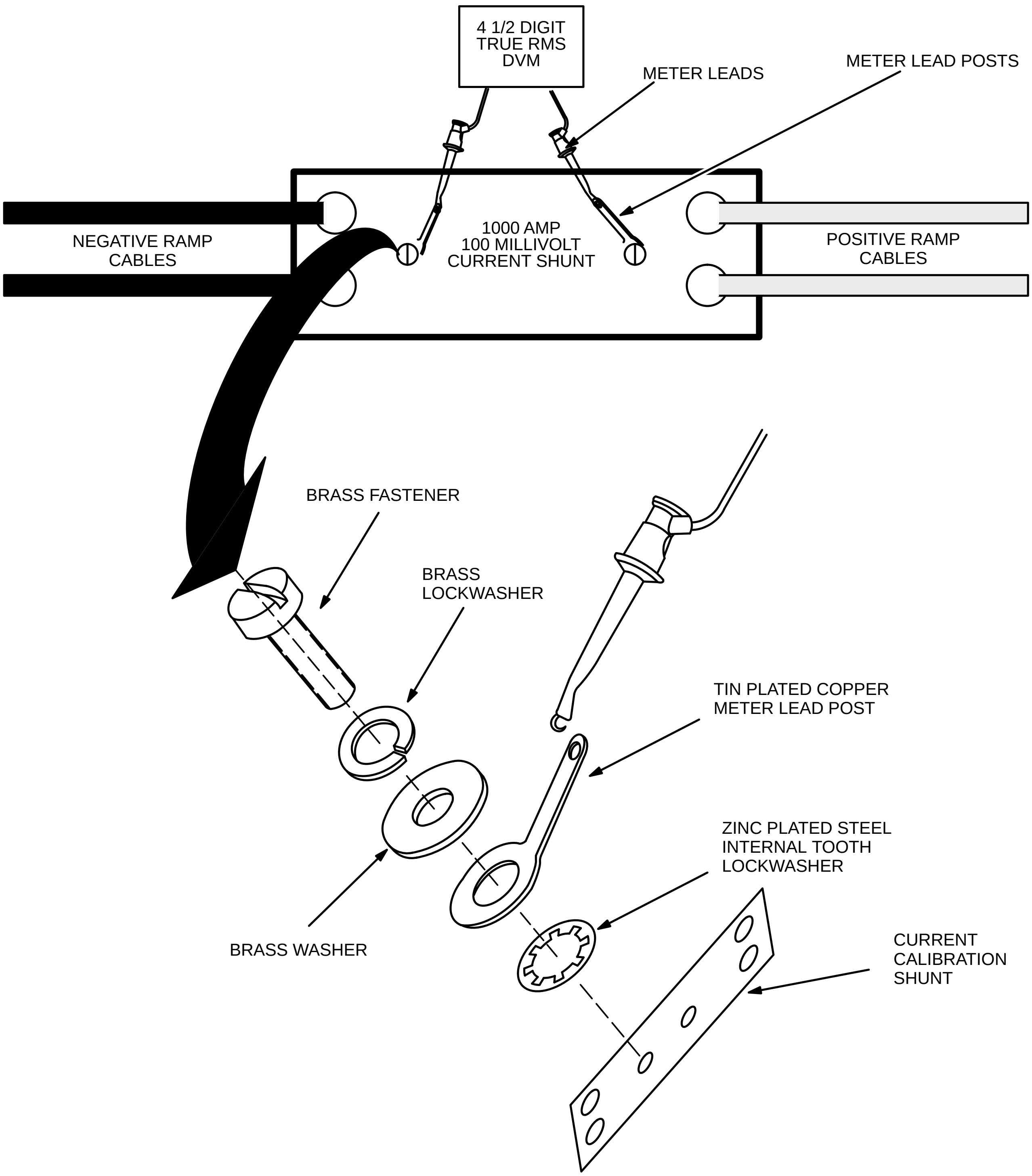
13. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL toggle switches to “0” (off).
14. Adjust VOLTAGE CONTROL pot to maximum (full CW). Make sure CURRENT ADJUST pots are set to minimum (full CCW).

Note

Erroneous readings will result, in Steps 24 through 26 below, if the Meter Lead Post Fasteners are not tight. All materials used for the Meter Lead Posts, Fasteners, and washers were chosen to avoid the possibility of thermocouple action.

15. Install Meter Lead Posts, Fasteners and Washers to External Current Shunt as shown in Illustration 7–13. Make sure Meter Lead Post Fasteners are tight.
16. Connect a 4 1/2 digit “True RMS” Digital Voltmeter (DVM) to the Meter Lead Posts on the Current Calibration Shunt. See Illustration 7–13.
17. Set DVM to read DC millivolts.
18. Connect Oscilloscope X1 probe ground lead to output negative terminal buss bar and the signal lead to the positive output terminal.
19. Set the Oscilloscope TIME BASE control to 5 msec/div.
20. Set the Oscilloscope VOLT / DIV to 100 mV / div.
21. Set the input coupling to AC.
22. Set power supply MAIN POWER and POWER ON switches to ON.
23. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL toggle switches to “1” (on).

7–2–5 CURRENT CALIBRATION AND CURRENT POT NOISE CHECK (continued)



CURRENT SHUNT CONNECTIONS
ILLUSTRATION 7–13

7–2–5 CURRENT CALIBRATION AND CURRENT POT NOISE CHECK (continued)

Note
Each millivolt increment on the DVM corresponds to 10 amps. Make sure the meter used, in this procedure, is capable of reading to three decimal places.

24. Adjust CURRENT ADJUST controls to maximum (full CW). The external DVM should indicate a minimum of 80.0 mVDC. If this voltage is low, maximum rated current (800 amps) will not be achievable and the power supply should be returned for repair. Returned power supplies should have a written description of the problem.

25. Adjust CURRENT ADJUST FINE / COARSE controls to obtain a reading of 80.0 mVDC on the external DVM. This corresponds to a power supply output of 800 amps. Adjust R613, located on the A600 board, to display a reading of 800 amps on the Power Supply Digital Current Meter. If a reading of 800 amps cannot be achieved, perform Step 26 below.

Note
Perform Step 26 only if a reading of 800 amps on the Power Supply Digital Current Meter cannot be achieved by adjusting R613.

26. Adjust power supply Current Meter “Full Scale” Trim Pot for 800 Amps. See Illustration 7–12.

27. Adjust the CURRENT ADJUST potentiometers through the full range of operation while observing the Oscilloscope. The signal should be free from spikes. See Illustration 7–11 for an example of a bad pot.

28. If either Potentiometer fails this test, turn off and disconnect power supply input power and replace the pot. The CURRENT ADJUST pot is a 5K 10 turn pot. The CURRENT ADJUST FINE pot is a 100 ohm 10 turn pot. Extra potentiometers are included in the Power Supply Checkout Kit P/N 2101360.

29. Adjust all CURRENT and VOLTAGE ADJUST pots to minimum (full CCW).

30. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL switches to 0 (off).

31. Set POWER ON and MAIN POWER switches to OFF.

32. Reinstall power supply control panel.

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:

8–1 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS

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.

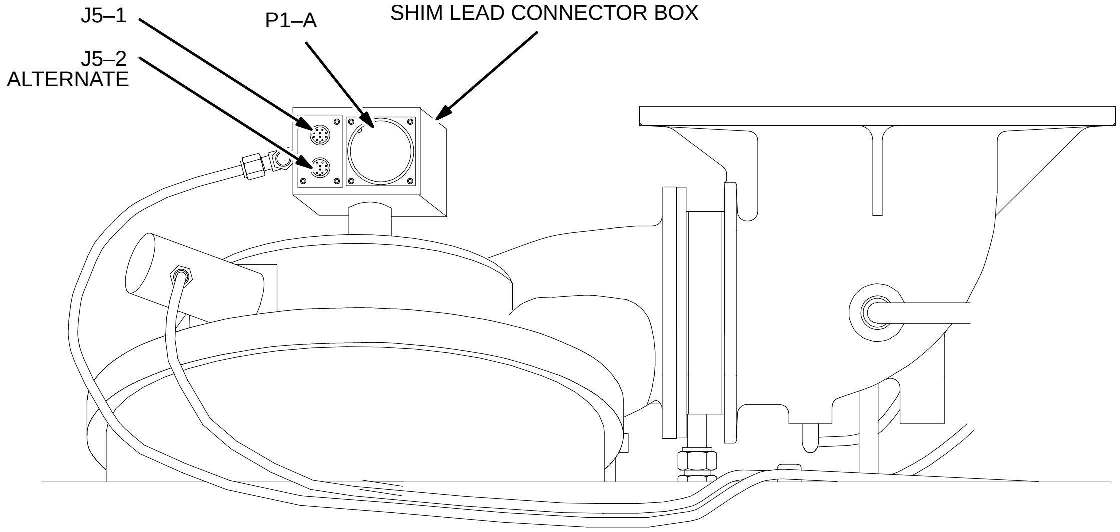
CONNECTING THE SUPERCONDUCTING SHIM COIL HARNESS TO THE MAGNET WHEN THE SUPERCONDUCTING SHIM COIL POWER SUPPLY IS ON MAY CAUSE IRREPARABLE DAMAGE TO THE VAPOR COOLED SHIM LEADS.

CAUTION

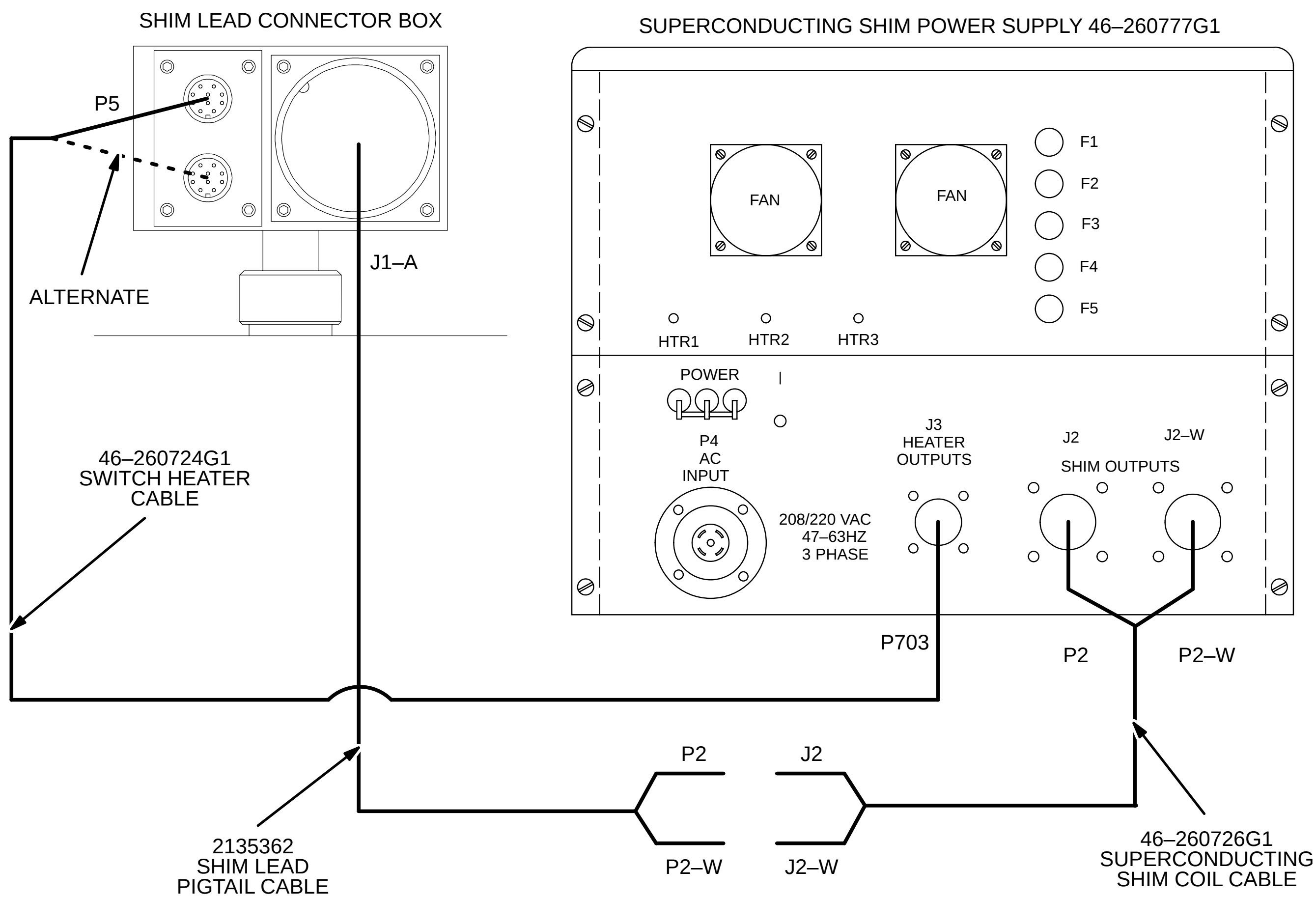
Never place weight (objects) on the coldhead sleeve as irreparable damage may result.

1. Verify that input power to the Superconducting Shim Coil Power Supply is disconnected.
2. Connect electrical cabling to the Superconducting Shim Coil Power Supply as shown in Illustrations 8–1 and 8–2.

8–1 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)



MAGNET ELECTRICAL CONNECTIONS
ILLUSTRATION 8–1



SHIM POWER SUPPLY OUTPUT CONNECTIONS
ILLUSTRATION 8–2

8–2 MAIN COIL POWER SUPPLY CONNECTIONS

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

2. Connect electrical cabling to the Main Coil Power Supply as shown in Illustrations 8–1, 8–3 and 8–4.

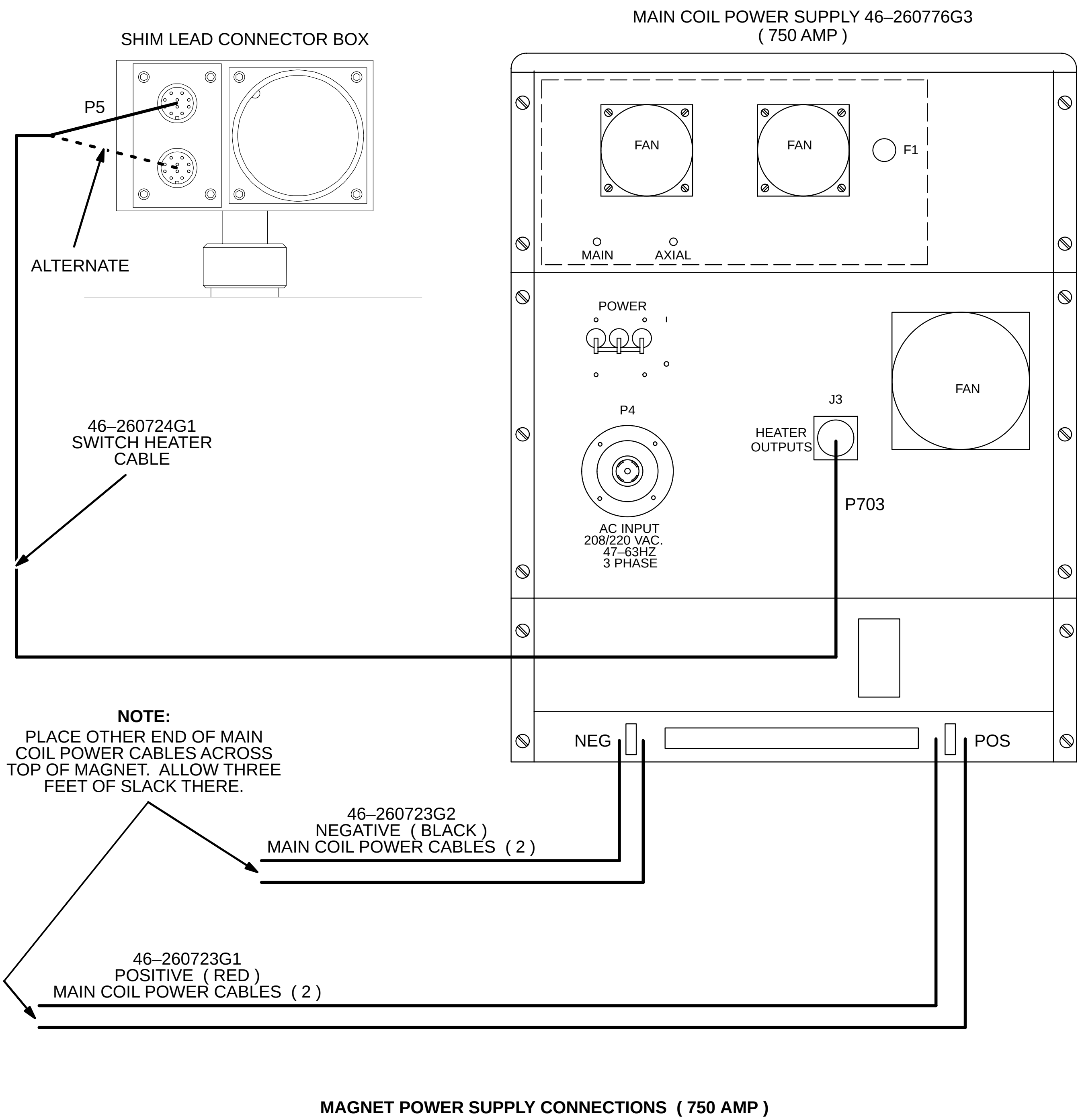
Note

Clean all connection points on Power Leads and Power Lead Extensions to prevent high resistance contacts and minimize voltage drops. A scouring pad can be used to clean all connections.

Make sure the nuts are tightened sufficiently to prevent a high resistance contact. Connect Red Cables to the positive (+) Buss Bar and Black Cables to the negative (–) 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.

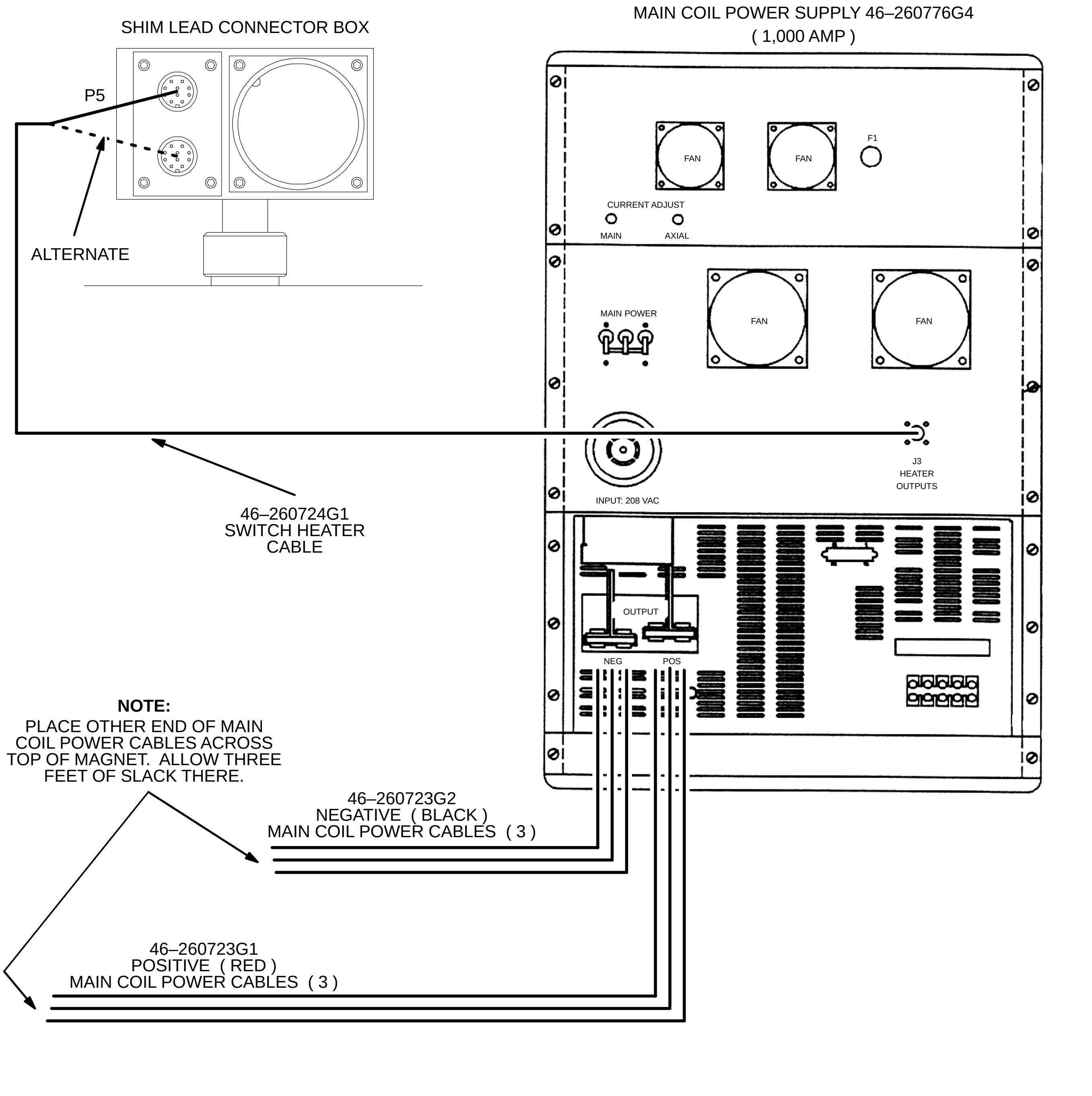
3. Check Cryostat Pressure Gauge. If the pressure is above 0.25 psi, slowly open Helium Vent Valve (V2) and allow pressure to drop to 0.25 psi. Then close valve (V2).

8–2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)



MAGNET POWER SUPPLY CONNECTIONS (750 AMP)
ILLUSTRATION 8–3

8–2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)



MAGNET POWER SUPPLY CONNECTIONS (1,000 AMP)
ILLUSTRATION 8–4

8–2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

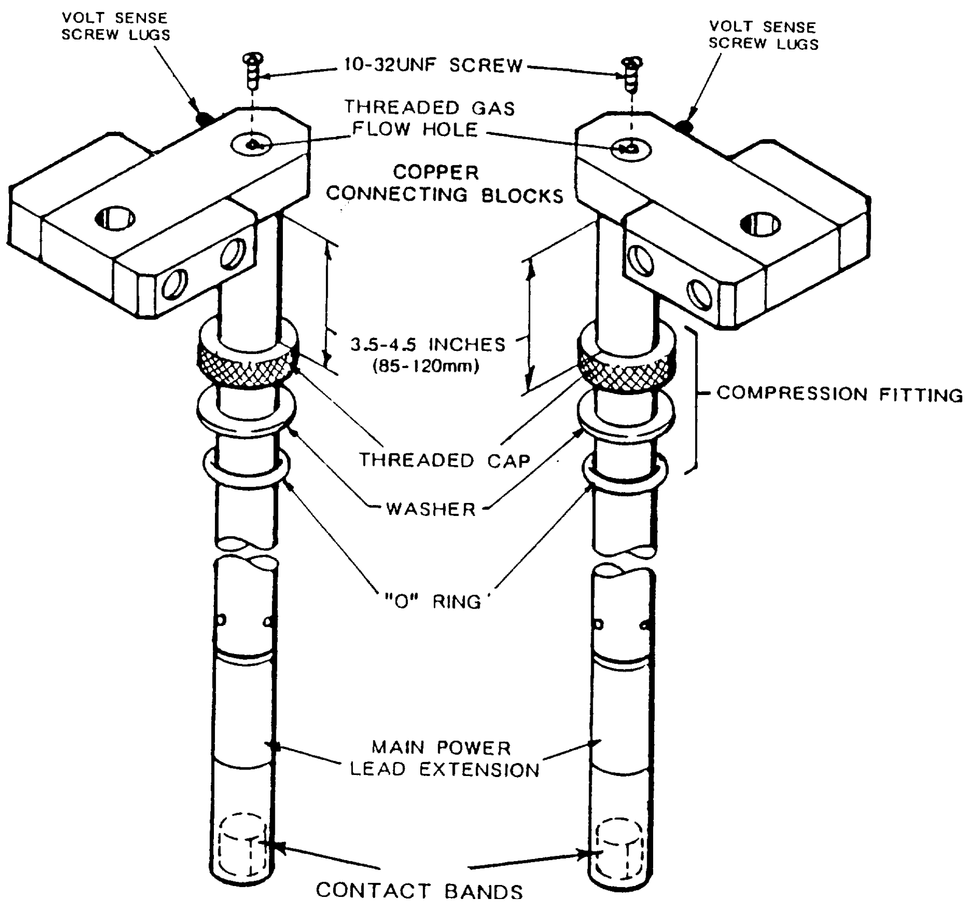
CAUTION

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

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

4. Replace Contact Bands on Main Power Lead Extensions. Make sure gas flow holes are not blocked. See REPLACEMENT / MAINTENANCE, Section 12.

5. 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 8–5.



COMPRESSION FITTING MOUNTING ON MAIN POWER LEAD EXTENSION
ILLUSTRATION 8–5

8–2 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.

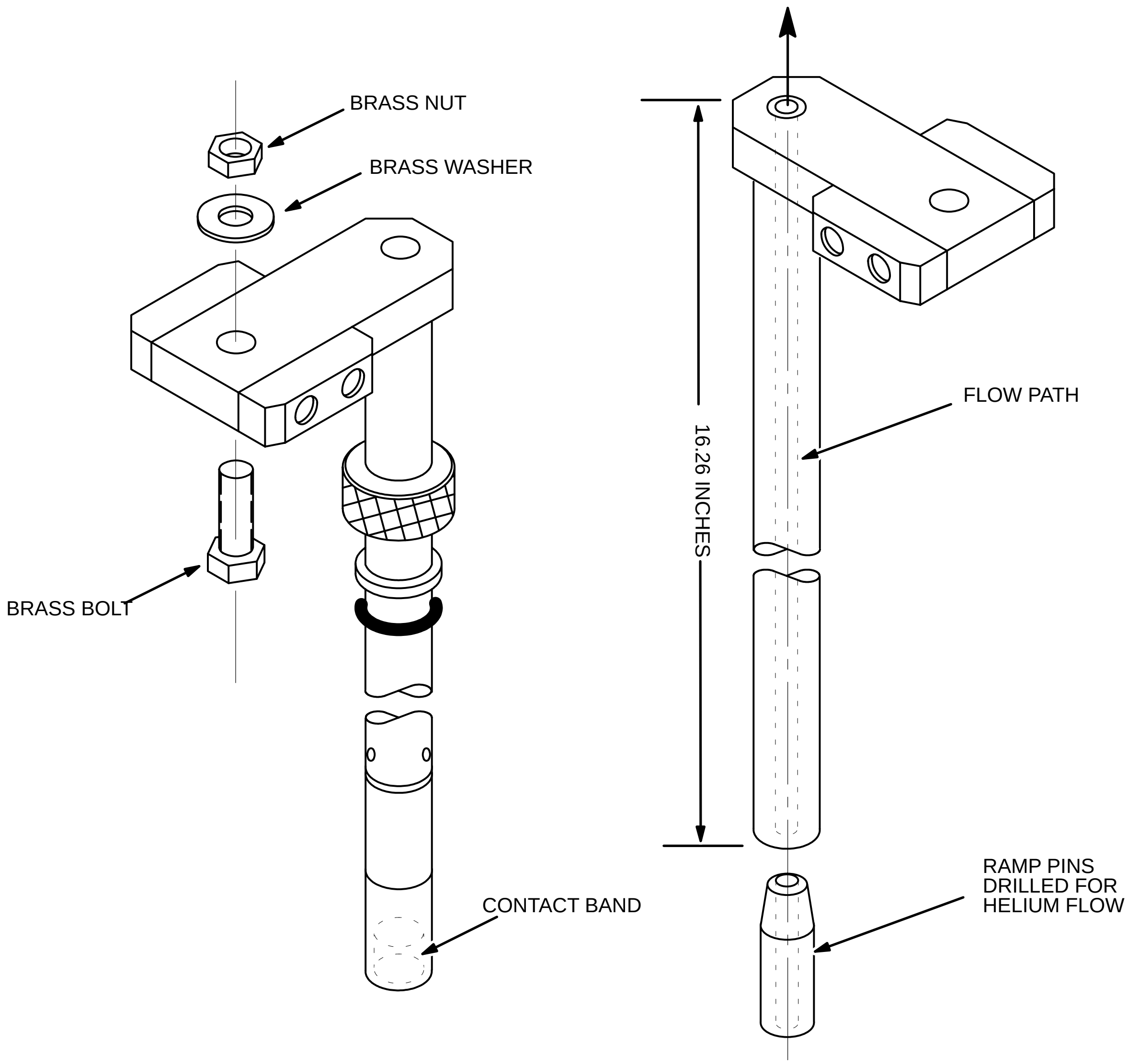
Note
Use only Brass Washers when connecting Main Power Leads to the Main Lead Extensions to keep voltage drops to a minimum.

CAUTION

Make sure the Brass Bolts in Step 6 are installed as shown in Illustration 8–6 to prevent any possibility of contact with the Fill Port Cap during ramping which would quench the magnet.

6. 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 8–6. Secure bolts with the Brass Nuts and Brass Washers provided. Tighten the connections sufficiently to provide a good electrical connection.
7. Install the 10–32UNF Gas Flow Hole Screws into the gas flow holes on each Ramp Lead Extension. See Illustration 8–5.

8–2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)



HARDWARE MOUNTING ON RAMP LEAD EXTENSIONS
ILLUSTRATION 8–6

8–2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

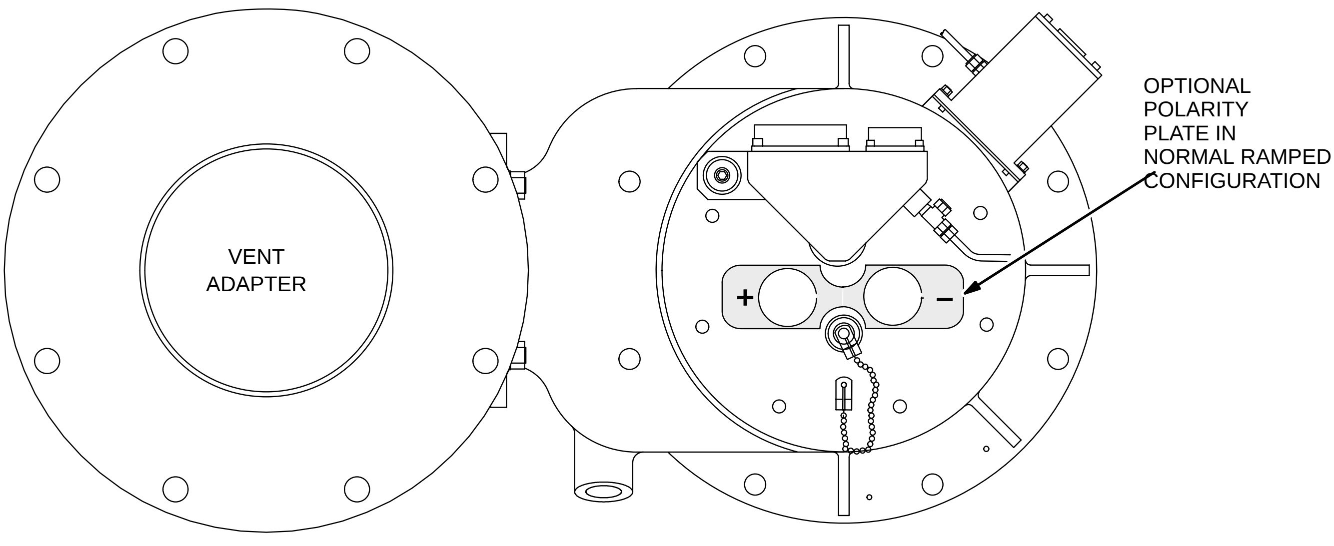
CAUTION

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.

8. 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 8–7 for Reverse Ramp Indication.



RAMP LEAD POLARITY
ILLUSTRATION 8–7

9. 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 8–7.

Note

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

8–2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

Note

For Reverse Ramped magnet, reverse the connections in Step 10 (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).

10. 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 8–7 for correct connection polarities.
11. Repeat Steps 9 through 10 for the other Lead Extension.
12. Connect the volt sense leads to the Main Power Lead Extensions. See Illustration 8–8. Terminate other end of volt sense leads to a DVM or VOM placed near the Main Coil Power Supply.
13. Remove Flow Hole Screws. See Illustration 8–8.

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!

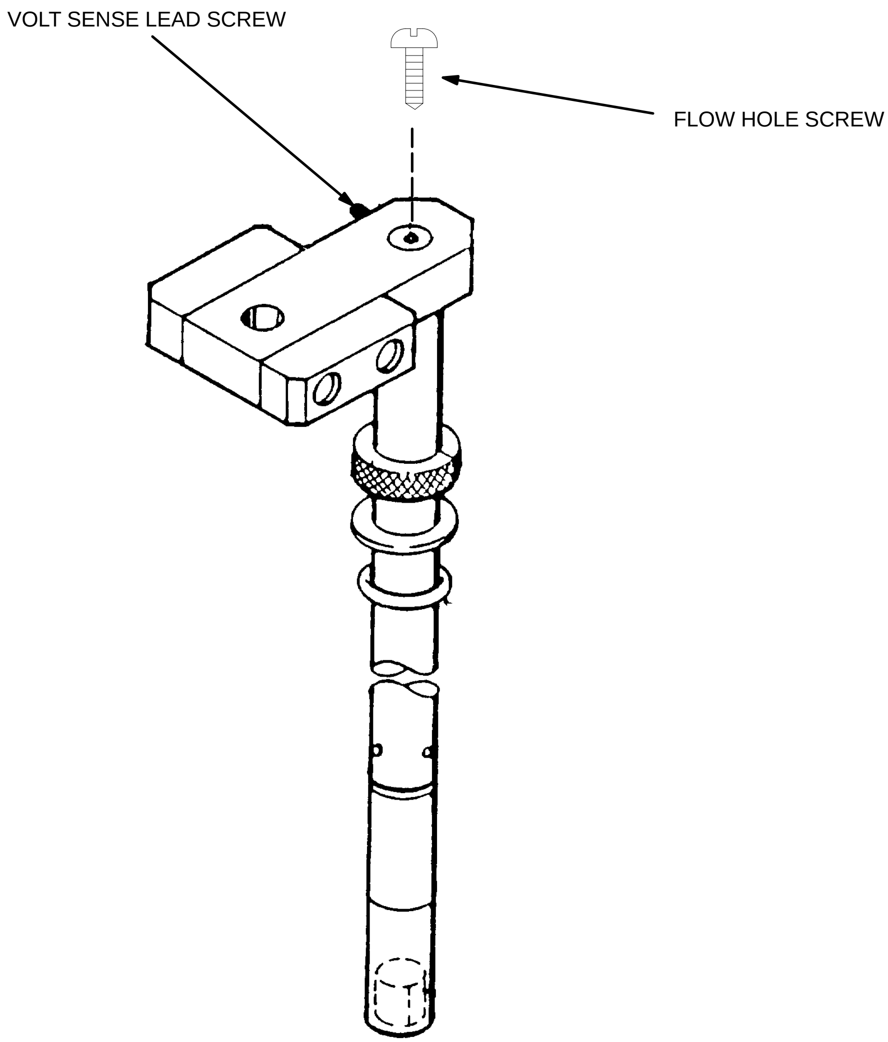
IF THE MAGNET IS RAMPED UP, WAIT FOR THE LEAD EXTENSIONS TO COOL SUFFICIENTLY (A FOG OR WATER VAPOR FORMS AROUND THE LEAD EXTENSIONS) BEFORE FULLY ENGAGING THEM, TO PREVENT THE RISK OF QUENCHING THE MAGNET.

14. 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.

8–2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)



VOLT SENSE LEAD CONNECTIONS
ILLUSTRATION 8–8

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.

15. 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.

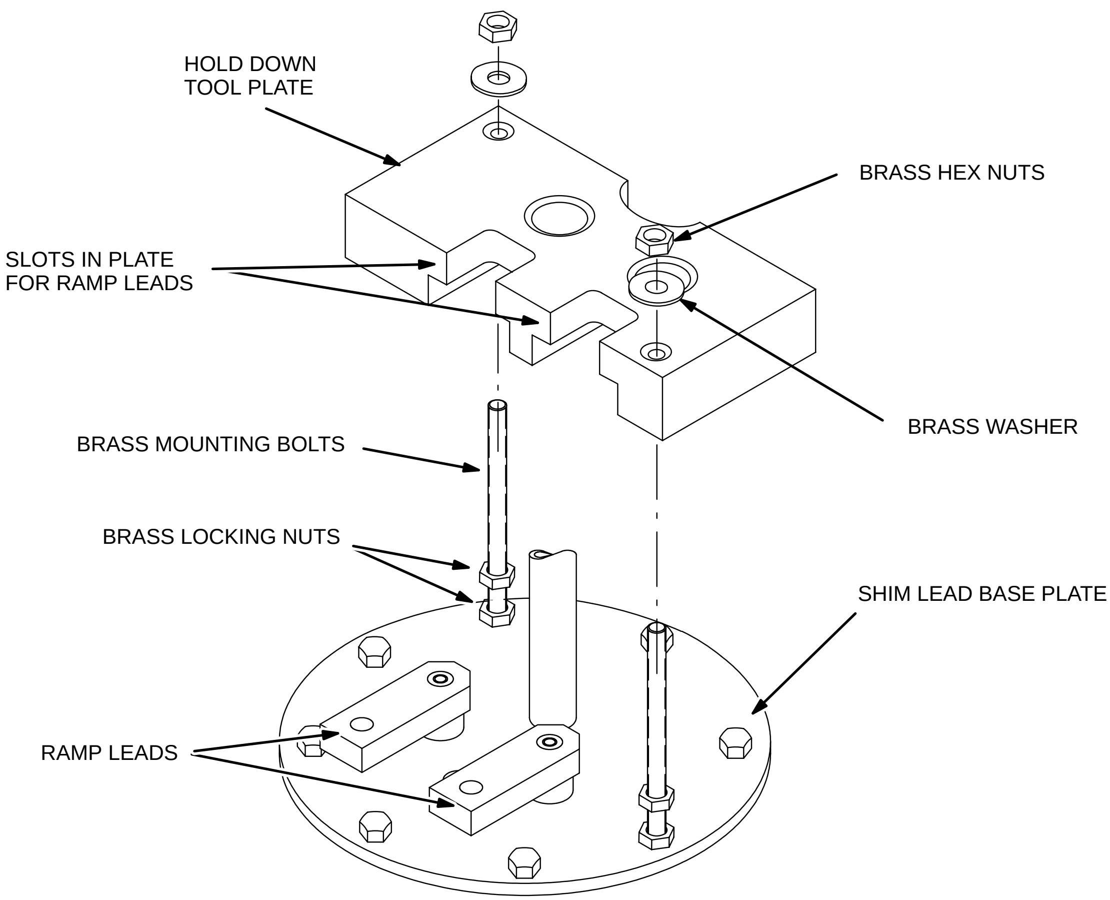
8–2 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

16. A Ramp Lead Hold Down Tool (2185743), 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 8–9.
17. 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 8–9.

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.

18. 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 8–9.



HOLD DOWN TOOL INSTALLATION
ILLUSTRATION 8–9

SECTION 9 – CRYOSTABLE MAGNET RAMPING PROCEDURE

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE SAFETY CHECKLIST SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

Description:

The Cryostable magnet Ramping current is approximately 745 amps for 1.0T and 742 amps for 1.5T. 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.

SECTION 9 – CRYOSTABLE MAGNET RAMPING PROCEDURE (continued)

WARNING!

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

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).

NOTIFY SITE ADMINISTRATION BEFORE RAMPING THE MAGNET THAT ALL MAGNETIC SAFETY PRECAUTIONS MUST BE TAKEN.

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.

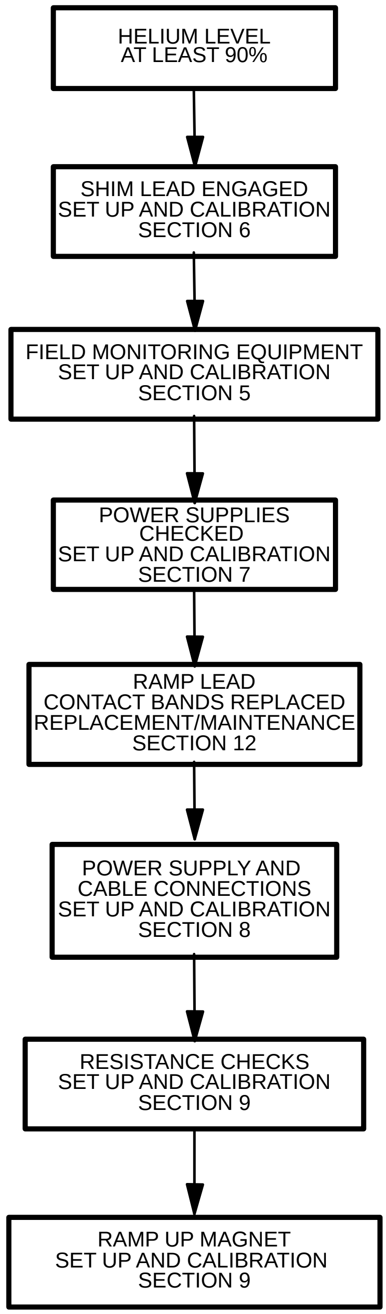
POST “RAMPED MAGNET” AND “AUTHORIZED PERSONNEL ONLY” WARNING SIGNS AT THE MAGNET ROOM ENTRANCE AND AT THE MR SUITE ENTRANCE, RESPECTIVELY, PRIOR TO RAMPING THE MAGNET. WARNINGS ARE TO ALERT PERSONNEL THAT NO FERROMAGNETIC MATERIAL OR INDIVIDUALS WITH CARDIAC PACEMAKERS, NEUROSTIMULATORS OR STEEL PLATES ARE ALLOWED IN THE MAGNET ROOM WHEN THE MAGNET IS RAMPED.

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.

MAKE SURE 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.

MAKE SURE THE MAGNET IS AT LEAST 90% FULL OF LIQUID HELIUM TO PREVENT THE LIQUID HELIUM LEVEL FROM DROPPING TO A POINT, DURING RAMPING, WHERE A QUENCH MAY OCCUR.

SECTION 9 – CRYOSTABLE MAGNET RAMPING PROCEDURE (continued)



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 90% full of helium before Ramping the magnet.

WARNING!

THE 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.

9–2 RESISTANCE CHECKS (continued)

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).
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 COARSE control 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 current running; readings may drop as Power Lead Extensions cool.
   - Tighten the nuts on top of the Hold Down Tool.
   - If the reading still exceeds 150 mV, turn VOLTAGE and CURRENT ADJUST controls to zero (full CCW), turn off Magnet Power Supply input power, then check / tighten 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.)

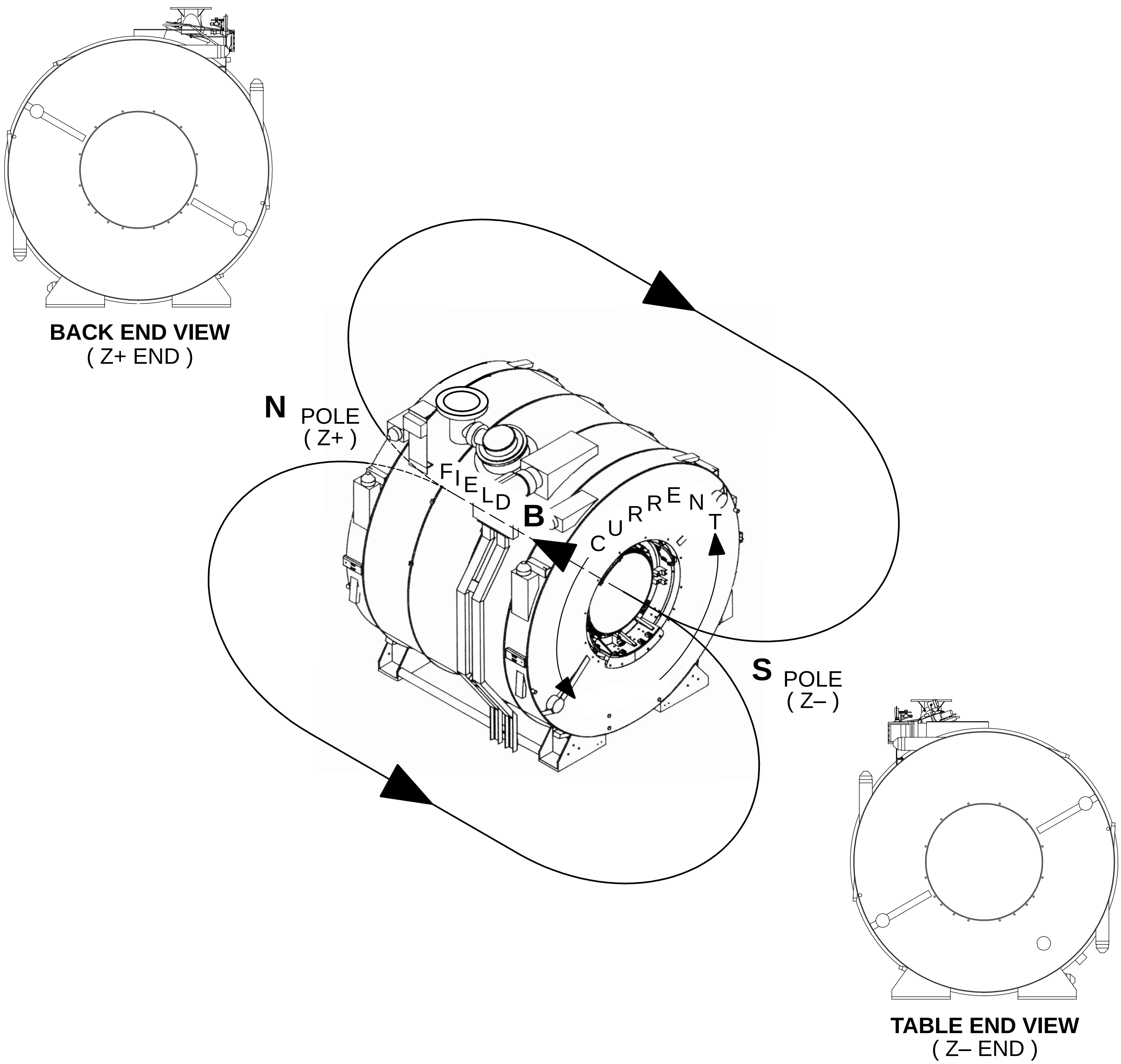
Note

A voltage less than 2.2V at 750A indicates acceptable system resistance. If the voltage exceeds 2.2V during the test, follow the procedures in Step 9 for adjusting contact resistance.

9–2 RESISTANCE CHECKS (continued)

11. Gradually increase the VOLTAGE ADJUST control to pass 750A 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 FOR 1.0T

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 HEATERS ARE 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.

IF MAGNET IS A 1.0T MOBILE, TRANSVERSE 1 AND 2 SWITCH HEATERS MUST BE "ON". THE SHIM POWER SUPPLY IS REQUIRED FOR TRANSVERSE HEATERS.

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).

Note

The Axial Switch Heater current is supplied by the Main Service Ramp Supply. The Transverse 1 and Transverse 2 Switch Heaters currents are supplied by the Shim Supply. Do not use the Axial Heater on the Shim Supply as this will increase boil off.

3. Set HEATER 2 SHIM AXIAL Switch, on the Main Power Supply, to 1 (ON).
4. Set Main Ramp Power Supply MAIN POWER Switch to ON.
5. Adjust the CURRENT ADJUST controls to maximum (full clockwise). Adjust the VOLTAGE ADJUST control to minimum (full counterclockwise).
6. Set HEATER 1 MAIN switch to 1 (on). Wait 3 minutes.
7. Set the power supply VOLTMETER SELECT SWITCH to MAIN COIL position.

9–3 RAMPING FOR 1.0T (continued)

8. Access spreadsheet on floppy disk sent with magnet ATR. Obtain currents from spreadsheet as indicated below.

   Cx10_15.XLW
   1.0T PARKING
   1.5T PARKING

   INPUT
   AXIAL 2, 4, 6 CURRENTS
   DECOMP 2, 0 4, 0 6, 0 PPM VALUES

   With no shim power connected during ramp, park magnet at frequency indicated by the spreadsheet.

TABLE 9–1
RAMPING VOLTAGE VERSUS CURRENT

MAIN COIL DRIVING VOLTAGE	MAIN COIL CURRENT
5.00 VOLTS	FROM 0 TO 100 AMPS
4.6 VOLTS	FROM 100 TO 200 AMPS
4.2 VOLTS	FROM 200 TO 300 AMPS
3.8 VOLTS	FROM 300 TO 400 AMPS
3.3 VOLTS	FROM 400 TO 500 AMPS
2.5 VOLTS	FROM 500 TO 550 AMPS
2.0 VOLTS	FROM 550 TO 600 AMPS
1.5 VOLTS	FROM 600 TO 625 AMPS
1.0 VOLTS	FROM 625 TO 650 AMPS
0.75 VOLTS	FROM 650 TO 675 AMPS
0.60 VOLTS	FROM 675 TO 700 AMPS
0.50 VOLTS	FROM 700 TO 720 AMPS
0.30 VOLTS	FROM 720 TO 730 AMPS
SLOWLY LOWER DRIVE VOLTAGE FROM 0.3 VOLTS	730 AMPS
0.1 VOLTS	WHEN MAGNET REACHES 0.990 T
0.025 VOLTS	WHEN MAGNET REACHES 0.990 T
EQUALIZE	WHEN MAGNET REACHES 1.001 T

9. Turn power supply VOLTAGE ADJUST control until a reading of 5.00 volts is observed on the power supply digital VOLTMETER.

Note
Measured inductance should be approximately 5.0 henrys. If the calculated value is between 4.8 – 5.2 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.

9–3 RAMPING FOR 1.0T (continued)

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 to approximately 515 amps (using a Range 5 Probe). This usually occurs between 0.6 and 0.7 Tesla (25.545900 MHz – 29.803550 MHz).

WARNING!

THE 1.0T MAGNET CAN BE QUENCHED IF LARGE CURRENT OR VOLTAGE CHANGES OCCUR NEAR PARKING. WHEN ADJUSTING CURRENT IN STEP 10 BELOW, TURN CURRENT CONTROL IN A SLOW, CONTINUOUS MOTION. BE CAREFUL NOT TO JERK THE CURRENT 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 4.6V and do not readjust until Step 12).

11. When the magnet current reaches 100 amps, slowly adjust the VOLTAGE ADJUST control, counterclockwise, for 4.6 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 4.2 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 3.8 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 3.3 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 2.5 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.

16. When the magnet current reaches 550 amps, slowly adjust the VOLTAGE ADJUST control for 2.0 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.

17. When the magnet current reaches 600 amps, slowly adjust the VOLTAGE ADJUST control for 1.5 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.

18. When the magnet current reaches 625 amps, slowly adjust the VOLTAGE ADJUST control for 1.0 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.

19. When the magnet current reaches 650 amps, slowly adjust the VOLTAGE ADJUST control for 0.75 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.

9–3 RAMPING FOR 1.0T (continued)

20. When the magnet current reaches 675 amps, slowly adjust the VOLTAGE ADJUST control for 0.6 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
21. When the magnet current reaches 700 amps, slowly adjust the VOLTAGE ADJUST control for 0.5 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
22. When the magnet current reaches 720 amps, slowly adjust the VOLTAGE ADJUST control for 0.3 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
23. When the magnet current reaches 730 amps, slowly lower the VOLTAGE ADJUST control from 0.3 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
24. When the magnet current reaches 0.990 Tesla, slowly adjust the VOLTAGE ADJUST control for 0.1 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
25. When the magnet current reaches 0.999 Tesla, slowly adjust the VOLTAGE ADJUST control for 0.025 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
26. Check Teslameter and slowly adjust the VOLTAGE ADJUST controls, as required, to bring Magnetic Field to frequency shown on ATR. The total current will be approximately 745 amps. Allow final field to stabilize. The last two digits on the Teslameter should be the only digits changing.
27. Maintain field at final setting for 5 minutes before proceeding to Step 28.

Note

Observe voltage (read on Power Supply Voltmeter with toggle switch in MAIN COIL position). When the switch goes “persistent” the voltage across the magnet terminals will stabilize at 0.00.

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

WARNING!

MAKE SURE 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 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.

30. When the switch goes “persistent”, **slowly** turn the power supply VOLTAGE control to zero over a two minute period (Full CCW).

9–3 RAMPING FOR 1.0T (continued)

31. Gradually turn the CURRENT ADJUST control to zero (over a one minute period).
32. Set HEATER 2 SHIM AXIAL switch to 0 (off).
33. Set MAIN POWER AND POWER ON switches to OFF, on Main Power Supply and disconnect Input Power Cable.
34. Remove ramp lead hold down tool and replace bolts on lead assembly mounting plate.

CAUTION

Step 35 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.

35. 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.

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

36. 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).

9–3 RAMPING FOR 1.0T (continued)

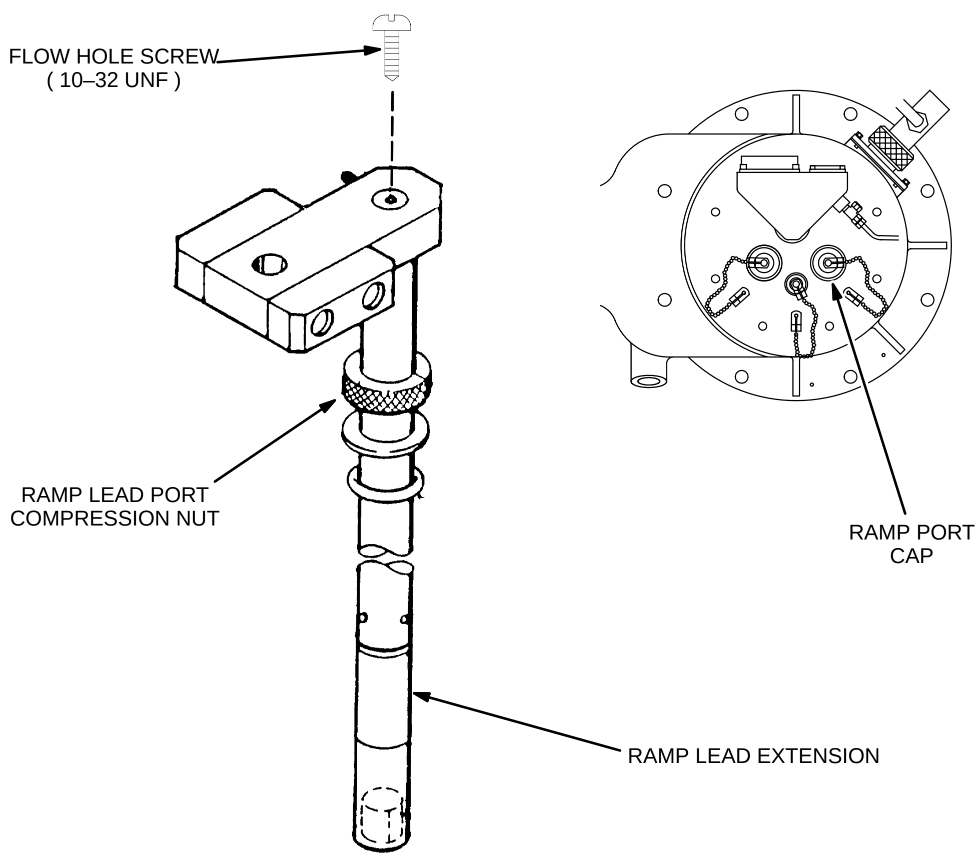
37. Make sure the following conditions are maintained. Re–check settings in three days and again after one week:

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.

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



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

9–4 RAMPING FOR 1.5T

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 HEATERS ARE 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.

IF MAGNET IS A 1.5T MOBILE, TRANSVERSE 1 AND 2 SWITCH HEATERS MUST BE “ON”. THE SHIM POWER SUPPLY IS REQUIRED FOR TRANSVERSE HEATERS.

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).

Note

The Axial Switch Heater current is supplied by the Main Service Ramp Supply. The Transverse 1 and Transverse 2 Switch Heaters currents are supplied by the Shim Supply. Do not use the Axial Heater on the Shim Supply as this will increase boil off.

3. Set HEATER 2 SHIM AXIAL Switch, on the Main Power Supply, to 1 (ON).

4. Set Main Ramp Power Supply MAIN POWER Switch to ON.

5. Adjust the CURRENT ADJUST controls to maximum (full clockwise).

6. Adjust the VOLTAGE ADJUST control to minimum (full counterclockwise).

7. Set HEATER 1 MAIN switch to 1 (on). Wait 3 minutes.

8. Set the power supply VOLTMETER SELECT SWITCH to MAIN COIL position.

9–4 RAMPING FOR 1.5T (continued)

9. Access spreadsheet on floppy disk sent with magnet ATR. Obtain currents from spreadsheet as indicated below.

   Cx10_15.XLW
   1.0T PARKING
   1.5T PARKING

   INPUT
   AXIAL 2, 4, 6 CURRENTS
   DECOMP 2, 0 4, 0 6, 0 PPM VALUES

   With no shim power connected during ramp, park magnet at frequency indicated by the spreadsheet.

TABLE 9–2
RAMPING VOLTAGE VERSUS CURRENT

MAIN COIL DRIVING VOLTAGE	MAIN COIL CURRENT
6.0 VOLTS	FROM 0 TO 100 AMPS
5.6 VOLTS	FROM 100 TO 200 AMPS
5.2 VOLTS	FROM 200 TO 300 AMPS
4.7 VOLTS	FROM 300 TO 400 AMPS
4.3 VOLTS	FROM 400 TO 500 AMPS
3.5 VOLTS	FROM 500 TO 550 AMPS
3.0 VOLTS	FROM 550 TO 600 AMPS
2.35 VOLTS	FROM 600 TO 625 AMPS
2.0 VOLTS	FROM 625 TO 650 AMPS
1.0 VOLTS	FROM 650 TO 675 AMPS
0.75 VOLTS	FROM 675 TO 700 AMPS
0.5 VOLTS	FROM 700 TO 720 AMPS
0.3 VOLTS	FROM 720 TO 730 AMPS
SLOWLY LOWER DRIVE VOLTAGE FROM 0.3 VOLTS	730 AMPS
0.1 VOLTS	WHEN MAGNET REACHES 1.490 T
0.025 VOLTS	WHEN MAGNET REACHES 1.499 T
EQUALIZE	WHEN MAGNET REACHES 1.501 T

10. Turn power supply VOLTAGE ADJUST control until a reading of 6.00 volts is observed on the power supply digital VOLTMETER.

Note

Measured inductance should be approximately 10.3 henrys. If the calculated value is between 10.0 – 10.5 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.

9–4 RAMPING FOR 1.5T (continued)

11. 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 to approximately 515 amps (using a Range 5 Probe). This usually occurs between 0.6 and 0.7 Tesla (25.545900 MHz – 29.803550 MHz).

WARNING!

THE 1.5T MAGNET CAN BE QUENCHED IF LARGE CURRENT OR VOLTAGE CHANGES OCCUR NEAR PARKING. WHEN ADJUSTING THE CURRENT IN STEP 11 BELOW, TURN THE CURRENT CONTROL IN A SLOW, CONTINUOUS MOTION. BE CAREFUL NOT TO JERK THE CURRENT CONTROL.

Note
Allow Main Coil Driving voltage to decay between each of the steps below (e.g. in Step 12 adjust the Main Coil Driving voltage to 5.6V and do not readjust until Step 13).

12. When the magnet current reaches 100 amps, slowly adjust the VOLTAGE ADJUST control, counterclockwise, for 5.6 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter (Voltmeter Select Switch in the Main Coil position).
13. When the magnet current reaches 200 amps, slowly adjust the VOLTAGE ADJUST control for 5.2 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.
14. When the magnet current reaches 300 amps, slowly adjust the VOLTAGE ADJUST control for 4.7 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.
15. When the magnet current reaches 400 amps, slowly adjust the VOLTAGE ADJUST control for 4.3 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.
16. When the magnet current reaches 500 amps, slowly adjust the VOLTAGE ADJUST control for 3.5 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.
17. When the magnet current reaches 550 amps, slowly adjust the VOLTAGE ADJUST control for 3.0 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.
18. When the magnet current reaches 600 amps, slowly adjust the VOLTAGE ADJUST control for 2.35 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.
19. When the magnet current reaches 625 amps, slowly adjust the VOLTAGE ADJUST control for 2.0 Volts Main Coil Driving Voltage as indicated on the Power Supply Voltmeter.

9–4 RAMPING FOR 1.5T (continued)

20. When the magnet current reaches 650 amps, slowly adjust the VOLTAGE ADJUST control for 1.0 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
21. When the magnet current reaches 675 amps, slowly adjust the VOLTAGE ADJUST control for 0.75 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
22. When the magnet current reaches 700 amps, slowly adjust the VOLTAGE ADJUST control for 0.5 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
23. When the magnet current reaches 720 amps, slowly adjust the VOLTAGE ADJUST control for 0.3 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
24. When the magnet current reaches 730 amps, slowly adjust the VOLTAGE ADJUST control for 0.3 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
25. When the magnet current reaches 1.490 Tesla, slowly adjust the VOLTAGE ADJUST control for 0.1 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
26. When the magnet current reaches 1.499 Tesla, slowly adjust the VOLTAGE ADJUST control for 0.025 Volts MAIN Coil Driving Voltage as indicated on the Power Supply Voltmeter.
27. Check Teslameter and **slowly** adjust the VOLTAGE ADJUST controls, as required, to bring Magnetic Field to frequency shown on ATR. The total current will be approximately 742 amps. Allow final field to stabilize. The last two digits on the Teslameter should be the only digits changing.
28. Maintain field at final setting for 5 minutes before proceeding to Step 29.

Note

Observe voltage (read on Power Supply Voltmeter with toggle switch in MAIN COIL position). When the switch goes “persistent” the voltage across the magnet terminals will stabilize at 0.00.

29. Turn off Main Switch Heater. Wait a minimum of 15 minutes for the switch to fully cool and go “persistent”.
30. 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 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.

9–4 RAMPING FOR 1.5T (continued)

31. When the switch goes “persistent”, **slowly** turn the power supply VOLTAGE control to zero over a two minute period (Full CCW).

32. Gradually turn the CURRENT ADJUST control to zero (over a one minute period).

33. Set HEATER 2 SHIM AXIAL switch to 0 (off).

34. Set MAIN POWER AND POWER ON switches to OFF, on Main Power Supply and disconnect Input Power Cable.

35. Remove ramp lead hold down tool and replace bolts on lead assembly mounting plate.

CAUTION

Step 36 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.

36. 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 9–4.
    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 9–4.
    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.

Note

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

37. 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.

9–4 RAMPING FOR 1.5T (continued)

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).

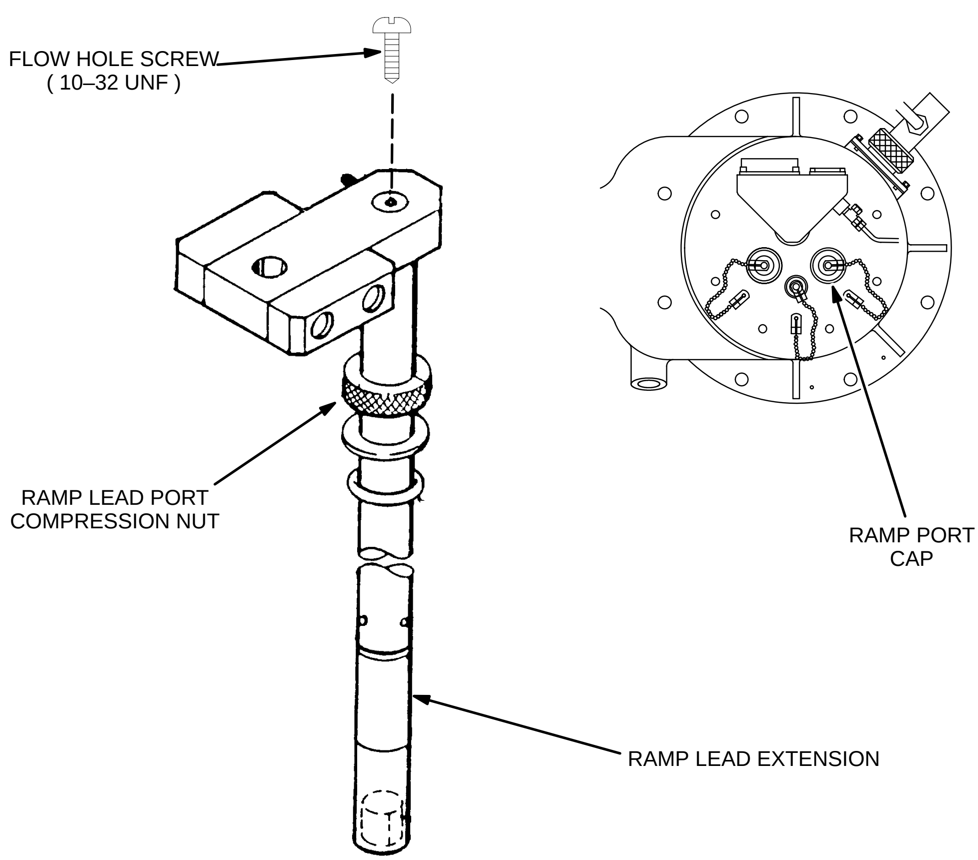
38. Make sure the following conditions are maintained. Re–check settings in three days and again after one week:

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.

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



RAMP LEAD EXTENSION AND RAMP PORT COMPRESSION NUT
ILLUSTRATION 9–4

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

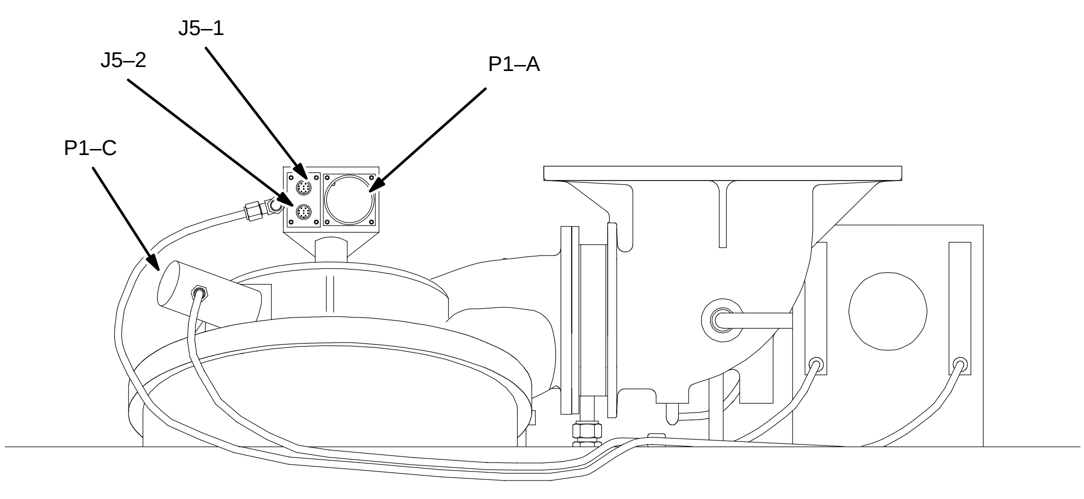
Moving articles or equipment in the Exam Room may affect field readings.

10–1 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS

CAUTION

Never place weight (objects) on the coldhead or sleeve as irreparable damage may result.

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

10–1 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 6. 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.

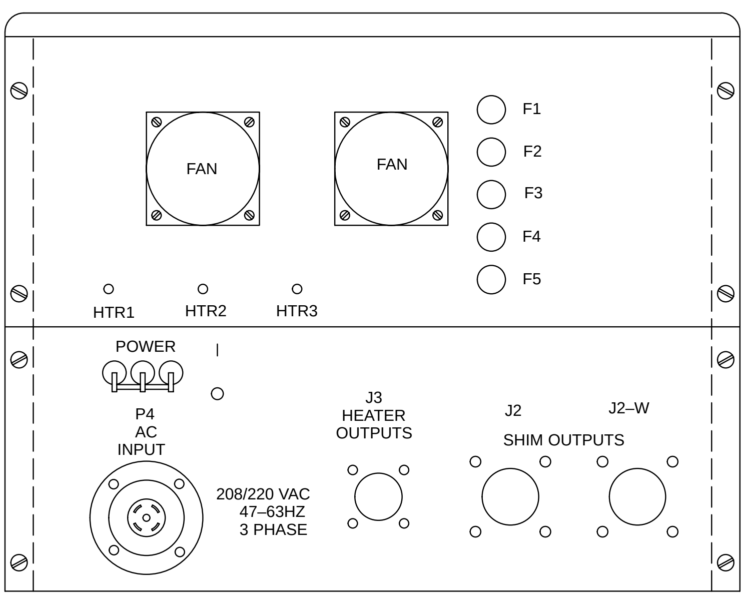
5. Verify all six Shim Power Supplies operate at both positive and negative polarities.

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

10–1 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.

10–2 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.

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 11 – SHIMMING

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE SAFETY CHECKLIST SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

Description:

“Shimming” is the process of measuring the change in the magnetic field over a fixed volume and using the acquired data to improve the field homogeneity through shimming programs, selected from the Magnet Maintenance Menu. The magnet is shimmed at the factory on a 45cm DSV.

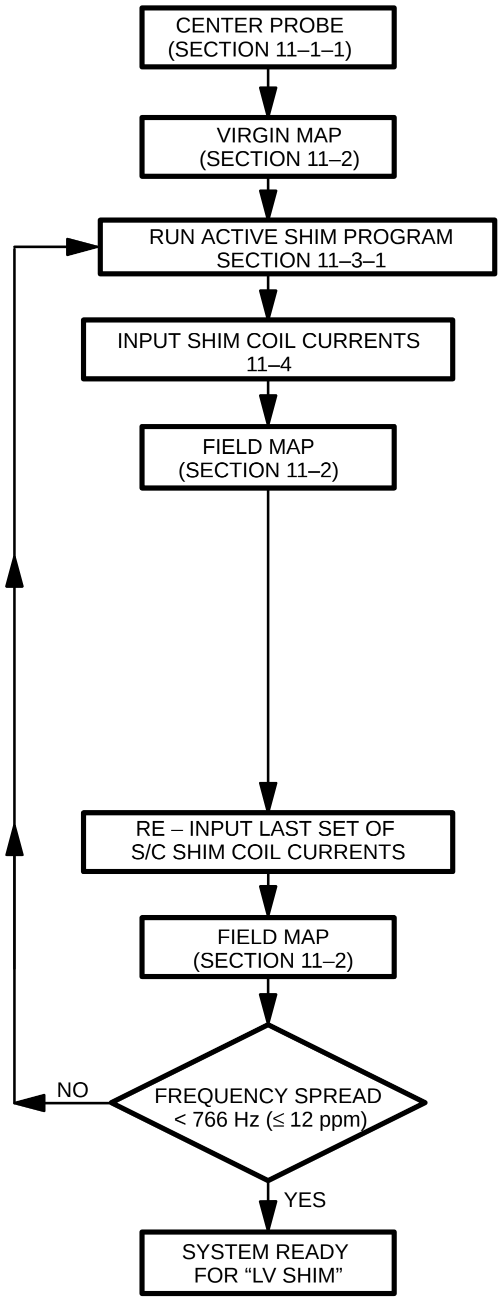
Shimming is performed after the magnet has been brought up to field and stabilized in conformance with SET UP AND CALIBRATION, Section 8, or when environmental changes significantly reduce the homogeneity of the magnet.

Both “Active” and “Passive” shimming processes are used to obtain a specified homogeneity of ≤12 ppm within the specified 45cm DSV volume (316 points). The self contained “NMR” Probe and Field Mapping Fixture are used to obtain “Point Data” for the shim programs.

Follow the Shimming Flow Chart shown in Illustration 11–1 to shim your magnet. Use the procedure in the section, referenced in the flow chart, for each step.

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).



NOTES

MAKE SURE ALL CURRENT, IN SHIM COILS, IS “DUMPED” I.E., 0 AMPS IN ALL COILS

1. LOAD FIELD MAP DATA
2. EXECUTE SHIM PROGRAM
3. RECORD COIL CURRENTS

*(HIGH SHIM CURRENTS > 20 AMPS, INDICATES NEED FOR EXTERNAL PASSIVE SHIMS.)

* HIGH T1–2, T1–4, OR T1–1 TRANSVERSE COIL CURRENTS INDICATE NEED TO COMPENSATE FOR STEEL IN THE EXAM ROOM FLOOR. HIGH T1–1 CURRENT INDICATES THE PRESENCE OF A STEEL COLUMN OR OTHER STEEL OBJECT AT A SPECIFIC LOCATION IN OR NEAR EXAM ROOM FLOOR. CALL ”MAC” TEAM REPRESENTATIVE IF HIGH SHIM COIL CURRENTS REQUIRED (> 20 AMPS) FOR THE POSSIBILITY OF EXTERNAL PASSIVE SHIMMING.

SHIMMING FLOW DIAGRAM

ILLUSTRATION 11–1

SECTION 11 – SHIMMING (continued)

Procedure:

11–1 CENTERING PROBE TO MAGNETIC CENTER

To minimize the number of iterations required to shim the magnet, center the probe on the Field Mapping Fixture at the magnetic center of the Superconducting Coils (R = 0, Z = 0). If the Field Mapping Fixture is mechanically centered in conformance with Section 5, only minor adjustments should be required, if any, during magnetic centering.

Only Axial Magnetic Centering is performed in this procedure. Transverse Probe Centering is performed mechanically in conformance with Set Up And Calibration, Section 5.

11–1–1 Axial Probe Centering:

1. Verify that the probe and mapping fixture are installed in conformance with SET UP AND CALIBRATION, Section 5 (“Field Monitoring Equipment”).
2. Verify that the Superconducting Shim Coil Cables, Heater Cable and Power Supply are connected in conformance with SET UP AND CALIBRATION, Section 10–1.
3. Set the probe to 0 cm radius and move it to the center of the magnet (i.e., axial = 0 cm and 0 degree rotation).

11–1–1 Axial Probe Centering (continued)

4. Make sure the Shim Power Supply is turned off and CURRENT ADJUST controls are at 0 (full CCW). Connect input power to and switch on Shim Power Supply.

Note

The cryostat pressure could decrease to approximately zero psig after the Shim Lead Vent Cap is removed in Step 5. Shutting off the Cold Head Compressor, while inputting Shim Currents, may help build cryostat pressure.

5. Remove the cap on the Shim Lead Exhaust T Fitting to vent Shim Lead Assembly. Turn on the Axial and Transverse Switch Heaters and allow the heaters to warm up for 2 minutes to dump any induced currents in the S/C Shim Coils.

CAUTION

Save Shim Lead Vent Cap for replacement in Step 15 in Transverse Probe Centering. Do not leave cap off for extended period of time or allow Cryostat to depressurize below 0.2 psig.

6. Turn off the Axial and Transverse Switch Heaters. Allow the heaters to cool for 2 minutes.

Note

If the heater switches are persistent (cooled), the magnetic field should not change by more than 10 Hz over a 2 minute period.

7. Record the virgin field value, in hertz, at +22.5cm, the center of the magnet (0 cm), and –22.5 cm, along Z–axis in Table 11–1.

TABLE 11–1
AXIAL PROBE CENTERING

S/C COIL STATUS	FREQUENCY READING IN HERTZ (42,3XXXXX Hz. FOR 1.0T AND 63,8XXXXX Hz FOR 1.5T) AT Z–AXIS POSITION		
	+22.5 cm	0 cm	–22.5 cm
VIRGIN PLOT			
AXIAL 1 (10 AMPS)			
PEAK DIFFERENCE	Δ	Δ	Δ

11–1–1 Axial Probe Centering (continued)

8. Set all POLARITY switches on the front of the Power Supply Cabinet to the positive position.
9. Turn on the Axial Switch Heater. Allow the heater to warm up for 2 minutes.

WARNING!

MAKE SURE VAPOR COOLED SHIM LEADS ARE FROSTED BEFORE SETTING POWER SUPPLY CURRENTS TO PREVENT IRREPARABLE DAMAGE TO VAPOR COOLED LEADS.

10. Turn on the Axial 1 on Shim Power Supply and adjust it to 10.0 Amps.
11. Record the field (in frequency) at +22.5 cm, the center of the magnet and at –22.5 cm in Table 11–1.
12. Make sure field at +22.5 cm, or –22.5 cm, has changed by at least 12 KHz from the virgin field value. If the field has not changed from virgin field (at +22.5 cm or –22.5 cm), no current is being supplied to axial 1. Check connections.

