



**GE Medical Systems**

---

# **Technical Publications**

**Direction 46-015537**

**Revision 3**

# **GE 1.0T Magnet And Cryogen Subsystem**

**Copyright © 1993, 1994, 1995, 1997, 1998 by General Electric Company**

**Operating Documentation**

## DAMAGE IN TRANSPORTATION

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

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

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

3/12/92



**GE Medical Systems**

GE Medical Systems: Telex 3797371  
P.O. Box 414, Milwaukee, Wisconsin 53201 U.S.A.  
(Asia, Pacific, Latin America, North America)

GE Medical Systems — Europe: Telex 261794  
Shortlands, Hammersmith, London W6 8BX U.K.

**WARNING**

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

**AVERTISSEMENT**

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

**WARNUNG**

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

**AVISO**

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

**ATENÇÃO**

- ESTE MANUAL DE ASSISTÊNCIA TÉCNICA SÓ SE ENCONTRA DISPONÍVEL EM INGLÊS.
- SE QUALQUER OUTRO SERVIÇO DE ASSISTÊNCIA TÉCNICA, QUE NÃO A GEMS, SOLICITAR ESTES MANUAIS NOUTRO IDIOMA, É DA RESPONSABILIDADE DO CLIENTE FORNECER OS SERVIÇOS DE TRADUÇÃO.
- NÃO TENHA TENTADO REPARAR O EQUIPAMENTO SEM TER CONSULTADO E COMPREENDIDO ESTE MANUAL DE ASSISTÊNCIA TÉCNICA.
- O NÃO CUMPRIMENTO DESTA 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

0	Feb. 25, 1994	Initial Release	2	February 28, 1997
1	June 30, 1995		3	February 20, 1998

LIST OF EFFECTIVE PAGES

PAGE REV

Title Page ..... 3  
 Damage in Trans. ... -  
 Direction 2128126 ... 0  
 A ..... 3  
 B ..... 2  
 i to viii ..... 2

INTRODUCTION .... -

MR380 ..... -  
 i ..... 0  
 1-1 to 1-4 ..... 0  
 2-1 ..... 1  
 3-1 ..... 0  
 4-1 to 4-2 ..... 0  
 4-3 ..... 1  
 4-4 to 4-7 ..... 0  
 5-1 to 5-7 ..... 0

SET UP AND CALIBRATION .... -

MR381 ..... -  
 i to iii ..... 2  
 1-1 to 1-6 ..... 0  
 1-7 ..... 2  
 1-8 to 1-14 ..... 0  
 1-15 ..... 1  
 1-16 to 1-24 ..... 0  
 1-25 to 1-29 ..... 2  
 2-1 to 2-9 ..... 0  
 2-10 ..... 2  
 3-1 to 3-12 ..... 0  
 4-1 ..... 2  
 4-2 to 4-20 ..... 0  
 5-1 to 5-2 ..... 0  
 5-3 ..... 1  
 5-4 to 5-18 ..... 0  
 6-1 to 6-2 ..... 0  
 7-1 to 7-14 ..... 2  
 8-1 to 8-11 ..... 0  
 9-1 to 9-7 ..... 0

PAGE REV

9-8 to 9-10 ..... 2  
 10-1 ..... 2  
 10-2 to 10-4 ..... 0  
 11-1 to 11-39 ..... 2  
 12-1 to 12-15 ..... 0  
 13-1 to 13-8 ..... 0  
 13-9 ..... 2

FUNCTIONAL

CHECKS ..... -  
 MR382 ..... -  
 i ..... 0  
 1-1 ..... 0  
 1-2 ..... 2  
 2-1 to 2-2 ..... 0  
 3-1 ..... 0  
 3-2 ..... 1  
 3-3 ..... 0  
 4-1 to 4-2 ..... 0  
 5-1 ..... 0  
 6-1 ..... 0  
 7-1 to 7-2 ..... 0  
 8-1 ..... 0  
 8-2 to 8-3 ..... 2

REPLACEMENT

MAINTENANCE ..... -  
 MR384 ..... -  
 i ..... 0  
 1-1 to 1-3 ..... 0  
 1-4 to 1-5 ..... 2  
 1-6 ..... 0  
 1-7 ..... 2  
 2-1 to 2-7 ..... 0  
 2-8 ..... 3  
 2-9 ..... 2  
 3-1 to 3-9 ..... 0  
 4-1 to 4-4 ..... 0  
 5-1 to 5-5 ..... 0  
 5-6 to 5-7 ..... 2

PAGE REV

5-8 ..... 0  
 6-1 to 6-6 ..... 0  
 7-1 to 7-8 ..... 0  
 7-9 ..... 2  
 8-1 ..... 0  
 9-1 ..... 0  
 10-1 to 10-4 ..... 0  
 11-1 to 11-15 ..... 0  
 12-1 to 12-2 ..... 0

SCHEMATICS

INTERCONNECTS ... -  
 MR385 ..... -  
 i ..... 0  
 1-1 ..... 0  
 1-2 ..... 1  
 2-1 to 2-7 ..... 0  
 3-1 to 3-5 ..... 0  
 4-1 ..... 1

RENEWAL PARTS ... -

MR386 ..... -  
 i ..... 1  
 ii ..... 2  
 1-1 to 1-4 ..... 0  
 1-5 ..... 1  
 1-6 ..... 2  
 1-7 ..... 1  
 2-1 ..... 1  
 2-2 to 2-4 ..... 0  
 2-5 to 2-9 ..... 1  
 3-1 to 3-2 ..... 2  
 3-3 ..... 0  
 3-4 ..... 1  
 3-5 ..... 0  
 4-1 to 4-17 ..... 0  
 4-18 ..... 2  
 4-19 ..... 0  
 4-20 to 4-23 ..... 1

**REVISION HISTORY**

**LIST OF EFFECTIVE PAGES ( continued )**

<u>PAGE</u>	<u>REV</u>
DATA .....	-
MR387 .....	-
i .....	0
1-1 to 1-2 .....	0
2-1 to 2-4 .....	0
3-1 to 3-3 .....	0
3-4 .....	1
4-1 to 4-4 .....	0
5-1 .....	0
6-1 to 6-4 .....	0

<u>PAGE</u>	<u>REV</u>
7-1 to 7-4 .....	0
8-1 to 8-4 .....	0
9-1 to 9-4 .....	0
<b>RIGGING</b> .....	-
MR391 .....	-
i .....	0
1-1 to 1-7 .....	0
2-1 to 2-2 .....	0

<u>PAGE</u>	<u>REV</u>
2-3 .....	1
2-4 .....	0
3-1 .....	0
3-2 .....	1
3-3 to 3-4 .....	0
4-1 to 4-2 .....	0
5-1 .....	0
5-2 .....	1
5-3 .....	0
6-1 to 6-2 .....	0

# TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
<b>INTRODUCTION</b>	
<b>SECTION 1 – DOCUMENTATION ORGANIZATION</b> .....	1-1
1-1 System Documentation Organization .....	1-1
1-2 Subsystem Manual (Direction 46-015537) Organization .....	1-2
<b>SECTION 2 – VENDOR MANUAL MATRIX</b> .....	2-1
<b>SECTION 3 – EXPLANATION OF DESIGNATOR SYSTEM</b> .....	3-1
<b>SECTION 4 – COMPONENT IDENTIFICATION</b> .....	4-1
<b>SECTION 5 – SAFETY CONSIDERATIONS</b> .....	5-1
5-1 Magnetic Field Considerations .....	5-1
5-2 Emergency Ramp down Of Magnetic Field .....	5-4
5-3 Cryogen Safety .....	5-5
5-4 First Aid .....	5-7
5-5 Training – The Best Investment In Safety .....	5-7
<b>SET UP AND CALIBRATION</b>	
<b>SECTION 1 – MAGNET SYSTEM INSTALLATION</b> .....	1-1
1-1 Conversion To Operating Configuration .....	1-1
1-2 Venting Installation .....	1-8
1-3 Shield Cooler Installation And Check Out .....	1-12
1-4 Shield Cooler System .....	1-12
1-4-1 Increasing Shield Cooler Gas Pressure Preparation .....	1-12
1-4-2 Increasing Gas Pressure .....	1-12
1-4-3 Decreasing Shield Cooler Gas Pressure .....	1-15
1-4-4 Disconnection And Stowage Of Hoses And Regulator .....	1-15
1-4-5 Flexible Gas Line Connections .....	1-15
1-4-6 Shield Cooler Electrical Cable Connections .....	1-18
1-4-7 Monitoring Shield Cooler Temperatures .....	1-19
1-4-8 Setting Cold Head Tension .....	1-20
1-4-9 RF Shielding .....	1-23
1-4-10 Installing Helium Line Insulation Kit .....	1-25
1-5 Magnet Rundown Unit (MRU) Installation .....	1-26
1-6 Cryogen Monitor Installation .....	1-28

<u>SECTION</u>	<u>PAGE</u>
<b>SET UP AND CALIBRATION (Continued)</b>	
<b>SECTION 2 – MAGNET COMMISSIONING CHECKS</b> .....	2-1
2-1 Magnet Electrical Check .....	2-1
2-2 Cryostat Temperature Check & Cooling/Filling Requirements .....	2-1
2-2-1 Use of Lakeshore Cryotronics Model 208 – Digital Cryogenic Thermometer Kit (46-301477G1) .....	2-1
2-2-2 Diode Temperature Sensing Circuit .....	2-3
2-2-3 Cryostat Cooling/Cryogen Filling Requirements .....	2-9
2-3 Cryostat Pressure/Flow Check .....	2-10
<b>SECTION 3 – NITROGEN PURGE/PRECOOL</b> .....	3-1
3-1 Gaseous Nitrogen Purge .....	3-2
3-2 Liquid Nitrogen Precool .....	3-7
3-3 Helium Purge .....	3-10
<b>SECTION 4 – LIQUID HELIUM FILL</b> .....	4-1
4-1 Equipment .....	4-1
4-2 Preparation .....	4-3
4-3 Liquid Helium Fill (Fixed Site) .....	4-5
4-4 Liquid Helium Fill (Mobile Van) .....	4-11
4-5 Changing Helium Dewars .....	4-17
4-6 Changing Helium Gas Bottles .....	4-20
<b>SECTION 5 – FIELD MONITORING EQUIPMENT OPERATION</b> .....	5-1
5-1 Magnet Access .....	5-1
5-2 Service Tool Mapping Fixture Set Up (Model #46-294060G2) .....	5-2
5-3 Probe Position Reference Adjustments (Radial, Angular & Axial) .....	5-11
5-4 Teslameter And Probe Mechanical Centering .....	5-12
5-5 Teslameter Adjustment (Ramp Up) .....	5-17
5-6 Teslameter Adjustment (Ramp Down) .....	5-17
5-7 Teslameter Re-sync. ....	5-18
<b>SECTION 6 – SHIM LEAD ENGAGE/DISENGAGE</b> .....	6-1
6-1 Shim Lead Engage .....	6-1
6-2 Shim Lead Disengage .....	6-1
<b>SECTION 7 – TCR 7.5T750 MAIN POWER SUPPLY TEST</b> .....	7-1
7-1 POWER SUPPLY CHECK OUT .....	7-1
7-1-1 Heater Current Meter Zero Calibration .....	7-1
7-1-2 Heater Calibration .....	7-2
7-1-3 Voltage Calibration .....	7-5
7-1-4 Voltage Adjust Potentiometer Noise Test .....	7-7
7-1-5 Current Calibration and Current Pot Noise Check .....	7-10
7-1-6 Voltage Ripple Check .....	7-14
<b>SECTION 8 – ELECTRICAL CONNECTIONS FOR RAMPING AND SHIMMING</b> .....	8-1
8-1 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS ...	8-1
8-2 MAIN COIL POWER SUPPLY CONNECTIONS .....	8-4

<u>SECTION</u>	<u>PAGE</u>
----------------	-------------

## SET UP AND CALIBRATION (Continued)

<b>SECTION 9 – MAGNET RAMPING</b> .....	9-1
9-1 PREPARATION .....	9-3
9-3 RESISTANCE CHECKS .....	9-11
9-4 RAMPING .....	9-13
<b>SECTION 10 – SHIMMING PREPARATION/FIELD STABILIZATION</b> .....	10-1
10-1 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS ...	10-1
10-2 MAGNET STABILITY CHECK .....	10-4
<b>SECTION 11 – SHIMMING</b> .....	11-1
11-1 CENTERING PROBE TO MAGNETIC CENTER .....	11-3
11-1-1 Axial Probe Centering: .....	11-3
11-2 FIELD MAPPING .....	11-7
11-3 RUNNING SHIM PROGRAMS .....	11-10
11-3-1 Loading Software On Laptop .....	11-11
11-3-2 Data Collection .....	11-11
11-3-3 Running SCSHIM .....	11-12
11-3-4 Coil Numbers .....	11-15
11-3-5 SCSHIM Output File .....	11-16
11-4 ADJUSTING S/C SHIM COIL POWER SUPPLY CURRENTS FOR ACTIVE SHIMMING .....	11-18
11-5 PASSIVE SHIMMING .....	11-21
11-5-1 Running PLATESHM .....	11-23
11-5-2 Plateshm Output File .....	11-27
11-6 PASSIVE SHIM INSTALLATION .....	11-30
11-7 SHIM DESCRIPTION .....	11-39
<b>SECTION 12 – POLARITY AND FUNCTIONAL CHECKS</b> .....	12-1
12-1 AXIAL CORRECTION COILS .....	12-1
12-2 TRANSVERSE CORRECTION COILS .....	12-6
<b>SECTION 13 – FIELD ADJUSTMENT AFTER SHIMMING</b> .....	13-1
13-1 REMOVING AXIAL AND TRANSVERSE SHIM CURRENTS .....	13-1
13-2 RESISTANCE CHECKS .....	13-2
13-3 MAIN FIELD ADJUSTMENT .....	13-5
13-4 INPUT SHIM CURRENTS .....	13-8

SECTION

PAGE

**FUNCTIONAL CHECKS**

**SECTION 1 – MAGNET FUNCTIONAL CHECKS** ..... 1-1

**SECTION 2 – MAGNETIC FIELD STABILITY** ..... 2-1

**SECTION 3 – MAGNET ELECTRICAL- CHECKS** ..... 3-1

**SECTION 4 – CRYOSTAT VACUUM CHECK** ..... 4-1

**SECTION 5 – MAGNET RUNDOWN UNIT (MRU)** ..... 5-1

**SECTION 6 – CRYOGEN BOIL- OFF RATE** ..... 6-1

**SECTION 7 – SHIELD COOLER CHECKS** ..... 7-1

**SECTION 8 – MAGNET QUENCHES** ..... 8-1

**REPLACEMENT/MAINTENANCE**

**SECTION 1 – ICE PLUG REMOVAL** ..... 1-1

    1-1 Block In 1/4 Inch Exhaust System ..... 1-2

    1-2 Block In 1/2 Inch Helium Vent System ..... 1-5

    2-4 Magnet Rampdown (Decrease To Zero) ..... 2-14

**SECTION 2 – MAGNET RAMPDOWN (DECREASE TO ZERO)** ..... 2-1

    2-1 Preparation For Field Change ..... 2-3

    2-2 Resistance Checks ..... 2-5

    2-3 Magnet Rampdown (Decrease To Zero) ..... 2-7

**SECTION 3 – WARMING UP CRYOSTAT** ..... 3-1

    3-1 Warming Up Cryostat ..... 3-2

**SECTION 4 – BURST DISC REPLACEMENT** ..... 4-1

<u>SECTION</u>	<u>PAGE</u>
----------------	-------------

**REPLACEMENT/MAINTENANCE (Continued)**

<b>SECTION 5—SHIM LEAD/BAFFLE ASSEMBLY REMOVAL/REPLACEMENT .....</b>	<b>5-1</b>
5-1 Shim Lead Assembly Removal .....	5-2
5-2 Shim Lead Assembly Replacement .....	5-4
5-3 Baffle Assembly Replacement .....	5-7
<b>SECTION 6 – SAV CON CONNECTOR REMOVAL/REPLACEMENT .....</b>	<b>6-1</b>
6-1 Sav Con Connector Removal .....	6-2
6-2 Sav Con Connector Replacement .....	6-6
7-1 Instrumentation Lead Assembly Removal/Replacement .....	7-2
<b>SECTION 7 – INSTRUMENTATION LEAD ASSEMBLY REMOVAL/REPLACEMENT ....</b>	<b>7-1</b>
7-1 Instrumentation Lead Assembly Removal/Replacement .....	7-2
<b>SECTION 8 – RE-EVACUATION OF CRYOSTAT .....</b>	<b>8-1</b>
<b>SECTION 9 – RE-EVACUATION OF VACUUM JACKETED TRANSFER LINE .....</b>	<b>9-1</b>
<b>SECTION 10 – CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS .....</b>	<b>10-1</b>
<b>SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT .....</b>	<b>11-1</b>
<b>SECTION 12 – MAIN LEAD EXTENSION CONTACT BAND REPLACEMENT .....</b>	<b>12-1</b>

**SECTION**

**PAGE**

**SCHEMATICS/INTERCONNECTS**

**SECTION 1 – INTERCONNECT DIAGRAMS**

1-1 Magnet System Interconnect Diagram ..... 1-1  
 1-2 Magnet Shield Cooler Interconnect Diagram ..... 1-2

**SECTION 2 – WIRING DIAGRAMS**

2-1 Magnet System ..... 2-1  
 2-2 Magnet Cable 46-260709G1 ..... 2-3  
 2-3 S/C Shim Coil Cable 46-260726G1 ..... 2-4  
 2-4 Voltage Monitor & Switch Heaters Cable 46-260724G1 ..... 2-5  
 2-5 Liquid Helium Monitor Circuit ..... 2-6  
 2-6 Magnet Rundown System For Main Coil Heaters ..... 2-7

**SECTION 3 – POWER SUPPLIES**

3-1 Superconducting Main Coil Service Power Supply Cabinet ..... 3-1  
 3-2 Superconducting Shim Coil Service Power Supply Cabinet ..... 3-2  
 3-3 Magnet/Shim Phase III-A Power Supply System ..... 3-3  
 3-4 Magnet/Shim Phase III-A Power Supply Control Panel ..... 3-4  
 3-5 Power Supply Input/Output Connector Pinouts ..... 3-5

**SECTION 4 – CRYOGEN MONITOR PANEL ..... 4-1**

**RENEWAL PARTS**

**SECTION 1 – MAGNET SYSTEM ..... 1-1**

1-1 Magnet System ..... 1-2  
 1-2 GE & Vendor Service Manuals ..... 1-7

**SECTION 2 – MAGNET COMPONENTS ..... 2-1**

2-1 Magnet Components ..... 2-1  
 2-2 Shim Lead Components ..... 2-8

**SECTION 3 – MAGNET ACCESSORIES ..... 3-1**

3-1 Leybold Shield Cooler Compressor 46-294141G1,G2  
 \* ( Vendor Renewal Parts Cross Reference ) ..... 3-1  
 3-2 Fieldspare Kit 46-294744G1 ..... 3-1  
 3-3 Magnet Rundown Unit 46-294231G1 ..... 3-2  
 3-4 Cryogen Monitor 46-281811P1, 2122498 ..... 3-2  
 3-5 Magnet Leveling Kit 46-260888G1 ..... 3-2  
 3-6 Helium Vent Kit 46-318057G1 ..... 3-3  
 3-7 Shield Cooler Cold Head Assembly Component  
 ( Sleeve Mount ) Leybold ( 2100832 ) ..... 3-4  
 3-8 Ramp Cable Kit 46-318036G1 ..... 3-5

**RENEWAL PARTS (Continued)**

<u>SECTION</u>	<u>PAGE</u>
<b>SECTION 4 – SERVICE TOOL KITS / COMPONENTS</b> .....	4-1
4-1 Magnet Ramping Equipment Kit 46-260703G2 .....	4-1
4-2 Power Supplies .....	4-2
4-3 Ramp Cable Holder 46-318314G2 .....	4-2
4-4 Water Flow Meter Kit 46-294052G1 .....	4-2
4-5 Ramping Supply And Equipment 46-294998G1 .....	4-2
4-6 Service Power Supply Renewal Parts 46-260776G3 & 46-260777G3 * ( Vendor Renewal Parts Cross Reference ) .....	4-3
4-7 Universal Fill Line Kit 46-294705G1 .....	4-4
4-8 Helium Transfer Line Kit Renewal Parts .....	4-5
4-9 Dewar Stingers, Helium And Nitrogen Transfer Lines .....	4-6
4-10 Other Helium Transfer Service Items .....	4-6
4-11 Cold Head / Compressor Installation / Maintenance Kit 46-281088G2 ...	4-7
4-12 Extra Equipment Needed To Service Cold Head And Compressor .....	4-8
4-13 Lakeshore 208 Thermometer Kit 46-301477G1 .....	4-8
4-14 Low Cost Shield Temperature Diode Box 46-317543G1 .....	4-8
4-15 Shield Cooler Vacuum Pump Kit 46-294047G1 .....	4-9
4-16 Vacuum Maintenance Equipment .....	4-10
4-17 Tao Monitor 46-281406G1 .....	4-11
4-18 Fill Line Adapter For Tao Monitoring 46-281232G1 .....	4-12
4-19 Sav-con And Instrumentation Lead Installation / Removal Kit 46-294872G2 .....	4-13
4-20 Service Tool Mapping Fixture 46-294060G2 .....	4-14
4-21 Mapping Fixture H-frame 46-294553G1 .....	4-16
4-22 Specialty Tools For Specific Magnet Types .....	4-17
4-23 Magnet Centering / Verification Kit 46-281967G1 .....	4-17
4-24 Water Tee Assembly 46-318696G1 .....	4-17
4-25 Region Shim Kit 2181921 .....	4-18
4-26 Shield Cooler Test Kit 46-318784G2 .....	4-18
4-27 Oxygen Monitors .....	4-19
4-28 Magnet Tool Matrix .....	4-20

**SECTION**

**PAGE**

**DATA SHEETS**

**SECTION 1 – MAGNET COMMISSIONING LOG ..... 1-1**

**SECTION 2 – LIQUID HELIUM REFILL CHART ..... 2-1**

**SECTION 3 – CRYOGEN LOG ..... 3-1**

**SECTION 4 – HELIUM FILL DATA SHEET ..... 4-1**

**SECTION 5 – VOLUMETRIC CONVERSION OF LIQUID HELIUM LEVEL ..... 5-2**

**SECTION 6 – MAGNET RAMPING, PARKING CURRENT, AND DRIFT LOG ..... 6-1**

**SECTION 7 – SHIM PLOT DATA ..... 7-1**

**SECTION 8 – CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS ..... 8-1**

**SECTION 9 – SHIM SIZE/LOCATION (MILS) ..... 9-1**

**GE MAGNET RIGGING**

**SECTION 1 – DELIVERY INSTRUCTIONS ..... 1-1**

    1-1 Intransit Service ..... 1-1

    1-2 Shipping/Handling ..... 1-4

    1-3 Unloading/Loading Magnet And Crate ..... 1-5

    1-4 Pre-delivery Instructions ..... 1-7

**SECTION 2 – UNCRATING MAGNET SYSTEM ..... 2-1**

**SECTION 3 – MAGNET SYSTEM COMPONENT CHECK ..... 3-1**

**SECTION 4 – REMOVING THE MAGNET FROM THE SHIPPING SKID ..... 4-1**

**SECTION 5 – MOVING MAGNET TO EXAM ROOM ..... 5-1**

**SECTION 6 – LEVELING MAGNET ..... 6-1**

## SECTION 1 – DOCUMENTATION ORGANIZATION

### 1-1 SYSTEM DOCUMENTATION ORGANIZATION

The documentation structure for the Magnetic Resonance Signa<sup>®</sup> Advantage<sup>™</sup> 1.0T System can be found in *Direction 15400, Signa<sup>®</sup> Advantage<sup>™</sup> 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 46-015537) ORGANIZATION**

**Note**

Direction 15537 REV 0 ( 46-015537 ) – GE 1.0T Magnet and Cryogenics Subsystem covers Fixed Site, and Mobile 1.0T Magnet Systems used on 1.0T Signa products. Applicable magnet system / model numbers shown in Table 1-1.

**TABLE 1-1**  
MAGNET MODEL / ASSEMBLY NUMBERS

MAGNET MODEL NUMBER	MAGNET ASSEMBLY NUMBER
46-318864G1 ( Fixed Site )	46-318865G1 ( Fixed Site )
46-318864G2 ( Fixed Site )	46-318865G2 ( Fixed Site )
46-318755G1 ( Mobile )	46-318746G1 ( Mobile )
46-318755G2 ( Mobile )	46-318746G2 ( Mobile )

**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 46-015537) ORGANIZATION (continued)****SCHEMATICS/INTERCONNECTS**

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

**RENEWAL PARTS**

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

**DATA SHEETS**

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

**RIGGING**

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

**Note**

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

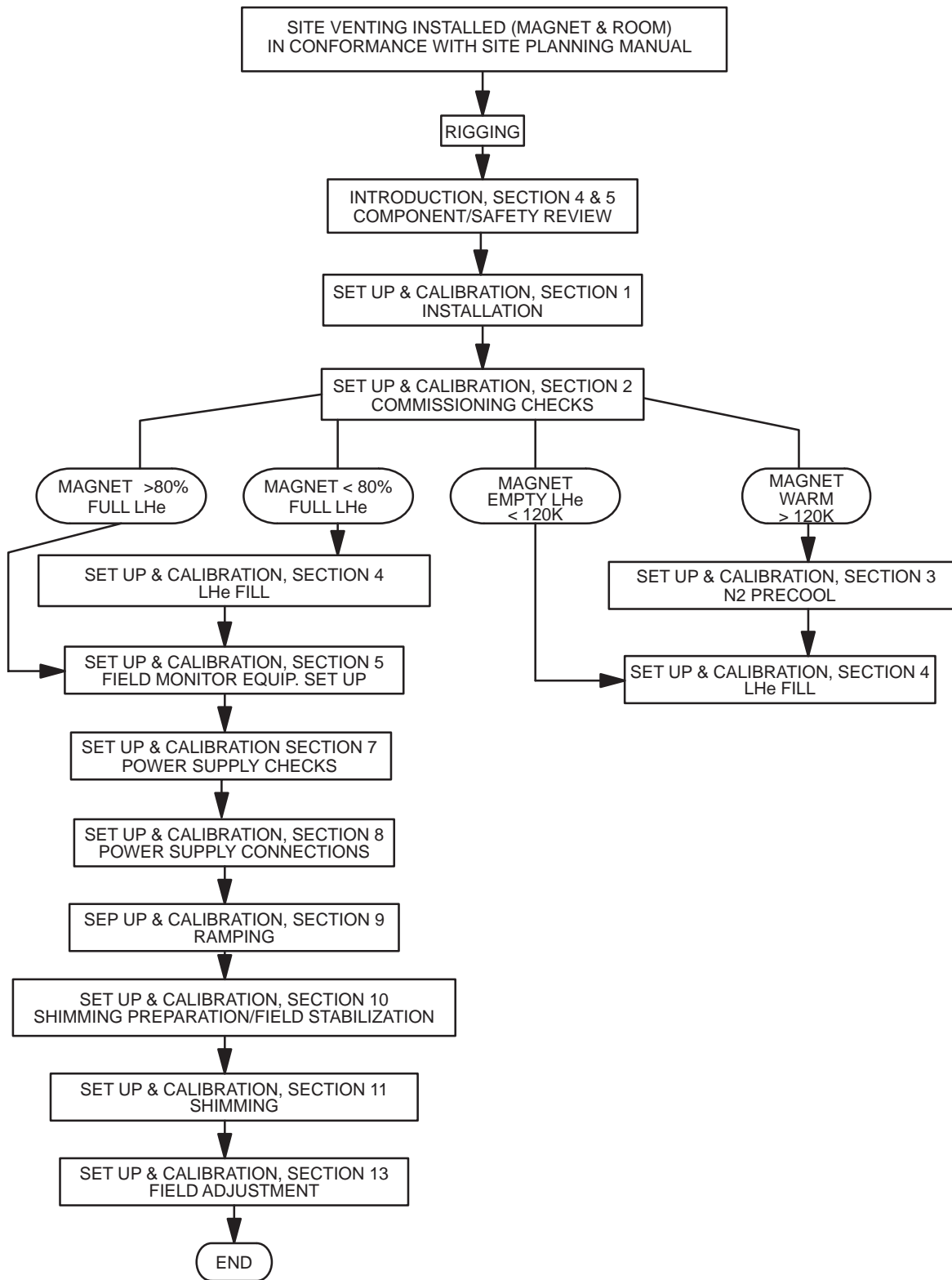
**Note**

All schematics/circuit diagrams, component parts lists, descriptions, adjustments/calibrations and other information necessary for the field service of this Magnet System, are contained within *DIRECTION 46-015537*.