Note

The minimum distance to move probe is 1mm. When the probe is centered, the calculation below should yield **LESS THAN 1MM.**

13. Calculate the distance the probe must be moved axially in Step 14, by using the following formula:

$$\text{DISTANCE}(mm) = \frac{\Delta 0cm\ X\ 450mm}{(+\ 22.5\ cm\ )\Delta\ +\ (\,-\,22.5\ cm\ )\Delta} \qquad \text{(10 AMPS IN AXIAL \#1)}$$

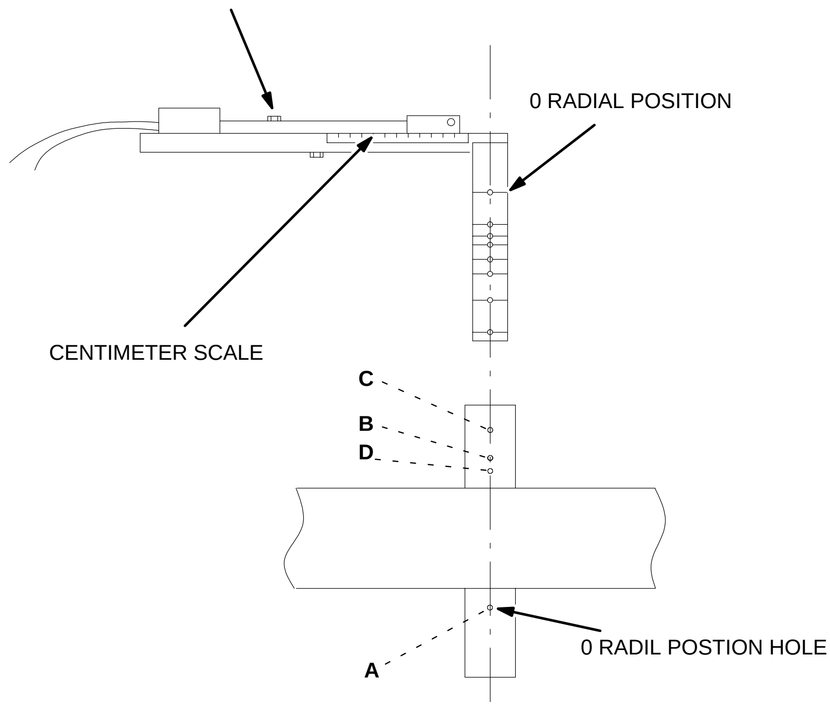
Note

Note where two of the three PEAK DIFFERENCE readings are the same (+22.5cm and 0cm, or –22.5 cm and 0cm) and move the Teslameter Probe towards the opposite direction by the amount calculated in Step 13. For example, if the Peak Difference readings recorded in Table 10–1 were: –170 KHz for –22.5 cm, +194 KHz for +22.5 cm and +180 Hz for 0cm, the Testlameter Probe should be moved by 3mm towards the Z– end of the magnet.

11–1–1 Axial Probe Centering (continued)

14. Loosen the Probe Mounting Screw and slide the probe the appropriate length on the Probe Support Table using the scale on the side of the Probe Support Table as a reference. See Illustration 11–2.
15. Recheck all readings with 10 amps in Axial Coil1.
16. Ramp down the Axial 1 Shim Power Supply and record all virgin readings.
17. Perform the calculation in Step 13 and repeat Steps 14 through 17 until the calculation in Step 13 yields less than 1mm.
18. Ramp down the Axial 1 Shim Power Supply and then turn supply off.
19. Turn off the Axial Switch Heater.
20. Replace Shim Lead Vent Cap when centering is complete.

NOTE: LOOSEN SCREW TO MOVE PROBE AXIALLY TO POSITION AT MAGNETIC CENTER.



AXIAL ADJUSTMENT OF TESLAMETER PROBE
ILLUSTRATION 11–2

CAUTION

Make sure Shim Lead Vent Cap is tight and does not leak after cap is replaced.

11–2 FIELD MAPPING

Description:

Field mapping is performed within a 45cm DSV, centered in the magnet bore, by taking NMR frequency measurements at discrete points (data points). Full field maps (316 points) are obtained by collecting frequency measurements at four data points along the Z–axis (R = 0 cm), at Z= –24.0, Z = +24.0, Z = –22.5 cm , and Z = + 22.5 cm and at 24 data points at 15 degree intervals around a specified circle on 13 different planes. Collecting of the “NMR” frequency at circle Data Points begins at 0 degrees at the top of the Magnet and continues by measuring at angular increments clockwise, facing the Magnet from the Table End(front). The frequency data is recorded in the DATA SHEETS Section of this manual.

Data is recorded as frequency values from the Teslameter. Record the “BASE” frequency at the top of Table 7–1 in the DATA SHEETS Section. See Illustration 11–5. The base frequency is the frequency whose digits are common to all 314 data points.

Example: If the lowest frequency is 63,801,230 Hertz and the highest frequency is 63,801,330, the base frequency is 63,801,000.

Record the variable numbers (the last 4 or 5 digits) of each displayed value in the appropriate space within the Data Sheets Table. After the first shimming operation, only the last three or four digits will change in subsequent mapping.

Because of the wide range of Teslameter measurement and because of the digital display, some fluctuation in meter readings will occur. Because of this anomaly, round the reading to the nearest 10 Hz.

Indicate the Magnet number and map number in the DATA SHEETS Section, Table 7–1. Number Maps consecutively.

Follow the diagram in Illustration 11–1 when performing this procedure.

Procedure:

1. Use the field monitoring equipment with the probe centered in conformance with SET UP AND CALIBRATION, Section 5.

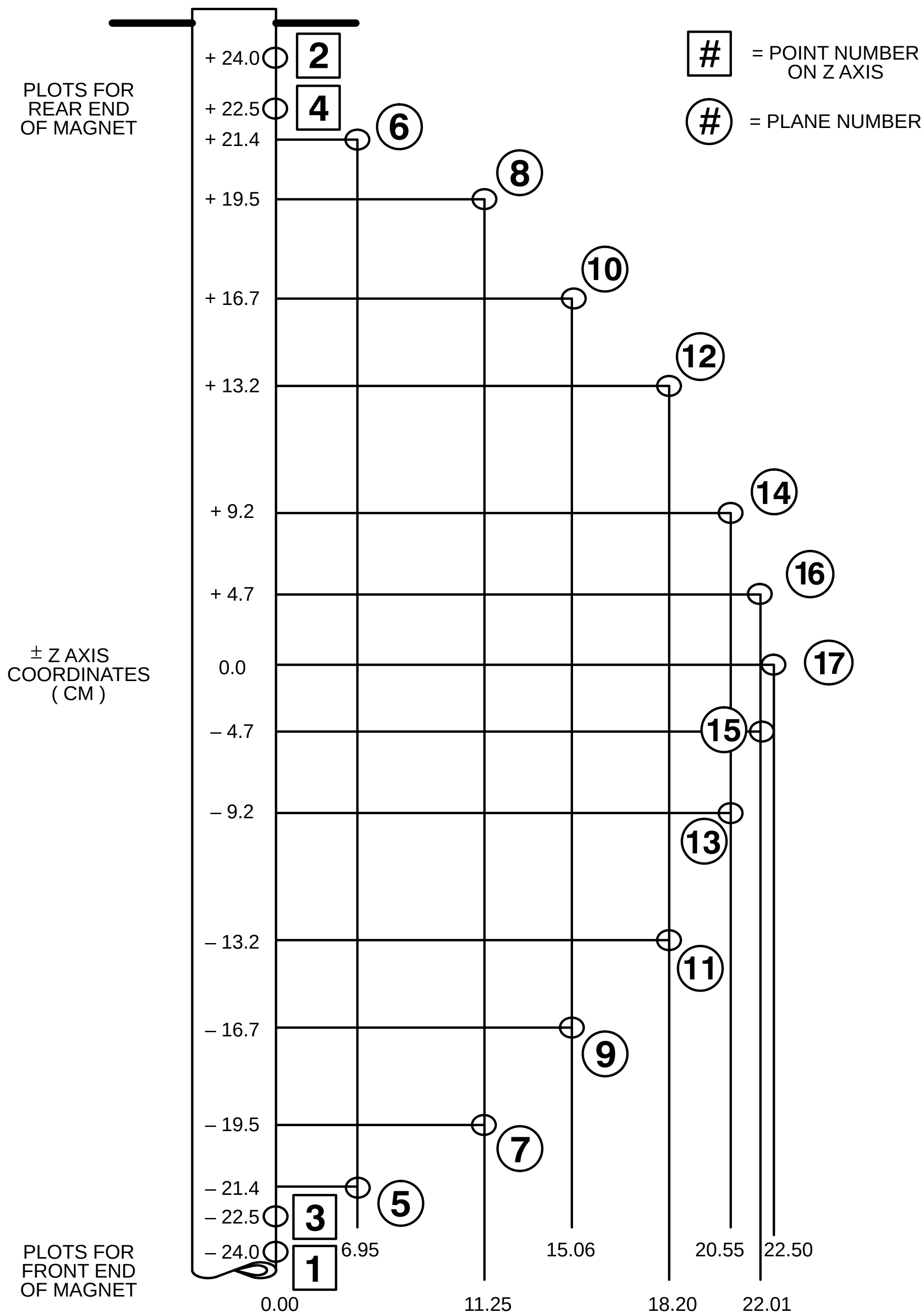
2. Make sure magnet is stabilized in conformance with SET UP AND CALIBRATION, Section 10.

3. Map bore volume by plotting a full field map in conformance with the Shim Plot Data, Table 7–1 of DATA SHEETS and in the sequence shown in Illustration 11–3. See SET UP AND CALIBRATION, Section 5–3 for angular, axial and radial probe positioning.

4. Check data for errors using the following criteria. Retake measurement for any data point outside criteria.

   a. FREQUENCIES OF ALL DATA POINTS SHOULD LIE WITHIN A 20 KHz BANDWIDTH.

   b. THERE SHOULD BE NO MORE THAN 1 KHz DIFFERENCE BETWEEN ADJACENT DATA POINTS (ABOVE, BELOW, AND ASIDE).

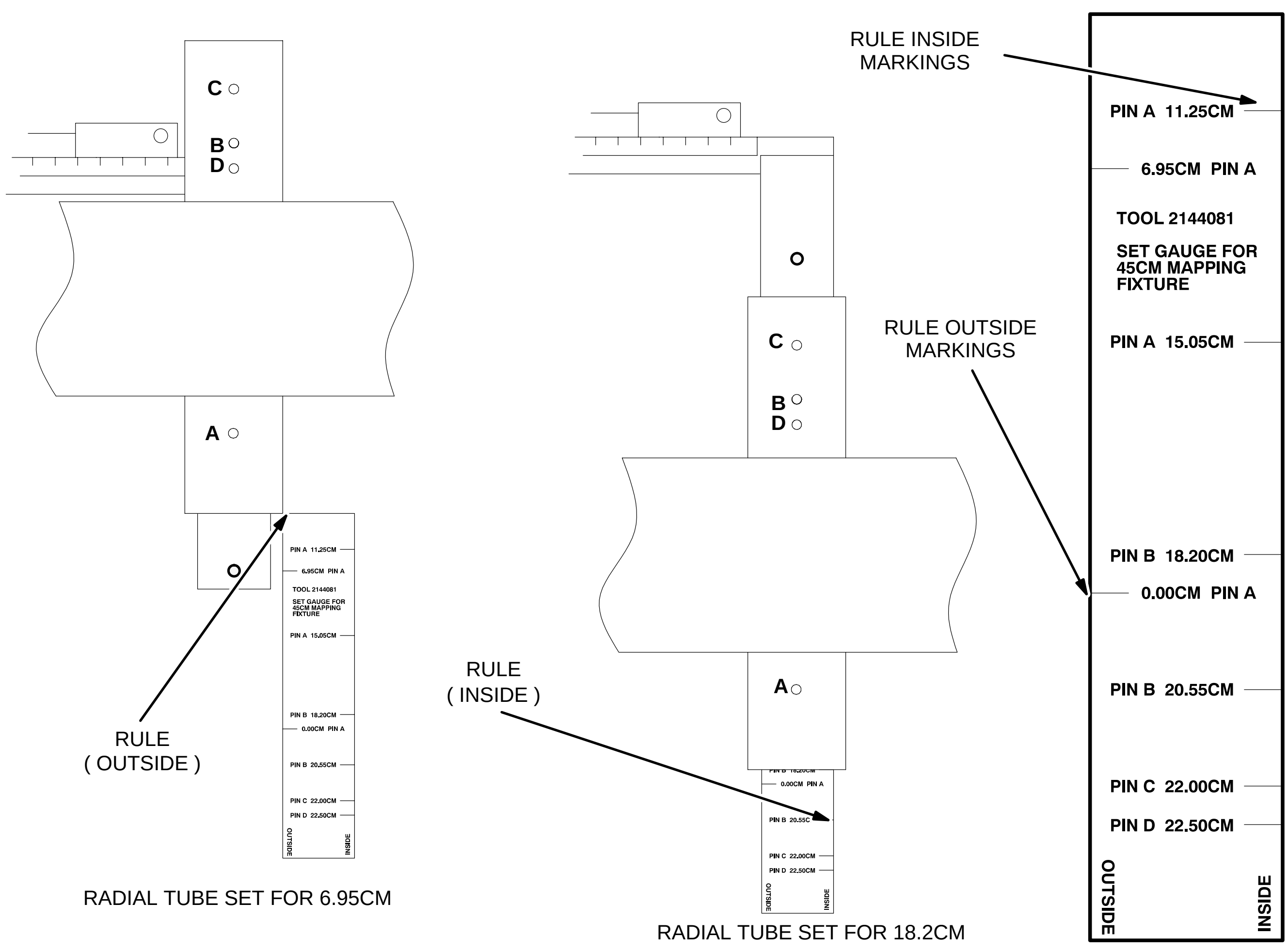


RADIAL SPACE COORDINATES
R (CM)

PROBE POSITIONER LOCATIONS – 45 CM DSV
ILLUSTRATION 11–3

TABLE 11–2
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 11–4

DATE:______________________MAGNET:______________________LOCATION:_________________________PLOT#:_______________________________

POINT 1 (R = 0, Z = –24.0cm):____________________POINT 2 (R = 0, Z = +24.0CM):____________________POINT 3 (R = 0, Z = –22.5CM):____________________

POINT 4 (R = 0, Z = +22.5CM):_____________________________BASE FREQUENCY:____

ROTATION COORD. (DEGREES)	PLANE												
	5	6	7	8	9	10	11	12	13	14	15	16	17
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)

SHIM PLOT DATA
ILLUSTRATION 11–5

11–3 SUPERCONDUCTING SHIM PROGRAM FOR MECHANICAL SHIMMING

Description:

Computer System and Software Requirements:
Nonproprietary Shim Software (22xxyyz)
Signa Horizon LX Platform PC Subsystem

The program, named SCSHIM, is used for calculating S/C shim currents and allows the user to select either of the following options:

1. Limit the output of the power supplies to a specific current.
2. Disable the current calculation for a specific coil(s).

The program will automatically link to the appropriate calibration files. All you need to know is your magnet serial number (make note of the first letter in the serial number), and the size of the mechanical shim volume you are performing (45 cm DSV, 40 cm DSV etc.). With this information you will be able to pick the appropriate option and the software does the rest.

Conventions:
The file name is divided into two parts; the prefix and the suffix. In the DOS environment, the prefix is limited to eight characters and the suffix is limited to three characters.

In order to reduce confusion and maintain consistency between all users the following file name conventions have been established.

The prefix will contain the magnet serial number followed by the present iteration. The sequence for iteration will be v for virgin, then a, b, c and so on. The suffix will contain characters which represent which program code is being used to generate the file. See example below.

Filename Extension	Description
.plo	316 pt field file
.shm	SCSHIM output file

11–3–1 LOADING SOFTWARE ON PC

1. Boot the PC and start Microsoft Windows™ .
2. Insert nonproprietary software floppy, (22xxyyz), into the “a” drive.
3. Type **a: install < ENTER >**
4. Load disk into the “c” drive and create folder called “software”.

Note

The software will automatically load the calibration files and executable programs into the following directory: c:\software

The Cal Files, Map Plot Files, and Executable Shim Code Files are contained in the Shim Directory. The Output Passive Shim, and Supercon Shim Current Files are contained in the Data Directory (C:\SHIM\DATA).

Note

When using Windows95™ , you should be able to view the files in the directory c:\software.

11–3–2 DATA COLLECTION

Description:

Before you start running the shim programs you must have a field map file which contains the frequency data for specified points within the magnet bore. There are two ways to collect the data.

1. Manually read and record the frequencies onto a field map data sheet.
   The file should be transferred to the following directory: c:\testshim
2. Create a map file on the laptop computer using a word processor such as MS WORD™ .
   - Type in the number of map points (316) and the base frequency at the top of the file. Do not use any commas or periods. It is not necessary to include data to the right of the decimal point (i.e. numbers less than 0).
   - Separate the number of map points from the Base Frequency by at least one space.
   - The last point in the base frequency (units position) can be entered as a “0”.
   - Type each of the map 316 data points in one column down the page. See the example below for map file format.

Example:

```
316     63000000
        928560
        899840
        924620
        .
        .
        .
        882510
        882810
        883530
```

11–3–3 Running SCSHIM

Procedure:

1. Open MSDOS™ and type **cd . .** < ENTER >
2. Type **cd software** < ENTER >
3. Type **dir** < ENTER >
4. Type **conqpc** < ENTER >

Note
The following screen will appear. If “N” is pressed the program will be terminated.

PROGRAM CONQPC REVISION 0 DATED 12/23/97

THIS PROGRAM IS PROPERTY OF GENERAL ELECTRIC
MEDICAL SYSTEMS AND IS FOR USE BY AUTHORIZED
PERSONNEL ONLY. DISCLOSURE TO UNAUTHORIZED PARTIES
IS PROHIBITED

Press Y to continue

Press N to exit
Y < ENTER >

SELECT MAGNET RAMP POLARITY – NORMAL / REVERSE (1/–1)
1 < ENTER >

5. Select the magnet type for shimming after the screen below. For example, to select a 1.0T mobile “P” magnet, type **2** followed by < ENTER >.

Note
If “Y” is entered the following screen will appear.

11–3–3 Running SCSHIM (continued)

MAGNET TYPE & SHIM VOLUME CONFIGURATION MENU

Magnet Type	Shim Volume
**************************************	***************
1 . Prefix ”P” = 1.0 T FIXED SITE	45/48 cm dsv
2 . Prefix ”P” = 1.0 T MOBILE	45/48 cm dsv
3 . Prefix ”N” = 1.5 T FIXED SITE	45/48 cm dsv
4 . Prefix ”N” = 1.5 T MOBILE	45/48 cm dsv
5 . Prefix ”Q” = 1.0 T FIXED SITE	45/48 cm dsv
6 . Prefix ”R” = 1.5 T FIXED SITE	45/48 cm dsv

Select the appropriate option by Magnet serial number prefix and
the mechanical plot volume
Enter selection number: 2 < ENTER >

Note
After entering “2”, in Step 5 above, the screen will continue.

Note
Always code input measured field file with a letter that corresponds to the shim iteration. For example the first iteration should be coded with the letter “a” as in the example in Step 6. The second iteration would look like **P2KN_b.plo** and so on.

SC SHIM OPTIONS MENU

OPTIONS	Present Option Settings
1. Analysis option	SHIM ADDITION ONLY (FIRST TIME SHIMMING)
2. Shimming option	SUPERCONDUCTING ALONE

3. Expected Tolerance, Number of Range 7

Map Pt 1	Map Pt 2	PPM
1	2	9.0
3	4	3.0
5	296	9.0
297	301	3.0
302	308	9.0
309	313	3.0
314	316	9.0

6. Total mapping pts. & No. of Circles 316 & 13
7. Number of shim coils, max I 18 15.0

11–3–3 Running SCSHIM (continued)

Do you want to change option settings? (Y/N)
N < ENTER >

Active shim calibration filename is PS45SC.CAL

6. Enter the name of the input measured field file (Maximum of 8 Chars and press < ENTER >. For example, **P2KN_a.plo** < ENTER >. This is understood as the first plot after the virgin plot (avoid using the letter "v" in the plot file name unless removing all passive shims and supercon currents).

Note
The screen will append with a prompt to enter (Y / N) ? to the deselection of any shim coils type
N < ENTER >

Enter the name of the input field file (Maximum of 8 Chars < filename.PLO >):
P2KN.PLO < ENTER >
INPUT FILE = P2KN.PLO

OUTPUT FILE = P2KN.SHM

This program will allow you to de–select a shim coil so currents are not
calculated for that coil. To de–select one or more coils, refer to the
service manual for the proper coil numbering sequence.
Do you want to de–select any of the shim coils (Y/N)? N < ENTER >

The initial average field is 10007.240000 Gauss.
The initial tot. field tolerance is 8.942251 PPM.
Initial Tol. for pts 1 TO 2 is –3.85 to –4.47
Initial Tol. for pts 3 TO 4 is –.39 to –.75
Initial Tol. for pts 5 TO 296 is 4.47 to –4.24
Initial Tol. for pts 297 TO 301 is –.40 to –1.31
Initial Tol. for pts 302 TO 308 is –.40 to –4.21
Initial Tol. for pts 309 TO 313 is –2.35 to –3.76
Initial Tol. for pts 314 TO 316 is –2.03 to –2.30

Execution begins...
ITER= 10
ITER= 20
ITER= 30
PROGRAM EXECUTION COMPLETED.
Stop – Program terminated.

11–3–3 Running SCSHIM (continued)

Note
The screen will append with the following message:

"This program will allow you to de–select a shim coil so currents are not calculated for that coil. To de–select one or more coils, refer to the service manual for the proper coil numbering sequence".
Do you want to de–select any of the shim coils (Y/N)?

Note
If you enter "y" for yes then you need to know the appropriate coil number for the coil you wish to de–select based on magnet the type. Refer to Section 11–3–4 to determine the coil numbers.

Note
The following is displayed if you answered yes to the above question:

Enter the number of coils you want to de–select: *Example:* **"3" <enter>**

Note
You may de–select as many coils as you wish. If you enter 3 then you must enter 3 coil numbers when prompted by the next statement:

Enter the de–selected coil numbers: *Example:* **"2, 9, 13" <enter>**

Note
After the current limit is set and any shim coils are de–selected, the program execution begins. The screen appends with the following information:

Execution begins...
Program execution completed or terminated by user.

C:\ SHIM >

11–3–4 COIL NUMBERS

Coil #	Coil Name
Coil 1	T1–1
Coil 2	T1–2
Coil 3	T1–3
Coil 4	T1–4
Coil 5	T1–5
Coil 6	T1–6
Coil 7	T2–1
Coil 8	T2–2
Coil 9	T2–3
Coil 10	T2–4
Coil 11	T2–5
Coil 12	T2–6
Coil 13	Ax–1
Coil 14	Ax–2
Coil 15	Ax–3
Coil 16	Ax–4
Coil 17	Ax–5
Coil 18	Ax–6

11–3–5 SCSHIM OUTPUT FILE

Example of an SCSHIM output file – (SV MAGNET).

SUPPLY NAME	PREVIOUS CURRENT (A)	CHANGE (A)	NEW TOTAL CURRENT (A)
T1–1(C31)	0.000	0.007	0.007
T1–2(C11+)	0.000	0.029	0.029
T1–4(C11–)	0.000	0.008	0.008
T2–1(S31)	0.000	–0.056	–0.056
T2–2(S11+)	0.000	–0.017	–0.017
T2–4(S11–)	0.000	0.069	0.069
AX 1	0.000	0.355	0.355
AX 2	0.000	–0.080	–0.080
AX 3	0.000	–0.314	–0.314
AX 4	0.000	0.014	0.014
AX 5	0.000	0.284	0.284
AX 6	0.000	0.000	0.000

AVERAGE FIELD (GAUSS) Initial= 5001.23
Final= 5001.10

FIELD TOLERANCE (PPM) Initial= 7.138
Final= 2.279

TOTAL CURRENT CHANGE (AMPS) = 1.614

NUMBER OF ITERATIONS = 45

11–4 INPUT SHIM CURRENTS

1. Connect the Shim Power Supply to the magnet in conformance to SET UP AND CALIBRATION, Section 10–1.
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

   <u>For each of these groups, follow steps 4 through 11 below:</u>

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 15 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.

11–4 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, frosting and ice in vertical penetration.

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. Disconnect the Main Power Leads, Volt Sense Leads and remove Main Power Lead Extensions on the top of the magnet. Immediately replace the caps onto the Magnet Ramp Ports.
17. 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).

18. 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 –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

Use black ring and markings on mapping fixture tube when performing checks in this section.

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

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.

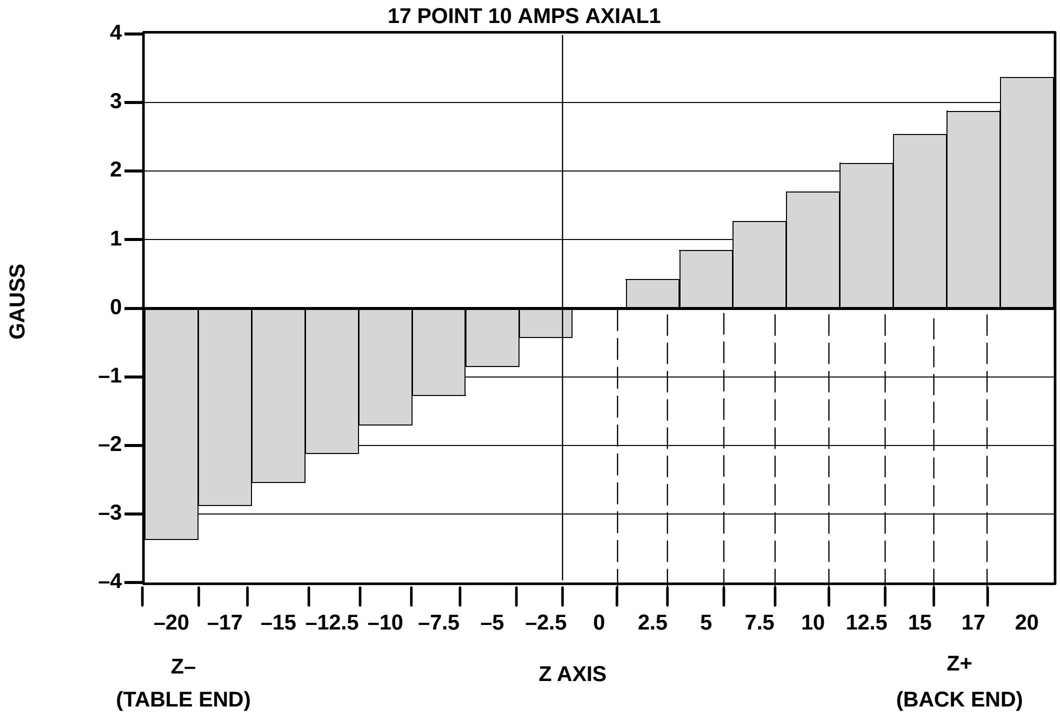
8. Apply 10 A to the Axial–1 coil (i.e. set Axial–1 Power Supply to 10 A).
9. Turn off the Axial and Transverse S/C Switch Heaters. Allow the heaters to cool for 2 minutes.
10. Ramp the Axial – 1 S/C Power Supply to 0 A after the Switch Heaters have cooled down for 2 minutes.
11. Move the probe to the –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

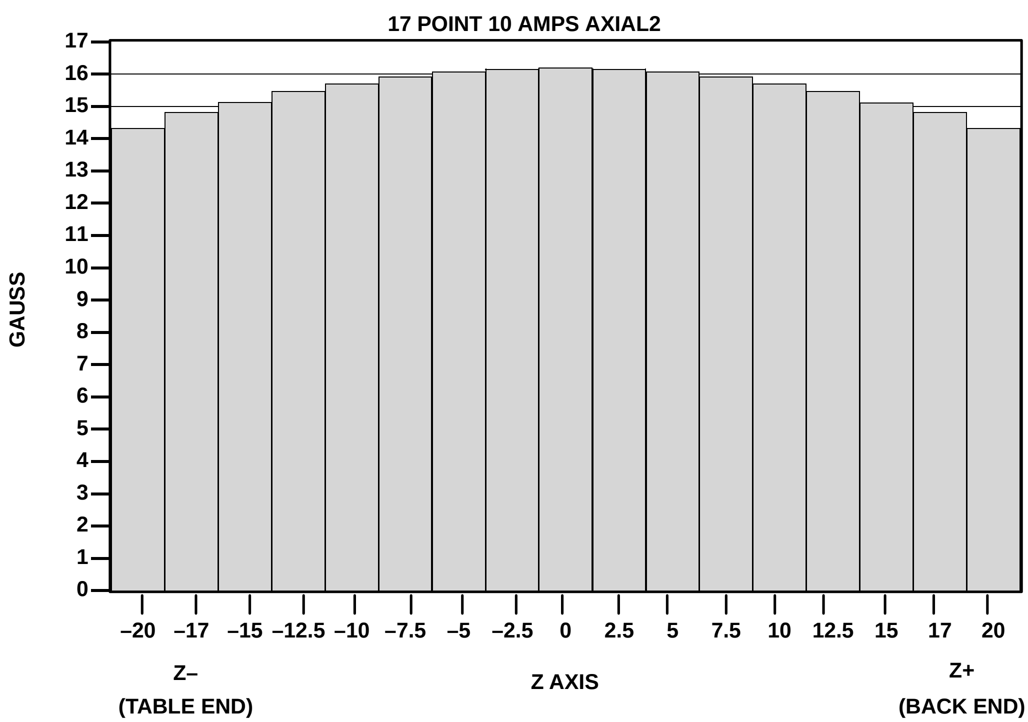
Note

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 –20 cm virgin map value. However, the gauss value at +20 cm along the z–axis is approximately 4 gauss greater than the +20 cm 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).

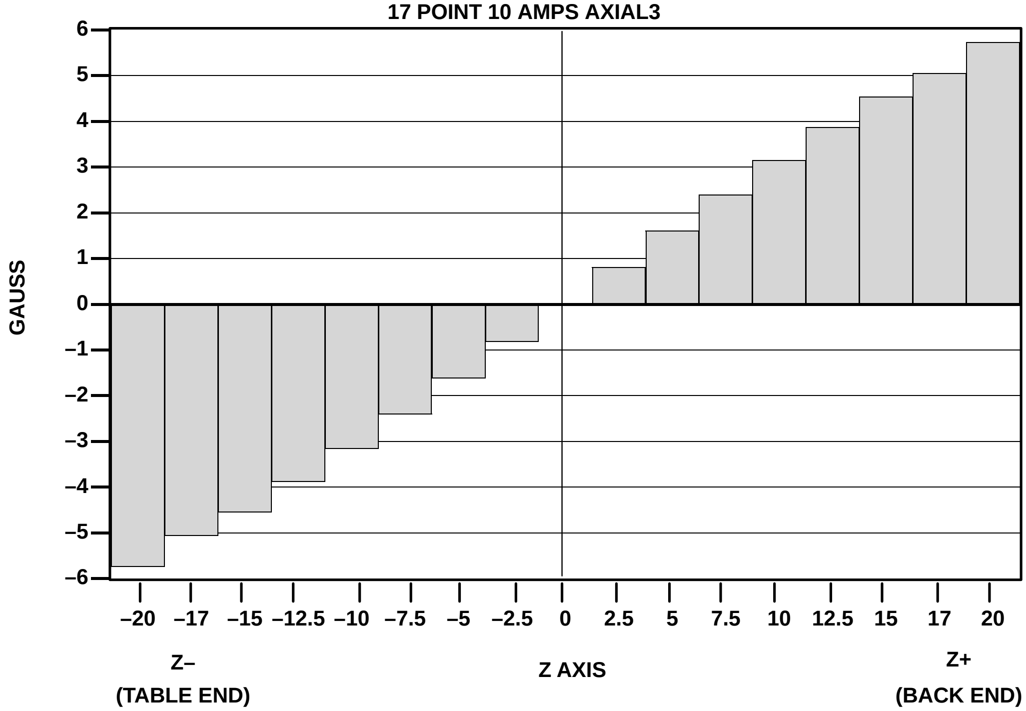
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.

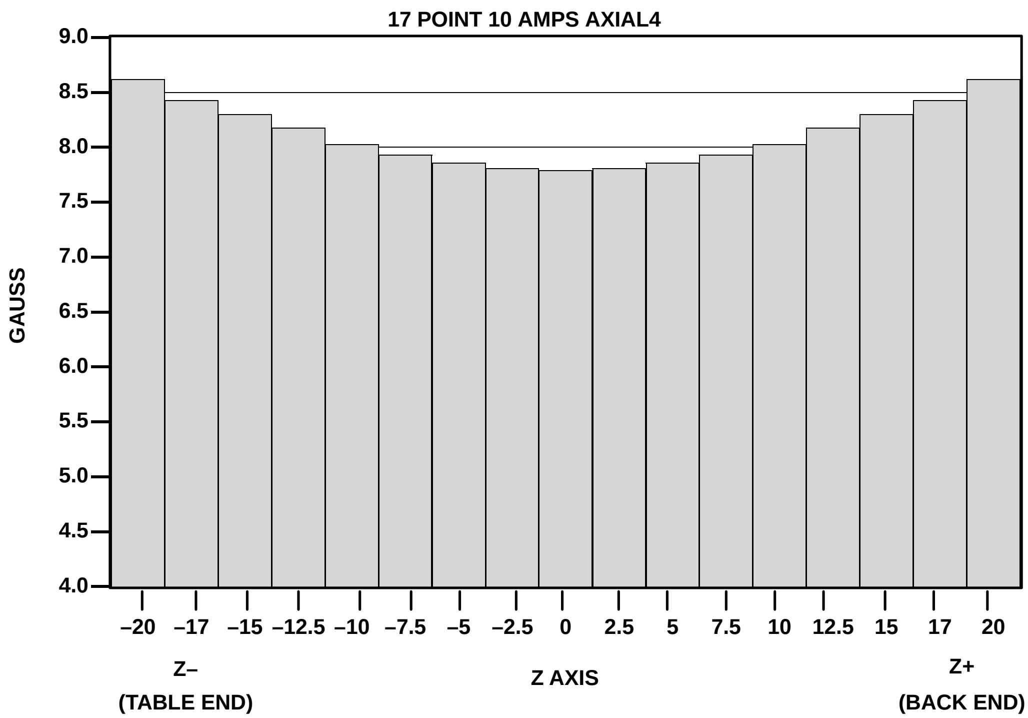




AXIAL 1 AND AXIAL 2 CORRECTION COIL PLOTS
ILLUSTRATION 12–1

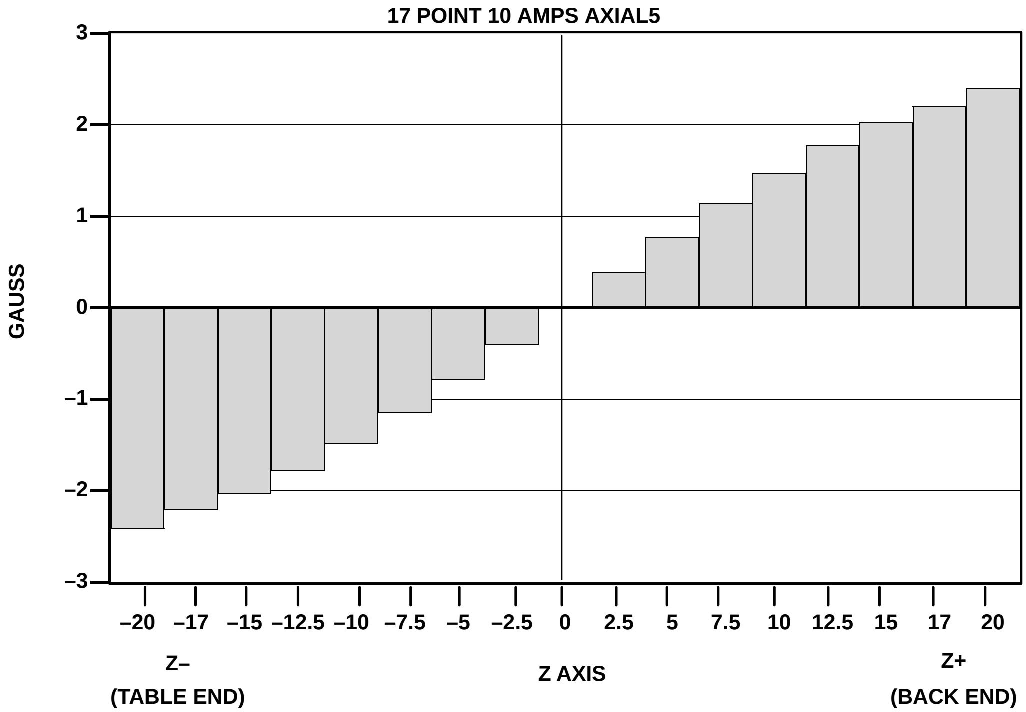
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.

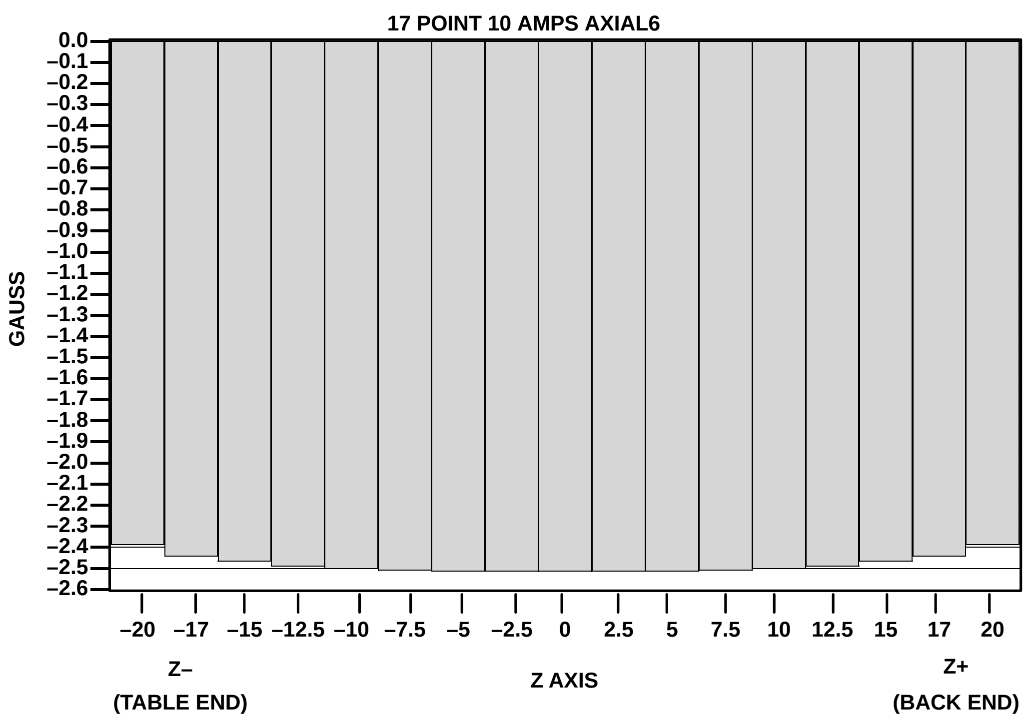




AXIAL 3 AND AXIAL 4 CORRECTION COIL PLOTS
ILLUSTRATION 12–2

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





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 and the T1–4 (C11–) supply to 6A.

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 +) and T1–4 (C11–) Power Supplies 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, 1 35, 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 O cm 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 **<u>differences</u>** with the plots in Illustrations 12–4 through 12–9.

Note

The lead connections for any individual coil could be reversed or could be interchanged with another coil. See Illustrations 12–10 and 12–11 for determining where wiring problems could occur.

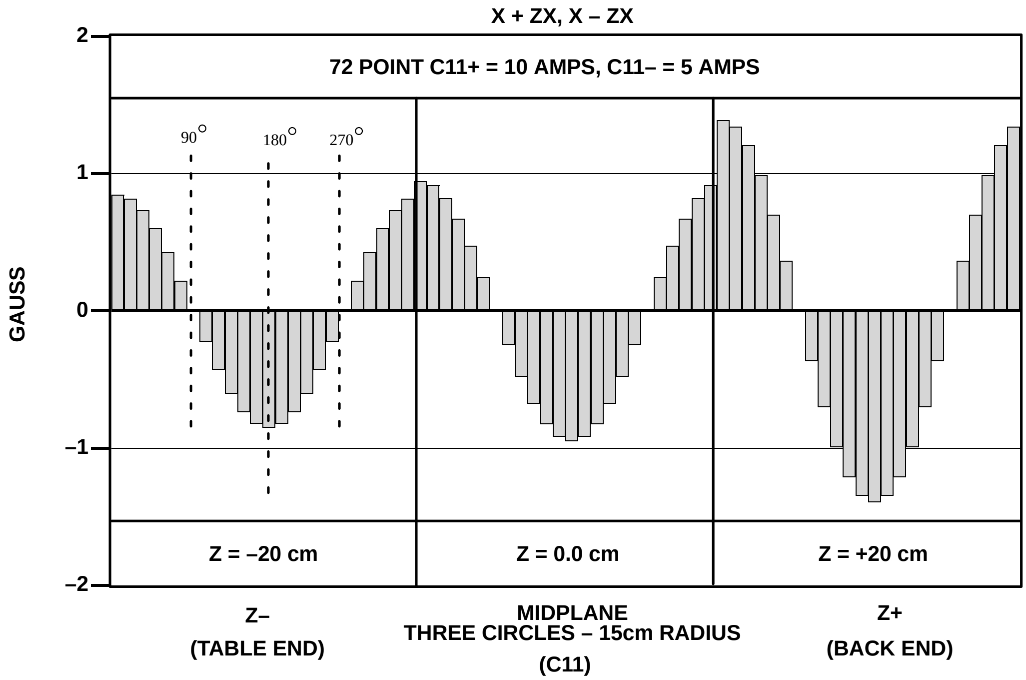
15. Turn on both the Axial and Transverse Switch Heaters and allow the heaters to warm up for 2 minutes.

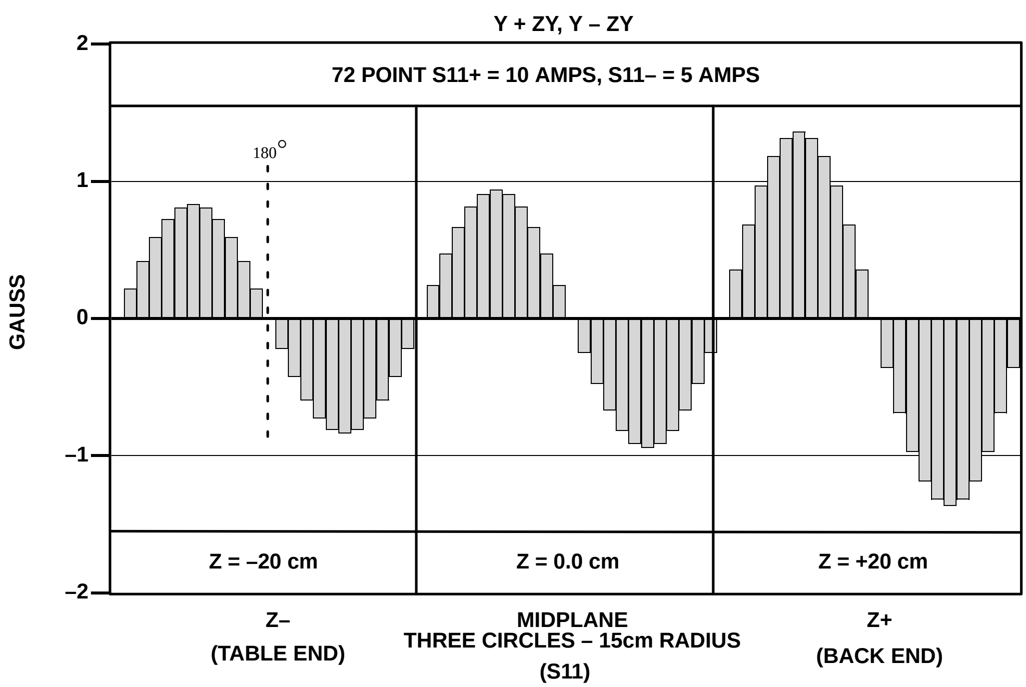
16. Repeat steps 8 – 15 for each of the Correction Coil configurations. Use the ampere values in Table 12–2.

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								
T1–2(C11+) = 10 AMPS	+20cm								
	0cm								
T1–4(C11–) = 5 AMPS	–20cm								
T2–2(S11+) = 10 AMPS	+20cm								
	0cm								
T2–4(S11–) = 5 AMPS	–20cm								
T1–3(C22+) = 10 AMPS	+20cm								
	0cm								
T1–5(C22–) = 5 AMPS	–20cm								
T2–3(S22+) = 10 AMPS	+20cm								
	0cm								
T2–5(S22–) = 5 AMPS	–20cm								
	+20cm								
T1–1(C31) = 10 AMPS	0cm								
	–20cm								
	+20cm								
T2–1(S31) = 10 AMPS	0cm								
	–20cm								
	+20cm								
T1–6(C33) = 10 AMPS	0cm								
	–20cm								
	+20cm								
T2–6(S33) = 10 AMPS	0cm								
	–20cm								

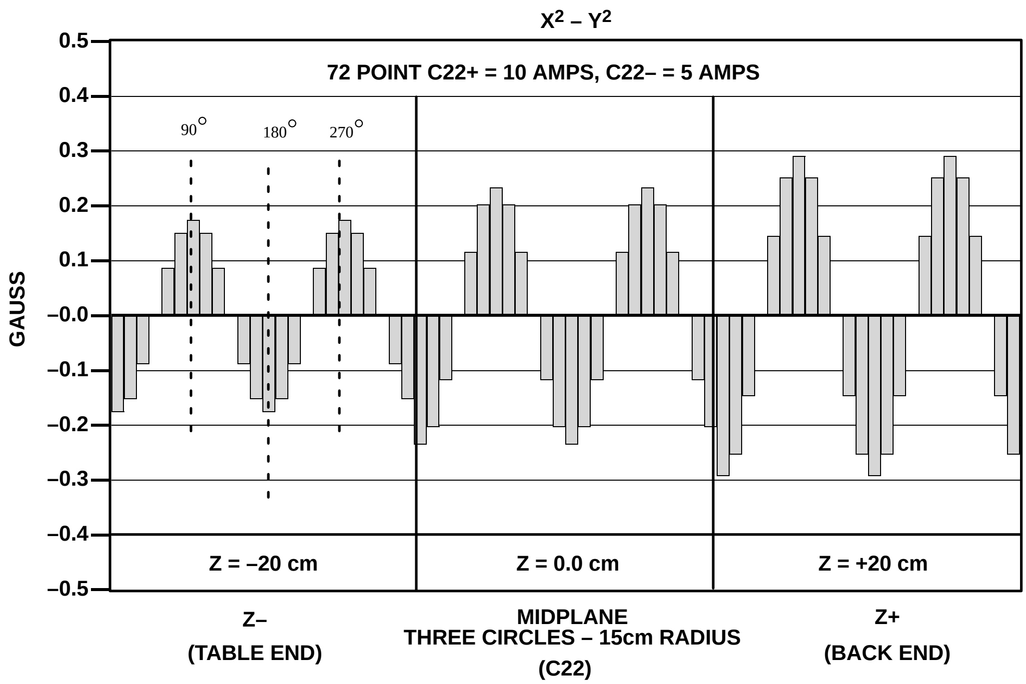
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.

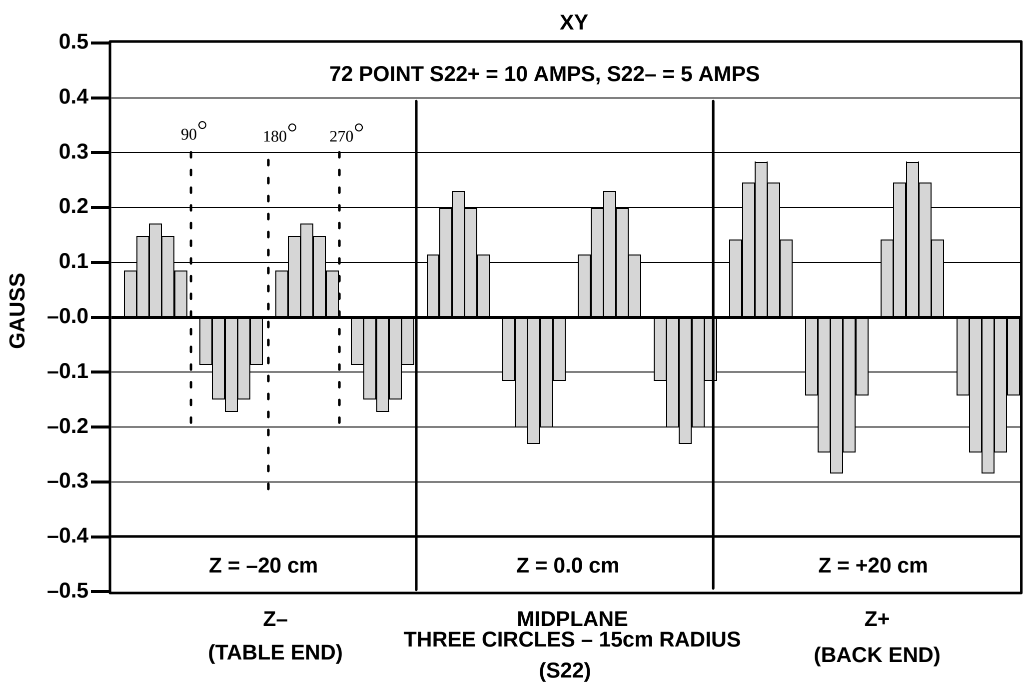




TRANSVERSE CORRECTION COIL PLOTS C11 AND S11
ILLUSTRATION 12–4

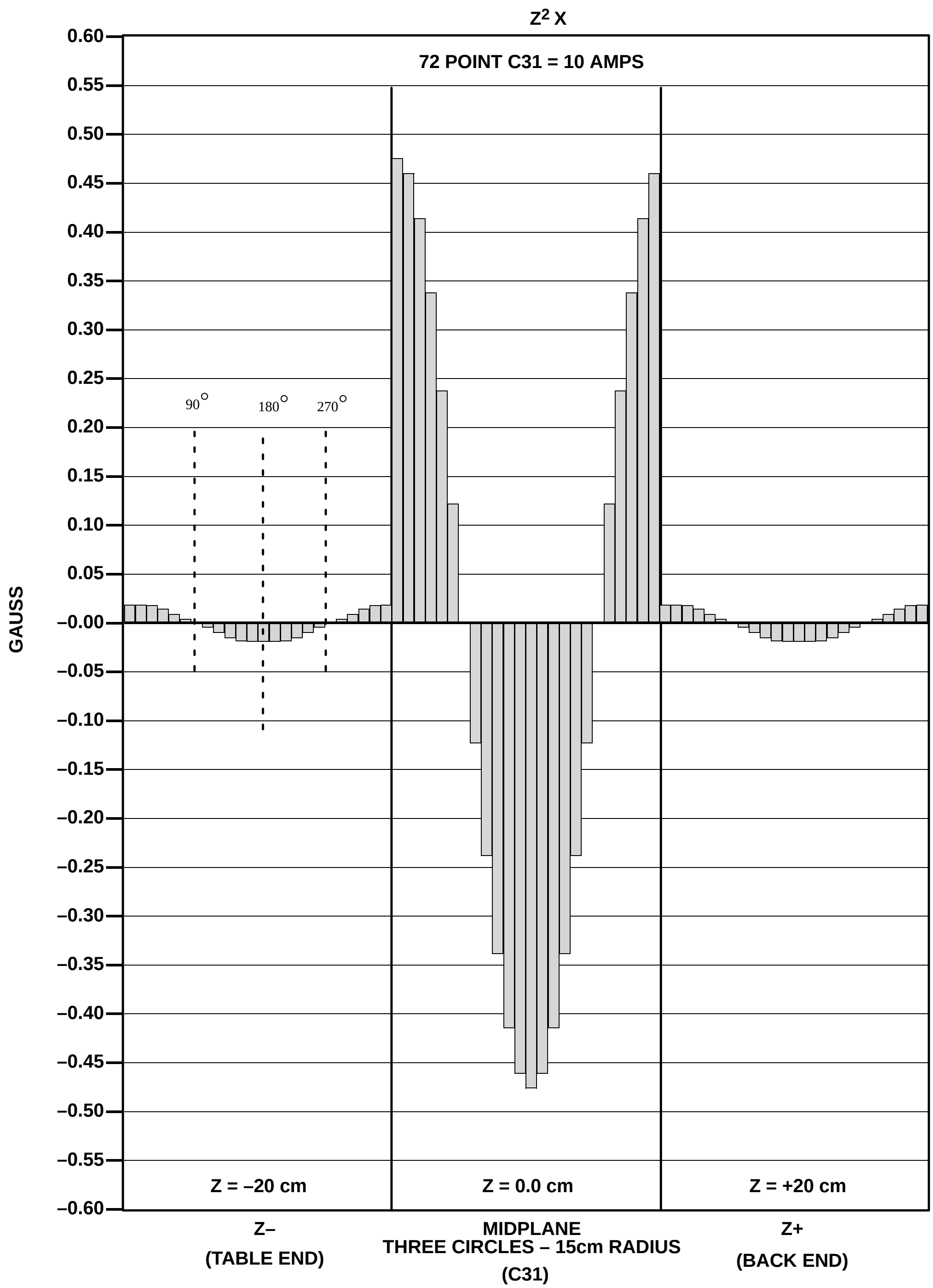
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.





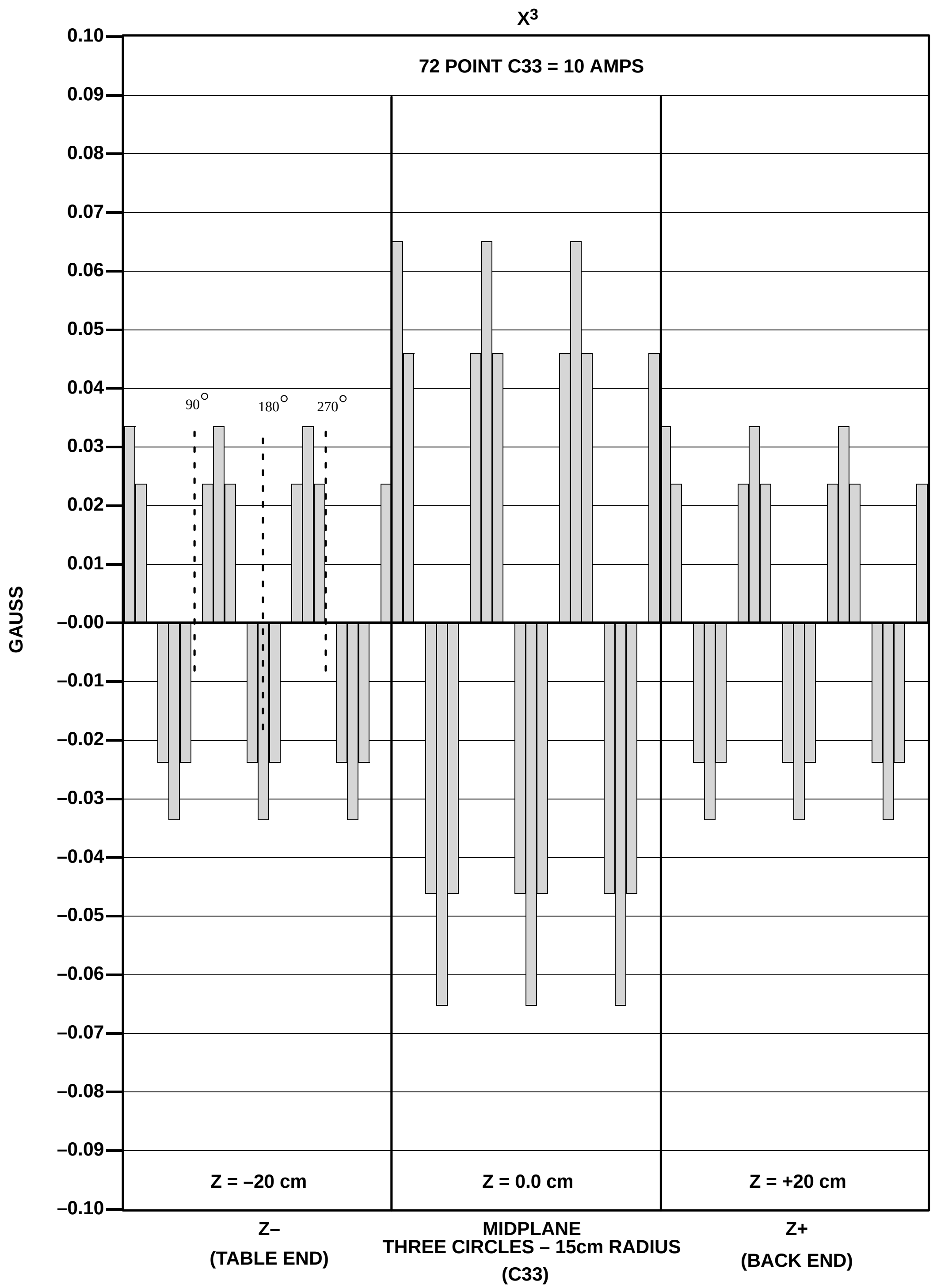
TRANSVERSE CORRECTION COIL PLOTS C22 AND S22
ILLUSTRATION 12–5

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



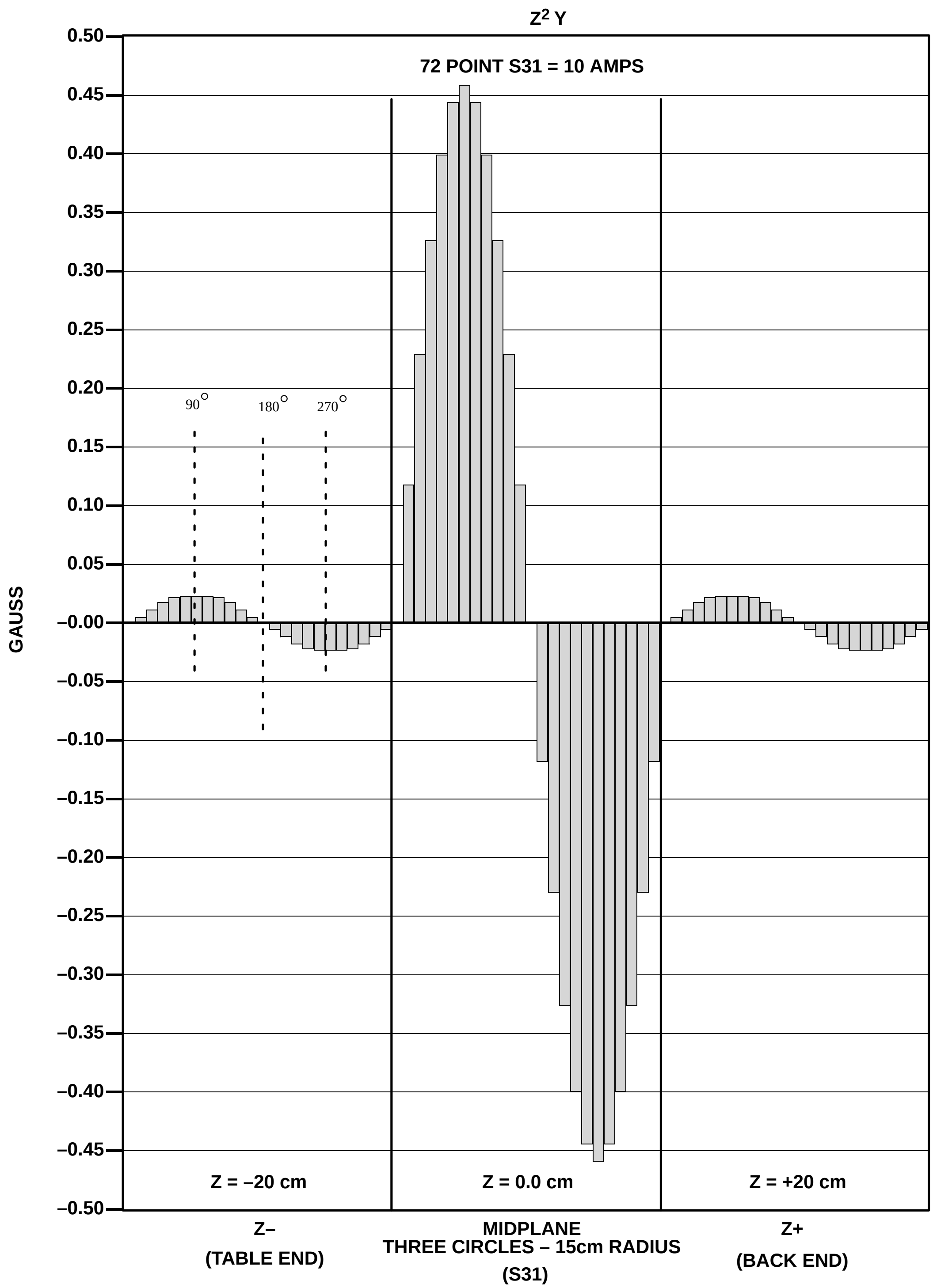
TRANSVERSE CORRECTION COIL PLOT C31
ILLUSTRATION 12–6

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



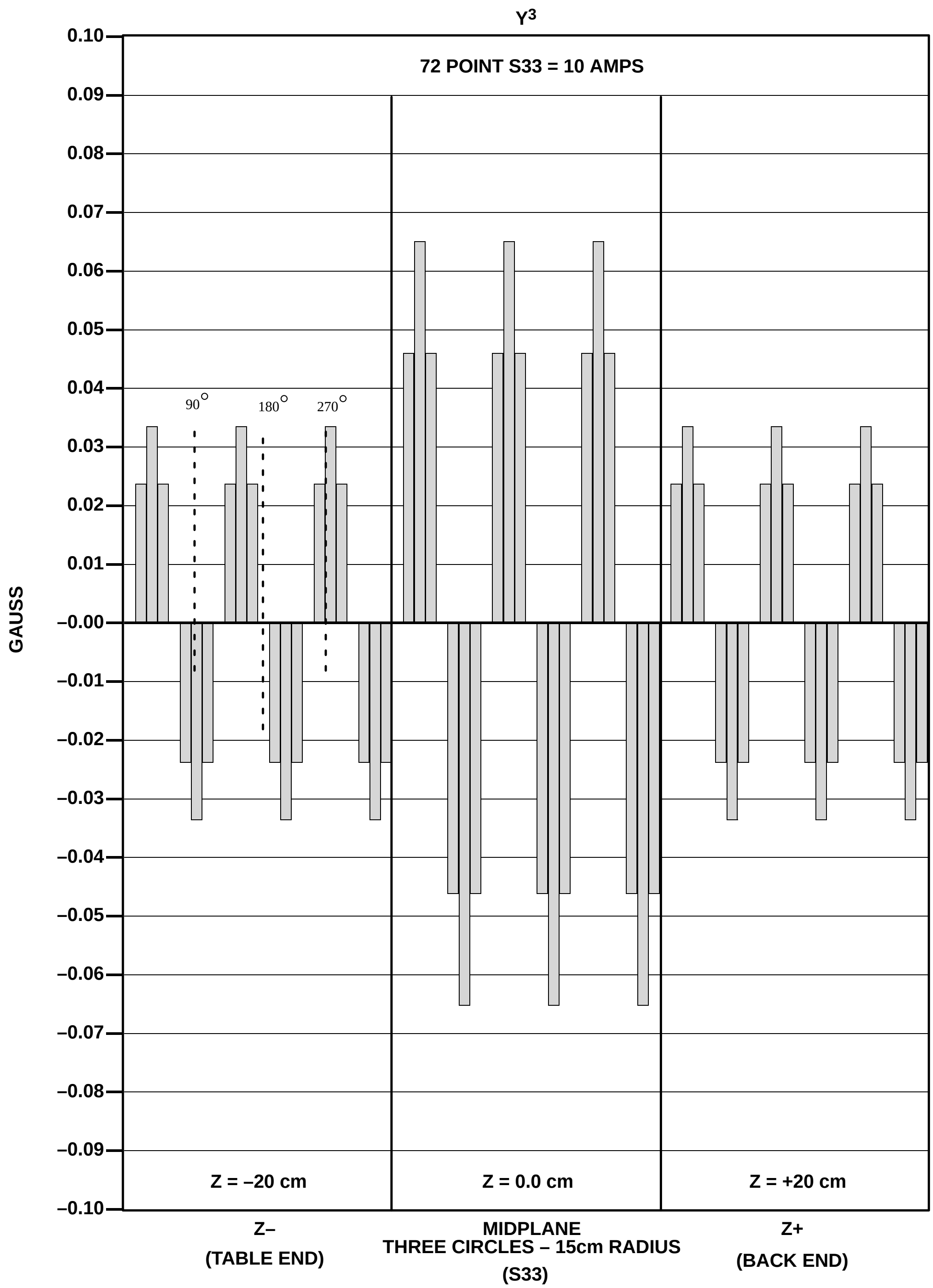
TRANSVERSE CORRECTION COIL PLOT C33
ILLUSTRATION 12–7

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



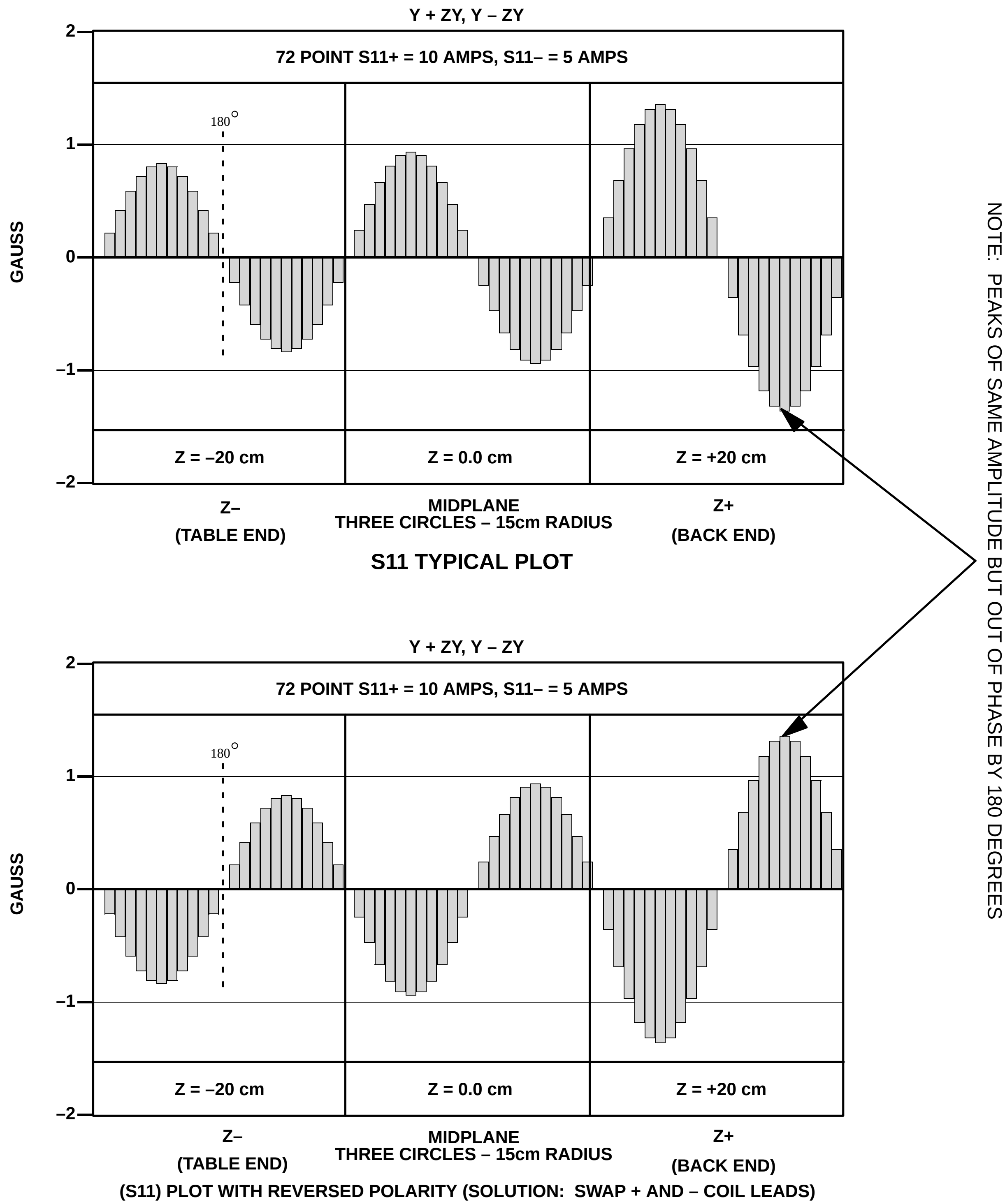
TRANSVERSE CORRECTION COIL PLOT S31
ILLUSTRATION 12–8

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



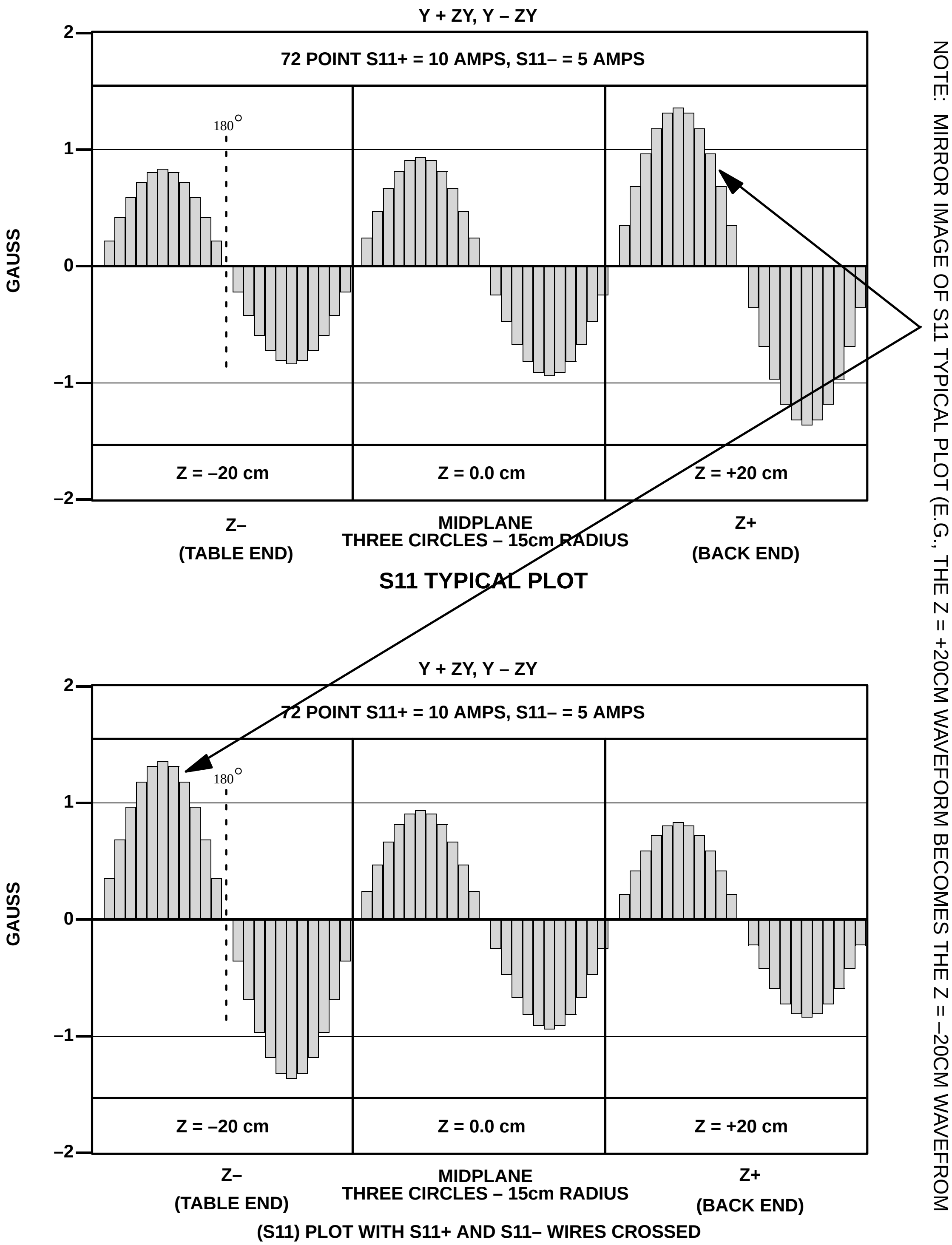
TRANSVERSE CORRECTION COIL PLOT S33
ILLUSTRATION 12–9

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



CORRECTION COIL WIRING PROBLEMS
ILLUSTRATION 12–10

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



CORRECTION COIL WIRING PROBLEMS
ILLUSTRATION 12–11

SECTION 13 – FIELD ADJUSTMENT AFTER SHIMMING

Description:

If the magnetic field is outside the range of 1.0T = 10025 Gauss +/– 5.0 Gauss (42682440 Hz +/– 21288 Hz) or 1.5T = 15000 Gauss +/– 7.5 Gauss (63864000 Hz +/– 31932 Hz) after performing “LVshim”, 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 8–1.
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. If resistance checks were not previously performed on ramping circuit, 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 8. (“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 Heaters 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 Main Heater Switch is stays 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 500A 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. Perform on or more of the bulleted steps below, as necessary, if the DVM voltage is greater than 150mV.

13–2 RESISTANCE CHECKS (continued)

- 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 12, 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 9 – 14.

14. Upon passing the internal resistance check, continue with Step 15.
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 750 Amps indicates acceptable system resistance. If the voltage exceeds 2.2V during the test, follow the procedures in Step 13 for adjusting contact resistance.
16. Upon passing Step 15, turn the CURRENT ADJUST controls and VOLTAGE control off (full CCW) and continue with the MAIN FIELD ADJUSTMENT procedure.

13–3 MAIN FIELD ADJUSTMENT

WARNING!

A MAGNET QUENCH CAN OCCUR 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 <u>MUST</u> 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 coldhead side of the magnet. Call the National Support Center if the two do not match.

1. Retrieve the Main Coil Connection Polarity and Parking Current in the DATA SHEET, Table 6–1.

Note

The Center Frequency will change by about 86 KHz per amp change for 1.5T and will change by about 57 KHz per amp change for 1.0T 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 1.
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 1 above.

13–3 MAIN FIELD ADJUSTMENT (continued)

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.

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. Remove Power Leads from magnet.

13–4 INPUT SHIM CURRENTS

1. Reconnect the Shim Power Supply to the magnet in conformance to SET UP AND CALIBRATION, Section 10–1.
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 15 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, frosting and ice in vertical penetration.

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. Disconnect the Main Power Leads, Volt Sense Leads and remove Main Power Lead Extensions on the top of the magnet. Immediately replace the caps onto the Magnet Ramp Ports.
17. 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).

18. 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.

FUNCTIONAL CHECKS

TABLE OF CONTENTS

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	1.0T = 10025 GAUSS +/– 5.0 GAUSS (42682440 Hz +/– 21288 Hz) 1.5T = 15000 GAUSS +/– 7.5 GAUSS (63864000 Hz +/– 31932 Hz)	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 @ 500A	< 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
INST LEAD FLOW (F2)	0.8 – 1.2 SCFH	NOTE: SPEC VALUES ARE
SHIM LEAD FLOW (F1)	1.8 – 2.2 SCFH	STEADY STATE AFTER
BOIL–OFF	< 0.18 LITER/Hr. (AVERAGE) [1]	PASSING LEAK CHECK
HELIUM LEVEL	90% FOR RAMP UP, RAMP DOWN OR FIELD ADJUSTMENT 42% MINIMUM [2] SHIM 75%	BEFORE RAMP UP, RAMP DOWN, FIELD ADJUSTMENT BEFORE REFILL
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 CHECK ATR FOR READINGS

Notes

1. Customer data sheets indicate boil–off specification is < 0.14 L/hr. This spec. is achieved by using a wetcell flowmeter. The calculated average boil–off will be higher than spec. when using the capacity table and helium meter readings to approximate boil–off values.
2. LHe values are cryogen monitor readings. See Volumetric Conversion Chart / Curve in Data Sheets, Sections 5–1 and 5–2 for vloume conversions.

SECTION 2 – 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 2 – 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 3 – 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)		CONNECTOR	PIN #	RESISTANCE (OHMS)	
			TYPICAL	MEASURED			TYPICAL	MEASURED
MAIN COIL	MAIN COIL POWER LUGS OR J5–1	+ – 9, 10	< 6 OHMS					
SUPERCONDUCTING SHIM COILS	CANNON (P1–A) ON SHIM LEAD				PIGTAIL CONNECTORS P2 AND P2W			
Z1		1, 19	0.3 – 0.5		P2	A, * (K, L)	0.3 – 0.6	
Z2		2, 20	0.3 – 0.5		P2W	A, (K, L)	0.3 – 0.6	
Z3		3, 21	0.3 – 0.5		P2	B, (M, N)	0.3 – 0.6	
Z4		4, 22	0.3 – 0.5		P2W	B, (M, N)	0.3 – 0.6	
Z5		5, 23	0.3 – 0.5		P2	C, P	0.3 – 0.6	
Z6		6, 24	0.3 – 0.5		P2W	C, P	0.3 – 0.6	
C11 +		16, 19	0.3 – 0.5		P2	F, (K, L)	0.3 – 0.6	
C11 –		17, 20	0.3 – 0.5		P2W	F, (K, L)	0.3 – 0.6	
C22 +		14, 21	0.3 – 0.5		P2	G, (M, N)	0.3 – 0.6	
C22 –		15, 22	0.3 – 0.5		P2W	G, (M, N)	0.3 – 0.6	
S11 +		9, 19	0.3 – 0.5		P2	H, (K, L)	0.3 – 0.6	
S11 –		10, 20	0.3 – 0.5		P2W	H, (K, L)	0.3 – 0.6	
S22 +		7, 21	0.3 – 0.5		P2	J, (M, N)	0.3 – 0.6	
S22 –		8, 22	0.3 – 0.5		P2W	J, (M, N)	0.3 – 0.6	
C31		13, 23	0.3 – 0.5		P2	D, P	0.3 – 0.6	
S31		11, 23	0.3 – 0.5		P2	E, P	0.3 – 0.6	
C33		18, 24	0.3 – 0.5		P2W	D, P	0.3 – 0.6	
S33		12, 24	0.3 – 0.5		P2W	E, P	0.3 – 0.6	
SUPERCONDUCTING SWITCH HEATERS MAIN SWITCH	J5–1 & J5–2 ON SHIM LEAD (MS1–A3, A1)	1, 2	22 – 27					
AXIAL SHIMS		5, 6	27 – 33					
TRANSVERSE 1		7, 6	8 – 10					
TRANSVERSE 2		8, 6	8 – 10					

SECTION 4 – 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 – 4 CRYOSTAT VACUUM CHECK (continued)

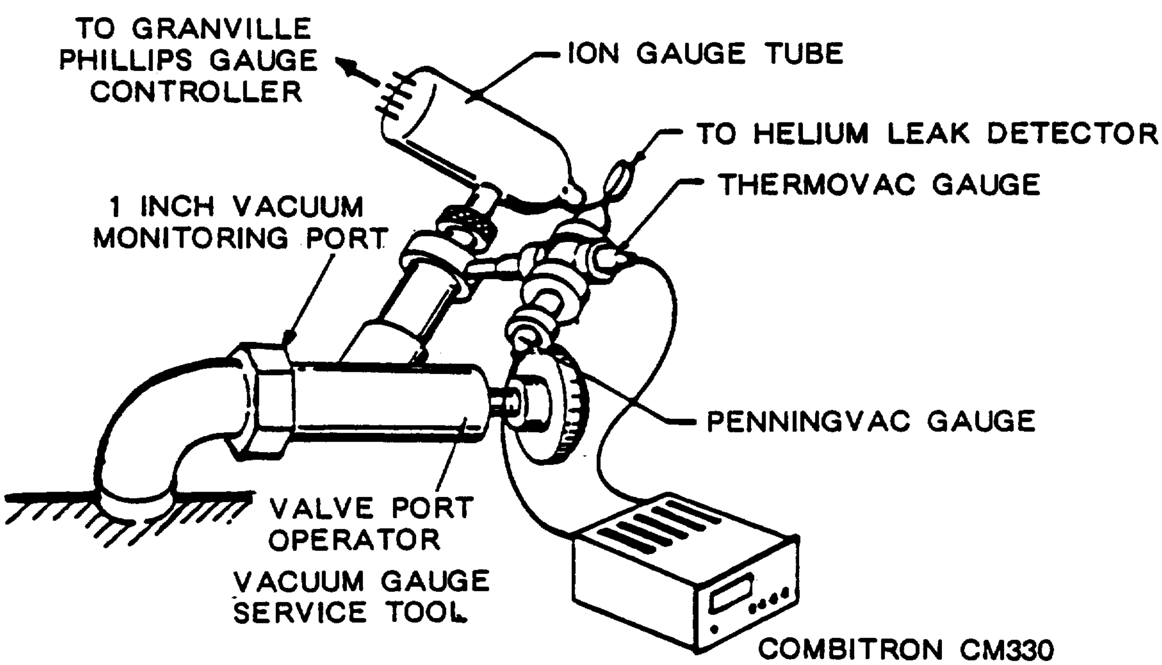
8. Turn on Gauge Controller power and thermocouple. Record reading __________Torr.

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, $< 1 \times 10^{-6}$ 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 5 – 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 3 for Main Switch Heaters continuity check.

SECTION 6 – CRYOGEN BOIL–OFF RATE

1. An instantaneous boil off rate can be estimated, within an order of magnitude, 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, Section 1, Illustration 1–2.

2. A more accurate, time averaged boiling rate is obtained by calculating helium boiling off rate, at periodic refill intervals, in DATA SHEETS, Section 3 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.

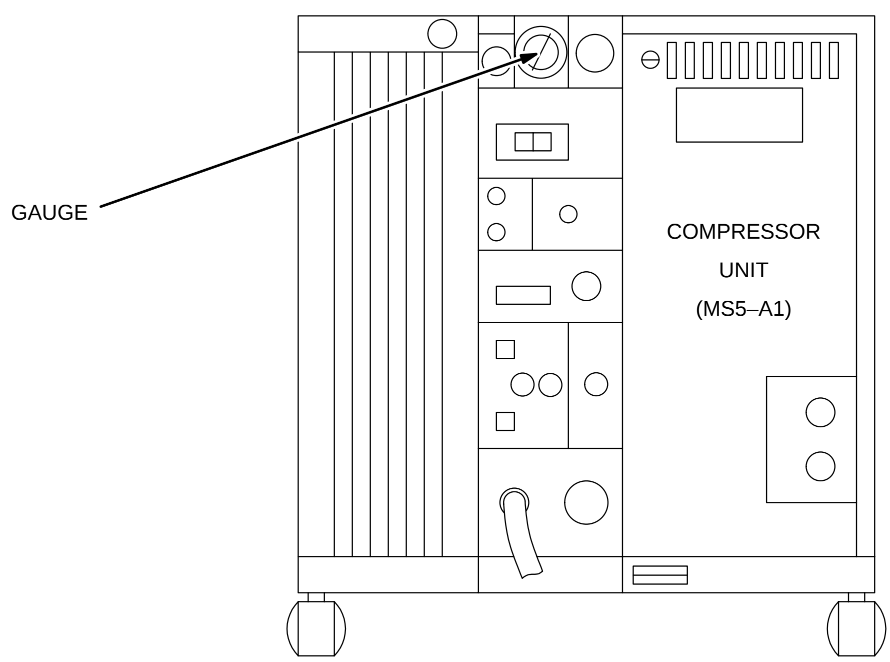
SECTION 7 – SHIELD COOLER CHECKS

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 7 – 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 NO TAG (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 NO TAG.

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 8 – 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 90% 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 8 – MAGNET QUENCHES (continued)

QUENCH RECOVERY

REPORT ALL QUENCHES TO YOUR MAC TEAM REPRESENTATIVE.

1. Check and replace Burst Disc (46–252838P7) and gaskets (46–252839P2) immediately.

2. Order and replace LHe as soon as possible.

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. Inspect Ventglas (46–281971P2) and replace if damaged.

5. Order and replace Baffle Assembly (2133618) if baffles are disintegrated. Replace and return Shim Lead Assembly(2148084) 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 9 – THERMAL ACOUSTIC OSCILLATION (TAO) CHECKS

Description:
The functional checks / settings described below are performed to establish the level of TAO's in the shim lead and minimize them.

The checks / settings should be performed as part of troubleshooting for excessive boil–off.

Required Equipment:

* TAO Monitor – 46–281406G1
* Adapter Tool – 46–281232G2
* Oscilloscope or Digital Voltmeter (DVM)

Procedure:

WARNING!

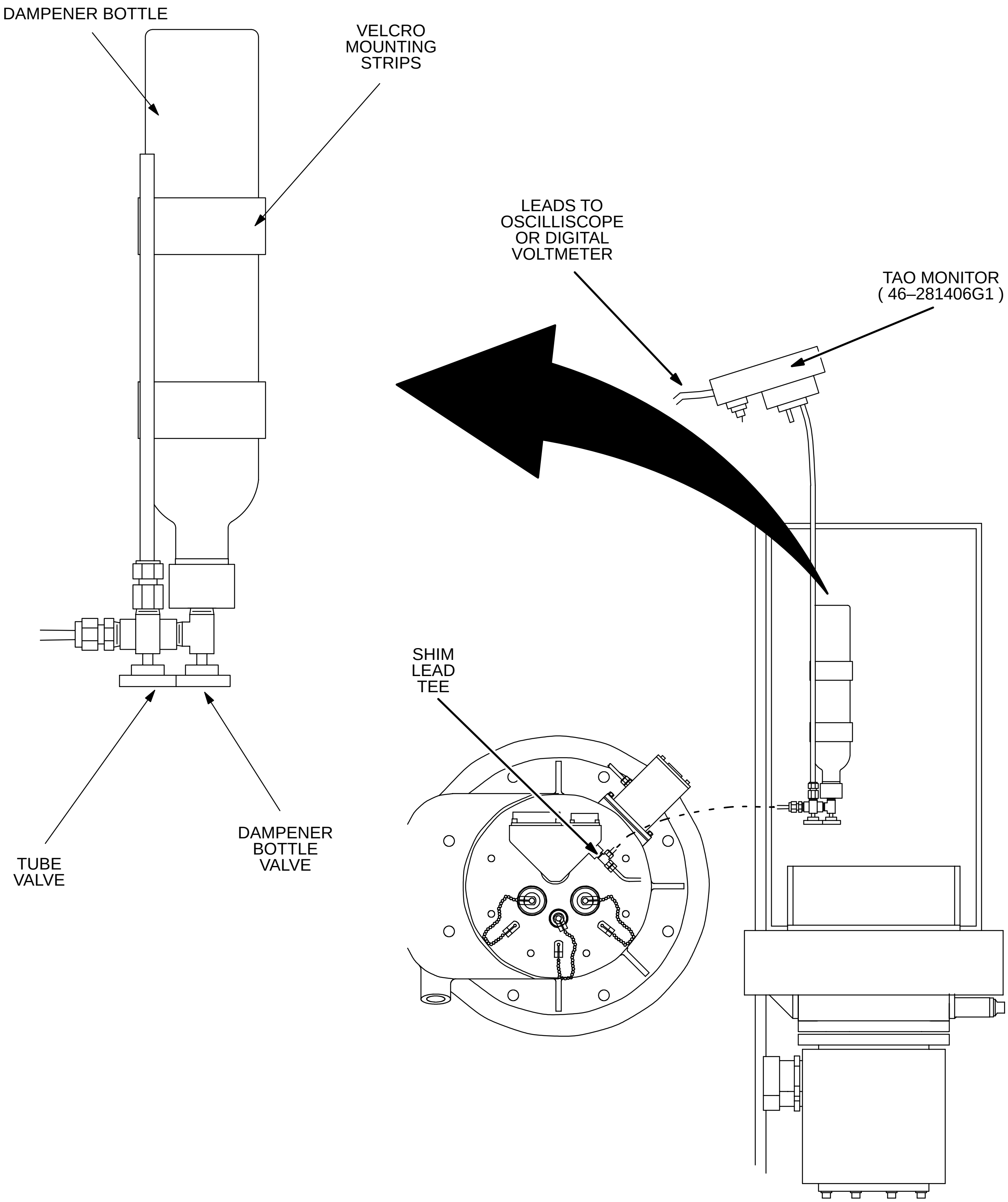
DO NOT BRING AN OSCILLOSCOPE INTO THE MAGNET ROOM, IF THE MAGNET IS RAMPED, TO PREVENT SCOPE MALFUNCTION AND BEING ATTRACTED INTO THE MAGNET.

1. Vent cryostat pressure to 0.5 psig and allow pressure to stabilize if cryostat pressure is above 0.5 psig.
2. Connect TAO monitor to poly tube off dampener bottle. See Illustration 9–1.
3. Connect TAO monitor leads to oscilloscope or DVM. Set oscilloscope scale to 10 mV / cm or DVM scale to 260 mV AC.
4. Slowly open tube valve and monitor signal amplitude on scope / meter. Peak to peak signal should have an amplitude less than 175 mV.
5. Adjust valve on dampener bottle gradually clockwise / counterclockwise to minimize signal amplitude.

Note

TAO's can be checked on magnets without thermal acoustic oscillation kits by removing the cap at the shim lead tee and connecting the adapter tool. If TAO's exceed 175 mV, peak to peak signal, a Thermal Acoustic Oscillation Kit (2195558) can be ordered and mounted as shown in Illustration 9–1.

9–0 THERMAL ACOUSTIC OSCILLATION (TAO) CHECKS (continued)



THERMAL ACOUSTIC OSCILLATION (TAO) CHECKS
ILLUSTRATION 9–1

REPLACEMENT / MAINTENANCE

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

SECTION 1 – ICE REMOVAL

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE <u>SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS</u> SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE <u>SAFETY CHECKLIST</u> SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

Description:

Ice Plugs can form in the Instrumentation Lead Assembly, Shim Lead Assembly, Fill Port or Gas Plumbing. Ice formation can be caused by the cryopumping of air entering through a ruptured Burst Disc, open Cryogen Fill / Vent Ports or a leak at plumbing joints or fittings. The method of ice plug removal is dependent on the location of the plug and is very “technique” sensitive. Read and understand the following precautions before performing this procedure.

- Maintain a positive pressure inside the Cryostat at all times during this procedure to minimize the cryopumping of air.
- Keep all valves closed in strict accordance with this procedure.
- Insertion devices (snakes, tubing...) rapidly lose flexibility and may become extremely brittle when exposed to extremely low temperatures. Avoid excessive force, twisting or straining of insertion devices and keep insertion devices in motion until seated.
- Do not insert devices into the Vertical Penetration deeper than 22 inches (559mm).

Improper performance of the following procedures can result in more severe problems (ice blocks relocated deeper in the system, broken Insertion devices stuck in the system).

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 PROCEDURES. WEAR NON ABSORBENT GLOVES AND GOGGLES OR FACE SHIELD WHEN PERFORMING THESE PROCEDURES.

MAKE SURE 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 PENETRATION.

1–1 BLOCK IN 1/4 INCH EXHAUST SYSTEM

Note

A block in the 1/4 Inch Exhaust System, indicated by no gas flow through Flowmeter(s) F1 and/or F2 may occur between the Vertical Stack and the Flowmeters or between the Flowmeters and the Vent Adapter. See Illustration 1–1.

1. Slowly open Vent Valve (V2 and vent the Cryostat until the internal pressure is less than 0.3 psi. Close V2.

Note

Inability to vent the Cryostat indicates that a block is also in the 1/2 inch plumbing. Go to Section 1–2, “BLOCK IN 1/2 INCH PLUMBING”.

2. Remove the 1/4 inch Exhaust Plumbing between the Flowmeters and the Vent Adapter.

3. Observe the Flowmeters.

Note

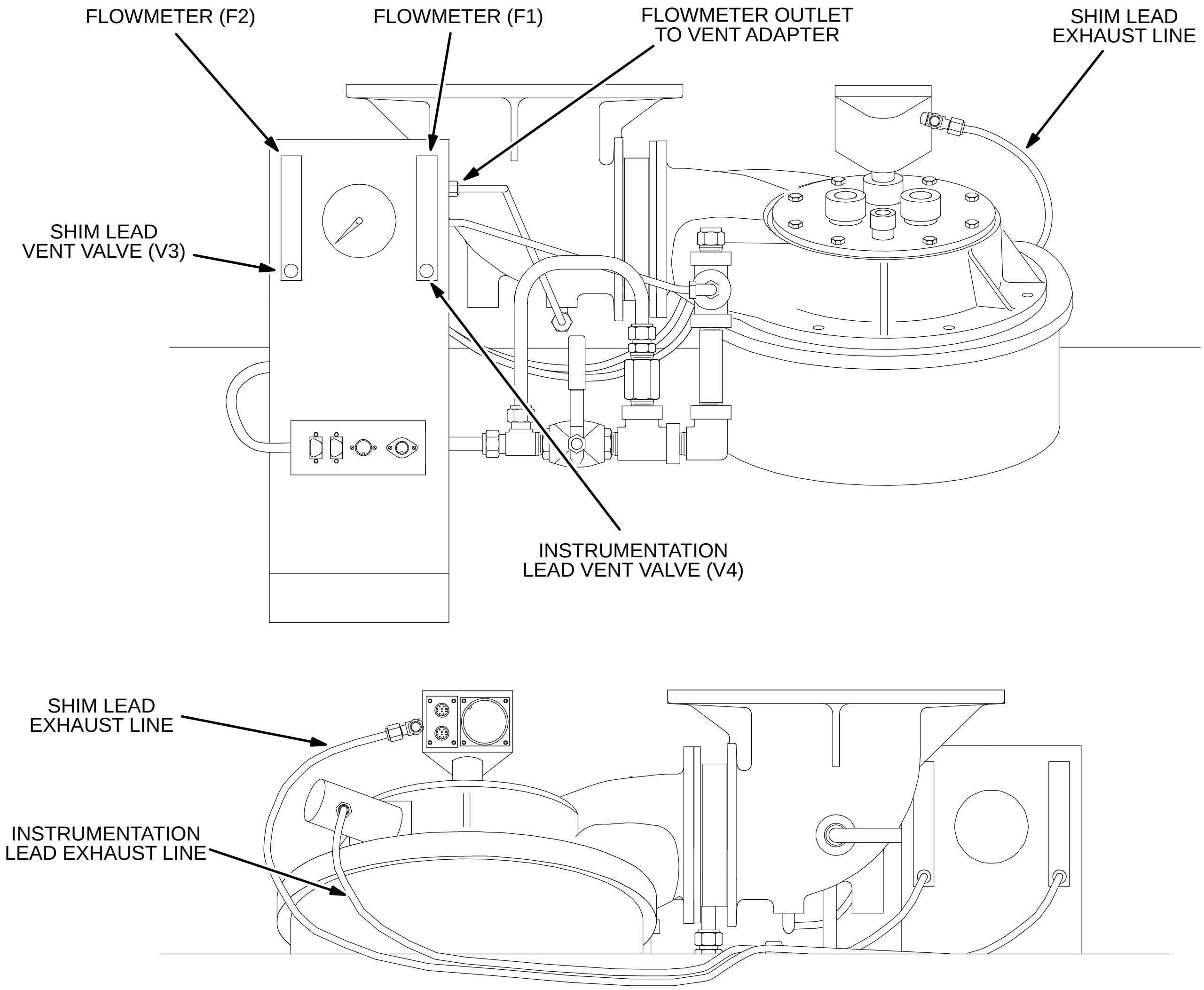
If sufficient flow exists in both Flowmeters, the block is in the removed plumbing. If sufficient flow does not exist in both flow meters, the block is further back toward the Vertical Stack.

4. If the block is in the removed line, take it out of the Exam Room and thaw it with a heat gun. Blow dry, compressed air through the line. If the line is not blocked, reconnect it to the Exhaust System.

Note

If flow is restored in Step 4, go to Step 12. If not, perform Steps 5 and 6 on one section of plumbing at a time.

1–1 BLOCK IN 1/4 INCH EXHAUST SYSTEM (continued)



1/4 INCH EXHAUST PLUMBING
ILLUSTRATION 1–1

5. If the block is further back toward Vertical Stack, remove the section of plumbing that is blocked and cap the port at the Vertical Stack with the 1/4 inch cap (46– 260284P1) provided in the magnet Field Spare Parts Kit.

6. Take the section of removed plumbing out of the Exam Room and thaw it with a heat gun. Blow dry, compressed air through it.

Note

If sufficient flow is established in both Flowmeters (ice block removed), go to Step 12. If flow is not established in F1, the block is in the Instrumentation Lead Assembly; go to Step 7. If flow is not established in F2, the block is in the Shim Lead Assembly; go to Step 10.

7. If no flow exists in F1, disconnect the plumbing to F1 at the Instrumentation Lead Flow Outlet. See Illustration 1–1.

1–1 BLOCK IN 1/4 INCH EXHAUST SYSTEM (continued)

8. Insert a non ferromagnetic snake or rod = 1/8 inch (3mm) diameter into the Flow Outlet of the Vertical Stack.

Note

If the snake penetrates greater than 1 inch (25.4mm) the outlet is clear and the Service Turret will have to be removed according to REPLACEMENT/MAINTENANCE, Section 7 to clear the block from the Instrumentation Lead Assembly. If the snake penetration is less than 1 inch (25.4mm) the block is in the Instrumentation Lead Flow Outlet and Step 9 must be performed.

9. Insert a heated insertion tool, used in Step 8, into the Flow Outlet and carefully chip the ice block with a pushing/twisting motion. Repeated heating and insertion may be necessary. Wipe moisture from insertion tool before reinsertions.

Note

When ice block is removed, cold helium gas should be observed expelling from the Instrumentation Lead Flow Outlet. If Step 9 does not restore flow, the Service Turret will have to be removed according to REPLACEMENT/MAINTENANCE, Section 7 to clear the block from the Instrumentation Lead Assembly. If flow is restored, go to Step 8 in Section 1–2.

10. If no flow exists in F2, remove the Shim Lead Assembly in conformance with REPLACEMENT/MAINTENANCE, Section 5.

11. Remove Shim Lead Assembly from Exam Room and thaw. Reassemble in conformance with REPLACEMENT/MAINTENANCE, Section 5.

12. When flow is restored, remove protective cap, if applied and reconnect and leak test all Exhaust Plumbing.

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).

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

Note

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

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

15. 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.

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

17. 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.

1–1 BLOCK IN 1/4 INCH EXHAUST SYSTEM (continued)

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

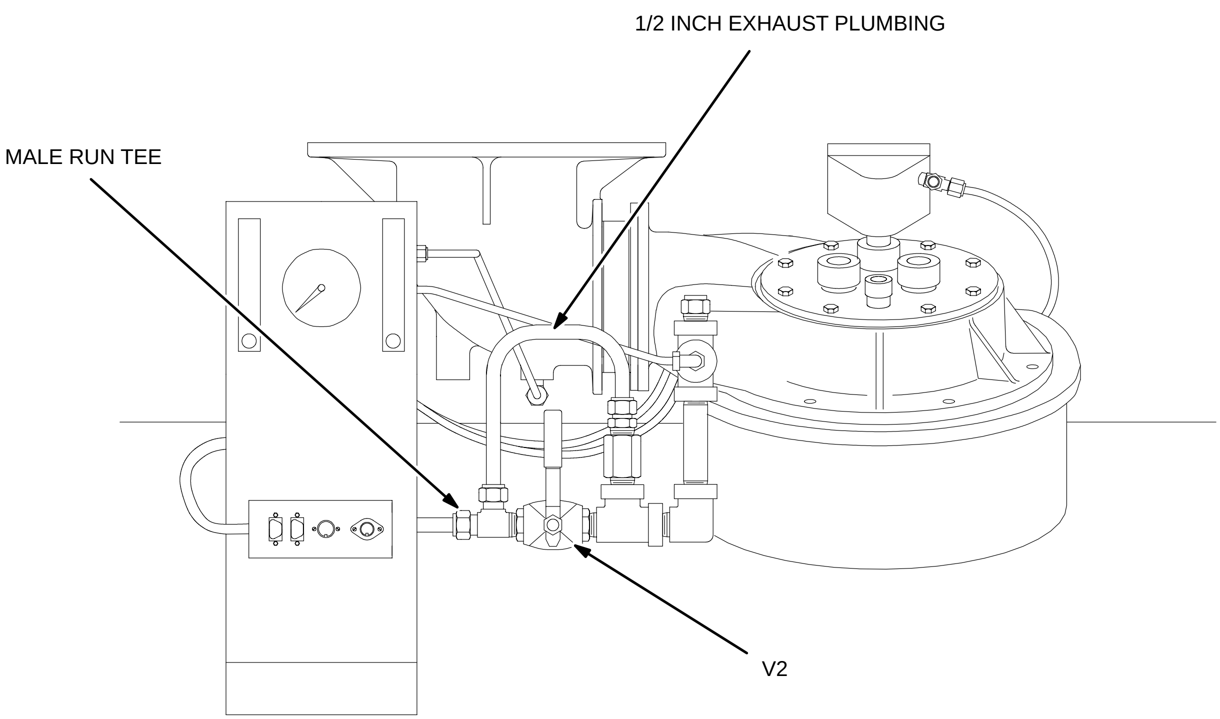
    INSTRUMENTATION FLOWMETER (F2) = 0.8 – 1.2 SCFH
    SHIM LEAD FLOWMETER (F1) = 1.8 – 2.2 SCFH
    CRYOSTAT GAUGE PRESSURE = 0.25 – 0.50 psig

1–2 BLOCK IN 1/2 INCH HELIUM VENT SYSTEM

Note

An ice block in the Helium Vent System, indicated by no internal pressure drop when the Vent Valve (V2) is opened, may occur in the plumbing between the Turret Assembly and the Check Valve and Vent Valve, or in the plumbing between the Vent Valve and the Vent Adapter.

1. Make sure Vent Valve (V2) is closed. Disconnect plumbing at the Male Run Tee as shown in Illustration 1–2 then slowly open V2.
2. Check for gas flow from Male Run Tee where plumbing is disconnected. Close V2.



MAGNET PLUMBING SIDE VIEW
ILLUSTRATION 1–2

Note

If gas flow is present, the block in the plumbing is removed; go to Step 3. If flow is not present, go to Step 5.

1–2 BLOCK IN 1/2 INCH HELIUM VENT SYSTEM (continued)

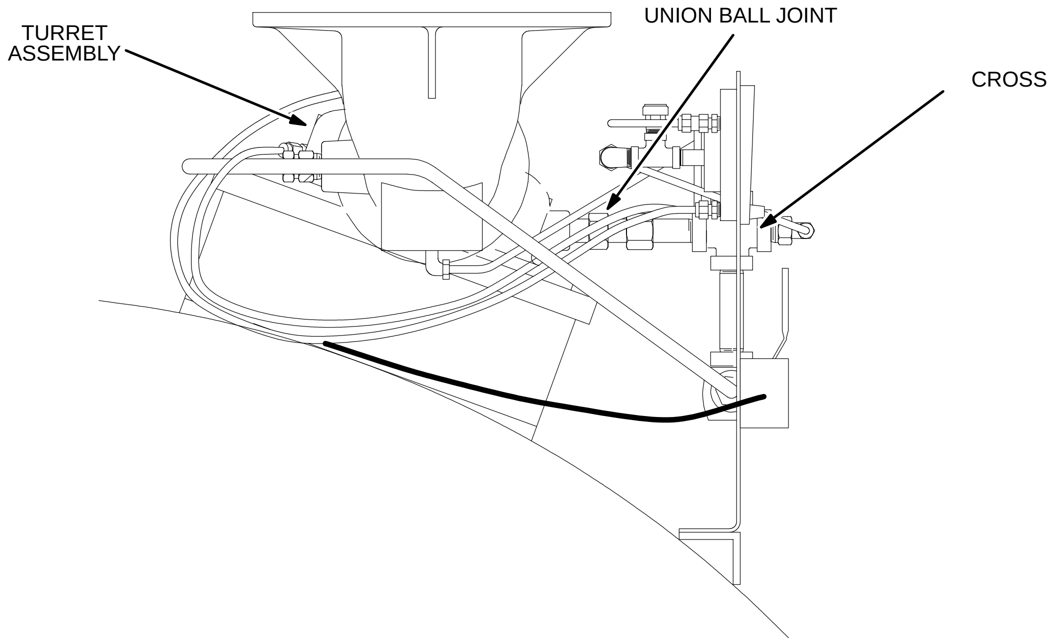
3. Disconnect the remaining end of the plumbing at the Vent Adapter, remove the line from the exam room and thaw with a heat gun. Blow dry, compressed air through the line until no moisture is visible from the other end.

4. Clean threads on all fittings. Wrap with Teflon Tape and reinstall plumbing.

Note

Once flow is restored, go to Step 8.

5. Loosen Cap at Turret Assembly. See Illustration 1–3. If flow exists, block is in plumbing between the Cross, Check Valve and Vent Valve.



MAGNET PLUMBING END VIEW
ILLUSTRATION 1–3

6. Detach the entire 1/2 inch Plumbing Assembly and remove from the exam room and thaw with a heat gun. Blow dry, compressed air through the Plumbing Assembly from the Turret Assembly end; first with V2 open, then with V2 closed.

7. When no moisture is observed with V2 in either position, clean threads on all fittings. Wrap with Teflon Tape and reinstall Plumbing Assembly. Make sure V2 is closed.

1–2 BLOCK IN 1/2 INCH HELIUM VENT SYSTEM (continued)

Note
Once flow is restored, go to Step 8.

8. Bubble leak test all plumbing.

CAUTION

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

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

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

10. Set INSTRUMENTATION Flowmeter (F2) between 0.8 – 1.2 SCFH.
11. Set SHIM LEAD Flowmeter (F1) between 1.8 – 2.2 SCFH to maintain a Cryostat Pressure Gauge reading between 0.25 – 0.50 psig.
12. Make sure flow rate through F2 is equal to or greater than 0.8 SCFH.
13. 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.
14. Make sure the following conditions are maintained. Re–check 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

1–3 SHIM LEAD CONNECTOR DEICING

1–3–1 DESCRIPTION:

When resistance measurements of the magnet’s electrical circuits are done and the resistance readings are open or intermittent it is usually due to icing in the P100 magnet connector.

The condition is corrected either by 1. Unseating and reseating the shim lead 2. Total removal of the shim lead and cleaning the vertical penetration with GHe (gaseous helium) or 3. Blowing gaseous helium through shim lead tee.

1–3 SHIM LEAD CONNECTOR DEICING (continued)

1–3–2 TOOLS NEEDED:

- Small quantity of GHe (135 cubic feet) needs to be available on site at the time of magnet delivery.
- 9/16 – 7/16 wrench.
- 3/4 inch outer diameter x 8 inch long copper or steel pipe
- Tubing to attach to the pipe from the gaseous helium cylinder.

1–3–3 PROCEDURE:

1. Disengage shim lead and re–engage. If not successful go to Step 2
2. Use Helium Cylinder and tubing, blow gas through shim lead tee. If not successful go to Step 3.
3. Remove fill port cap and insert lead pipe to blow Helium gas on P100 connector.
4. Continue applying gas for 3 minutes then remove pipe and close fill port with cap.
5. Engage shim lead and conduct resistance readings.

SECTION 2 – MAGNET RAMPDOWN (DECREASE TO ZERO)

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE SAFETY CHECKLIST SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

WARNING!

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

POWER SUPPLIES MUST BE LOCATED OUTSIDE THE EXAM ROOM TO RAMP DOWN THE MAGNET.

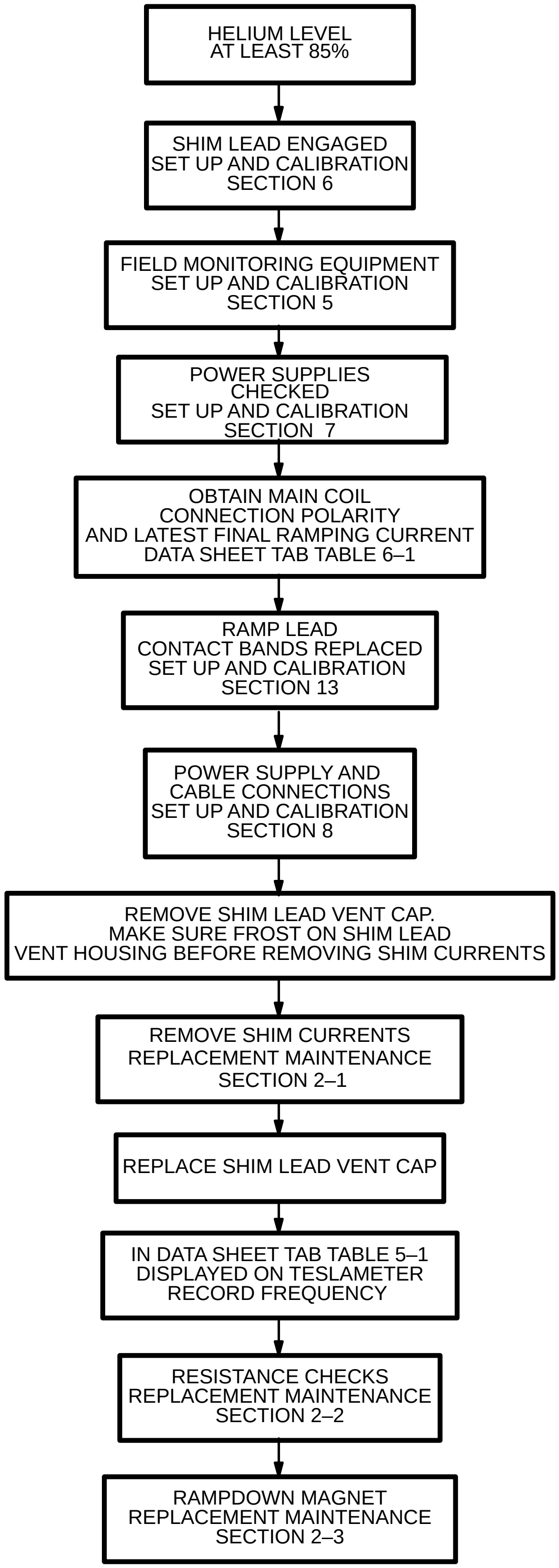
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN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

MAKE SURE 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.

METAL OBJECTS CAN BECOME DANGEROUS PROJECTILES IN A MAGNETIC FIELD.

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 THAT INPUT POWER TO THE MAIN POWER SUPPLY IS DISCONNECTED WHEN CONNECTING MAIN POWER LEADS AND THAT THE POSITIVE AND NEGATIVE POWER LUGS DO NOT CONNECT TO EACH OTHER.



RAMPDOWN FLOWCHART
ILLUSTRATION 2–1

2–1 PREPARATION FOR RAMP DOWN

Note
The Rampdown procedure requires approximately 5 hours to complete.

"Top" fill the magnet to at least 85% helium level before continuing with this procedure.

Make sure Shim Lead Assembly is "Engaged" in conformance with SET UP AND CALIBRATION, Section NO TAG. If the Shim Lead Assembly cannot be "Engaged", the magnet can be ramped down with the Auxiliary Rampdown Cable as shown in SCHEMATICS/INTERCONNECTS, Illustration NO TAG.

Set up the field monitoring equipment Probe and Teslameter in conformance with SET UP AND CALIBRATION, Section NO TAG.

Perform Ramp Power Supply checks in conformance with SET UP AND CALIBRATION, Section NO TAG. Verify Shim Supply Heater currents are set at 810 mA ± 10 mA.

Make sure that the Input Power Cables for the Power Supplies are disconnected.

Replace the Ramp Lead Contact Bands in conformance to REPLACEMENT/MAINTENANCE, Section 13.

Connect the Shim Power Supply to the magnet by making all cable connections In conformance with SET UP AND CALIBRATION, Section NO TAG.

Remove the Shim Lead Vent Cap and allow frost to appear on the Shim Lead Connector Housing before removing shim currents.

Connect the input power supply cable to the Shim Power Supply.

Note
This section allows one to remove all shim currents to find the actual main field to document and use as a target parking frequency when re–ramping the magnet. This will enable parking the magnet at a more accurate frequency and prevent retuning the rest of the system.

WARNING!

BEFORE CONTINUING THE RAMP DOWN PROCEDURE, THE MAGNET CRYOGEN LEVEL SHOULD BE NO LESS 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 PRIOR TO TURNING ON THE SHIM POWER SUPPLY.

Set the MAIN POWER Switch (Shim Power Supply) to the ON position.

Dial in all last recorded Transverse 1 Currents from DATA SHEETS, Section 8 into the Shim Supply. Make sure the Current polarities are correct.

Set Transverse 1 Heater Switch (Shim Power Supply) to 1 (on). Verify that the heater current is 810mA ±10mA. If it is not correct, adjust it with the adjustment screw located in the rear of the Shim Power Supply. Allow a few minutes for the heater to drive the switches resistive.

2–1 PREPARATION FOR RAMP DOWN (continued)

Note

The field strength reading on the Teslameter should change as the Axial Shim currents are adjusted down to zero. If no change in the Teslameter reading is noticed, the Axial Heater Switch may still be "persistent; if this occurs a delay of about 2 more minutes is necessary before continuing to decrease currents.

Slowly adjust all Shim CURRENT controls to zero.

Set Heater Switch to 0 (off).

Repeat Steps NO TAG through NO TAG for Transverse 2 and Axial Shim Coils.

Set the MAIN POWER Switch (Shim Power Supply) to OFF and disconnect all cables.

Note

The frequency displayed on the Teslameter after the shim currents are removed is the target frequency for when the magnet is reramped.

Record the frequency displayed on the Teslameter in the DATA SHEET Tab, Table 6–1.

Replace the Shim Lead Vent Cap.

Note

All "Main Coil Driving Voltages" provided in this procedure will be equal in magnitude and opposite in polarity for "Reversed Ramped" magnets.

2–2 RESISTANCE CHECKS

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

Connect the Magnet 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")

Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL switches to the 0 (off) position.

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

Connect the Input Power Cable for the Magnet Power Supply.

WARNING!

MAKE SURE MAIN HEATER SWITCH IS OFF DURING THE RESISTANCE CHECKS. SETTING THE MAIN HEATER SWITCH TO O (ON), DURING THE RESISTANCE CHECKS, WILL CAUSE A MAGNET QUENCH.

Set the MAIN POWER and POWER ON switches to ON.

2–2 RESISTANCE CHECKS (continued)

Set HEATER 2 SHIM AXIAL Switch to 1 (on) and observe current rise in Analog Ammeter (800–820 mA) to verify circuit continuity. Make sure Main Heater Switch is off.

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

Set CURRENT ADJUST controls on Magnet Power Supply to maximum (full CW).

Observe the Digital CURRENT Meter and slowly turn the VOLTAGE control (CW) to set 500A current through the Main Power Leads, Lead Extensions and persistent Main Switch.

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

WARNING!

A VOLTAGE READING GREATER THAN 150 MILLIVOLTS AT 500 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.

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 1 through 11.

Continue to Step NO TAG after the DVM voltage is less than 150mV.

Gradually increase 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, discontinue the test and perform Step NO TAG above.

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). 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 NO TAG for adjusting contact resistance.

Turn the CURRENT ADJUST and VOLTAGE controls off (full CCW) and continue with Section 2–3, MAGNET RAMPDOWN.

2–3 MAGNET RAMPDOWN (DECREASE TO ZERO) FOR 1.0T AND 1.5T MAGNETS

WARNING!

THE MAGNET CAN BE QUENCHED IF THE MAGNET POWER SUPPLY EXPERIENCES LARGE OUTPUT VOLTAGE FLUCTUATIONS AND/OR EXCESSIVE RIPPLE. MAKE SURE THE POWER SUPPLY IS CHECKED FOR THE ABOVE AS REQUIRED DURING CALIBRATION. RIPPLE CAN ONLY BE ACCURATELY CHECKED AND ADJUSTED BY THE VENDOR.

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

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. IT THE TWO DO NOT MATCH, CALL THE NATIONAL SUPPORT CENTER TO AVOID A QUENCH.

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 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.

Note

Ice will build up around the ramp lead hold down tool flow holes during ramping down. Remove ice as needed to maintain helium gas flow through the flow holes.

2–3 MAGNET RAMPDOWN (DECREASE TO ZERO) FOR 1.0T AND 1.5T MAGNETS (continued)

1. Retrieve the main coil connection polarity and latest final parking current in the DATA SHEET Tab, Table 6–1.

Note
The axial shim heater must remain on throughout the rampdown procedure.

2. Make sure the Axial Shim Heater is on and Ramp Leads are connected with the polarity indicated in Step 1.
3. Set the power supply VOLTMETER SELECT SWITCH to MAIN COIL position.
4. Set CURRENT ADJUST controls on power supply to:
   * maximum (full clockwise) for 750 amp supply 46–260776G3.
   * 10 amps over parking current (retrieved in Step 1) for 1,000 amp supply 46–260776G4.
5. Set VOLTAGE control to adjust power supply output current to the Parking Current value obtained in Step 1 above.
6. Set the HEATER 1 MAIN Switch to 1 (on).
7. Allow approximately 1 minute for the main switch to go normal.
8. When the main switch is normal, slowly decrease VOLTAGE control, counterclockwise, until negative 0.3 volts (–0.3 V) is observed across the power supply voltmeter (MAIN COIL position).
9. Continue to adjust power supply voltage (using the VOLTAGE control) during rampdown in conformance with the voltages and main coil current ranges shown in Table 2–1.

TABLE 2–1
RAMPING VOLTAGE VERSUS CURRENT

MAIN COIL VOLTAGE	MAIN COIL CURRENT RANGE
–0.30 VOLTS	START TO 720 AMPS
–0.50 VOLTS	720 AMPS TO 700 AMPS
–0.60 VOLTS	700 AMPS TO 675 AMPS
–0.75 VOLTS	675 AMPS TO 650 AMPS
–1.00 VOLTS	650 AMPS TO 625 AMPS
* –1.50 VOLTS	625 AMPS TO 500 AMPS
GRADUALLY TURN VOLTAGE CONTROL TO ZERO (FULL COUNTERCLOCKWISE) THEN CURRENT CONTROL TO ZERO (FULL COUNTERCLOCKWISE)	500 AMPS TO 0 AMPS

* –1.50 volts approximate maximum negative voltage obtainable during rampdown.

2–3 MAGNET RAMPDOWN (DECREASE TO ZERO) FOR 1.0T AND 1.5T MAGNETS (continued)

10 Observe voltmeter reading with power supply VOLTMETER SELECT SWITCH in the MAIN COIL position. A zero reading, on the power supply digital VOLTAGE and CURRENT meters, indicates that the magnet is fully discharged.

11. When the magnet is full discharged, set the HEATER 1 MAIN and THE HEATER 2 SHIM AXIAL switches to 0 (off).

12. Set the MAIN POWER and POWER ON Switches to OFF.

13. Disconnect input power cables from magnet power supply.

14. Open vent valve (V2), de–pressurize the helium vessel 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 down and the AC power has been disconnected from the ramp power source.

15. Install a screw into the flow hole of only one of the ramp lead extensions. See Illustration 2–1.

16. 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 15). See Illustration 2–1.

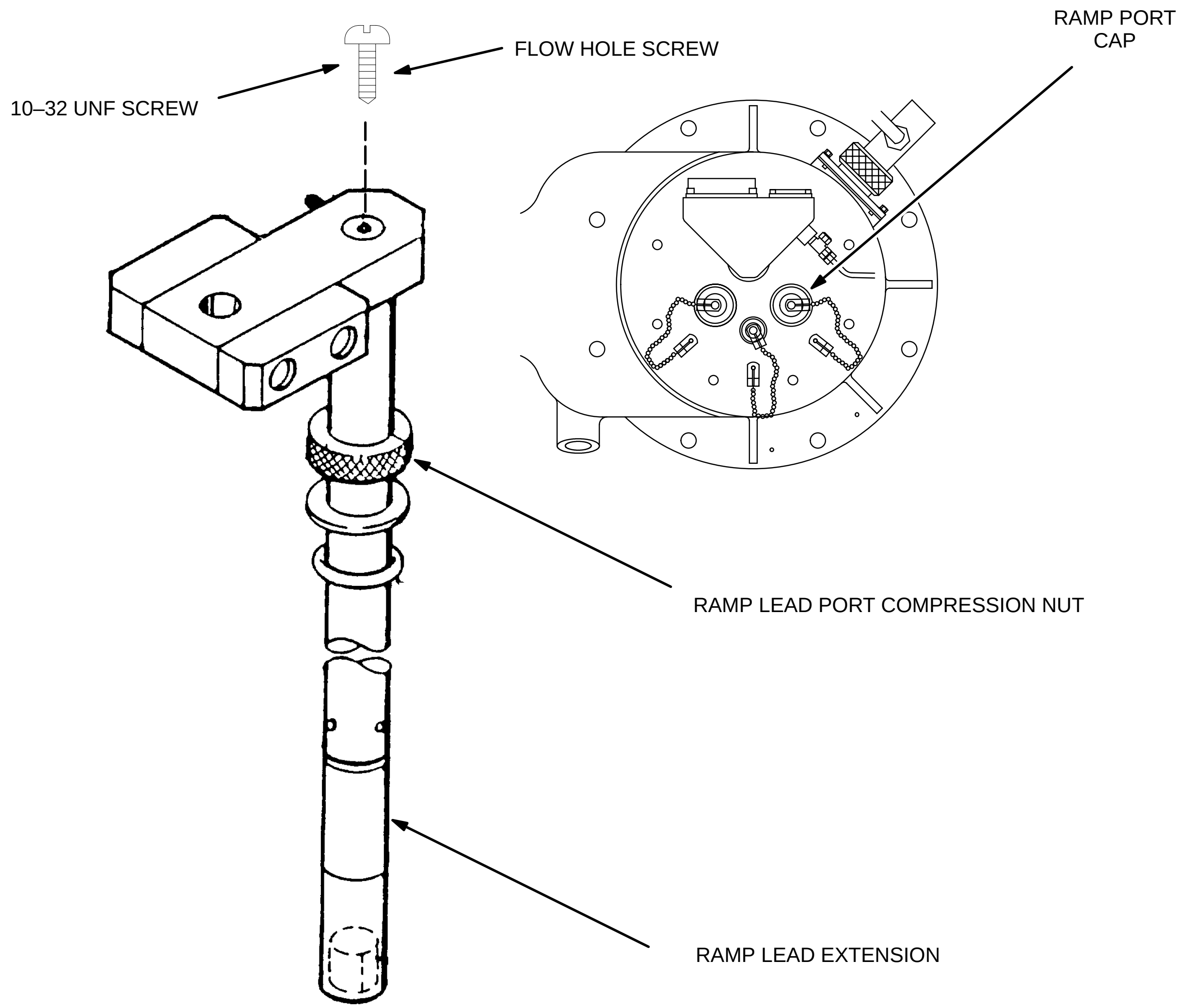
17. Unscrew the ramp lead port compression nut and remove the ramp lead extension from the magnet. Immediately replace the cap onto the ramp lead port.

18. Repeat Steps 15 through 17 for the other ramp lead extension.

CAUTION

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

2–3 MAGNET RAMPDOWN (DECREASE TO ZERO) FOR 1.0T AND 1.5T MAGNETS (continued)



RAMP LEAD EXTENSION AND RAMP PORT COMPRESSION NUT
ILLUSTRATION 2–1

2–3 MAGNET RAMPDOWN (DECREASE TO ZERO) FOR 1.0T AND 1.5T MAGNETS (continued)

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).

19. 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 3 – WARMING UP CRYOSTAT

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE <u>SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS</u> SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE <u>SAFETY CHECKLIST</u> SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

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!

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.

SECTION 3 – WARMING UP CRYOSTAT (continued)

CAUTION

Make sure the MAC Team Representative is present and has determined that Magnet Warm Up is required before proceeding.

3–1 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 4.
3. Connect the Lakeshore Cryotonic 208 Thermometer Kit (46–301477G1) to monitor silicon diode temperature in conformance with SET–UP AND CALIBRATION, Section NO TAG.
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.

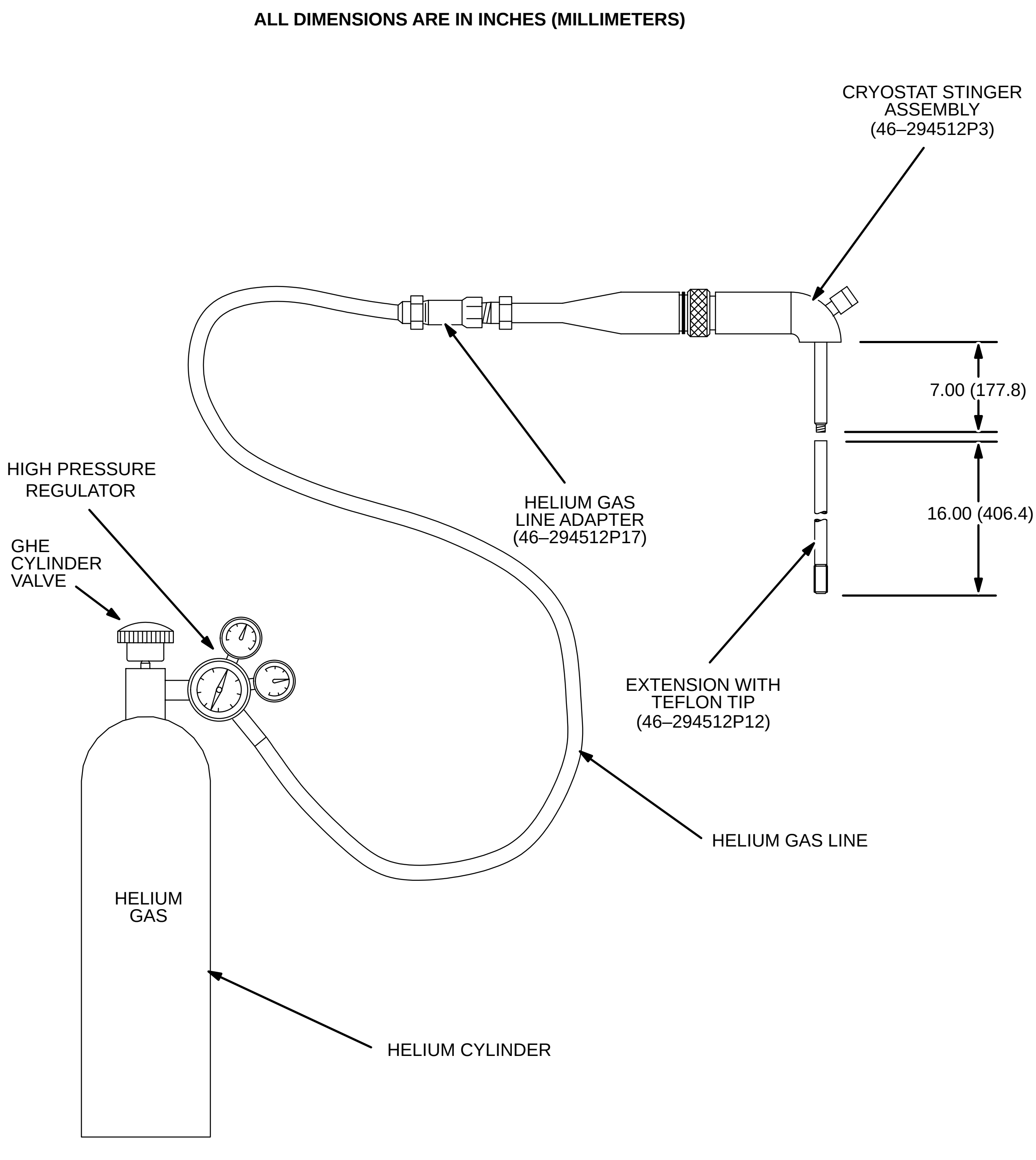
5. Connect standard high pressure GHe regulator and hose assembly to valve outlet (CGA 580) on GHe cylinder.
6. Connect Helium Gas Line Adapter to Purge / Precool Adapter then connect Helium Gas Line to Adapter. See Illustration 3–1.
7. Make sure that regulator adjusting handle is fully backed out, then 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.

3–1 WARMING UP CRYOSTAT (continued)



HELIUM PURGE SET–UP
ILLUSTRATION 3–1

3–1 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).

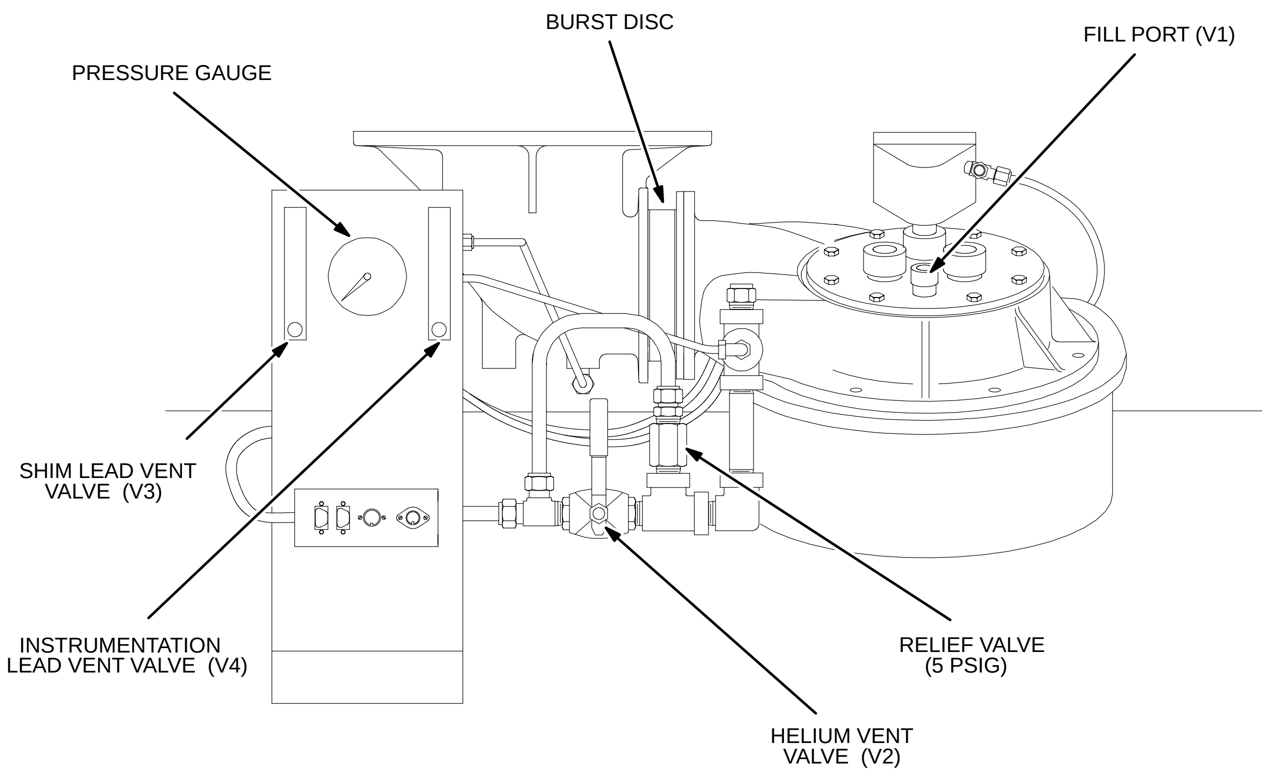
Note

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

3–1 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.

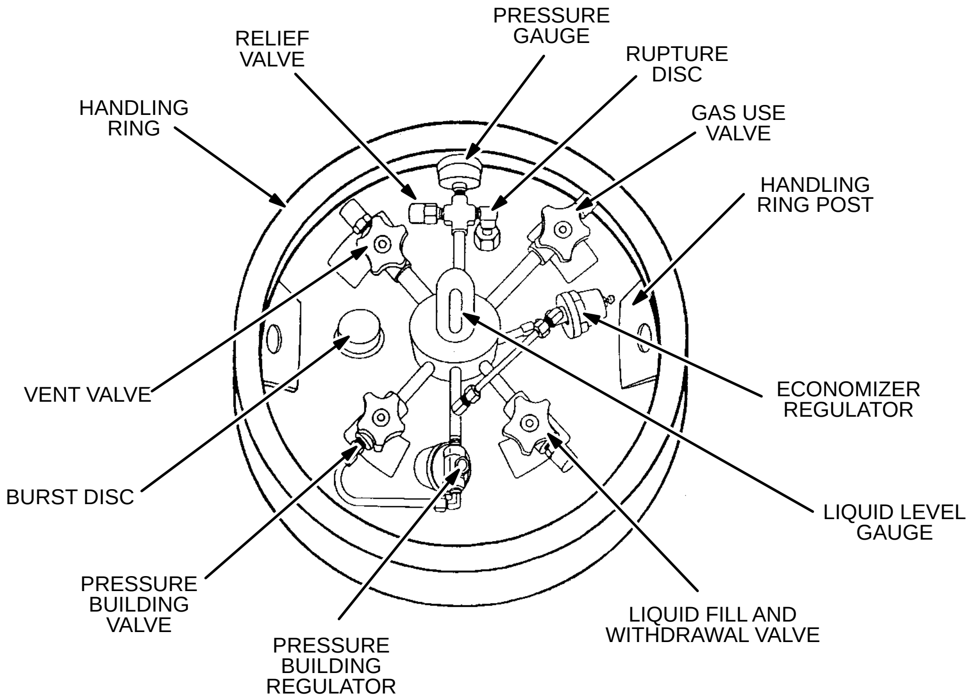
17. Obtain a full Liquid Nitrogen Dewar (PLC–230A). Verify that all valves are in the closed position.

Note

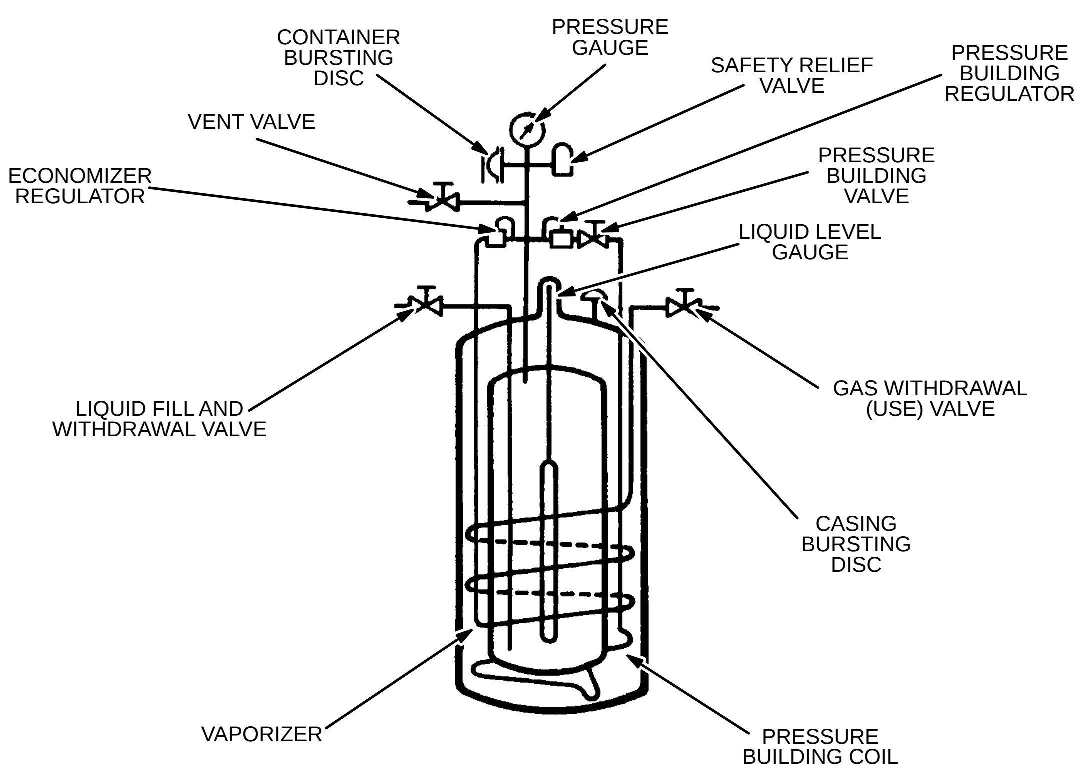
Other sources of gaseous nitrogen may be used with appropriate setup apparatus.

18. Open Pressure Building Valve on PLC–230A, verify that pressure gauge reading does not exceed 20 psig. See Illustration 3–3.

3–1 WARMING UP CRYOSTAT (continued)



TOP VIEW OF NITROGEN DEWAR



NITROGEN GAS/LIQUID DEWAR

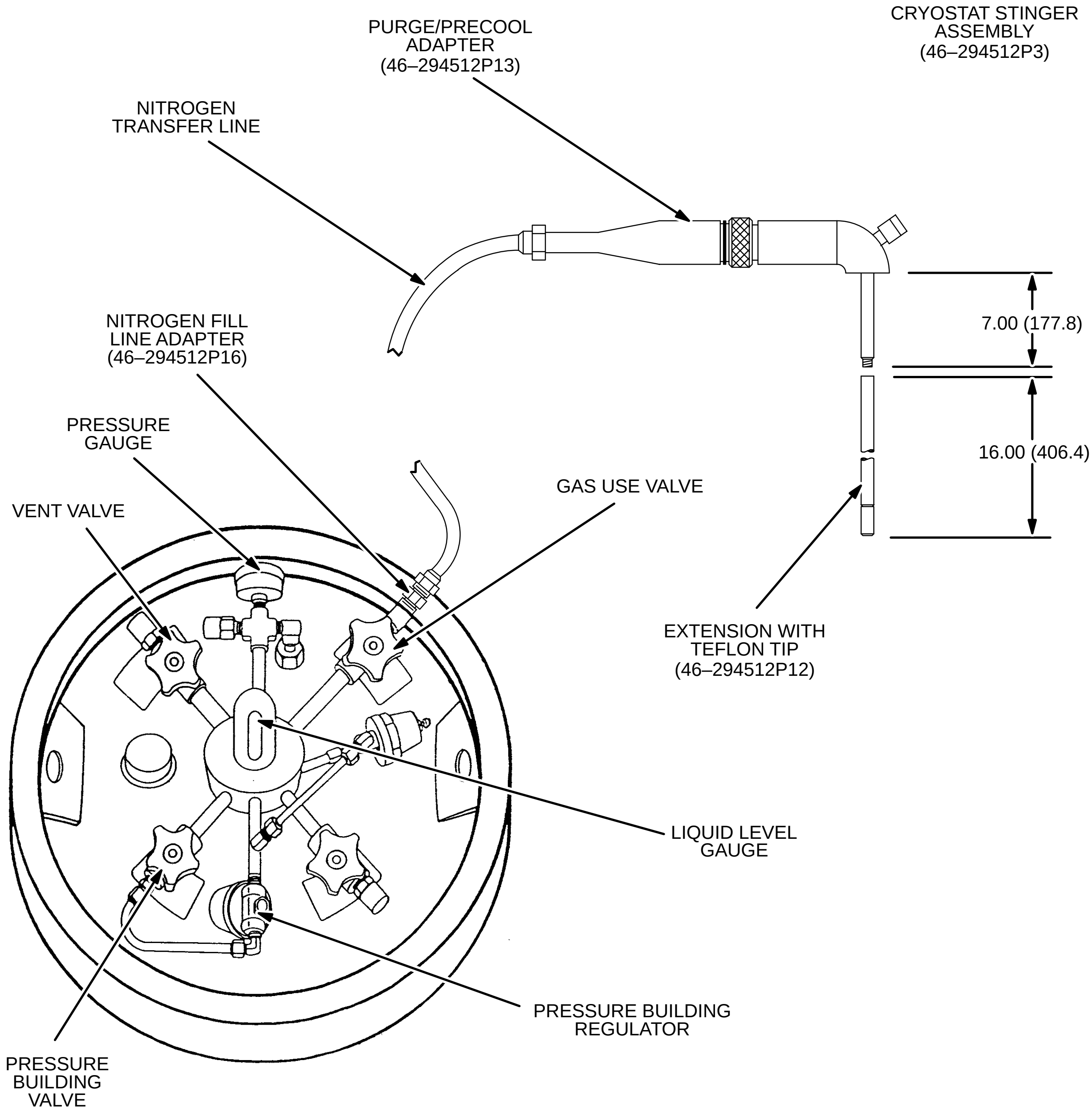
ILLUSTRATION 3–3

3–1 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.

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



TOP VIEW OF NITROGEN DEWAR

NITROGEN PURGE/PRECOOL ADAPTER
ILLUSTRATION 3–4

3–1 WARMING UP CRYOSTAT (continued)

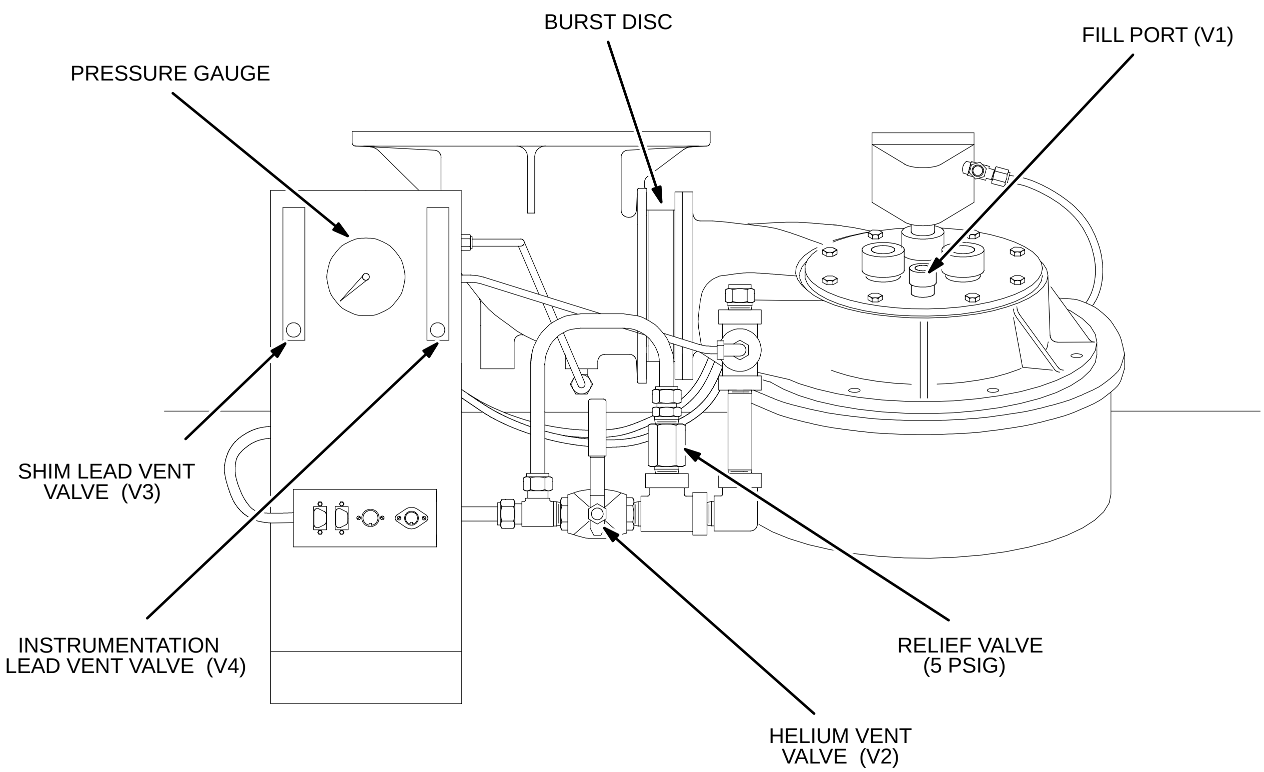
CAUTION

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 NO TAG, 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

3–1 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 4 – BURST DISC REPLACEMENT

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE SAFETY CHECKLIST SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

Description:

Burst Disc replacement is required as a result of rupture during a magnet quench or the result of a defect. It is important to replace a ruptured Burst Disc rapidly to prevent cryopumping and ice blocks from forming in the system. Cryogen refill will be required as a result of cryogen depletion during a quench. If cryogen refill does not take place during the Burst Disc replacement call, helium gas should be applied to the Helium Vessel to prevent continued cryopumping and ice block formation in the Helium Exhaust Lines and Vertical Stack. If the Burst Disc from the Spare Parts Kit is used, order a new Burst Disc for the kit.

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).

WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES OR FACE SHIELD, WHEN REPLACING BURST DISC ON COLD VENT SYSTEM.

SECTION 4 – BURST DISK REPLACEMENT (continued)

CAUTION

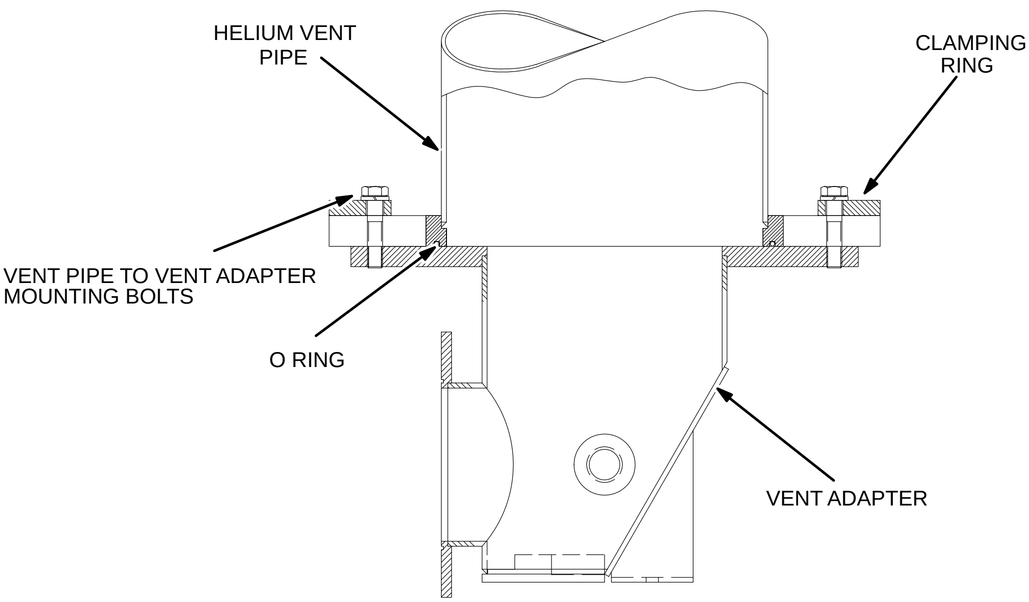
Replace Burst Disc immediately after rupturing to avoid cryopumping. Ice blocks can form inside the Exhaust Lines and Vertical Stack if the Burst Disc is not replaced promptly.

1. Loosen the 8 Vent Pipe to Vent Adapter Mounting Bolts. See Illustration 4–1.

Note
Heat gun may be required to remove frost on Vent Adapter before Step 2.

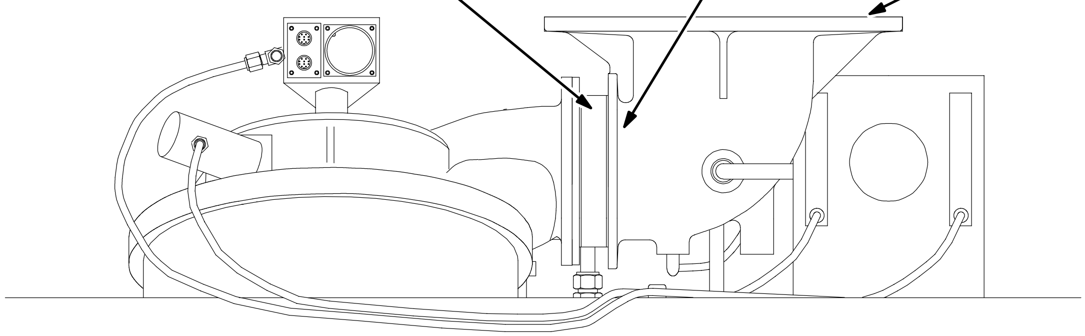
2. Loosen and remove magnet vent plumbing from Vent Adapter.

3. Unbolt and remove Vent Adapter Mounting Bolts to gain access to the Burst Disc, Gaskets and Retaining Bolts. See Illustration 4–2.



VENT ADAPTER CROSS–SECTIONAL VIEW
ILLUSTRATION 4–1

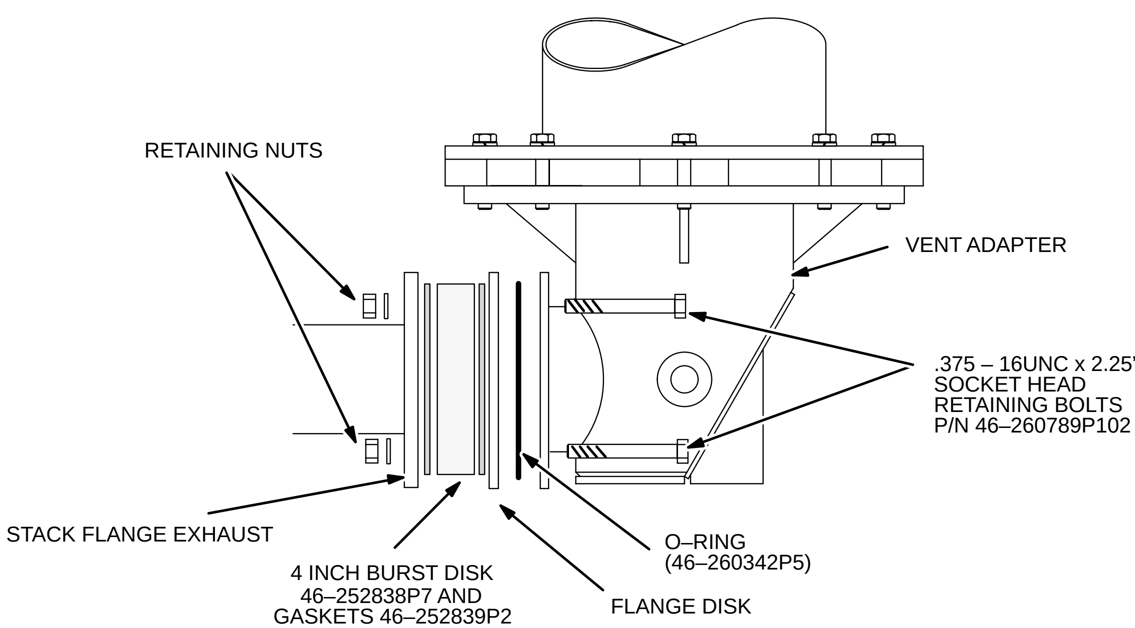
SECTION 4 – BURST DISK REPLACEMENT (continued)



BURST DISC LOCATION
ILLUSTRATION 4–2

4. Loosen the four 3/8 inch Retaining Nuts. Remove the top two Retaining Nuts and Socket Head Retaining Bolts while holding the Burst Disc, Gaskets and Flange Disc to the Stack Flange Exhaust. A 5/16 inch Allen Wrench Tool will be needed for the Socket Head Retaining Bolts. See Illustration 4–3.

5. Remove ruptured Burst Disc and clean any fragments out of vent system.



BURST DISC ASSEMBLY
ILLUSTRATION 4–3

SECTION 4 – BURST DISK REPLACEMENT (continued)

6. Unpack and inspect new Burst Disc and Gaskets for nicks and scratches. Assure that Burst Disc is undamaged and has proper part number (46–252838P7) and 10 psi rating on the rating plate.
7. Install new Burst Disc with fiat face towards the Vent Adapter.
8. Assemble and tighten the four Retaining Bolts sufficiently to prevent leakage around the gaskets.
9. Reassemble Vent Adapter.
10. Reassemble Helium Exhaust Vent.

CAUTION

If cryogen refill does not take place during the Burst Disc replacement call, pressurize the Helium Vessel in accordance with Step 11 and 12 to prevent continued cryopumping and ice blocks in the Helium Exhaust Line.

11. Disconnect Instrumentation Lead Assembly Plumbing at Flowmeter (F1).
12. Connect 99.995% Helium Gas Cylinder with pressure gauge to removed plumbing in Step 11 and flow gaseous Helium into the Vertical Stack at 1/2 psi. Observe Flowmeter (F2) for Exhaust Flow.
13. If ice block present, follow procedure in Replacement/Maintenance, Section 1.