**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/Emergency Rundown Unit, should be performed by a General Electric authorized service representative.**



MAGNET COMMISSIONING FLOW DIAGRAM

ILLUSTRATION 1-1

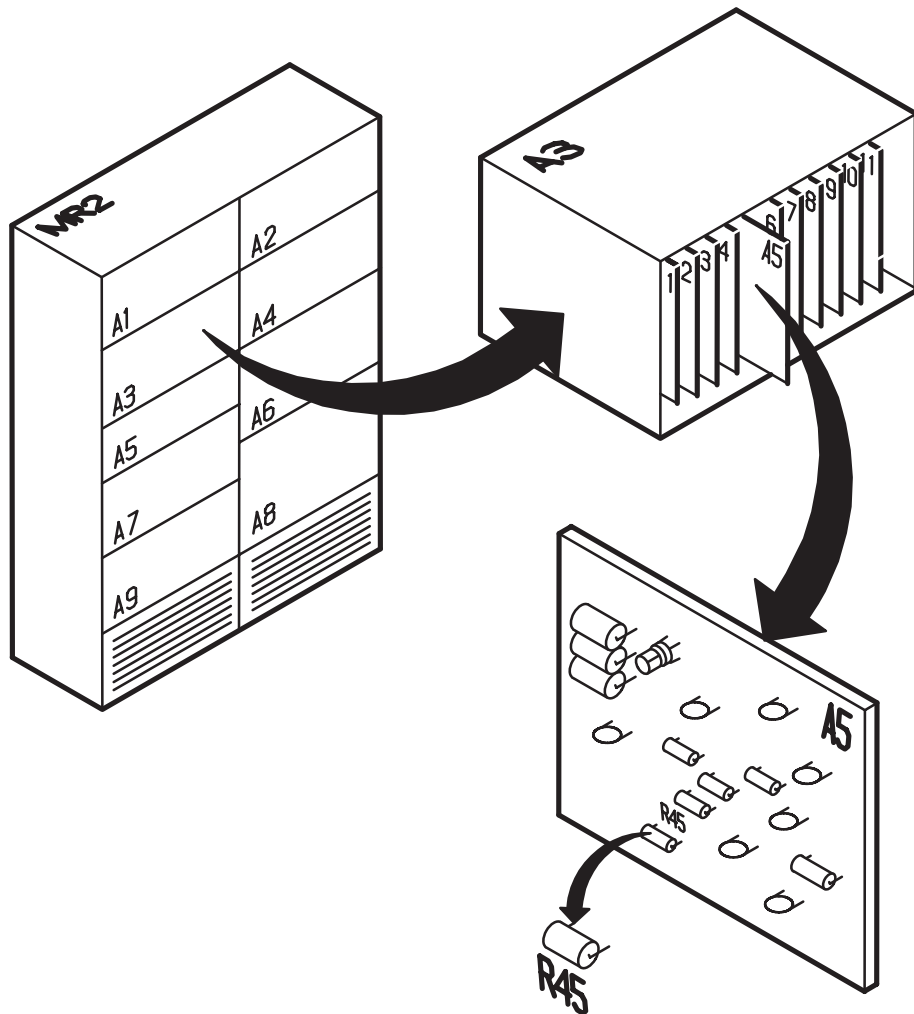
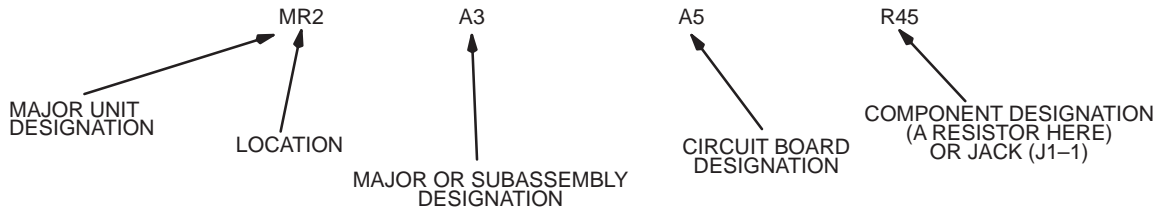
**SECTION 2 – VENDOR MANUAL MATRIX**

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



### SECTION 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



M1110A

COMPONENT DESIGNATOR SYSTEM

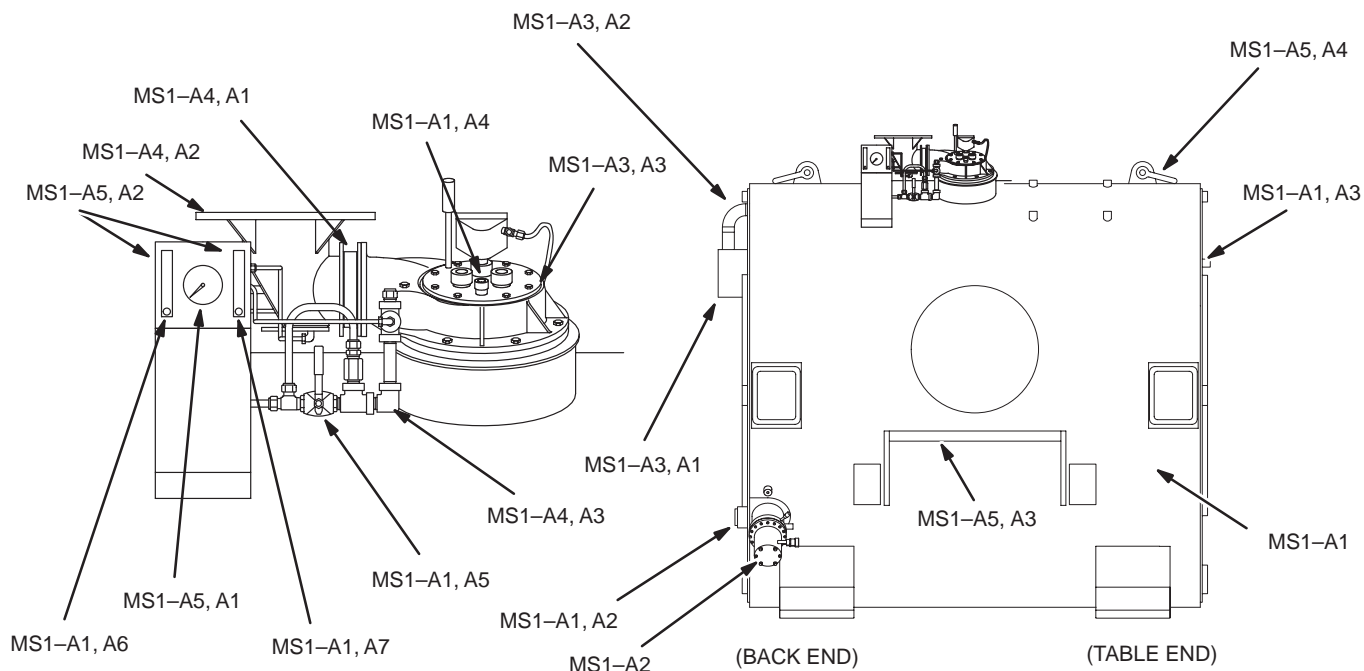
ILLUSTRATION 3-1



### SECTION 4 – COMPONENT IDENTIFICATION

This manual covers the major components shown in illustration 4-1 through 4-7.

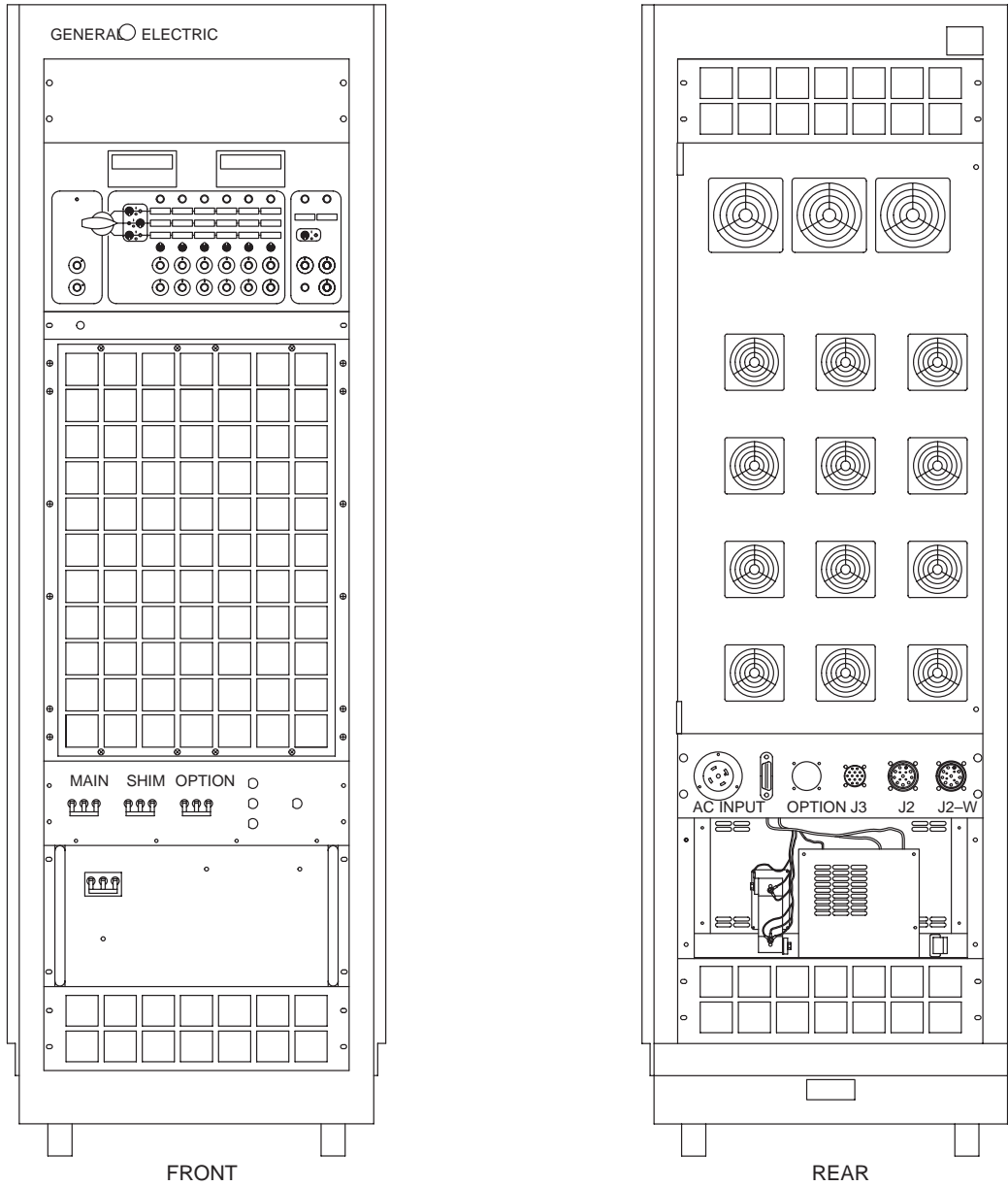
#### MS1 1.0T SUPERCONDUCTING MAGNET/CRYOSTAT



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

1.0T SUPERCONDUCTING MAGNET/CRYOSTAT  
COMPONENT DESIGNATIONS  
ILLUSTRATION 4-1

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



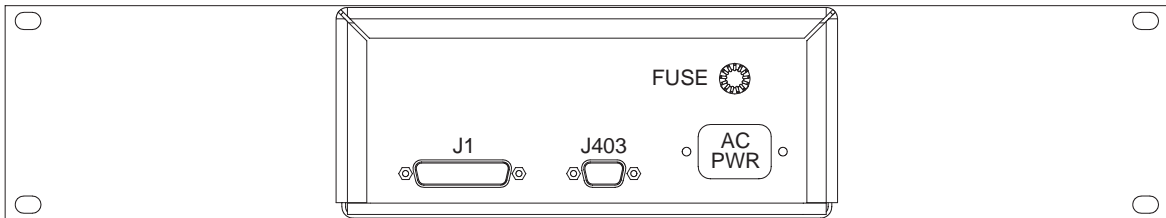
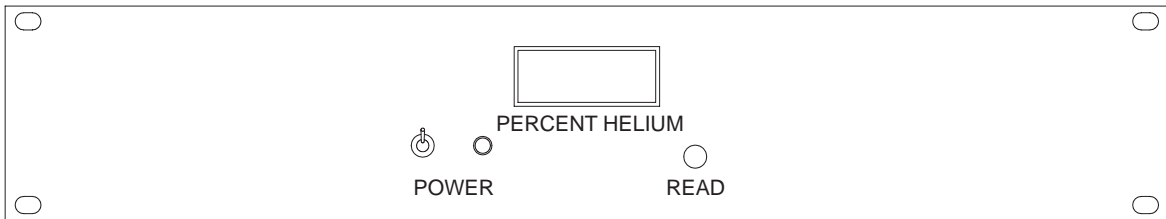
**Note**

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

**MS2 MAGNET/SHIM PHASE III-A POWER SUPPLY SYSTEM**

ILLUSTRATION 4-2

MR2-A6 CRYOGEN MONITORING SYSTEM



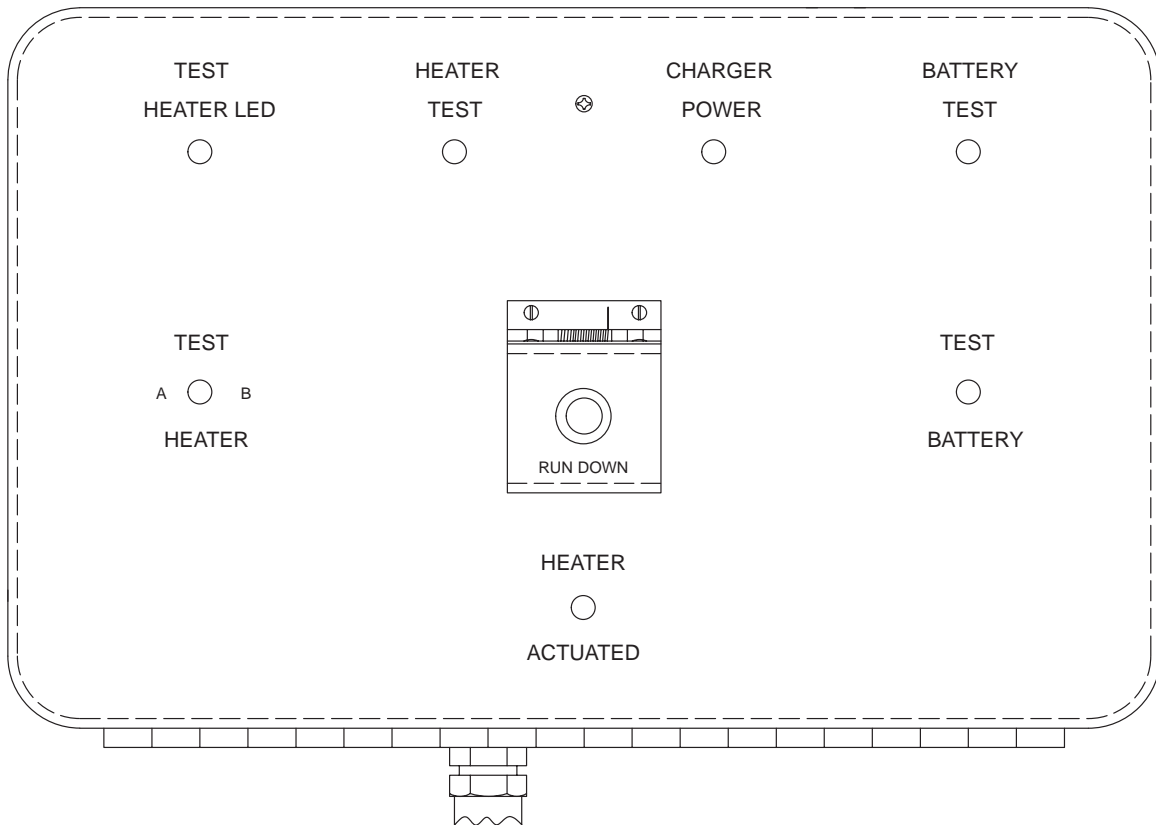
**CRYOGEN MONITORING CABINET  
MR2-A6,A 1**

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

**CRYOGEN MONITORING  
COMPONENT DESIGNATIONS**

ILLUSTRATION 4-3

MS4 MAGNET RUNDOWN UNIT (MRU)



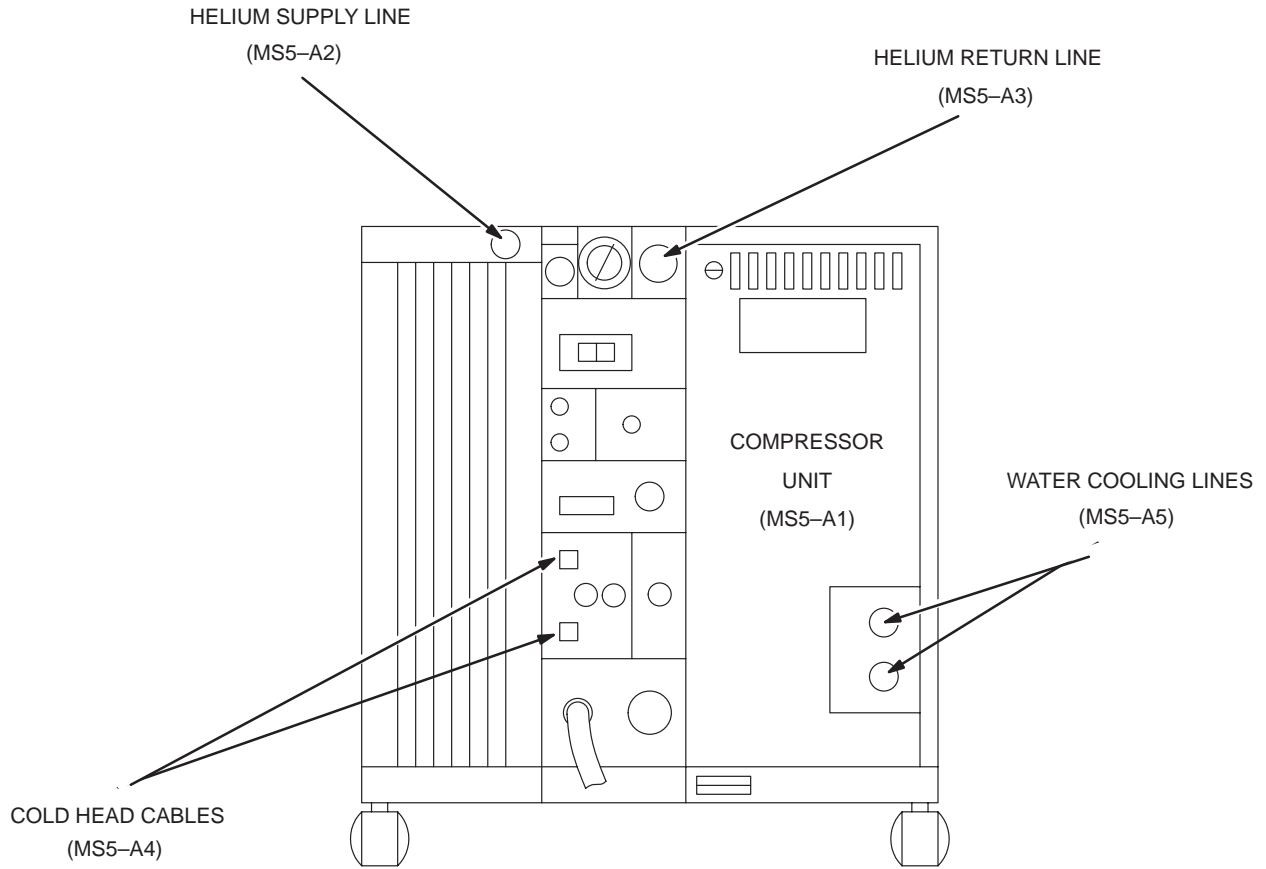
**MAGNET RUNDOWN CABINET  
(MS4A-A1)**

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

**MAGNET RUNDOWN UNIT (MRU)  
COMPONENT DESIGNATIONS**

ILLUSTRATION 4-4

MS5 SHIELD COOLER COMPRESSOR

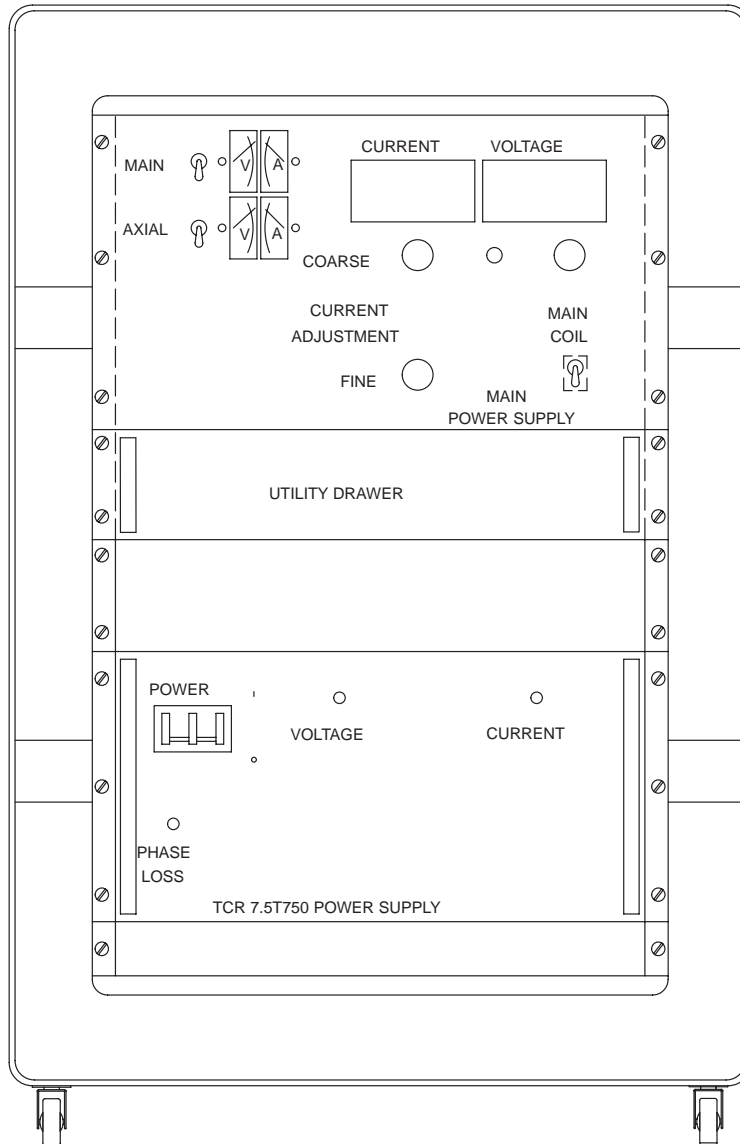


DESIGNATOR	DESCRIPTION
MS5-A1	* SHIELD COOLER COMPRESSOR
MS5-A2	HELIUM SUPPLY LINE
MS5-A3	HELIUM RETURN LINE
MS5-A4	COLD HEAD CABLES
MS5-A5	WATER COOLING LINES

**SHIELD COOLER COMPRESSOR  
COMPONENT DESIGNATIONS**

ILLUSTRATION 4-5

MS6 MAGNET SERVICE POWER SUPPLY CABINET

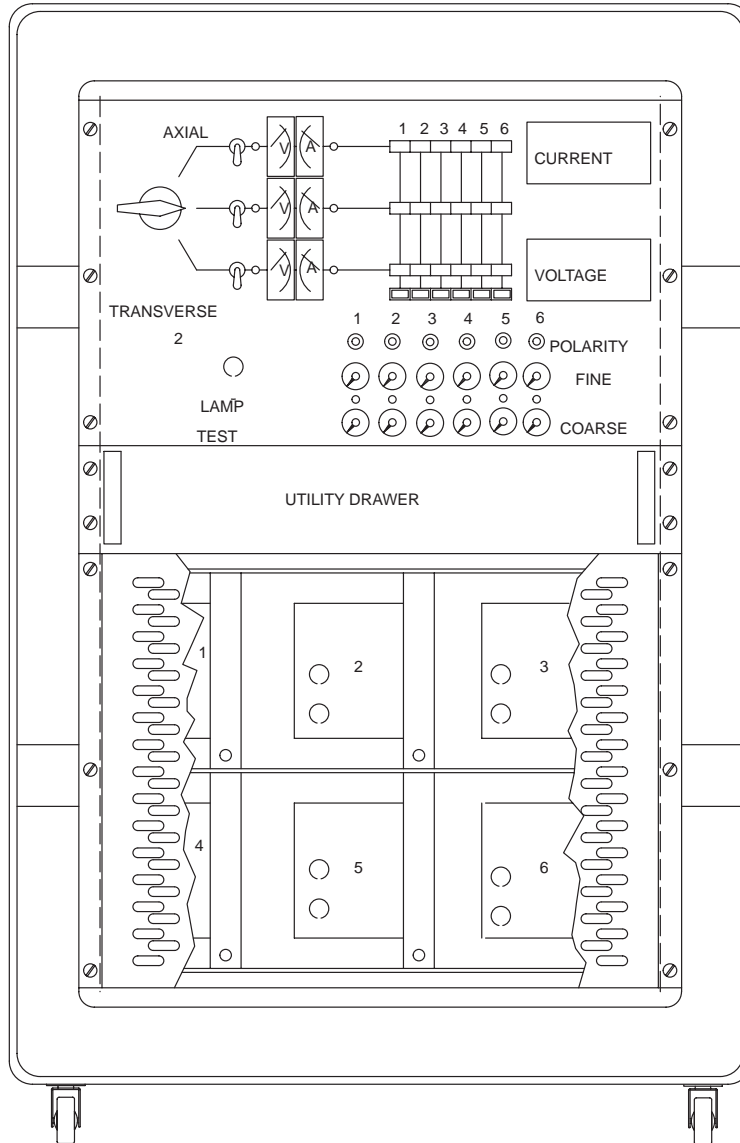


DESIGNATOR	DESCRIPTION
MS6-A1	MAGNET SERVICE POWER SUPPLY CABINET
MS6-A2	MAIN COIL POWER LEADS
MS6-A3	INPUT POWER CORD

**MS6 MAGNET SERVICE POWER SUPPLY CABINET**

ILLUSTRATION 4-6

**MS7 SHIM SERVICE POWER SUPPLY CABINET**



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

**MS7 SHIM SERVICE POWER SUPPLY CABINET**

ILLUSTRATION 4-7



## SECTION 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, before 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.

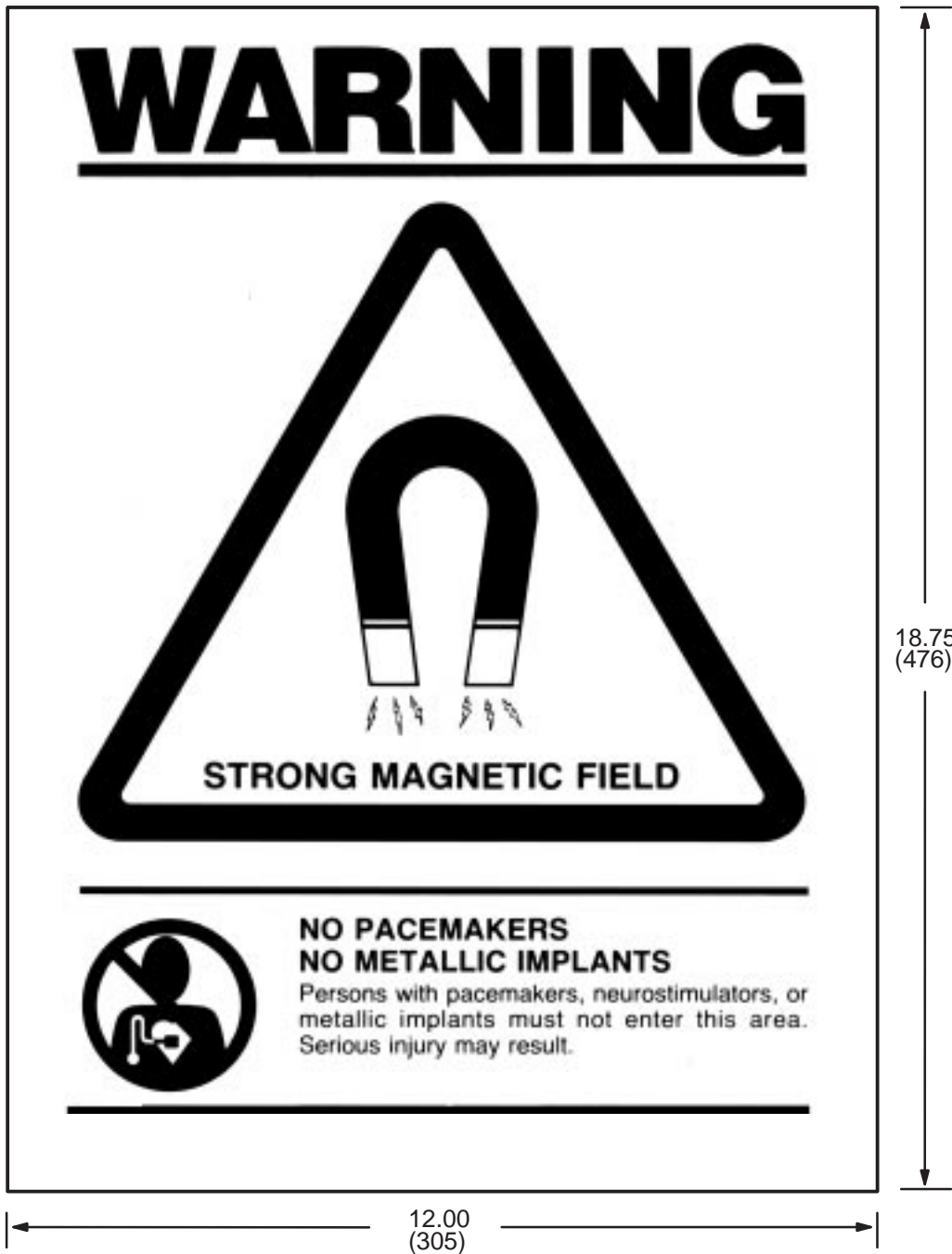
E8819C – One MR Security Warning Sign, in Spanish.

E8819D – One MR security Warning Sign, in French.

E8819BA – MR Warning Label Kit (Peel Off Back).

- Notify responsible personnel two days before ramping the Magnet to allow for preparatory actions to be accomplished.
- Do not bring ferromagnetic objects (e.g., TOOLS, pens, tape measures, steel-toe shoes, vacuum pumps, etc.) into the exam room when the Magnet is at field. Do not bring large metal objects near the outside walls of the exam room. Refer to *Direction 15402, Signa Advantage 1.5T, 1.0T, & 0.5T Site Planning, Section 2*, for equipment proximity limits.
- Use only nonmagnetic cylinders and dewars when transferring cryogenics 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)



46-255326P1

**MAGNETIC FIELD WARNING SIGN**  
ILLUSTRATION 5-1

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



46-255325P1

**MAGNETIC FIELD EXCLUSION 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:



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

**INCORPORATE THE SAFETY PRECAUTIONS LISTED IN THE NEXT SECTION (5-3) CRYOGENS.**

### Note

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

### METHOD 1

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

### METHOD 2

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

### METHOD 3

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

### Note

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

### METHOD 4

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

### 5-3 CRYOGEN SAFETY

Liquid helium and liquid nitrogen are odorless, colorless and nontoxic. They are extremely cold (liquid helium =  $-452^{\circ}\text{F}$  [ $-269^{\circ}\text{C}$ ] and liquid nitrogen =  $-320^{\circ}\text{F}$  [ $-196^{\circ}\text{C}$ ]) and will cause severe cold contact burns if the liquids or exhausting vapors contact the skin. Wear nonabsorbent, thermally insulated gloves and nonabsorbent clothing when transferring cryogenes.

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

Gaseous helium and nitrogen both displace air without warning and can cause rapid asphyxiation if ventilation is insufficient. Install the oxygen monitor before transferring cryogenes. Store cryogen cylinders and dewars in a well-ventilated area.