SECTION 5 – SHIM LEAD / BAFFLE ASSEMBLY REMOVAL / REPLACEMENT

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE SAFETY CHECKLIST SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

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:

5–1 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 2.
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

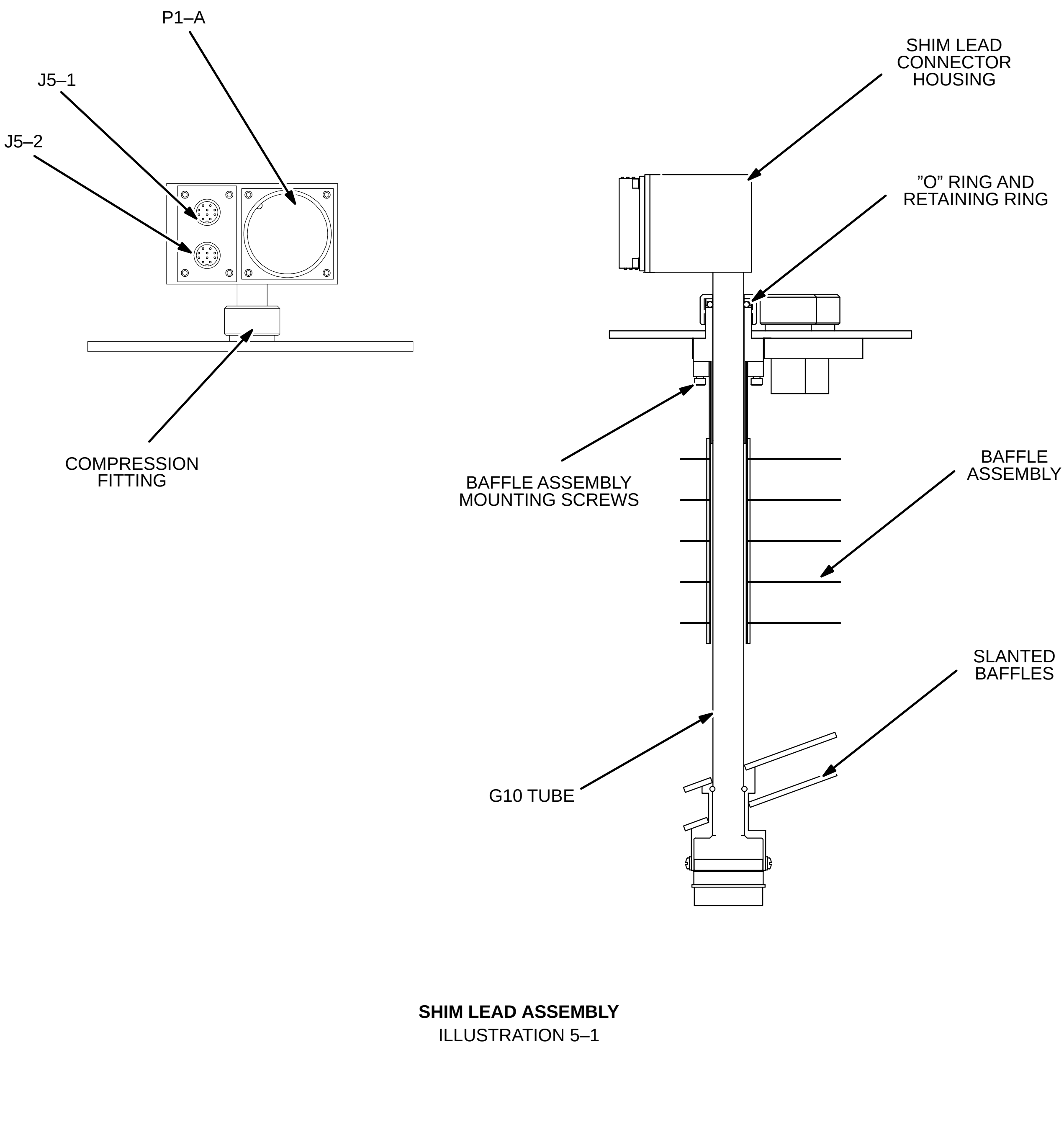
Perform Steps 7 and 8 rapidly to prevent cryopumping of air into the Vertical Stack. Make sure that the Lexan Cover Plate P/N 46–294765G1 is on the service platform before removing the Shim Lead Assembly.

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 5–3.

5–1 SHIM LEAD ASSEMBLY REMOVAL (continued)



SHIM LEAD ASSEMBLY
ILLUSTRATION 5–1

5–2 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

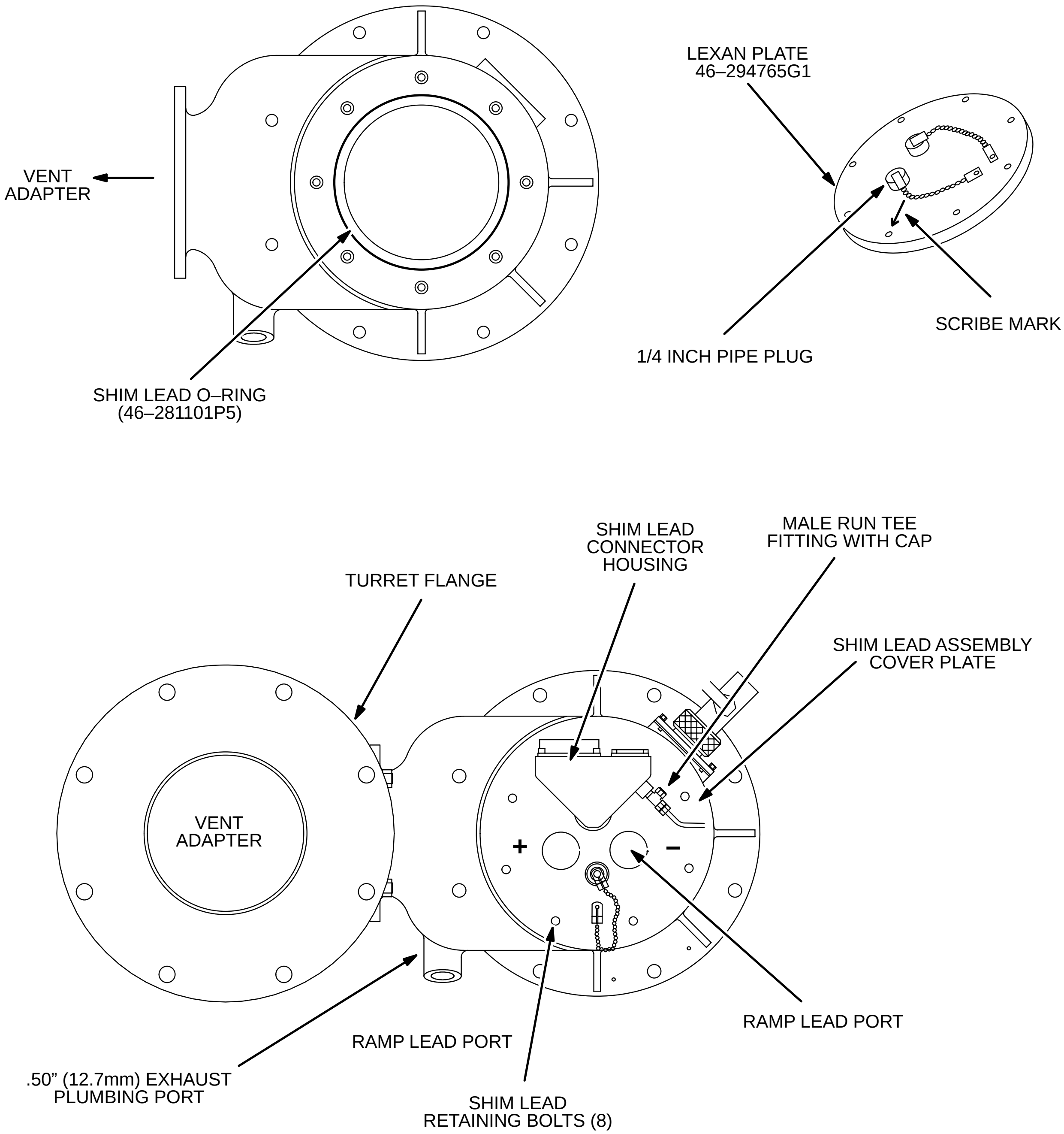
Make sure the caps in Step 3 are in place and the Shim Lead is carefully inserted into the Vertical Stack to prevent "cold shock" and possible permanent damage of the Shim Leads.

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.

5–2 SHIM LEAD ASSEMBLY REPLACEMENT (continued)



SHIM LEAD ASSEMBLY ORIENTATION

ILLUSTRATION 5–2

5–2 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

5–2 SHIM LEAD ASSEMBLY REPLACEMENT (continued)

21. Make sure flow rate through F2 is equal to or greater than 0.8 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

5–3 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 5–1.
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

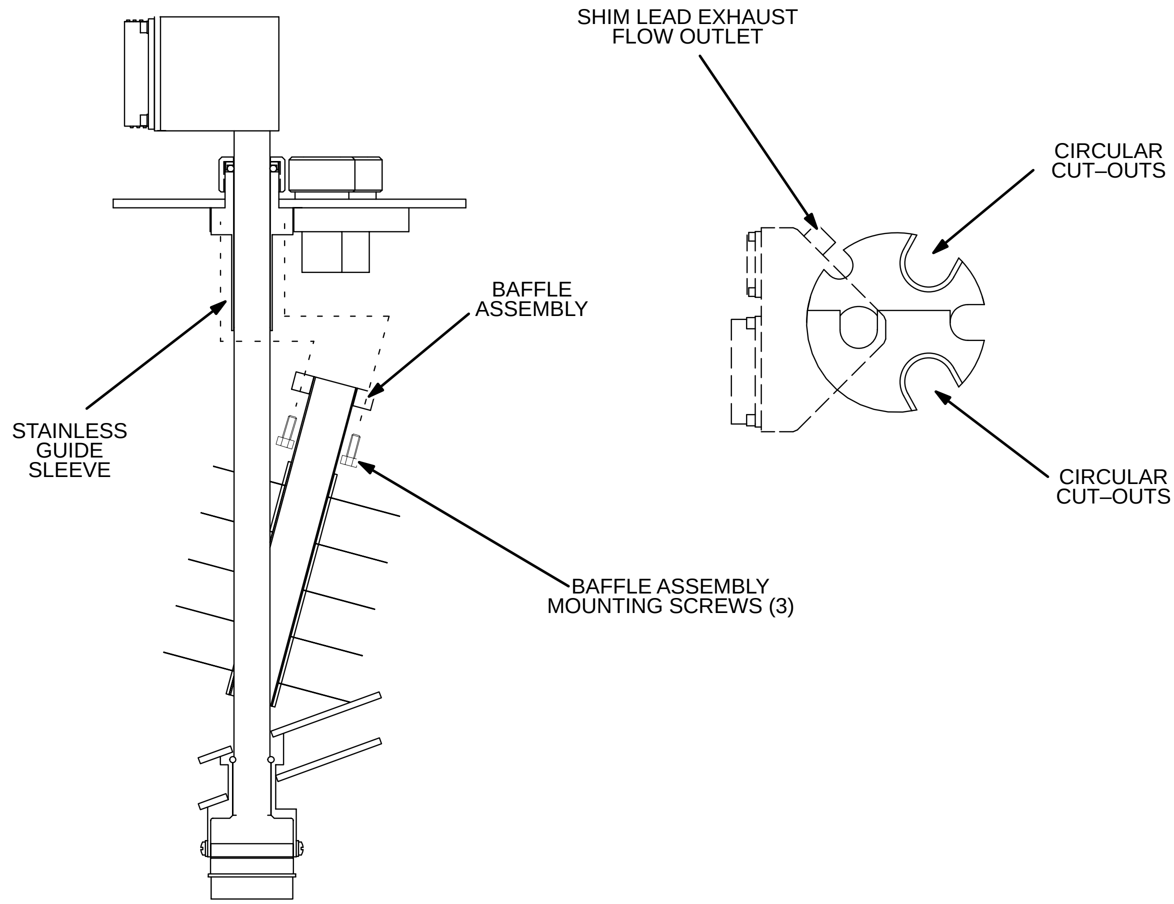
Care must be taken not to pinch the baffles between the Shim Lead G10 tube and the Baffle Assembly, while installing, to avoid damaging the baffles.

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.

5–3 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 5–2, 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 6 – SAV CON CONNECTOR REMOVAL / REPLACEMENT

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE <u>SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS</u> SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE <u>SAFETY CHECKLIST</u> SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

SECTION 6 – SAV CON CONNECTOR REMOVAL / REPLACEMENT (continued)

WARNING!

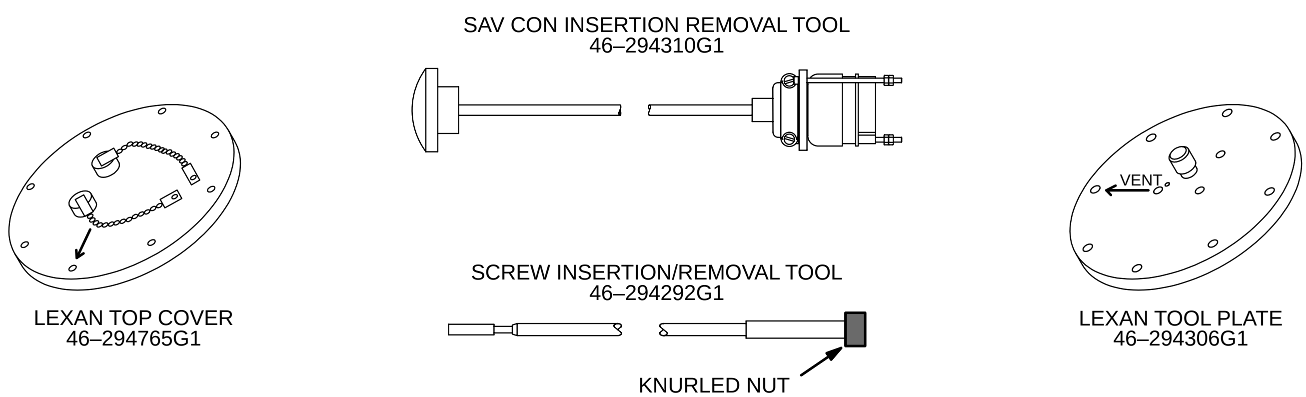
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN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

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.

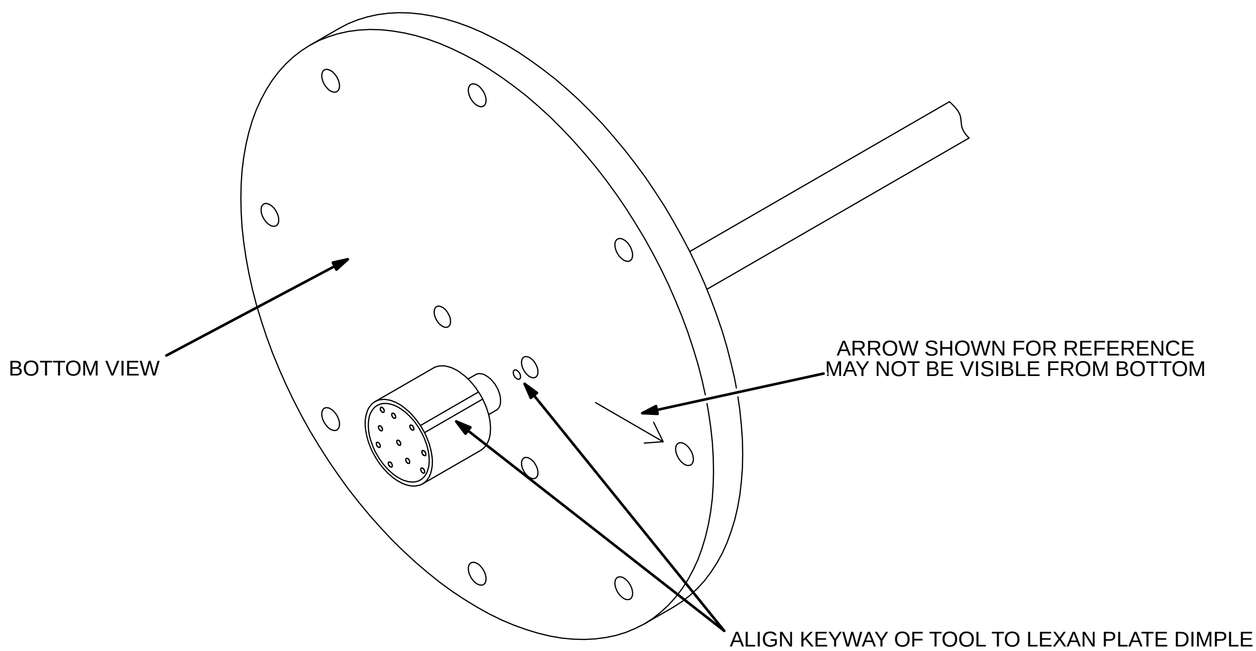
READ AND UNDERSTAND THIS PROCEDURE AND HAVE ALL REQUIRED TOOLS AND EQUIPMENT ON HAND (INCLUDING TOOL KIT P/N 46–294743G1, HELIUM GAS, HEAT GUN, WRENCHES, FLASHLIGHT, SNOOP, SAFETY FACE SHIELD AND GLOVES) BEFORE STARTING.



SAV CON REPLACEMENT/REMOVAL TOOLS
ILLUSTRATION 6–1

6–1 SAV CON CONNECTOR REMOVAL

1. Ramp magnet down to zero field in conformance with REPLACEMENT / MAINTENANCE, Section 2.
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.

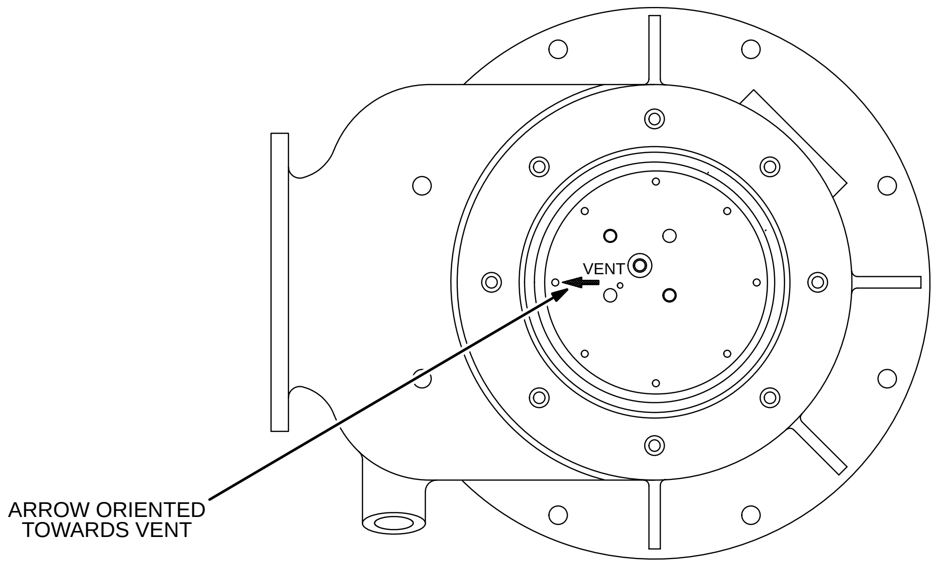


SAV CON SET UP
ILLUSTRATION 6–2

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 5 and store carefully.
6. Immediately position Lexan Tool Plate / Tool assembly onto Vertical Penetration; orient scribe mark as shown in Illustration 6–3.

6–1 SAV CON CONNECTOR REMOVAL (continued)



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.

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.

Note

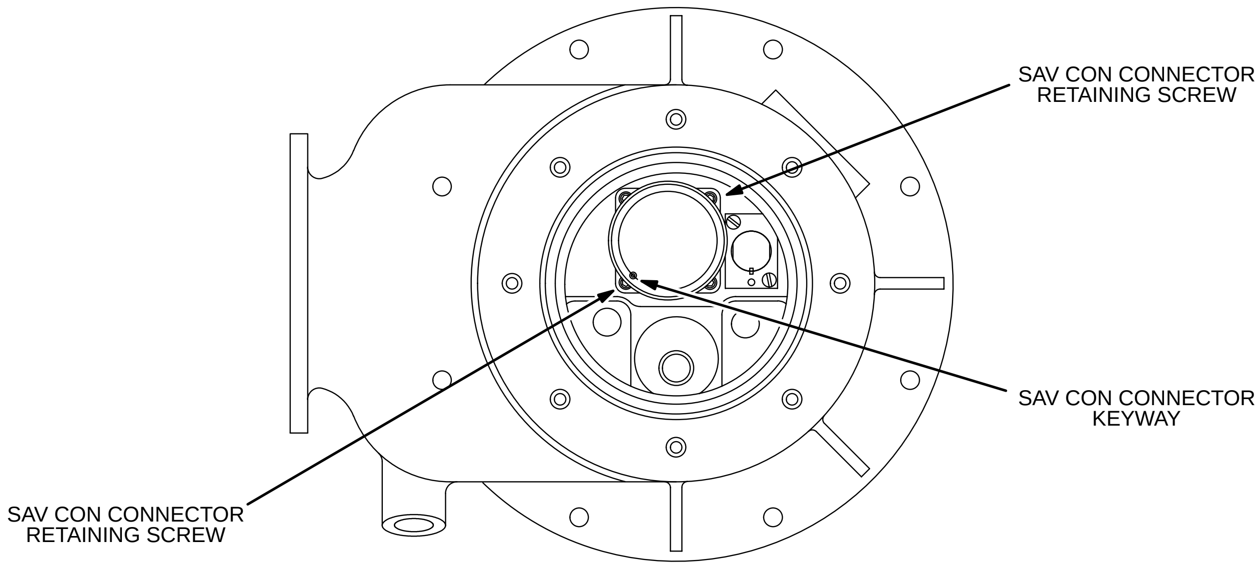
Sav Con Retaining Screws are captured by locking nut under Flange to prevent them from falling off the Sav Con Flange during removal.

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.

6–1 SAV CON CONNECTOR REMOVAL (continued)



SAV CON CONNECTOR RETAINING SCREW LOCATION
ILLUSTRATION 6–4

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.

Note
The Sav Con Tool Screws are needed to grip the Sav Con Connector for easy removal.

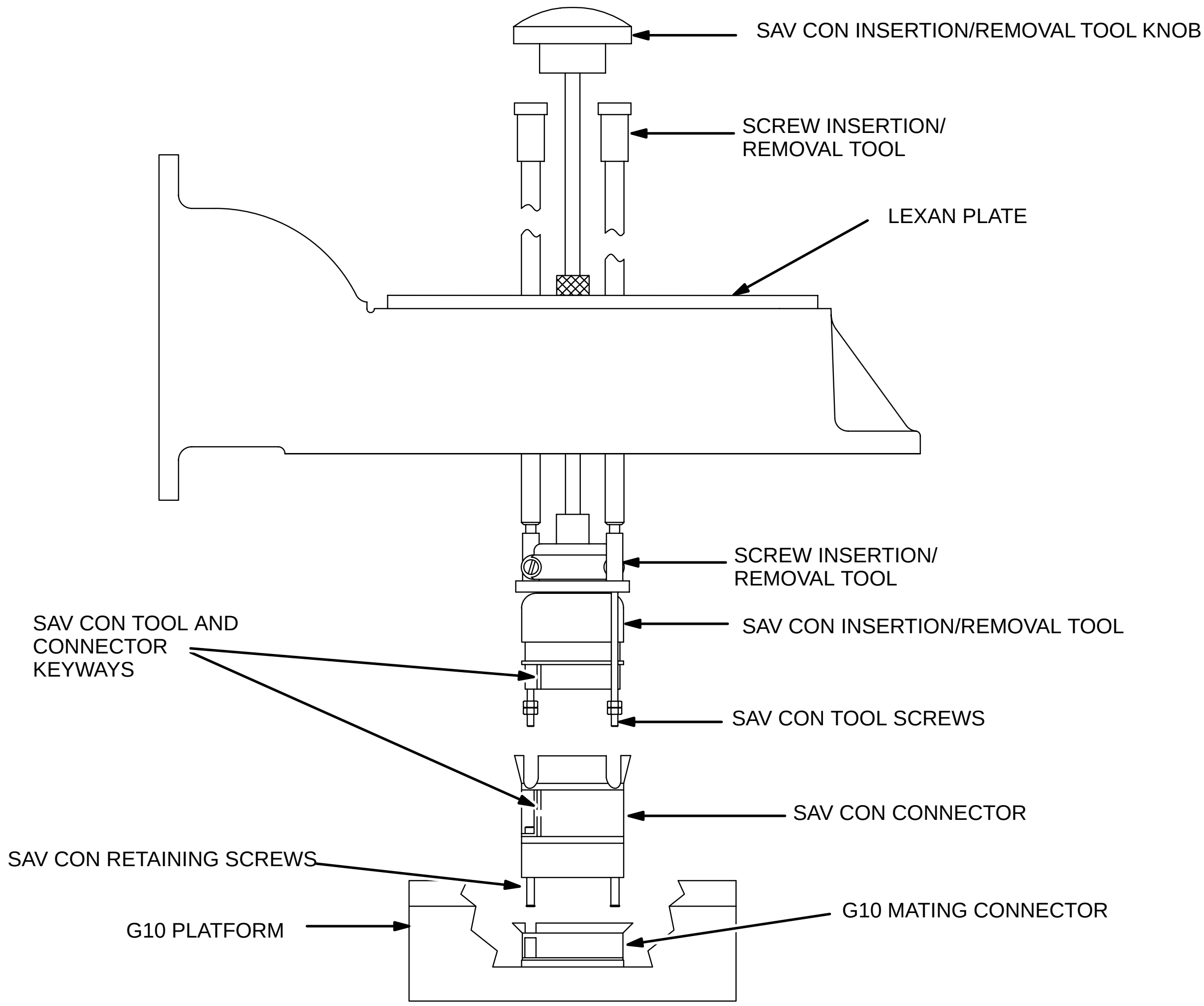
15. Insert the Screw Insertion / Removal Tool through the appropriate holes in the Lexan Tool Plate and engage each screw on the Sav Con Connector Tool.

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).

6–1 SAV CON CONNECTOR REMOVAL (continued)



SAV CON TOOL ASSEMBLY AND CONNECTOR MATING
ILLUSTRATION 6–5

6–2 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 6–1.

Note
Always be sure to align all key ways on all connectors.

6–2 SAV CON CONNECTOR REPLACEMENT (continued)

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 7 – INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE <u>SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS</u> SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE <u>SAFETY CHECKLIST</u> SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

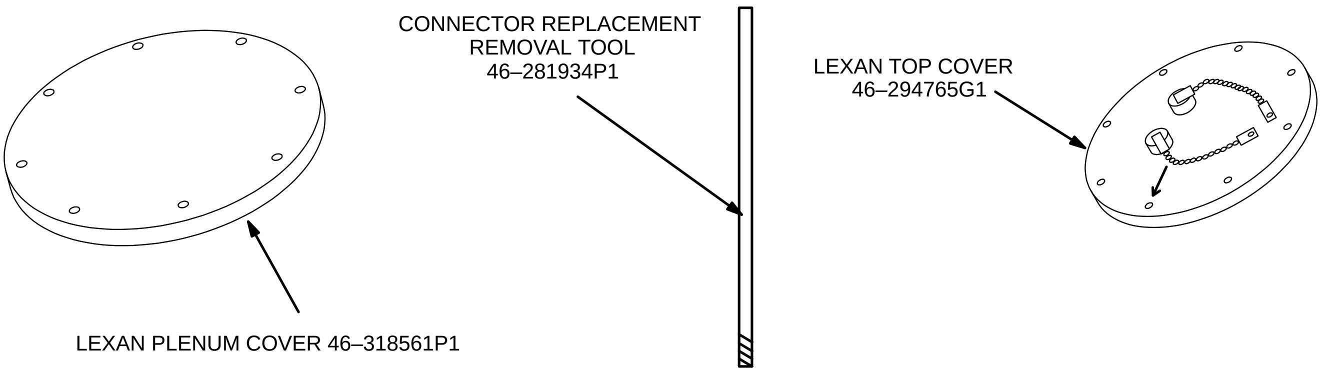
Description:

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)	Heat Gun (46–306830G3)
Teflon O–ring (46–281101P5) – Shim Lead	Teflon Tape (46–252065P19)
Teflon O–ring (46–281101P9) – Instrumentation Lead Connector Port	4 mm Allen Wrench
Teflon O–ring (46–281101P6) – Turret	7/16” Wrench
Lexan Plenum Cover (46–318561P1)	1/2” Wrench
Lexan Top Cover with 1/4 inch Pipe Plugs (46–294765G1)	9/16” Wrench
Connector Removal Tool (46–281934P1)	Pipe Wrench (1 3/4” jaw opening minimum)
Face Shield	2 x 4 Lumber (24.00” long)
Gloves	Masking Tape

Description (continued)



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 2, before starting this procedure.

7–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT

WARNING!

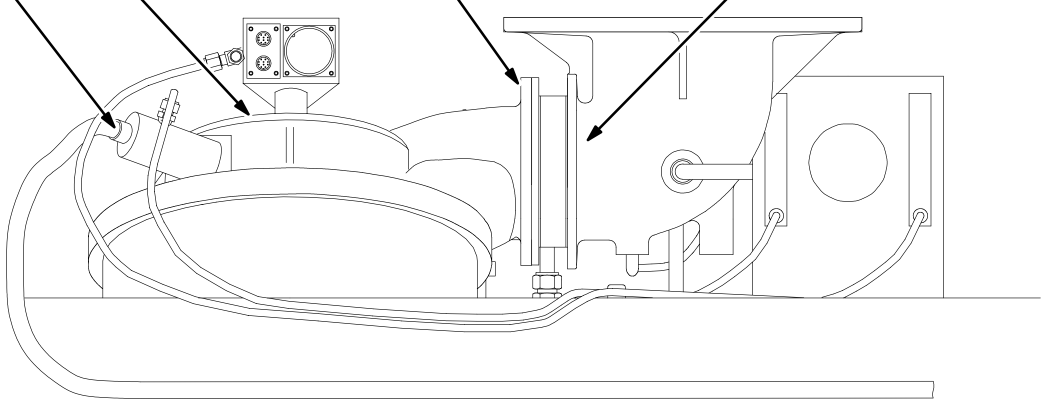
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN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

RAPID EXHAUSTING OF COLD HELIUM GAS MAY BE ENCOUNTERED DURING THE FOLLOWING 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.

7–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)



INSTRUMENTATION LEAD CONNECTOR LOCATION
ILLUSTRATION 7–2

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.

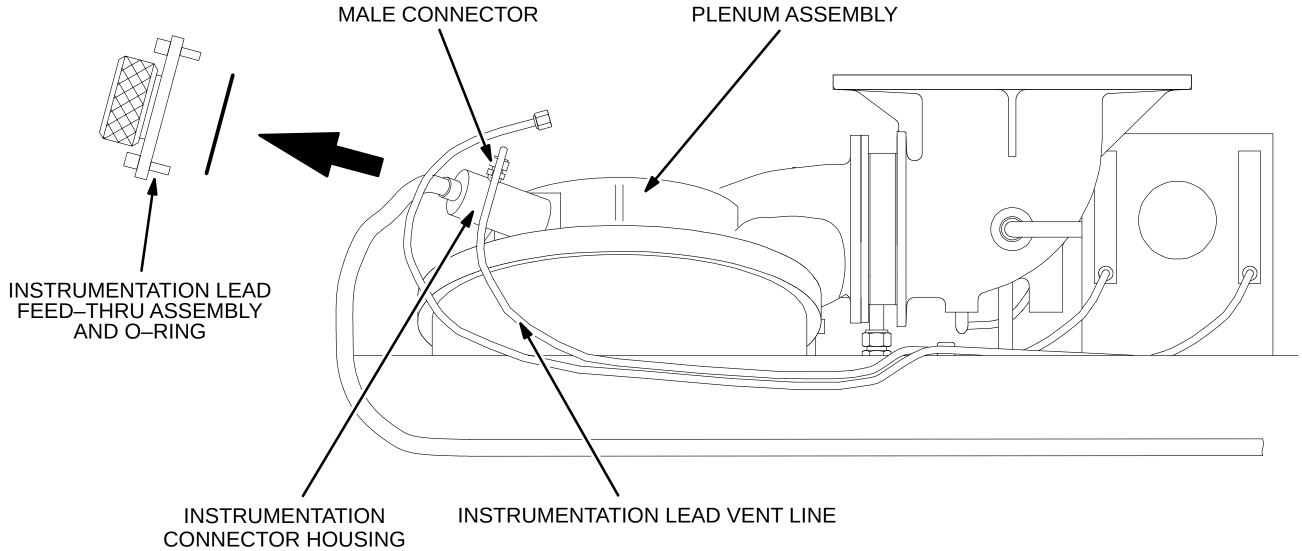
4. Unbolt and remove the four retaining bolts holding the Vent Adaptor to the Plenum Assembly. See Illustration 7–2.

5. Remove Shim Lead Assembly according to REPLACEMENT / MAINTENANCE, Section 5.

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.

7–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)



INSTRUMENTATION LEAD MALE CONNECTOR LOCATION
ILLUSTRATION 7–3

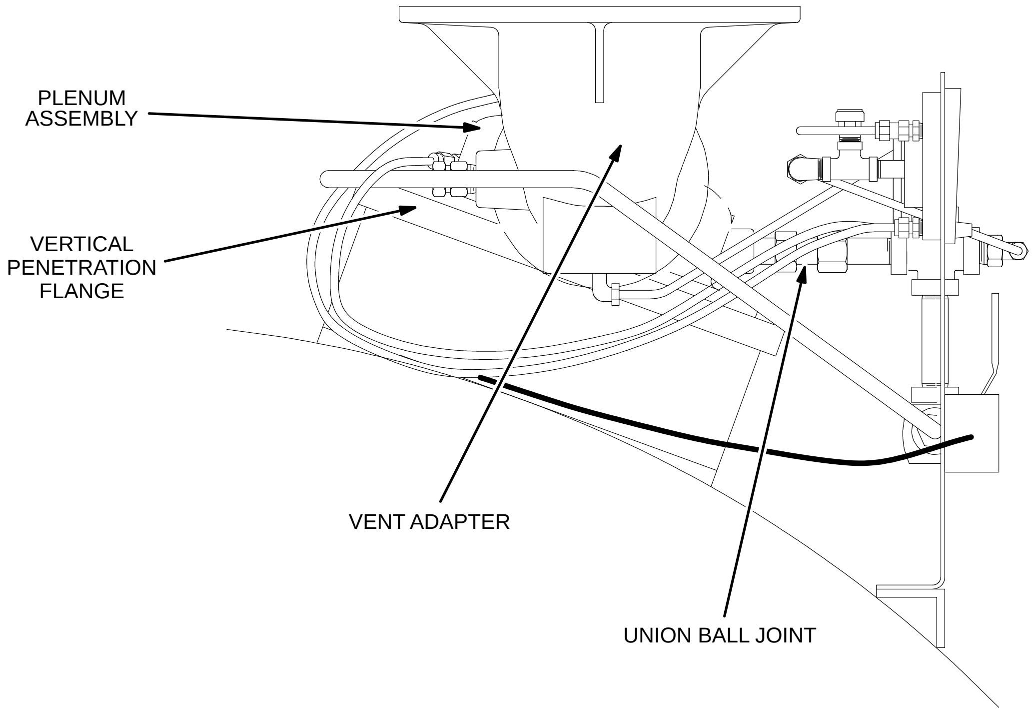
8. Loosen and remove the Male Connector from the top of the defective Instrumentation Lead Assembly. See Illustration 7–3.
9. Loosen the compression fitting and remove the four socket head bolts holding the Instrumentation Lead Feed–Thru Assembly to the Plenum Assembly. Remove Feed–Thru and O–ring from assembly. See Illustration 7–3.
10. Disconnect “UNION BALL JOINT” on the 1/2 inch plumbing from the Plenum Assembly using pipe wrench. See Illustration 7–4.

Note

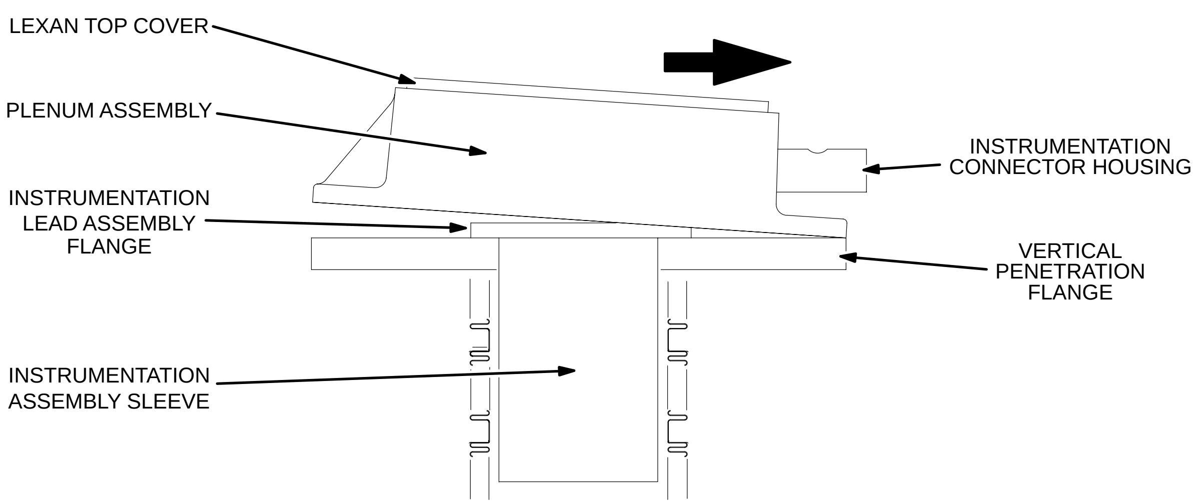
Make sure the Lexan Plenum Cover is Immediately accessible for mounting on the Vertical Penetration Flange when the Plenum Assembly is removed.

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

7–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)



MAGNET PLUMBING END VIEW
ILLUSTRATION 7–4



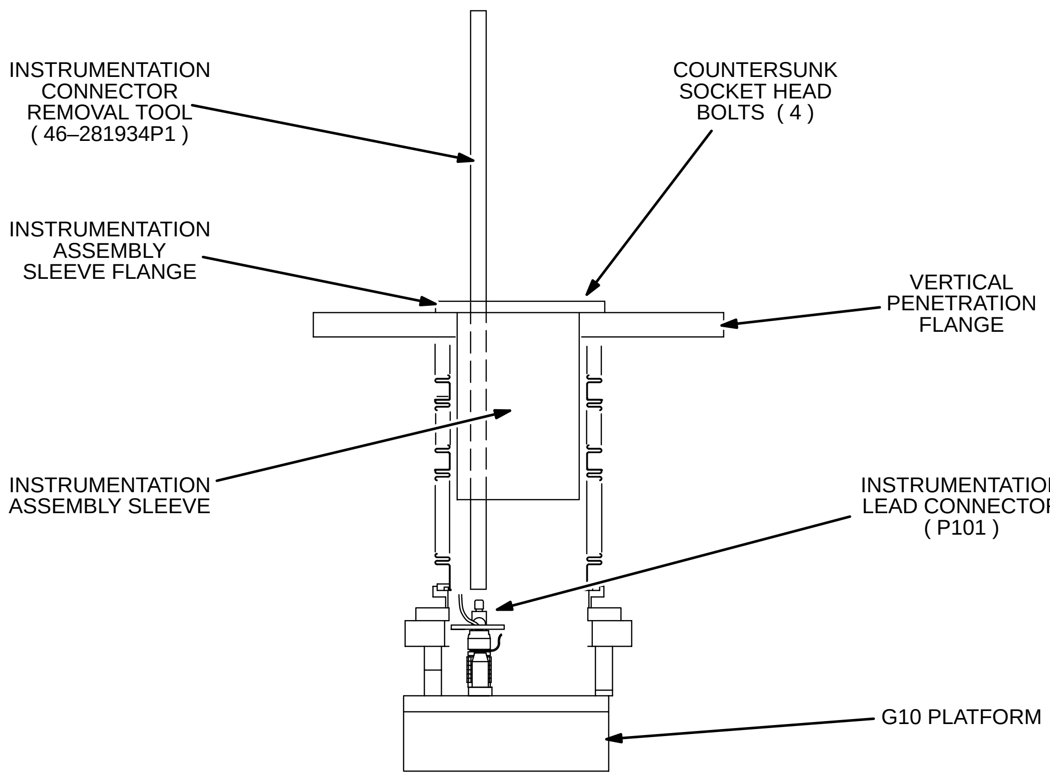
PLENUM ASSEMBLY REMOVAL
ILLUSTRATION 7–5

7–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)

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



ATTACHING THE CONNECTOR REMOVAL TOOL
ILLUSTRATION 7–6

13. Locate the Connector Removal Tool (46–281934P1). Warm with heat gun to remove any moisture.

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.

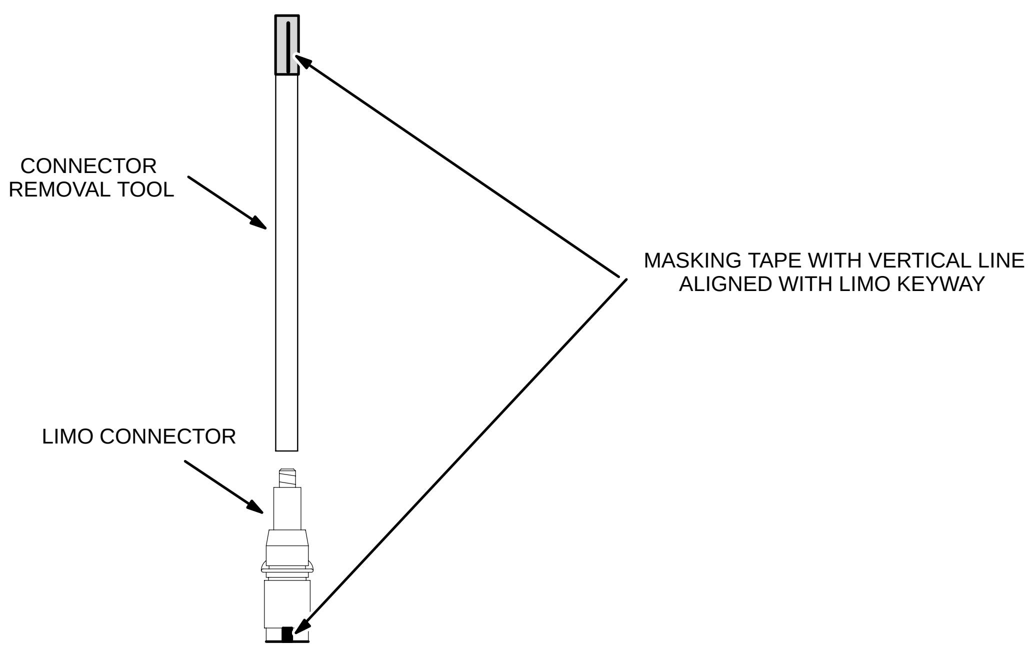
7–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)

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.

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

7–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL / REPLACEMENT (continued)

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.

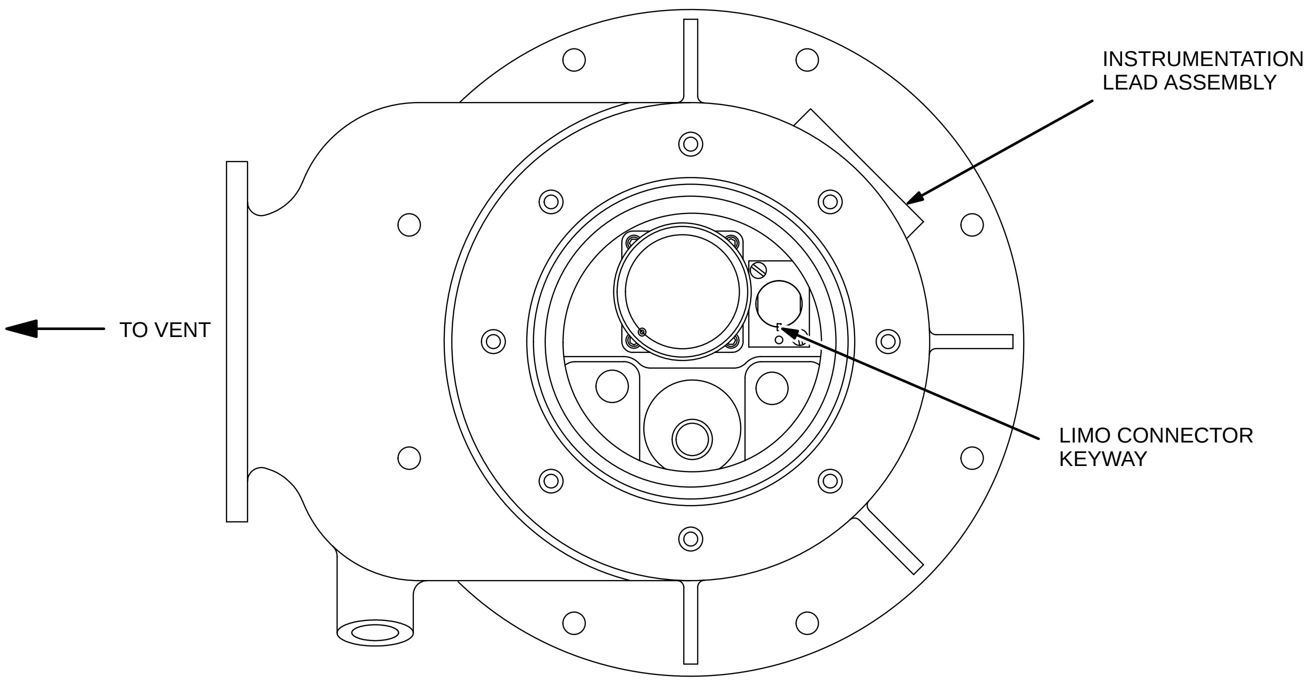
24. Insert the new Instrumentation Lead Assembly into the Penetration Flange.

25. Secure new Instrumentation Lead Assembly to 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 location of key ways on 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.

7–1 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.

CAUTION

The vent adapter will sag due to the weight of the vent and will make reconnection difficult. Use 2 x 4 lumber to assist in leveraging the vent adapter to align bolt holes.

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 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.

7–1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL/REPLACEMENT (continued)

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 NO TAG, 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.

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 – 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 9 – RE–EVACUATION OF VACUUM JACKETED TRANSFER LINE

A Vacuum Pump Cart System has been developed for the re–evacuation of the Vacuum Jacketed Transfer Line. Connection, monitoring and pumping procedures are supplied with Vacuum Pump Cart System. Contact your MAC Team Representative for further information.

Note

Frosting and loss of transfer efficiency are signs of a vacuum loss in Vacuum Jacketed Transfer Lines.

SECTION 10 – 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 10 – 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.

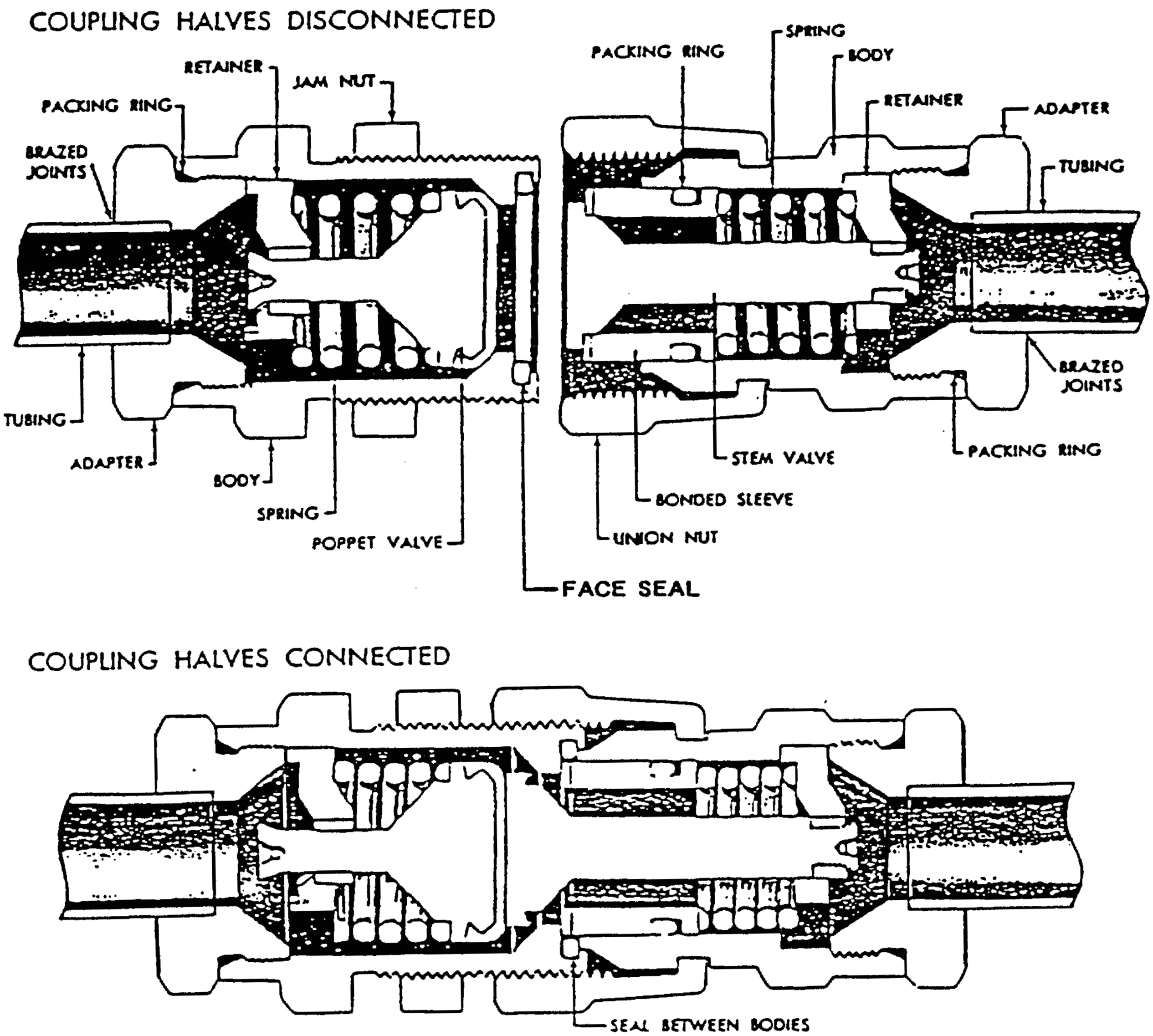
6. When the hoses are disconnected check each male coupling to ensure the face seal is in place.

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 10 – CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS (continued)

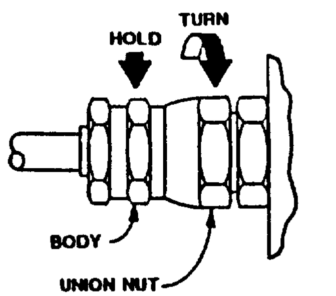


VIEW OF DISCONNECTED AND CONNECTED SELF–SEALING (AEROQUIP)
ILLUSTRATION 10–1

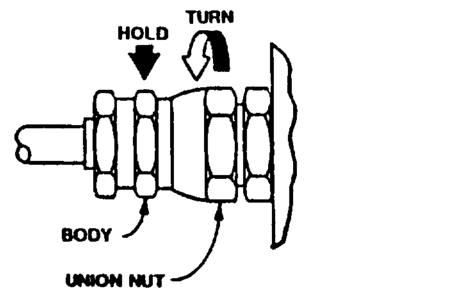
SECTION 10 – CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS (continued)

NOTES:

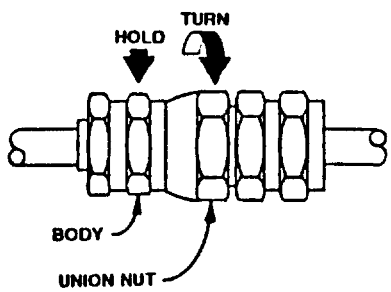
1. **INSURE THE MALE COUPLINGS AT THE COMPRESSOR AND COLD HEAD DO NOT ROTATE WHEN DISCONNECT ING LINES.**
2. **AVOID TORSIONAL FORCES ON THE FLEX SECTIONS.**



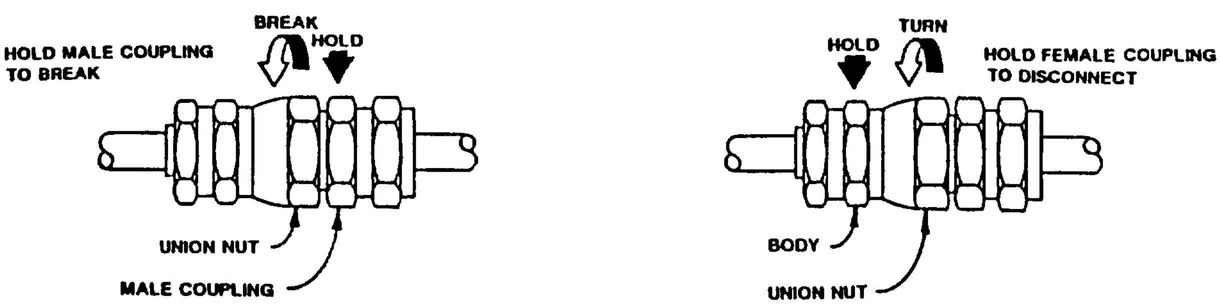
CONNECTING TO COMPRESSOR



DISCONNECTING FROM COMPRESSOR



CONNECTING TO COLD HEAD



DISCONNECTING FROM COLD HEAD

VIEW OF DISCONNECTED AND CONNECTED SELF–SEALING (AEROQUIP)
ILLUSTRATION 10–2

SECTION 11 – LEYBOLD COLDHEAD REPLACEMENT

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE <u>SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS</u> SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE <u>SAFETY CHECKLIST</u> SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

WARNING!

THE FOLLOWING SAFETY PRECAUTIONS MUST BE TAKEN BEFORE STARTING TO CHANGE OUT A COLDHEAD OF A MAGNET AT FIELD. THESE PRECAUTIONS ARE REQUIRED TO PREVENT FERROMAGNETIC MATERIAL FROM BECOMING DANGEROUS PROJECTILES IN THE MAGNETIC FIELD OR THE COLDHEAD FROM BEING ATTRACTED INTO THE BORE OR ONTO THE OUTER VESSEL OF THE MAGNET.

THIS PROCEDURE MUST BE PERFORMED BY PERSONNEL TRAINED AND QUALIFIED IN THE REPLACEMENT OF A COLDHEAD WHILE THE MAGNET IS AT FIELD.

THE COLDHEAD MUST NEVER BE BROUGHT NEAR THE MAGNET BORE OR IN CONTACT WITH THE OUTER VESSEL DURING REMOVAL / REPLACEMENT.

DO NOT BRING ANY FERROMAGNETIC TOOLS OR EQUIPMENT INTO MAGNET ROOM. FERROMAGNETIC MATERIAL CAN BECOME DANGEROUS PROJECTILES IN A MAGNETIC FIELD.

MAKE SURE THE MAGNET RUNDOWN UNIT IS FUNCTIONING PROPERLY TO ENABLE THE MAGNETIC FIELD TO BE QUICKLY DISCHARGED IN CASE OF AN EMERGENCY. SEE SECTION 5 OF FUNCTIONAL CHECKS.

THE COLDHEAD TRANSPORT BAG ON SIDE OF VAN MUST BE USED TO TRANSPORT THE COLDHEAD FROM TOP OF MAGNET IN A MOBILE VAN. IN A FIXED SITE, BOTH OLD AND NEW COLDHEADS MUST BE CARRIED FROM / TO SIDE OF MAGNET IN A DIRECT PATH FROM / TO WALL OF THE ROOM. NEVER BRING THE COLDHEAD NEAR THE END FLANGES OF THE MAGNET WHERE IT CAN BE DRAWN IN THE BORE.

A SECOND PERSON IS REQUIRED TO ASSIST CHANGING OUT A COLDHEAD IN A MOBILE VAN. THIS ENABLES THE PERSON REMOVING THE COLDHEAD TO HAND IT OFF TO THE SECOND PERSON.

IF ALL OF THE ABOVE CONDITIONS ARE NOT MET, THE MAGNET MUST BE RAMPED DOWN BEFORE CHANGING THE COLDHEAD.

11–1 PREPARATION

CAUTION

When coldhead motorshield is opened for coldhead changeout, the coldhead and attached bellows assembly should NEVER have any type of weight placed on or across them. Serious damage to magnet components could occur. See Illustration 11–5.

EQUIPMENT:

- New / reconditioned coldhead kit (2100832)
- Full helium gas cylinder (99.9995%)
- Shield Cooler Maintenance Kit (46–281088G3)
- Shield Cooler Vacuum Pump Kit (46–294047G1)
- Leather gloves (for opening and closing coldhead motor shield)
- Portable Oxygen Monitor (2106236 or 2106237)
- Gas cylinder cart (46–258150P1)
- Regulator kit (46–306734G1)
- Non–magnetic tool kit
- Flashlight

1. Make sure that a new / reconditioned coldhead kit and all required equipment is on site before starting procedure.
2. Make sure that the procedure is performed by a person trained and qualified to change out a coldhead in a magnetic field!
3. Remove magnet side cover in a fixed site. In a mobile site, undock table and remove table and front cover. Lift or remove front facade in a mobile van to gain access to the top of the magnet.

Note

Access to the top of the magnet from the front is required in a mobile van to run helium gas lines and the vacuum line to the adapter tee.

CAUTION

Prepare new coldhead for a fixed site outside of the magnet room to prevent attraction of the coldhead to the magnet.

If in a mobile van, transport the new coldhead to the top of the van in strict conformance with Section 11–4–2, TRANSPORTING COLDHEAD TO MAGNET, before it is prepared to prevent damaging gaskets when inserting coldhead into transport bag.

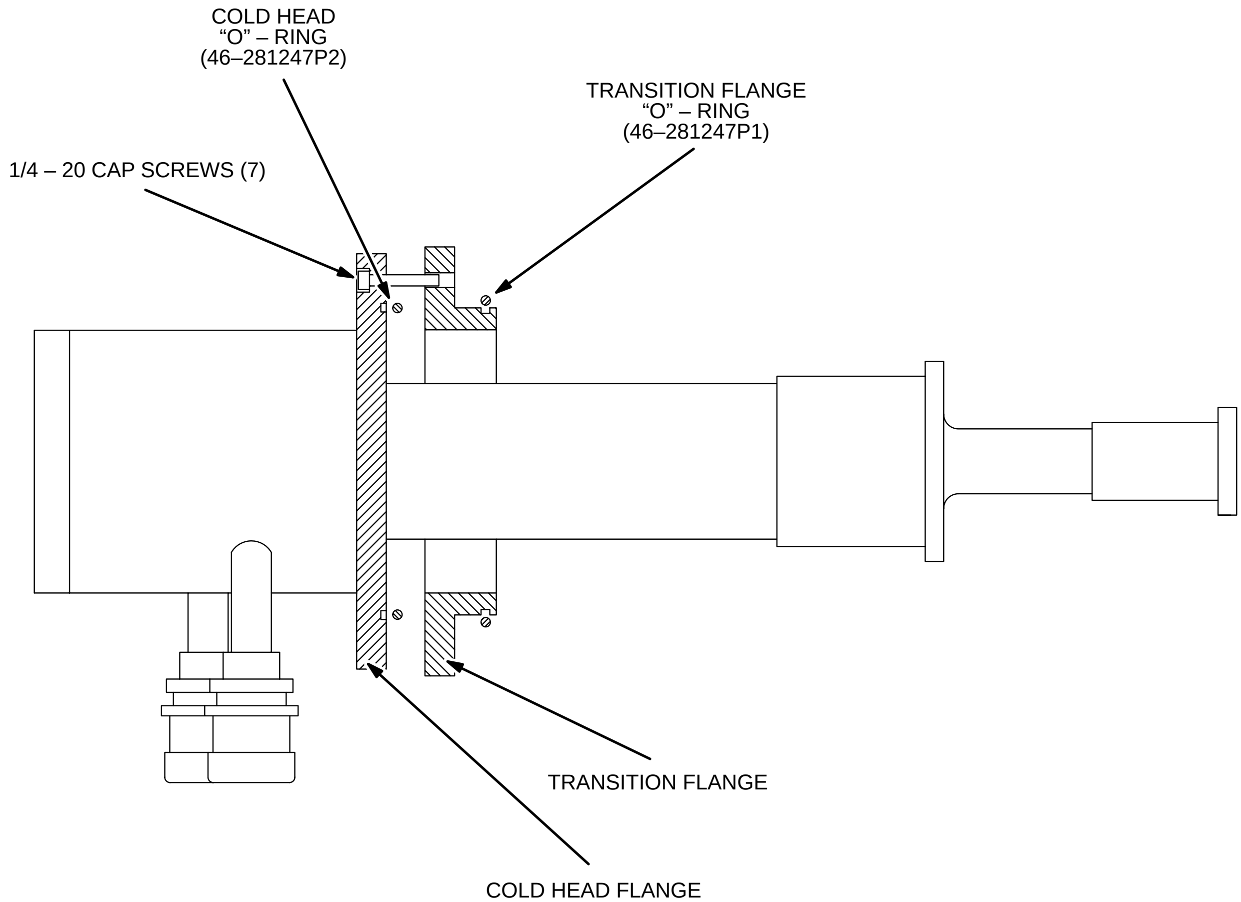
WARNING!

FOLLOW THE PROCEDURE IN SECTION 11–4, TRANSPORTING COLDHEAD FROM / TO MAGNET, COMPLETELY TO PREVENT THE COLDHEAD FROM BEING ATTRACTED (DRAWN INTO) THE MAGNET BORE.

11–1 PREPARATION (continued)

4. Remove the new / reconditioned Coldhead 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.

5. Remove o–ring (46–281247P2) from the Poly–bag attached to the Coldhead and wipe with a dry, lint free cloth/towel. Inspect the o–ring for nicks or cuts.



COLDHEAD O–RING PLACEMENT
ILLUSTRATION 11–1

6. 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 Coldhead Flange. Apply a thin film of Vacuum Grease to the top surf ace of the o–ring and groove. See Illustration 11–1.

7. Remove the Transition Flange (46–260938P1) from the removed Coldhead. See Illustrations 11–1 and 11–2. Save the seven Socket Head Cap Screws for installation of the flange on the new Coldhead.

8. Remove the o–ring from the Transition Flange and clean the entire flange using the same materials as in Step 1.

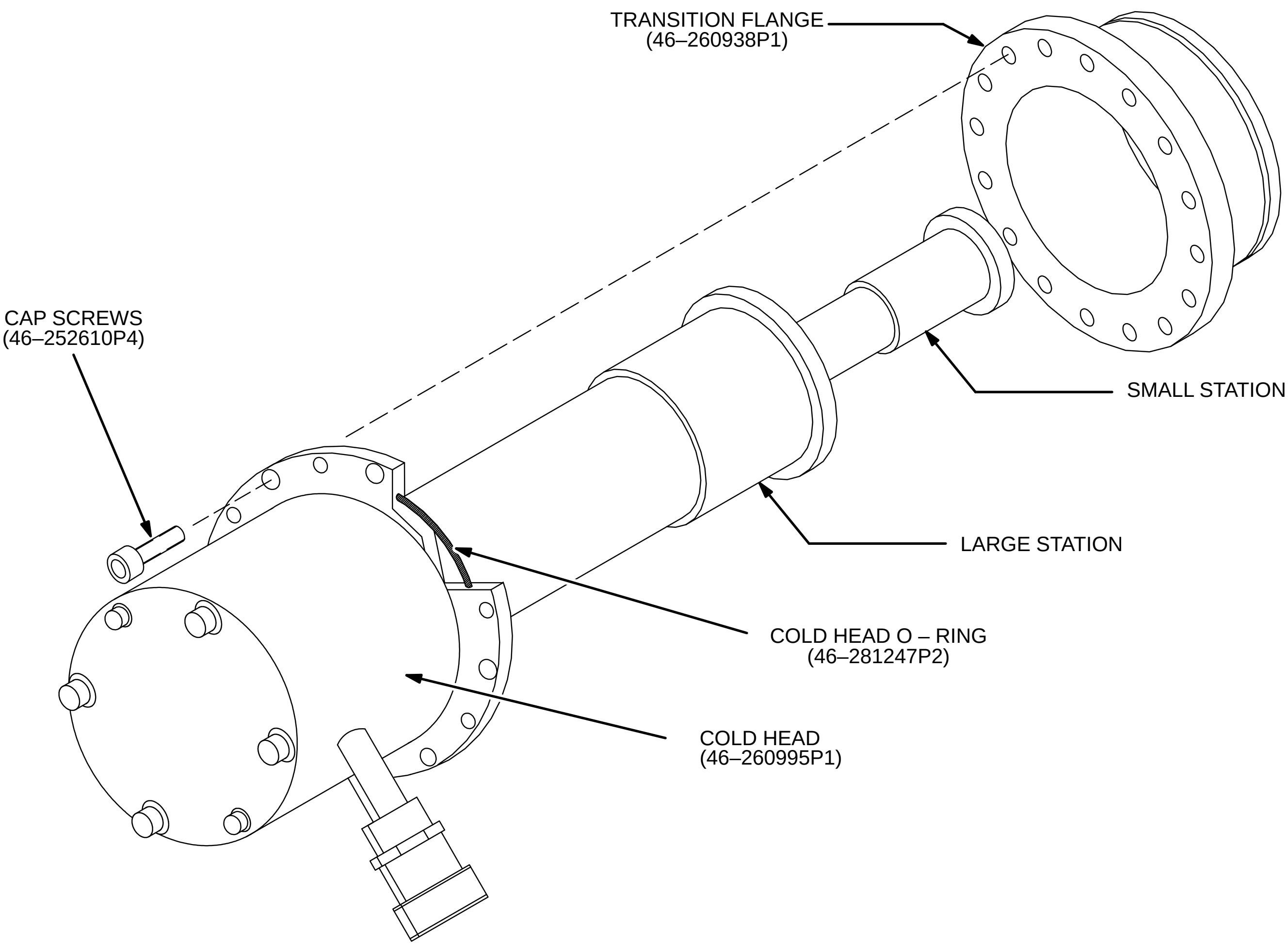
11–1 PREPARATION (continued)

9. Apply a thin film of Vacuum Grease to the flat surface of the flange which contacts the o–ring on the Coldhead Flange.

10. Slide the Transition Flange over the first and second stages of the Coldhead and rest the flange on the Coldhead o–ring. See Illustration 11–2.

11. Align the bolt hole pattern of the Transition Flange and Coldhead Flange.

12. Insert the seven 1/4–20 Cap Screws (46–252610P4) through the bolt holes into Coldhead. Pull the Transition Flange flush to the Coldhead and hand tighten the Cap Screws until the Transition Flange is evenly sealed around the Coldhead o–ring. Tighten each Cap Screw uniformity until the Transition Flange is tightly assembled against the Coldhead. See Illustration 11–2.



TRANSITION FLANGE MOUNTING
ILLUSTRATION 11–2

11–1 PREPARATION (continued)

Note

Coldhead 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.

13. 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.
14. Slide the lubricated o–ring over the two stations of the Coldhead and place in the groove of the Transition Flange. See Illustration 11–1.
15. Place small Indium Gasket (46–281241P2) on the small Copper Station of the Coldhead. Fold the tabs on the gasket over the station to keep the gasket in place. See Illustration 11–14.
16. Place large Indium Gasket (46–281241P1) on the large Copper Station of the Coldhead. 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.

11–2 REMOVING INERTIA MASS DAMPENER AND MOTOR SHIELD

Note

Inertia Mass Dampener Assembly may not have been required and therefore not installed on all magnets. If assembly is not present, move on to Step 11.

WARNING!

THIS PROCEDURE REQUIRES THE HANDLING OF HEAVY PARTS (UP TO 33 POUNDS). MAKE SURE SERVICE LADDER IS FIRMLY IN PLACE AND USE CAUTION IN HANDLING PARTS TO AVOID DROPPING PARTS OR STRAINING MUSCLES. CARE MUST BE TAKEN WHEN INSTALLING THE HEAVY PLATES. PINCHED FINGERS OR OTHER SERIOUS BODILY INJURY CAN OCCUR.

CAUTION

Make sure to store all hardware from the inertia mass dampener in a secure place for re–assembly after coldhead change.

11–2 REMOVING INERTIA MASS DAMPENER AND MOTOR SHIELD (continued)

1. Remove side shroud from rail to expose inertia mass dampener.
2. Remove 5/16–18 stn. stl. from inboard end of the three guide rods. See Illustration 11–3.
3. Remove 5/16–18 (fixed site) or 1/2–13 (mobile site) stn. stl. nuts from outboard end of the three guide rods. Loosen nuts on inside of plates.
4. Loosen 5/16–18 stn. stl. jam nuts, on inside end of the three guide rods, as far back as they will go.
5. Remove the three guide rods by screwing out of threaded holes in the outside brass plate.

IMPORTANT !!!

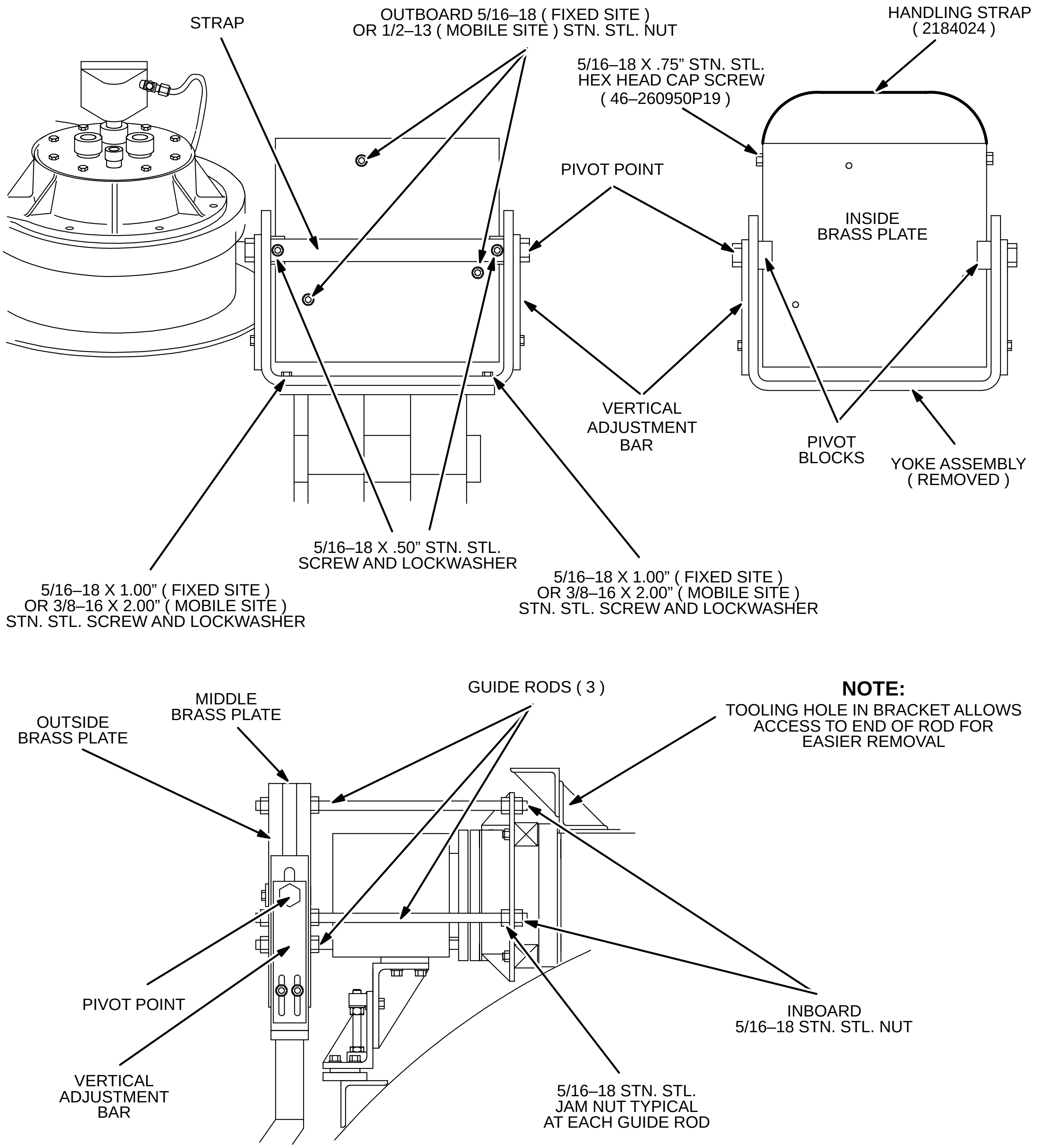
If coldhead is being removed in a mobile van, swing brass plate and yoke assembly back fully towards the van wall. If assembly clears vertical channel on van wall it will not need to be removed. See Illustration 11–4. If removal of brass plate and yoke assembly is not required continue with Step 11 in this procedure.

6. Remove strap across outside of plate stack by removing the 5/16–18 x .50” long stn. stl. screws and washers at either end of the strap.

Note

Plate handling straps should be used in moving plates to or from yoke assembly. Remove straps once plates are re–installed to prevent interference when tightening plates together. See Illustration 11–3. It may be necessary to insert a non–magnetic, flathead screwdriver between the brass plates to seperate them in Step 7.

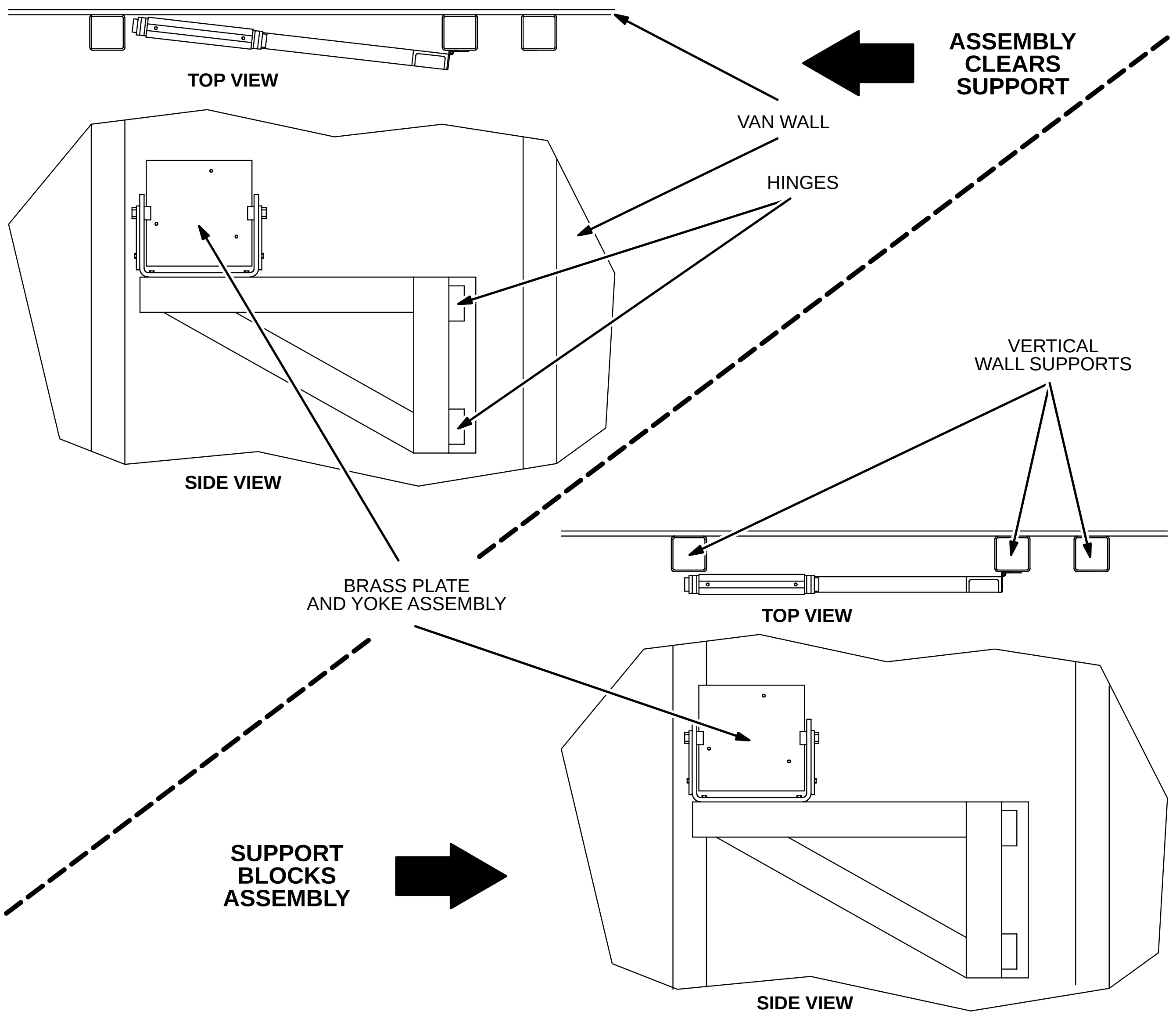
11–2 REMOVING INERTIA MASS DAMPENER AND MOTOR SHIELD (continued)



INERTIA MASS DAMPENER REMOVAL
ILLUSTRATION 11–3

11–2 REMOVING INERTIA MASS DAMPENER AND MOTOR SHIELD (continued)

7. Carefully slide outside brass plate off pivot blocks and lower to the floor. See Illustration 11–3.
8. Carefully slide middle brass plate off pivot blocks and lower to floor in like manner.
9. Pivot inside brass block on yoke assembly to access the two 5/16–18 x 1.00” (fixed site) or 3/8–16 x 2.00” (mobile site) long stn. stl. screws securing the yoke assembly.
10. Remove the two screws and washers while firmly holding the yoke assembly in place. Carefully lift and remove the yoke assembly (inside brass block, pivots, pivot blocks and vertical adjustment bars).



INERTIA MASS DAMPENER MOUNTING IN MOBILE VAN
ILLUSTRATION 11–4

11–2 REMOVING INERTIA MASS DAMPENER AND MOTOR SHIELD (continued)

WARNING!

THE COLDHEAD SHIELD IS MADE OF FERROMAGNETIC MATERIAL AND HAS A LARGE ATTRACTIVE FORCE TO THE MAGNET. DO NOT LOOSEN OR REMOVE THE MOTOR SHIELD MOUNTING SCREWS UNDER ANY CIRCUMSTANCE.

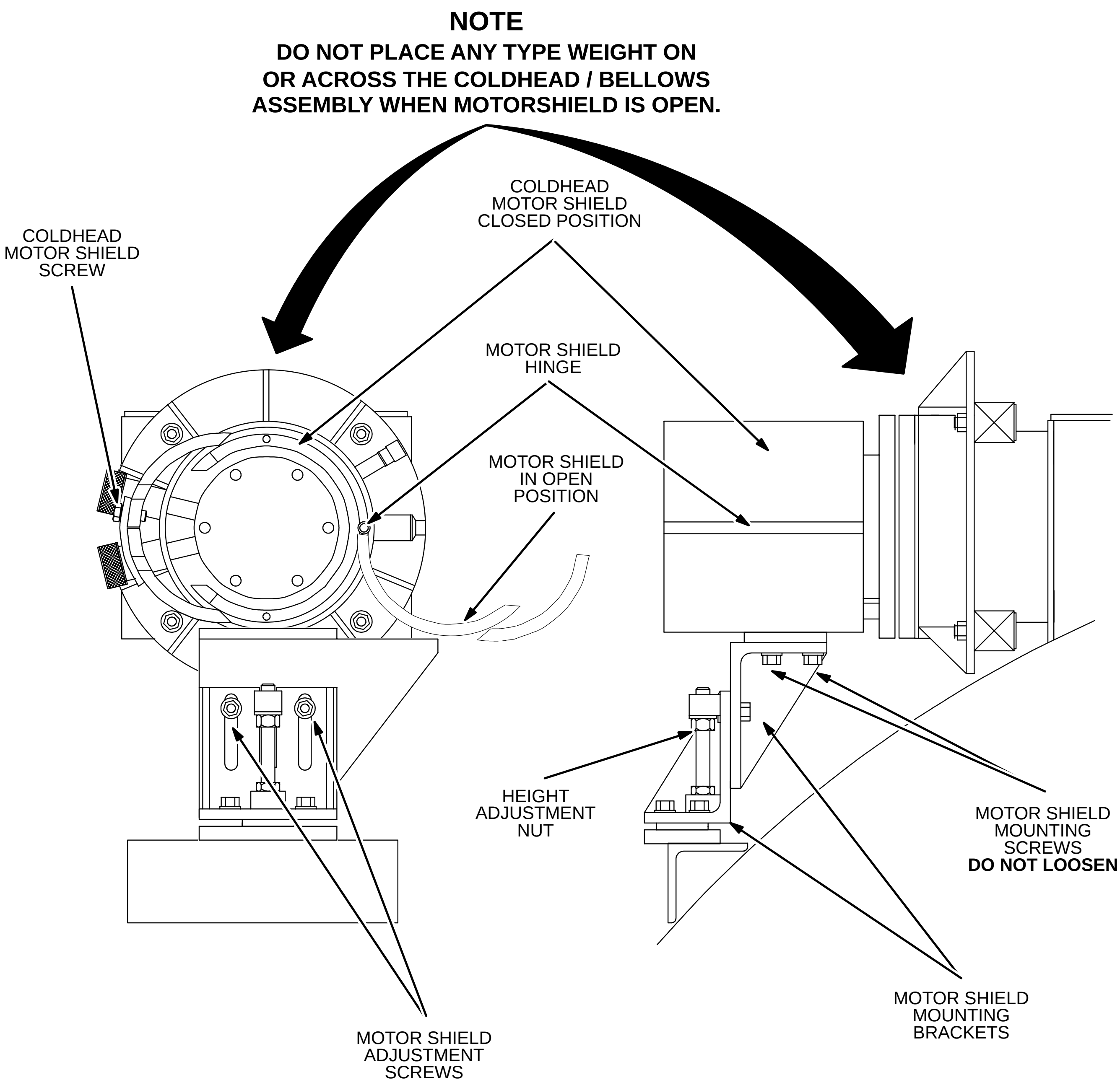
WEAR LEATHER GLOVES AND USE EXTREME CAUTION WHEN PIVOTING THE TOP HALF OF THE MOTOR SHIELD TOWARD THE MAGNET TO EXPOSE THE COLDHEAD OR PERSONAL INJURY MAY RESULT. DO NOT PUT FINGERS OR HAND BETWEEN THE MOTOR SHIELD AND THE MOUNTING BRACKET WHEN PIVOTING THE MOTOR SHIELD.

CAUTION

When coldhead motorshield is opened for coldhead changeout, the coldhead and attached bellows assembly should NEVER have any type of weight placed on or across them. Serious damage to magnet components could occur. See Illustration 11–5.

11. Turn off coldhead. Remove coldhead power cord and helium gas lines. Leave helium gas lines in safety strap and power cord inside ty–wraps that secure them. Position them in a convenient, out of the way location.
12. Remove and save the screw securing the top half of the motor shield. See Illustration 11–5.
13. Carefully pivot the top half of the shield to the full open position keeping fingers and hand away from vacuum vessel. See Illustration 11–5.
14. Loosen (do not remove) adjustment screws on motor shield base approximately 1/2 to 1 turn. Use height adjustment nut to lower motor shield to the bottom most position to allow maximum clearance for coldhead removal. See Illustration 11–5.

11–2 REMOVING INERTIA MASS DAMPENER AND MOTOR SHIELD (continued)



COLDHEAD MOTOR SHIELD REMOVAL
ILLUSTRATION 11–5

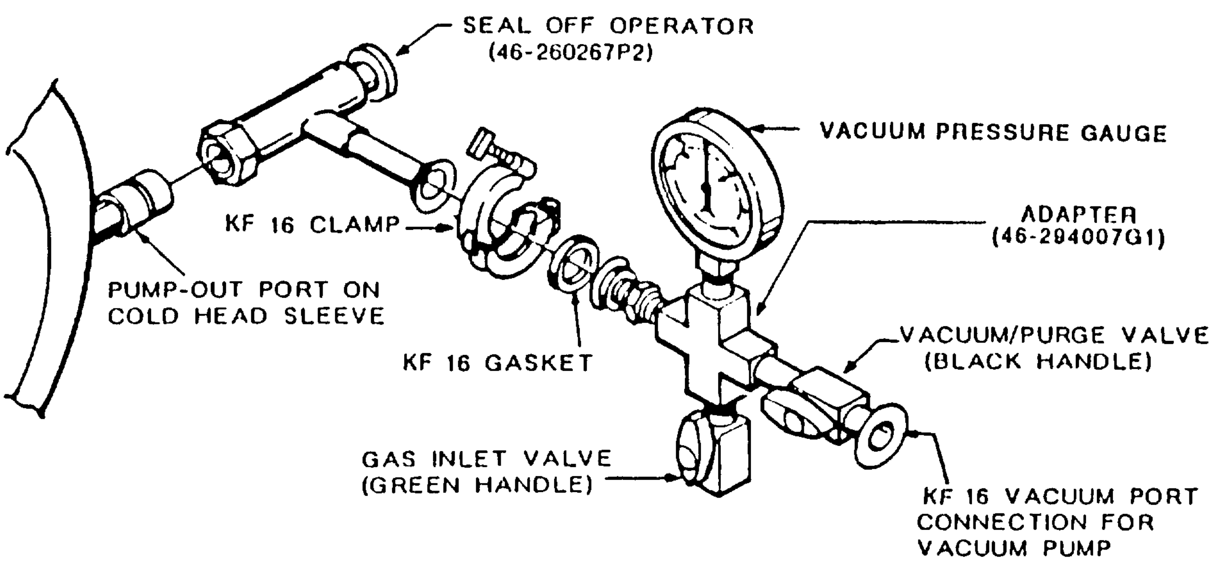
11–3 COLDHEAD REMOVAL

Procedure:

CAUTION

Keep strain relief ty–wraps on gas lines. Do not put a downward force on the Aeroquip fittings during removal of gas line connections to prevent a bending moment on the Aeroquip stem and increase friction force on the Aeroquip fitting threads.

1. Disconnect the gas lines at the Coldhead with the wrenches provided in the Shield Cooler Maintenance Kit. See REPLACEMENT MAINTENANCE, Section 10 (CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS).
2. Clean all vacuum fittings on apparatus shown in Illustration 11–x to make sure vacuum seals are tight.
3. Connect the Seal Off Operator (46–260267P2) to Adapter (46–294007G1).
4. Attach the Seal Off Operator and Adapter to the Pump Out Port on the Coldhead Sleeve. See Illustration 11–6.
5. 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 11–6

11–3 COLDHEAD REMOVAL (continued)

6. Connect Helium Gas Regulator (46–258151 P1) to the Helium Gas Cylinder (99.9995% pure) then to Flexible Hose (46–271135P1). Connect the hose to the Adapter Inlet Valve (green handle). See Illustration 11–7.

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.

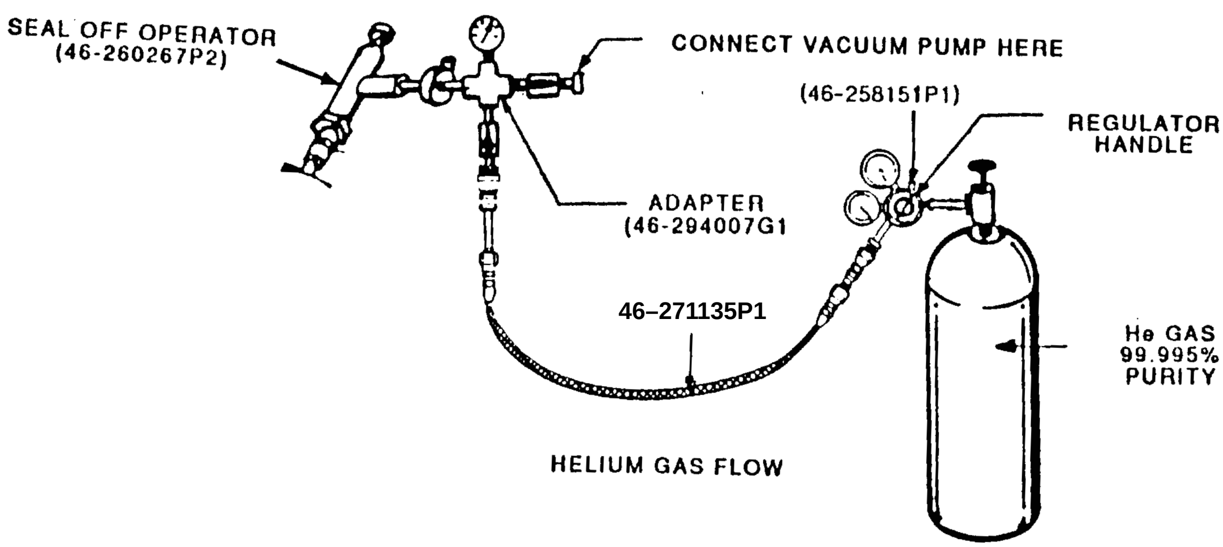
Note
A full gas cylinder is required for this procedure.

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 11–7

11–3 COLDHEAD REMOVAL (continued)

Note

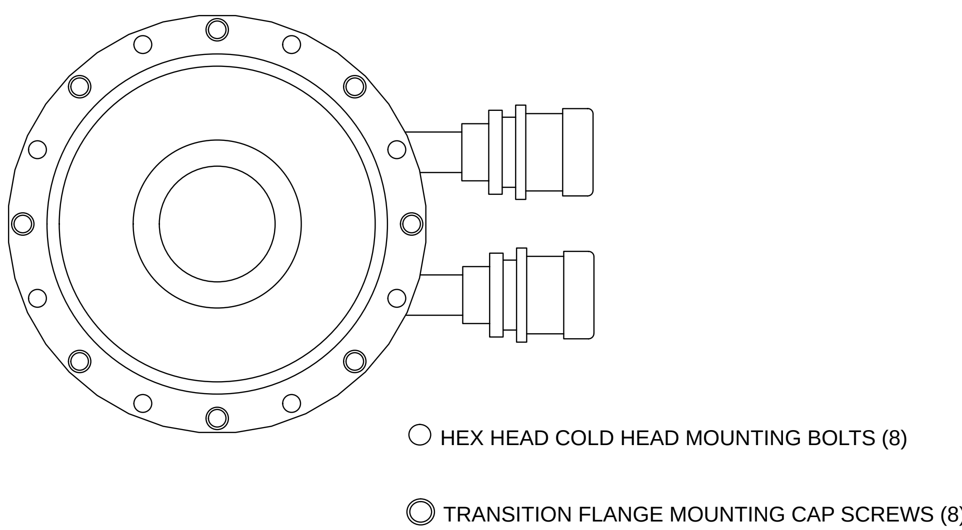
When the handle is pulled out, the gauge on the Adapter should indicate a vacuum.

12. Remove six of the eight Hex Head Bolts with Bellville Washers securing the Coldhead, leaving the remaining two bolts in to prevent the Coldhead from sliding out. See Illustration 11–8.

Note

Save the removed bolts and washers, leaving the same number of washers on each bolt. These will be used to mount the new Coldhead and will make sure that the proper interface spacing is maintained.

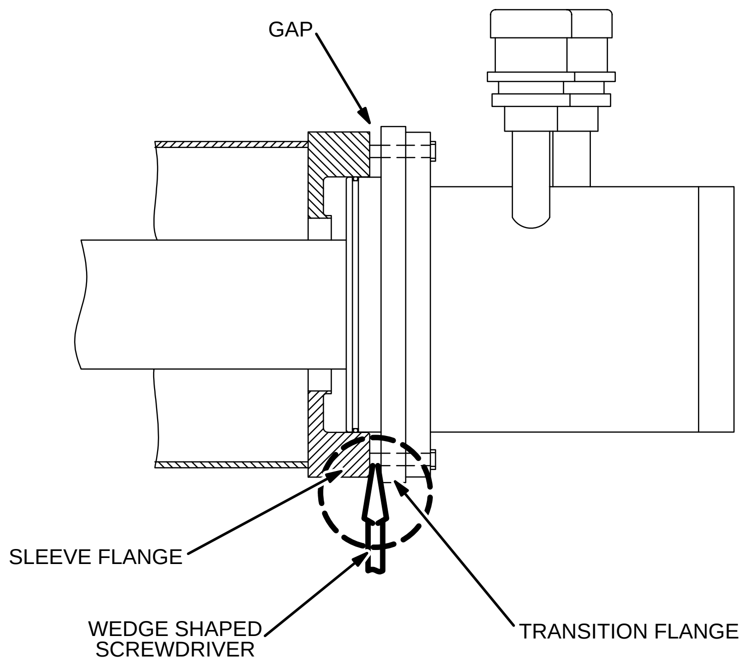
13. Open the Gas Inlet Valve (green handle) and fill the vacuum space in the sleeve with Helium Gas at a small positive pressure (≈ 1 psig).



COLDHEAD MOUNTING
ILLUSTRATION 11–8

11–3 COLDHEAD REMOVAL (continued)

14. Loosen the remaining two bolts to produce a 6 mm (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 11–9. Gas pressure in sleeve may be increased to 3 psig if required to aid in freeing coldhead.



SEPARATION OF TRANSITION FLANGE–SLEEVE FLANGE
ILLUSTRATION 11–9

Note
It will be evident when the coldhead “pops” away from the first stage contact in Step 15.

11–3 COLDHEAD REMOVAL (continued)

WARNING!

THE FOLLOWING PRECAUTIONS MUST BE TAKEN WHEN REMOVING THE COLDHEAD TO PREVENT THE COLDHEAD FROM BEING ATTRACTED BY THE MAGNETIC FIELD AND AVOID CRYOGEN BURNS:

- **MAKE SURE ALL REQUIRED EQUIPMENT IS ACCESSIBLE WITHIN YOUR REACH.**
- **MAKE SURE TO WEAR NON–ABSORBENT GLOVES WHEN REMOVING THE COLDHEAD. THE FIRST AND SECOND STAGES OF THE COLDHEAD ARE COLD AND CAN CAUSE CRYOGENIC BURNS IF CONTACT IS MADE WITH THE SKIN.**
- **WHEN THE COLDHEAD IS REMOVED, MAKE SURE IT IS SECURE AT THE TOP OF THE MAGNET COLDHEAD BOX OR TOP OF VAN IF A MOBILE.**

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 coldhead is removed, Immediately cover hole with plexiglas cover plate to prevent contamination.

CAUTION

The coldhead weighs approximately 35 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.

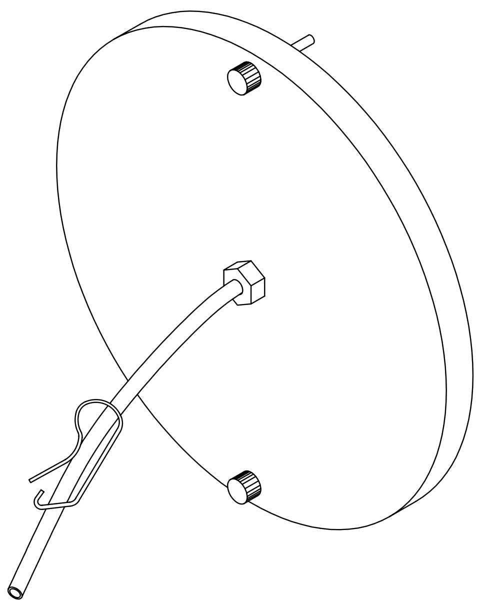
11–3 COLDHEAD REMOVAL (continued)

16 When the Coldhead "pops" free, remove the remaining two bolts. Lift the Coldhead straight out of the Coldhead sleeve rotating it 30 degrees clockwise to allow the connector to clear shield. Place coldhead securely on top of the coldhead box for a fixed site. In a mobile van, hand coldhead to person #2 to place on top of van.

Note

If Coldhead does not pull free in Step 16, perform Steps 18 through 21 to loosen the coldhead then repeat Step 16. If the Coldhead has been removed continue with Step 17.

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. Continue with Step 22. See Illustration 11–10.



PLEXIGLAS COVER PLATE (46–294010G1)
ILLUSTRATION 11–10

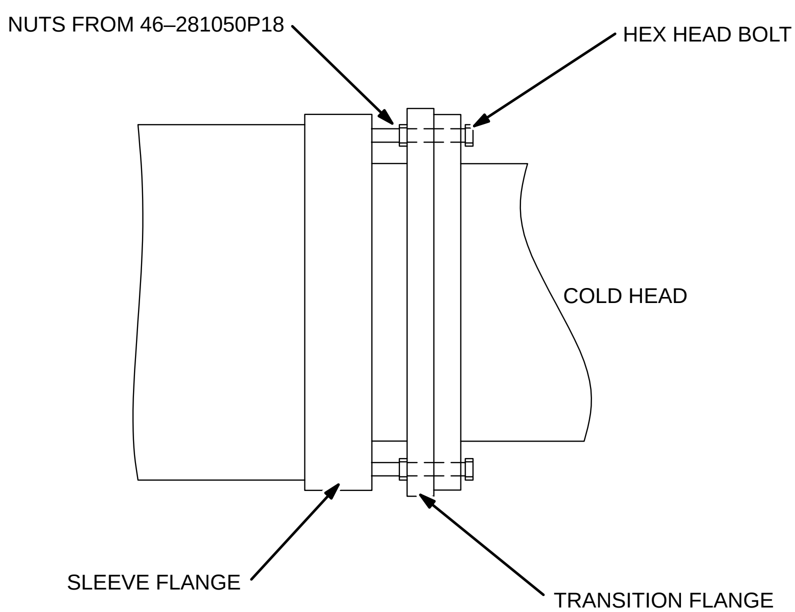
18. Insert two Hex Head Bolts through the bolt holes in the Transition Flange, 180 degrees apart. Remove the Bellville Washers temporarily from two bolts before inserting them.

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 11–11.

11–3 COLDHEAD REMOVAL (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 11–11

WARNING!

FOLLOW THE PROCEDURE IN SECTION 11–4, TRANSPORTING COLDHEAD FROM / TO MAGNET, COMPLETELY TO PREVENT THE COLDHEAD FROM BEING ATTRACTED (DRAWN INTO) THE MAGNET BORE.

22. Transport removed coldhead away from magnet in strict conformance with Section 11–4–1, TRANSPORTING COLDHEAD FROM MAGNET.

11–4 TRANSPORTING COLDHEAD FROM / TO MAGNET

WARNING!

DO NOT CARRY THE COLDHEAD NEAR THE MAGNET END FLANGE WHERE THE MAGNETIC ATTRACTION IS STRONG TO PREVENT THE COLDHEAD FROM BEING ATTRACTED INTO THE MAGNET BORE.

IMPORTANT !!!

Coldhead removal and replacement in a mobile van is a two person operation.

Both persons must wear non–absorbent gloves when handling a cold (frosted) coldhead.

The first person must be fully trained in the coldhead removal / replacement procedure and must be positioned:

- **Facing the coldhead box at the side rail of the magnet to provide ready access for all actions related to the removal / replacement of the coldhead from the coldhead sleeve.**
- **Facing the coldhead transport bag at the side rail when removing / returning the coldhead from / to the bag. See Illustration 11–12.**

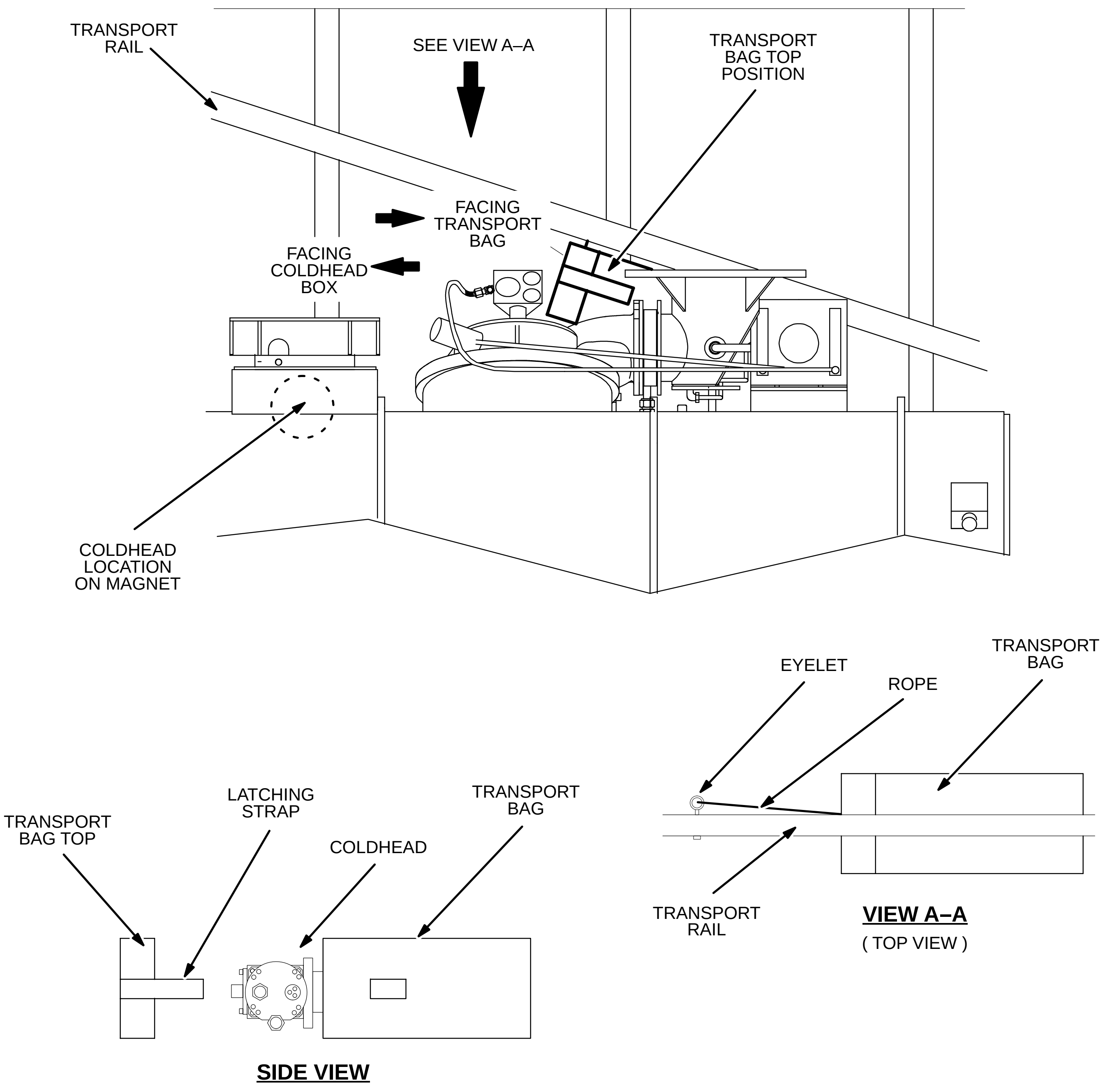
The second person must be trained in the preparation of the coldhead and must be positioned at the top of the magnet at the van hatch to:

- **Receive the used coldhead from the first person and place it securely on the top of the van.**
- **Receive the replacement coldhead to be prepared at the top of the van.**
- **Hand off the old coldhead for insertion into the transport bag.**
- **Hand off the new, prepared coldhead for insertion into the coldhead sleeve.**

Allow a removed coldhead to warm up before removing it from the top of the van.

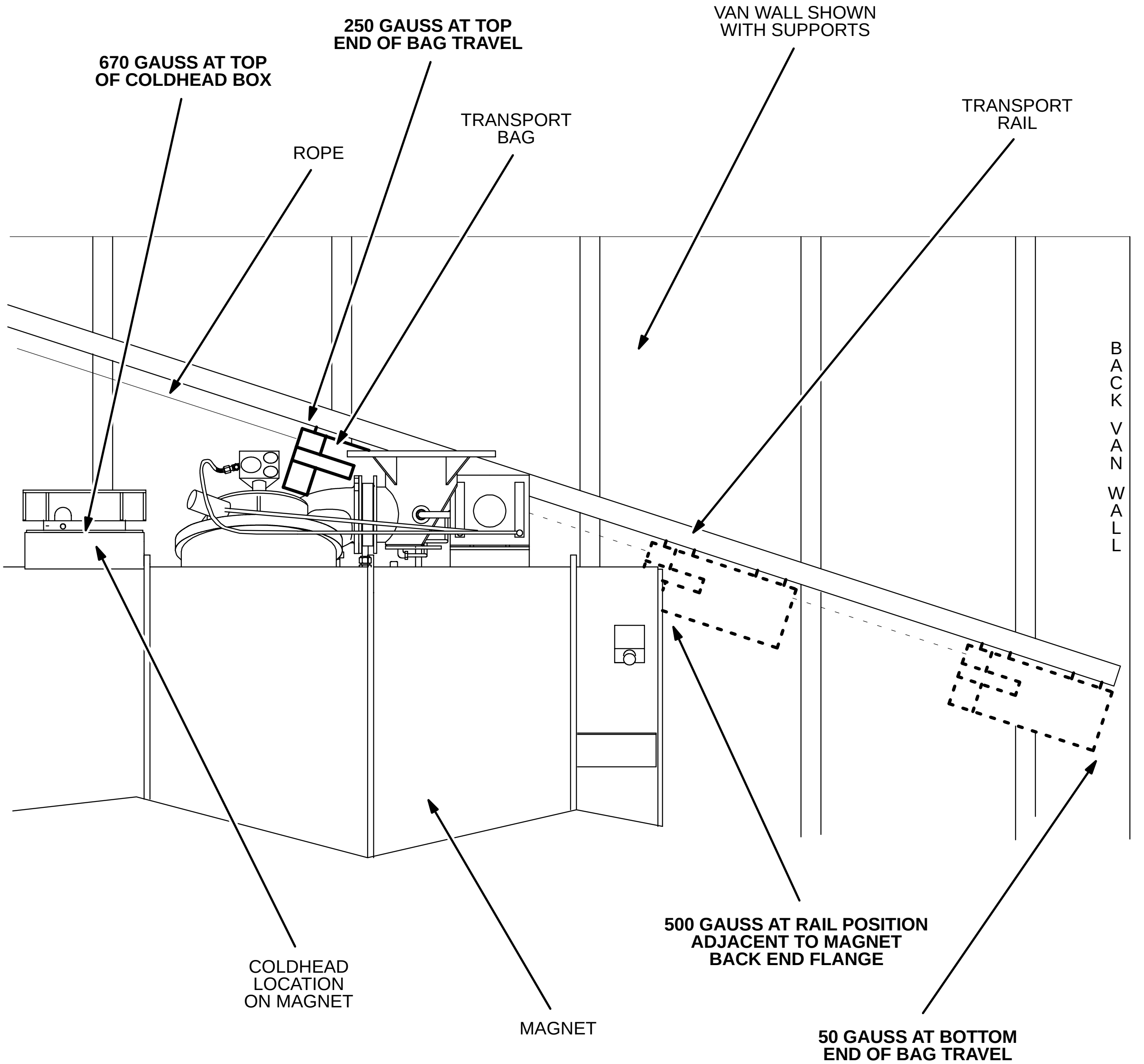
Illustration 11–13 shows the approximate gauss levels for the 1.5T magnet, along the route of the coldhead transport bag and at the coldhead box. Review this illustration before transporting a coldhead.

11–4–2 TRANSPORTING COLDHEAD TO MAGNET (continued)



COLDHEAD / TRANSPORT BAG
1.5T Cx MAGNET IN MOBILE VAN
ILLUSTRATION 11–12

11–4–2 TRANSPORTING COLDHEAD TO MAGNET (continued)



APPROXIMATE GAUSS LEVELS
1.5T Cx MAGNET IN MOBILE VAN
ILLUSTRATION 11–13

11–4 TRANSPORTING COLDHEAD FROM / TO MAGNET (continued)

11–4–1 TRANSPORTING COLDHEAD FROM MAGNET

FIXED SITE:

1. Handle coldhead securely with non–absorbent gloves and carry it from the coldhead box down to the bottom of the service ladder.
2. Carry the coldhead straight back to the magnet room wall.
3. Carry the coldhead along the magnet room wall and through the exit door.

MOBILE VAN:

1. Remove all ladders and apparatus from the side wall of the mobile van that will interfere with the travel of the coldhead transport bag along the rail.
2. Make sure the coldhead transport bag is locked at the top of the rail with the cover open and the first person is at the side rail facing the bag. See Illustration 11–12.
3. Retrieve the used coldhead securely from the top of the van (person #2) and hand it to person #1.
4. Place the coldhead into the coldhead transport bag and secure the bag cover (person #1). See Illustration 11–12.
5. Unlatch the rope from the eyelet on the transport rail and gradually lower the coldhead transport bag down the rail until it reaches the back van wall. See Illustration 11–12.
6. Remove the used coldhead from the transport bag and carry it along the back wall and out the rear door of the van.
7. Place the used coldhead in the replacement's shipping container for return.

11–4–2 TRANSPORTING COLDHEAD TO MAGNET

FIXED SITE:

CAUTION

Prepare the new coldhead outside the magnet room. See Section 11–1, PREPARATION, before bringing it to the magnet to prevent any magnetic attraction on the coldhead.

11–4–2 TRANSPORTING COLDHEAD TO MAGNET (continued)

FIXED SITE:

1. Carry the coldhead firmly into the magnet room and along the wall until it is adjacent to the coldhead side of the magnet.
2. Carry the coldhead from the wall directly to the service ladder.
3. Carry the prepared coldhead up the service ladder and secure on top of the coldhead box until ready for insertion into the coldhead sleeve.

MOBILE VAN:

CAUTION

Prepare the coldhead in conformance with Section 11–1, PREPARATION, on top of the mobile van after it has been transported in the coldhead transport bag tp prevent any damage to the coldhead gaskets during insertion into / removal from the bag.

1. Remove all ladders and apparatus from the side wall of the mobile van that will interfere with the travel of the coldhead transport bag along the rail.
2. Slide coldhead transport bag to the end of the transport rail against the back wall of the van.
3. Open transport bag cover and load new “unprep’ed” coldhead into the transport bag and close cover. See Illustration 11–12.
4. Pass rope from transport bag to the top of the magnet.

Note
Pressure gauge / flowmeter bracket will need to be loosened and moved if interference is encountered in sliding the transport bag up the rail.

5. Position person #1 at magnet side rail facing the transport bag. Pull the transport bag to the top position with the rope and connect the rope latch to the eyelet on the rail. See Illustration 11–12.
6. Person #1 then removes coldhead from the transport bag and hands it to person #2 at the top of the magnet.
7. Person #2 prepares the coldhead at the top of the van in conformance with Section 11–1, PREPARATION.

Note
Person #1 will need to be repositioned at the magnet side rail facing the coldhead box to install the new, prepared coldhead.

8. Reposition and tighten pressure gauge / flowmeter bracket if moved during this procedure.

11–5 COLDHEAD REPLACEMENT

1. 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.

CAUTION

If indium removal in Step 2 is required, do not keep the Sleeve Flange uncovered for an extended period of time (over 1 minute) to minimize icing.

2. 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.
3. If ice is present in sleeve use warmed helium gas, heat gun designed for use in a magnetic field or other appropriate method to remove ice.

CAUTION

Monitor Coldhead Diode temperatures if a Heat Gun is installed. Maintain the temperature between 285 and 300K. Do not allow the temperature to exceed 300K.

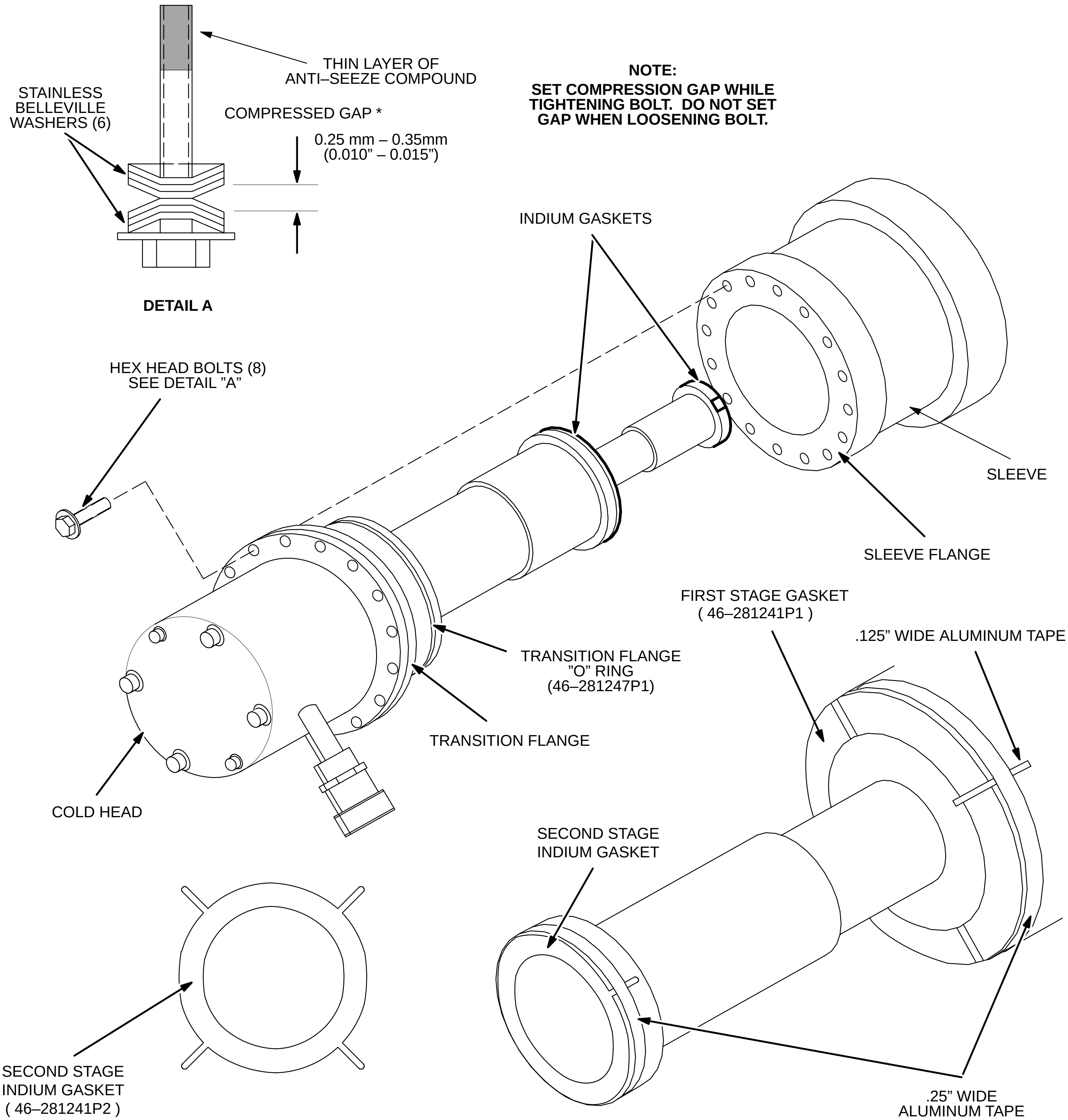
4. Continue helium gas purge to warm sleeve until new coldhead is ready for insertion.

WARNING!

FOLLOW THE PROCEDURE IN SECTION 11–4, TRANSPORTING COLDHEAD FROM / TO MAGNET, COMPLETELY TO PREVENT THE COLDHEAD FROM BEING ATTRACTED (DRAWN INTO) THE MAGNET BORE.

5. Transport new coldhead to magnet in strict conformance with Section 11–4–2, TRANSPORT COLDHEAD TO MAGNET, for fixed site. If in a mobile van, make sure prepared coldhead is on top of van. See Section 11–1, PREPARATION.
6. Replace Belleville washers on the eight coldhead mounting bolts removed for coldhead removal. Make sure the number and orientation is the same as shown in Illustration 11–14.
7. Apply a thin film of anti–seeze compound to the end of the eight coldhead mounting bolts. See Illustration 11–14.

11–5 COLDHEAD REPLACEMENT (continued)



COLDHEAD MOUNTING BOLT GAP SETTING
ILLUSTRATION 11–14

11–5 COLDHEAD REPLACEMENT (continued)

8. Temporarily remove the Bellville Washers from three bolts, leaving the fiat washers on the bolts if present. These will be used to insert the new Coldhead.

9. Close gas inlet valve (green handle on pump out adapter) and discontinue helium purge in sleeve. Remove plexiglas cover plate.

10. Inspect inside of sleeve. Make sure it is dry and clean.

11. Clean inside of sleeve using a lint free cloth / towel and alcohol or other commercially available non–residue forming substance.

WARNING!

THE FOLLOWING PRECAUTIONS MUST BE TAKEN WHEN REPLACING THE COLDHEAD INTO THE MAGNET SLEEVE:

- **MAKE SURE THAT THE COLDHEAD IS READY FOR INSERTION INTO THE SLEEVE AND ALL REQUIRED EQUIPMENT AND COMPONENTS (BOLTS AND BELLEVILLE WASHERS) ARE PRESENT.**
- **MAINTAIN A FIRM HOLD ON THE COLDHEAD AND CARRY IT UP THE SERVICE LADDER. IF IN A MOBILE VAN, PLACE THE COLDHEAD IN THE COLDHEAD TRANSPORT BAG AND SLIDE THE BAG UP THE DIAGONAL PIPE TO THE TOP POSITION.**

12. Securely bring prepared coldhead to top of magnet and align with sleeve.

CAUTION

Do not rotate the coldhead, in Step 13, with the indium gaskets in contact with the sleeve to prevent damaging the indium gasket. Be careful not to damage or displace the indium gaskets during coldhead insertion.

13. Carefully insert the Coldhead into the sleeve, rotate coldhead 30 degrees to allow connector to clear motor shield, then rotate back to position before contacting indium gaskets. Insert coldhead until the o–ring contacts the opening of the sleeve.

CAUTION

Do not attempt to insert the coldhead by hand beyond the point of o–ring contact as o–ring damage will result.

14. Insert the three bolts, with Bellville Washers removed in Step 8, equally spaced at 120 degree increments, in the mounting holes of the Coldhead Flange.

11–5 COLDHEAD REPLACEMENT (continued)

15. Thread and tighten 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.
16. Assemble and tighten the remaining 5 bolts with Bellville Washers. checked in Step 7, through the mounting holes in the Coldhead Flange.
17. Remove the three bolts inserted in Step 14; reassemble the Bellville Washers with the proper orientation; insert and tighten through the mounting holes in the Coldhead Flange.
18. Tighten all eight bolts evenly (hand tight).
19. Open the Vacuum Valve (black handle) and operate the Vacuum Pump for ten minutes to evacuate the sleeve space. During this time, reconnect gas flexlines, power cord and strain relief.
20. Close vacuum valve. 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 coldhead o–ring (46–281247P2) is required and the coldhead removal / replacement will have to be repeated using the same coldhead.

21. 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 Plug. Do not pull out the Knob Extension at this time.
22. Slowly crack open the Gas Inlet Valve (green handle) to observe the Vacuum Gauge slowly rising to approximately read –15 psig. Close the Gas Inlet Valve (green handle) to maintain a mid–range reading.
23. Pull out the Knob Extension on the Pump Out Port Operator approximately 50 mm (2 inches). Monitor the Vacuum Gauge, the reading should not change. If the gauge drops to a reading close to –30, then the Knob Extension was not completely unthreaded from the Pump Out Port Plug and you must re–evacuate the sleeve and re–check vacuum (Step 26).
24. When vacuum checks are good, reposition motorshield (centered around coldhead motor) by turning the height adjustment nut to raise the motorshield. See Illustration 11–5. Tighten all hardware. Install and tighten motorshield bolt.
25. Turn on compressor and coldhead to start the cooldown. This will result in the thermal contraction of the coldhead reducing its overall length. Check–out system. See Set–Up and Calibration, Section 1–4.
26. Measure and record the coldhead first and second stage temperatures in conformance with the magnet service manual, Section 1–5–7 of Set–Up and Calibration (“Monitoring Shield Cooler Temperatures”).
27. Turn off and remove Gas Supply, turn off Vacuum Pump, open Gas Inlet Valve (green handle) to vent system and disconnect and remove apparatus.
28. Place the removed Coldhead in the New Coldhead Carton and return for servicing per instructions in carton. Make sure Coldhead is properly packaged and secure in the carton.

11–5 COLDHEAD REPLACEMENT (continued)

Note

Record the following information for dispatching and future tracking purposes. Both the new and old coldhead model and serial numbers, installation date, compressor model, serial number and current hour meter reading.

29. Re–measure and record the coldhead first and second stage temperatures in conformance with the magnet service manual, Section 1–5–7 of Set–Up and Calibration (“Monitoring Shield Cooler Temperatures”). Compare the readings to the reading obtained in Step 33. You should notice the temperatures have started to fall on both stages.

11–6 COLDHEAD SETTINGS

1. After the coldhead has cooled down for approximately four hours, tighten the coldhead mounting bolts hand tight in a “CW” rotational pattern.

Note

If time does not permit a 4 hour wait period, allow the coldhead to run at least one hour from initial turn–on. During this one hour interval, maintain the hand tightness of the mounting bolts. After the one hour interval has passed, tighten the mounting bolts to the largest gap allowed on the Belleville washers. See Illustration 11–14, Detail A. If this alternative step is used, you must return the following day to set the final Belleville washer gap continuing at Step 3.

2. Continue to hand tighten the coldhead mounting bolts in the above manner, at approximately four hour intervals, until the first and second stage temperatures have stabilized.

3. When temperatures have stabilized, tighten all coldhead mounting bolts evenly, in a “star” pattern, to result in the Bellville washer gap setting between 0.010” – 0.015” (0.25 mm – 0.35 mm). See Illustration 11–14. Measure the distance between the transition flange and the cryostat sleeve flange.

Note

First and second stage temperature may decrease farther, after setting the Bellville washer gap.

4. Establish if the stabilized temperatures are within specification range (32 – 60 K First Stage, 7 –17 K Second Stage). The temperatures that were found for your magnet in the factory are recorded in the Acceptance Test Report (ATR) found in the DATA SHEET Section or your manual. If temperatures are higher than those values, perform the tests listed in FUNCTIONAL CHECKS, Section 6 of this manual.

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

11–7 COLDHEAD INERTIA MASS DAMPENER ASSEMBLY INSTALLATION

Note

Inertia Mass Dampener Assembly may not have been required and therefore not installed on all magnets. If assembly was not present, this subsection will not be necessary.

WARNING!

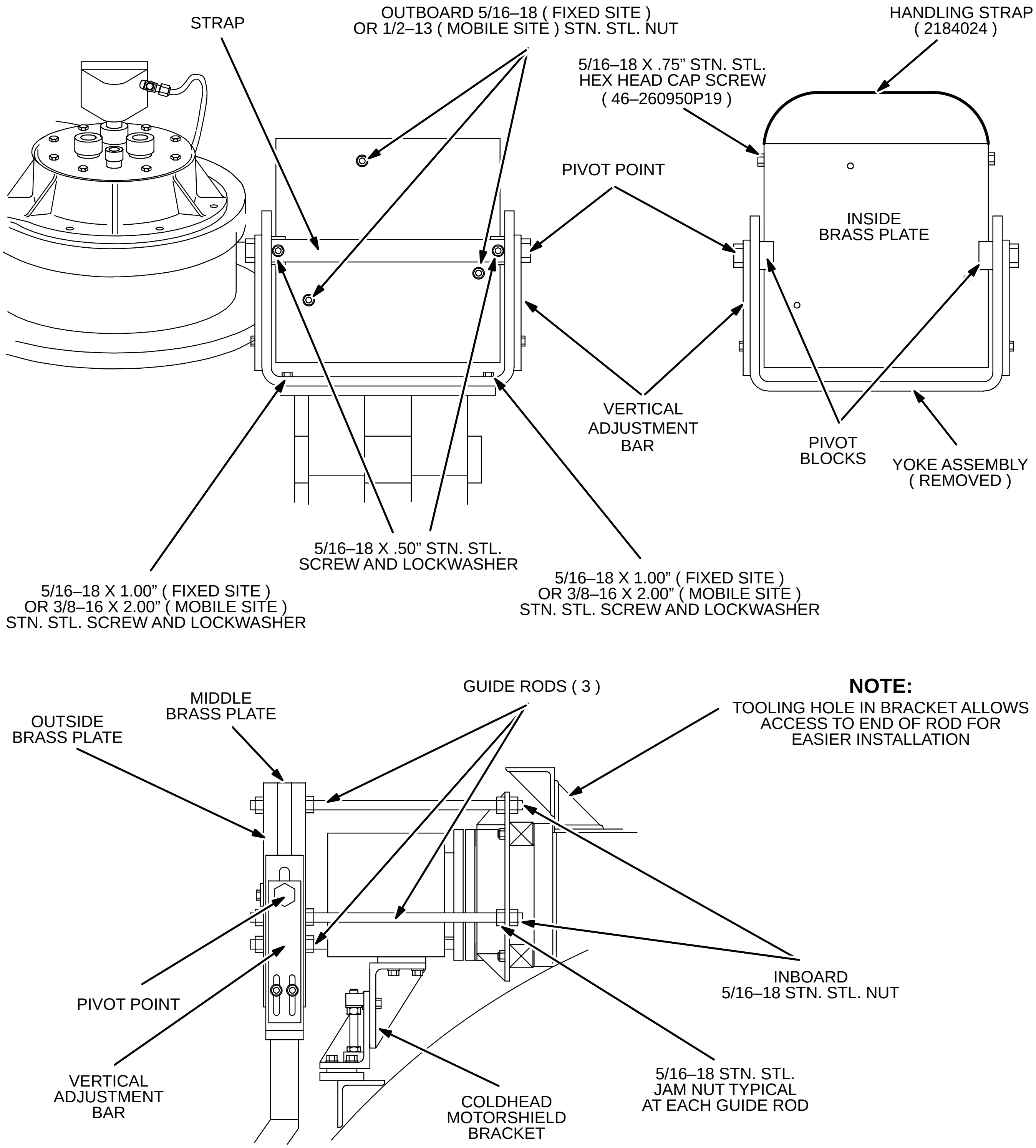
THIS PROCEDURE REQUIRES THE HANDLING OF HEAVY PARTS (UP TO 33 POUNDS). MAKE SURE SERVICE LADDER IS FIRMLY IN PLACE AND USE CAUTION IN HANDLING PARTS TO AVOID DROPPING PARTS OR STRAINING MUSCLES.

Note

If brass block and yoke assembly is installed, go to Sep 5.

1. Install yoke assembly (inside brass plate, pivots, pivot blocks and vertical adjustment bars) on top of frame with holes in pivot block facing outboard. Secure yoke assembly to frame using two 5/16–18 x 1.00” (fixed site) or 3/8–16 x 2.00” (mobile site) long stn. stl. screws and washers. See Illustration 11–15.
2. Carefully slide middle brass plate onto pivot blocks against inside plate.
3. Carefully slide outside brass plate onto pivot blocks against middle plate.
4. Install strap across outside face of plate stack and secure with two 5/16–18 x .50” long stn. stl. screws and washers. Tighten screws to compress plate stack.
5. Thread the three guide rods through plates into holes in the outside plate until 1/2” to 3/4” of the threads extend beyond the face of the plate. Secure with 5/16–18 (fixed site) or 1/2–13 (mobile site) stn. stl. nuts. Tighten nuts on inside of plates. See Illustration 11–15.
6. Thread 5/16” nuts fully onto the other end of each rod.
7. Push plate stack / guide rods through holes in the isolator brackets until plates contact coldhead motor or guide rods contact vacuum vessel. See Illustration 11–15.
8. Install 5/16–18 nuts onto end of rods to capture on the isolator brackets.
9. Adjust nuts on guide rods to align plate stack along coldhead axis until 1/8” minimum gaps exist between the coldhead inertia mass dampener assembly, coldhead motorshield bracket, support tube, vacuum vessel, shroud, enclosure and rails (at mobile site). See Illustration 11–15.
10. When a minimum of 1/8” gap envelope exists around the coldhead inertia assembly, tighten outboard guide rod nuts and three jam nuts. Make sure no binding of guide rods exist.
11. Manually push / pull plate stack with coldhead off (10 to 30 pound force) to confirm smooth motion. Any binding must be adjusted out.
12. Turn coldhead on and confirm minimum clearance of 1/8” around the coldhead inertia assembly.
13. Re–assemble shroud side cover. Confirm no contact with inertia assembly.

11–7 COLDHEAD INERTIA MASS DAMPENER ASSEMBLY INSTALLATION



INERTIA MASS DAMPENER INSTALLATION

ILLUSTRATION 11–15

SECTION 12 – SHI COLDHEAD REPLACEMENT

DANGER!!

MAKE SURE THAT THE FOLLOWING ACTIONS ARE TAKEN BEFORE STARTING THIS PROCEDURE TO PREVENT POTENTIAL FATAL INJURY !!!

REVIEW AND FULLY UNDERSTAND THE SUPERCONDUCTING MAGNET SAFETY REQUIREMENTS SECTION (INTRODUCTION, SECTION 5–3) OF THIS MANUAL.

FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THIS PROCEDURE IN THE SAFETY CHECKLIST SECTION (INTRODUCTION, SECTION 5–5, TABLE 5–1) OF THIS MANUAL.

WARNING!

THE FOLLOWING SAFETY PRECAUTIONS MUST BE TAKEN BEFORE STARTING TO CHANGE OUT A COLDHEAD OF A MAGNET AT FIELD. THESE PRECAUTIONS ARE REQUIRED TO PREVENT FERROMAGNETIC MATERIAL FROM BECOMING DANGEROUS PROJECTILES IN THE MAGNETIC FIELD OR THE COLDHEAD FROM BEING ATTRACTED INTO THE BORE OR ONTO THE OUTER VESSEL OF THE MAGNET.

THIS PROCEDURE MUST BE PERFORMED BY PERSONNEL TRAINED AND QUALIFIED IN THE REPLACEMENT OF A COLDHEAD WHILE THE MAGNET IS AT FIELD.

THE COLDHEAD MUST NEVER BE BROUGHT NEAR THE MAGNET BORE OR IN CONTACT WITH THE OUTER VESSEL DURING REMOVAL / REPLACEMENT.

DO NOT BRING ANY FERROMAGNETIC TOOLS OR EQUIPMENT INTO THE MAGNET ROOM. FERROMAGNETIC MATERIAL CAN BECOME DANGEROUS PROJECTILES IN A MAGNETIC FIELD.

MAKE SURE THE MAGNET RUNDOWN UNIT IS FUNCTIONING PROPERLY TO ENABLE THE MAGNETIC FIELD TO BE QUICKLY DISCHARGED IN CASE OF AN EMERGENCY. SEE SECTION 5 OF FUNCTIONAL CHECKS.

THE COLDHEAD TRANSPORT BAG ON SIDE OF VAN MUST BE USED TO TRANSPORT COLDHEAD FROM TOP OF MAGNET IN A MOBILE VAN. IN A FIXED SITE, BOTH OLD AND NEW COLDHEADS MUST BE CARRIED FROM / TO SIDE OF MAGNET IN A DIRECT PATH FROM / TO WALL OF THE ROOM. NEVER BRING THE COLDHEAD NEAR THE END FLANGES OF THE MAGNET WHERE IT CAN BE DRAWN IN THE BORE.

A SECOND PERSON IS REQUIRED TO ASSIST IN THE CHANGEOUT OF A COLDHEAD IN A MOBILE VAN. THIS ENABLES THE PERSON REMOVING THE COLDHEAD TO HAND IT OFF TO THE SECOND PERSON.

IF ALL OF THE ABOVE CONDITIONS ARE NOT MET, THE MAGNET MUST BE RAMPED DOWN BEFORE CHANGING THE COLDHEAD.

12–1 PREPARATION

CAUTION

When coldhead motorshield is opened for coldhead changeout, the coldhead and attached bellows assembly should NEVER have any type of weight placed on or across them. Serious damage to magnet components could occur. See Illustration 12–3.

EQUIPMENT:

- New / reconditioned coldhead kit (2209470)
- Full helium gas cylinder (99.9995%)
- Shield cooler maintenance kit (46–281088G3)
- Shield cooler vacuum pump kit (46–294047G1)
- Gas cylinder cart (46–258150P1)
- Regulator kit (46–306734G1)
- Non–magnetic tool kit
- Flashlight

1. Make sure a new / reconditioned coldhead kit and all required equipment is on site before starting procedure.
2. Make sure the procedure is performed by a person trained and qualified to change out a coldhead in a magnetic field!
3. Remove magnet side cover in a fixed site. In a mobile site, undock table and remove table and front cover. Lift or remove front facade in a mobile van to gain access to the top of the magnet.

Note

Access to the top of the magnet from the front is required in a mobile van to run helium gas lines and the vacuum line to the adapter tee.

CAUTION

Prepare new coldhead for a fixed site outside of the magnet room to prevent attraction of the coldhead to the magnet.

If in a mobile van, transport the new coldhead to the top of the van in strict conformance with Section 12–4–2, TRANSPORTING COLDHEAD TO MAGNET, before it is prepared to prevent damaging gaskets when inserting coldhead into transport bag.

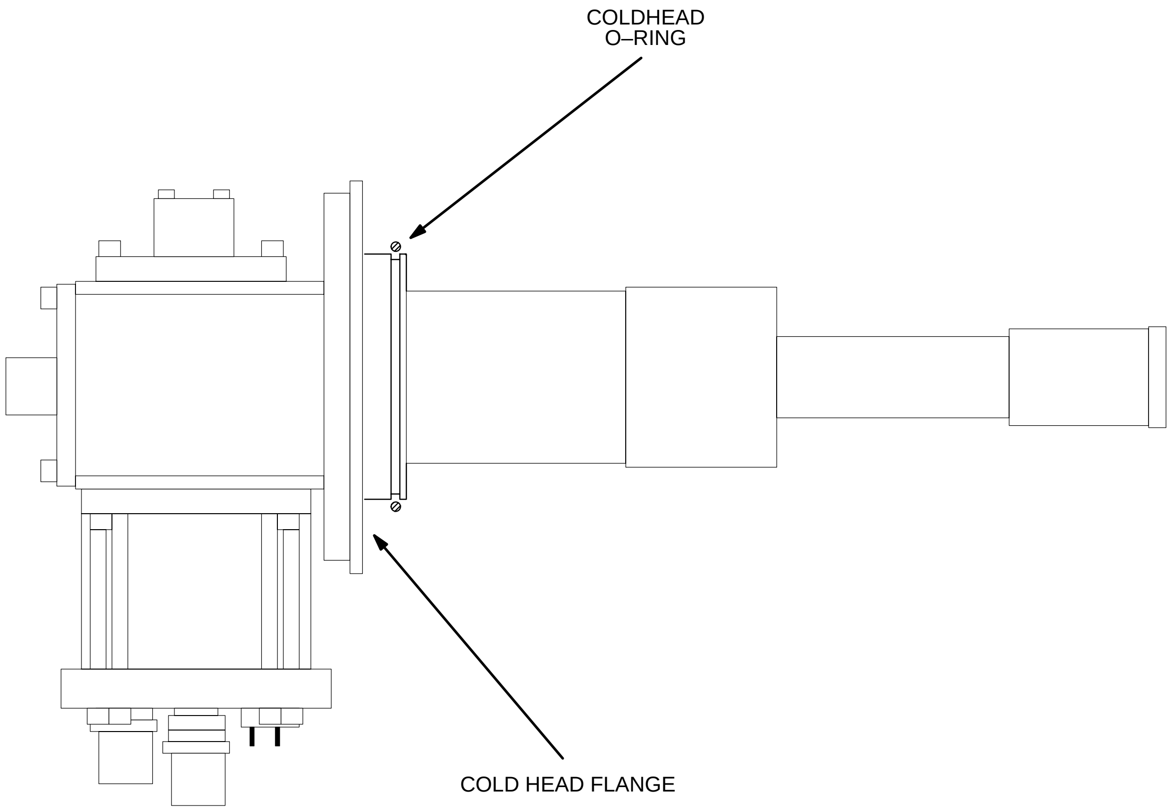
WARNING!

FOLLOW THE PROCEDURE IN SECTION 12–4, TRANSPORTING COLDHEAD FROM / TO MAGNET, COMPLETELY TO PREVENT THE COLDHEAD FROM BEING ATTRACTED (DRAWN INTO) THE MAGNET BORE.

12–1 PREPARATION (continued)

4. Remove the new / reconditioned Coldhead 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.

5. Remove o–ring (46–281247P1) from the Poly–bag attached to the Coldhead and wipe with a dry, lint free cloth/towel. Inspect the o–ring for nicks or cuts.

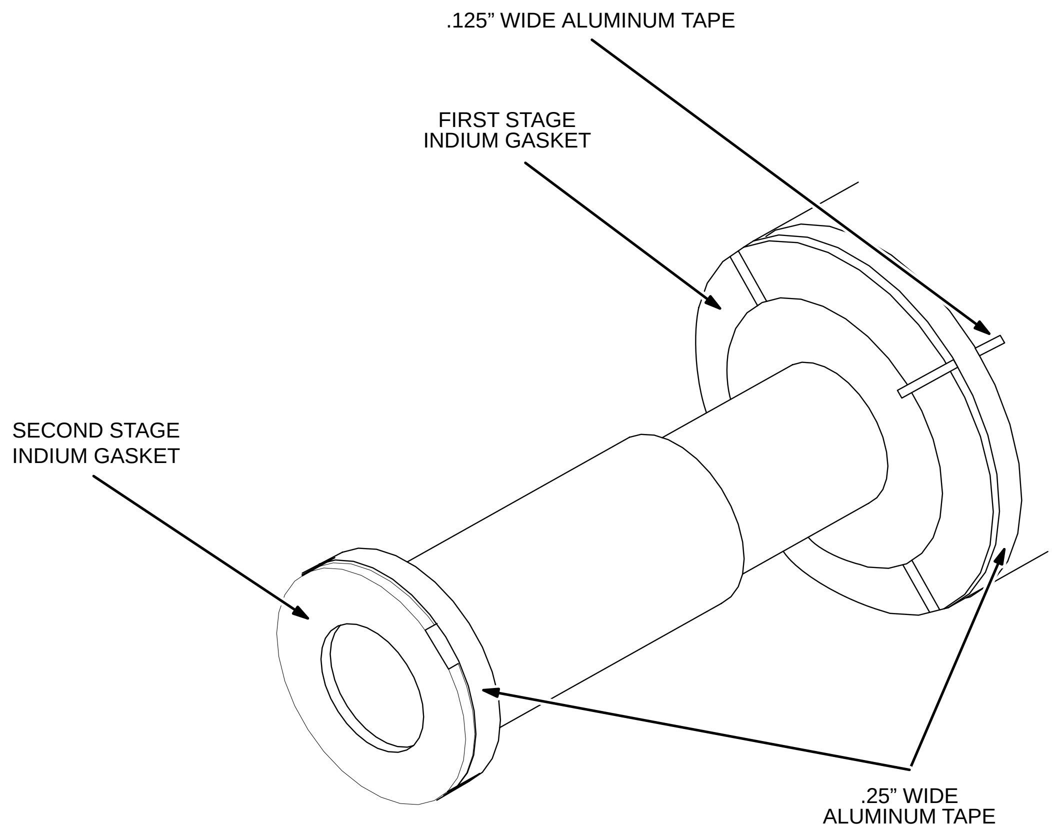


COLDHEAD O–RING PLACEMENT
ILLUSTRATION 12–1

6. 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 Coldhead Flange. Apply a thin film of Vacuum Grease to the top surf ace of the o–ring and groove. See Illustration 12–1.

7. Place small Indium Gasket (46–281241P2) on the small Copper Station of the Coldhead. Fold the tabs on the gasket over the station to keep the gasket in place. See Illustration 12–2.

12–1 PREPARATION (continued)



COLDHEAD INDIUM GASKET INSTALLATION
ILLUSTRATION 12–2

8. Place large Indium Gasket (46–281241P1) on the large Copper Station of the Coldhead. 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.

12–2 REMOVING MOTOR SHIELD

1. Turn off coldhead at compressor.

WARNING!

THE COLDHEAD SHIELD IS MADE OF FERROMAGNETIC MATERIAL AND HAS A LARGE ATTRACTIVE FORCE TO THE MAGNET. DO NOT REMOVE THE MOTOR SHIELD MOUNTING SCREWS UNDER ANY CIRCUMSTANCE.

USE EXTREME CAUTION WHEN PIVOTING THE TOP HALF OF THE MOTOR SHIELD TO EXPOSE THE COLDHEAD. DO NOT PUT FINGERS OR HAND BETWEEN THE MOTOR SHIELD AND THE MOUNTING BRACKET WHEN PIVOTING THE MOTOR SHIELD TOWARD THE MAGNET.

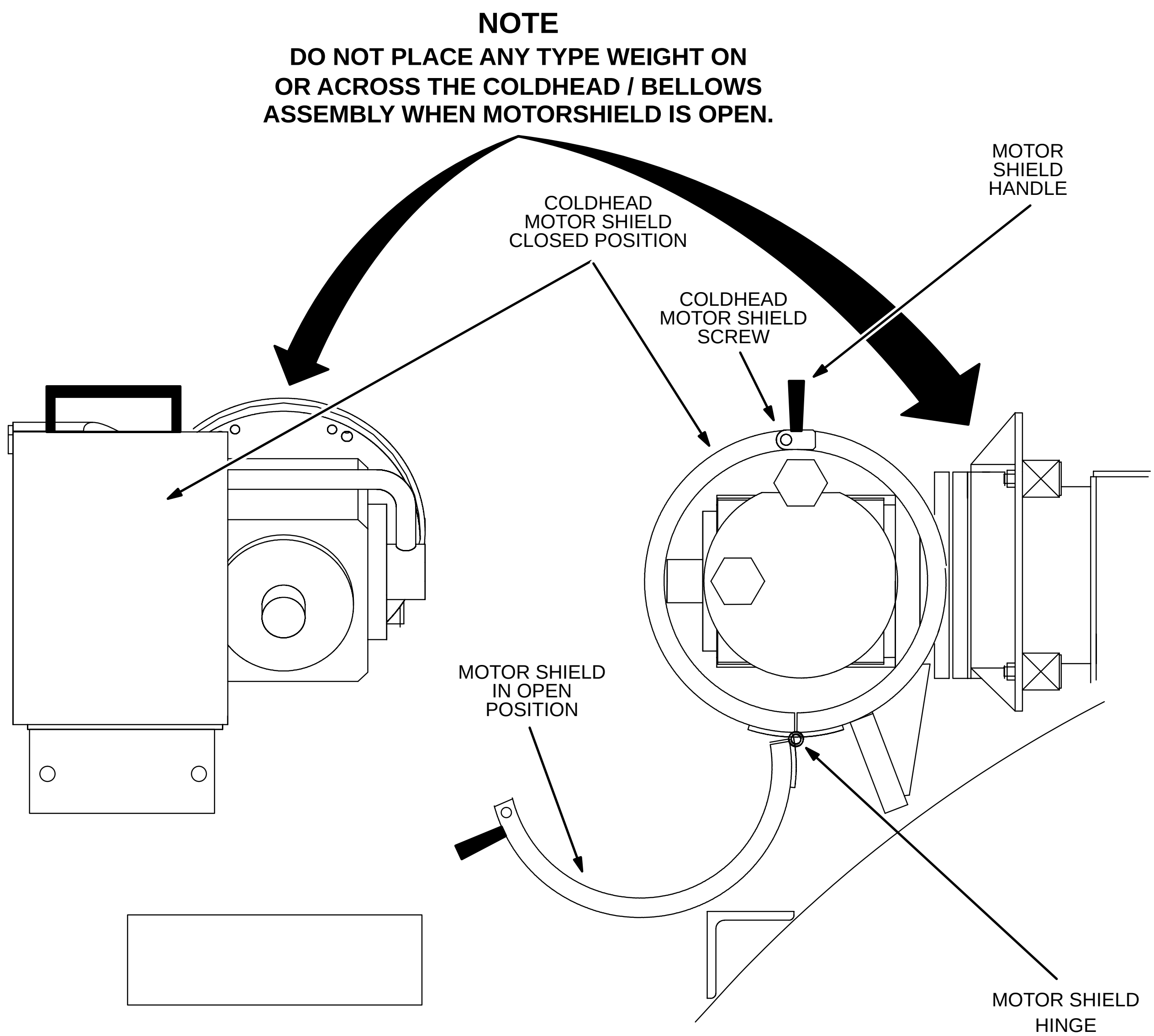
2. Remove and save the Allen head screw on the motorshield tab. Grab motorshield handle and gently lower front half of shield against stop. See Illustration 12–3.

CAUTION

When coldhead motorshield is opened for coldhead changeout, the coldhead and attached bellows assembly should NEVER have any type of weight placed on or across them. Serious damage to magnet components could occur. See Illustration 12–3.

3. Remove coldhead power cord and helium gas lines. Leave helium gas lines in safety strap and power cord inside ty–wraps that secure them. Position them in a convenient, out of the way location.

12–2 REMOVING MOTOR SHIELD (continued)



COLDHEAD MOTOR SHIELD REMOVAL
ILLUSTRATION 12–3

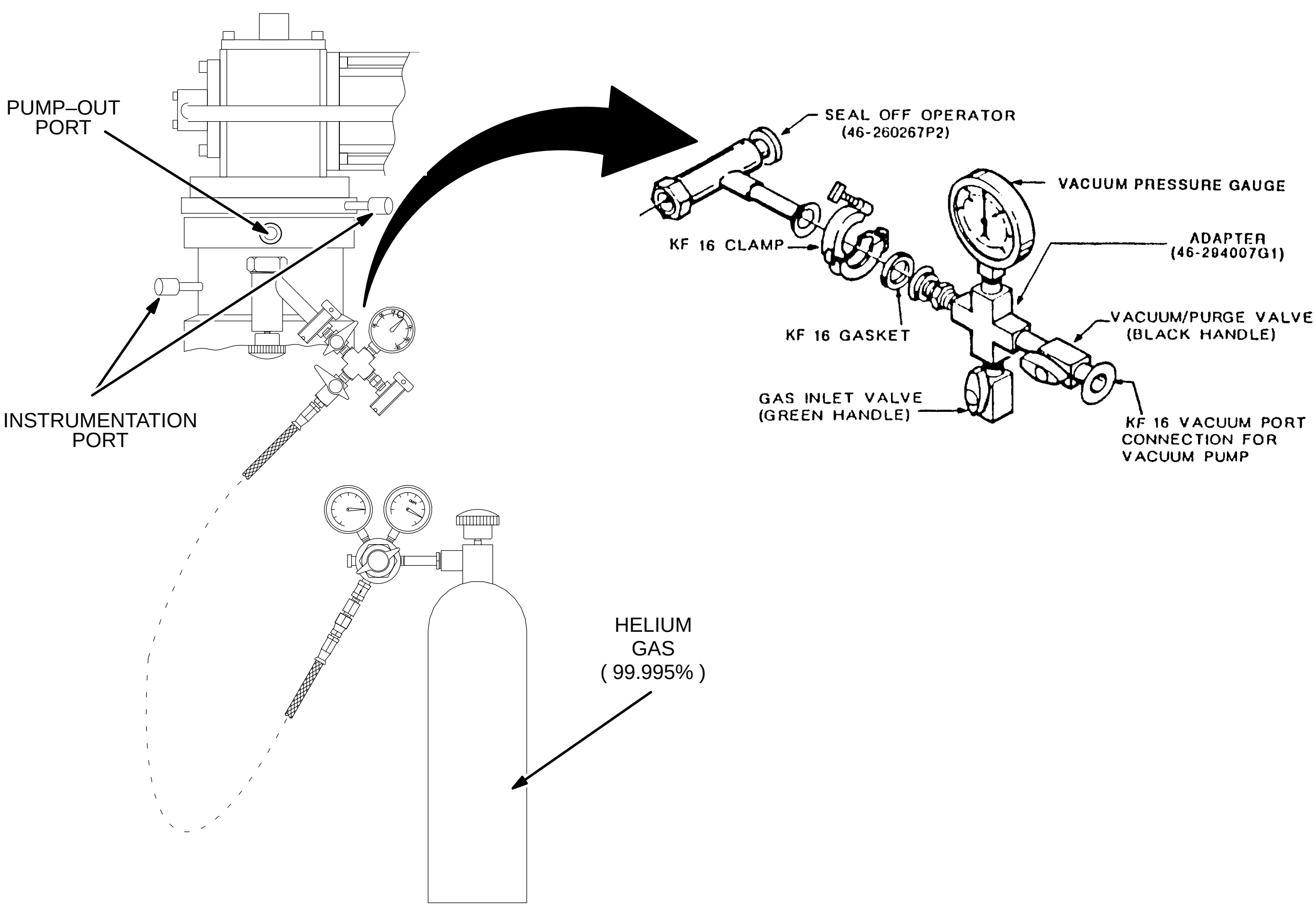
12–3 COLDHEAD REMOVAL

Procedure:

CAUTION

Keep strain relief ty–wraps on gas lines. Do not put a downward force on the Aeroquip fittings during removal of gas line connections to prevent a bending moment on the Aeroquip stem and increase friction force on the Aeroquip fitting threads.

1. Disconnect the gas lines at the Coldhead with the wrenches provided in the Shield Cooler Maintenance Kit. See REPLACEMENT MAINTENANCE, Section 10 (CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS).
2. Clean all vacuum fittings on apparatus shown in Illustration 12–4 to make sure vacuum seals are tight.
3. Connect the Seal Off Operator (46–260267P2) to Adapter (46–294007G1).
4. Attach the Seal Off Operator and Adapter to the Pump Out Port on the Coldhead Sleeve. See Illustration 12–4.
5. Tighten the Seal Off Operator to the Pump Out Port by holding the body of the operator and tightening the nut with a wrench.



COLDHEAD GAS / VACUUM SERVICE APPARATUS
ILLUSTRATION 12–4

12–3 COLDHEAD REMOVAL (continued)

6. Connect Helium Gas Regulator (46–258151 P1) to the Helium Gas Cylinder (99.9995% pure) then to Flexible Hose (46–271135P1). Connect the hose to the Adapter Inlet Valve (green handle). See Illustration 12–5.

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.

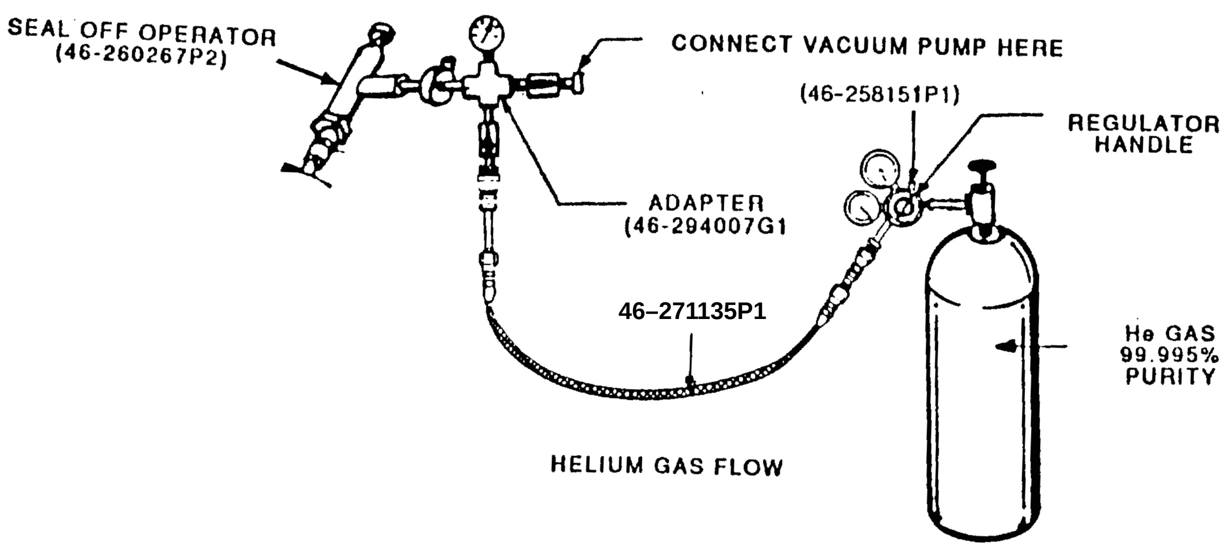
Note
A full gas cylinder is required for this procedure.

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 12–5

12–3 COLDHEAD REMOVAL (continued)

Note

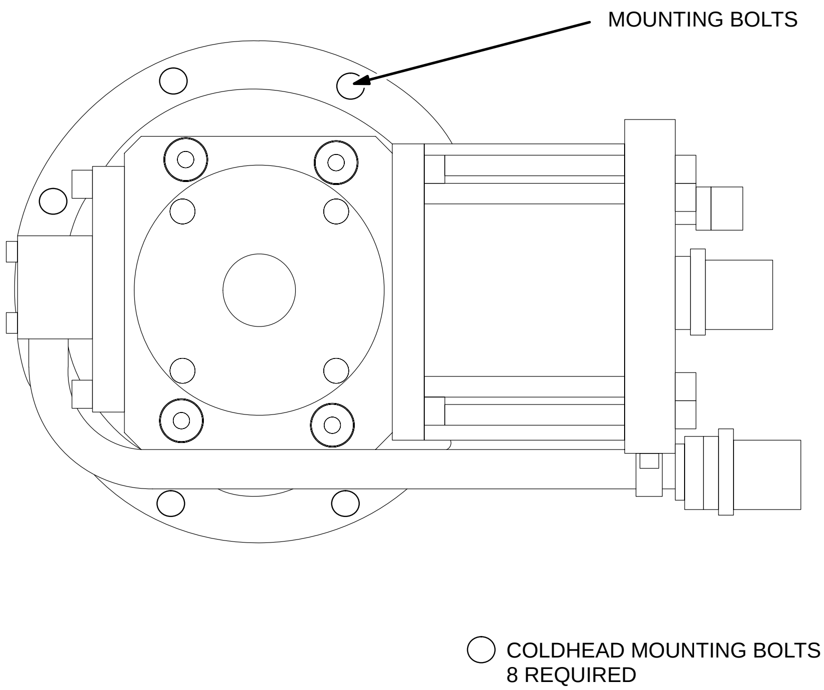
When the handle is pulled out, the gauge on the Adapter should indicate a vacuum.