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

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

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

#### CRYOGEN SAFETY:



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

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

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

## 5-3 CRYOGEN SAFETY ( continued )

**CRYOGEN SAFETY:**

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

- 1. MAKE SURE BOTH MAGNET AND ROOM VENT REQUIREMENTS ARE INCORPORATED, IN CONFORMANCE WITH THE SITE PLANNING MANUAL ( REV. 4 AND ABOVE ), BEFORE DELIVERING THE MAGNET INTO THE MAGNET ROOM.**
- 2. SECURE THE MAGNET ROOM DOOR IN THE OPEN POSITION AND TURN ON MAGNET ROOM VENT EXHAUST FAN, AND OPEN THE ROOM “HATCH” IF A MOBILE VAN, BEFORE INITIATING ANY MAGNET SERVICE THAT WILL RESULT IN HELIUM EXHAUST. IN ADDITION TO ELIMINATING THE POSSIBILITY OF ASPHYXIATION, THE ABOVE ACTION WILL PREVENT THE MAGNET ROOM FROM BECOMING PRESSURIZED, PREVENTING THE DOOR FROM BEING OPENED, IN THE UNLIKELY EVENT OF A MAGNET QUENCH AND SIMULTANEOUS VENT FAILURE.**
- 3. MAKE SURE A SECOND PERSON IS PRESENT ( GE OR HOSPITAL PERSONNEL ) WHILE SERVICING THE MAGNET, IN CASE OF ANY EMERGENCY.**
- 4. IN CASE OF A MAGNET QUENCH WHERE HELIUM ENTERS THE EXAM ROOM, MAKE SURE THE MAGNET ROOM VENT EXHAUST FAN IS “ON” AND IMMEDIATELY EXIT THE ROOM. IF THE DOOR CANNOT BE OPENED:**
  - A. STAY NEAR THE FLOOR WHERE THE OXYGEN WILL BE.**
  - B. IMPLEMENT EMERGENCY EXITING PROCEDURES FOR THE MAGNET ROOM, IE, REMOVE A “POPOUT WINDOW.**
  - C. IF THE ROOM HAS PIPED IN OXYGEN OR AIR, KNOW WHERE IT IS AND HOW TO USE IT.**

**Note**

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

**5-4 FIRST AID**

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

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

**5-5 TRAINING – THE BEST INVESTMENT IN SAFETY**

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

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

**Note**

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



## SECTION 1 – MAGNET SYSTEM INSTALLATION



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

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

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

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

### 1-1 CONVERSION TO OPERATING CONFIGURATION

#### **Description:**

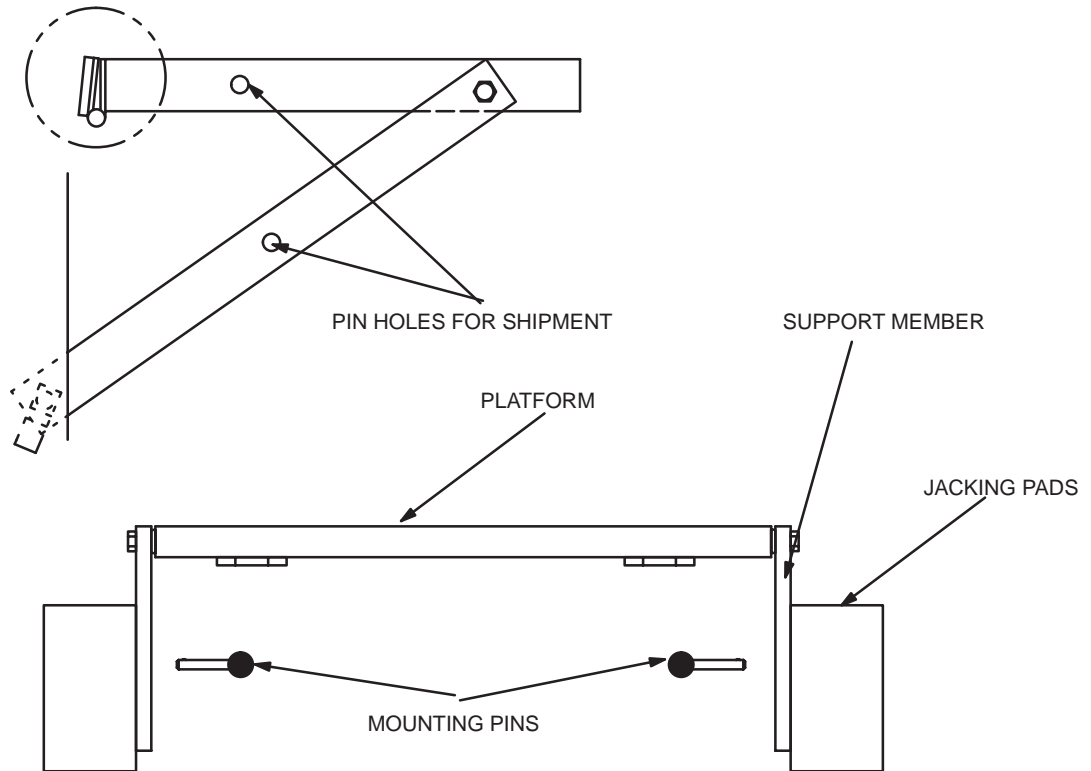
The magnet arrives at the installation site in a shipping configuration and requires the actions covered in this procedure to convert it to the operating configuration. Ground shipments (over land or sea) are made with all Helium Vent Plumbing installed on the magnet. Air shipments are made with the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

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

1-1 CONVERSION TO OPERATING CONFIGURATION (continued)

Procedure:

1. Install the Service Platform by removing the Mounting Pins, which attach the support members to the platform during shipment, and attaching the support members to the Jacking Pads as shown in Illustration 1-1.



SERVICE PLATFORM INSTALLATION  
ILLUSTRATION 1-1

2. Make sure plumbing valves are in the following positions. See Illustration 1-2.

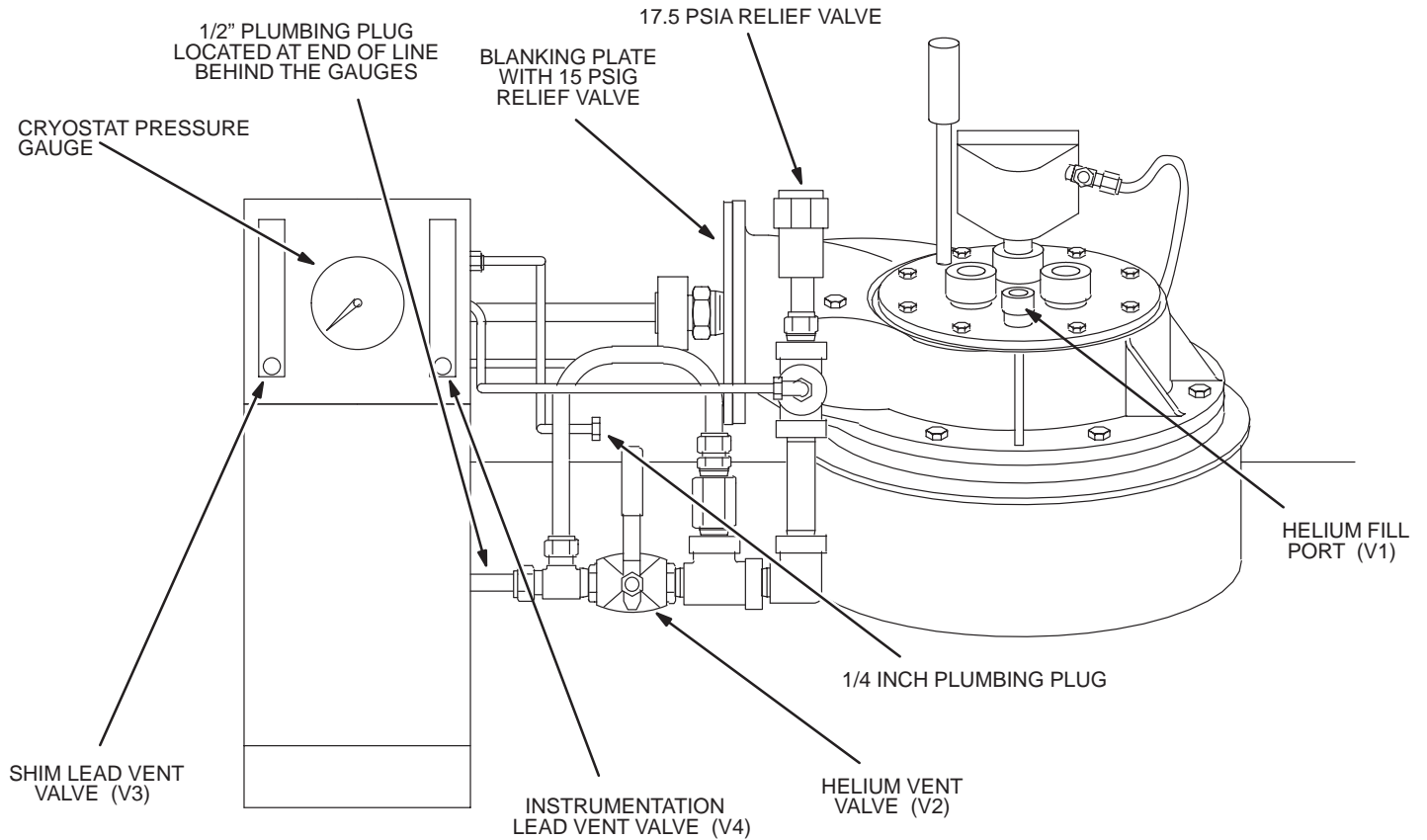
V2 – Closed

\* V3 – Partially Open

\* V4 – Partially Open

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

1-1 CONVERSION TO OPERATING CONFIGURATION (continued)



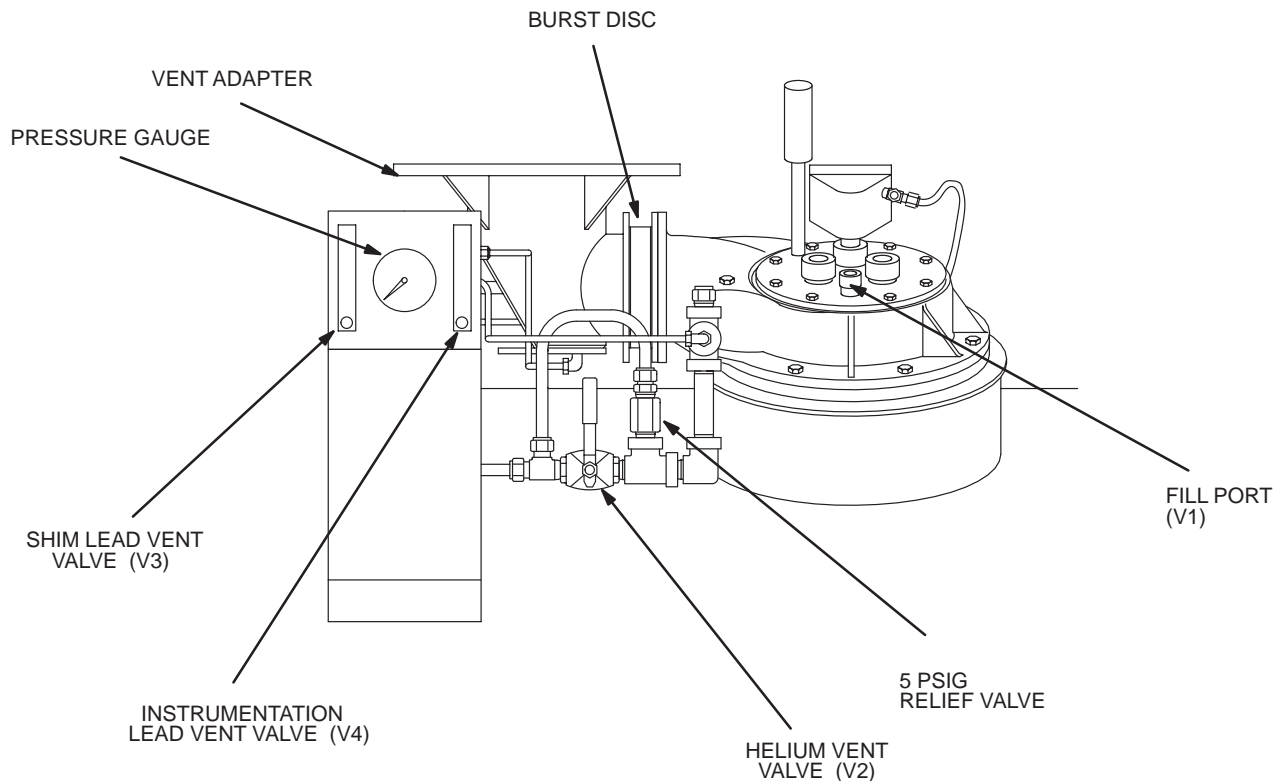
MAGNET AIR SHIPMENT CONFIGURATION  
ILLUSTRATION 1-2

- 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.

1-1 CONVERSION TO OPERATING CONFIGURATION (continued)



VALVE LOCATIONS  
ILLUSTRATION 1-3



**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.**

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

1-1 CONVERSION TO OPERATING CONFIGURATION (continued)

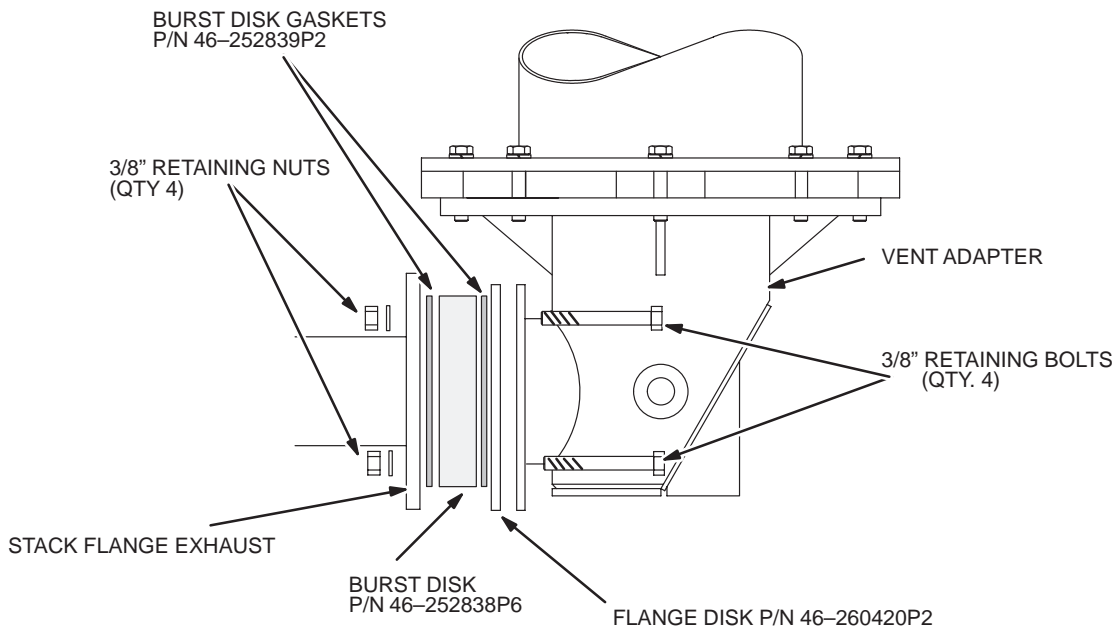
- 6. Close valves V3 and V4 at the base of the flow meters. See Illustration 1-3.
- 7. Slowly open Vent Valve V2 and allow the Cryostat to exhaust until the pressure, indicated on the pressure gauge on top of the magnet, is between 0.2 and 0.3 PSI. Close V2.



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

- 8. Remove the 17.5 psia, Absolute Pressure Relief Valve, located on the Magnet Vent Plumbing adjacent to Valve V2. Quickly wrap the threads with Teflon Tape and install the 1/2 Brass Pipe Plug (P/N 46-252552P4), shipped with the magnet, onto the Threaded Tee where the relief valve was removed.
- 9. Unpack the 20 psi Burst Disc from its container, located in the Venting Hardware Kit, and inspect it for visible damage (nicks/scratches). Make sure that the Burst Disc has the proper part number (46-252838P6) and rating plate marking of 20 psi.
- 10. Loosen the four 3/8 inch Retaining Bolts holding the 15 psi Shipping Relief Valve and Blanking Plate to the Stack Flange Exhaust and remove the top two bolts, while holding the Blanking Plate and Flange Disc. See Illustration 1-2.
- 11. Remove the 15 psi Shipping Relief Valve and Blanking Plate.
- 12. Install the Burst Disc and Gaskets with the flat face of the disc facing out from the Stack Flange. See Illustration 1-4.

SIDE VIEW OF MAGNET OPPOSITE THE COLD HEAD



HELIUM VESSEL BURST DISC ASSEMBLY

ILLUSTRATION 1-4

1-1 CONVERSION TO OPERATING CONFIGURATION (continued)

**Note**

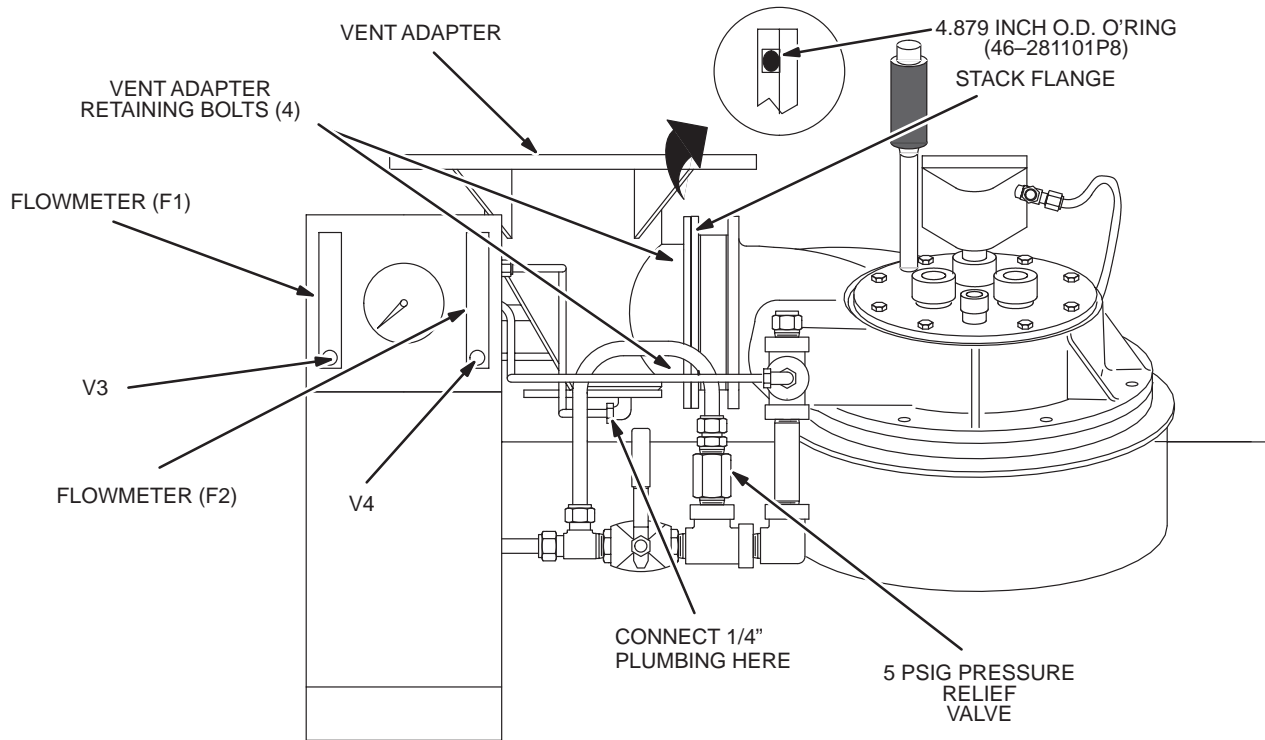
Make sure that the Burst Disc is fully sandwiched between the two rubber gaskets, (i.e., the gaskets are flat and the Burst Disc is not in contact with the flanges).

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

**Note**

See Illustration 1-5 for Steps 13 through 16.

14. Install the 4 inch "O"- Ring (46-281101P8), located in the Venting Hardware Kit, in the groove of the Vent Adapter.
15. 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.
16. Connect the 1/2 inch Plumbing line, where the Plumbing Plug was connected, to the Vent Adapter.
17. Connect the 1/4 inch Plumbing, from the Swagelok Fitting on the Flowmeter, to the under side of the Vent Adapter.



VENT ADAPTER & PLUMBING CONNECTIONS  
ILLUSTRATION 1-5

**1-1 CONVERSION TO OPERATING CONFIGURATION (continued)**

18. Open valves V3 and V4 on Flowmeters F1 and F2.
19. Remove the 15 psi Relief Valve from the Blanking Plate. Pack and return the 17.5 psia and 15 psig Relief Valves to:

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



**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).**

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

**Note**

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

21. Set Instrumentation Lead Vent Valve (V4) for a reading between 0.8 – 1.2 SCFH on Flowmeter (F2).
22. 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.
23. Make sure flow rate through F2 is equal or greater than 0.8 SCFH.
24. If flow rate through F2 is less than 0.8 SCFH or the pressure gauge reads less than 0.25 psig, pressurize the vessel and bubble test all exhaust plumbing joints, Relief Valve and Shim Lead Connector. Make sure V2 is fully closed. Repair any leaks. If a 0.8 SCFH flow rate through F2 cannot be achieved, under the above conditions, contact your Region Magnet Service Engineer.
25. 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

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

**1-2 VENTING INSTALLATION****WARNING!**

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

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

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

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

**CAUTION**

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

**Note**

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

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

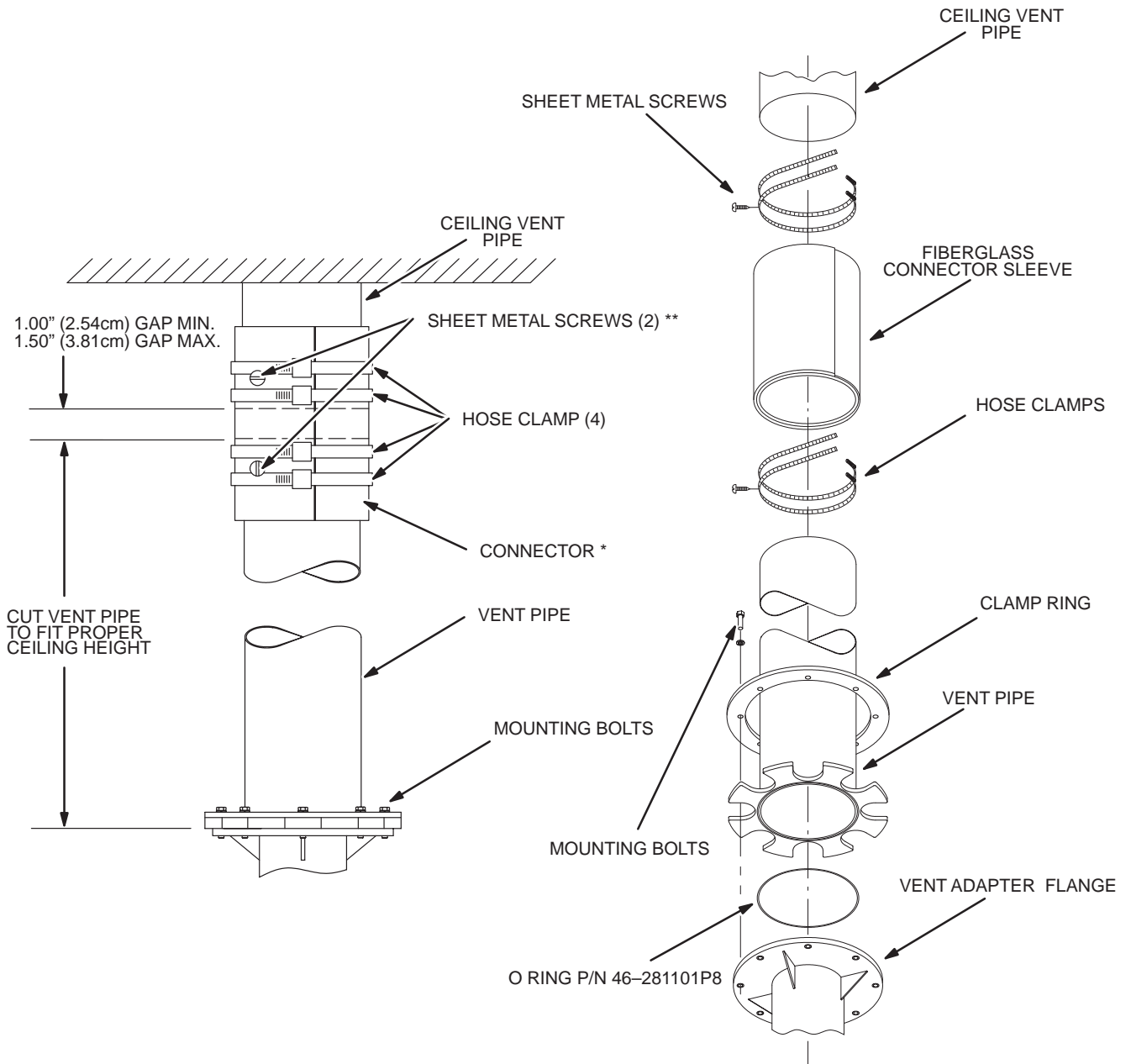
**Note**

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.

1-2 VENTING INSTALLATION (continued)

CEILING VENT PIPE (REF.)  
(RF PENETRATION)



\* 80.00 INCHES X 8.00 INCHES FIBERGLASS CONTINUOUS WRAP SLEEVE

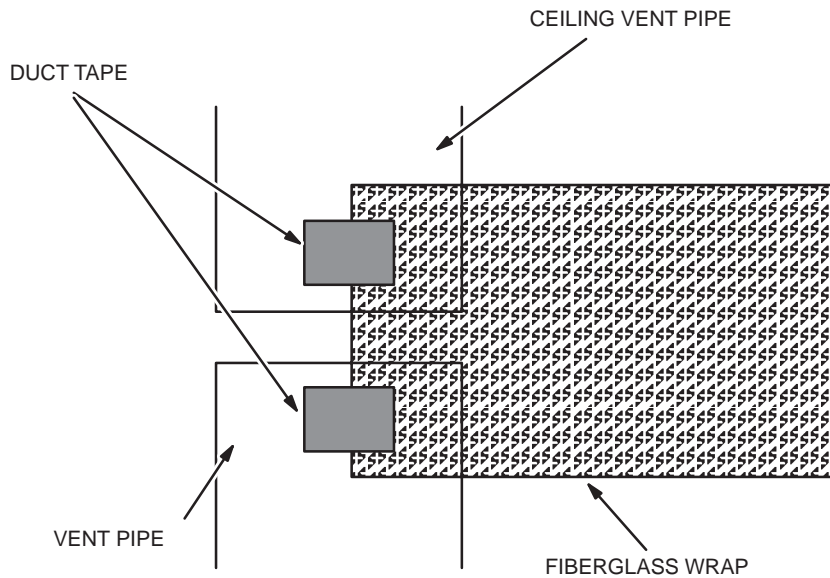
\*\* INSTALL SCREWS AS LAST STEP IN ASSEMBLY AFTER DRILLING HOLES ADJACENT TO HOSE CLAMPS AS SHOWN.

**HELIUM VENT KIT ASSEMBLY P/N 46-318057G1**

ILLUSTRATION 1-6

**1-2 VENTING INSTALLATION (continued)**

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



**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. Drill 2 holes, using a number 17 Drill Bit (4.4mm), as shown in Illustration 1-6. 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.

1-2 VENTING INSTALLATION (continued)

TABLE 1-1  
HELIUM VENT LINE PRESSURE DROP MATRIX

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

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

Note 2: The table data is based on the following:

- a. Initial flow conditions at magnet interface
- b. Gas temperature starting at 4.5 Kelvin (-452° F or -268° C).
- c. Helium gas flow rate of 2737 cubic feet per minute (77.5 cubic meters per minute)
- d. 45° standard sweep elbow K = 15 F<sub>t</sub>
- e. 90° standard sweep elbow K = 30 F<sub>t</sub>
- f. 45° long sweep elbow K = 7.5 F<sub>t</sub>
- g. 90° long sweep elbow K = 15 F<sub>t</sub>
- h. No offset between magnet vent adapter and ceiling RF vent adapter.

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

**Note**

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

### 1-3 SHIELD COOLER INSTALLATION AND CHECK OUT

#### Description:

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

### 1-4 SHIELD COOLER SYSTEM

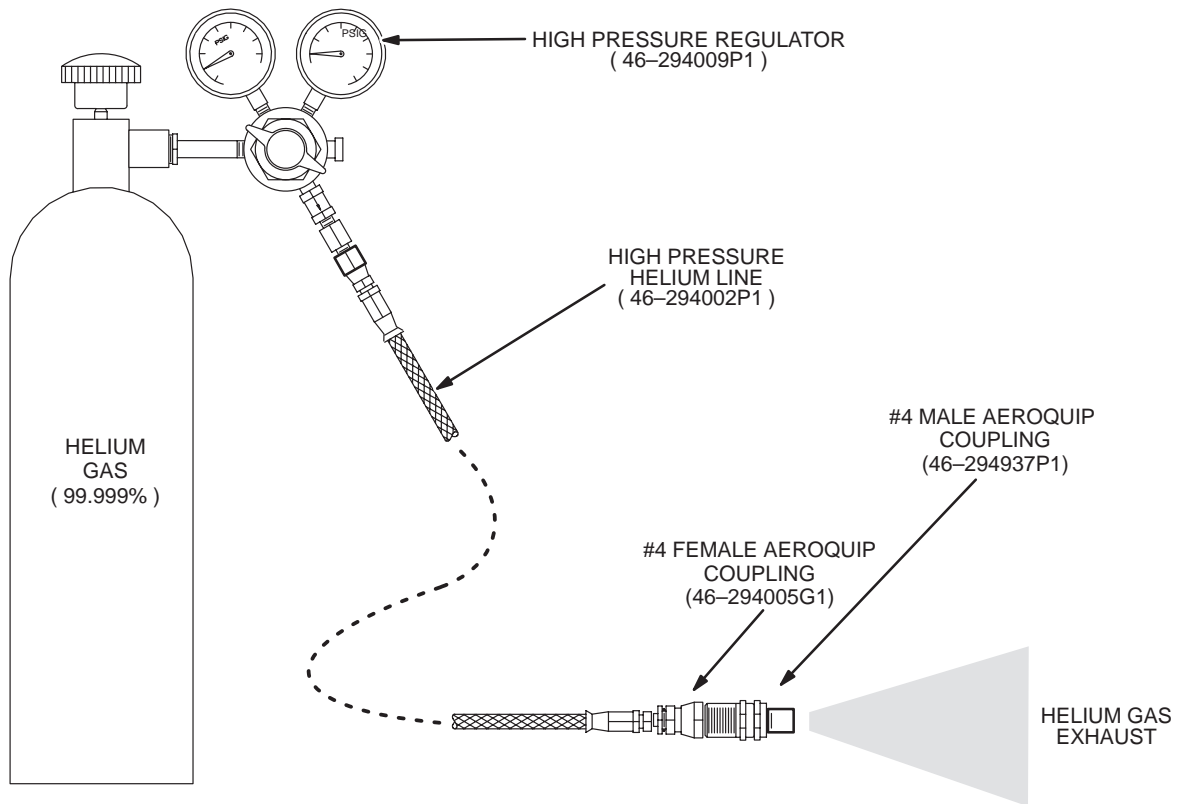
#### 1-4-1 Preparation For Increasing Shield Cooler Gas Pressure



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

1. Refer to the vendor manual (P/N 722-78-037; GE P/N 46-294439P4) for instructions on compressor installation, power, cooling requirements, leaks etc.
2. Obtain a cylinder of 99.999% Helium Gas.
3. Loosely attach the high pressure regulator (46-294009P1) to the gas cylinder, per the following steps.
  - A. Thread in the screw that connects the regulator to the Helium bottle about 2 turns.
  - B. Turn Regulator handle fully clockwise to open the regulator.
  - C. Open Helium bottle, and immediately tighten the Regulator to the Helium bottle.
  - D. Close the Regulator Valve by turning the handle counter clockwise.
4. Attach high pressure helium line (46-294002P1) to regulator at shut off valve. See Illustration 1-8.

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



SET-UP FOR COMPRESSOR CHARGING  
ILLUSTRATION 1-8

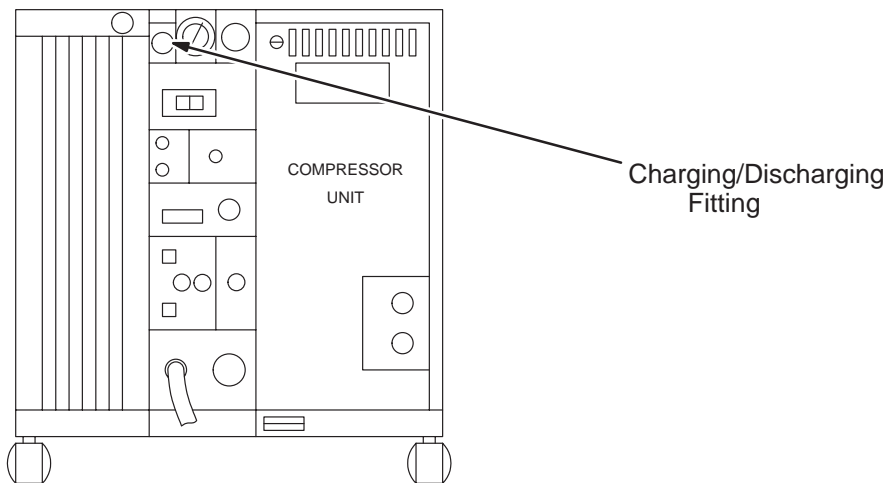
**1-4-1 Increasing Shield Cooler Gas Pressure Preparation (continued)**

- 5. Attach the #4 Female Aeroquip Coupling (46-294005G1) to the end of the high pressure charging line. See Illustration 1-8.



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

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



**CHARGING FITTING LEYBOLD COMPRESSOR**  
ILLUSTRATION 1-9

**1-4-2 Increasing Gas Pressure**

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

**1-4-3 Decreasing Gas Pressure**

1. Remove Protective Cap from compressor front panel fitting.
2. Connect oil charging hose and fitting (46-294003P1) to the small fitting on the front of the compressor. See Illustration 1-9.
3. Slowly tighten fitting until you hear gas escaping.
4. When a pressure of 218-232 psig (15.03 – 16.00 Bar) is reached, immediately unscrew fitting and hose to prevent further gas removal.
5. Replace protective cap on front panel fitting.

**1-4-4 Disconnection and Stowage of Hoses and Regulator**

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

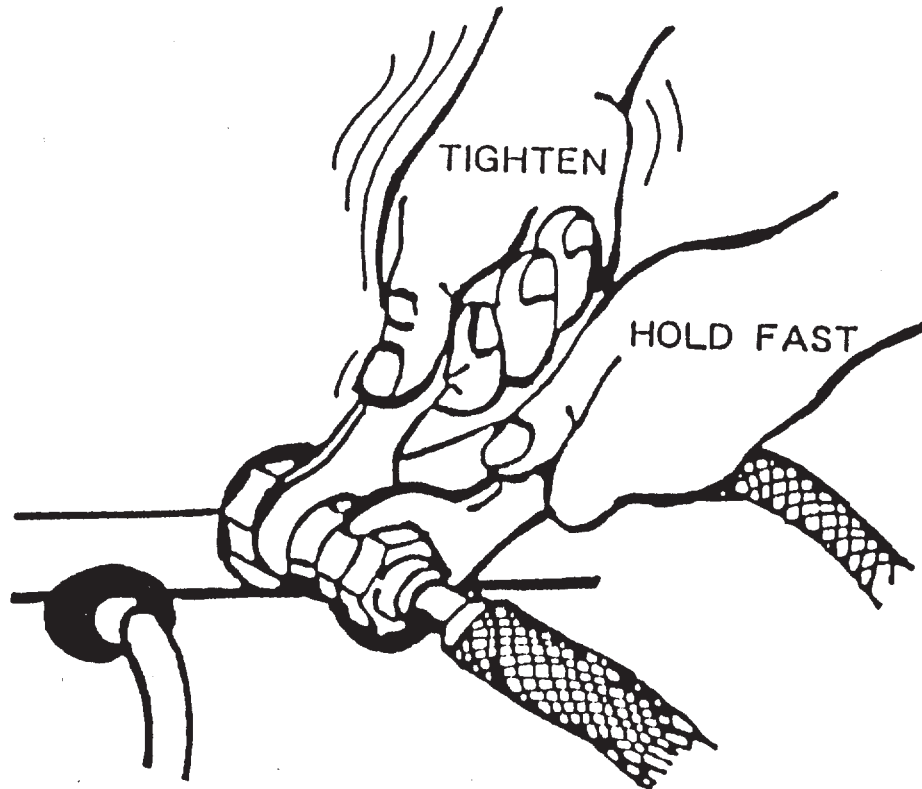
**1-4-5 Flexible Gas Line Connections****Note**

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



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

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

**1-4-5 Flexible Gas Line Connections (continued)**

**PROPER TECHNIQUE FOR CONNECTION OF AEROQUIP COUPLINGS**  
ILLUSTRATION 1-10

2. Similarly feed the flexible Gas Return Line (RUN 622) through the other port in the penetration panel and route in parallel with the supply line.
3. Connect the lines to the compressor using the appropriate Aeroquip connection wrenches. See Illustration 1-10. Always use two wrenches as shown, so that the back adaptor connection is not disturbed, to prevent system gas leaks from occurring.
4. Observe the compressor pressure gauge reading after connecting the gas lines, the reading should remain constant.

**Note**

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

5. Route the Flexible Gas Lines through the base pad of the magnet before connecting them at the Cold Head. See Illustration 1-11.

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



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

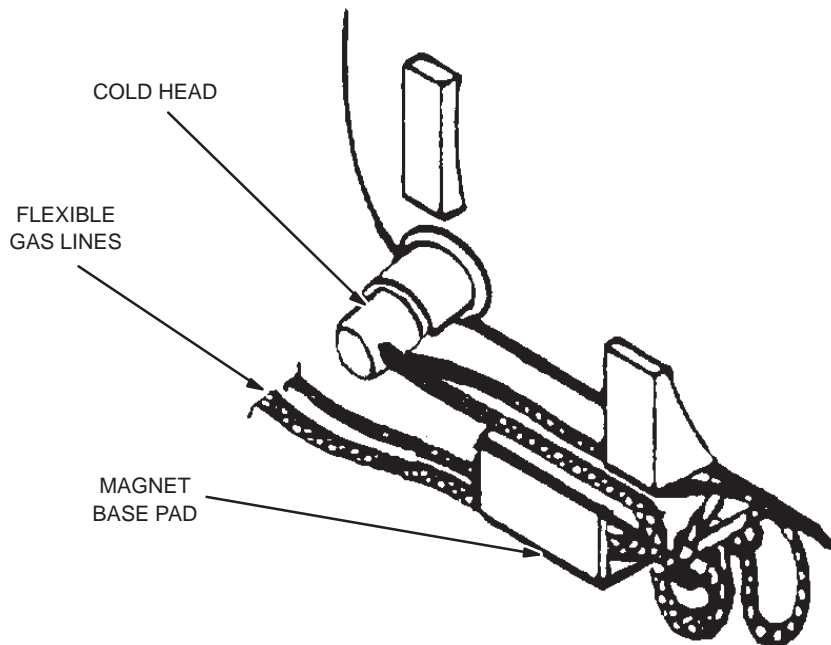
6. Connect the other ends of the flex lines to the Cold Head. Connect the free ends of the flex lines at the mating fittings on the Cold Head, using two wrenches on the fittings.
7. Observe the reading on the compressor pressure gauge. If the pressure reading is constant, then a leak is not suspected.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

**Note**

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

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

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



**FLEXIBLE GAS LINE ROUTING AT MAGNET**  
ILLUSTRATION 1-11

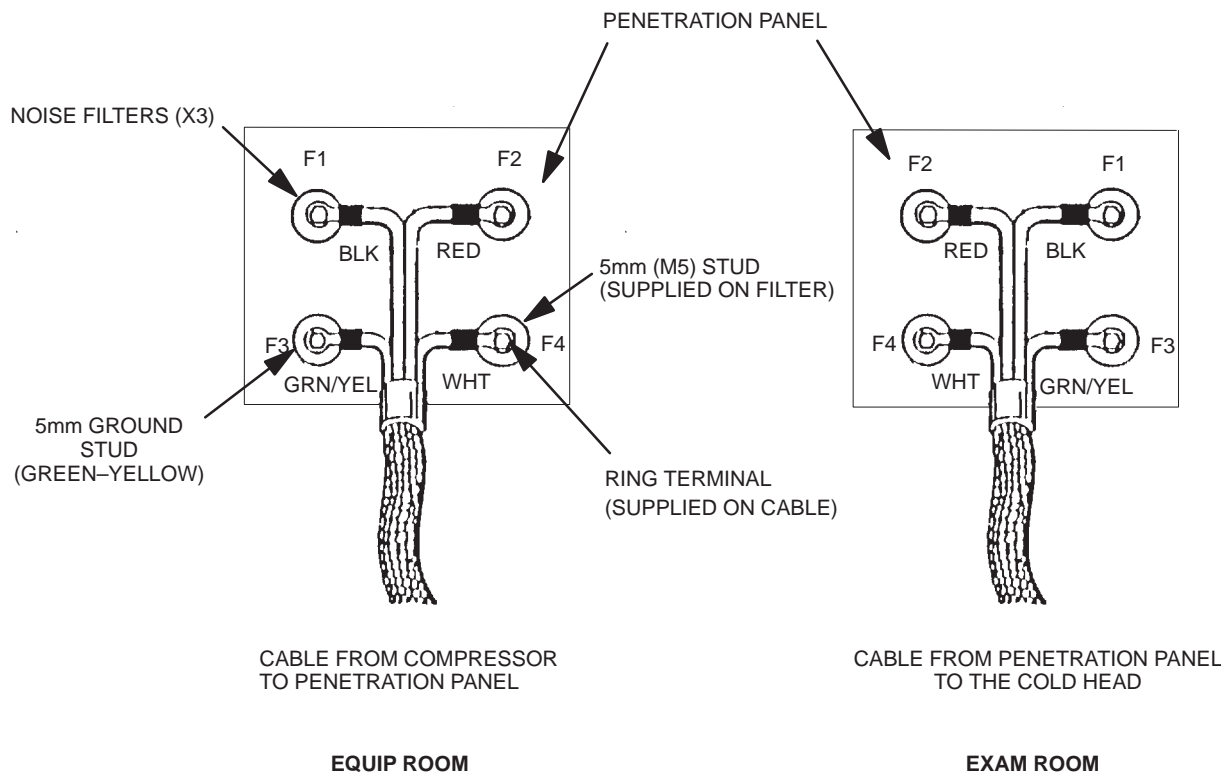
**1-4-6 Shield Cooler Electrical Cable Connections**

1. Connect the four ring terminals on the end of the Cold Head Electrical Cable (RUN #624) to the four studs of the Noise Filter on the inside the Penetration Panel. See Illustration 1-12
2. Connect the other end of the cable to the mating connector on the Cold Head.
3. Connect the four ring terminals on the end of the Compressor Electrical Cable (RUN #623) to the four studs of the Noise Filter on the outside the Penetration Panel (equipment room side).



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

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



**SHIELD COOLER ELECTRICAL CABLE CONNECTIONS**  
ILLUSTRATION 1-12

**1-4-7 Monitoring Shield Cooler Temperatures**

1. Use the Lakeshore Cryotronics Digital Cryogenic Thermometer Model 208 Thermometer Kit (46-301477G1) to monitor Cold Head first and second stage temperatures.
2. Connect the Cryogenic Thermometer to the Cold Head in conformance with Illustration 1-13.
3. Select the Cold Head stage to be monitored as shown below.

STAGE	DRC – 80	208 THERMOMETER KIT
FIRST	PRESS “A” BUTTON	SELECT CHANNEL 1
SECOND	PRESS “B” BUTTON	SELECT CHANNEL 2

4. Refer to vendor operations manual for 208 Thermometer. Make sure curve 2 (DT-500DRC- D) is selected.

**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.

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



**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**

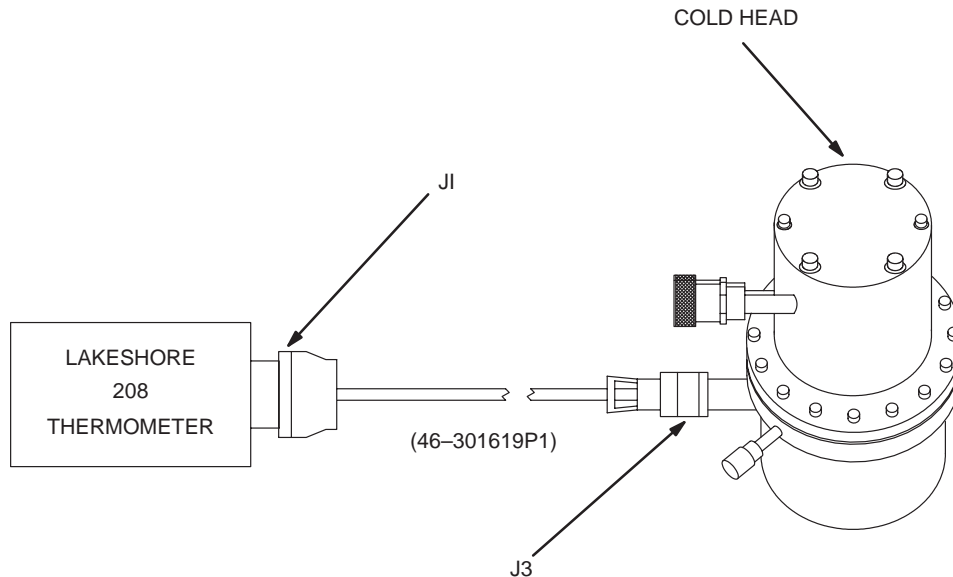
A SHORTED sensor circuit will cause the meter to display a reading of approximately 400 K whereas an OPEN sensor circuit will cause the meter display to flash. Check for problems in the connector cable or for proper plug termination before ruling the sensing diode defective.

**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.

**1-4-7 Monitoring Shield Cooler Temperatures (continued)**



**SHIELD COOLER TEMPERATURE MEASUREMENT SET-UP**  
ILLUSTRATION 1-13

**1-4-8 Setting Cold Head Tension**

**Description:**

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

**Procedure:**

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

**1-4-8 Setting Cold Head Tension (continued)****Overtightening the Cold Head Mounting Bolts can damage the Cold Head Sleeve.**

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

**Note**

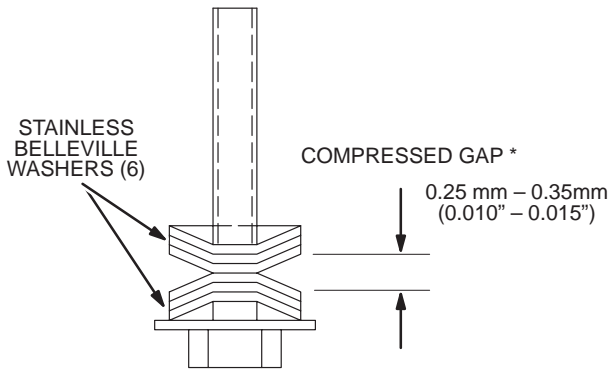
Set the gap by tightening to the proper setting. Do not set gap by overtightening then loosening as insufficient pressure will result, due to the hysteresis characteristic of the Belleville Washers.

3. After the Cold Head has been operating and cooling for approximately two hours, tighten the mounting bolts in a CW rotation pattern to achieve the Belleville Washer Gap setting shown in Illustration 1-14. 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 1-14.
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**

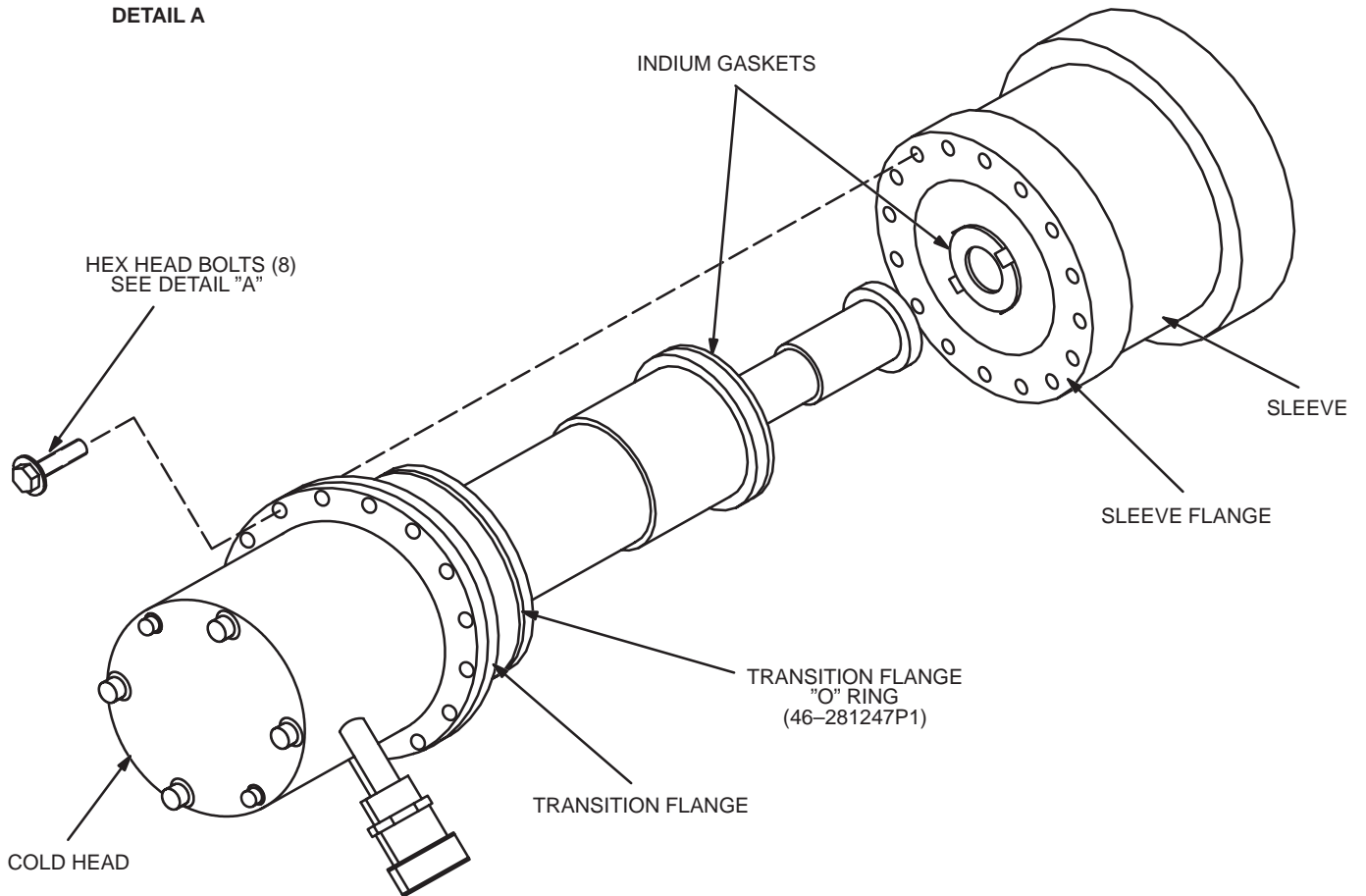
The temperatures readings, taken for your magnet at the factory, were recorded in the Acceptance Test Report (ATR). If temperatures are higher than those values, perform the tests listed in FUNCTIONAL CHECKS, Section NO TAG of this manual.



DETAIL A

**NOTE:**

**SET COMPRESSION GAP WHILE TIGHTENING BOLT. DO NOT SET GAP WHEN LOOSENING BOLT.**



**COLD HEAD MOUNTING BOLT GAP SETTING**  
ILLUSTRATION 1-14

**1-4-9 RF Shielding****Note**

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

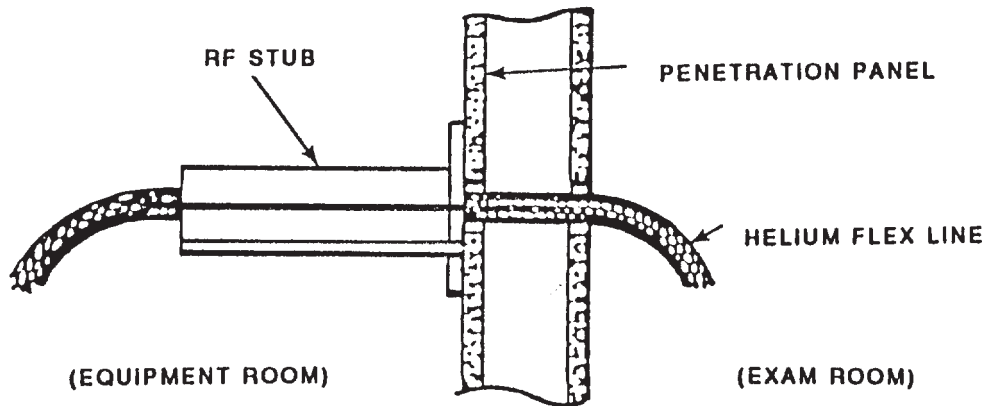
1. Adjust the slack on the Helium Supply and Return Flex lines for the most suitable length on both sides of the Penetration Panel.
2. Position half of the RF Stub Assembly (46-260860G1) underneath the Helium Supply Line, with the flange end oriented toward the Penetration Panel. See Illustration 1-11.

**Note**

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

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

1-4-9 Rf Shielding (continued)



RF STUB ASSEMBLY MOUNTING  
ILLUSTRATION 1-15

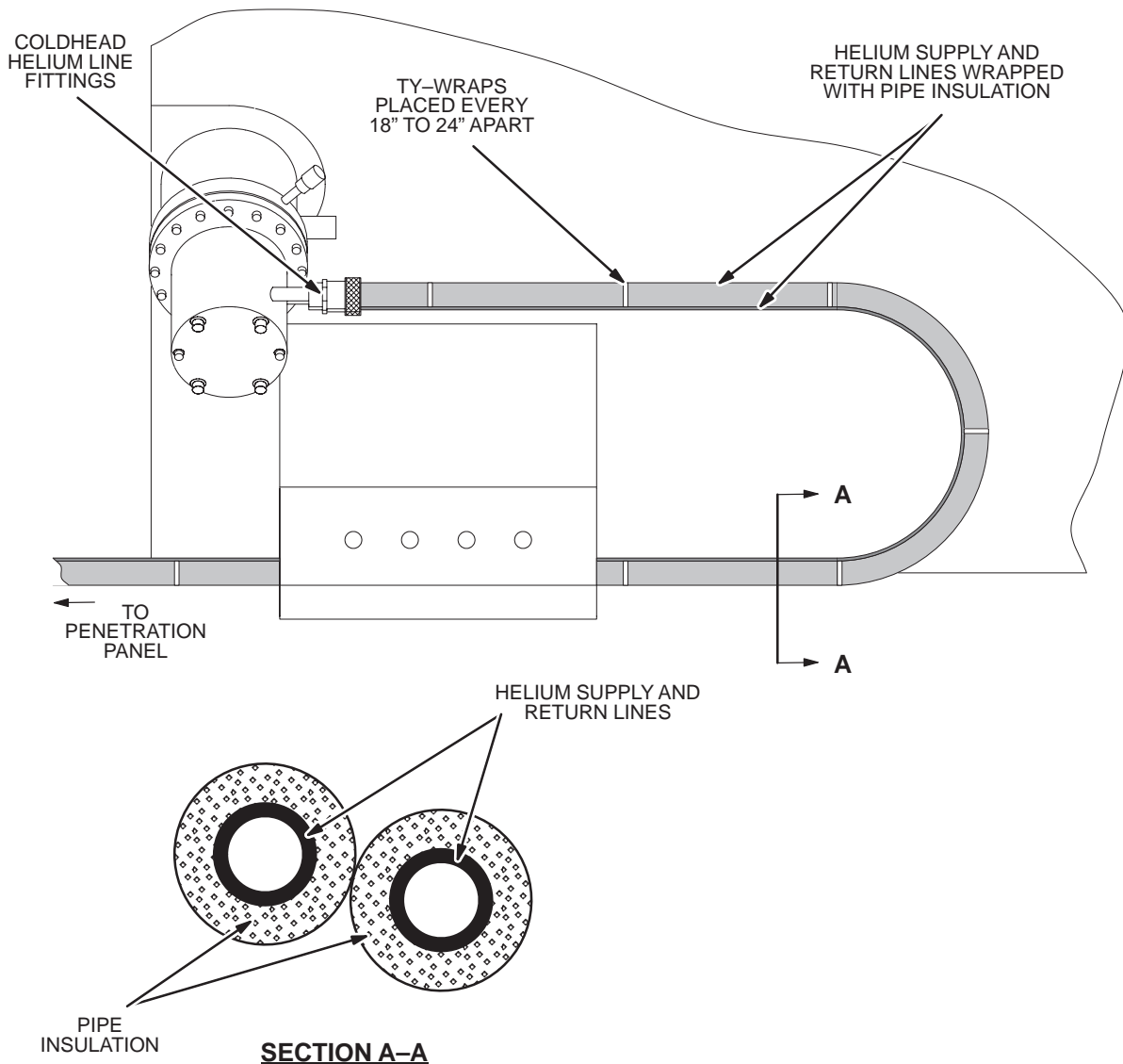
6. Secure the flange of the top half of the RF Penetration Stub Assembly to the Penetration Panel with four screws, aligning the flange holes with holes in the Penetration Panel.
7. Repeat the procedure for the Helium Return Line.

1-4-10 Installing Helium Line Insulation Kit

**Note**

Helium Gas Line Insulation Kit ( 2156980 ) has been created to isolate helium gas lines from each other and from ground to prevent spike noise. See Illustration 1-11 for routing of helium lines.

Pipe insulation should cover lines completely from the helium line fittings on the coldhead to the penetration panel where the lines exit the magnet room. See Illustration 1-16.



HELIUM INSULATION KIT  
ILLUSTRATION 1-16

**1-5 MAGNET RUNDOWN UNIT (MRU) INSTALLATION**

1. Install and inspect the “MRU” in conformance to the vendor service manual supplied with the unit.
2. Batteries are installed and fully charged before leaving the factory. The Charge should be verified according to the vendor service manual.

**Note**

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

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



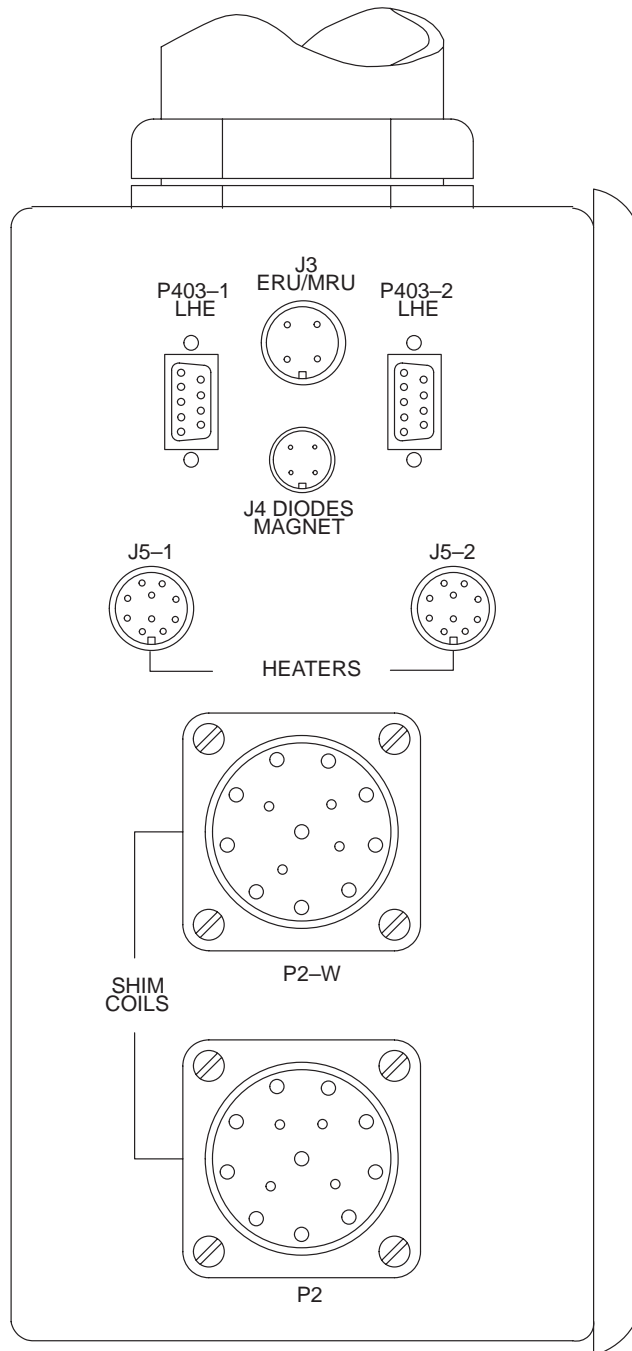
**The MRU Cable is a shielded cable with the shield terminated at only the MRU end. It is essential that the cable be properly connected.**



**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 2-1 and 2-7.
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 1-17 for (J3) Location.

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



MAGNET HARNESS TERMINAL BOX  
ILLUSTRATION 1-17

**1-5 MAGNET RUNDOWN UNIT (MRU) INSTALLATION (continued)**

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



**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 NO TAG of this manual.

**1-6 CRYOGEN MONITOR INSTALLATION**

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



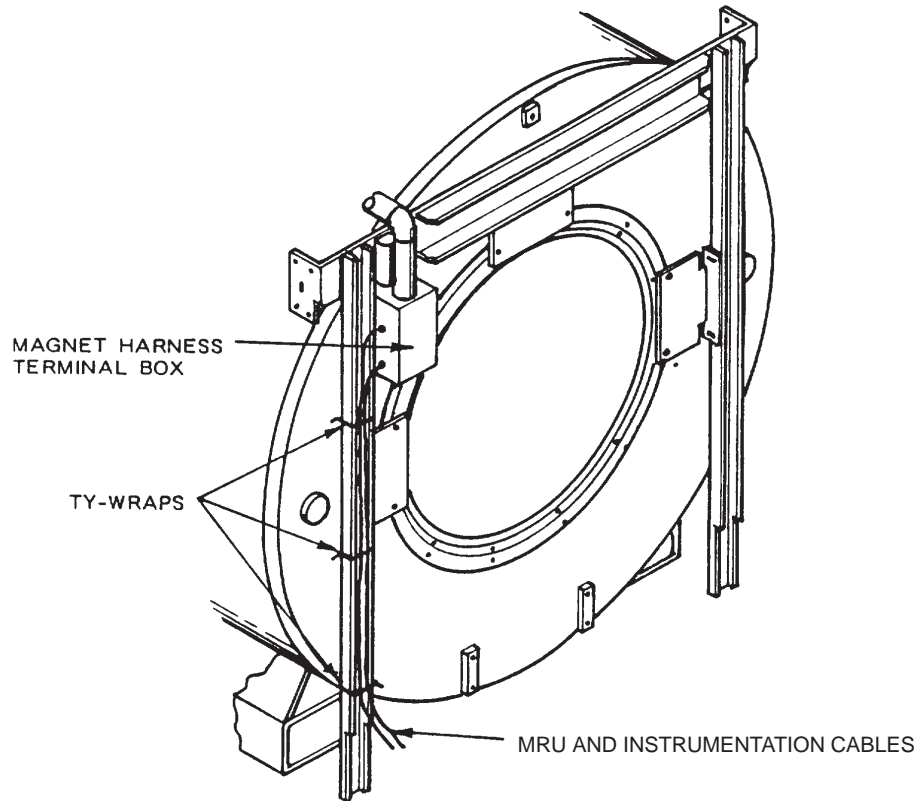
**Establish power source values and make sure Cryogen Monitor is properly wired for input power in conformance to Section 3 of the vendor service manual for proper operation. A change to the power cord plug may be required.**

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 2-1.
3. Connect Instrumentation Cable #1 (RUN #605) from (J403) on the Magnet Harness Terminal Box to (J403) on the Penetration Panel. See Illustration 1-17 for (P403) location.
4. Ty-wrap MRU Cable (RUN #606) and Instrumentation Cable (RUN #605) to Back End, left Vertical Shroud Channel. See Illustration 1-18.