12. Remove six of the eight Hex Head Bolts with Bellville Washers securing the Coldhead, leaving the remaining two bolts in to prevent the Coldhead from sliding out. See Illustration 12–6.

Note

Save the removed bolts and washers, leaving the same number of washers on each bolt. These will be used to mount the new Coldhead and will make sure that the proper interface spacing is maintained.

13. 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).

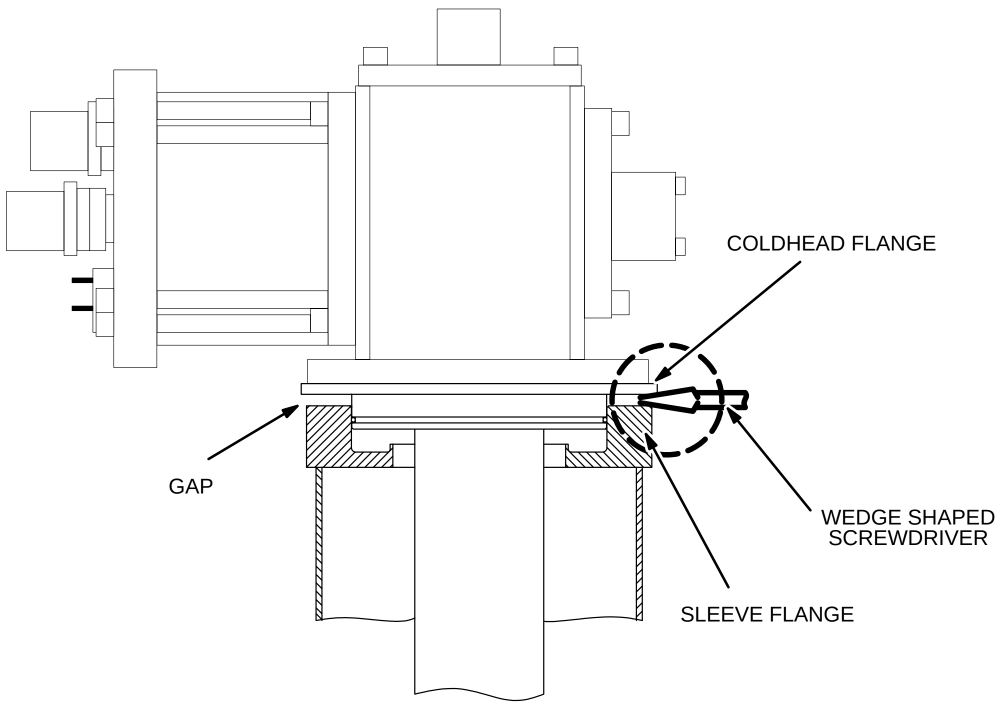


COLDHEAD MOUNTING
ILLUSTRATION 12–6

12–3 COLDHEAD REMOVAL (continued)

14. Loosen the remaining two bolts to produce a 6 mm (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 12–7. Gas pressure in sleeve may be increased to 3 psig if required to aid in freeing coldhead.



SEPARATION OF TRANSITION FLANGE–SLEEVE FLANGE
ILLUSTRATION 12–7

Note
It will be evident when the coldhead “pops” away from the first stage contact in Step 15.

12–3 COLDHEAD REMOVAL (continued)

WARNING!

THE FOLLOWING PRECAUTIONS MUST BE TAKEN WHEN REMOVING THE COLDHEAD TO PREVENT THE COLDHEAD FROM BEING ATTRACTED BY THE MAGNETIC FIELD AND AVOID CRYOGEN BURNS:

- **MAKE SURE ALL REQUIRED EQUIPMENT IS ACCESSIBLE WITHIN YOUR REACH.**
- **MAKE SURE TO WEAR NON–ABSORBENT GLOVES WHEN REMOVING THE COLDHEAD. THE FIRST AND SECOND STAGES OF THE COLDHEAD ARE COLD AND CAN CAUSE CRYOGENIC BURNS IF CONTACT IS MADE WITH THE SKIN.**
- **WHEN THE COLDHEAD IS REMOVED, MAKE SURE IT IS SECURE AT THE TOP OF THE MAGNET COLDHEAD BOX OR TOP OF VAN IF A MOBILE.**

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 coldhead is removed, Immediately cover hole with plexiglas cover plate to prevent contamination.

CAUTION

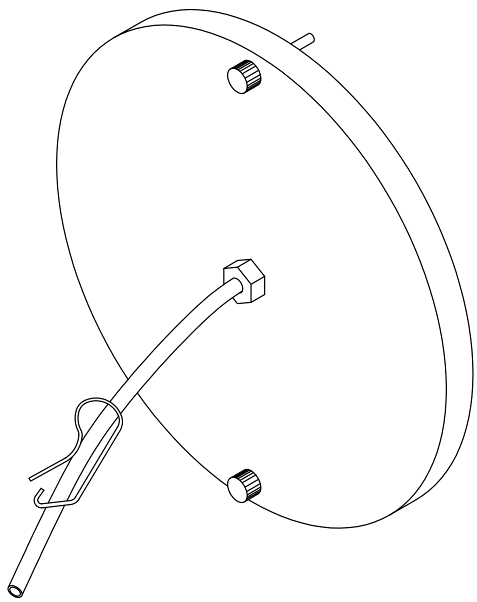
The coldhead weighs approximately 45 pounds and will require lifting straight out to prevent binding. Make sure there is adequate reach and support for its weight before lifting it out.

12–3 COLDHEAD REMOVAL (continued)

CAUTION

The coldhead weighs approximately 40 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 Coldhead “pops” free, remove the remaining two bolts. Lift the Coldhead straight out of the Coldhead sleeve and place it in a secure position. Place coldhead securely on top of the coldhead box for a fixed site. In a mobile van, hand coldhead to person #2 to place on top of van.
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 12–8.



PLEXIGLAS COVER PLATE (46–294010G1)
ILLUSTRATION 12–8

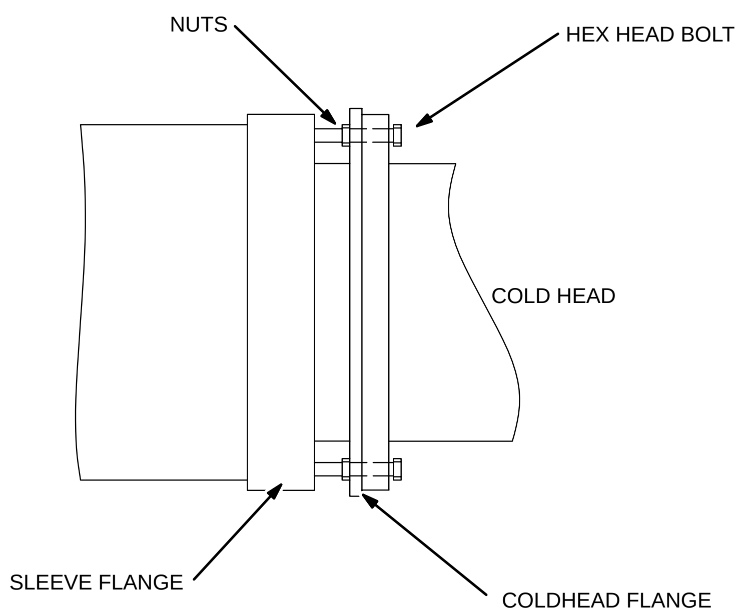
Note

If Coldhead does not pull free in Step 16, perform Steps 18 through 21 to loosen the coldhead then repeat Steps 16 and 17. If the Coldhead has been removed and the Plexiglas cover plate installed in Step 17 go to Step 22.

18. Insert two Hex Head Bolts through the bolt holes in the Coldhead 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 Coldhead Flange and Cryostat Sleeve Flange and thread them onto the two Hex Head Bolts inserted in Step 18. See Illustration 12–9.

12–3 COLDHEAD REMOVAL (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 12–9

WARNING!

FOLLOW THE PROCEDURE IN SECTION 12–4, TRANSPORTING COLDHEAD FROM / TO MAGNET, COMPLETELY TO PREVENT THE COLDHEAD FROM BEING ATTRACTED (DRAWN INTO) THE MAGNET BORE.

22. Transport removed coldhead away from magnet in strict conformance with Section 12–4–1, TRANSPORTING COLDHEAD FROM MAGNET.

12–4 TRANSPORTING COLDHEAD FROM / TO MAGNET

WARNING!

DO NOT CARRY THE COLDHEAD NEAR THE MAGNET END FLANGE WHERE THE MAGNETIC ATTRACTION IS STRONG TO PREVENT THE COLDHEAD FROM BEING ATTRACTED INTO THE MAGNET BORE.

IMPORTANT !!!

Coldhead removal and replacement in a mobile van is a two person operation.

Both persons must wear non–absorbent gloves when handling a cold (frosted) coldhead.

The first person must be fully trained in the coldhead removal / replacement procedure and must be positioned:

- **Facing the coldhead box at the side rail of the magnet to provide ready access for all actions related to the removal / replacement of the coldhead from the coldhead sleeve.**

- **Facing the coldhead transport bag at the side rail when removing / returning the coldhead from / to the bag. See Illustration 12–10.**

The second person must be trained in the preparation of the coldhead and must be positioned at the top of the magnet at the van hatch to:

- **Receive the used coldhead from the first person and place it securely on the top of the van.**

- **Receive the replacement coldhead to be prepared at the top of the van.**

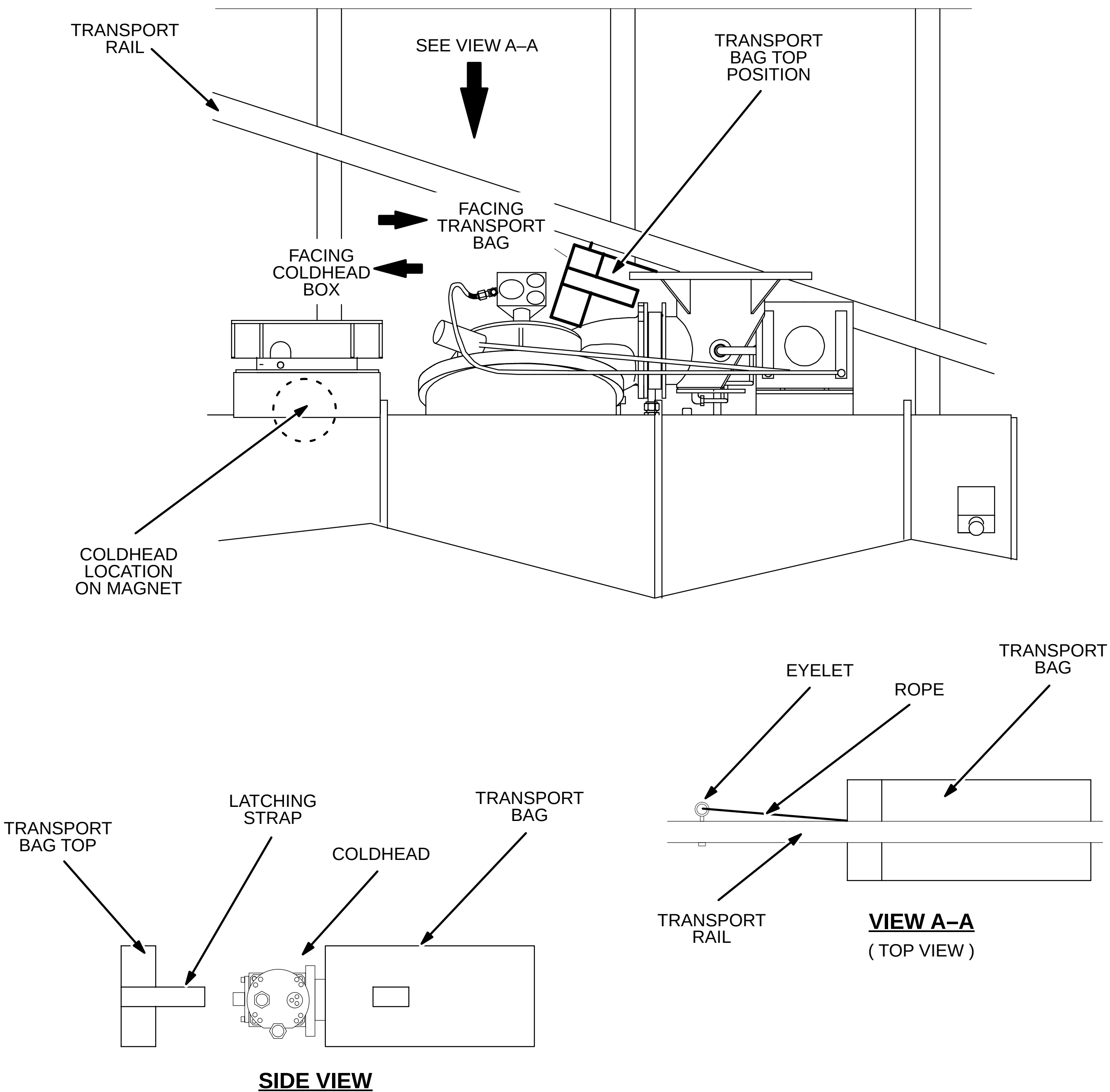
- **Hand off the old coldhead for insertion into the transport bag.**

- **Hand off the new, prepared coldhead for insertion into the coldhead sleeve.**

Allow a removed coldhead to warm up before removing it from the top of the van.

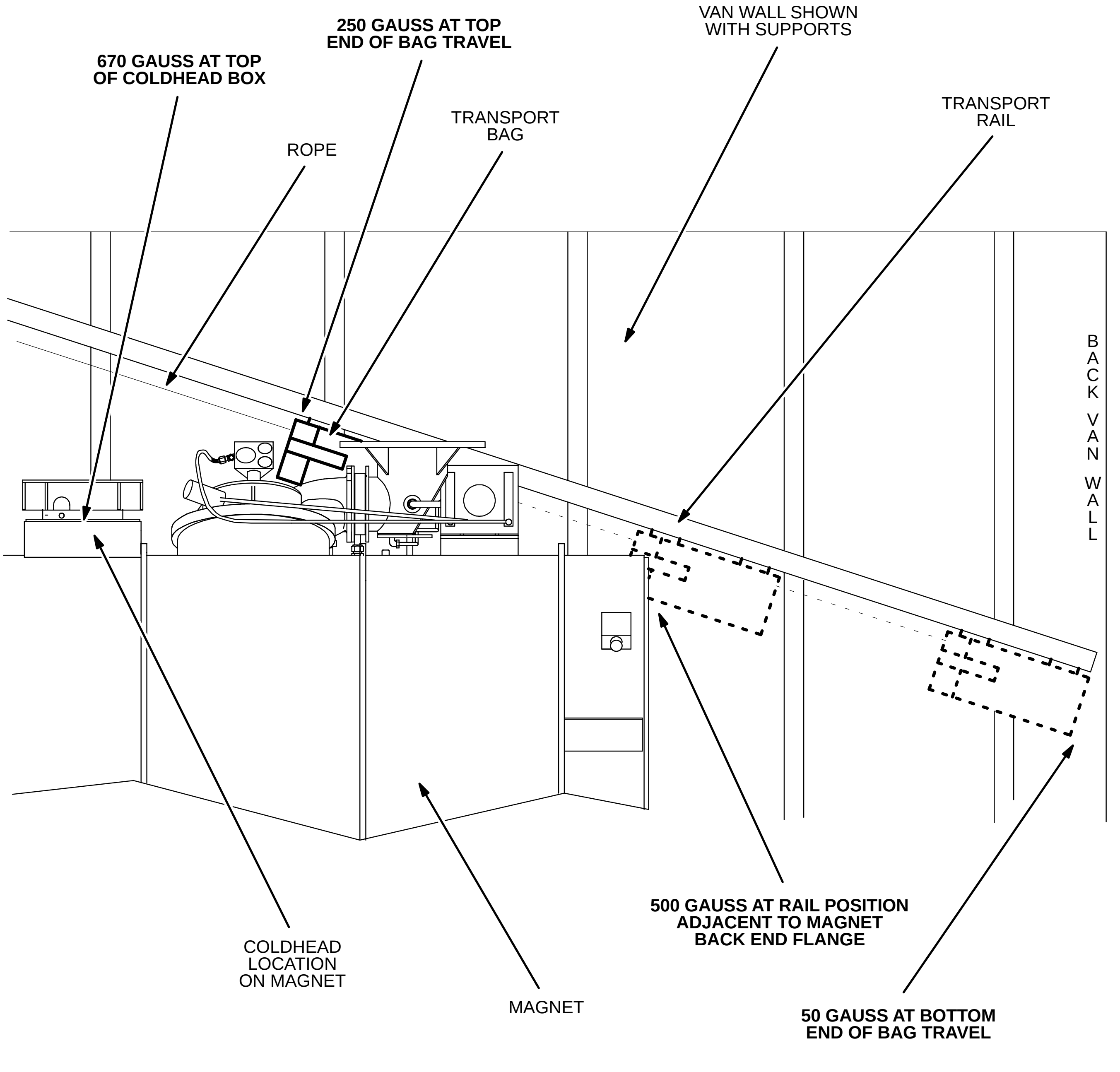
Illustration 12–11 shows the approximate gauss levels for the 1.5T magnet, along the route of the coldhead transport bag and at the coldhead box. Review this illustration before transporting a coldhead.

12–4 TRANSPORTING COLDHEAD FROM / TO MAGNET (continued)



COLDHEAD / TRANSPORT BAG
1.5T Cx MAGNET IN MOBILE VAN
ILLUSTRATION 12–10

12–4 TRANSPORTING COLDHEAD FROM / TO MAGNET (continued)



APPROXIMATE GAUSS LEVELS
1.5T Cx MAGNET IN MOBILE VAN
ILLUSTRATION 12–11

12–4 TRANSPORTING COLDHEAD FROM / TO MAGNET (continued)

12–4–1 TRANSPORTING COLDHEAD FROM MAGNET

FIXED SITE:

1. Handle coldhead securely with non–absorbent gloves and carry it from the coldhead box down to the bottom of the service ladder.
2. Carry the coldhead straight back to the magnet room wall.
3. Carry the coldhead along the magnet room wall and through the exit door.

MOBILE VAN:

1. Remove all ladders and apparatus from the side wall of the mobile van that will interfere with the travel of the coldhead transport bag along the rail.
2. Make sure the coldhead transport bag is locked at the top of the rail with the cover open and the first person is at the side rail facing the bag. See Illustration 12–10.
3. Retrieve the used coldhead securely from the top of the van (person #2) and hand it to person #1.
4. Place the coldhead into the coldhead transport bag and secure the bag cover (person #1). See Illustration 12–10.
5. Unlatch the rope from the eyelet on the transport rail and gradually lower the coldhead transport bag down the rail until it reaches the back van wall. See Illustration 12–10.
6. Remove the used coldhead from the transport bag and carry it along the back wall and out the rear door of the van.
7. Place the used coldhead in the replacement's shipping container for return.

12–4–2 TRANSPORTING COLDHEAD TO MAGNET

FIXED SITE:

CAUTION

Prepare the new coldhead outside the magnet room. See Section 12–1, PREPARATION, before bringing it to the magnet to prevent any magnetic attraction on the coldhead.

12–4–2 TRANSPORTING COLDHEAD TO MAGNET (continued)

FIXED SITE:

1. Carry the coldhead firmly into the magnet room and along the wall until it is adjacent to the coldhead side of the magnet.
2. Carry the coldhead from the wall directly to the service ladder.
3. Carry the prepared coldhead up the service ladder and secure on top of the coldhead box until ready for insertion into the coldhead sleeve.

MOBILE VAN:

CAUTION

Prepare the coldhead in conformance with Section 12–1, PREPARATION, on top of the mobile van after it has been transported in the coldhead transport bag tp prevent any damage to the coldhead gaskets during insertion into / removal from the bag.

1. Remove all ladders and apparatus from the side wall of the mobile van that will interfere with the travel of the coldhead transport bag along the rail.
2. Slide coldhead transport bag to the end of the transport rail against the back wall of the van.
3. Open transport bag cover and load new “unprep’ed” coldhead into the transport bag and close cover. See Illustration 12–10.
4. Pass rope from transport bag to the top of the magnet.

Note
Pressure gauge / flowmeter bracket will need to be loosened and moved if interference is encountered in sliding the transport bag up the rail.

5. Position person #1 at magnet side rail facing the transport bag. Pull the transport bag to the top position with the rope and connect the rope latch to the eyelet on the rail. See Illustration 12–10.
6. Person #1 then removes coldhead from the transport bag and hands it to person #2 at the top of the magnet.
7. Person #2 prepares the coldhead at the top of the van in conformance with Section 12–1, PREPARATION.

Note
Person #1 will need to be repositioned at the magnet side rail facing the coldhead box to install the new, prepared coldhead.

8. Reposition and tighten pressure gauge / flowmeter bracket if moved during this procedure.

12–5 COLDHEAD REPLACEMENT

1. 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.

CAUTION

If indium removal in Step 2 is required, do not keep the Sleeve Flange uncovered for an extended period of time (over 1 minute) to minimize icing.

2. 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.

3. If ice is present in sleeve use warmed helium gas, heat gun designed for use in a magnetic field or other appropriate method to remove ice.

CAUTION

Monitor Coldhead Diode temperatures if a Heat Gun is installed. Maintain the temperature between 285 and 300K. Do not allow the temperature to exceed 300K.

4. Continue helium gas purge to warm sleeve until new coldhead is ready for insertion.

WARNING!

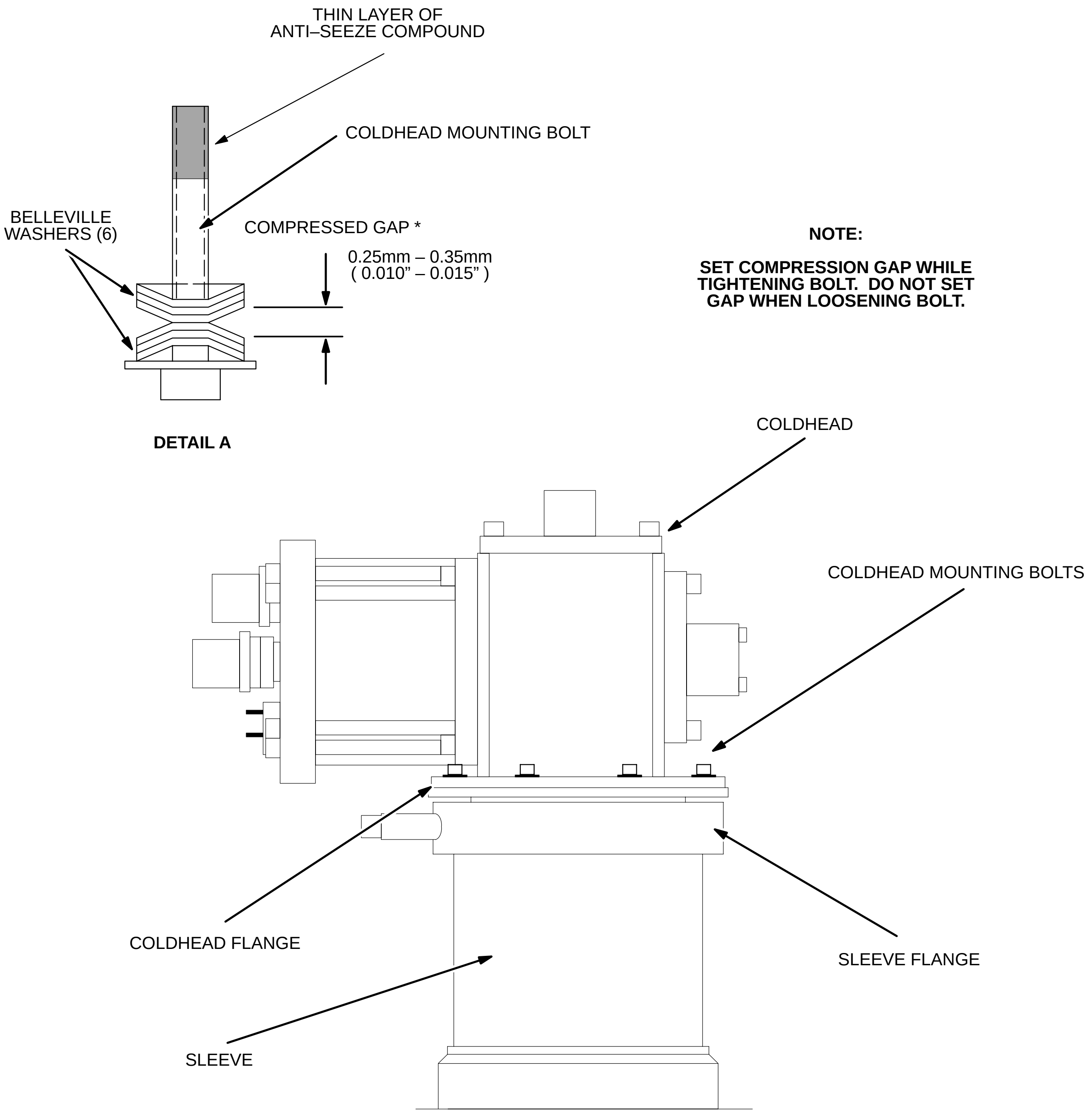
FOLLOW THE PROCEDURE IN SECTION 12–4, TRANSPORTING COLDHEAD FROM / TO MAGNET, COMPLETELY TO PREVENT THE COLDHEAD FROM BEING ATTRACTED (DRAWN INTO) THE MAGNET BORE.

5. Transport new coldhead to magnet in strict conformance with Section 12–4–2, TRANSPORT COLDHEAD TO MAGNET, for fixed site. If in a mobile van, make sure prepared coldhead is on top of van. See Section 12–1, PREPARATION.

6. Replace Belleville washers on the eight coldhead mounting bolts removed for coldhead removal. Make sure the number and orientation is the same as shown in Illustration 12–12.

7. Apply a thin film of anti–seeze compound to the end of the eight coldhead mounting bolts. See Illustration 12–12.

12–5 COLDHEAD REPLACEMENT (continued)



COLDHEAD MOUNTING BOLT GAP SETTING
ILLUSTRATION 12–12

12–5 COLDHEAD REPLACEMENT (continued)

8. Temporarily remove the Bellville Washers from three bolts, leaving the fiat washers on the bolts. These will be used to insert the new Coldhead.

9. Close gas inlet valve (green handle on pump out adapter) and discontinue helium purge in sleeve. Remove plexiglas cover plate.

10. Inspect inside of sleeve. Make sure it is dry and clean.

11. Clean inside of sleeve using a lint free cloth / towel and alcohol or other commercially available non–residue forming substance.

WARNING!

THE FOLLOWING PRECAUTIONS MUST BE TAKEN WHEN REPLACING THE COLDHEAD INTO THE MAGNET SLEEVE:

- **MAKE SURE THAT THE COLDHEAD IS READY FOR INSERTION INTO THE SLEEVE AND ALL REQUIRED EQUIPMENT AND COMPONENTS (BOLTS AND BELLEVILLE WASHERS) ARE PRESENT.**
- **MAINTAIN A FIRM HOLD ON THE COLDHEAD AND CARRY IT UP THE SERVICE LADDER. IF IN A MOBILE VAN, PLACE THE COLDHEAD IN THE COLDHEAD TRANSPORT BAG AND SLIDE THE BAG UP THE DIAGONAL PIPE TO THE TOP POSITION.**

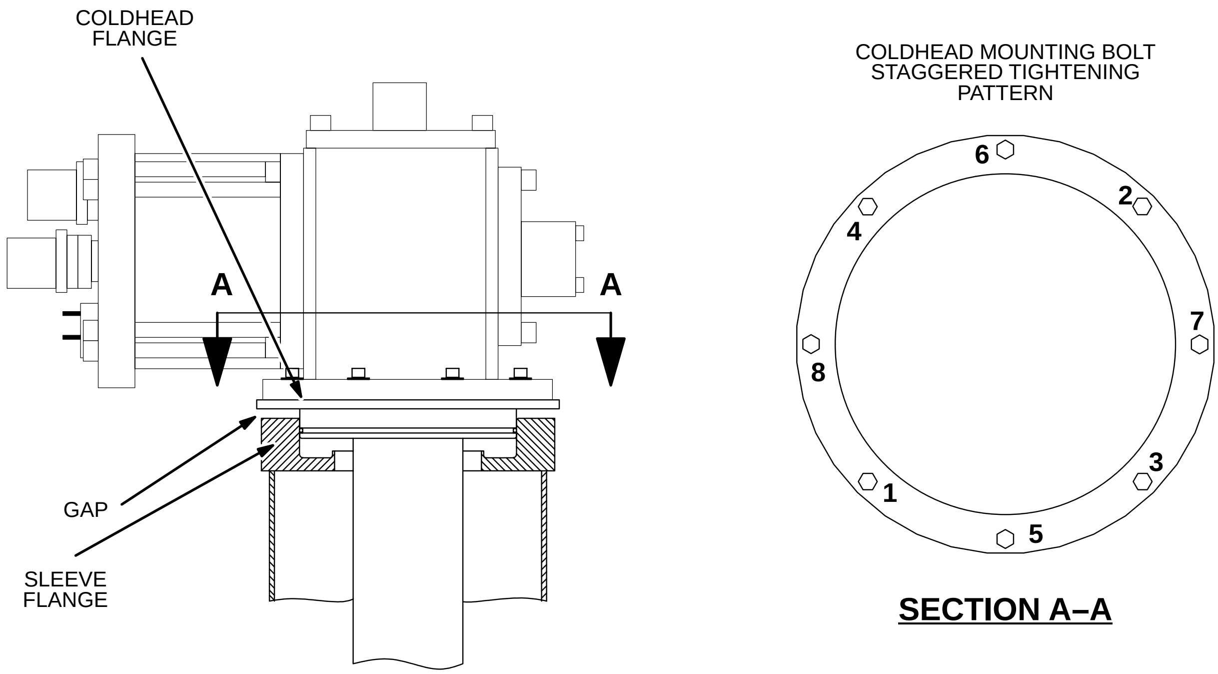
12. Securely bring prepared coldhead to top of magnet and align with sleeve.

CAUTION

Do not rotate the coldhead, in Step 13, with the indium gaskets in contact with the sleeve to prevent damaging the indium gasket. Be careful not to damage or displace the indium gaskets during coldhead insertion.

13. Carefully insert the Coldhead into the sleeve. Insert coldhead until the o–ring contacts the opening of the sleeve. See Illustration 12–13.

12–5 COLDHEAD REPLACEMENT (continued)



COLDHEAD FLANGE MOUNTING
ILLUSTRATION 12–13

CAUTION

Do not attempt to insert the coldhead by hand beyond the point of o–ring contact as o–ring damage will result.

14. Insert the three bolts, with Bellville Washers removed in Step 8, equally spaced at 120 degree increments, in the mounting holes of the Coldhead Flange.

12–5 COLDHEAD REPLACEMENT (continued)

15. Thread and tighten 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.

16. Assemble and tighten the remaining 5 bolts with Bellville Washers. checked in Step 6, through the mounting holes in the Coldhead Flange.

17. Remove the three bolts inserted in Step15; reassemble the Bellville Washers with the proper orientation; insert and tighten through the mounting holes in the Coldhead Flange.

18. Tighten all eight bolts evenly (hand tight).

19. Open the Vacuum Valve (black handle) and operate the Vacuum Pump for ten minutes to evacuate the sleeve space. During this time, reconnect gas flexlines, power cord and strain relief.

20. Close vacuum valve. 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 coldhead o–ring (46–281247P1) is required and the coldhead removal / replacement will have to be repeated using the same coldhead.

21. 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 Plug. Do not pull out the Knob Extension at this time.

22. Slowly crack open the Gas Inlet Valve (green handle) to observe the Vacuum Gauge slowly rising to approximately read –15 psig. Close the Gas Inlet Valve (green handle) to maintain a mid–range reading.

23. Pull out the Knob Extension on the Pump Out Port Operator approximately 50 mm (2 inches). Monitor the Vacuum Gauge, the reading should not change. If the gauge drops to a reading close to –30, then the Knob Extension was not completely unthreaded from the Pump Out Port Plug and you must re–evacuate the sleeve and re–check vacuum (Step 19).

24. When vacuum checks are good, grab motorshield handle and reposition motorshield (centered around coldhead motor). See Illustration 12–3. Install and tighten Allen head screw through motorshield tab, locking shield in the closed position.

25. Turn on compressor and coldhead to start the cooldown. This will result in the thermal contraction of the coldhead reducing its overall length. Check–out system. See Set–Up and Calibration, Section 1–4.

26. Measure and record the coldhead first and second stage temperatures in conformance with the magnet service manual, Section 1–5–7 of Set–Up and Calibration (“Monitoring Shield Cooler Temperatures”).

27. Turn off and remove Gas Supply, turn off Vacuum Pump, open Gas Inlet Valve (green handle) to vent system and disconnect and remove apparatus.

28. Place the removed Coldhead in the New Coldhead Carton and return for servicing per instructions in carton. Make sure Coldhead is properly packaged and secure in the carton.

12–5 COLDHEAD REPLACEMENT (continued)

Note

Record the following information for dispatching and future tracking purposes. Both the new and old coldhead model and serial numbers, installation date, compressor model, serial number and current hour meter reading.

29. Re–measure and record the coldhead first and second stage temperatures in conformance with the magnet service manual, Section 1–5–7 of Set–Up and Calibration (“Monitoring Shield Cooler Temperatures”). Compare the readings to the reading obtained in Step 33. You should notice the temperatures have started to fall on both stages.

12–6 COLDHEAD SETTINGS

1. After the coldhead has cooled down for approximately four hours, tighten the coldhead mounting bolts hand tight in a “CW” rotational pattern.

Note

If time does not permit a 4 hour wait period, allow the coldhead to run at least one hour from initial turn–on. During this one hour interval, maintain the hand tightness of the mounting bolts. After the one hour interval has passed, tighten the mounting bolts to the largest gap allowed on the Belleville washers. If this alternative step is used, you must return the following day to set the final Belleville washer gap continuing at Step 3.

2. Continue to hand tighten the coldhead mounting bolts in the above manner, at approximately four hour intervals, until the first and second stage temperatures have stabilized.

3. When temperatures have stabilized, tighten all coldhead mounting bolts evenly, in a “star” pattern, to result in the Bellville washer gap setting between 0.010” – 0.015” (0.25 mm – 0.35 mm). See Illustration 12–12. Measure the distance between the coldhead flange and the cryostat sleeve flange.

Note

First and second stage temperature may decrease farther, after setting the Bellville washer gap.

4. Establish if the stabilized temperatures are within specification range (32 – 60 K First Stage, 7 –17 K Second Stage). The temperatures that were found for your magnet in the factory are recorded in the Acceptance Test Report (ATR) found in the DATA SHEET Section or your manual. If temperatures are higher than those values, perform the tests listed in FUNCTIONAL CHECKS, Section 6 of this manual.

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

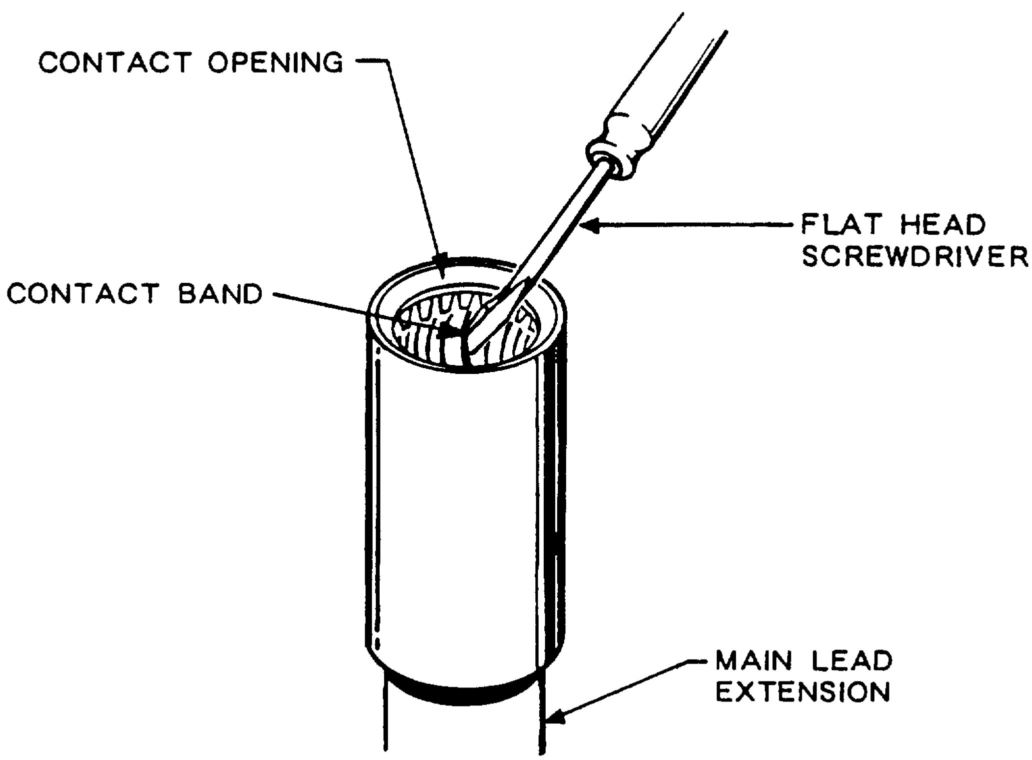
SECTION 13 – MAIN LEAD EXTENSION CONTACT BAND REPLACEMENT

1. Insert flat head screwdriver into 1/2 inch contact opening on end of Main Lead Extension. See Illustration 13–1.
2. Engage louvers in Contact Band with tip of screwdriver and gradually pry Contact Band out of Contact opening without scouring wall of Contact opening.

CAUTION

The contact area, on which the Contact Band seats, is silver plated and must be cleaned with a non–abrasive cloth and cleaning solution.

3. Clean the Ramp Lead cavity in which the Contact Band seats with a cloth and a decreasing solution such as trichlorethylene.
4. Obtain and inspect new Contact Band (46–281256P1).

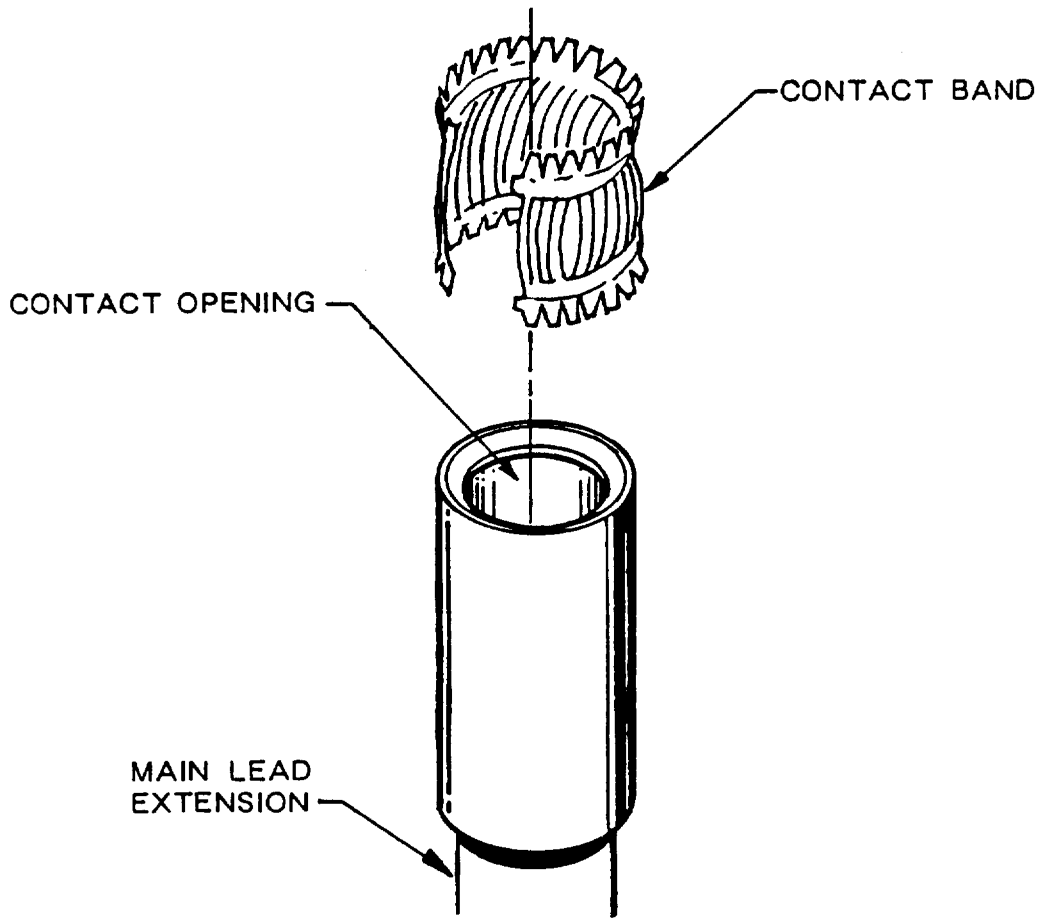


CONTACT BAND REMOVAL
ILLUSTRATION 13–1

13–1 MAIN LEAD EXTENSION CONTACT BAND REPLACEMENT (continued)

5. Roll new Contact Band into a uniform cylinder of less than 1/2 inch diameter and fully insert into Contact opening. See illustration 13–2.

6. Make sure Contact Band has expanded against walls of the Contact opening and is fully seated below rim on Contact opening.



CONTACT BAND REMOVAL
ILLUSTRATION 13–2

SCHEMATICS/INTERCONNECTS

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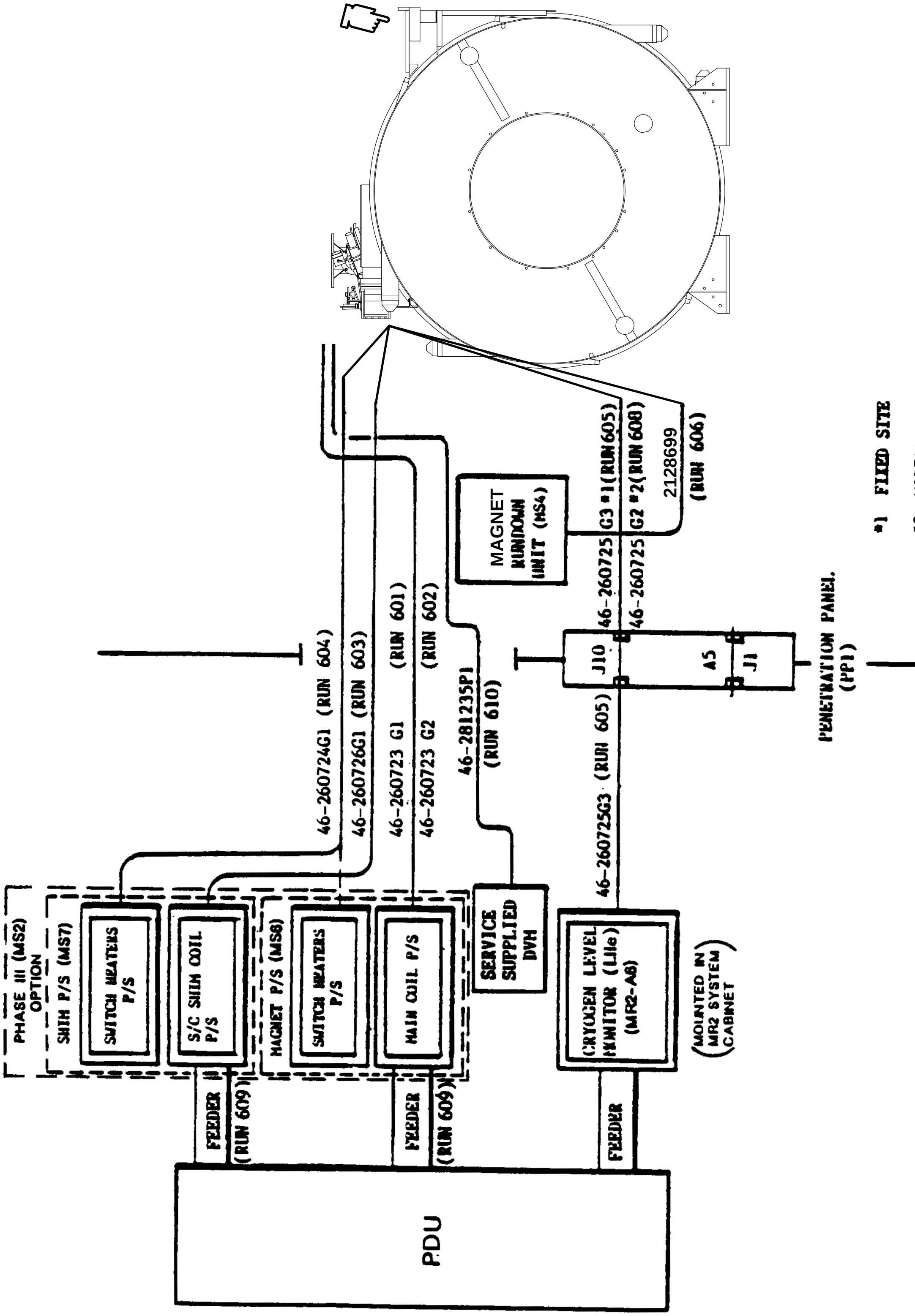
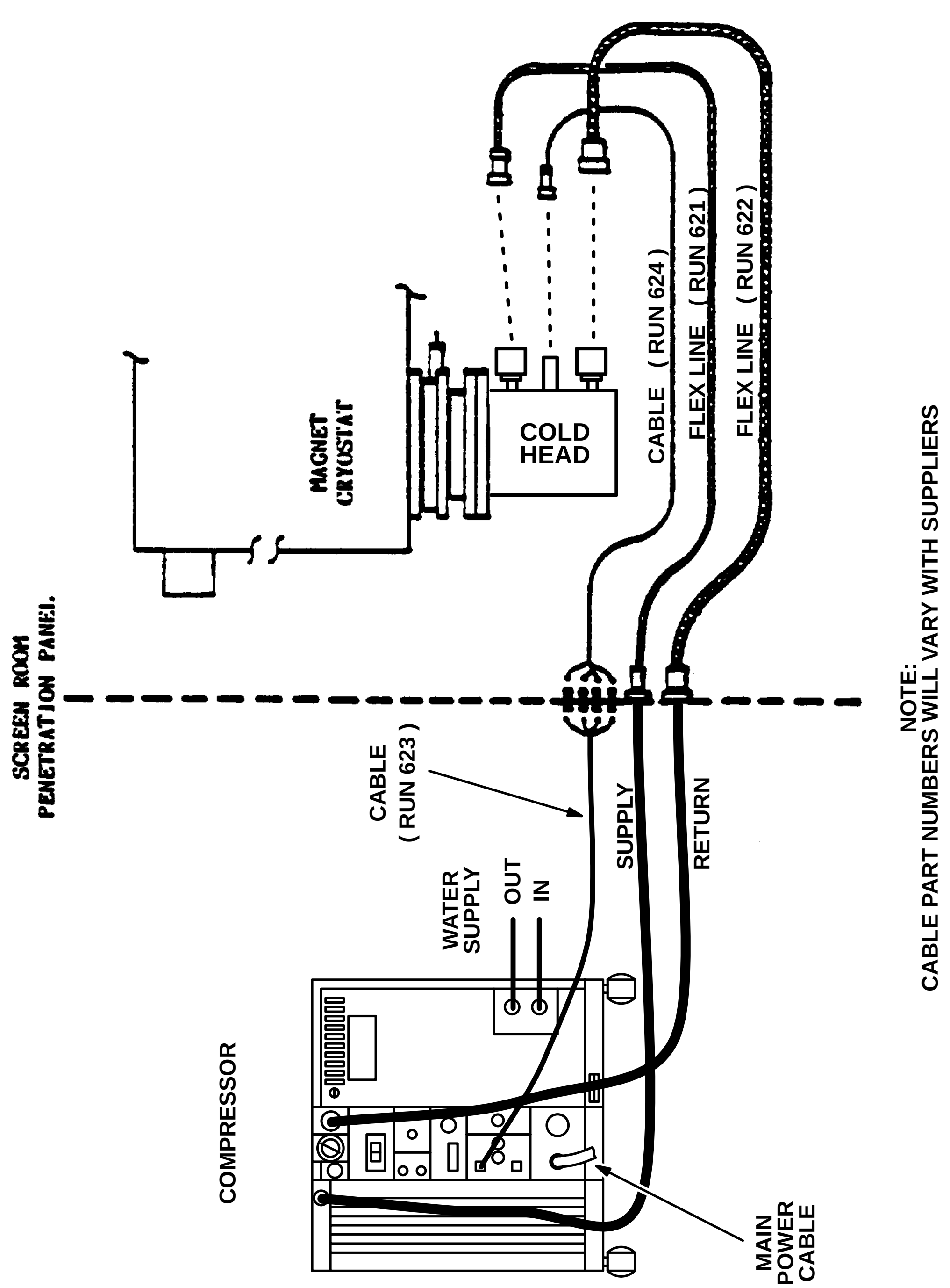
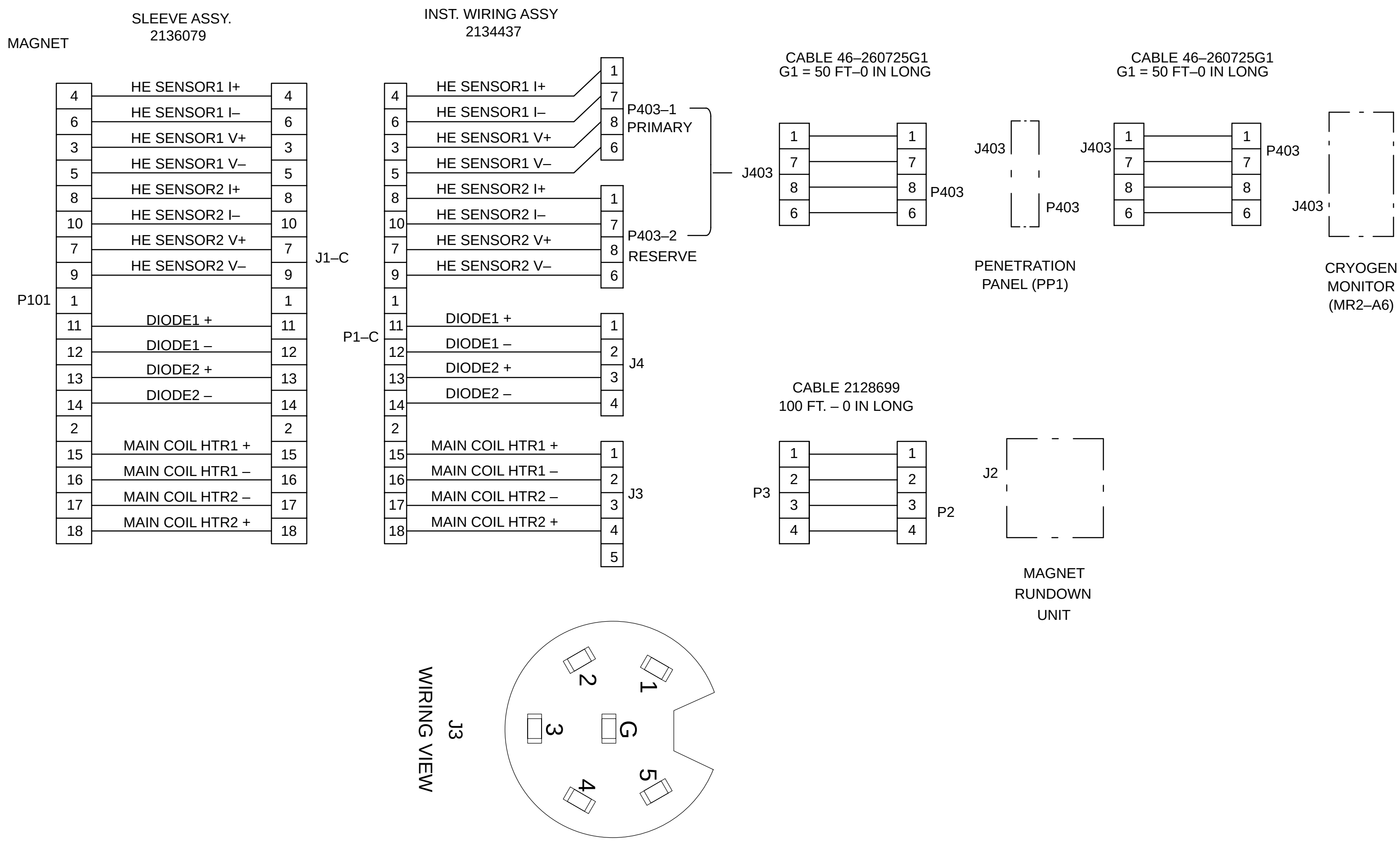


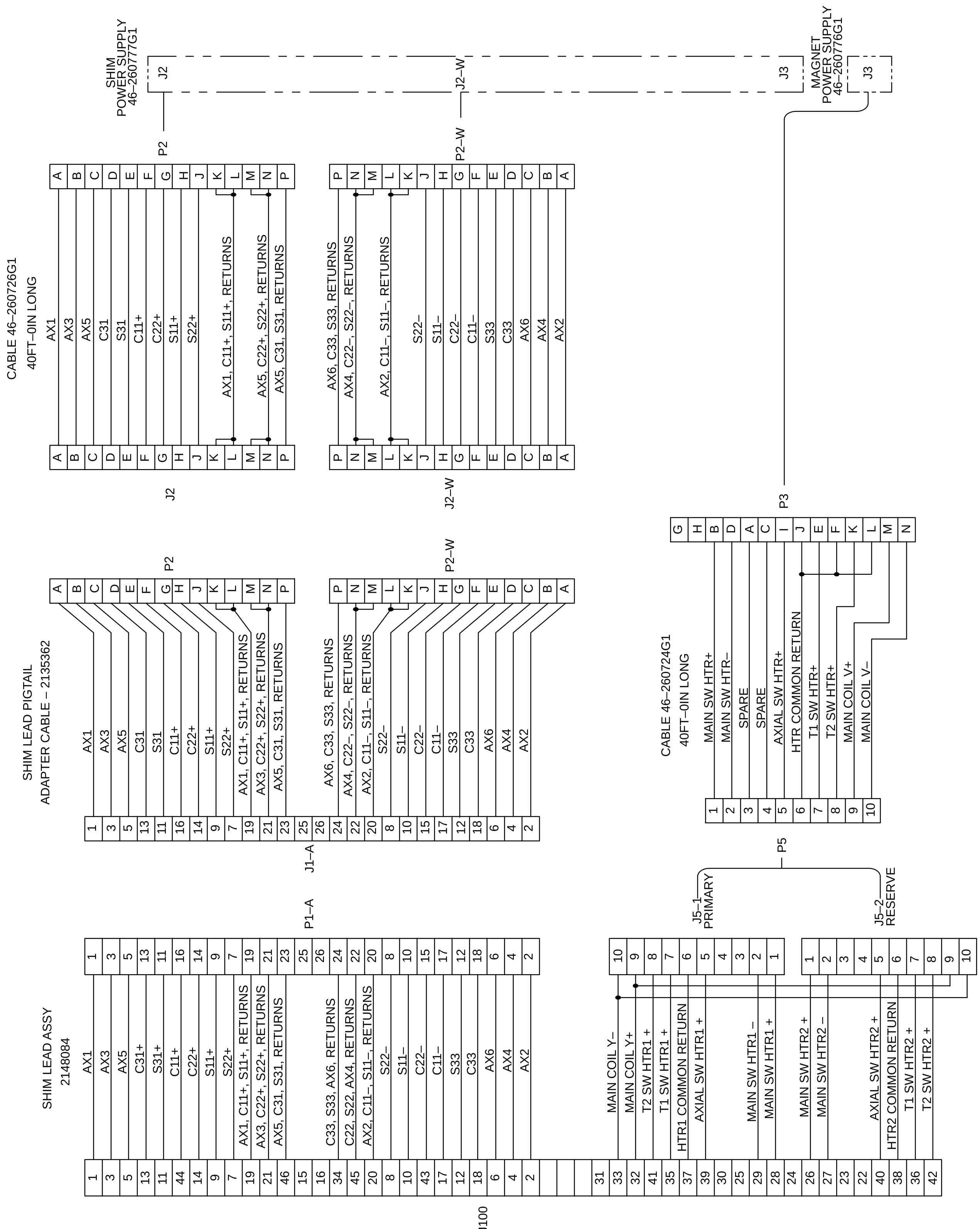
MAGNET SYSTEM INTERCONNECT DIAGRAM
ILLUSTRATION 1–1



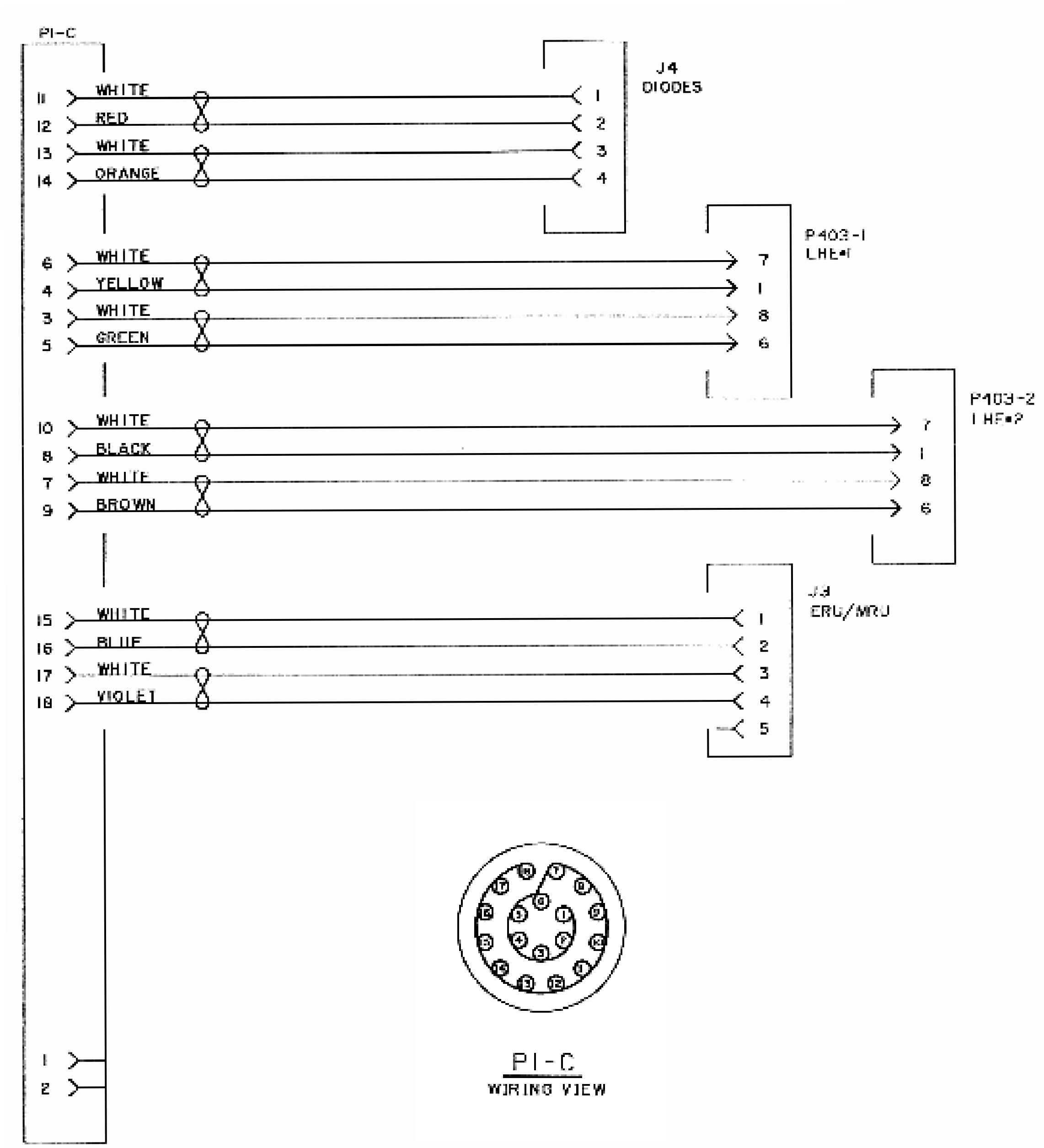
MAGNET SHIELD COOLER INTERCONNECT DIAGRAM
ILLUSTRATION 1–2



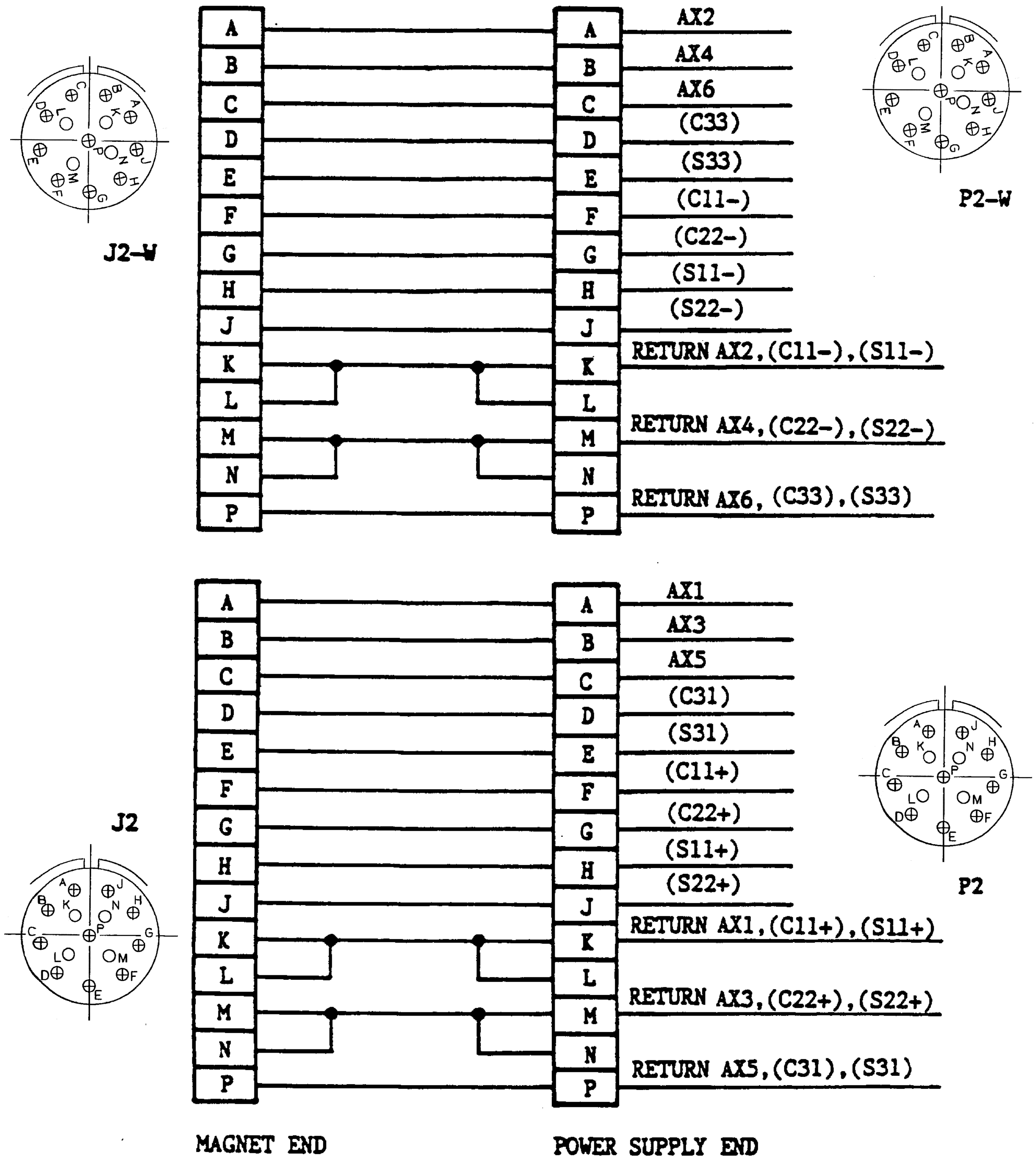
MAGNET SYSTEM WIRING DIAGRAM
ILLUSTRATION 2–1



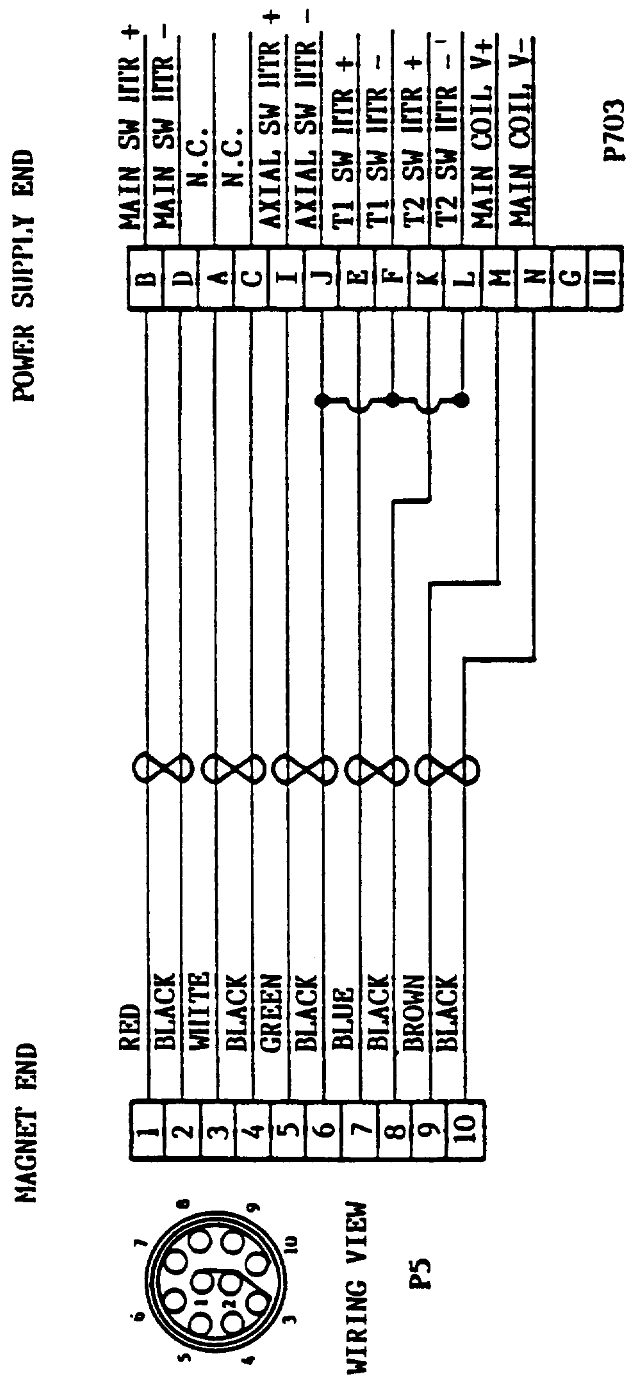
MAGNET SYSTEM WIRING DIAGRAM (continued)
ILLUSTRATION 2–2



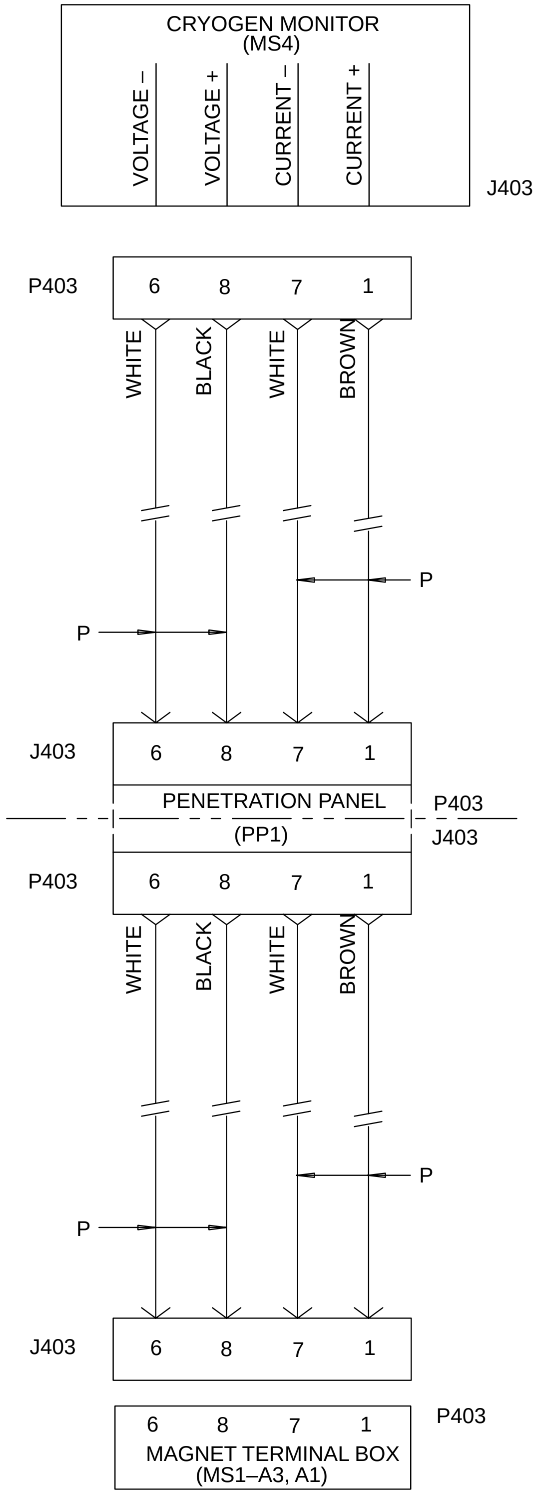
WIRING DIAGRAM
MAGNET CABLE 2134437
ILLUSTRATION 2–3



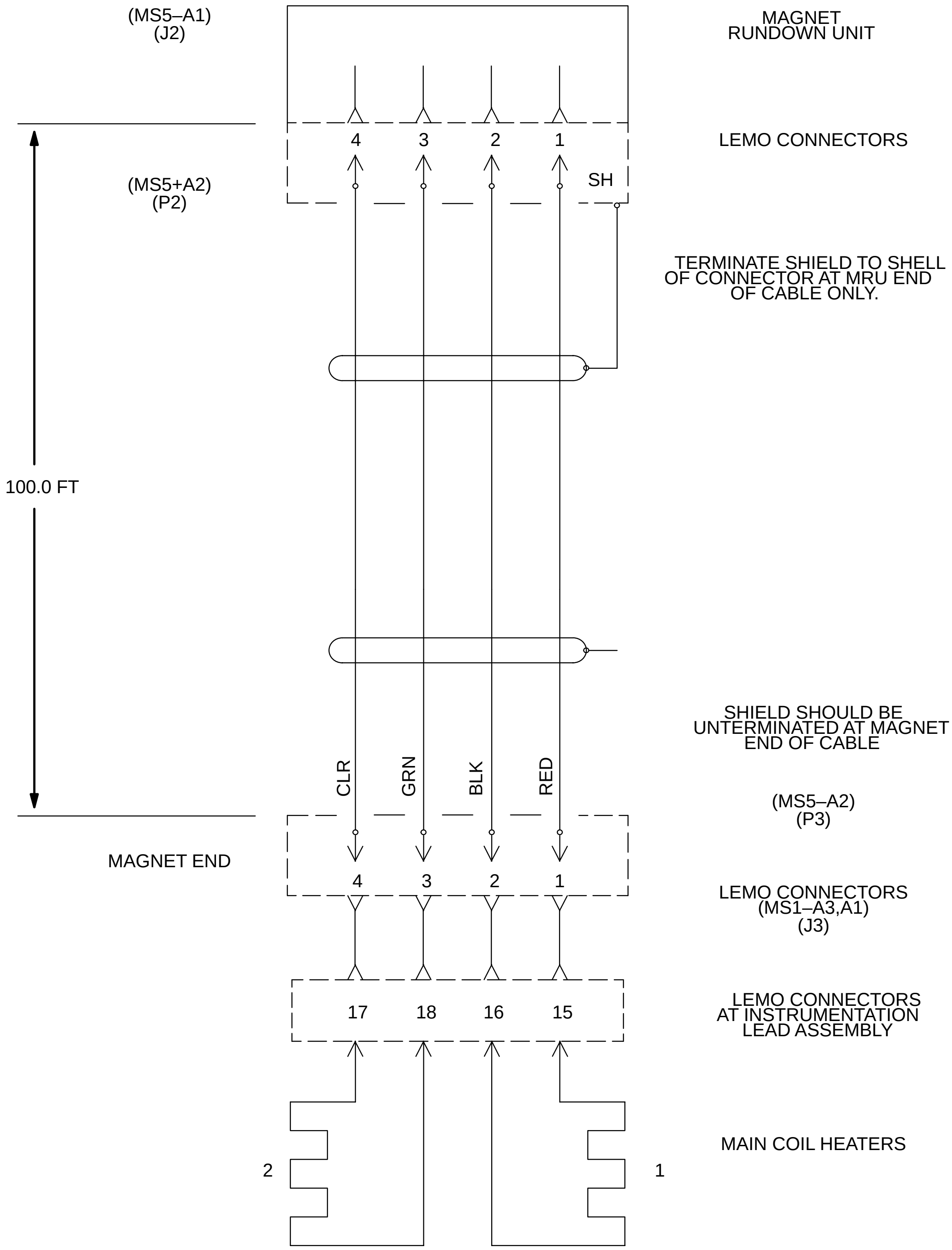
WIRING DIAGRAM
S/C SHIM COIL CABLE 46–260726G1
ILLUSTRATION 2–4



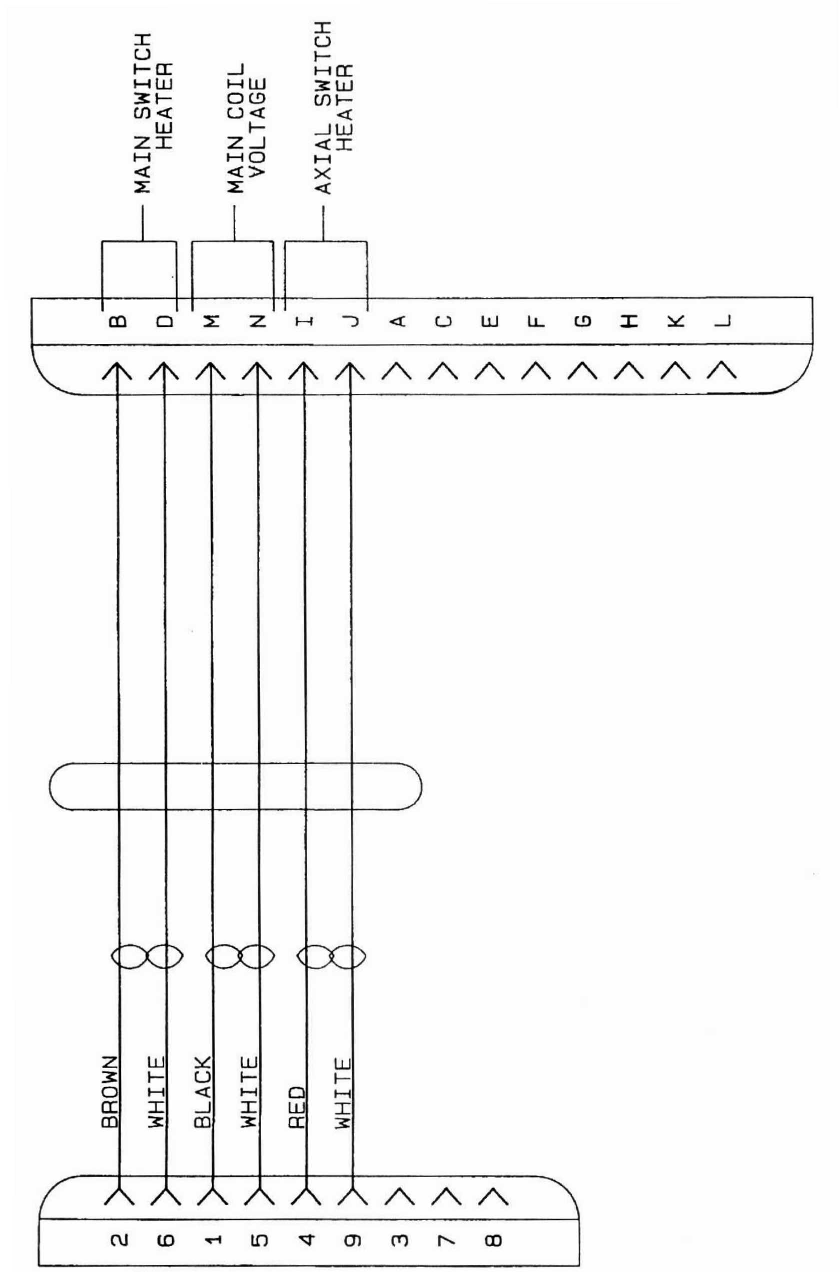
WIRING DIAGRAM
VOLTAGE MONITOR & SWITCH HEATERS CABLE 46–260724G1
ILLUSTRATION 2–5