**Note**

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

1-6 CRYOGEN MONITOR INSTALLATION ( continued )



MRU & INSTRUMENTATION CABLE ROUTING  
ILLUSTRATION 1-18

5. Perform the calibration procedure covered in the PM manual. Perform sensor length calibration and warning/alarm setting.

**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.

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

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

7. Set sample interval to 24 hours using thumb wheels on front of Cryogen Monitor.
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.).



**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:

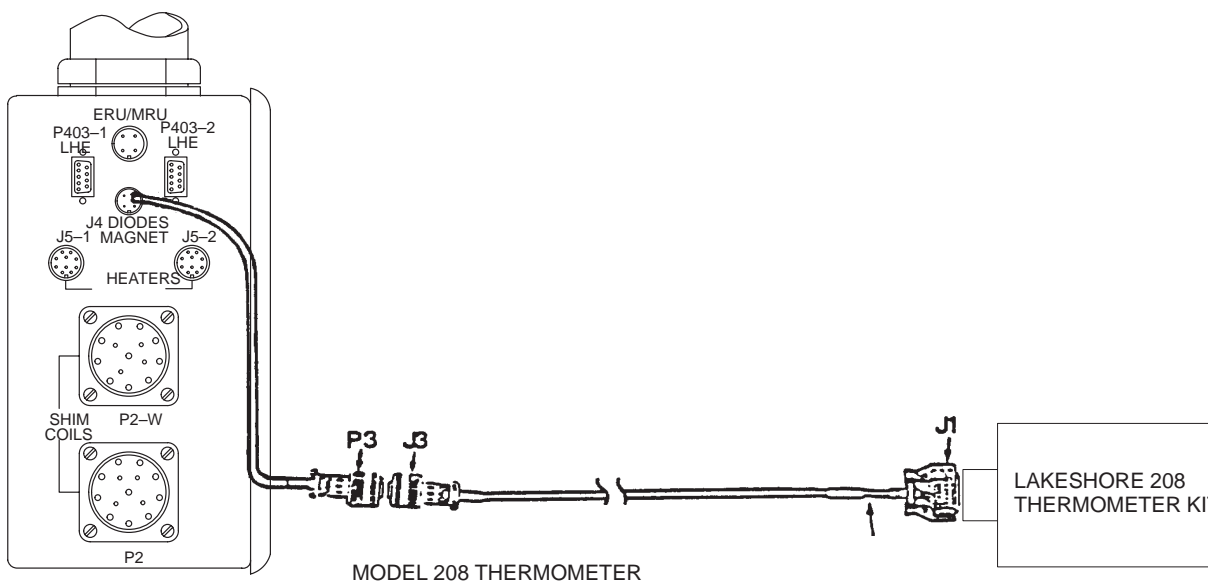
##### 2-2-1 Use of Lakeshore Cryotronics Model 208 – Digital Cryogenic Thermometer Kit (46-301477G1)

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.
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.

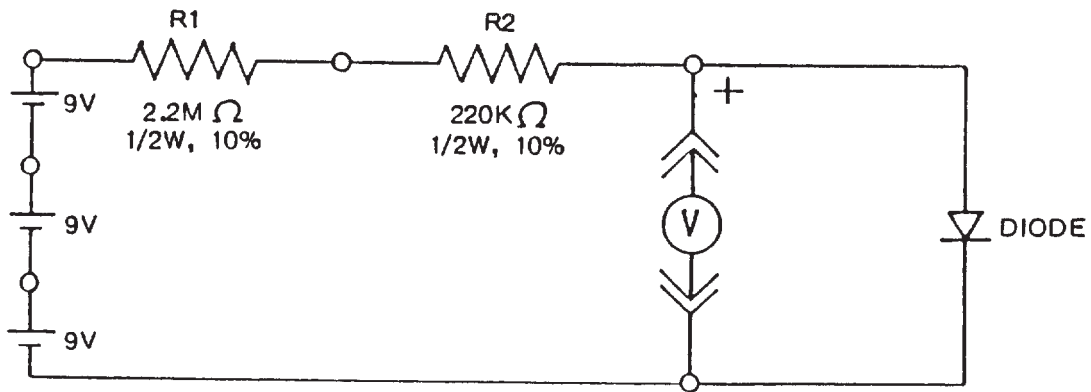
2-2-2 Diode Temperature Sensing Circuit

Description:

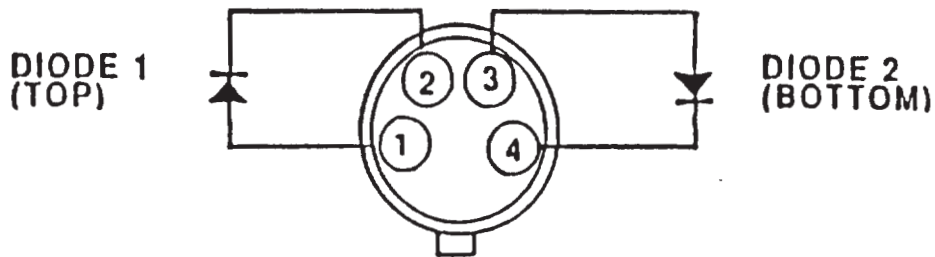
If the Lakeshore Cryotronics 208 Thermometer Kit is not available, the following temperature sensing circuit can be fabricated from commonly available components for temperature measurements.

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  $10 \pm 1 \mu A$  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

## SECTION 3 – NITROGEN PURGE/PRECOOL

### Description:

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

Since all magnets are shipped from the factory with the cryostat full of liquid helium, precooling is not normally required. If precooling is deemed necessary, make sure that the temperature check in SET UP AND CALIBRATION, Section 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.



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



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

**Procedure:****3-1 GASEOUS NITROGEN PURGE**

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

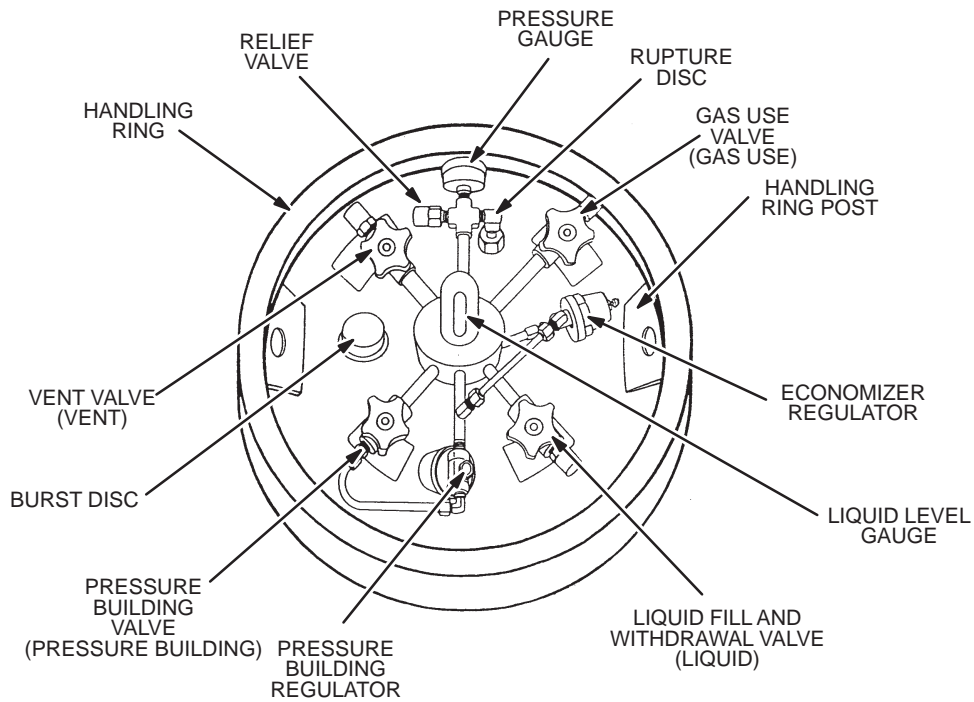
**MAKE SURE SUFFICIENT VENTILATION EXISTS IN THE EXAM ROOM TO DISPEL THE LARGE AMOUNTS OF NITROGEN GAS WHICH WILL DISPLACE THE AIR (OXYGEN) AND COULD CAUSE ASPHYXIATION. VENT NITROGEN FROM ROOM DURING PURGING PROCEDURE.**

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

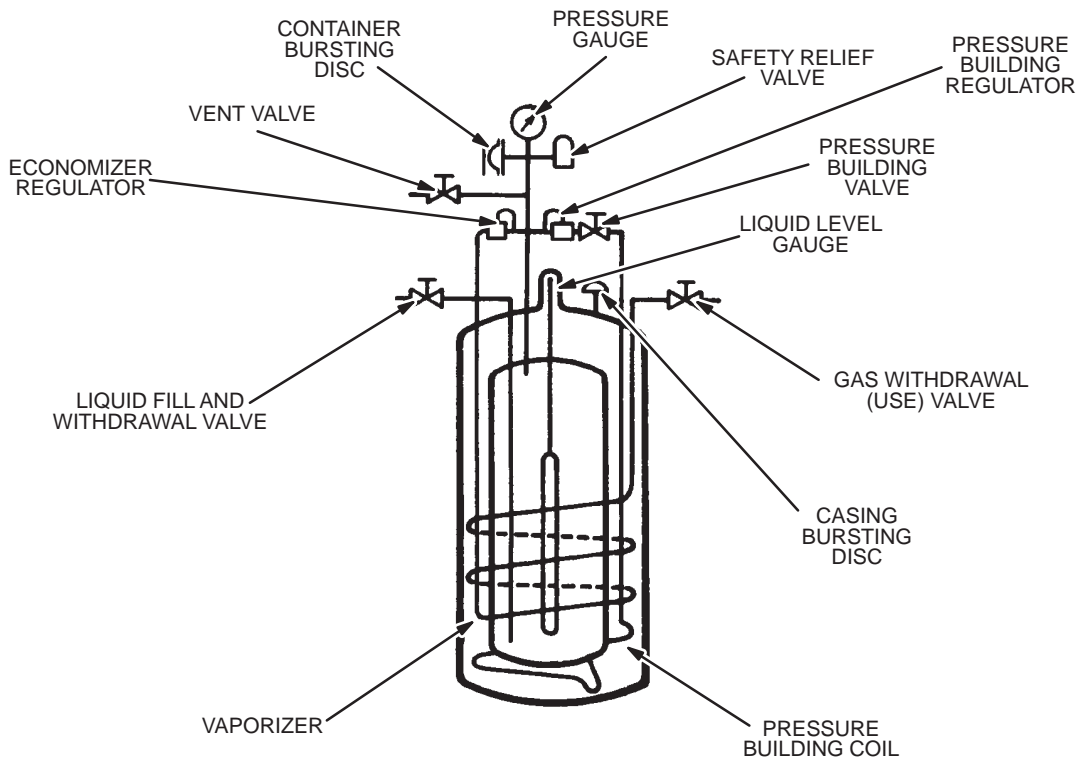
**Note**

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

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



TOP VIEW OF NITROGEN DEWAR



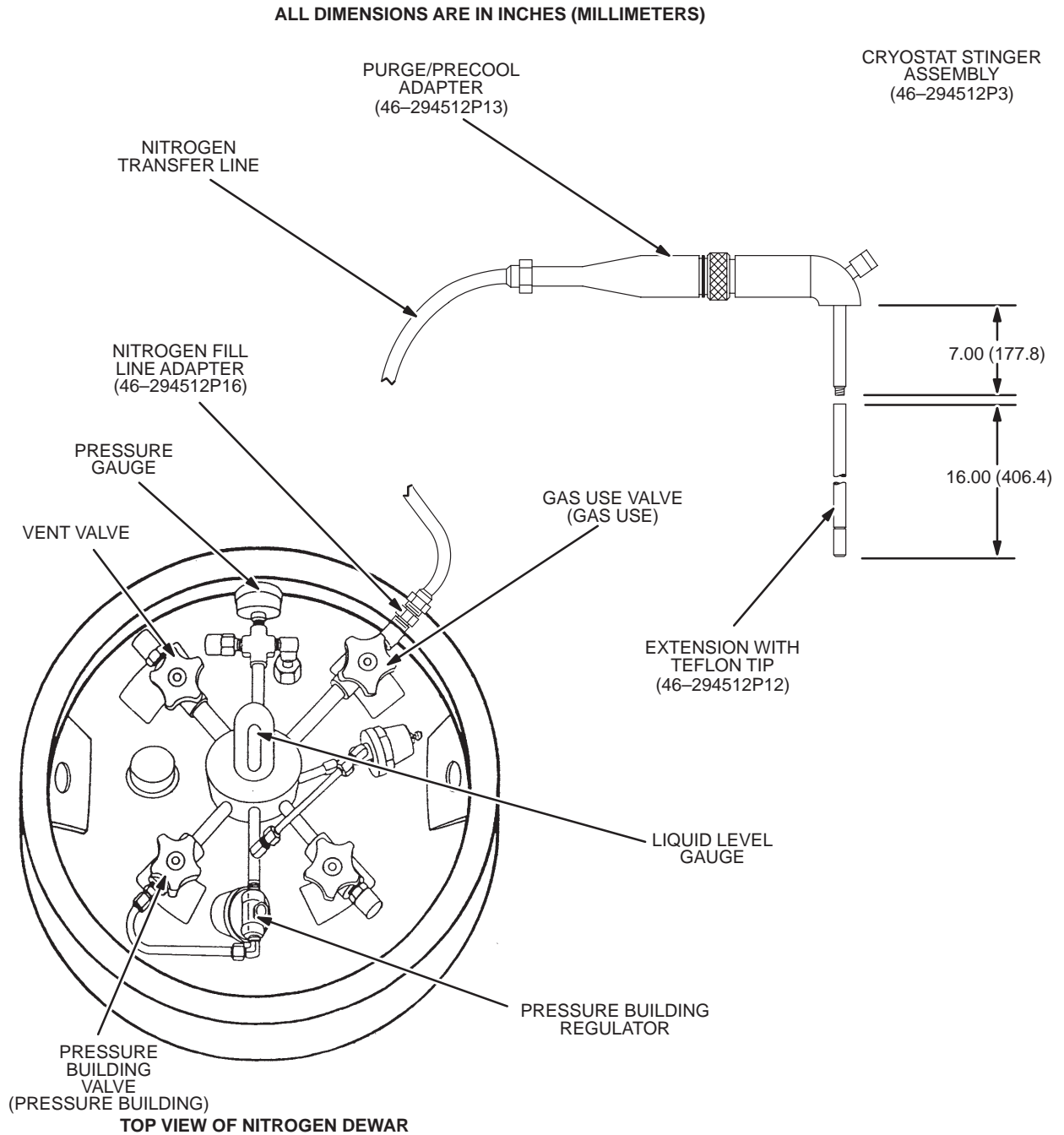
TEXT IN PARENTHESIS REFERS TO THE IDENTIFICATION LABELS ON THE DEWAR.

NITROGEN GAS/LIQUID DEWAR

ILLUSTRATION 3-1

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)

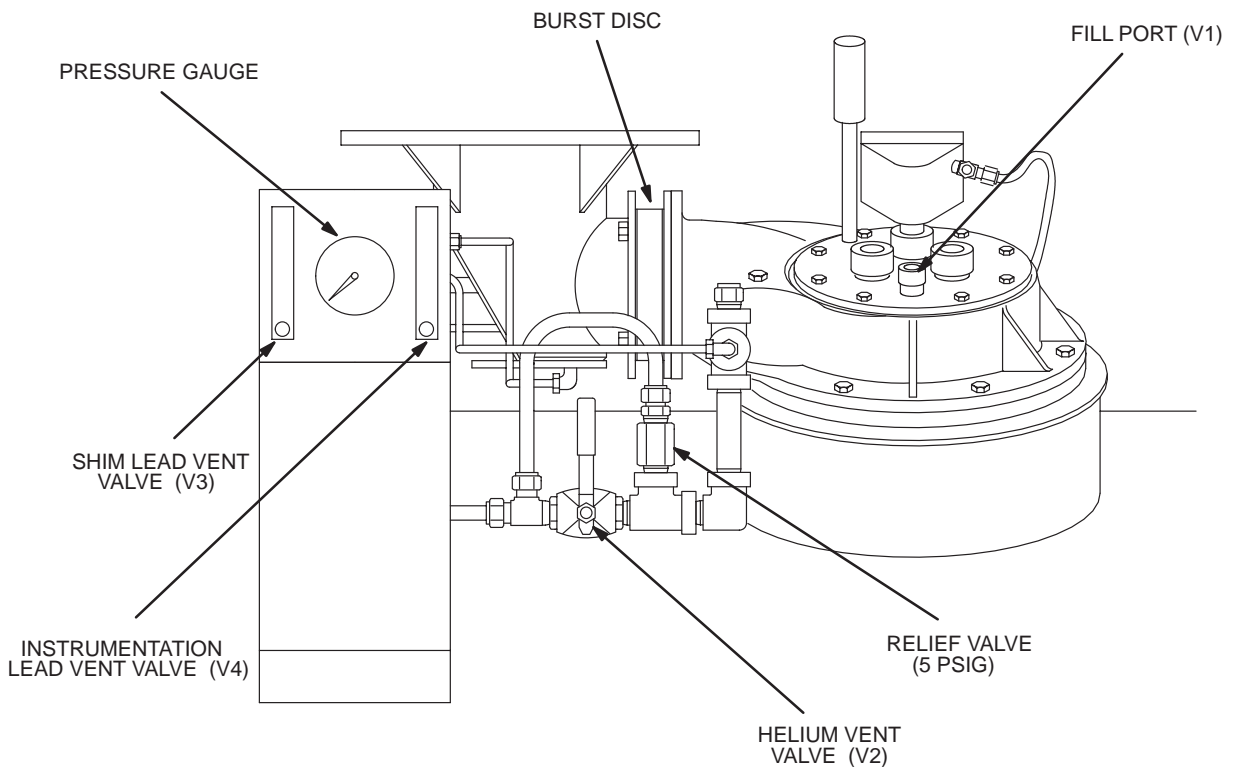


**Make sure that Cryostat Stinger Extension (16 inch) and Teflon Tip are firmly secured during installation to prevent it from loosening and falling into magnet.**

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.



**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.**

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

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).

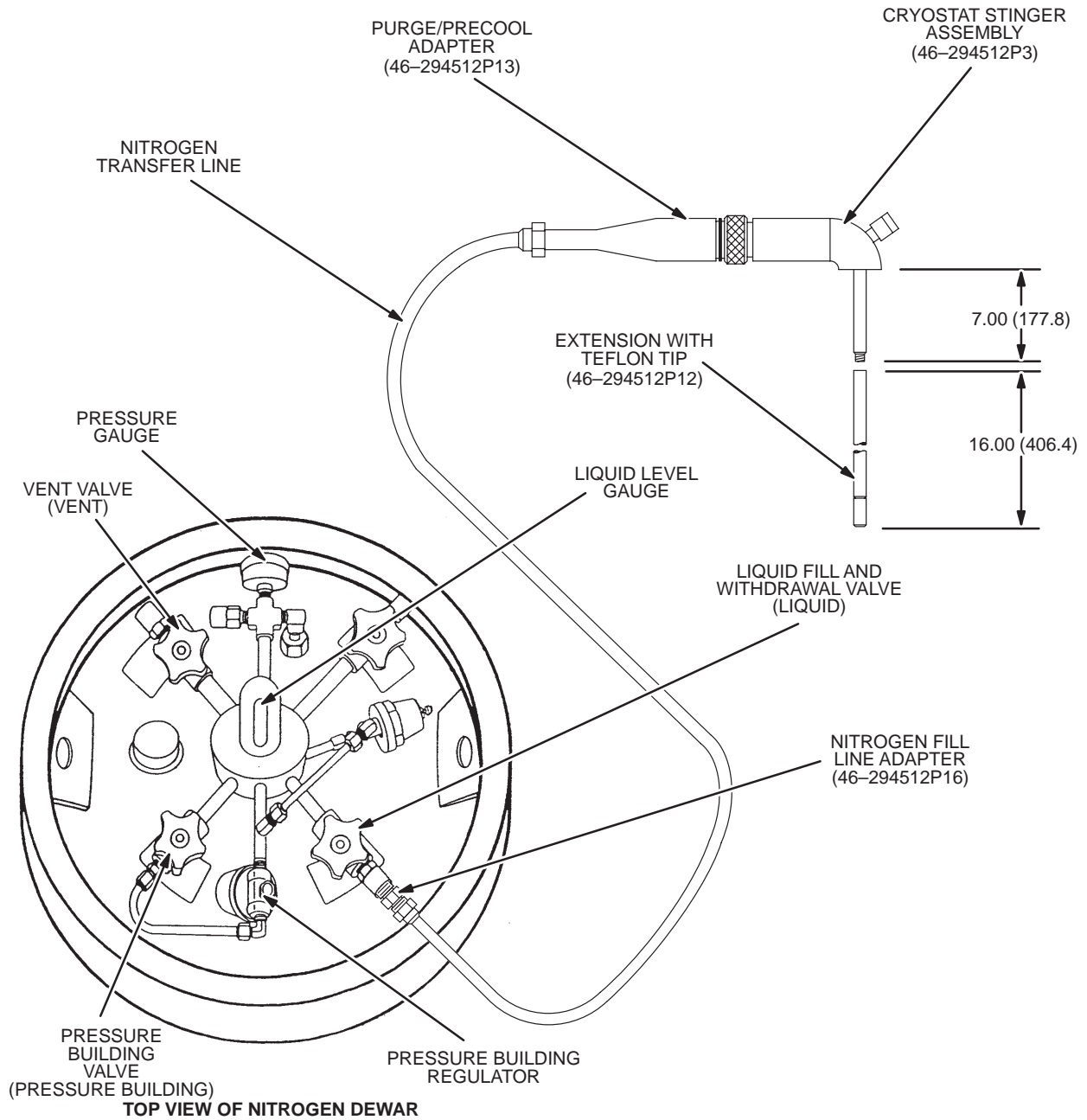
**Note**

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)

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



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.



**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.



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

**Observe  $\Delta T$  between magnet diodes. If  $\Delta T$  exceeds values shown in Table 2-1, temporarily suspend liquid nitrogen flow to allow diode temperatures to reach equilibrium.**

TABLE 3-1  
APPROXIMATE COOLDOWN RATES

FROM	TO	K/hr	*Diode $\Delta T$
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) for each consecutive dewar.



**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**

**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.

**3-3 HELIUM PURGE (continued)****WARNING!**

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

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

**WARNING!**

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

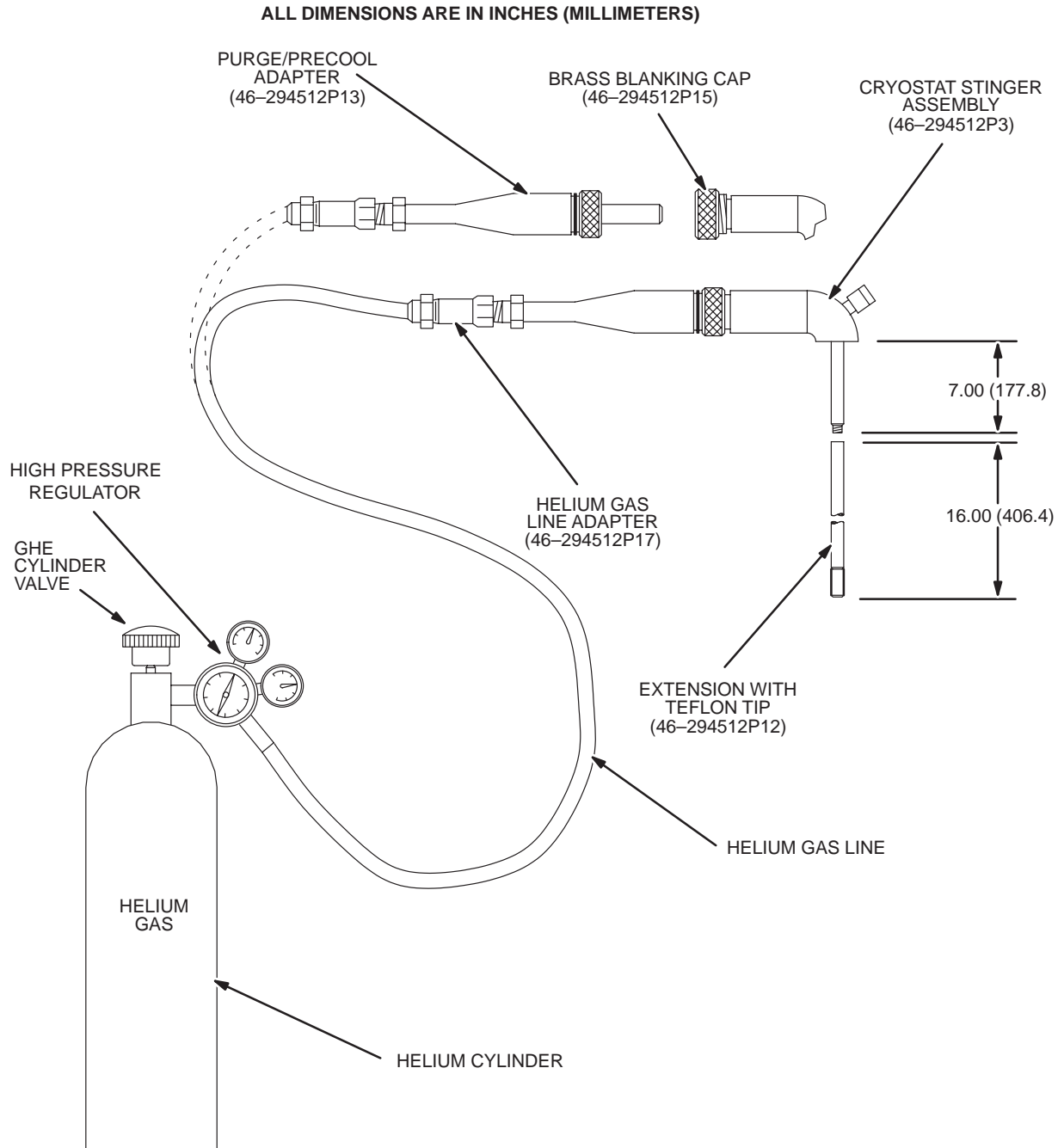
6. Purge regulator and gas line assembly by alternately turning regulator handle fully in and out 3 times. Upon completion of purge, back regulator out until minimal flow is felt exiting the Purge/Precool Adapter.
7. Remove Brass Blanking Cap from Cryostat Stinger Assembly and immediately connect Purge/Precool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

**Note**

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

11. Repeat Steps 2 thru 9 for second GHe cylinder.
12. Continue with Section 4, LIQUID HELIUM FILL.

3-3 HELIUM PURGE (continued)



HELIUM PURGE SET-UP  
ILLUSTRATION 3-5

**SECTION 4 – LIQUID HELIUM FILL**

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

MAGNET TYPE	3 Dewars	2 Dewars	1 Dewar	Emergency	Minimum Ramp Level	Minimum Shim Level
SX	55 – 60%	65 – 75%	76 – 90%	50%	80%	65%

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

**DESCRIPTION**

Helium fills should be performed 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 no liquid helium in the magnet such as after a quench.

**4-1 EQUIPMENT**

**TOP FILL EQUIPMENT**

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

**BOTTOM FILL EQUIPMENT**

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

**Note**

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

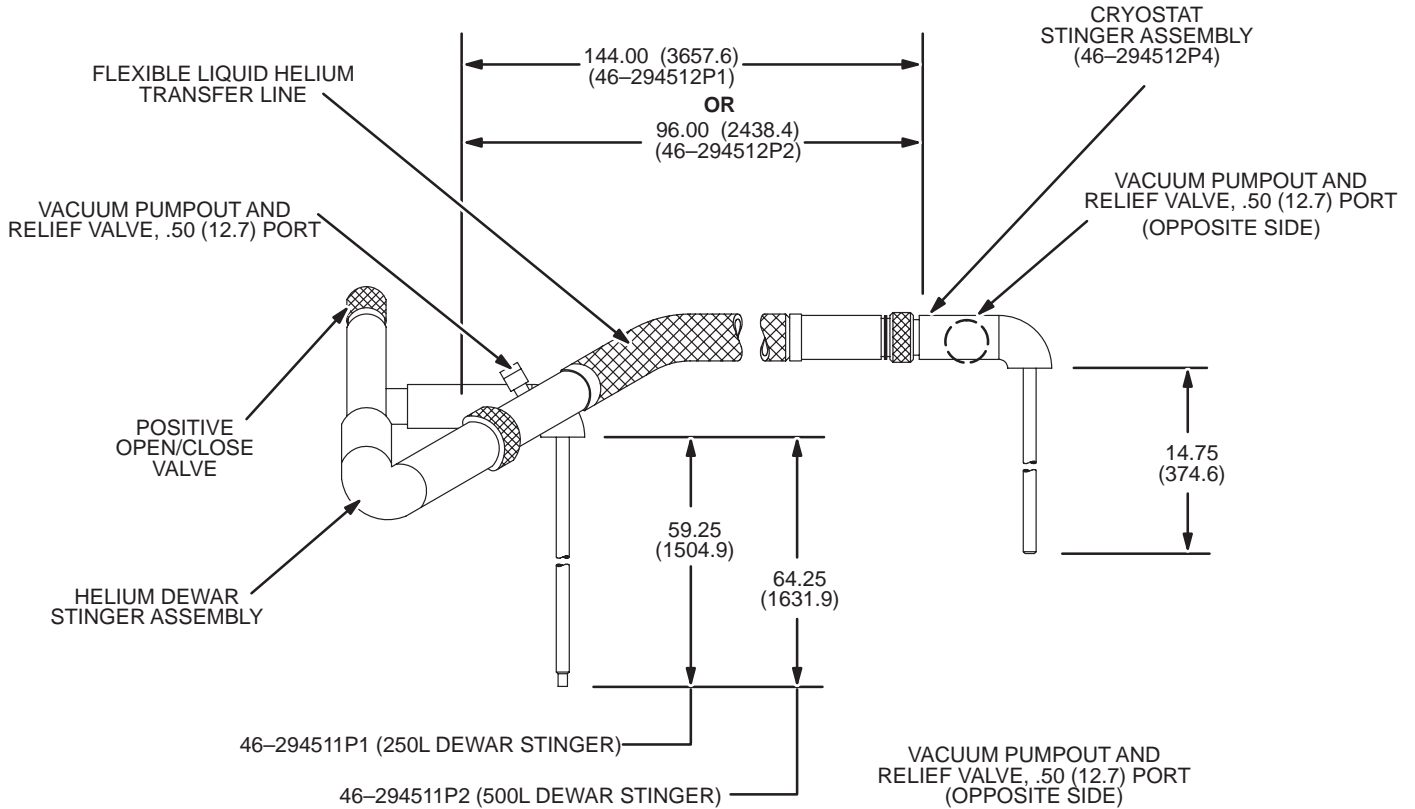
**OTHER EQUIPMENT NEEDED**

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, 46-260340P9

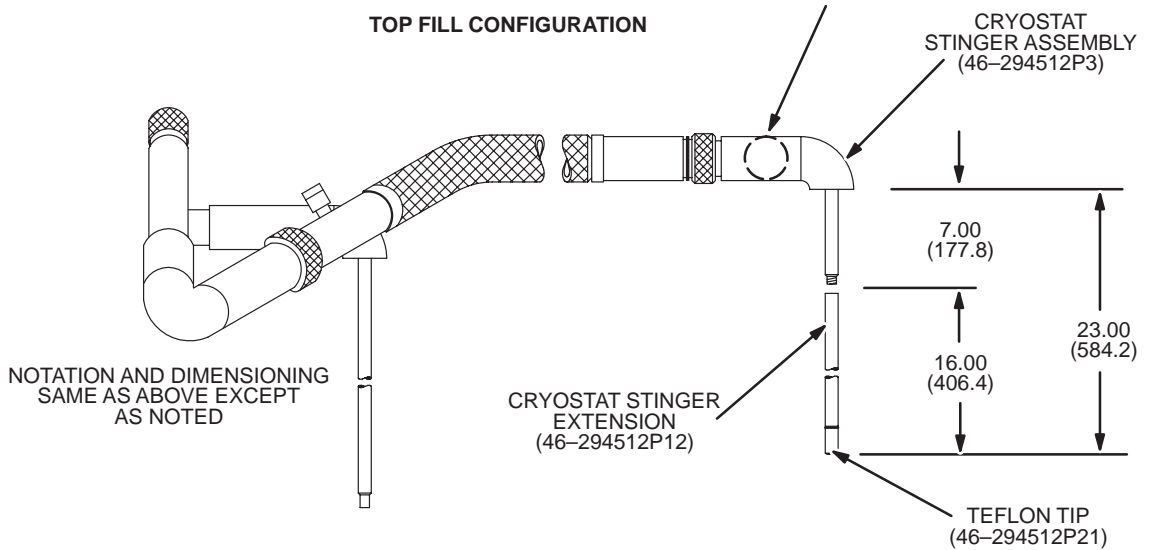
1. Select proper cryostat and Dewar stinger lengths to be used during the fill. Refer to Illustration 4-1 for appropriate stinger configuration.