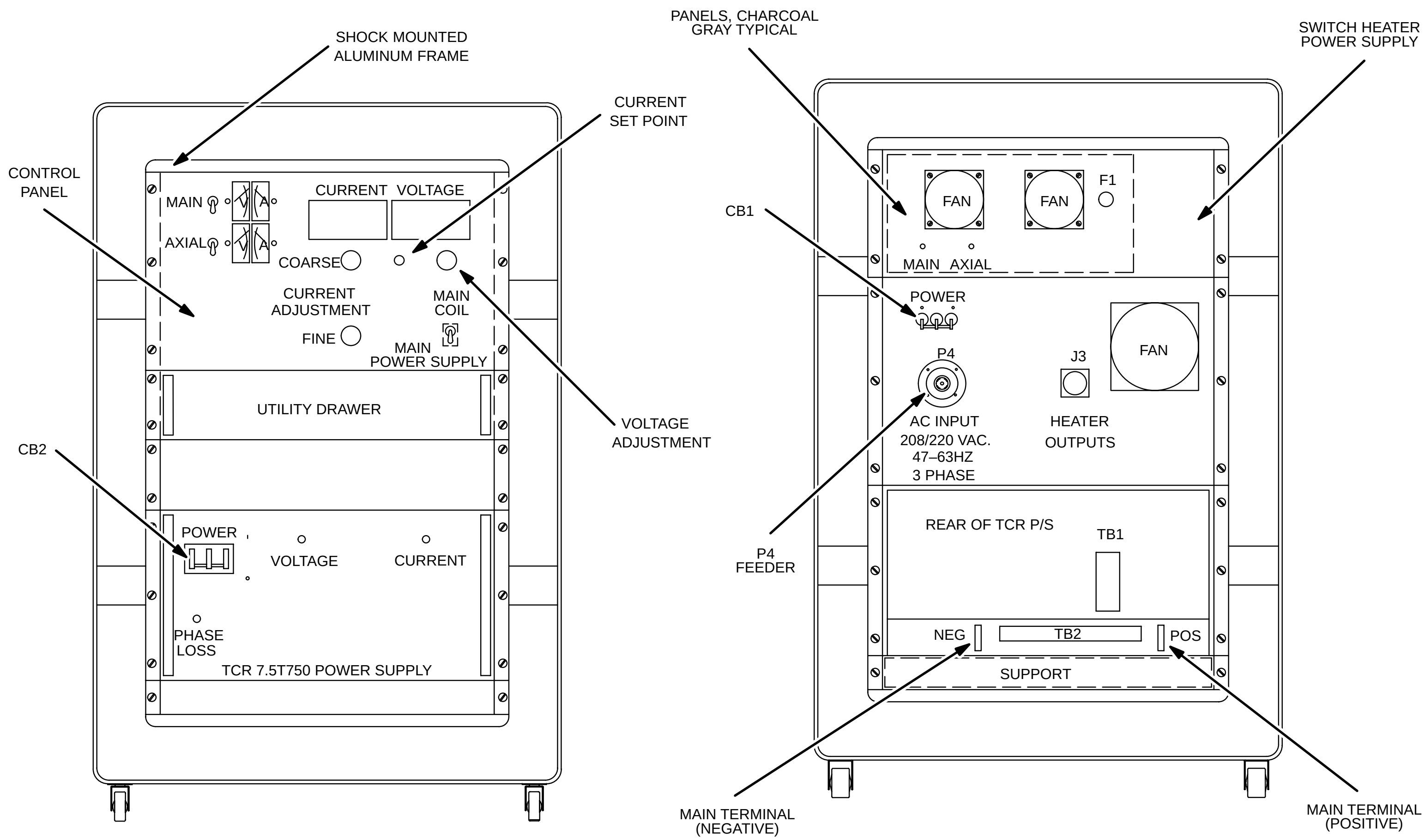
WIRING DIAGRAM
LIQUID HELIUM MONITOR CIRCUIT
ILLUSTRATION 2–6



WIRING DIAGRAM
MAGNET RUNDOWN SYSTEM FOR MAIN COIL HEATERS
ILLUSTRATION 2–7



WIRING DIAGRAM
SWITCH HEATER CABLE 46–281667G1
ILLUSTRATION 2–8

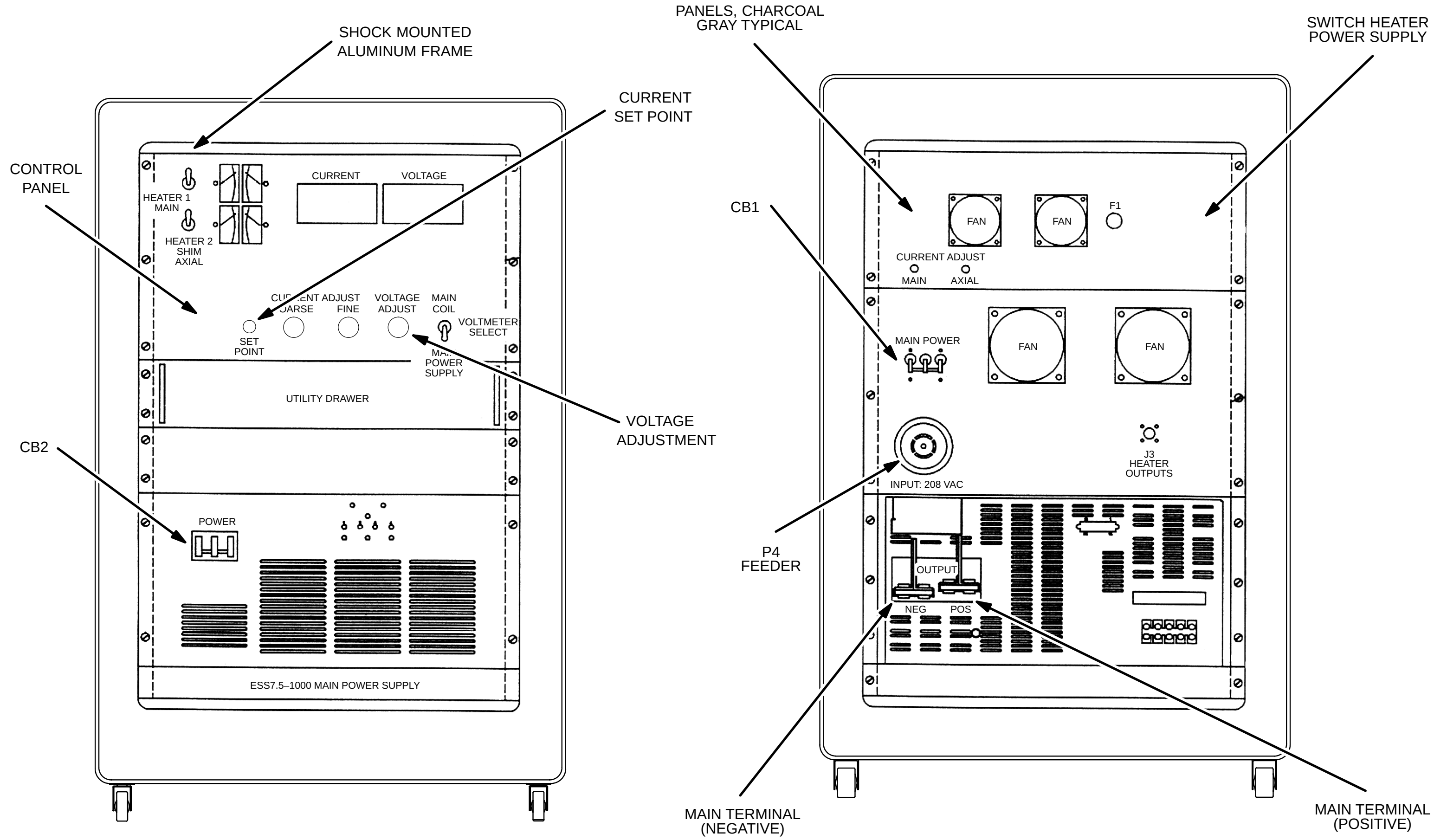


FUSES AND CIRCUIT BREAKERS	
DESIGNATOR	RATING AND TYPE
CB1 CABINET	3 POLE, 25 A, 250 VAC
CB1 SUPPLY	3 POLE, 25 A, 250 VAC
F1	4 A, 250 V, MDA

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 (750 AMP)

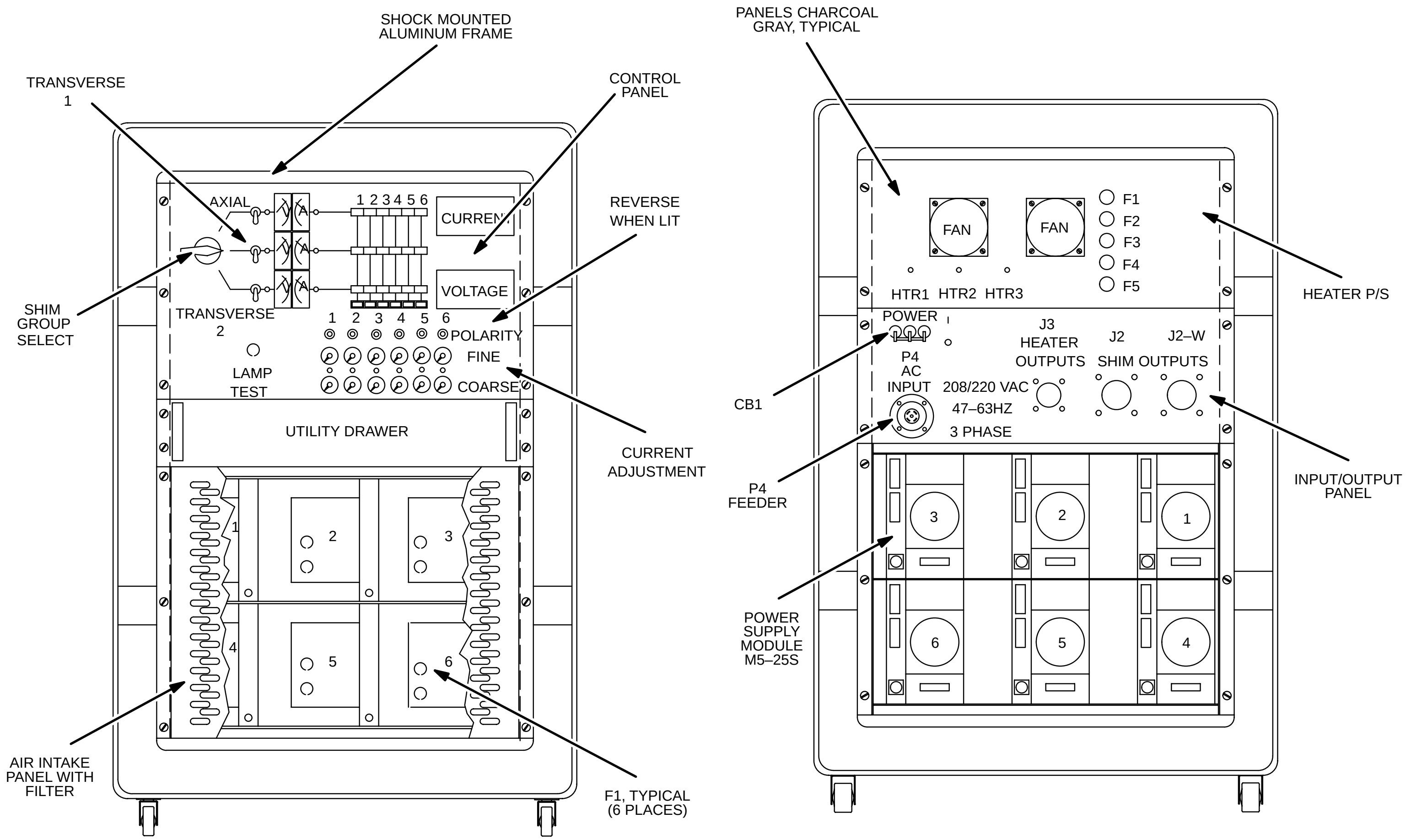
ILLUSTRATION 3–1



FUSES AND CIRCUIT BREAKERS	
DESIGNATOR	RATING AND TYPE
CB1 CABINET	3 POLE, 30 A, 250 VAC
CB1 SUPPLY	3 POLE, 30 A, 250 VAC
F1	1 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.	1,000 A BUS BAR	RED/POS. MAIN POWER LEADS (MS3–A2)
MAIN TERMINAL NEG.	1,000 A BUS BAR	BLACK/NEG. MAIN POWER LEADS (MS3–A2)
J3	1 AMP, MS3106A20–27P	HEATER WIRE HARNESS (MS3–A5) P3

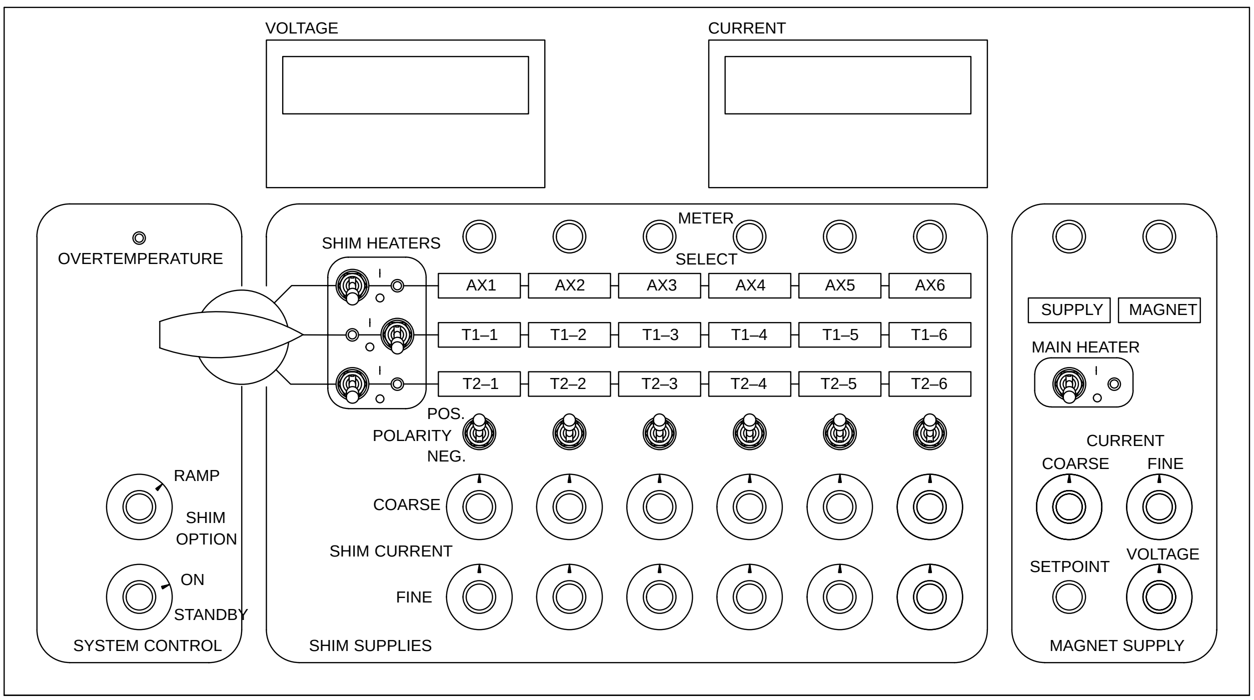
SUPERCONDUCTING MAIN COIL SERVICE POWER SUPPLY CABINET (1,000 AMP)
ILLUSTRATION 3–2



SUPERCONDUCTING SHIM COIL SERVICE POWER SUPPLY CABINET
ILLUSTRATION 3–3

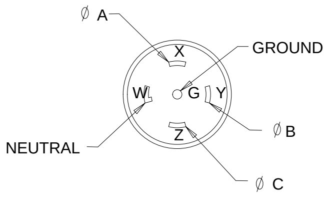
FUSES AND CIRCUIT BREAKERS	
DESIGNATOR	RATING AND TYPE
CB1	3 POLE, 25 A, 250VAC
F1 (TYP. 6 PLACES)	6.25 A, 250 V. MDA
F1, F5	4 A, 250 V. MDA
F2, F3, F4	1 A, 250 V. MDA

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



MAGNET/SHIM PHASE III–A POWER SUPPLY CONTROL PANEL
ILLUSTRATION 3–4

TWIST–LOCK FLANGED INLET
4 POLE—5 WIRE
30A 120/208V 3 ∅ Y
NEMA L21–30R

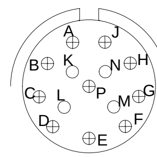


P4

AC INPUT PINOUTS
FOR SHIM AND MAGNET POWER SUPPLIES

* PINS PARALLELED

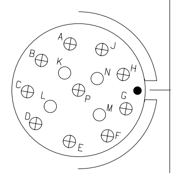
MS3102A28–20S



J2

- A– AX1
- B– AX3
- C– AX5
- D– T1–1
- E– T2–1
- F– T1–2
- G– T1–3
- H– T2–2
- J– T2–3
- K/L* – AX1,T1–2,T2–2 RETURNS
- M/N* – AX3,T1–3,T2–3 RETURNS
- P– AX5,T1–1,T2–1 RETURNS

MS3102A28–20SW



J2–W

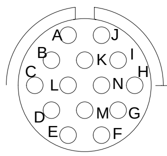
- A– AX2
- B– AX4
- C– AX6
- D– T1–6
- E– T2–6
- F– T1–4
- G– T1–5
- H– T2–4
- J– T2–5
- K/L* – AX2,T1–4,T2–4 RETURNS
- M/N* – AX4,T1–5,T2–5 RETURNS
- P– AX6,T1–6,T2–6 RETURNS

SHIM OUTPUTS
SHIM POWER SUPPLY

- A–
- B– MAIN SWITCH HTR+
- C–
- D– MAIN SWITCH HTR–
- E– TRANSVERSE #1+
- F– TRANSVERSE #1–
- G–
- H–
- I– AXIAL SW HTR+
- J– AXIAL SW HTR–
- K– TRANSVERSE #2+
- L– TRANSVERSE #2–
- M– MAIN COIL V+
- N– MAIN COIL V–

PHASE III P/S

MS3102A20–27S



- A–
- B–
- C–
- D–
- E– TRANSVERSE #1+
- F– TRANSVERSE #1–
- G–
- H–
- I– AXIAL SW HTR+
- J– AXIAL SW HTR–
- K– TRANSVERSE #2+
- L– TRANSVERSE #2–
- M–
- N–

SHIM POWER SUPPLY

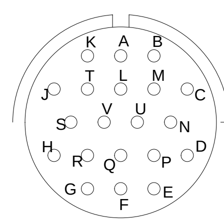
- A–
- B– MAIN SWITCH HTR+
- C–
- D– MAIN SWITCH HTR–
- E–
- F–
- G–
- H–
- I– AXIAL SW HTR+
- J– AXIAL SW HTR–
- K–
- L–
- M– MAIN COIL V+
- N– MAIN COIL V–

MAGNET POWER SUPPLY

SERVICE POWER SUPPLIES

J3 SWITCH HEATER OUTPUTS

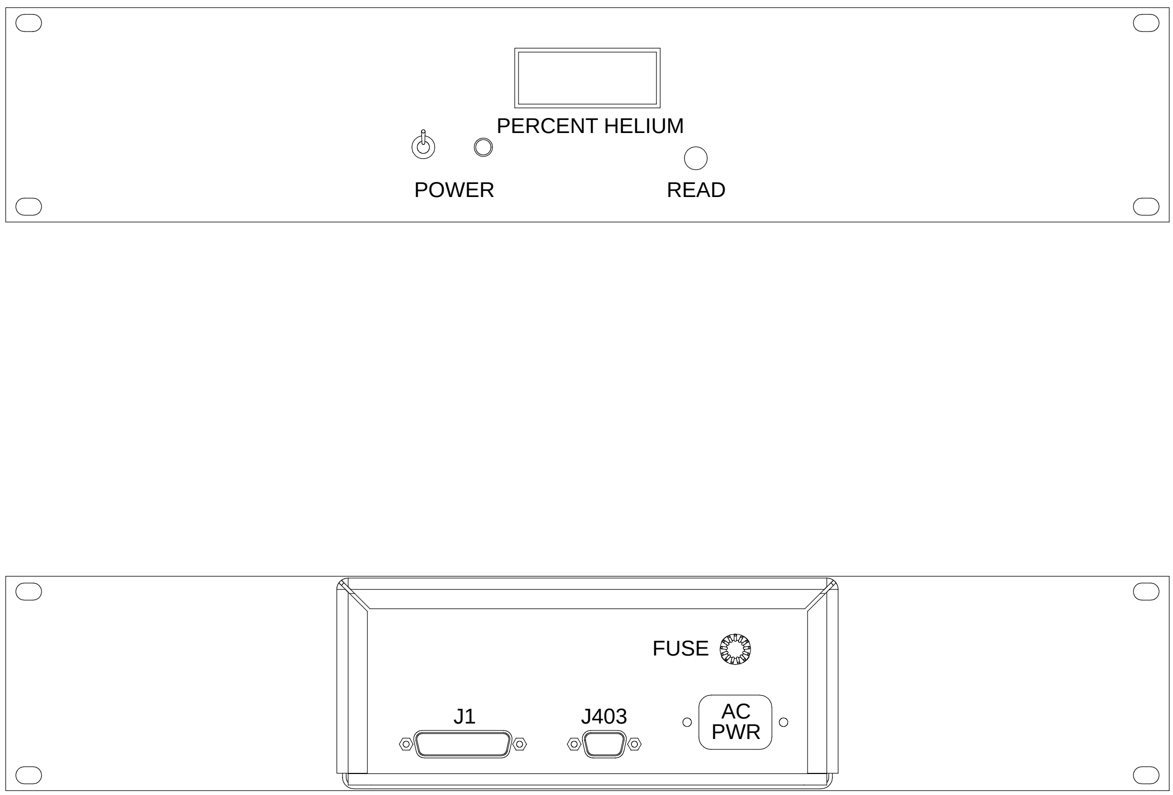
MS3102A28–16S



- A– CHAN A = ZY
- B– ZY RETURN
- C–
- D–
- E– CHAN B = XY
- F– XY RETURN
- G– CHAN C = ZX
- H– ZX RETURN
- J–
- K–
- L– CHAN D = $X^2 – Y^2$
- M– $X^2 – Y^2$ RETURN
- N–
- P–
- Q– CHAN F = Z3
- R– Z3 RETURN
- S– CHAN E = Z2
- T– Z2 RETURN
- U–
- V–

OPTIONAL OUTPUT
SHIM POWER SUPPLY

POWER SUPPLY INPUT/OUTPUT CONNECTOR PINOUTS
ILLUSTRATION 3–5



CRYOGEN MONITOR PANEL
ILLUSTRATION 4–1

RENEWAL PARTS

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TABLE OF CONTENTS (continued)

SECTION 1 – MAGNET SYSTEM

TABLE 1–1
MAGNET MODEL / ASSEMBLY NUMBERS (LEYBOLD CONFIGURATION)

MAGNET MODEL NUMBER	MAGNET ASSEMBLY NUMBER
2142600 for 1.5T with compressor	2148633
2163097 for 1.5T without compressor	2148633
2183098 for 1.5T mobile with compressor	2148633
2155534 for 1.0T with compressor	2148633
2163096 for 1.0T without compressor	2148633
2183097 for 1.0T mobile with compressor	2148633

TABLE 1–2
MAGNET MODEL / ASSEMBLY NUMBERS (SUMITOMO CONFIGURATION)

MAGNET MODEL NUMBER	MAGNET ASSEMBLY NUMBER
2142600–2 for 1.5T with compressor	2148633–2
2163097–2 for 1.5T without compressor	2148633–2
2183098–2 for 1.5T mobile with compressor	2148633–2
2155534–2 for 1.0T with compressor	2148633–2
2163096–2 for 1.0T without compressor	2148633–2
2183097–2 for 1.0T mobile with compressor	2148633–2

1–1 MAGNET SYSTEM (continued)

1–1 MAGNET SYSTEM 2148633 & 2148633–2 1.5T & 1.0T MAGNET SYSTEM

Item	Part Number	FRU	Name	Quantity	Description (Remarks)
1	2142600	N	MAGNET	1	GE Cx 1.5T MGT / CRYO ASSY – LEYBOLD FIXED
• 1A	2163097	N	MAGNET	1	GE Cx 1.5T MGT / CRYO ASSY – LEYBOLD FIXED
1B	2183098	N	MAGNET	1	GE Cx 1.5T MGT / CRYO ASSY – LEYBOLD MOBILE
1C	2155534	N	MAGNET	1	GE Cx 1.0T MGT / CRYO ASSY – LEYBOLD FIXED
• 1D	2163096	N	MAGNET	1	GE Cx 1.0T MGT / CRYO ASSY – LEYBOLD FIXED
1E	2183097	N	MAGNET	1	GE Cx 1.0T MGT / CRYO ASSY – LEYBOLD MOBILE
1F	2142600–2	N	MAGNET	1	GE Cx 1.5T MGT / CRYO ASSY – SUMITOMO FIXED
• 1G	2163097–2	N	MAGNET	1	GE Cx 1.5T MGT / CRYO ASSY – SUMITOMO FIXED
1H	2183098–2	N	MAGNET	1	GE Cx 1.5T MGT / CRYO ASSY – SUMITOMO MOBILE
1J	2155534–2	N	MAGNET	1	GE Cx 1.0T MGT / CRYO ASSY – SUMITOMO FIXED
• 1K	2163096–2	N	MAGNET	1	GE Cx 1.0T MGT / CRYO ASSY – SUMITOMO FIXED
1L	2183097–2	N	MAGNET	1	GE Cx 1.0T MGT / CRYO ASSY – SUMITOMO MOBILE
* 2	46–294141G1	2	COMPRESSOR	1	LEYBOLD SHIELD COOLER COMPRESSOR
* 2A	2168321	2	COMPRESSOR	1	LEYBOLD COOLPAK COMPRESSOR
* 3	46–294142P2	1	He GAS LINE	1	HELIUM SUPPLY LINE (70’ LONG) – LEYBOLD FIXED
* 3A	46–294142P4	1	He GAS LINE	1	HELIUM SUPPLY LINE (40’ LONG) – LEYBOLD MOBILE
* 4	46–294143P2	1	He GAS LINE	1	HELIUM RETURN LINE (70’ LONG) – LEYBOLD FIXED
* 4A	46–294143P4	1	He GAS LINE	1	HELIUM RETURN LINE (40’ LONG) – LEYBOLD MOBILE
** 5	2188440	2	COMPRESSOR	1	SUMITOMO SHIELD COOLER COMPRESSOR
** 6	2154502–2	1	He GAS LINE	1	HELIUM SUPPLY LINE (65.6’ LONG) – SUMITOMO FIXED
** 6A	2154502–4	1	He GAS LINE	1	HELIUM SUPPLY LINE (39.4’ LONG) – SUMITOMO MOBILE
** 7	2154505–2	1	He GAS LINE	1	HELIUM RETURN LINE (65.6’ LONG) – SUMITOMO FIXED
** 7A	2154505–4	1	He GAS LINE	1	HELIUM RETURN LINE (39.4’ LONG) – SUMITOMO MOBILE
8	46–294365G1	2	CABLE	1	RAMP DOWN CABLE
9	46–318068P1	2	WOOL	6	BRONZE WOOL
* 10	2104829	1	CABLE	1	COLDHEAD TO PEN PANEL (50’ LONG) – LEYBOLD
* 10A	REMOVED				
* 11	46–294144P2	1	CABLE	1	COMPRESSOR TO PEN PANEL (50’ LONG) – LEYBOLD
* 11A	REMOVED				
** 12	2172239–2	1	CABLE	1	COLDHEAD TO PEN PANEL (49.21’ LONG) – SUMITOMO
12A	REMOVED				
** 13	2155316–2	1	CABLE	1	COMP. TO PEN PANEL (49.21’ LONG) – SUMITOMO
13A	REMOVED				
** 14	2200835	1	CABLE	1	COMPRESSOR INPUT POWER CABLE – SUMITOMO
15	46–294231G1	1	MRU	1	MAGNET RUNDOWN UNIT
16	2128699	1	CABLE	1	FOR MAGNET RUNDOWN UNIT
17	46–260725G3	2	CABLE	2	FOR CRYOSTAT INSTRUMENTATION (80’ LONG)
18	2122498	2	MONITOR	1	CRYOGEN MONITOR ASSEMBLY
19	46–260888G3	2	KIT	1	MAGNET LEVELING KIT
20	46–260852G3	2	TOOL	1	VACUUM TOOL
21	46–318057G1	1	KIT	1	HELIUM VENTILATION KIT (FIXED)
21A	46–318057G2	1	KIT	1	HELIUM VENTILATION KIT (MOBILE)
22	46–294744G4	N	KIT	1	FIELD SPARE PARTS KIT
23	46–294765G1	N	FLANGE	1	TURRET COVER FLANGE ASSEMBLY

• THESE MAGNET MODELS ARE SHIPPED WITHOUT COMPRESSORS
* ITEMS 2, 2A, 3, 3A, 4, 4A, 10, 10A, 11, 11A FOR MAGNET MODELS 2142600, 2163097, 2183098, 2155534, 2163096 AND 2183097
** ITEMS 5, 6, 6A, 7, 7A, 12, 13, AND 14 FOR MAGNET MODELS 2142600–2, 2163097–2, 2183098–2, 2155534–2, 2163096–2 AND 2183097–2

1–1 MAGNET SYSTEM (continued)

1–1 MAGNET SYSTEM 2148633 & 2148633–2 1.5T & 1.0T MAGNET SYSTEM

Item	Part Number	FRU	Name	Quantity	Description (Remarks)
••24	2177596	N	KIT	1	INERTIA MASS DAMPENER KIT – LEYBOLD FIXED
••24A	2183100	N	KIT	1	INERTIA MASS DAMPENER KIT – LEYBOLD MOBILE
25	46–258770G4	N	KIT	1	WARNING SIGN AND LABEL KIT
26	46–318042P1	1	CABLE	1	METER CABLE, COLDHEAD SLEEVE TO REAR PEDESTAL
27	2114744–5	2	LADDER	1	SERVICE LADDER
28	2156980	2	KIT	1	HELIUM GAS LINE SPIKE NOISE KIT
29	2184023	2	RELIEF	1	STRAIN RELIEF FOR COMPRESSOR LINES
30	2105685	N	LABEL	1	RAMP CAUTION LABEL
•31	46–260724G1	2	CABLE	1	SWITCH HEATER CABLE
•32	46–281235P1	2	CABLE	1	VOLTAGE SENSE LEAD CABLE (40’ LONG)
33	2193153	N	COLLECTOR	1	FLEXURE COLLECTOR FOR Cx MOBILE MAGNETS
34	2209297	N	KIT	1	FLOWMETER BRACKET ROTATION KIT
35	2195887	2	PLATFORM	1	SERVICE PLATFORM

• THESE CABLES ARE CONTAINED IN RAMP AND SHIM CABLE KIT 2171719
•• INERTIA MASS DAMPENER KIT MAY NOT BE REQUIRED AND THEREFORE NOT SHIPPED WITH ALL MAGNETS.
(KITS ARE FOR LEYBOLD MAGNET CONFIGURATIONS ONLY)

1–2 MANUALS 46–294589G10 GE & VENDOR SERVICE MANUALS

Item	Part Number	FRU	Name	Quantity	Description (Remarks)
1	2159496	N	MANUAL	1	1.5T & 1.0T CX ACTIVE SHIELD MAGNET AND CRYOGENS 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 COLDHEAD & COMPRESSOR MANUAL
* 5A	2168322	N	MANUAL	1	LEYBOLD COOLPAK COMPRESSOR (ALTERNATE)
6	2168178	N	MANUAL	1	1.5T & 1.0T CX ACTIVE SHIELD MAGNET DELIVERY / INSTALLATION MANUAL

* ITEMS 5, 5A FOR MAGNET MODELS 2142600, 2163097, 2183098, 2155534, 2163096 AND 2183097

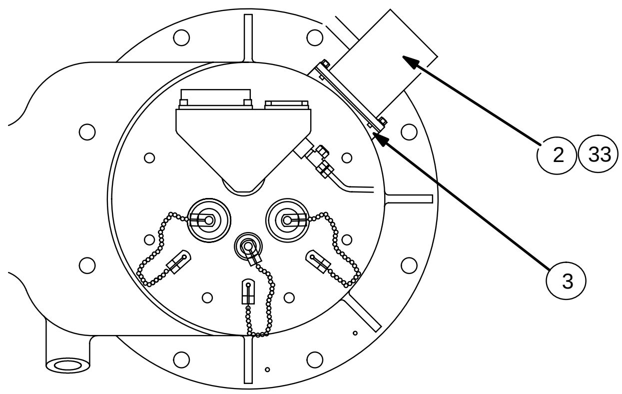
1–3 MANUALS 46–294589G12 GE & VENDOR SERVICE MANUALS

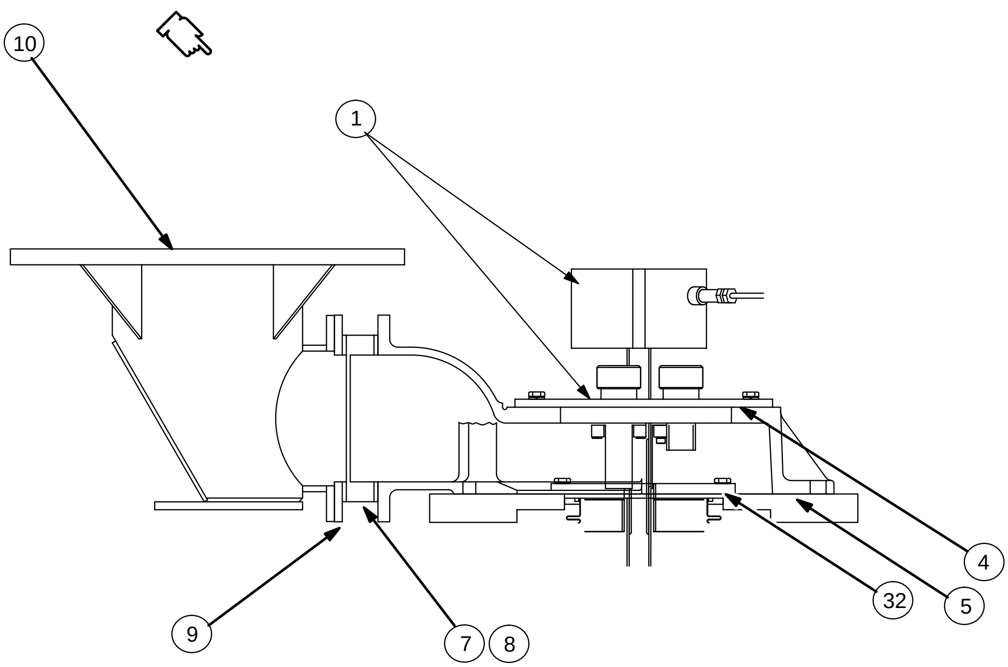
Item	Part Number	FRU	Name	Quantity	Description (Remarks)
1	2159496	N	MANUAL	1	1.5T & 1.0T CX ACTIVE SHIELD MAGNET AND CRYOGENS SUBSYSTEM SERVICE MANUAL
2	2120209	N	MANUAL	1	HELIUM LEVEL MONITOR OPER / MAINT MANUAL
3	46–318393	N	MANUAL	1	MAGNET RUNDOWN UNIT (MRU) SERVICE MANUAL
4	46–318394	N	MANUAL	1	MAGNET RUNDOWN UNIT (MRU) OPERATION MANUAL
** 5	2210552	N	MANUAL	1	SUMITOMO COLDHEAD & COMPRESSOR MANUAL
6	2168178	N	MANUAL	1	1.5T & 1.0T CX ACTIVE SHIELD MAGNET DELIVERY / INSTALLATION MANUAL

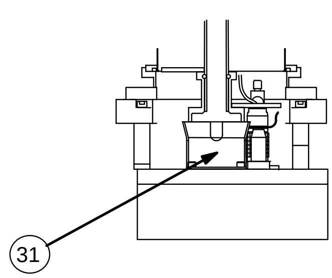
** ITEM 5 FOR MAGNET MODELS 2142600–2, 2163097–2, 2183098–2, 2155534–2, 2163096–2 AND 2183097–2

SECTION 2 – MAGNET COMPONENTS

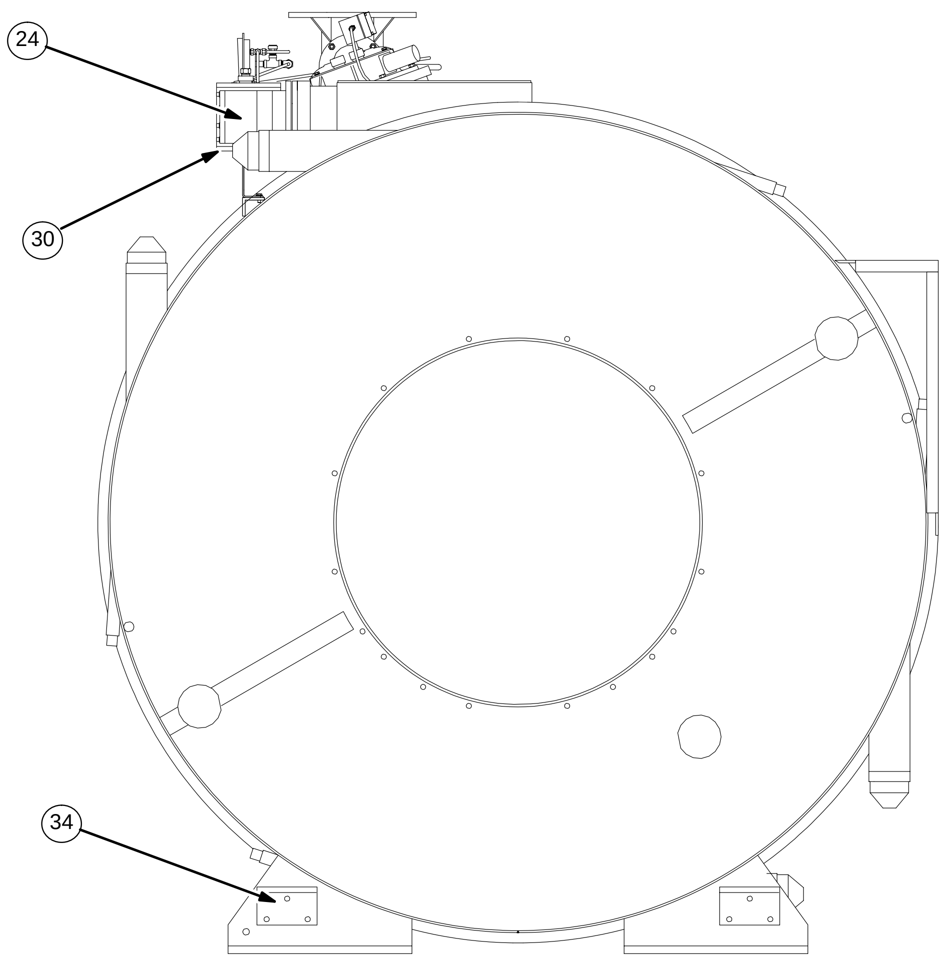
2–1 MAGNET COMPONENTS

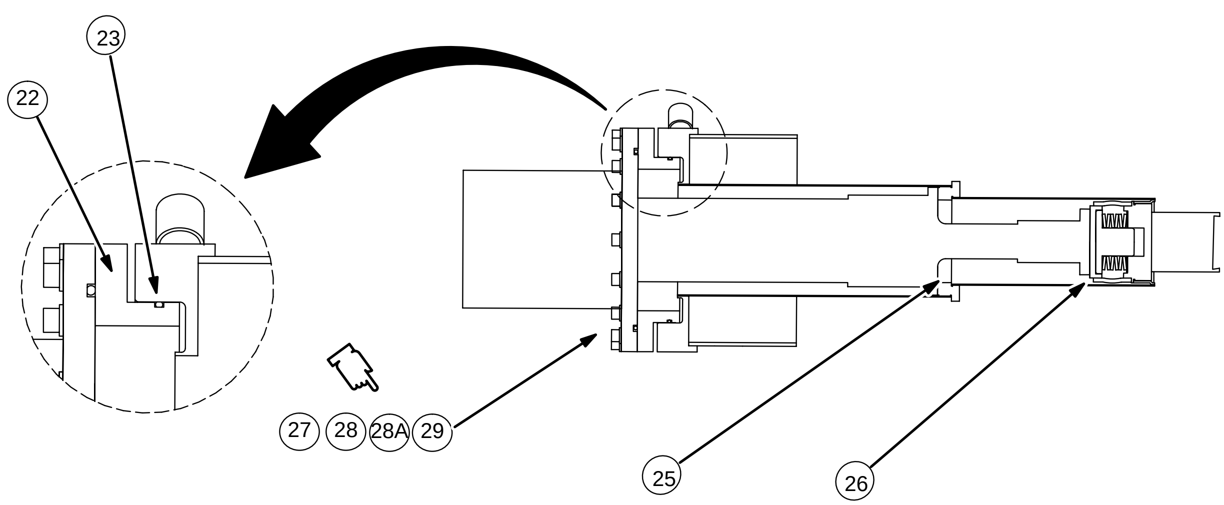




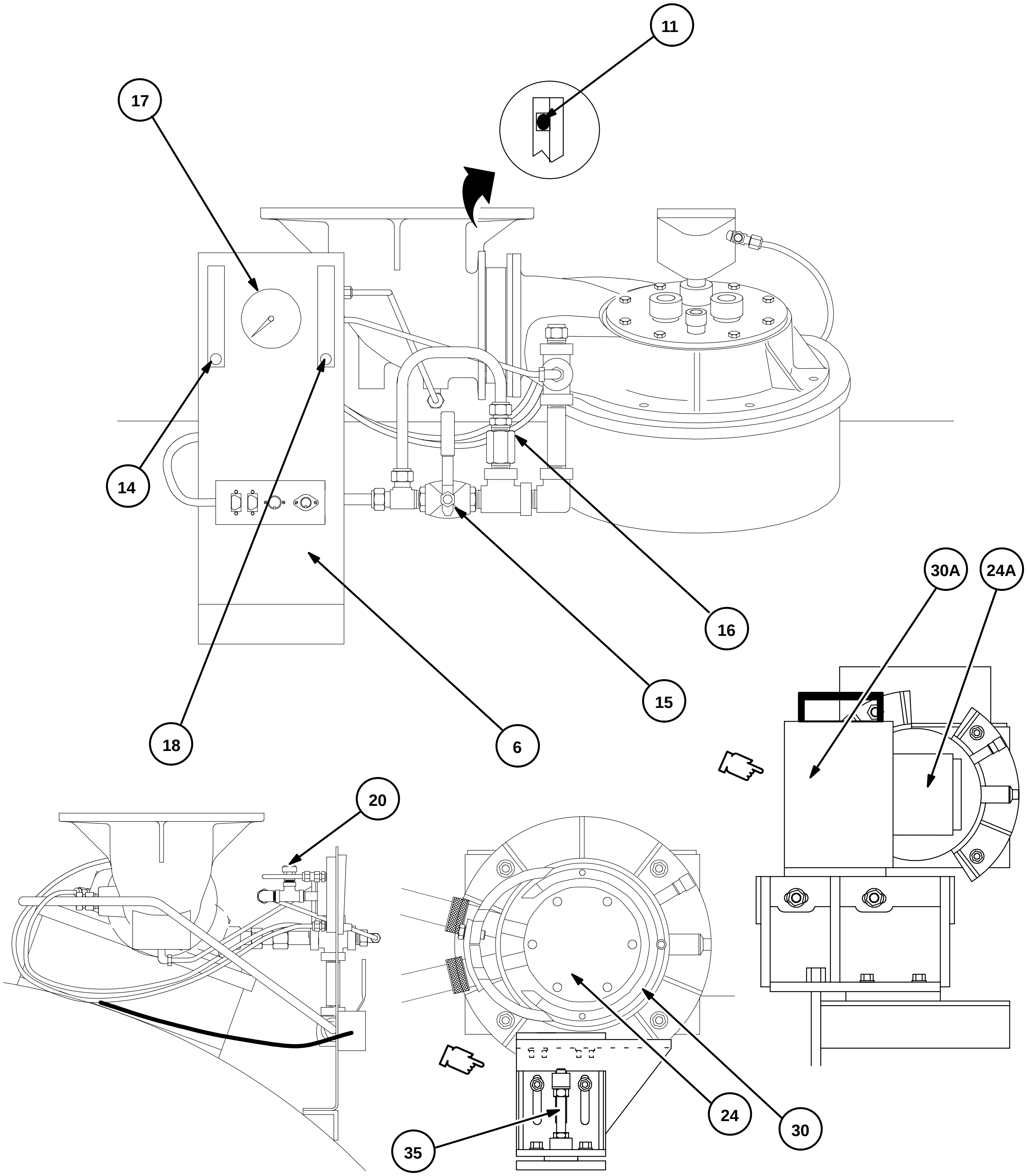


2–1 MAGNET COMPONENTS (continued)





2–1 MAGNET COMPONENTS (continued)



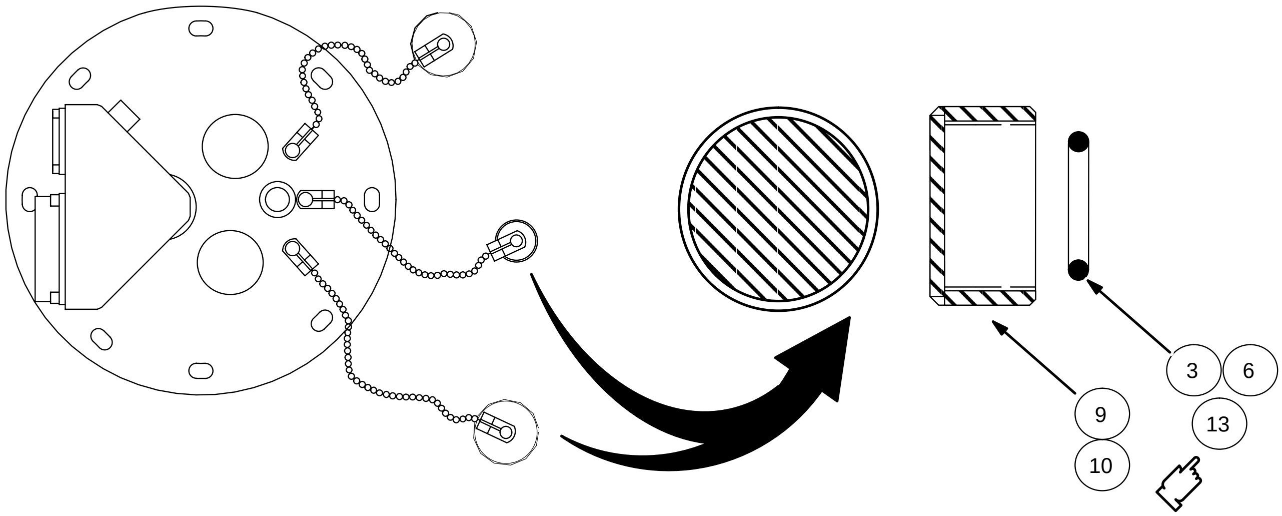
2–1 MAGNET COMPONENTS (continued)

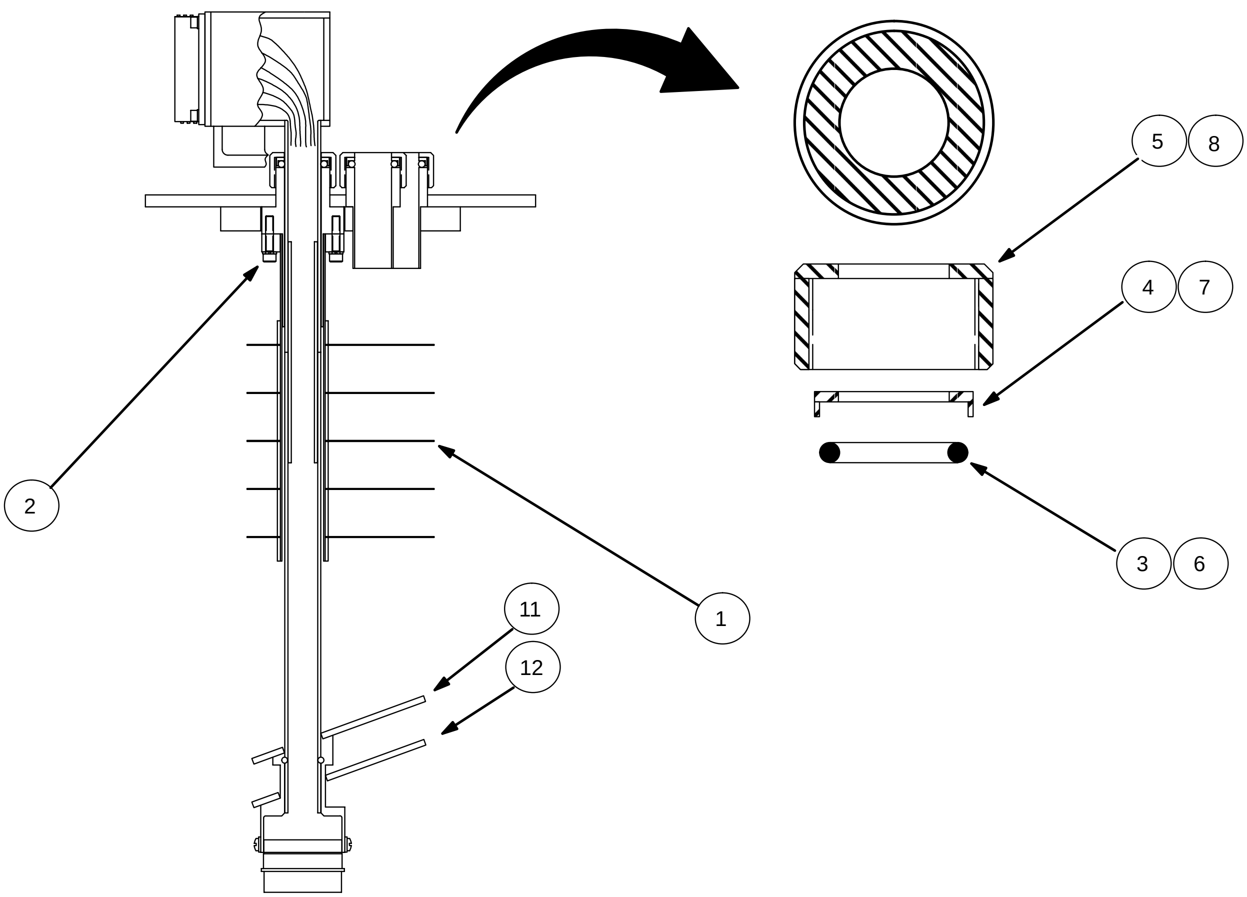
MAGNET COMP. 2148633 & 2148633–2 1.5T & 1.0T MAGNET COMPONENTS

Item	Part Number	FRU	Name	Quantity	Description (Remarks)
1	2148084	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	46–252838P7	1	BURST DISC	1	10 PSIG BURST DISC
8	46–252839P2	1	GASKET	2	NEOPRENE GASKET
9	46–260420P2	2	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	1	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	COLDHEAD TRANSITION FLANGE – LEYBOLD
23	46–281247P1	1	O–RING	1	BUNA O–RING, 4.987” I.D. X .103” THK.
* 24	2100832	1	COLDHEAD	1	LEYBOLD SHIELD COOLER COLDHEAD ASSEMBLY
** 24A	2200832	1	COLDHEAD	1	SUMITOMO SHIELD COOLER COLDHEAD 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. – LEYBOLD
* 28	46–252361P11	2	BOLT	8	STN. STL. HEX HD., .25–20UNC X 1.75” LG. – LEYBOLD
** 28A	46–260950P7	2	BOLT	8	STN. STL. HEX HD., .25–20UNC X .88” LG. – SUMITOMO
29	46–281387P1	1	WASHER	48	.25” NOM. STN. STL. BELLEVILLE WASHER
* 30	2155572	2	GUARD	1	LEYBOLD COLDHEAD MOTOR GUARD
** 30A	2217154	2	GUARD	1	SUMITOMO COLDHEAD MOTOR GUARD
31	46–318060P1	1	CONNECTOR	1	SAV–CON CONNECTOR
32	46–281101P10	1	O–RING	1	TEFLON O–RING, 6.237” I.D. X .103” THK.
33	2142318	2	COUPLING	1	INSTRUMENTATION LEAD ASSEMBLY COUPLING
34	2153833	N	BRACKET	4	JACKING BRACKET
35	2197434	2	STUD	1	.50–13UNC X 4.50” LONG, STN. STL. – LEYBOLD

* ITEMS 24, 28 AND 30 FOR MAGNET MODELS 2142600, 2163097, 2183098, 2155534, 2163096 AND 2183097
** ITEMS 24A, 28A AND 30A FOR MAGNET MODELS 2142600–2, 2163097–2, 2183098–2, 2155534–2, 2163096–2 AND 2183097–2

2–2 SHIM LEAD COMP. 2148084 SHIM LEAD AND TOP PLATE ASSEMBLY





2–2 SHIM LEAD COMPONENTS (continued)

2–2 SHIM LEAD COMP. 2148084 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	46–260342P10	1	O–RING	2	SILICONE O–RING, PARKER #2–112
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
13	46–260389P4	2	O–RING	1	SILICONE O–RING, PARKER #2–205

SECTION 3 – MAGNET ACCESSORIES

3–1 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

3–2 LEYBOLD COOLPACK 4000 SHIELD COOLER COMPRESSOR 2168321
*** (VENDOR RENEWAL PARTS CROSS REFERENCE)**

Item	Vendor Part #	FRU	Description	GE Part Number
1	200–19–460	2	BRASS HOSE NIPPLE	46–294150P7
2	200–20–074	2	.25” FILLING ADAPTER	46–294150P12
3	520–25–310	1	FUSE, 315 mA, 1100 mV, SLOW–BLO	46–294150P23
4	893–52	1	ADSORBER CACP 6000	46–294150P24
5	200–49–052	2	BRASS CLAMPING RING	46–294150P25
6	200–49–033	2	BRASS NUT	46–294150P26
7	725–52–220	2	.50” FLAT GASKET	46–294150P27
8	950–00–004	2	.50” PROTECTIVE CAP	46–294150P28
9	725–52–219	2	.25” FLAT GASKET	46–294150P29
10	200–19–837	2	.25” PROTECTIVE CAP	46–294150P30
11	200–20–934	2	BRASS CLAMPING RING	46–294150P31
12	200–81–174	2	ADAPTER CABLE	46–294150P32

3–3 SUMITOMO SHIELD COOLER COMPRESSOR 2188440
*** (VENDOR RENEWAL PARTS CROSS REFERENCE)**

Item	Vendor Part #	FRU	Description	GE Part Number
1	RE71TN0408	1	ADSORBER	2172241
2	RE71WT0602	1	CLASS G FUSE, 2A	2191112
3	RE71WT0601	1	CLASS G FUSE, 3A	2191112–3
4	RE71WN0538	1	PHASE FAILURE RELAY	2191112–5
5	RE38VT0689	N	HOSE NIPPLE, 12 x 3/8	2205309

* VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL.

3–4 FIELDSPARE KIT 46–294744G4

Item	Part Number	FRU	Name	Quantity	Description
1	2133618	1	BAFFLE ASM	1	SHIM LEAD BAFFLE ASSEMBLY
2	46–252838P7	1	BURST DISK	1	10 PSI BURST DISK
3	46–252839P2	1	GASKET	2	NEOPRENE GASKET
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	2	TEFLON O–RING, 6.237” I.D. X .103” THK.
13	46–260902P5	2	PLUG	1	.25” TUBE PLUG

3–5 MAGNET RUNDOWN UNIT 46–294231G1

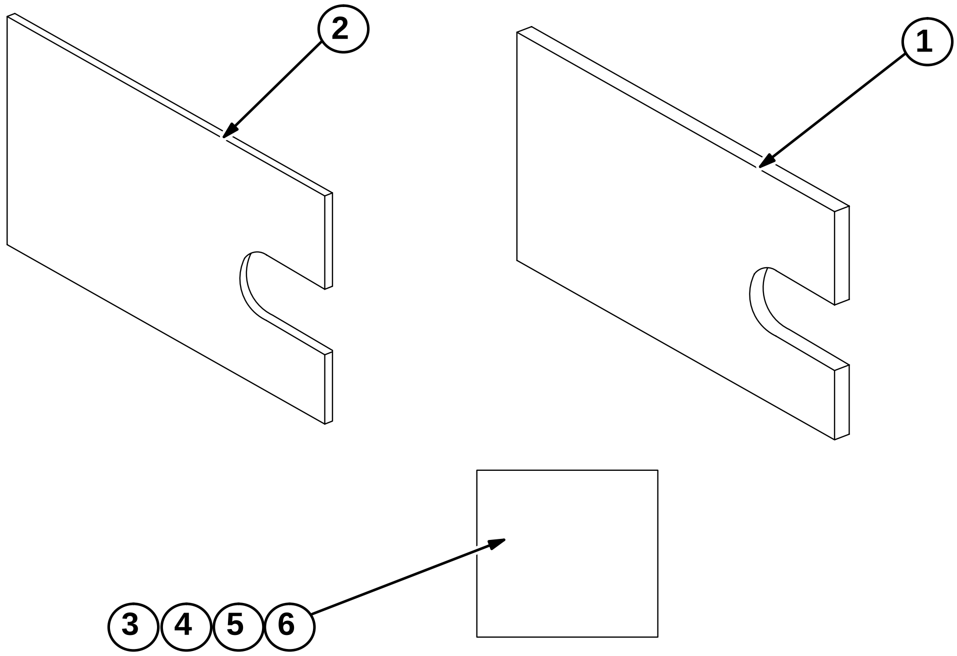
Item	Vendor Part #	FRU	Description	GE Part Number
1	EF1001	1	FUSE, F1, 110VAC .400 GDCTIME LAG	46–294231P1
2	EF1002	1	FUSE, F1, 220VAC .125GDC TIME LAG	46–294231P2
3	EF1008	1	FUSE, F2, 2.5A GDC TIME LAG	46–294231P3
4	GS4063	1	FUSE, F3/F4, 1.25A GDB	46–294231P4
5	GS4063	1	BATTERY, GEL CEL 6V 1.2AH YUSA NP1.2–6	46–294231P5
6	EC1140	1	CAPACITOR, CI, 470uF, 50V,	46–294231P6

3–6 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–1520	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

3–7 MAGNET LEVELING KIT 46–260888G3

Item	Part Number	FRU	Name	Quantity	Description
1	2159195	2	SHIM PLATE	12	.062” THICK ALUM. ALLOY PLATE
2	2159195–2	2	SHIM PLATE	8	.020” THICK ALUM. ALLOY PLATE
3	2180016	2	SHIM PLATE	24	.020” THICK, 6.00” x 6.00” ALUM.
4	2180016–2	2	SHIM PLATE	16	.032” THICK, 6.00” x 6.00” ALUM.
5	2180016–3	2	SHIM PLATE	8	.040” THICK, 6.00” x 6.00” ALUM.
6	2180016–4	2	SHIM PLATE	4	.063” THICK, 6.00” x 6.00” ALUM.

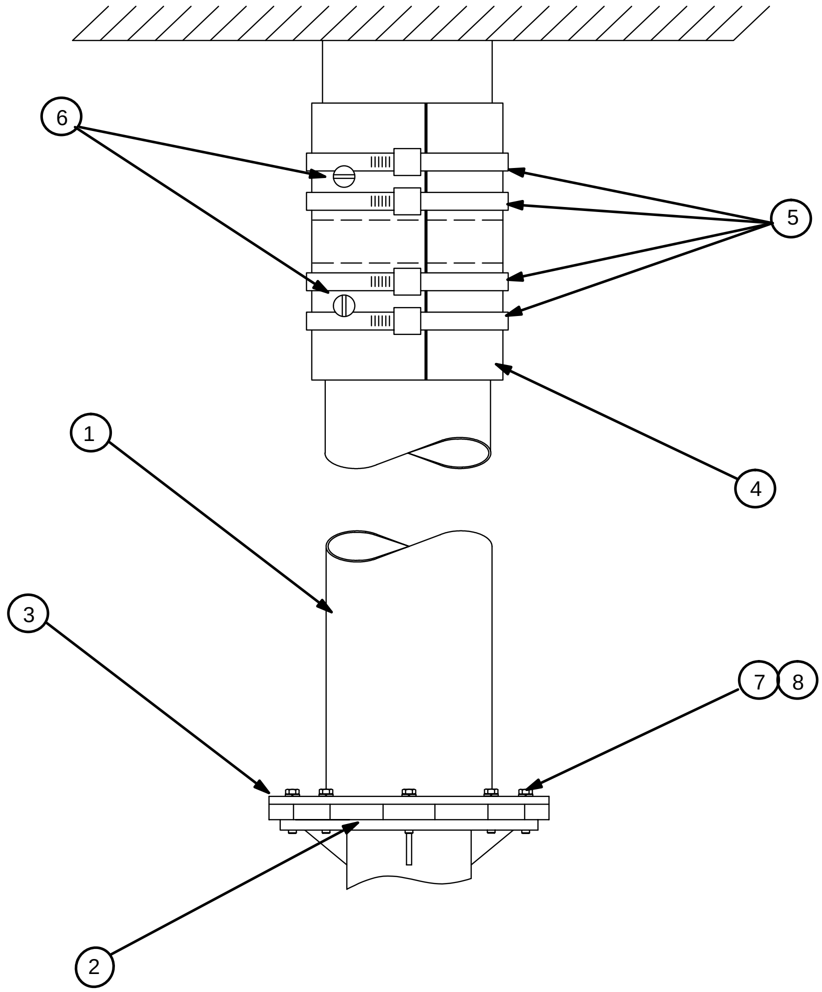


3–8 HELIUM VENT KIT 46–318057G1 & G2

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

* THESE ITEMS ONLY INCLUDED IN MOBILE KIT 46–318057G2

3–8 HELIUM VENT KIT 46–318057G1 & G2 (continued)

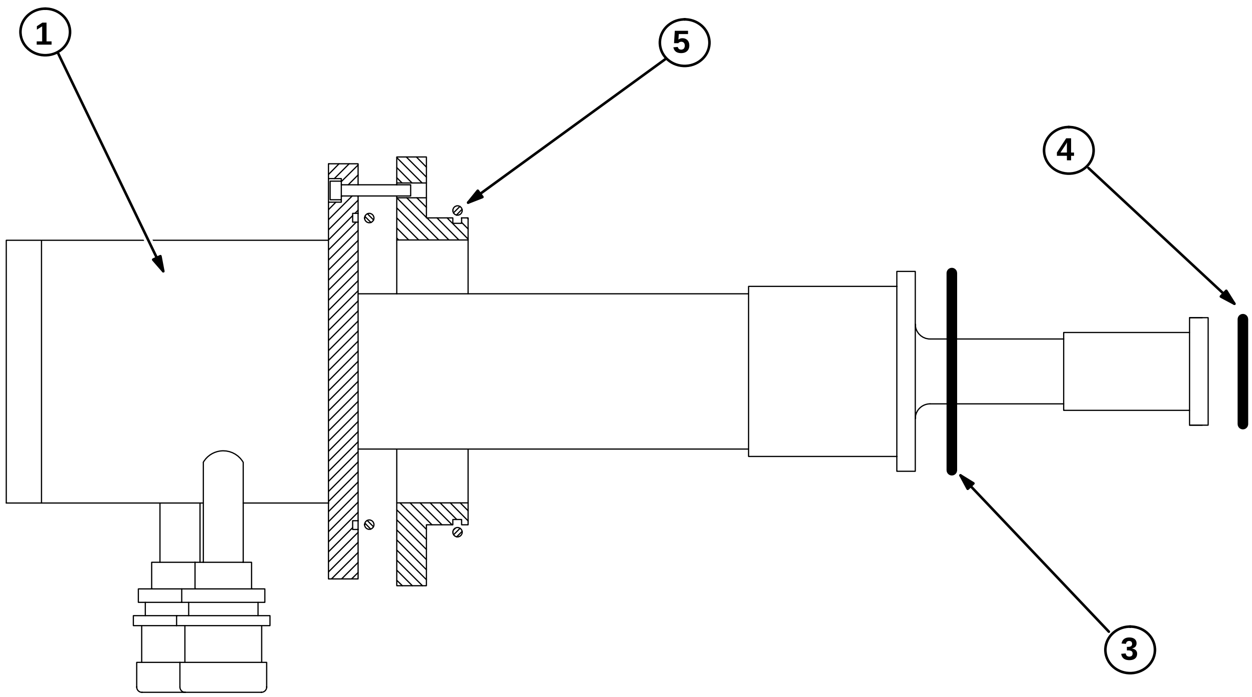


3–9 LEYBOLD COLDHEAD KIT – 2153515

Item	Part Number	FRU	Name	Quantity	Description
1	2100832	1	COLDHEAD	1	LEYBOLD COLDHEAD
* 2	46–252065P64	N	GLOVES	1	COTTON GLOVES, ONE PAIR
* 3	46–281241P3	1	GASKET	1	INDIUM GASKET, 3.37 O.D.
* 4	46–281241P4	1	GASKET	1	INDIUM GASKET, 1.75 O.D.
* 5	46–281247P1	1	O–RING	2	BUNA, 4.987 I.D. X .103 THICK

* THESE ITEMS ARE INCLUDED IN LEYBOLD PARTS KIT 2153516.

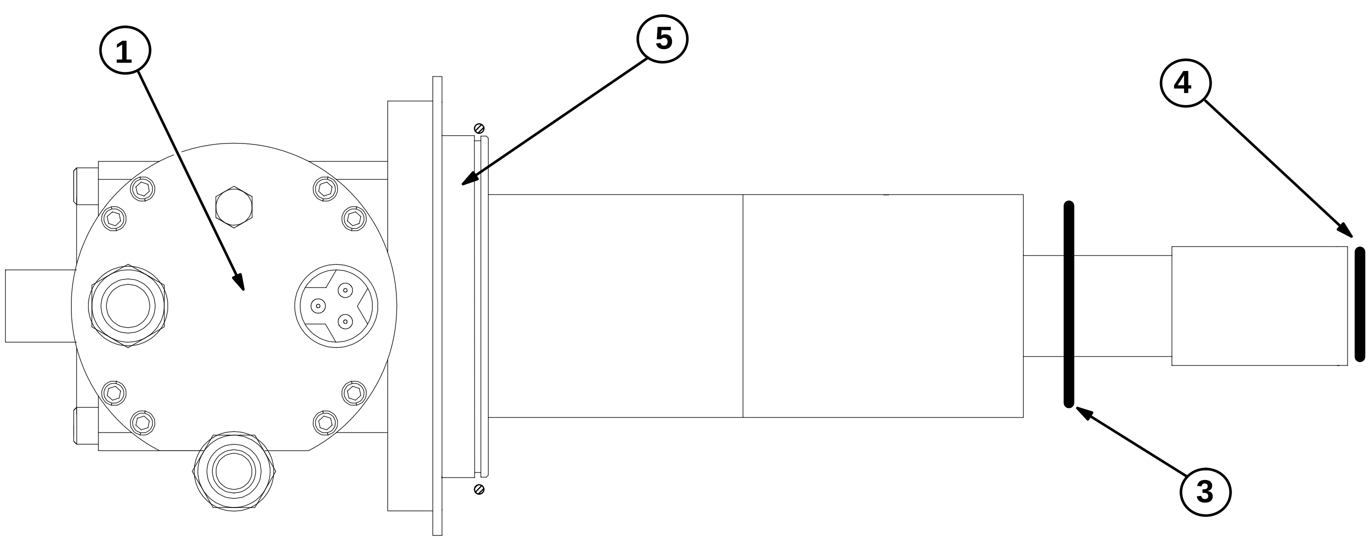
3–9 LEYBOLD COLDHEAD KIT – 2153515 (continued)



3–10 SUMITOMO COLDHEAD KIT – 2209470

Item	Part Number	FRU	Name	Quantity	Description
1	2200832	1	COLDHEAD	1	SUMITOMO COLDHEAD
* 2	46–252065P64	N	GLOVES	1	COTTON GLOVES, ONE PAIR
* 3	46–281241P3	1	GASKET	1	INDIUM GASKET, 3.37 O.D.
* 4	46–281241P4	1	GASKET	1	INDIUM GASKET, 1.75 O.D.
* 5	46–281247P1	1	O–RING	1	BUNA, 4.987 I.D. X .103 THICK

* THESE ITEMS ARE INCLUDED IN SUMITOMO PARTS KIT 2209497



3–11 INERTIA MASS DAMPENER KIT FOR FIXED SITE WITH LEYBOLD COLDHEADS – 2177596

Item	Part Number	FRU	Name	Quantity	Description
1	2172942	N	PLATE	1	.75” THICK BRASS COVER PLATE
2	2172944	N	PLATE	2	.75” THICK BRASS ACOUSTIC PLATE
3	2172946	2	ROD	3	DAMPENER HANGER ROD
4	2173169	N	BLOCK	2	DAMPENER PIVOT BLOCK
5	2173170	N	BAR	1	DAMPENER RETAINING BAR
6	2173171	N	BRACKET	1	HOLDER BRACKET FOR PLATES
7	2173172	N	SUPPORT	1	STRUCTURAL SUPPORT FOR DAMPENER
8	2173246	N	BAR	2	VERTICAL ADJUSTMENT BAR
9	2173791	N	U–BOLT	2	2.00” STN. STL. U–BOLT
10	46–260950P66	N	SCREW	2	.75”–10 X 1.50” LG. STN. STL. CAP SCREW
11	46–260950P19	N	SCREW	8	.312”–18 X .75” LG. STN. STL. CAP SCREW
12	46–252635P9	N	WASHER	4	.375” NOM. FLAT, STN. STL. WASHER
13	46–260950P21	N	SCREW	4	.312”–18 X 1.00” LG. STN. STL. CAP SCREW
14	46–252635P8	N	WASHER	6	.312” NOM. FLAT, STN. STL. WASHER
15	46–260950P23	N	SCREW	2	.312”–18 X 1.25” LG. STN. STL. CAP SCREW
16	46–281162P10	N	WASHER	12	.312” NOM. STN. STL. LOCKWASHER
17	46–252318P17	2	NUT	12	.312” BRASS HEX NUT
18	46–260789P75	N	SCREW	2	.312”–18 X .75” LG. STN. STL. SCK’T HD CAP SCREW
19	2184024	N	STRAP	3	DAMPENER PLATE HANDLE STRAP
20	2184023	N	STRAP	1	STRAIN RELIEF STRAP
21	46–252283P58	N	TY–WRAP	2	CABLE TY–WRAP

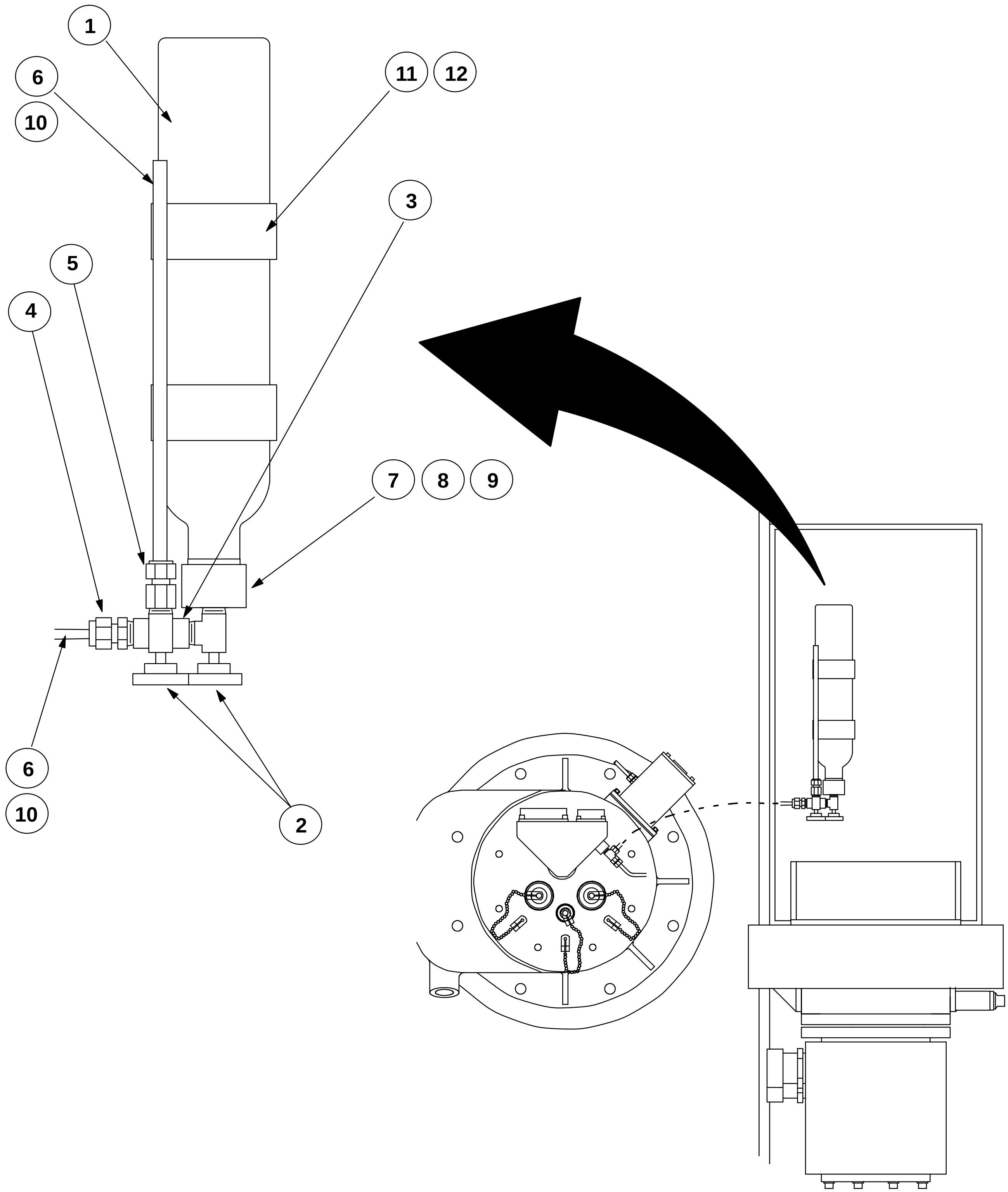
NOTE: INERTIA MASS DAMPENER KIT MAY NOT BE REQUIRED AND THEREFORE NOT SHIPPED WITH ALL MAGNETS.

3–12 INERTIA MASS DAMPENER KIT FOR MOBILE SITE WITH LEYBOLD COLDHEADS – 2183100

Item	Part Number	FRU	Name	Quantity	Description
1	2184021	N	PLATE	1	.75” THICK BRASS COVER PLATE
2	2184022	N	PLATE	2	.75” THICK BRASS ACOUSTIC PLATE
3	2184019	2	ROD	3	DAMPENER HANGER ROD
4	2173169	N	BLOCK	2	DAMPENER PIVOT BLOCK
5	2173170	N	BAR	1	DAMPENER RETAINING BAR
6	2173171	N	BRACKET	1	HOLDER BRACKET FOR PLATES
7	2183102	N	SUPPORT	1	STRUCTURAL SUPPORT FOR DAMPENER
8	2173246	N	BAR	2	VERTICAL ADJUSTMENT BAR
9	2184024	N	STRAP	3	DAMPENER PLATE HANDLE STRAP
10	46–260950P66	N	SCREW	2	.75”–10 X 1.50” LG. STN. STL. CAP SCREW
11	46–260950P19	N	SCREW	8	.312”–18 X .75” LG. STN. STL. CAP SCREW
12	46–252635P9	N	WASHER	4	.375” NOM. FLAT, STN. STL. WASHER
13	46–260950P21	N	SCREW	4	.312”–18 X 1.00” LG. STN. STL. CAP SCREW
14	46–252635P8	N	WASHER	4	.312” NOM. FLAT, STN. STL. WASHER
15	46–318672P38	N	SCREW	2	.375”–16 X 2.00” LG. STN. STL. CAP SCREW
16	46–281162P10	N	WASHER	4	.312” NOM. STN. STL. LOCKWASHER
17	46–252318P17	2	NUT	6	.312–16 STN. STL. HEX NUT
18	46–260789P75	N	SCREW	2	.312”–18 X .75” LG. STN. STL. SCK’T HD CAP SCREW
19	46–260166P3	N	NUT	6	.50–13 BRASS JAM NUT
20	46–281162P11	N	WASHER	2	.375” NOM. STN. STL. LOCKWASHER
21	46–252318P19	N	NUT	2	.375–16 STN. STL. HEX NUT
22	46–281162P13	N	WASHER	6	.50” NOM. STN. STL. LOCKWASHER

NOTE: INERTIA MASS DAMPENER KIT MAY NOT BE REQUIRED AND THEREFORE NOT SHIPPED WITH ALL MAGNETS.

3–13 THERMAL ACOUSTIC OSCILLATION KIT – 2195558



3–13 THERMAL ACOUSTIC OSCILLATION KIT – 2195558 (continued)

Item	Part Number	Name	Quantity	Description
1	46–281957P1	BOTTLE	1	DAMPENER BOTTLE ASSEMBLY
2	46–281109P1	VALVE	2	DAMPENER ANGLE VALVE
3	46–252205P2	TEE	1	1/4 NPT BRASS
4	46–260898P4	CONNECTOR	1	MALE, 1/4 OD X 1/4 NPT
5	46–260912P6	CONNECTOR	1	FEMALE, BRASS, .25” ODT TO .25” NPT
6	46–252065P45	POLY TUBING	3	TUBE .25 OD X .040 WALL
7	46–281909P1	FITTING	1	TAO FITTING
8	46–260342P11	O–RING	1	NITRILE, .614” ID X .070” DIA.
9	46–252065P19	TAPE	AR	TEFLON TAPE X .50” WIDE
10	46–252065P46	INSERT	3	BRASS INSERT FOR POLY TUBING
11	46–294167P4	VELCRO	1	VELCRO HOOK, .62 “ WIDE X 36.00” LONG
12	46–294167P5	VELCRO	1	VELCRO LOOP, .62 “ WIDE X 36.00” LONG

3–14 COLDHEAD CHANGE–OUT KIT FOR FIXED SITE – 2209024 (LEYBOLD TO SUMITOMO)

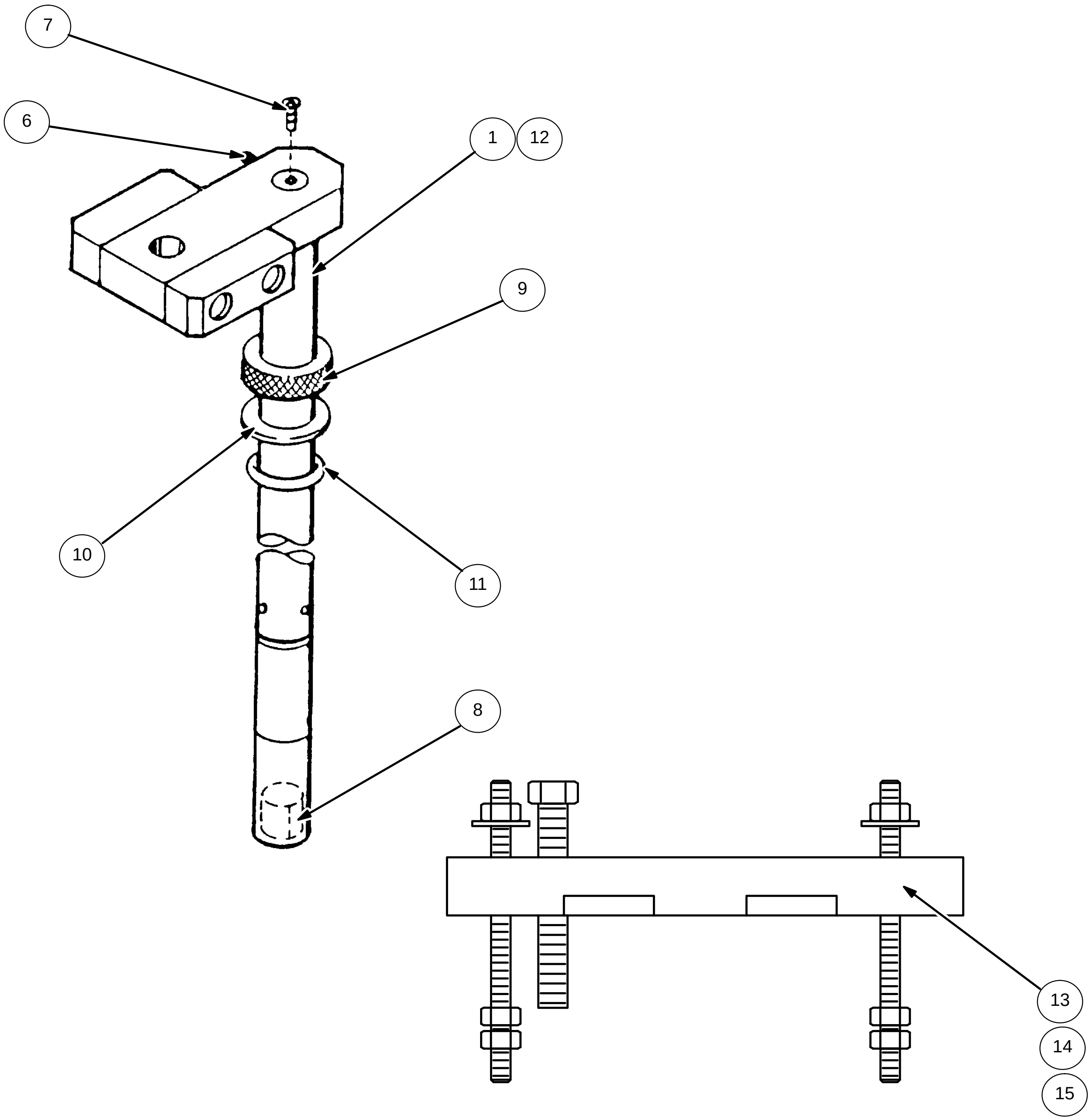
Item	Part Number	Name	Quantity	Description
1	2188440	COMPRESSOR	1	SUMITOMO COMPRESSOR
2	2209470	KIT	1	SUMITOMO COLDHEAD REPLACEMENT KIT
3	2154502–2	GAS LINE	1	SUMITOMO HELIUM SUPPLY LINE (65.6 FT. OR 20 M LONG)
4	2154505–2	GAS LINE	1	SUMITOMO HELIUM RETURN LINE (65.6 FT. OR 20 M LONG)
5	2155316–2	CABLE	1	COMPRESSOR TO PEN. PANEL (49.21 FT. OR 15 M LONG)
6	2172239–2	CABLE	1	COLDHEAD TO PEN. PANEL (49.21 FT. OR 15 M LONG)
7	2200835	CABLE	1	COMPRESSOR INPUT POWER CABLE
8	2187575	MOTORSHIELD	1	COLDHEAD MOTORSHIELD
9	2202003	BRACKET	1	MOTORSHIELD MOUNTING BRACKET
10	46–260950P73	CAP SCREW	2	STN. STL., HEX HD., .50–13UNC X 2.50” LONG
11	46–252639P4	HEX NUT	2	.50–13UNC, SILICON BRONZE
12	46–252635P11	FLAT WASHER	4	.50” NOMINAL
13	46–281162P13	LOCKWASHER	2	.50” NOMINAL
14	46–260950P7	SCREW	8	STN. STL., HEX HD., .25–20UNC X .88” LONG
15	2185300–2	STUD	1	.50–20UNF X 3.50” LONG
16	46–252283P58	TY–WRAP	4	TY–WRAP

3–15 COLDHEAD CHANGE–OUT KIT FOR MOBILE SITE – 2209023 (LEYBOLD TO SUMITOMO)

Item	Part Number	Name	Quantity	Description
1	2188440	COMPRESSOR	1	SUMITOMO COMPRESSOR
2	2209470	KIT	1	SUMITOMO COLDHEAD REPLACEMENT KIT
3	2154502–4	GAS LINE	1	SUMITOMO HELIUM SUPPLY LINE (39.4 FT. OR 12 M LONG)
4	2154505–4	GAS LINE	1	SUMITOMO HELIUM RETURN LINE (39.4 FT. OR 12 M LONG)
5	2155316–2	CABLE	1	COMPRESSOR TO PEN. PANEL (49.21 FT. OR 15 M LONG)
6	2172239–2	CABLE	1	COLDHEAD TO PEN. PANEL (49.21 FT. OR 15 M LONG)
7	2200835	CABLE	1	COMPRESSOR INPUT POWER CABLE
8	2187575	MOTORSHIELD	1	COLDHEAD MOTORSHIELD
9	2202003	BRACKET	1	MOTORSHIELD MOUNTING BRACKET
10	46–260950P73	CAP SCREW	2	STN. STL., HEX HD., .50–13UNC X 2.50” LONG
11	46–252639P4	HEX NUT	2	.50–13UNC, SILICON BRONZE
12	46–252635P11	FLAT WASHER	4	.50” NOMINAL
13	46–281162P13	LOCKWASHER	2	.50” NOMINAL
14	46–260950P7	SCREW	8	STN. STL., HEX HD., .25–20UNC X .88” LONG
15	2185300–2	STUD	1	.50–20UNF X 3.50” LONG
16	46–252283P58	TY–WRAP	4	TY–WRAP

SECTION 4 – SERVICE TOOL KITS / COMPONENTS

4–1 MAGNET RAMPING EQUIPMENT KIT 46–260703G4



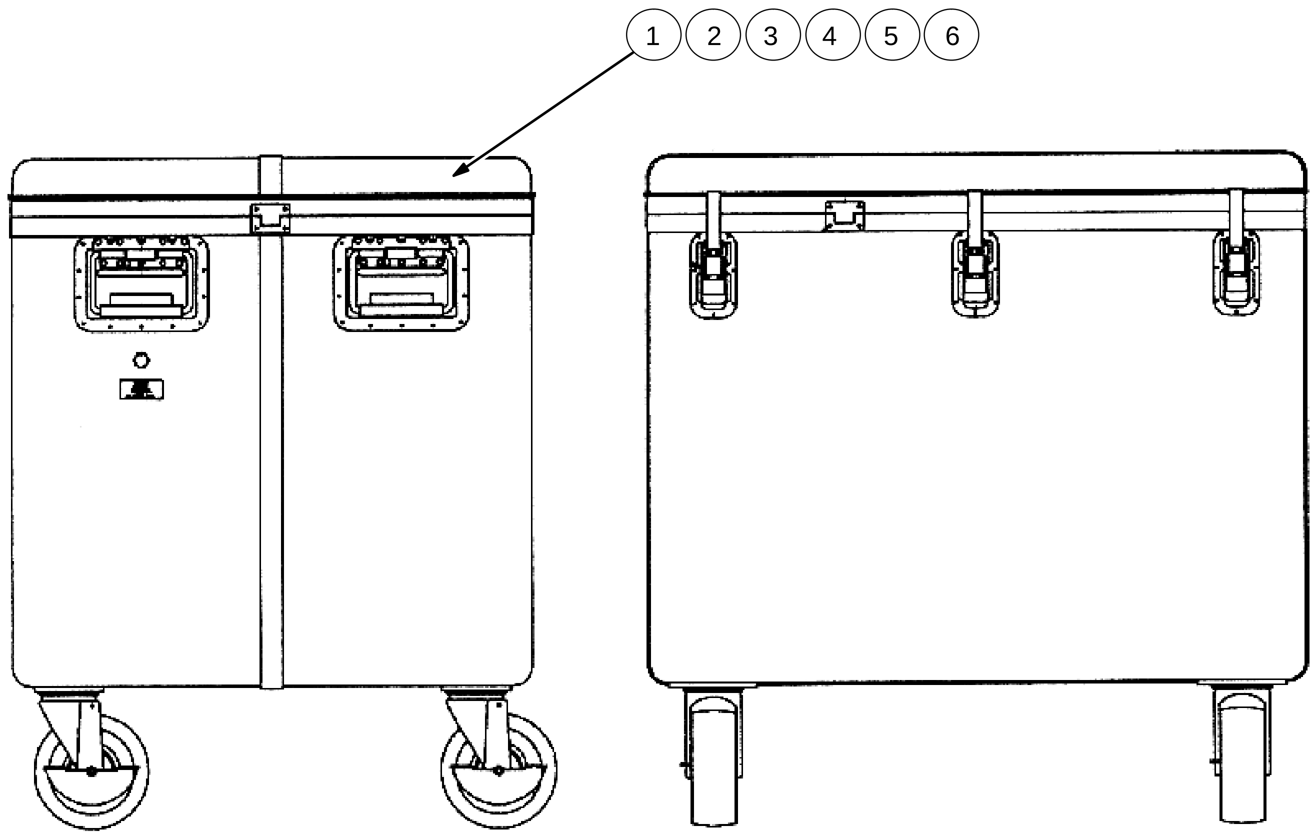
4–1 MAGNET RAMPING EQUIPMENT KIT 46–260703G4

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–260817G3	SII, SIII, & MAX	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	46–294204G1	SIV AS MAIN LEADS	2	VAPOR COOLED MAIN LEAD EXTENSIONS
13	2142687	RAMPING FIXTURE	1	HOLD DOWN TOOL FOR RAMP LEADS (SIV)
14	2152359	RAMPING FIXTURE	1	HOLD DOWN TOOL FOR RAMP LEADS (VMX, 0BO)
15	2185743	RAMPING FIXTURE	1	HOLD DOWN TOOL FOR RAMP LEADS
16	46–294236G1	CASE / FOAM	1	CASE FOR RAMPING ITEMS

4–2 POWER SUPPLIES

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–260776G3	MAIN P/S	1	750 AMP MAIN COIL POWER SUPPLY
2	46–260776G4	MAIN P/S	1	1,000 AMP MAIN COIL POWER SUPPLY
3	46–260777G3	SHIM P/S	1	SHIMMING POWER SUPPLY

4–3 RAMP CART / CABLE KITS



4–3–1 750 AMP RAMP CART / CABLE KIT 2135435

Item	Part Number	Name	Quantity	Description (Remarks)
1	2135434	CART	1	RAMP CABLE CART
2	46–260723G1	CABLE	2	POWER, POSITIVE 4/0
3	46–260723G2	CABLE	2	POWER, NEGATIVE 4/0
4	46–260724G1	CABLE	1	SWITCH HEATERS
5	46–281667G1	CABLE	1	SWITCH HEATERS, RJC & RJD
6	46–281235P1	CABLE	1	VOLTAGE SENSE LEAD X 40 FT.

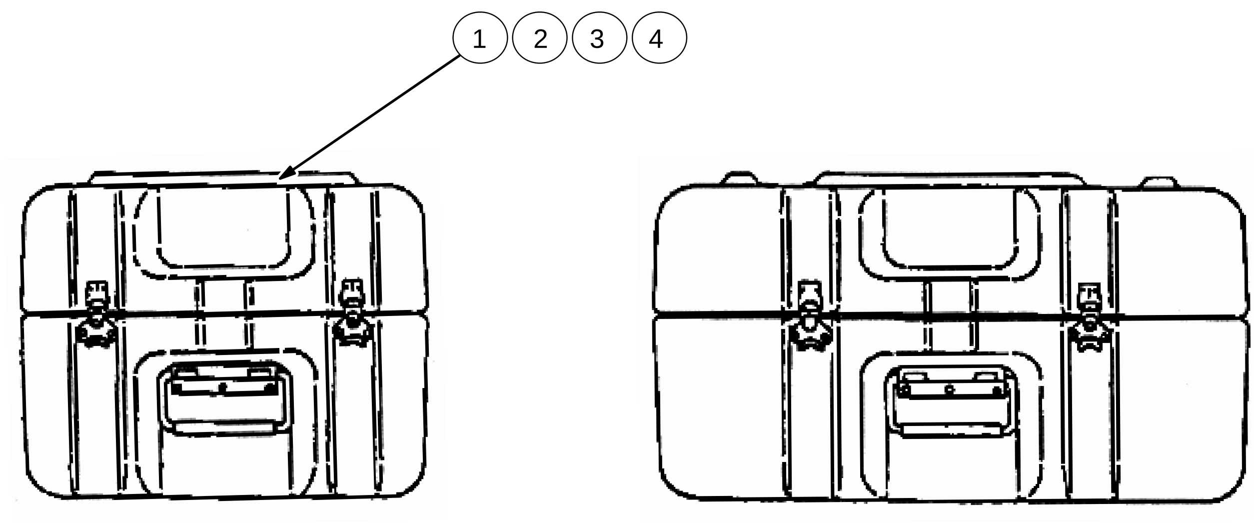
4–3–2 1,000 AMP RAMP CART / CABLE KIT 2180589

Item	Part Number	Name	Quantity	Description (Remarks)
1	2135434	CART	1	RAMP CABLE CART
2	46–260723G1	CABLE	3	POWER, POSITIVE 4/0
3	46–260723G2	CABLE	3	POWER, NEGATIVE 4/0
4	46–260724G1	CABLE	1	SWITCH HEATERS
5	46–281667G1	CABLE	1	SWITCH HEATERS, RJC & RJD
6	46–281235P1	CABLE	1	VOLTAGE SENSE LEAD X 40 FT.

4–3–3 RAMP CART / CABLE KIT UPGRADE 2180594 – 2135435 750 AMP TO 2180589 1,000 AMP

Item	Part Number	Name	Quantity	Description (Remarks)
1	46–260723G1	CABLE	1	POWER, POSITIVE 4/0
2	46–260723G2	CABLE	1	POWER, NEGATIVE 4/0
3	46–294167P20	TAPE	1	BLACK / YELLOW CHECKERED TAPE
4	2180592	LABEL	1	LABEL FOR 2180589 KIT

4–4 SHIM CASE / CABLE KIT 2135558



Item	Part Number	Name	Quantity	Description (Remarks)
1	2135557	CASE	1	SHIM CABLE CASE
2	46–260726G1	CABLE	1	SHIM COIL ASSEMBLY
3	46–260724G1	CABLE	1	SWITCH HEATERS
4	2135362	CABLE	1	SHIM LEAD ADAPTER – SV

4–5 SERVICE POWER SUPPLY RENEWAL PARTS 46–260776G3, G4 & 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	46–281469P
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

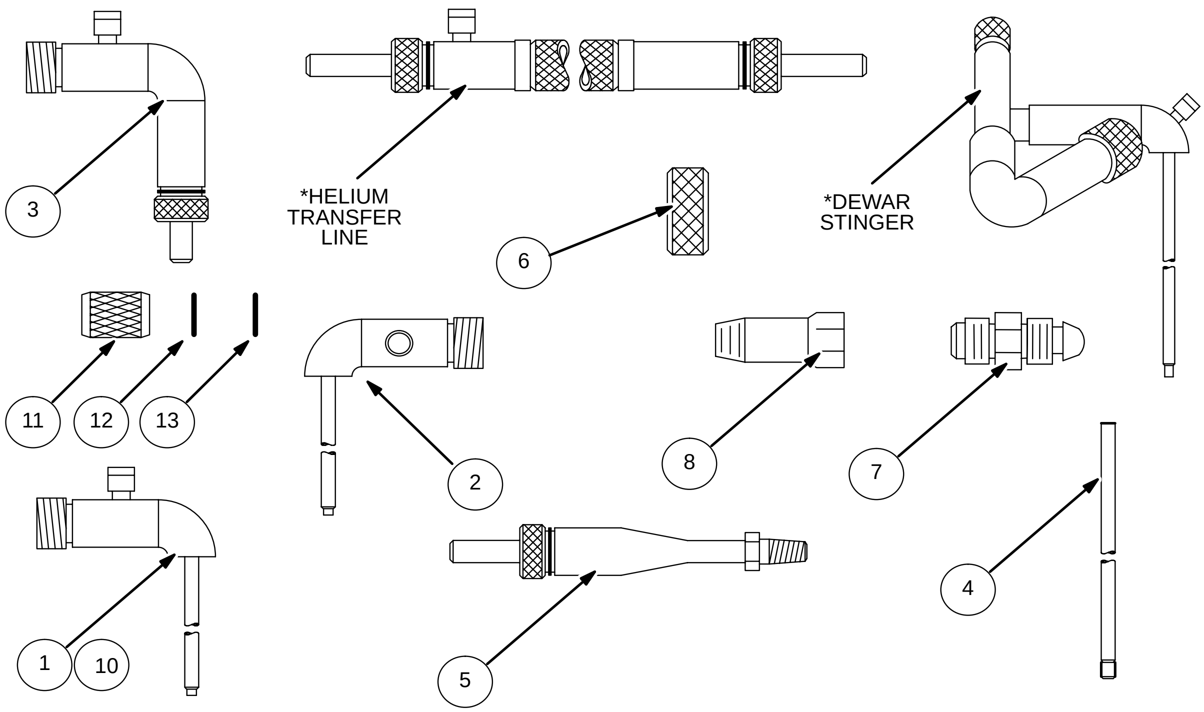
*** VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL**

4–5 SERVICE POWER SUPPLY RENEWAL PARTS 46–260776G3, G4 & 46–260777G3 * (VENDOR RENEWAL PARTS CROSS REFERENCE) (continued)

Item	Vendor Part Number	Description (Remarks)	GE Part Number
51	00–481–1305	MAIN COIL POWER SUPPLY ESS7.5–1000–2–D–1236	46–260219P113
52	67–136–001	10 TURN, 100 OHM WW OIL FILLED POT	46–260219P114
53	66–062–009	ANALOG AMMETER, 0–1 ADC	46–260219P115
54	66–082–014	DIGITAL VOLTMETER / AMMETER, 5.5 DIGIT	46–260219P116
55	80–001–013	PS1 MTR, P.S. +/– 12, +5	46–260219P117
56	67–136–002	10 TURN, 5K, WW OIL FILLED POT	46–260219P118

*** VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL**

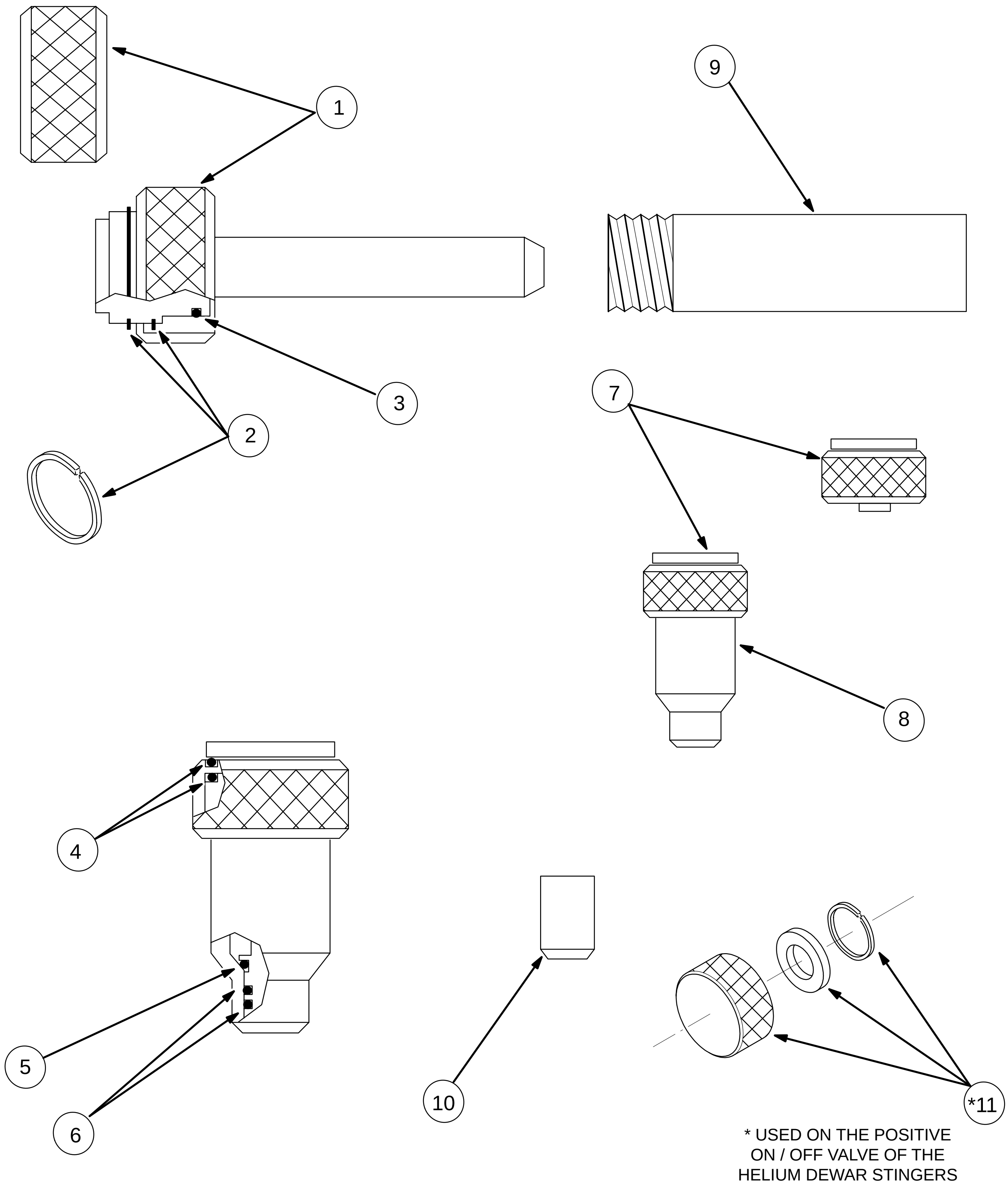
4–6 UNIVERSAL FILL LINE KIT 46–294705G1



* ITEMS ARE NOT INCLUDED IN UNIVERSAL FILL LINE KIT

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
11	46–318619P1	NUT	1	KNURLED BRASS .75–20UNEF COUPLING NUT (EXTENDED)
12	46–260272P1	RING	1	STN. STL. RETAINING RING X .687” O.D.
13	46–260342P9	O–RING	1	BUNA–N, .489” I.D. X .625” O.D.

4–7 HELIUM TRANSFER LINE KIT RENEWAL PARTS



4–7 HELIUM TRANSFER LINE KIT RENEWAL PARTS (continued)

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

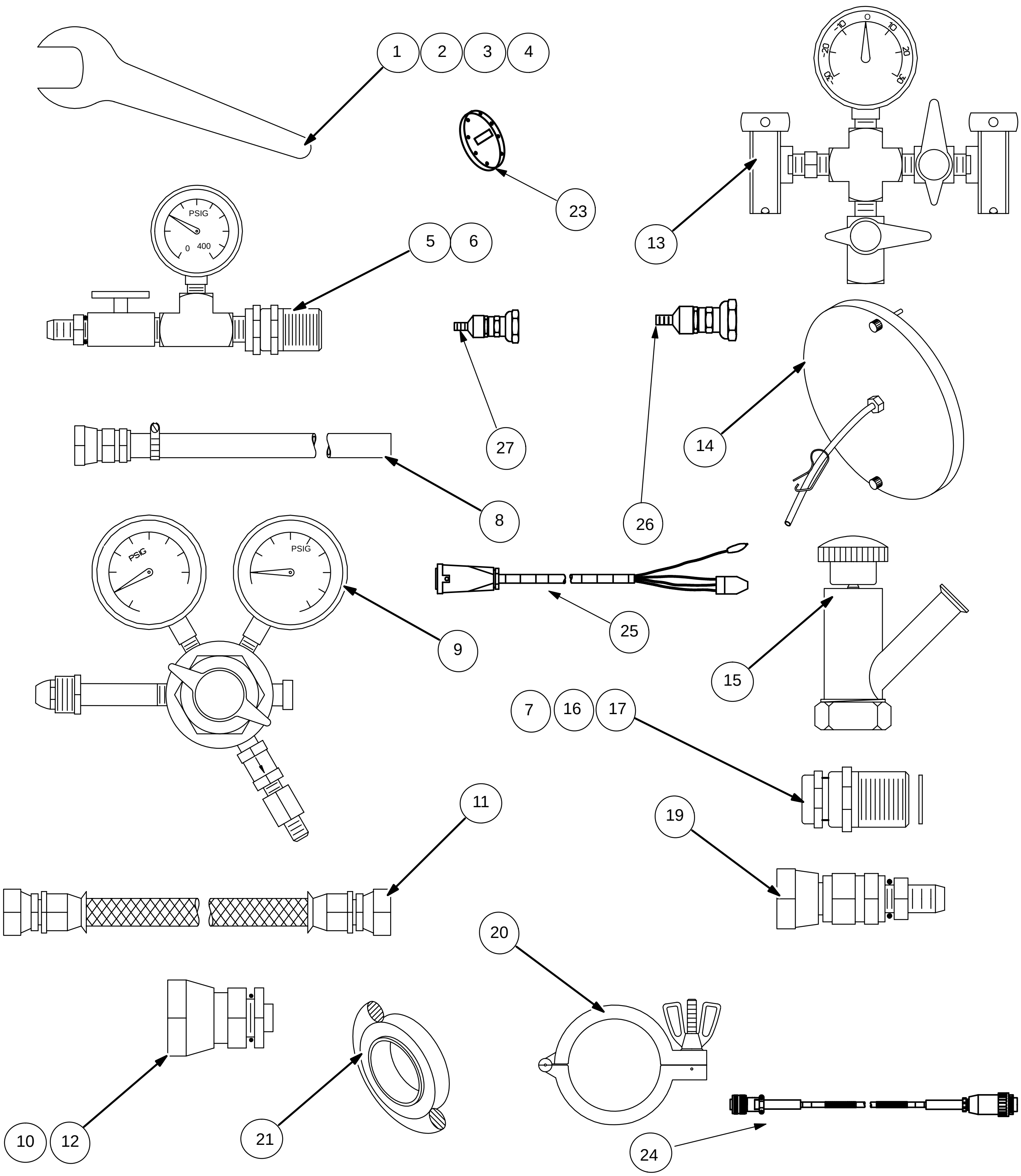
4–8 DEWAR STINGERS, HELIUM AND NITROGEN TRANSFER LINES

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

4–9 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

4–10 COLDHEAD / COMPRESSOR INSTALLATION / MAINTENANCE KIT 46–281088G3



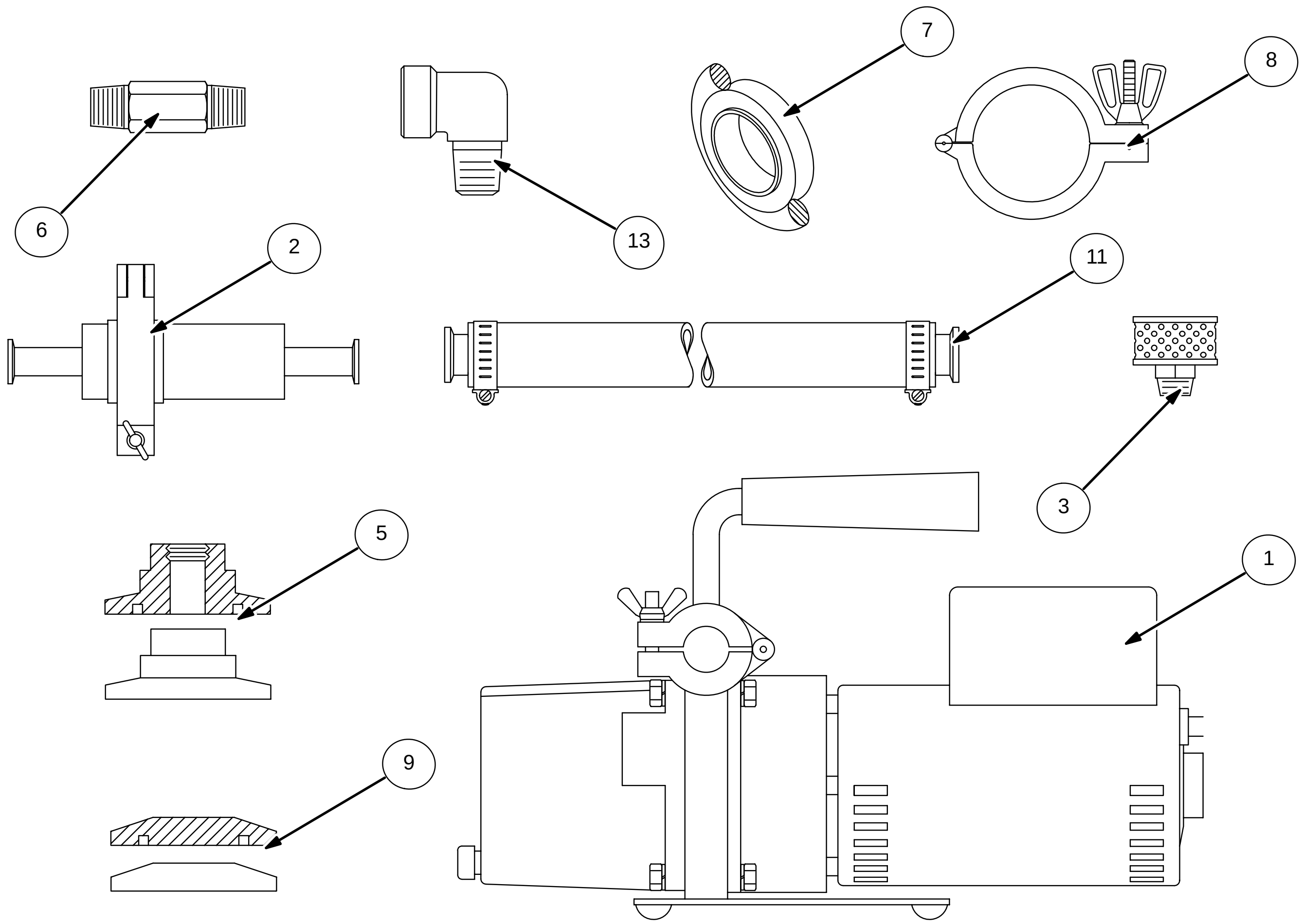
4–10 COLD HEAD / COMPRESSOR INSTALLATION / MAINTENANCE KIT 46–281088G3 (continued)

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

4–11 EXTRA EQUIPMENT NEEDED TO SERVICE COLDHEAD 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

4–12 SHIELD COOLER VACUUM PUMP KIT 46–294047G1

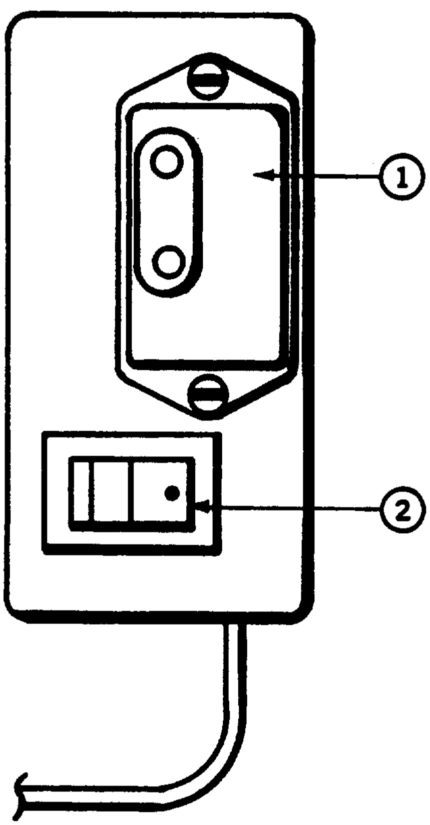


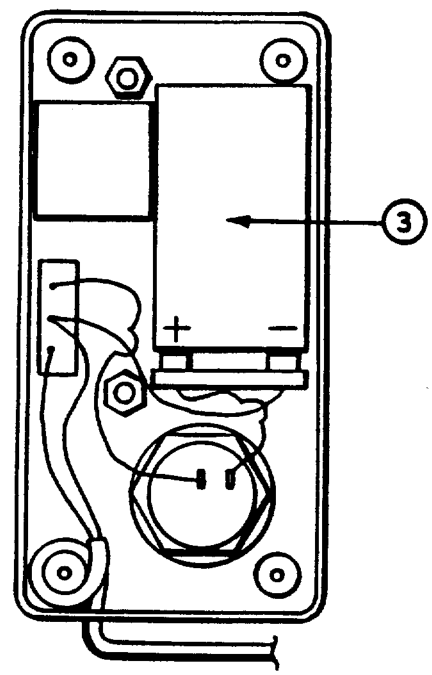
Item	Part Number	Name	Quantity	Description (Remarks)
1	46–294041P1	VAC. PUMP	1	SARGENT–WELCH PUMP
2	46–294041P3	OIL TRAP(INLET)	1	INLET FORELINE TRAP
3	46–294041P2	EXHAUST FILTER	1	EXHAUST FILTER
4	46–294041P4	CARTRIDGE FOR OIL	1	TRAP REPLACEMENT TRAP
5	46–294027P1	INLET ADAPTER	1	KF16 TO .25” NPT ADAPTER
6	46–294029P1	NIPPLE	1	2” NIPPLE
7	46–294030G1	CENTERING RING	1	CENTER AND O–RING
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	1	
13	46–252557P2	90 ELBOW	1	

4–13 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

4–14 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.

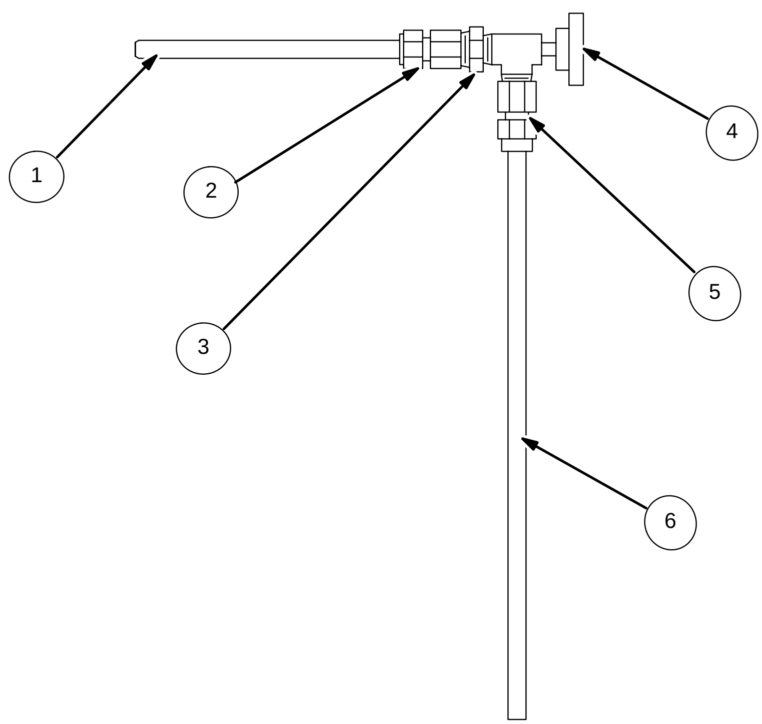
4–15 LAKESHORE 208 THERMOMETER KIT 46–301477G1

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”

4–16 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

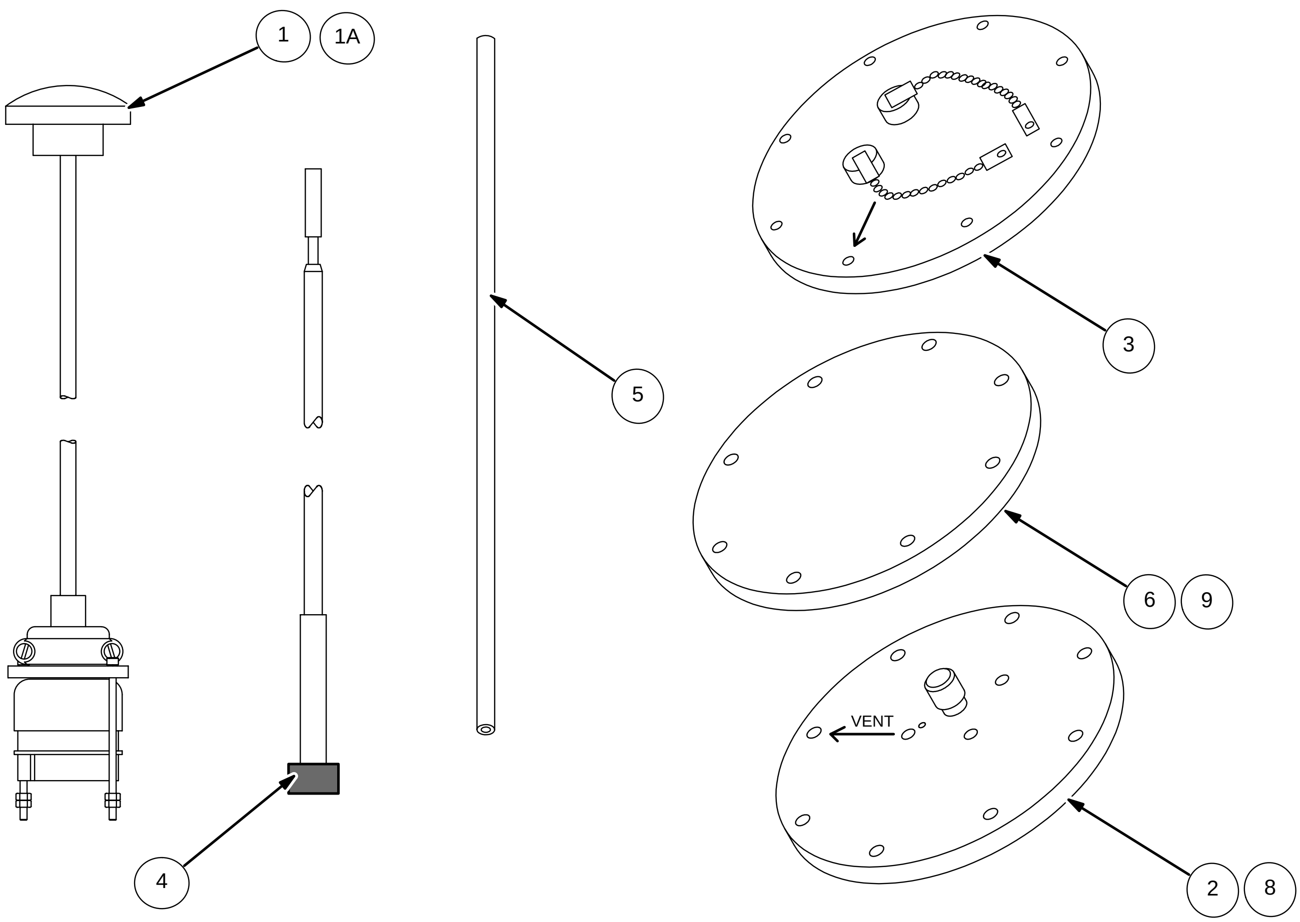
4–17 FILL LINE ADAPTER FOR TAO MONITORING 46–281232G1



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

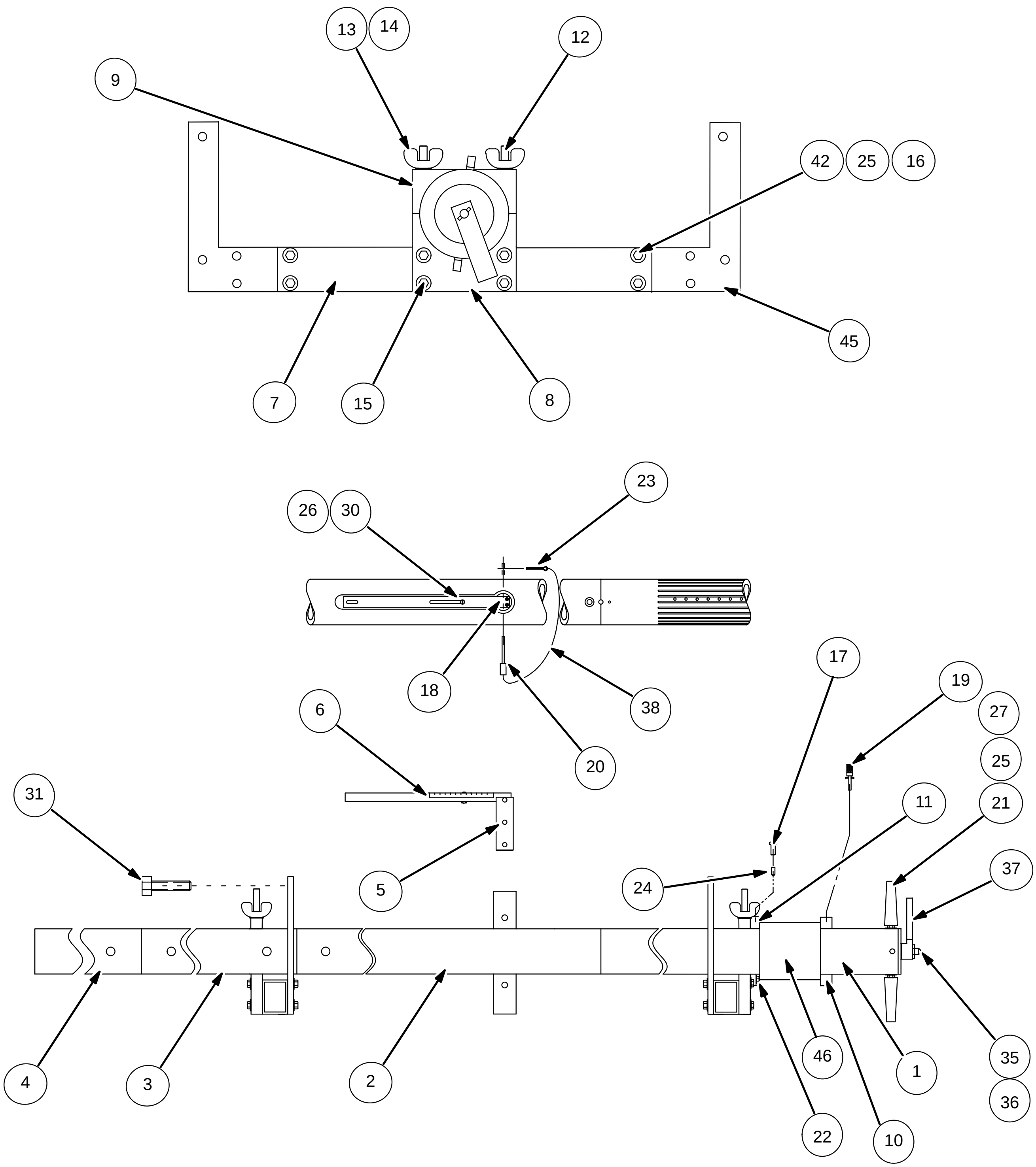
4–18 SAV–CON AND INSTRUMENTATION LEAD INSTALLATION / REMOVAL KIT 46–294872G2



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

4–19 SERVICE TOOL MAPPING FIXTURE 46–294060G4



4–19 SERVICE TOOL MAPPING FIXTURE 46–294060G4 (continued)

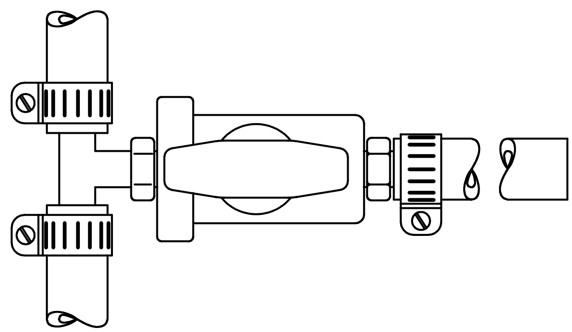
Item	Part Number	Name	Quantity	Description (Remarks)
1	2142701	TUBE SUPPORT	1	FRONT TUBE SUPPORT
2	46–294055G1	TUBE SUPPORT	1	MAGNETOMETER SUPPORT
3	46–294062G1	TUBE SUPPORT	1	REAR TUBE SUPPORT
4	46–294063G1	TUBE SUPPORT	1	REAR TUBE EXTENSION
5	2142703	RADIAL SLIDER	1	RADIAL SLIDER
6	46–281418P1	MAGT. SUPPORT	1	MAGNETOMETER SUPPORT
7	46–294553P3	SUPPORT	2	HORIZONTAL FRAME SUPPORT
8	46–281408P1	BEARING	2	HALF BEARING
9	46–281437P1	BEARING	2	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	.50–13 WING NUT
14	46–252322P10	BRASS WASHER	5	BRASS WASHER
15	46–281046P71	CAP SCREW	10	3/8–16 X 3.50 BOLT
16	46–252320P19	BRASS NUT	12	3/8–16 BRASS NUT
17	46–281046P31	CAP SCREW	1	3/8–16 X .74 LG. BRASS SCREW
18	46–252338P9	#6 SCREW	3	6–32 X .812 LG. 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. STL. BALL PLUNGER
25	46–252322P8	WASHER	32	WASHER
26	46–252320P13	BRASS NUT	1	10–24 BRASS HEX NUT
27	46–252188P6	THREADED RODS	2	3/8–16 X 2.00 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 2.00 IN SCREW
*31	46–318508P19	SCREW	8	M10 X 20 HEX HEAD
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	.75 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	46–281046P68	BRASS SCREW	4	3/8 X 3.00 IN BRASS SCREW
43	46–252320P19	BRASS NUT	2	3/8–16 BRASS NUT
*44	46–252322P8	WASHER	2	WASHER
*45	2158587	PLATE	4	MOUNTING PLATE
*46	2154411	TUBE	1	SPACER TUBE

* ITEMS MAY BE ORDERED AS AN UPGRADE KIT (2163971) FOR 46–294060G3 MAPPING FIXTURE

4–20 MAPPING FIXTURE UPGRADE KIT 2163971 – 46–294060G3 TO 46–294060G4

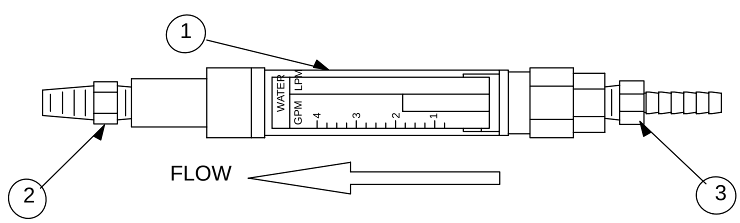
Item	Part Number	Name	Quantity	Description (Remarks)
1	46–318508P19	SCREW	8	M10 X 20 HEX HEAD
2	46–281046P68	BRASS SCREW	4	3/8 X 3.00 IN BRASS SCREW
3	46–252322P8	WASHER	2	WASHER
4	2158587	PLATE	4	MOUNTING PLATE
5	2143827–2	LABEL	1	LABEL FOR “G4” MAPPING FIXTURE
6	2154411	TUBE	1	SPACER TUBE
7	2193026DDW	INSTRUCTIONS	1	MAPPING FIXTURE UPGRADE INSTRUCTIONS

4–21 WATER TEE ASSEMBLY 46–318696G1



Item	Part Number	Name	Quantity	Description (Remarks)
1	46–318696G1	WATER TEE	1	WATER TEE ASSEMBLY

4–22 WATER FLOW METER KIT 46–294052G1

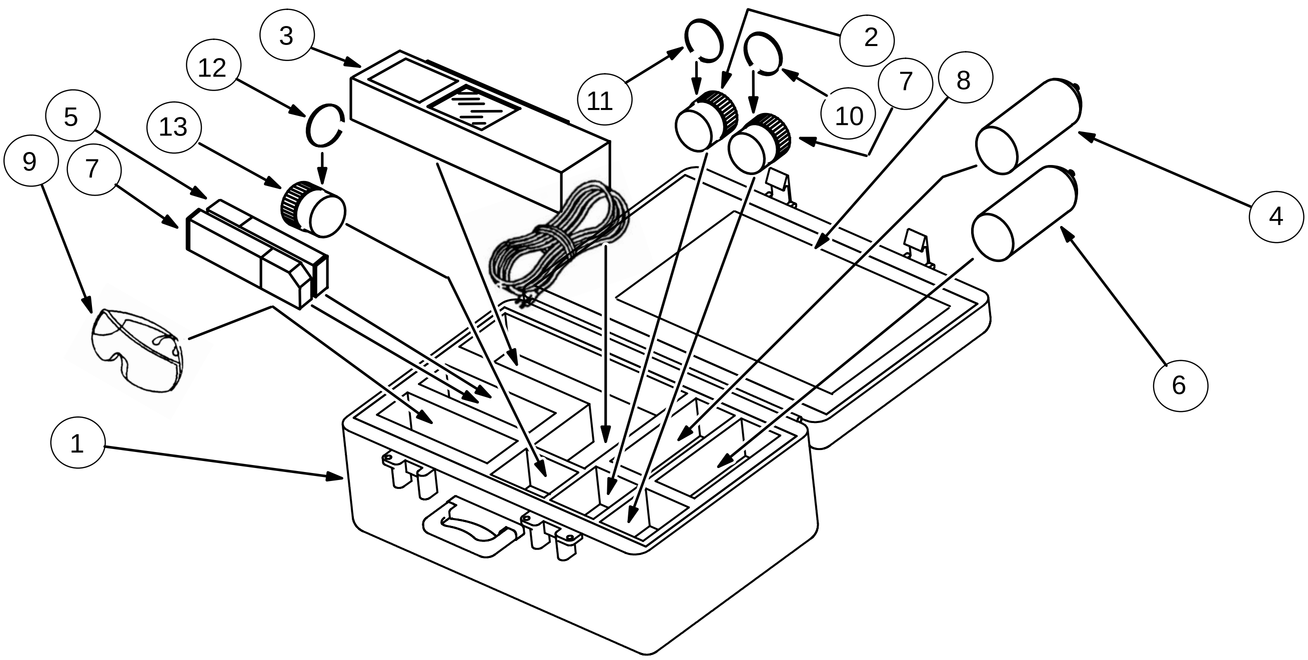


Item	Part Number	Name	Quantity	Description (Remarks)
1	46–294052P1	FLOW METER	1	INLINE FLOW METER
2	46–294052P2	HEX NIPPLE	1	BRASS, .50 NPT X .50 NPT
3	46–294052P3	HOSE CONNECTOR	1	BRASS, .50 NPT X .50 I.D. HOSE

4–23 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

4–24 SHIELD COOLER TEST KIT 46–318784G2



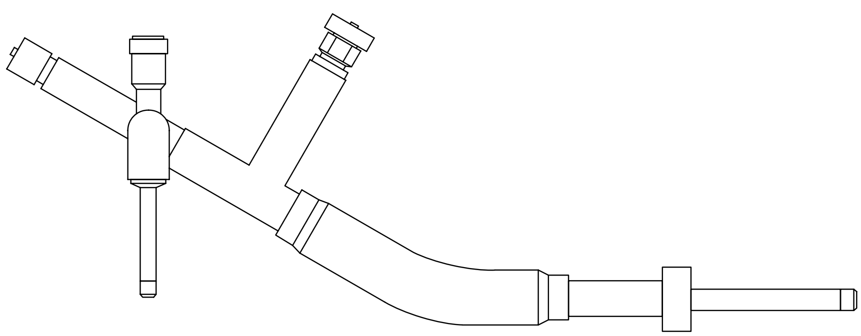
Item	Part Number	Name	Quantity	Description (Remarks)
1.	2100644	CASE ASSEMBLY	1	KIT CASE ASSEMBLY
2.	2100660	CONTAINER	1	SPECIMEN CONTAINER
3.	2100976	UV LIGHT	1	UV LIGHT & LABEL
4.	2100661	SOLUTION	1	FOR SOLIDS
5.	46–318649P1	TESTER	1	DISSOLVED SOLIDS
6.	2100662	SOLUTION	1	FOR PH
7.	46–318648P1	METER	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

4–25 BRM INSERTION TOOL KIT 2164744

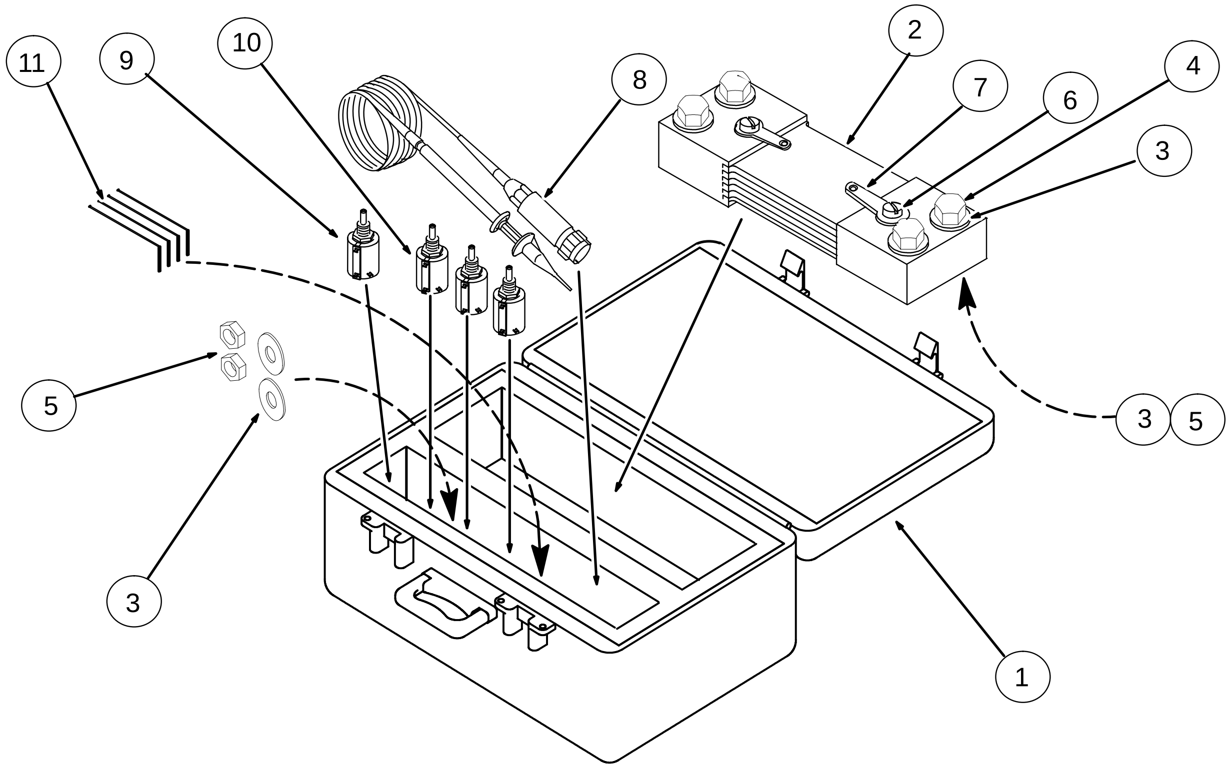
Item	Part Number	Name	Quantity	Description (Remarks)
1	2164685	PLATE	1	SUPPORT PLATE ASSEMBLY
2	2164690	TUBE	1	MALE SUPPORT TUBE ASSEMBLY
3	2164697	TUBE	1	FEMALE TUBE ASSEMBLY
4	2164707	ROLLER	2	TUBE GUIDE ROLLER ASSEMBLY
5	2164735	JACK	1	TUBE JACKING ASSEMBLY
6	46–318508P20	SCREW	4	M10 X 25, STN. STL. HEX HEAD CAP SCREW
7	46–318508P59	SCREW	10	M10 X 80, STN. STL. HEX HEAD CAP SCREW
8	2121111	WHEEL	2	BODY COIL WHEEL HOUSING ASSEMBLY
9	2180498	STUD	4	M10 X 120, STN. STL. STUD
10	2109875–4	NUT	4	M10 STN. STL. NUT
11	2109878–4	WASHER	4	M10 STN. STL. FLAT WASHER, 20 MM O.D.
12	46–318508P25	SCREW	10	M10 X 50, STN. STL. HEX HEAD CAP SCREW
13	2174160	LABEL	1	BRM TOOL KIT LABEL
14	2172196	CRATE	1	BRM INSERTION TOOL CRATE

4–26 Cx UNIQUE TOOLS

ITEM	PART NUMBER	NAME	QTY	DESCRIPTION
1	2166440	LINE	1	20 FT. MOBILE LIQUID HELIUM TRANSFER LINE



4–27 POWER SUPPLY CALIBRATION KIT 2101360



Item	Part Number	Name	Quantity	Description (Remarks)
1.	2101356	CASE	1	CASE ASSEMBLY
2.	2101358	AMMETER SHUNT	1	TYPE B – DC
3.	46–252322P8	WASHER	6	PLAIN, BRASS
4.	46–281046P38	CAP SCREW	4	HEX HEAD, BRASS
5.	46–260942P3	NUT	6	HEX, BRASS 3/8–16UNC
6.	46–294167P14	LOCK WASHER	4	#10 INTERNAL TOOTH
7.	2101361	LUG	4	SOLDER LUG
8.	46–294167P15	PROBE	1	X1 MONOLITHIC
9.	46–281468P26	POTENTIOMETER	1	10 TURN, 100 OHM, WW
10.	46–281468P12	POTENTIOMETER	3	10 TURN, 5K, WW
11.	46–294167P17	ALLEN WRENCH	1	HEX, .050” ACROSS FLATS

FUNCTIONAL CHECKS

TABLE OF CONTENTS

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	1.0T = 10025 GAUSS +/– 5.0 GAUSS (42682440 Hz +/– 21288 Hz) 1.5T = 15000 GAUSS +/– 7.5 GAUSS (63864000 Hz +/– 31932 Hz)	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 @ 500A	< 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
INST LEAD FLOW (F2)	0.8 – 1.2 SCFH	NOTE: SPEC VALUES ARE
SHIM LEAD FLOW (F1)	1.8 – 2.2 SCFH	STEADY STATE AFTER
BOIL–OFF	< 0.18 LITER/Hr. (AVERAGE) [1]	PASSING LEAK CHECK
HELIUM LEVEL	90% FOR RAMP UP, RAMP DOWN OR FIELD ADJUSTMENT 42% MINIMUM [2] SHIM 75%	BEFORE RAMP UP, RAMP DOWN, FIELD ADJUSTMENT BEFORE REFILL
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 CHECK ATR FOR READINGS

Notes

1. Customer data sheets indicate boil–off specification is < 0.14 L/hr. This spec. is achieved by using a wetcell flowmeter. The calculated average boil–off will be higher than spec. when using the capacity table and helium meter readings to approximate boil–off values.
2. LHe values are cryogen monitor readings. See Volumetric Conversion Chart / Curve in Data Sheets, Sections 5–1 and 5–2 for vloume conversions.

SECTION 2 – 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 2 – 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 3 – 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)		CONNECTOR	PIN #	RESISTANCE (OHMS)	
			TYPICAL	MEASURED			TYPICAL	MEASURED
MAIN COIL	MAIN COIL POWER LUGS OR J5–1	+ – 9, 10	< 6 OHMS		PIGTAIL CONNECTORS P2 AND P2W			
SUPERCONDUCTING SHIM COILS	CANNON (P1–A) ON SHIM LEAD							
Z1		1, 19	0.3 – 0.5		P2	A, * (K, L)	0.3 – 0.6	
Z2		2, 20	0.3 – 0.5		P2W	A, (K, L)	0.3 – 0.6	
Z3		3, 21	0.3 – 0.5		P2	B, (M, N)	0.3 – 0.6	
Z4		4, 22	0.3 – 0.5		P2W	B, (M, N)	0.3 – 0.6	
Z5		5, 23	0.3 – 0.5		P2	C, P	0.3 – 0.6	
Z6		6, 24	0.3 – 0.5		P2W	C, P	0.3 – 0.6	
C11 +		16, 19	0.3 – 0.5		P2	F, (K, L)	0.3 – 0.6	
C11 –		17, 20	0.3 – 0.5		P2W	F, (K, L)	0.3 – 0.6	
C22 +		14, 21	0.3 – 0.5		P2	G, (M, N)	0.3 – 0.6	
C22 –		15, 22	0.3 – 0.5		P2W	G, (M, N)	0.3 – 0.6	
S11 +		9, 19	0.3 – 0.5		P2	H, (K, L)	0.3 – 0.6	
S11 –		10, 20	0.3 – 0.5		P2W	H, (K, L)	0.3 – 0.6	
S22 +		7, 21	0.3 – 0.5		P2	J, (M, N)	0.3 – 0.6	
S22 –		8, 22	0.3 – 0.5		P2W	J, (M, N)	0.3 – 0.6	
C31		13, 23	0.3 – 0.5		P2	D, P	0.3 – 0.6	
S31		11, 23	0.3 – 0.5		P2	E, P	0.3 – 0.6	
C33		18, 24	0.3 – 0.5		P2W	D, P	0.3 – 0.6	
S33		12, 24	0.3 – 0.5		P2W	E, P	0.3 – 0.6	
SUPERCONDUCTING SWITCH HEATERS MAIN SWITCH	J5–1 & J5–2 ON SHIM LEAD (MS1–A3, A1)	1, 2	22 – 27					
AXIAL SHIMS		5, 6	27 – 33					
TRANSVERSE 1		7, 6	8 – 10					
TRANSVERSE 2		8, 6	8 – 10					

SECTION 4 – 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 – 4 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.

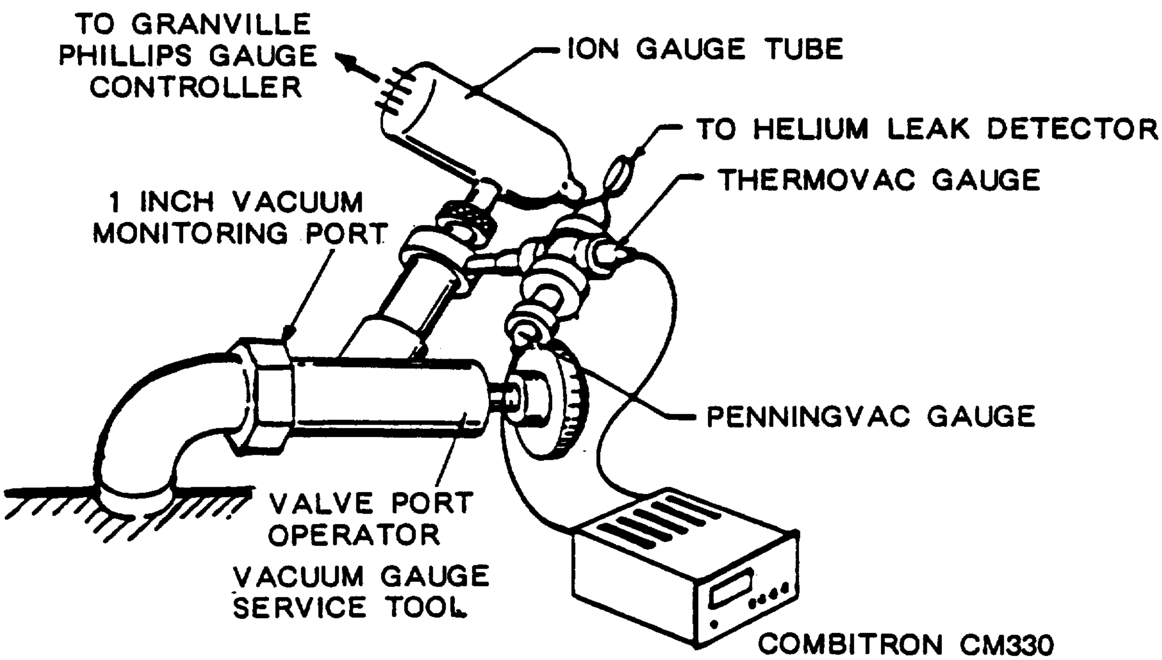
Note

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, $< 1 \times 10^{-6}$ 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 5 – 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 3 for Main Switch Heaters continuity check.

SECTION 6 – CRYOGEN BOIL–OFF RATE

1. An instantaneous boil off rate can be estimated, within an order of magnitude, 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, Section 1, Illustration 1–2.

2. A more accurate, time averaged boiling rate is obtained by calculating helium boiling off rate, at periodic refill intervals, in DATA SHEETS, Section 3 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.

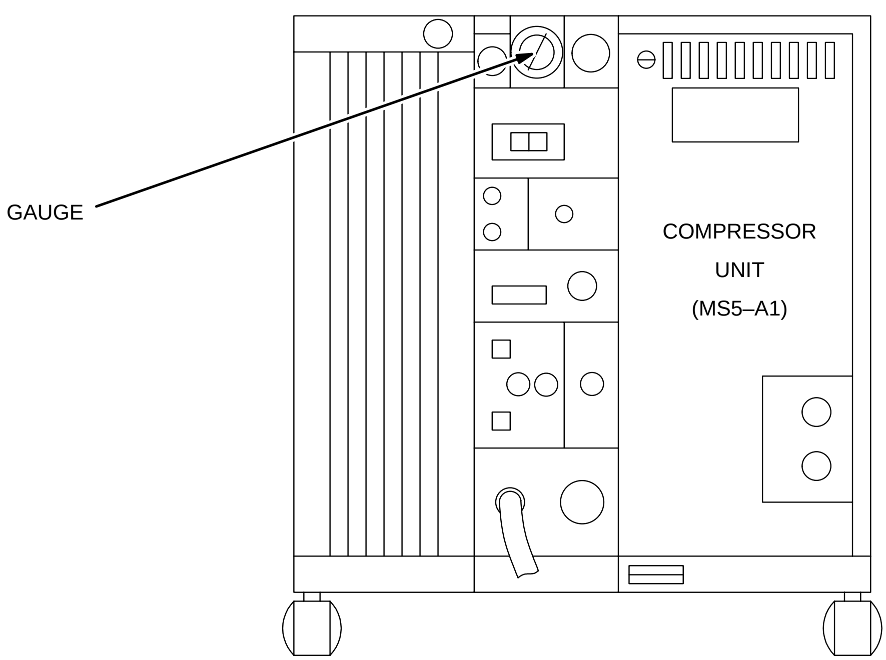
SECTION 7 – SHIELD COOLER CHECKS

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 7 – 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 NO TAG (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 NO TAG.

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 8 – 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 90% 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 8 – MAGNET QUENCHES (continued)

QUENCH RECOVERY

REPORT ALL QUENCHES TO YOUR MAC TEAM REPRESENTATIVE.

1. Check and replace Burst Disc (46–252838P7) and gaskets (46–252839P2) immediately.
2. Order and replace LHe as soon as possible.

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. Inspect Ventglas (46–281971P2) and replace if damaged.
5. Order and replace Baffle Assembly (2133618) if baffles are disintegrated. Replace and return Shim Lead Assembly(2148084) 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 9 – THERMAL ACOUSTIC OSCILLATION (TAO) CHECKS

Description:
The functional checks / settings described below are performed to establish the level of TAO's in the shim lead and minimize them.

The checks / settings should be performed as part of troubleshooting for excessive boil–off.

Required Equipment:

* TAO Monitor – 46–281406G1
* Adapter Tool – 46–281232G2
* Oscilloscope or Digital Voltmeter (DVM)

Procedure:

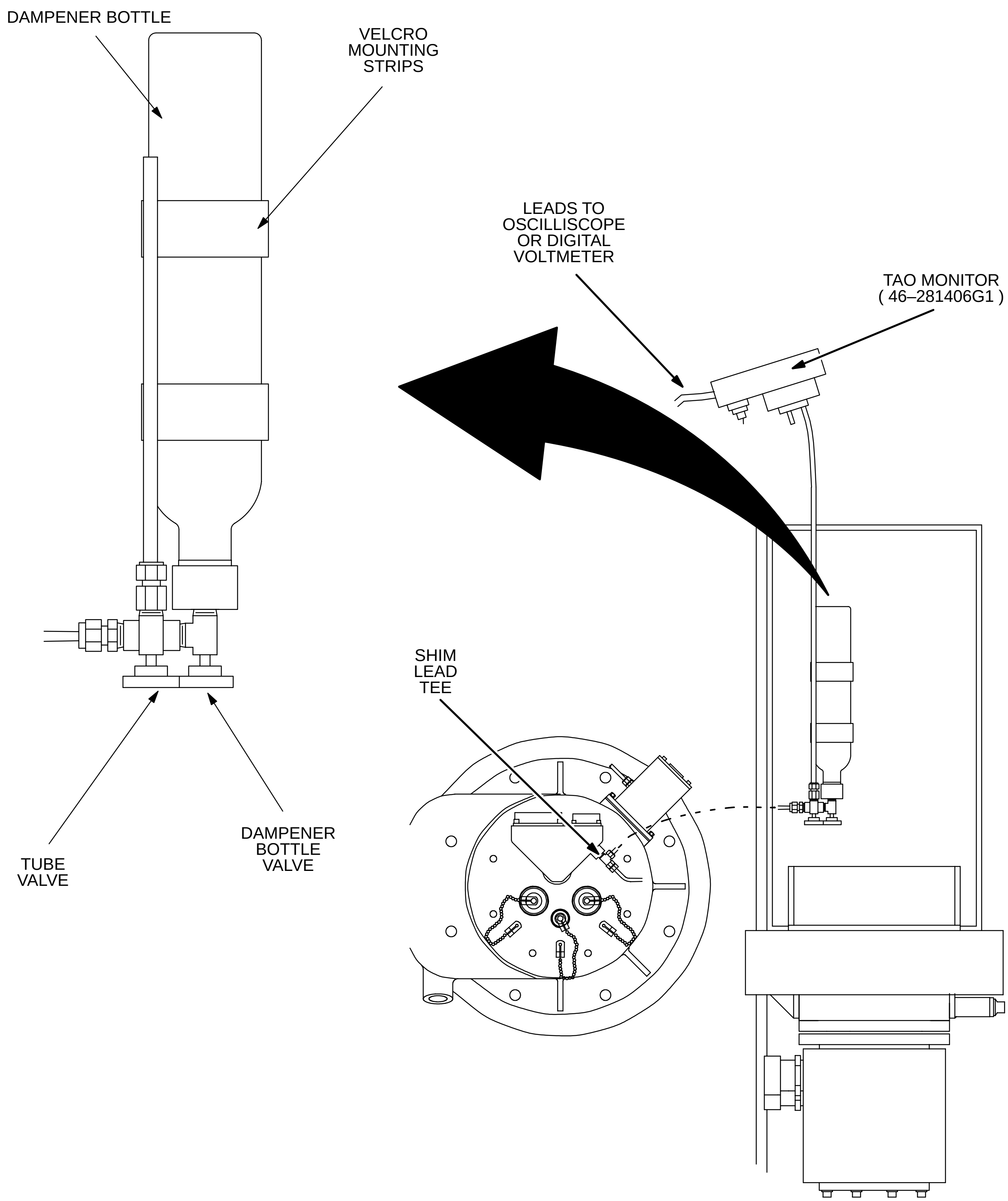
WARNING!

DO NOT BRING AN OSCILLOSCOPE INTO THE MAGNET ROOM, IF THE MAGNET IS RAMPED, TO PREVENT SCOPE MALFUNCTION AND BEING ATTRACTED INTO THE MAGNET.

1. Vent cryostat pressure to 0.5 psig and allow pressure to stabilize if cryostat pressure is above 0.5 psig.
2. Connect TAO monitor to poly tube off dampener bottle. See Illustration 9–1.
3. Connect TAO monitor leads to oscilloscope or DVM. Set oscilloscope scale to 10 mV / cm or DVM scale to 260 mV AC.
4. Slowly open tube valve and monitor signal amplitude on scope / meter. Peak to peak signal should have an amplitude less than 175 mV.
5. Adjust valve on dampener bottle gradually clockwise / counterclockwise to minimize signal amplitude.

Note
TAO's can be checked on magnets without thermal acoustic oscillation kits by removing the cap at the shim lead tee and connecting the adapter tool. If TAO's exceed 175 mV, peak to peak signal, a Thermal Acoustic Oscillation Kit (2195558) can be ordered and mounted as shown in Illustration 9–1.

9–0 THERMAL ACOUSTIC OSCILLATION (TAO) CHECKS (continued)



THERMAL ACOUSTIC OSCILLATION (TAO) CHECKS
ILLUSTRATION 9–1