4-1 EQUIPMENT (continued)

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



TOP FILL CONFIGURATION



BOTTOM FILL CONFIGURATION

VACUUM JACKETED HELIUM TRANSFER LINE AND DEWAR/CRYOSTAT STINGER ASSEMBLIES

ILLUSTRATION 4-1

4-1 EQUIPMENT (continued)



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 EXAM ROOM. FERROMAGNETIC OBJECTS WILL BECOME DANGEROUS PROJECTILES IN A STRONG MAGNETIC FIELD. MAKE SURE ALL EQUIPMENT AND TOOLS USED IN THE EXAM 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 EXAM AND CRYOGEN STORAGE ROOMS. LIQUID CRYOGENS CAN LIQUIFY ATMOSPHERIC OXYGEN THUS PRODUCING A HIGHLY ENRICHED OXYGEN LIQUID.



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



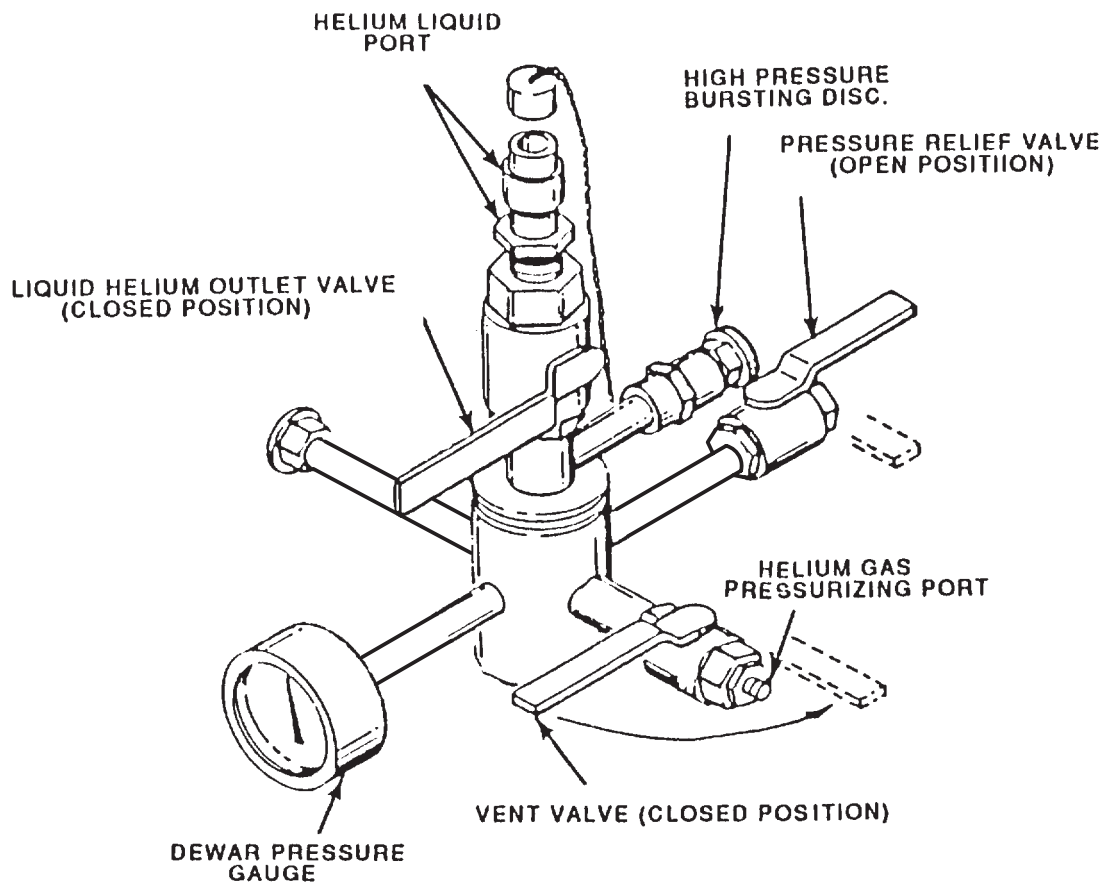
Make sure that Cryogen Level Meter has been calibrated in conformance with Signa Planned Maintenance Manual, *Direction 15343*. The calibration should be done yearly, and is recorded in the Planned Maintenance Report in the Site Log. A calibrated Cryogen Level Meter is required to accurately determine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

4-2 PREPARATION (continued)

**Note**

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

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

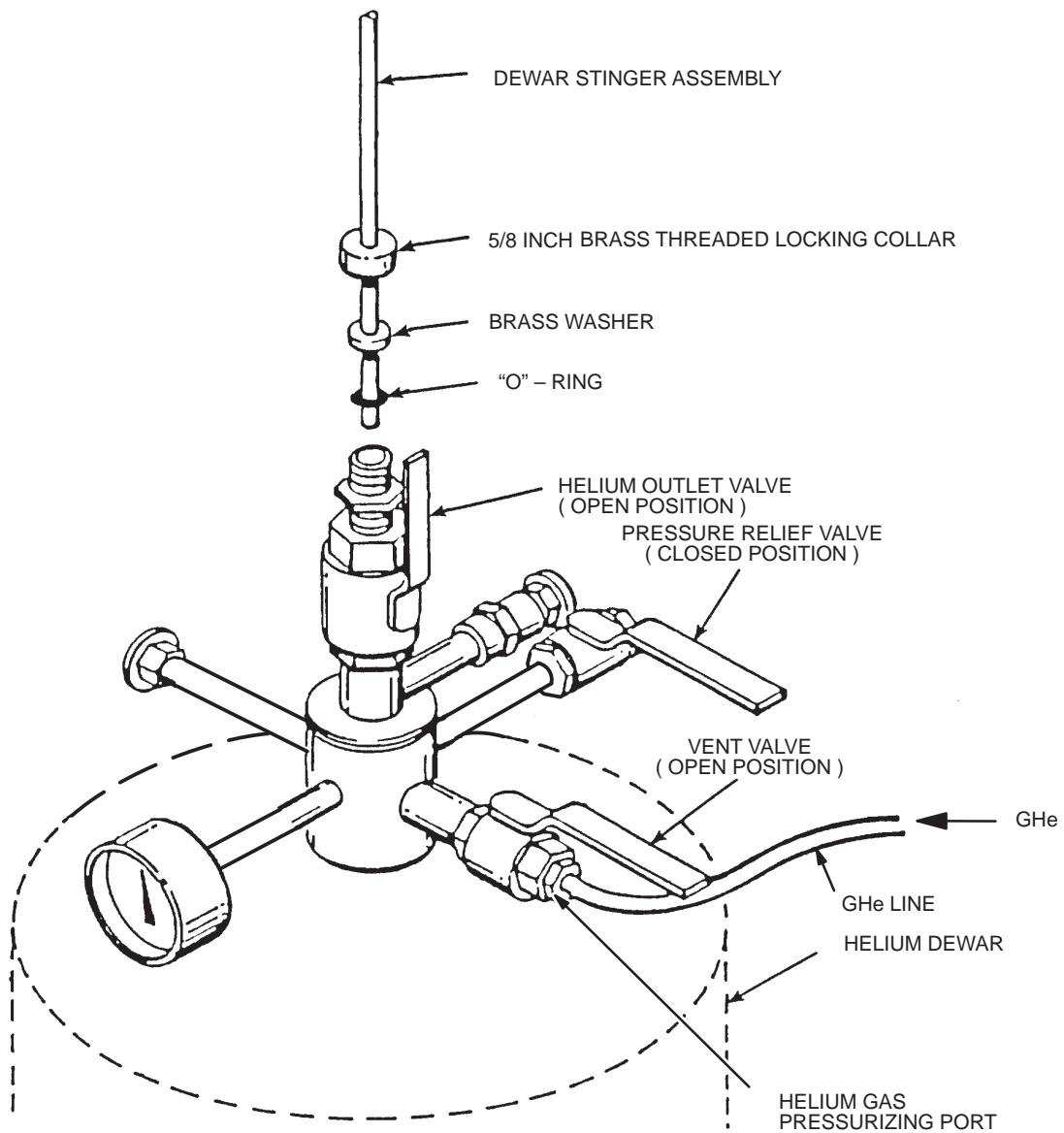
5. Connect standard GHe Cylinder Regulator And Hose Assembly to Valve Outlet (CGA 580) on GHe cylinder.
6. Make sure that Regulator Adjusting Handle is fully backed out, then slowly open GHe Cylinder Valve.
7. Observe Regulator High Pressure Gauge. Make sure indicated pressure is approximately 2000 psig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

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 (FIXED SITE) (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 (FIXED SITE) (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.



**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 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.



**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 (FIXED SITE) (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.



**To avoid damaging the helium line and causing a magnet quench, make sure cryostat stinger pump out 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.
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.



**Cryostat pressure is approximately 1 psig during fill. 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 (FIXED SITE) (continued)**

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

**Note**

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



**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.

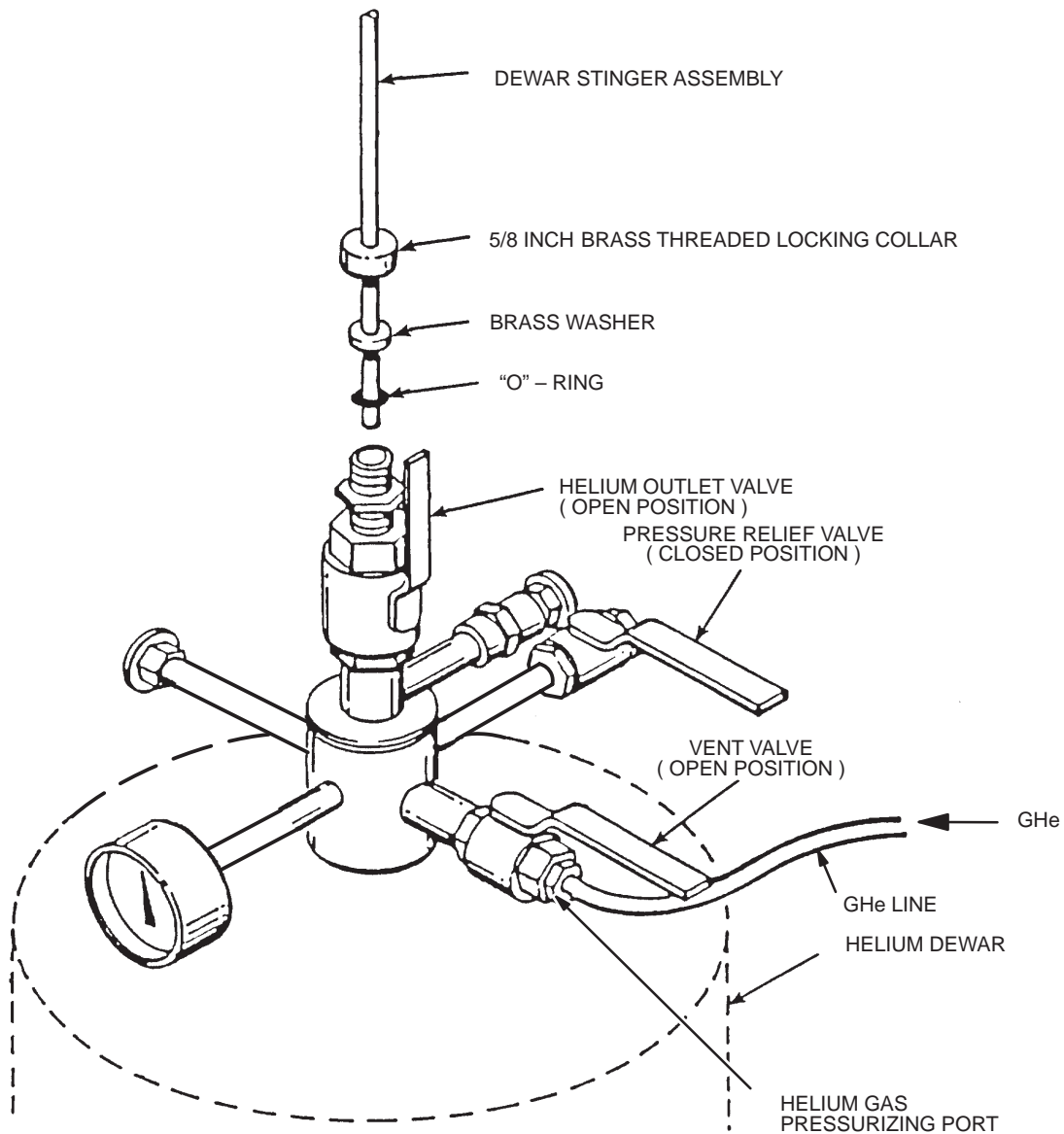
31. Tighten Compression Fitting at V1 to prevent a leak from occurring.
32. Disconnect Helium Transfer Line Assembly from Helium Dewar Stinger Assembly.

**4-3 LIQUID HELIUM FILL (FIXED SITE) (continued)**

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 LIQUID HELIUM FILL (MOBILE VAN)**

1. Verify Dewar LIQUID HELIUM OUTLET Valve is in the closed position. See Illustration 4-4.
2. Loosen 5/8 inch Brass Threaded Locking Collar.
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 4-4.
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 4-4.
6. Open Helium Outlet Valve.



**HELIUM DEWAR TRANSFER LINE EXTENSION CONNECTION**

ILLUSTRATION 4-4

**4-4 LIQUID HELIUM FILL (MOBILE VAN) (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).

**Note**

Excess dewar pressure will be used to precool helium fill line assembly.

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" Brass Threaded Locking Collar to helium dewar.
10. When dewar pressure stabilizes at 5 psig, close PRESSURE RELIEF VALVE.
11. Attach Helium Transfer line to dewar stinger.

**Note**

Magnets in a mobile van have a permanently connected LHe Transfer Line which allows for liquid helium fill from the outside the van, through an "under floor" compartment.

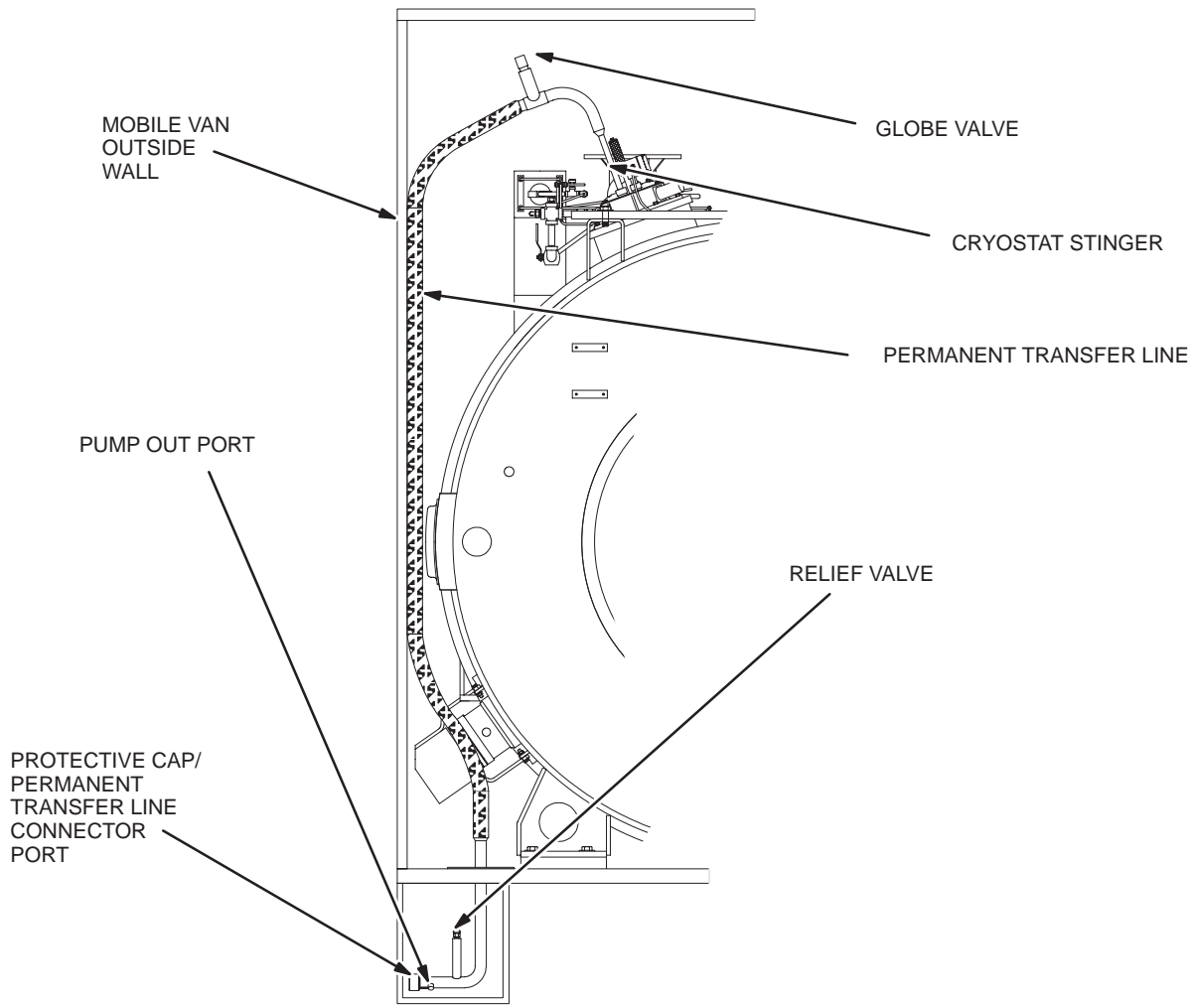
Permanently connected LHe Transfer Line mounting configuration may vary depending on the van manufacturer.

12. Remove the Protective Cap from the Permanent Transfer Line Connector Port. See Illustration 4-5.
13. Attach other end of helium transfer line to Permanent Transfer Line Connector Port.
14. Make sure the Globe Valve, on the Permanent Transfer Line, is in the closed position. See Illustration 4-5 for location of Globe Valve.

**WARNING!**

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

4-4 LIQUID HELIUM FILL (MOBILE VAN) (continued)



MOBILE PERMANENT FILL LINE  
ILLUSTRATION 4-5

**Note**

Steps 15 and 16 will provide a helium rich environment for connecting the GHe line to the Helium Gas Pressurizing Port.

15. 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.
16. Open Helium Dewar VENT VALVE to allow a small amount of gas flow.
17. Attach purged Gas Line Assembly to Liquid Helium Dewar Helium Gas Pressurizing Port. See Illustration 4-4.
18. Back out the Regulator Handle all the way,
19. Open the Helium Vent Valve (V2) on the magnet. Vent Magnet until cryostat pressure is between 0.25-0.5 psig.

**4-4 LIQUID HELIUM FILL (MOBILE VAN) (continued)**

20. Open Dewar Stinger Positive Open/Close Valve.
21. Install Brass Threaded Locking Collar, Retainer Ring, and O-Ring on Cryostat Stinger.
22. Partially open Globe Valve, on Permanent Transfer Line, allowing liquid helium to purge and precool Transfer Line Assembly. Continue purging the Transfer Line Assembly until a liquid plume is observed exiting the cryostat stinger and the helium dewar pressure is less than 3 psig. *See Illustration* for location of Globe Valve.
23. With plume present, uncap Fill Port (V1) and fully insert Cryostat Stinger into fill port, then screw Brass Threaded Locking Collar unto Fill Port.
24. Open VENT VALVE at Helium Gas Pressurizing Port on the helium dewar.
25. 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 3.5 psig.
26. Fully open Globe Valve on Permanent Transfer Line.



**Cryostat pressure is approximately 1 psig during fill. 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 and remove stinger from cryostat (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.

27. 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.



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

**Note**

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

**4-4 LIQUID HELIUM FILL (MOBILE VAN) (continued)****WARNING!**

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

28. 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.
29. Record information for each dewar in Table 2-1 of the DATA SHEETS Tab or on Magnet Fill Record.
30. When cryostat is full (100%), or when changing helium dewars, perform the following steps:
  - a. Close GHe Cylinder Valve.
  - b. Close Dewar Vent Valve.
  - c. Close valve on dewar stinger.
  - d. Close Globe Valve on Permanent Transfer Line (full CCW).
  - e. Open Dewar Pressure Relief Valve.

**Note**

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

31. Remove the Cryostat Stinger from the Fill Port (V1) then immediately replace the Fill Port Cap.
32. If additional dewars are required, change helium dewars in conformance with Section 4-4, "Changing Helium Dewars", before continuing with this procedure.
33. Monitor cryostat pressure. When cryostat pressure drops below 1.5 psig, close Helium Vent Valve V2 on magnet.
34. Tighten Fill Port Cap at V1 to prevent a leak from occurring.
35. Disconnect Helium Transfer Line from the Permanent Transfer Line Connector Port and reinstall the protective cap.

**4-4 LIQUID HELIUM FILL (MOBILE VAN) (continued)**

36. Disconnect Helium Transfer Line Assembly from Helium Dewar Stinger Assembly.
37. When Helium Dewar pressure falls below 1 psi, remove Helium Dewar Stinger Assembly from helium dewar.
38. Disconnect Helium Gas Line from dewar Helium Gas Pressurizing Port.
39. Back off Pressure Regulator Adjusting Handle (CCW) on helium gas cylinder until no resistance is felt.
40. 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
41. Remove GHe Cylinder Regulator from helium gas cylinder and install protective valve cap on cylinder.
42. Check and record cryogen level meter and cryostat pressure readings. Make sure cryostat pressure is at 1.5 psig or less before leaving site.

**4-5 CHANGING HELIUM DEWARs**

**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.
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.



**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.



**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.

**4-5 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.



**Make sure to wipe off all moisture on Dewar or Cryostat Stingers, before reinserting into dewar or cryostat, to avoid ice buildup in the Transfer line Assembly or in the magnet.**

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.

**4-5 CHANGING HELIUM DEWARS (continued)**

**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. For Fixed Sites, Proceed with LIQUID HELIUM FILL (FIXED SITE), Section 4-3, Step 18.
28. For Mobile Sites, Proceed with LIQUID HELIUM FILL (MOBILE SITE), Section 4-4, Step 19.

**4-6 CHANGING HELIUM GAS BOTTLES**

**HELIUM GAS BOTTLE CAPS ARE FERROUS AND MUST BE REMOVED BEFORE BRINGING BOTTLE INTO MAGNET ROOM AS THEY CAN BECOME DANGEROUS PROJECTILES IN A MAGNETIC FIELD.**

**Note**

Change the helium gas bottle when bottle pressure drops below 5 psig. Approximately one 235 SCF helium gas bottle is needed to pressurize a 500 liter liquid helium dewar.

1. Close vent valve on dewar and remove gas hose.
2. Close main valve and regulator on helium gas bottle.
3. Bring a full helium gas bottle into the exam room and reconnect the regulator and hoses.
4. Purge hose before reconnecting to dewar.

## SECTION 5 – FIELD MONITORING EQUIPMENT SET-UP & OPERATION

### 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.

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.

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 *DIRECTION 15406*, for installation of the Hinged Front Enclosure.

### 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. Remove the two Allen Screws where the Slide Fixture attaches to Front Cover.
7. Raise Front Cover up to expose Interface Ring (The Front Cover is hinged).
8. 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.
9. Remove Rear Pedestal side trim covers.
10. Unlatch the Rear Cover and move cover to the side.

### Note

At installation the Front Cover should be installed, placed into the raised position, and the Front Bridge Support should be disconnected until the Shimming Procedure is complete, in order to remove the Passive Shim Drawers.

5-2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46-294060G2)

**Note**

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

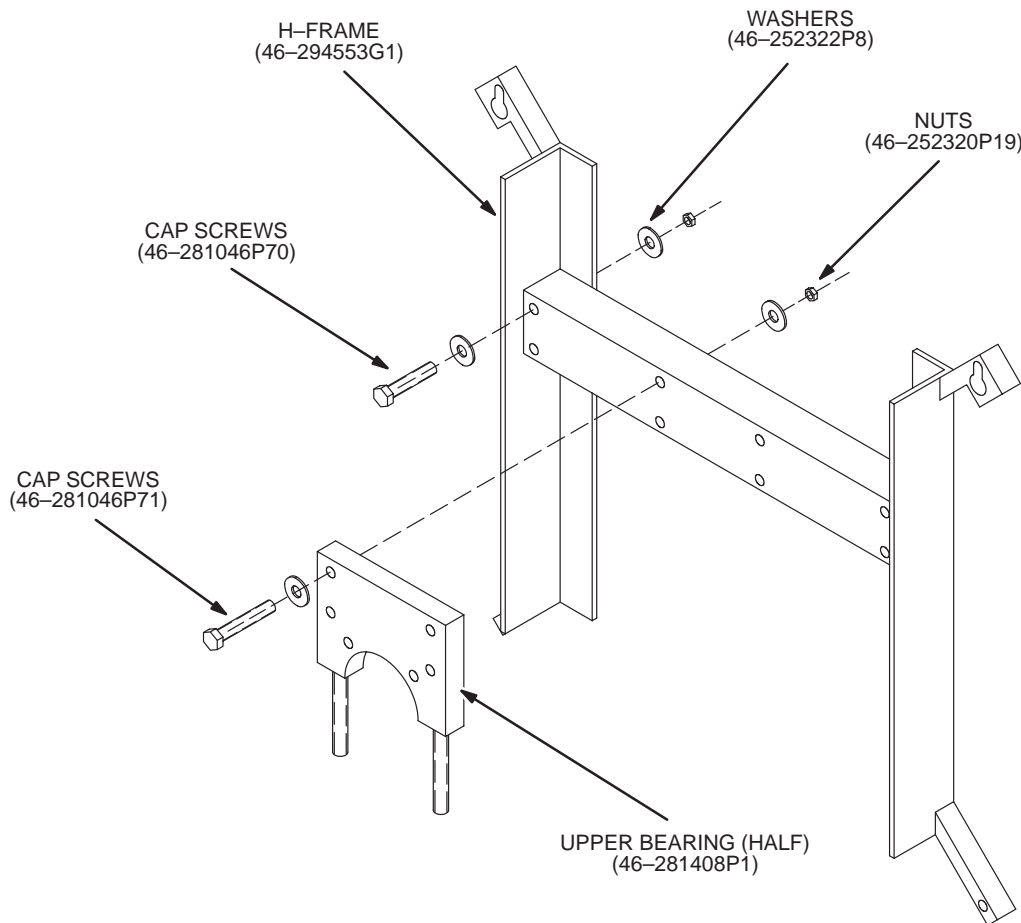
**Note**

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



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

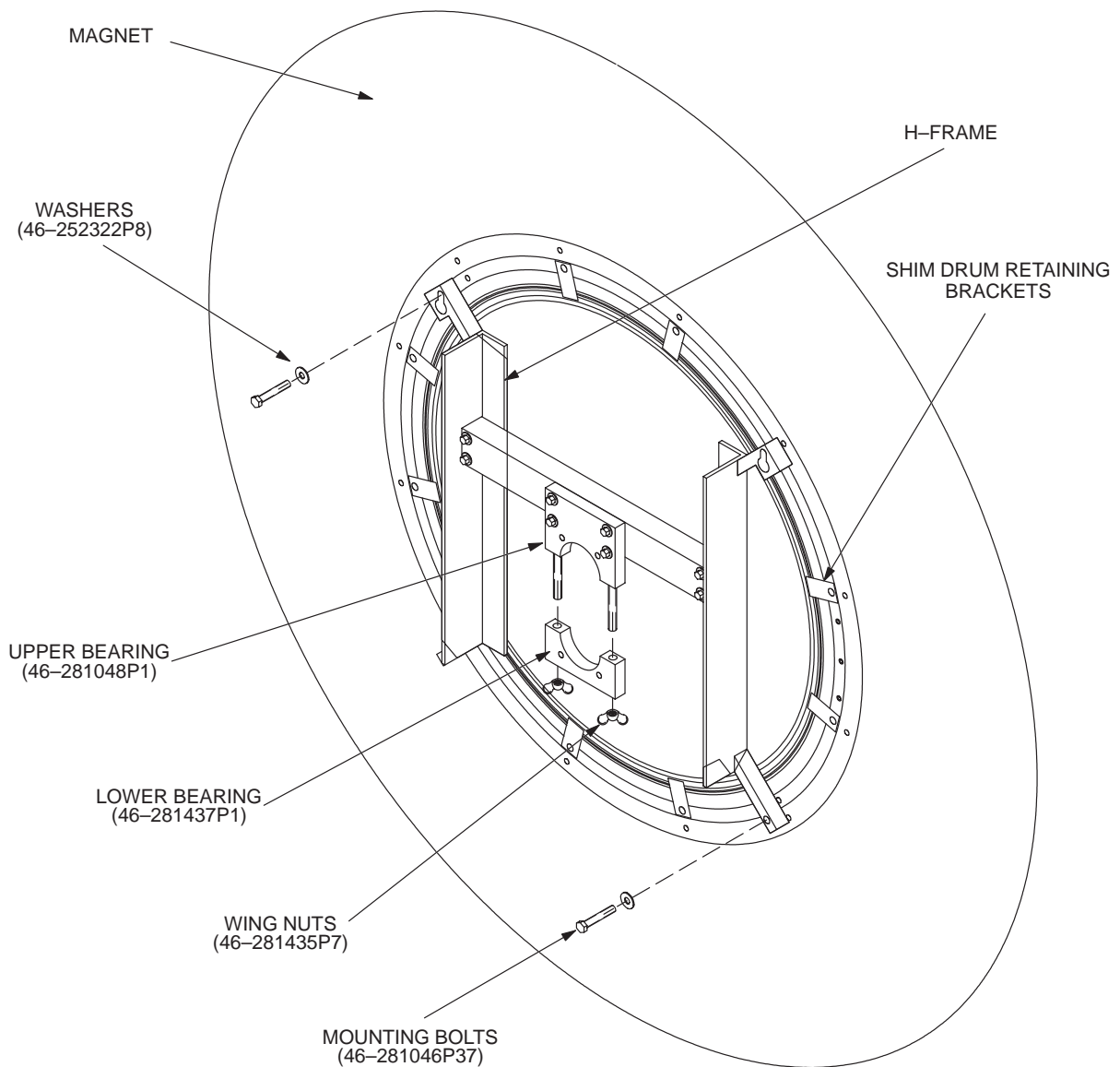
- 1. Assemble H-Frames using 2.75 inch long 3/8- 16 brass bolts, washers, and nuts. See Illustration 5-1.



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

**5-2 SERVICE TOOL MAPPING FIXTURE SETUP (MODEL #46-294060G2) (continued)**

2. Attach the upper bearings to the H-Frame cross beams using 3.5 inch long cap screws, washers, and nuts. See Illustration 5-1.
3. Remove the four Shim Drum Retaining Brackets which coincide with the H-Frame mounting hole locations.
4. Attach one of the H-Frames to the Interface Ring on Back End of the magnet with four 1.5 inch long 3/8-16 brass bolts, at the 45 degree positions. See Illustration 5-2. Use of Permatex ( 1 oz. tube – 2119594 ) or Bustik ( 4 oz. can – 46-294151P8 ) anti-sieze lubricant is recommended.

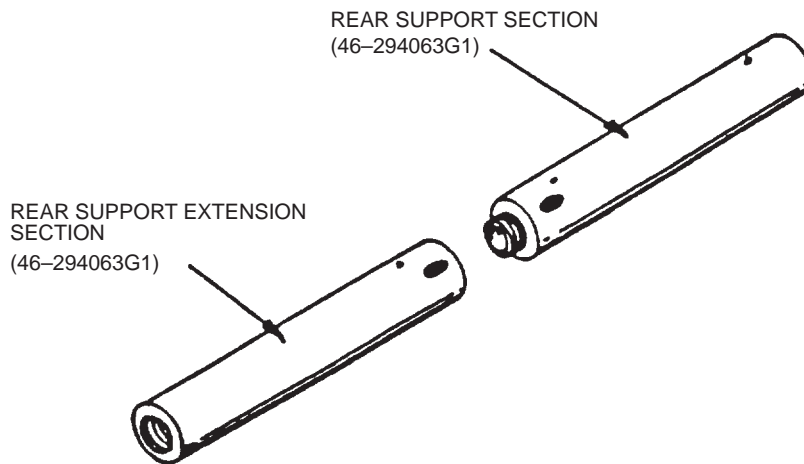


**H-FRAME MOUNTING & LOWER HALF BEARING ATTACHMENT**

ILLUSTRATION 5-2

**5-2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46-294060G2) (continued)**

5. Loosely attach the lower half of the bearing to the upper half of the bearing on both H – Frames. Use the Wing Nuts to support the lower half of the bearing. See Illustration 5-2.
  
6. Thread the Rear Support Extension Section into the Rear Support section. Twist them together as tightly as possible by hand then use a torquing bar (46-294019P1) through the holes near each joint as leverage to tighten the joint. See Illustration 5-3.



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



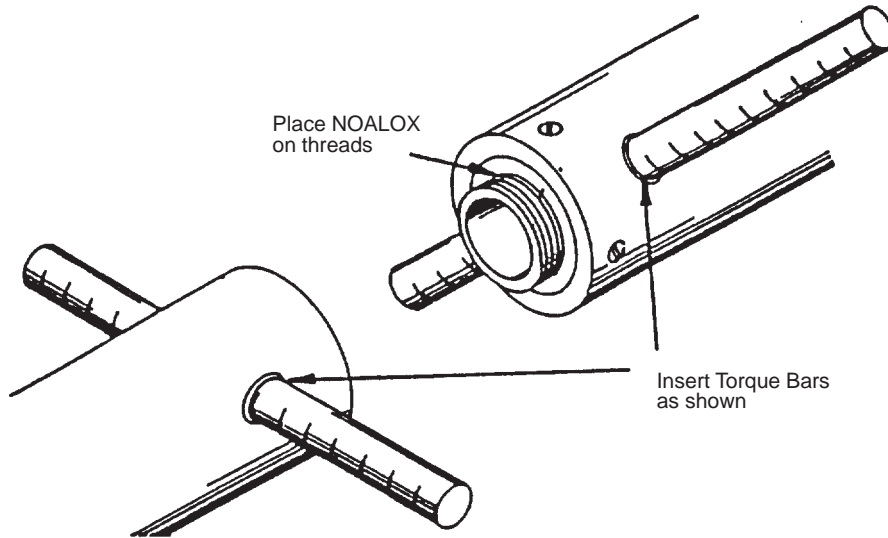
**Stainless Steel Torquing Bars may be slightly magnetic. Do not use near the magnet bore.**

**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.

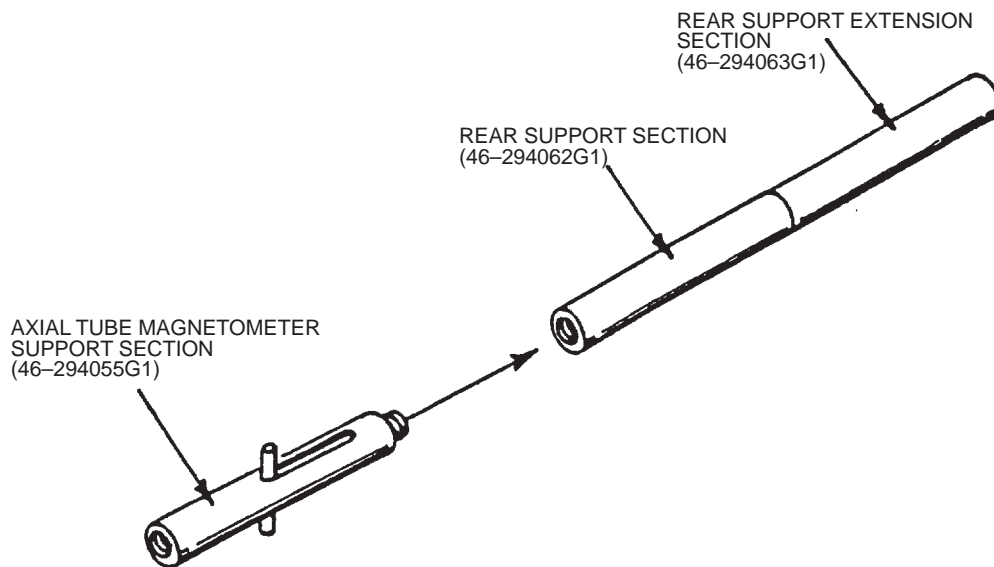
If it is difficult to align the tubes by hand, then use Torquing Bars as follows: All tubes have a pair of 3/4 inch diameter holes near each end. These holes should be used to insert Torquing Bars for leverage when torquing the tubes together. See Illustration 5-4.

5-2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46-294060G2) (continued)



LUBRICATION POINTS  
ILLUSTRATION 5-4

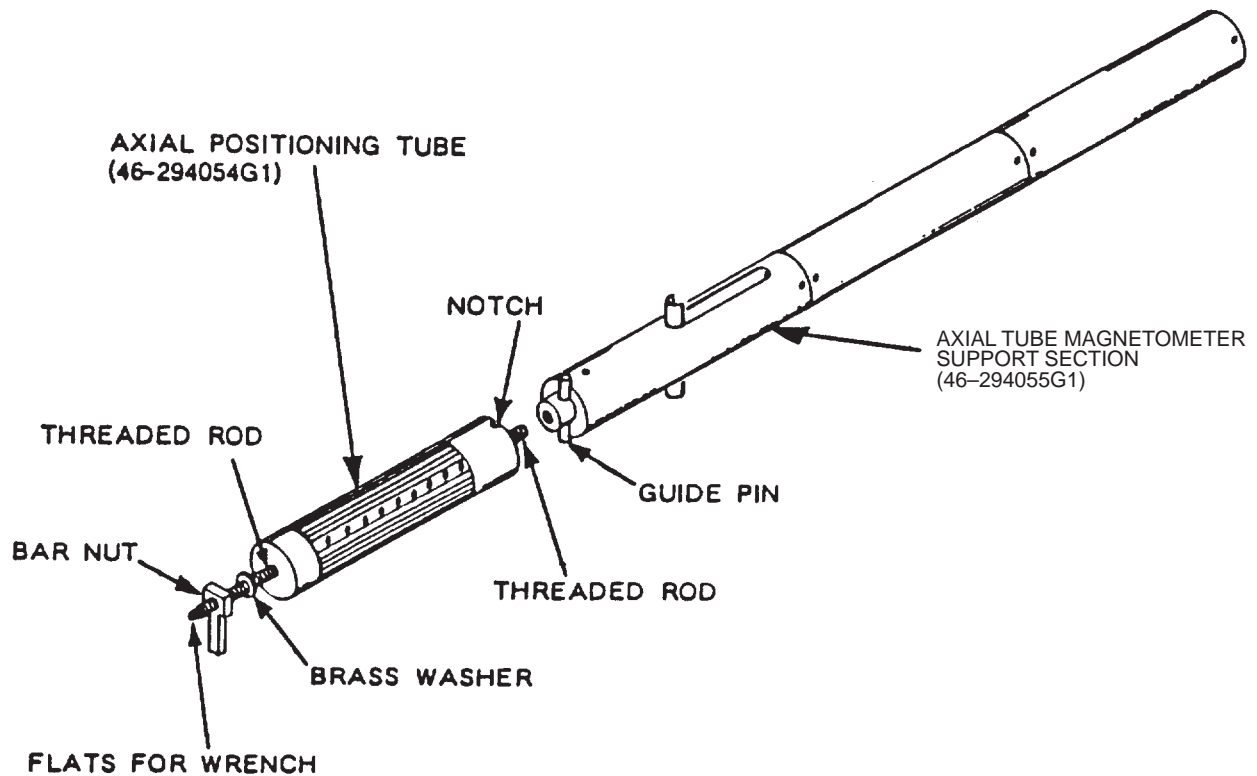
- 7. Thread the Axial Tube Magnetometer Support Section into the Rear Support Section. Tighten joint in same fashion as Step 6. See Illustration 5-5.



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 #46-294060G2) (continued)**

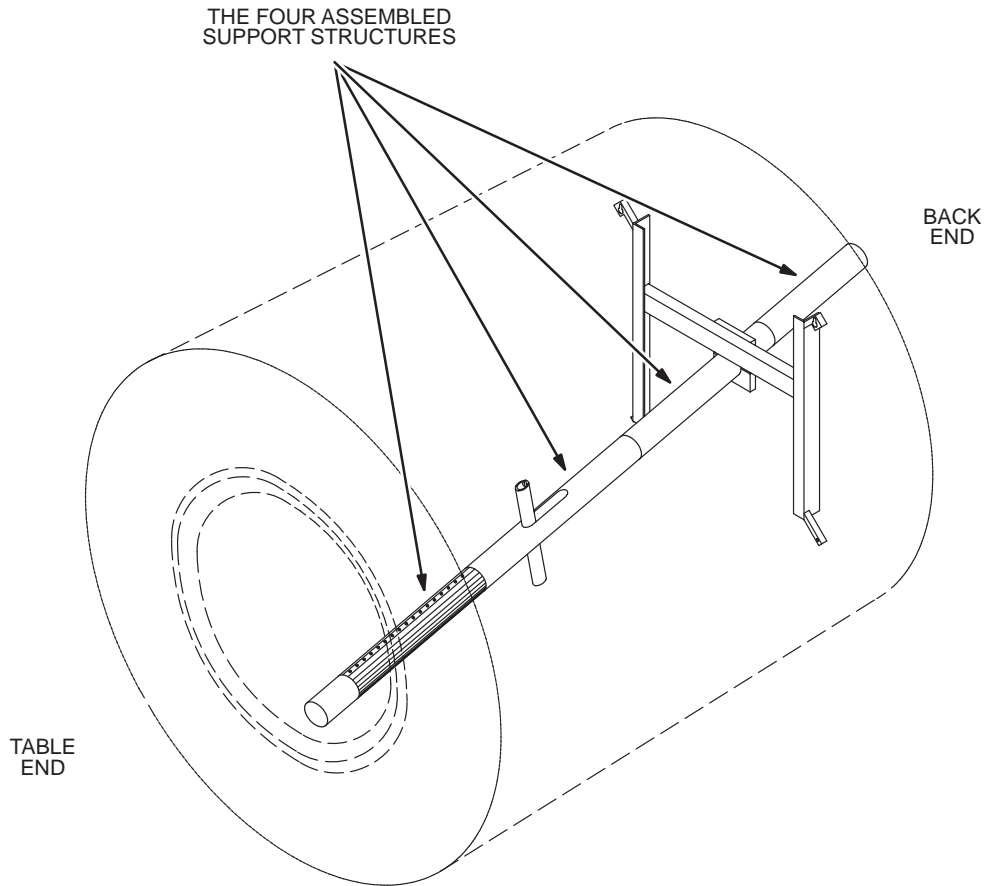
8. Join the Axial Positioning Tube (460294054G1), See Illustration 5-6, to the other assembled tubes as described below:
  - Line up the notch in the Axial Positioning Tube with the pin in the front of the Magnetometer Support Tube and slide the tubes together.
  - Using a 9/16 inch wrench on the “Flats” 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 #46-294060G2) (continued)**

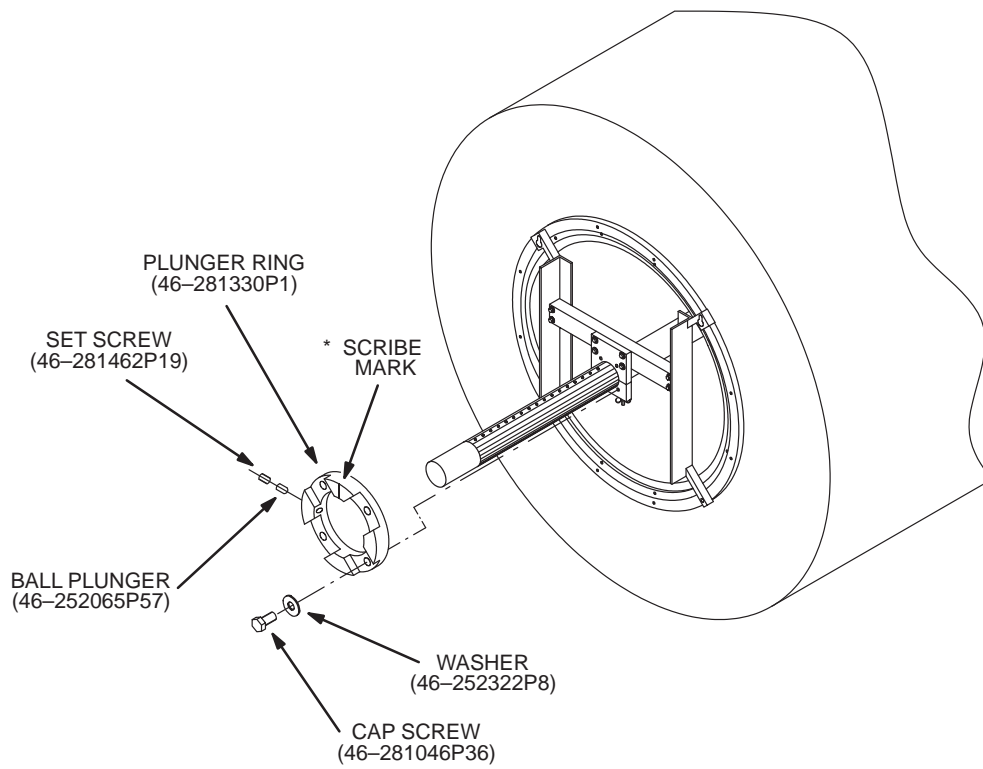
9. Place the four-piece tube assembly into the bore of the magnet, entering from the Table End of the magnet with the Rear Support Section. Insert the Rear Support Section into the open bearing at the Back End of the magnet and slide the tube assembly through until the tube assembly at the Table End is even with the front of the magnet. See Illustration 5-7.



**INSERTION OF THE FOUR ASSEMBLED SUPPORT TUBES**  
ILLUSTRATION 5-7

10. Attach the remaining H-Frame to the Table End of the magnet.
11. Lift and pull the tube assembly through the Table End bearing hole until the tube assembly is supported by the H-Frames. See Illustration 5-8.
12. Tighten the wing nuts, on both Lower Bearings, hand tight.
13. Slide the Plunger Ring onto the Axial Positioning Tube and secure it to the bearing with four 1.5 inch long 3/8 - 16 cap screws. Back out the Set Screw and Ball Plunger if it interferes with this process. See Illustration 5-8.

5-2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46-294060G2) (continued)

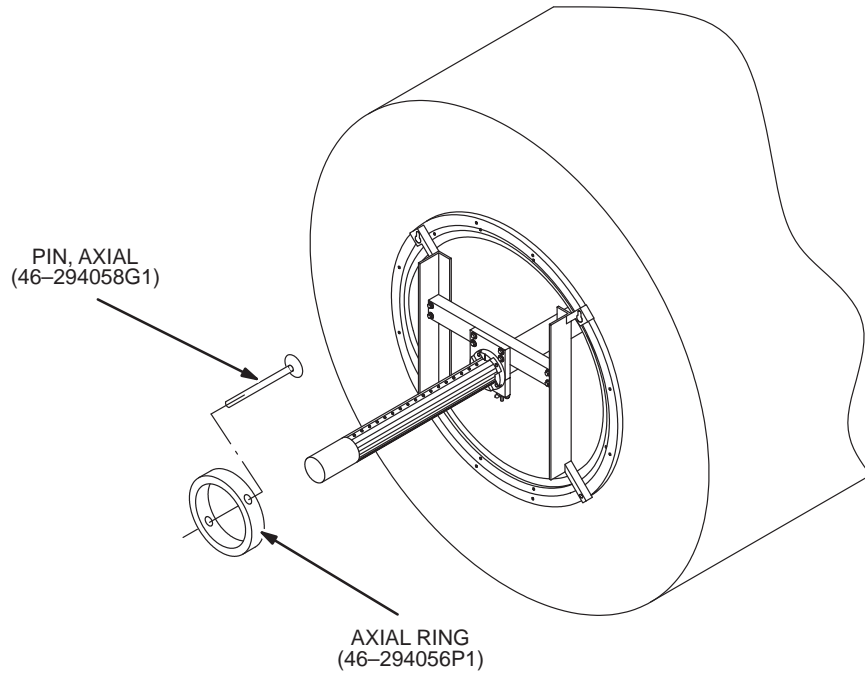


\* SCRIBE MARK TO BE AT TOP, 0 DEG. POSITION

**ATTACHMENT OF THE PLUNGER RING**  
ILLUSTRATION 5-8

- 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.

5-2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46-294060G2) (continued)



ATTACHMENT OF AXIAL POSITIONING RING  
ILLUSTRATION 5-9

**5-2 SERVICE TOOL MAPPING FIXTURE SET UP (MODEL #46-294060G2) (continued)**

15. Attach the Handles to the Axial Positioning Tube. See Illustration 5-10.



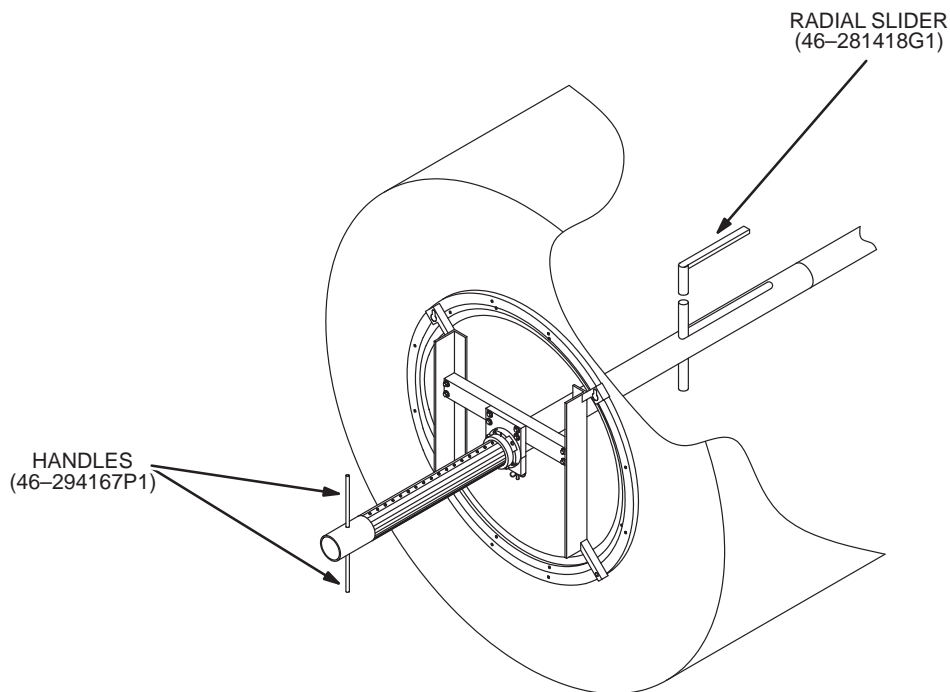
**Do not overtighten Ball Plunger as damage could result. Back Set Screw out as far as possible to still maintain “detent action”.**

16. Adjust the Ball Plunger. Move the fixture circumferentially to establish sufficient Plunger pressure to “click” in detente without binding. Adjust the Set Screw to maintain the Plunger at the proper pressure. See Illustration 5-8.

**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**

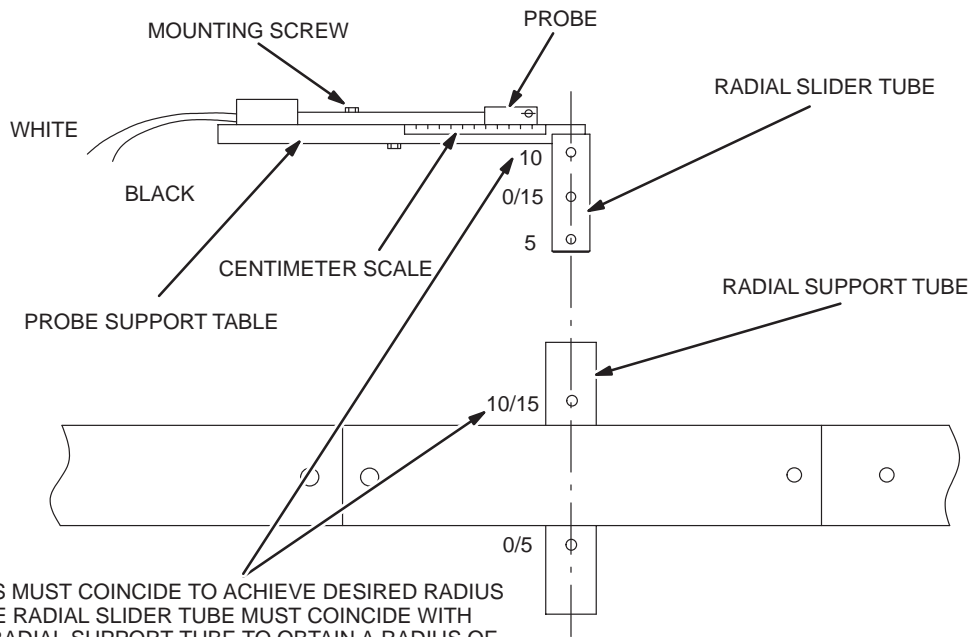
ILLUSTRATION 5-10

**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:

MODEL #46-294060G2

1. Radial Positioning: Adjust the Radial Slider Tube in the Radial Support Tube and pin through the desired position holes. See Illustration 5-11.

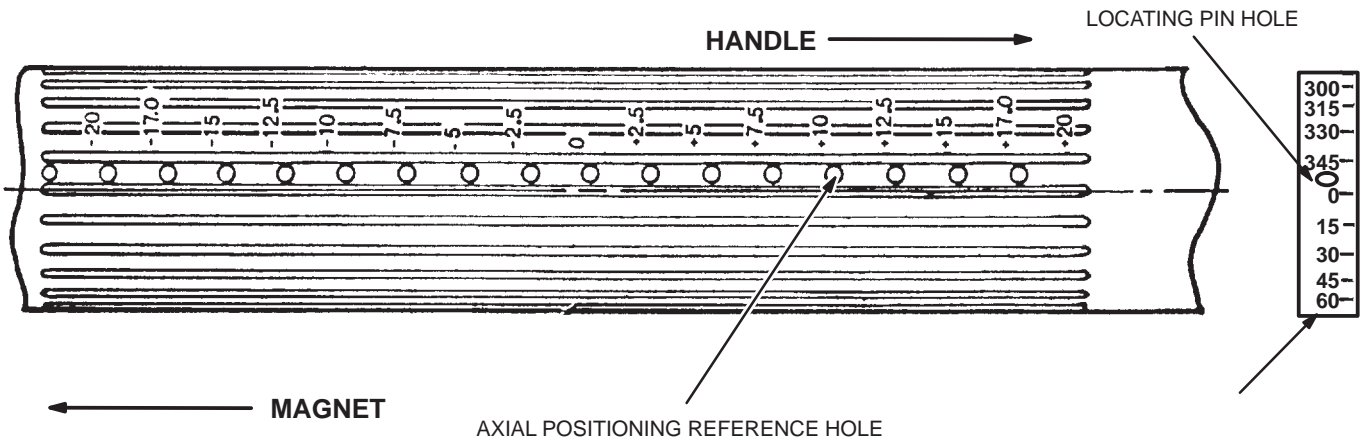


**NOTE:** NUMBERS MUST COINCIDE TO ACHIEVE DESIRED RADIUS  
E.G., "10" ON THE RADIAL SLIDER TUBE MUST COINCIDE WITH  
"10/15" ON THE RADIAL SUPPORT TUBE TO OBTAIN A RADIUS OF  
10 CM.

**RADIAL POSITIONING HOLES**  
ILLUSTRATION 5-11

**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 5-12.
- 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 5-12.



ANGULAR/AXIAL POSITIONING  
ILLUSTRATION 5-12

**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 Magnetometer Probe is centered physically at the bore center. In this procedure, it will be centered magnetically at the beginning of the shimming procedure.

Make sure red lines are aligned, on the Limo Connectors, when connecting the cables. Never force or twist the connectors as damage may result.

**5-4 TESLAMETER PROBE MECHANICAL CENTERING (continued)**

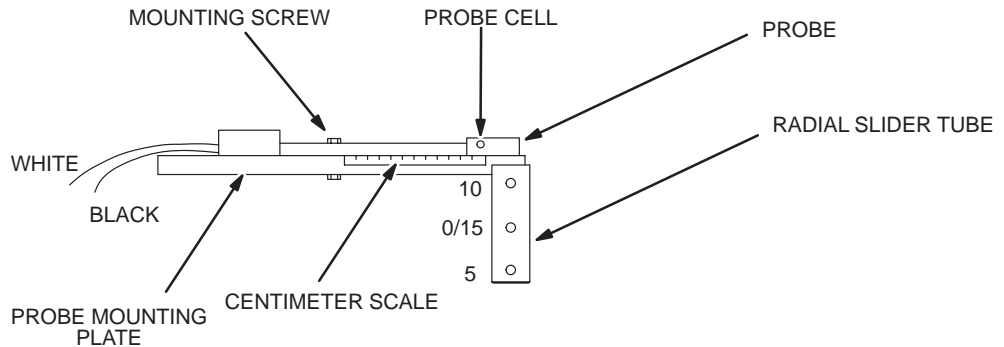
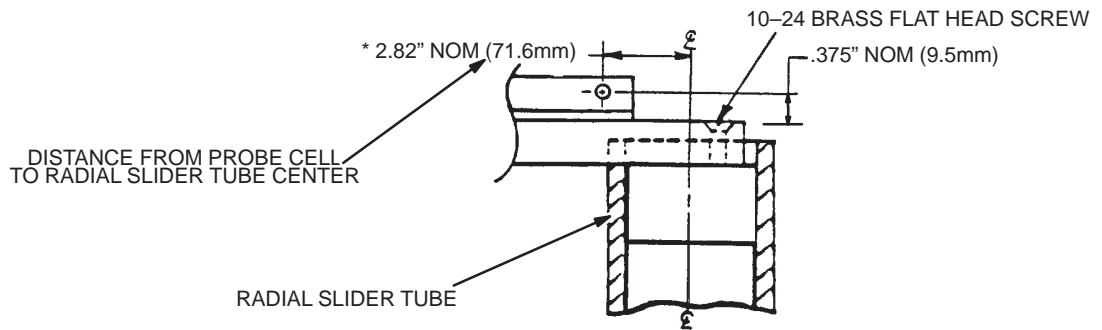
**Procedure:**

1. Attach the Probe to the probe mounting plate with brass machine screws as shown in illustration 5-13.

**Note**

To get proper radial spacing of the probe (.375 inches from the top of the Probe Mounting Plate), Nylon Spacers (46-294059P1 and P2) are included with the Service Tool Mapping Fixture (46-294060G2). These Shims should only be needed with the Metrolab Probe.

2. Loosen Probe Mounting Screw and set the Probe Cell 2.82 inches from the center of the Radial Slider Tube. See Illustration 5-13.
3. Install Shims, if necessary, to bring Probe height to .375 inches; measured from the center of the Probe Cell to the top of the Radial Slider Tube. See illustration 5-13.



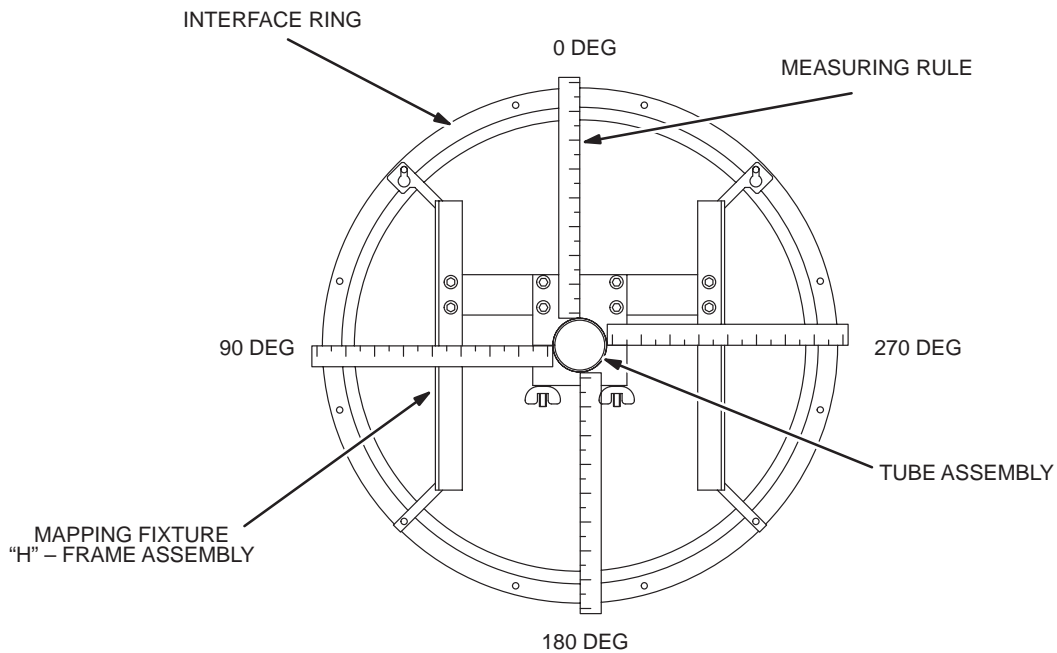
\* Loosen Mounting Screw to Adjust Probe to Magnet Center.

**AXIAL MECHANICAL CENTERING OF MAGNETOMETER PROBE**

ILLUSTRATION 5-13

**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 5-14.
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  $\pm 1$  mm (0.04 in).
6. Loosen the four H-Frame Mounting Bolts on the appropriate H-Frame slightly and adjust the H-Frame in the appropriate direction to bring the distances within the  $\pm 1$  mm tolerance.
7. Repeat Steps 3 through 5 for both sides of the Mapping fixture.

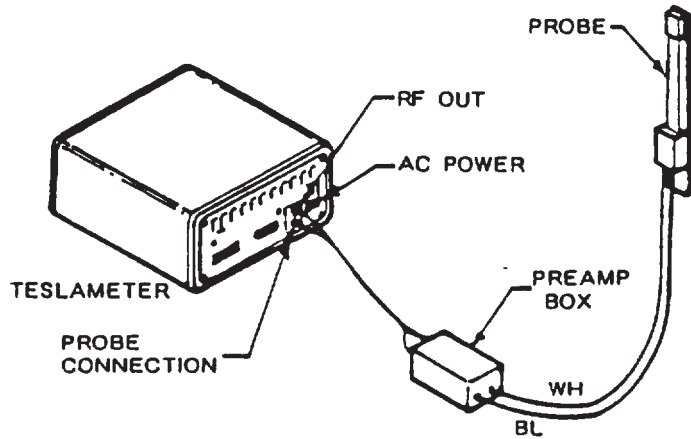


**TRANSVERSE MECHANICAL CENTERING OF MAPPING FIXTURE**  
ILLUSTRATION 5-14

8. Connect the Probe Output Cables to the Preamp Box. See Illustration 5-15.
9. Connect the preamp box to the two probe connection input plug on the Teslameter.

**5-4 TESLAMETER PROBE MECHANICAL CENTERING (continued)**

10. Position the Magnetometer probe at physical center of the bore ( $R=0, Z=0$ ).



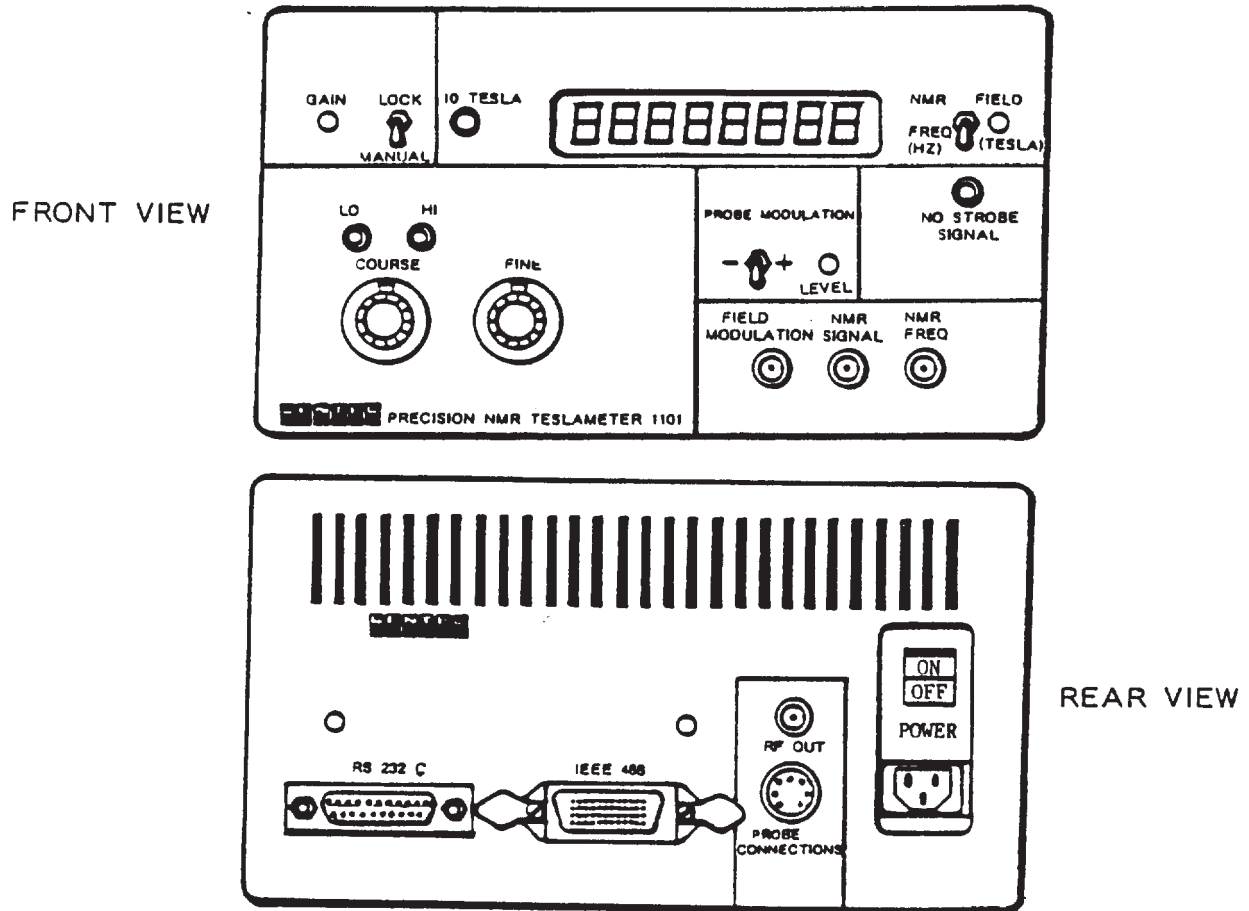
**TESLAMETER INTERCONNECTIONS**  
ILLUSTRATION 5-15

- 11. Turn on AC power to the meter. See Illustration 5-16 rear view.
- 12. Place the "LOCK/MANUAL" switch in the MANUAL position.



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

5-4 TESLAMETER PROBE MECHANICAL CENTERING (continued)



TESLAMETER  
ILLUSTRATION 5-16

13. Set the COARSE and FINE control knobs fully counterclockwise (CCW).
14. 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.

**5-5 TESLAMETER ADJUSTMENT (RAMP UP)**

1. Once ramping has started, monitor the power supply current meter until an indication of approximately 350 amps is approached. Now, start monitoring the Teslameter.
2. 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.
3. When the "NO STROBE SIGNAL" LED is out, change the "LOCK/MANUAL" switch to the LOCK position. See Illustration 5-16.

**Note**

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

4. 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.

**5-6 TESLAMETER ADJUSTMENT (RAMP DOWN)**

1. Increase the COARSE control knob until a field reading of approximately 1.0 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.

**5-7 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:

The Shim Lead Assembly must be placed in the “Engaged” position in order to Ramp and/or Shim the Magnet.

For Fixed Sited, the Shim Lead Assembly should only be placed in the “Disengaged” position for troubleshooting purposes only.

For Mobile Magnets, the Shim Lead Assembly should be placed in the “Disengaged” position after Quickshim is completed or before transporting the magnet.

### Procedure:

#### 6-1 SHIM LEAD ENGAGE

1. Remove ice, with Heat Gun, around Shim Lead Assembly and Shim Lead Compression Fitting.
2. Loosen Shim Lead Compression Fitting.
3. Unscrew the Double Threaded Brass Nut. The Brass Nut should be completely separated from the Guide Post Threads. See Illustration 6-1.
4. 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.

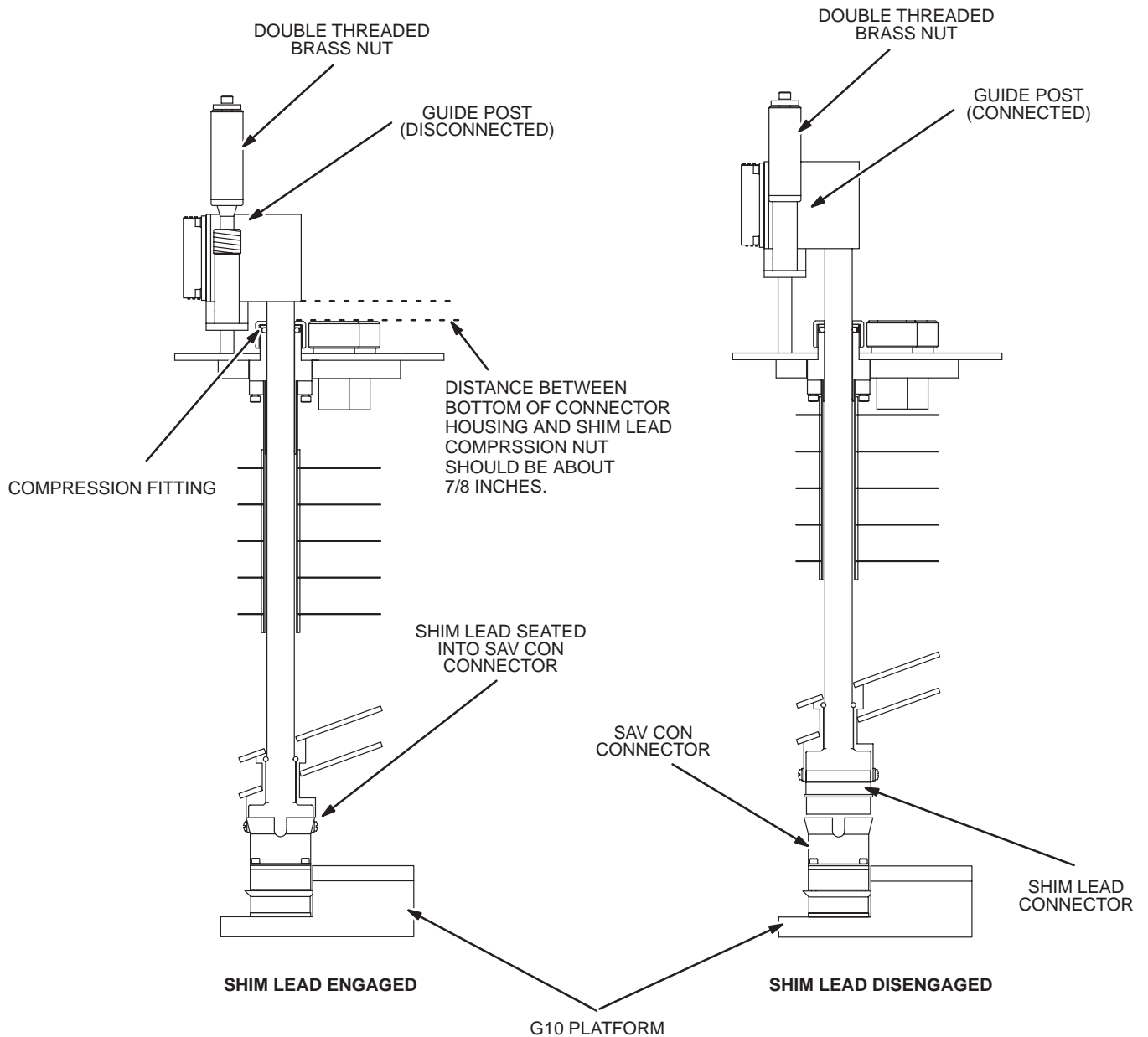
5. Seat Shim Lead fully, after contact is felt, by continuing to push on the Shim Lead Connector Housing with moderate pressure. Shim Lead should move down approximately 1/4 inch, after contact is felt, to fully engage.
6. Tighten the Shim Lead Compression Fitting.
7. Refer to Sections NO TAG through NO TAG, 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 and the Guide Screw on the Shim Lead Assembly contacts the Double Threaded Brass Nut. See Illustration 6-1.

- 
4. Screw the Double Threaded Brass Nut onto the Guide Post until the Shim Lead Assembly is in the correct position. See Illustration 6-1.
  5. 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 (  $810 \text{ mA} \pm 10 \text{ mA}$  ). 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.

### 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:

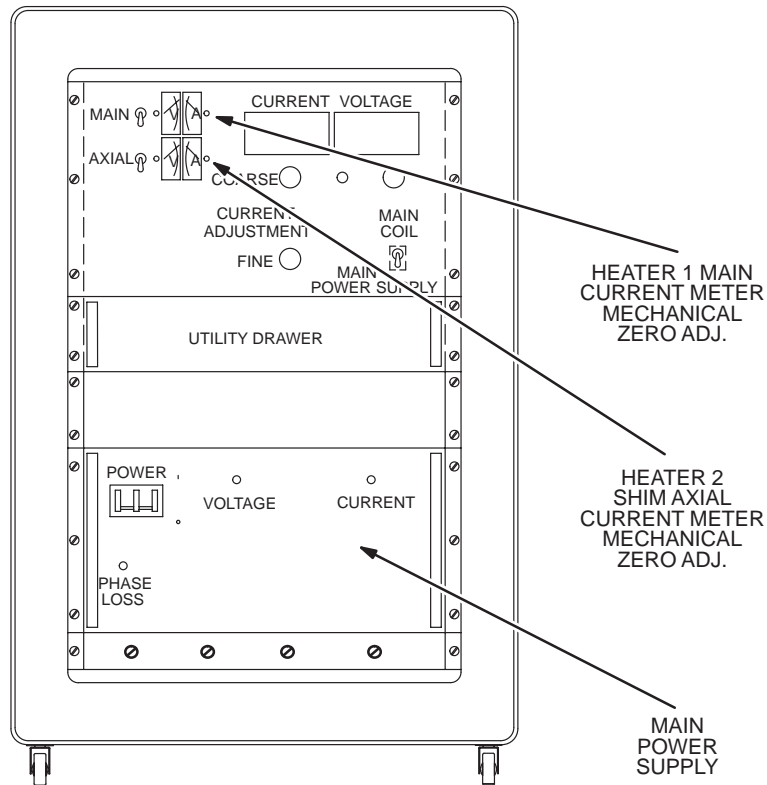
- 4 1/2 Digit True RMS Voltmeter ( Fluke 87 or equivalent )
- Oscilloscope
- Set of Ramping Cables – 2 each for 750 amp power supply.
- Power Supply Checkout Kit P/N 2101360
- Non metallic Tuning Tool

#### 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**

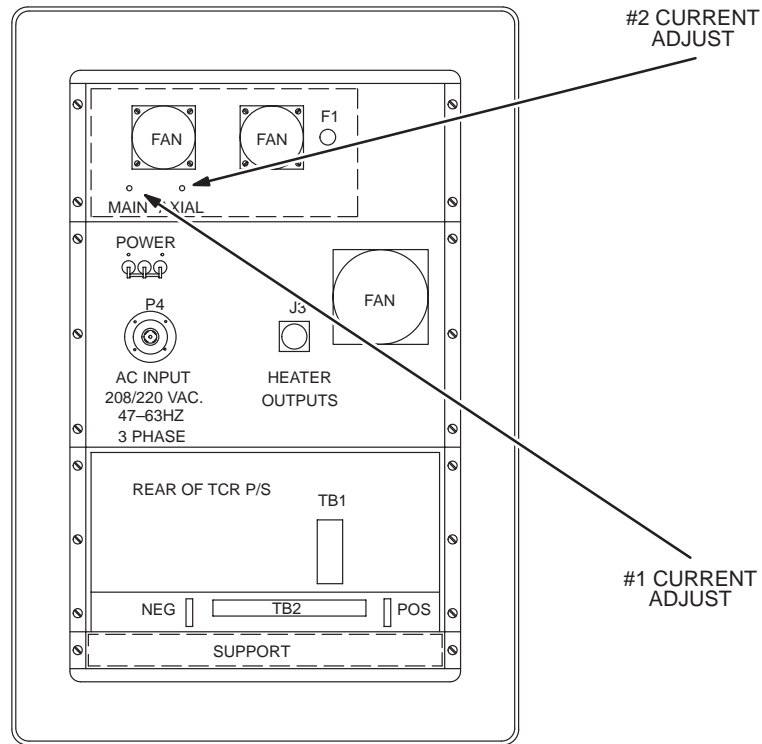
1. Disconnect input power cable to power supply under test.
2. Connect P3 test connector to J3 located on the rear of power supply.
3. Remove eight, Control Panel to Power Supply, mounting screws. See Illustration 7-1.
4. Pull out the UTILITY drawer, then place the Control Panel face down on the UTILITY 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.



HEATER 1 MAIN  
CURRENT METER  
MECHANICAL  
ZERO ADJ.

HEATER 2  
SHIM AXIAL  
CURRENT METER  
MECHANICAL  
ZERO ADJ.

MAIN  
POWER  
SUPPLY



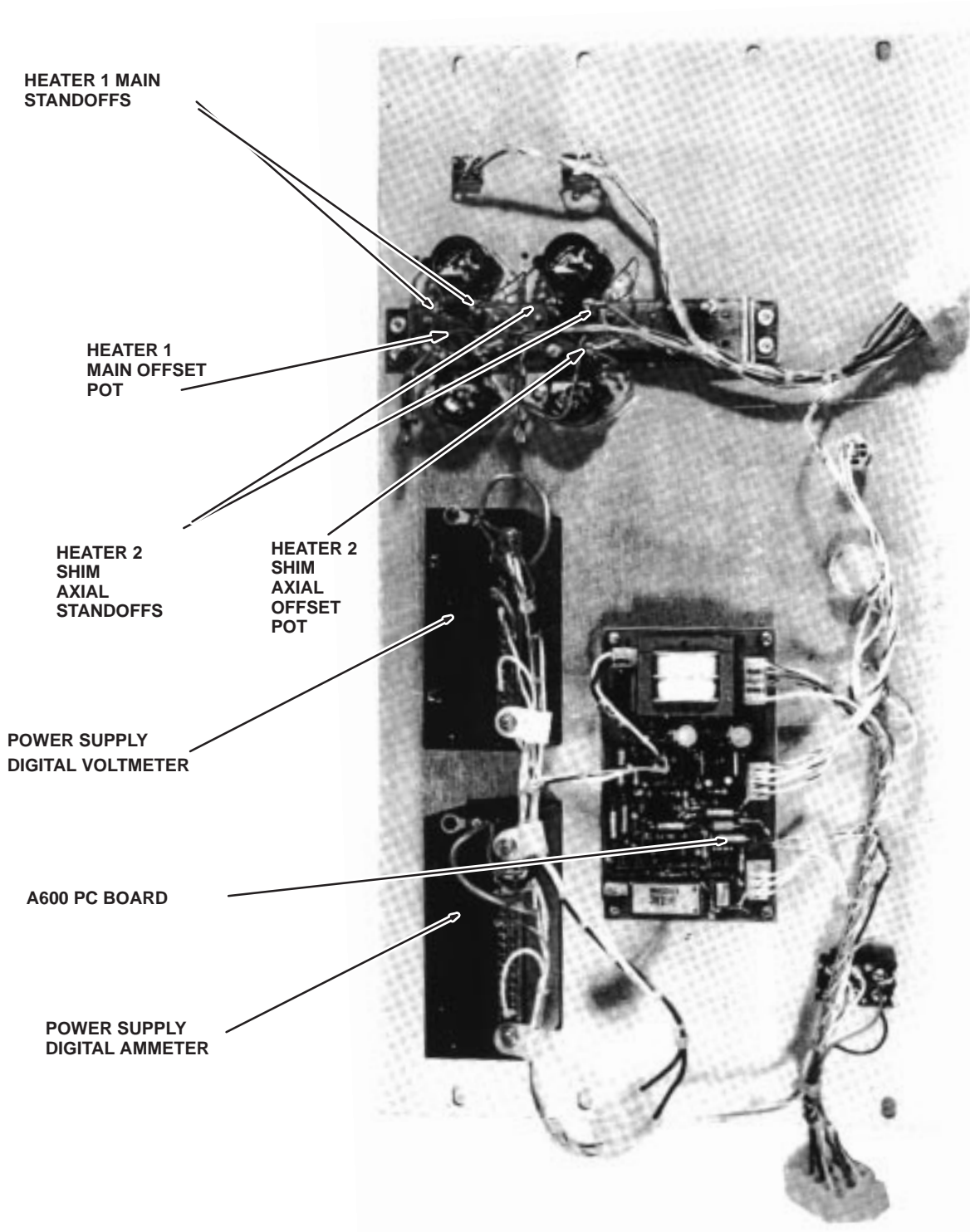
#2 CURRENT  
ADJUST

#1 CURRENT  
ADJUST

**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 ).



**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 10 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 10, 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 12, 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.

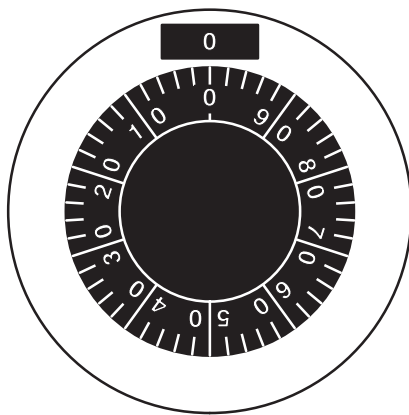
7-1-3 VOLTAGE CALIBRATION ( continued )

**Note**

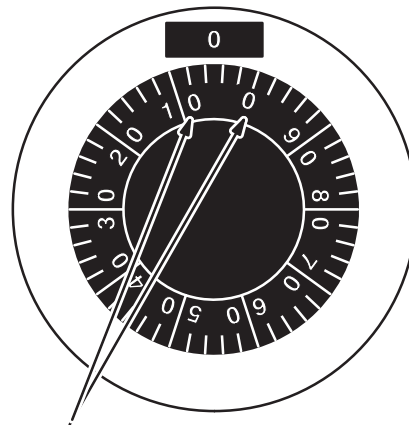
It takes approximately 2 minutes for the DVM reading, in Step 12, to decay to a value between 0.0 and -0.6 Volts. A few trials of adjusting the CURRENT ADJUST FINE pot must be done in order to insure power supply output voltage drops and rises as the CURRENT FINE ADJUST pot is adjusted in and out of the range shown in Illustration 7-3.

# CURRENT ADJUSTMENT

## COARSE



## FINE



AS THE CURRENT ADJUST FINE CONTROL IS ADJUSTED WITHIN 5 DIAL INDEX MARKINGS FROM FULL COUNTERCLOCKWISE, THE DVM READING SHOULD SLOWLY DROP TO WITHIN 0.0 TO -0.6 VOLTS.

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 11.

**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.

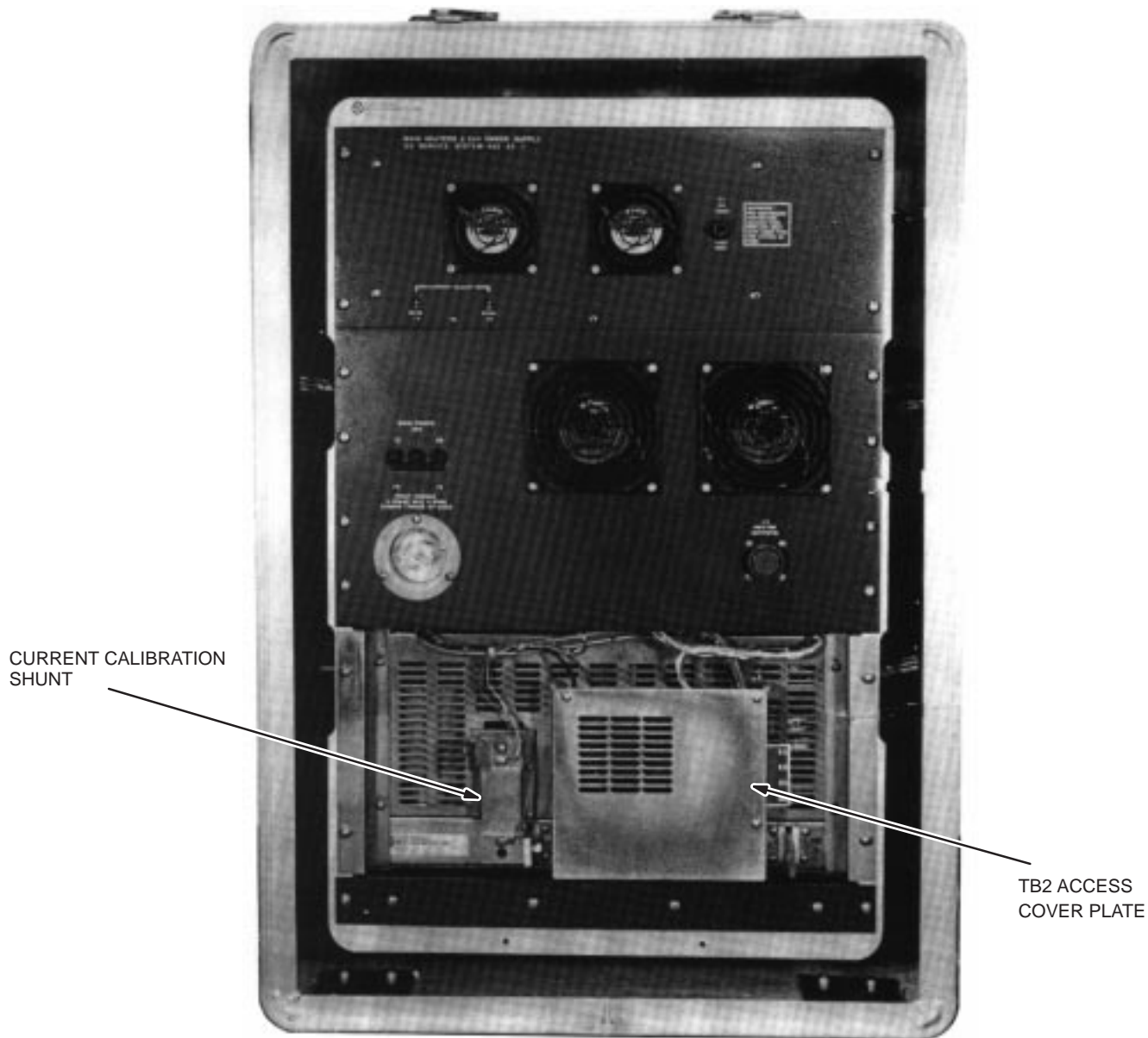
5. Connect the X1 Probe ground lead to TB2 pin 7 and the signal lead on TB2 pin 3.
6. Set the Oscilloscope TIME BASE control to 5 msec/div ( X1 PROBE ).
7. Set the Oscilloscope VOLT/DIV to 5 mV / div.
8. Set the input coupling to AC.
9. Connect Oscilloscope power cable plug into AC outlet and turn on 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 not 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 )**

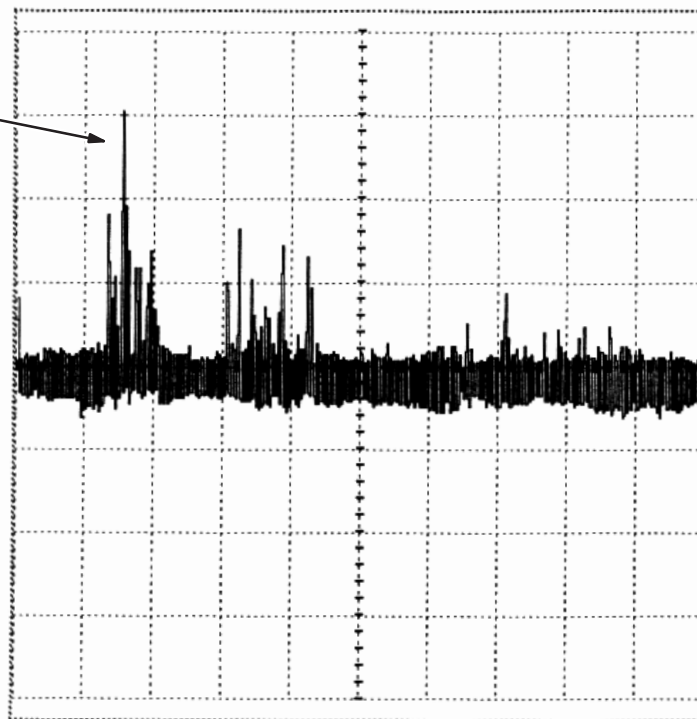
**Note**

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

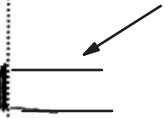
**Note**

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.

LARGE NOISE SPIKES EVIDENT WHEN POT IS BAD



BASELINE NOISE OKAY



**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.



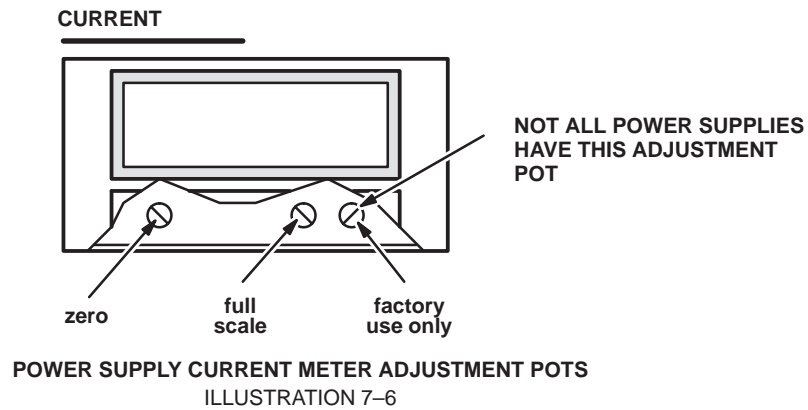
**Heat in excess of 60 watts could be present at the Ramp Cable/1000 amp 100mV Current Shunt junction if the cables in Steps 11 and 12 are not tightly connected to the Current Shunt.**

**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 )



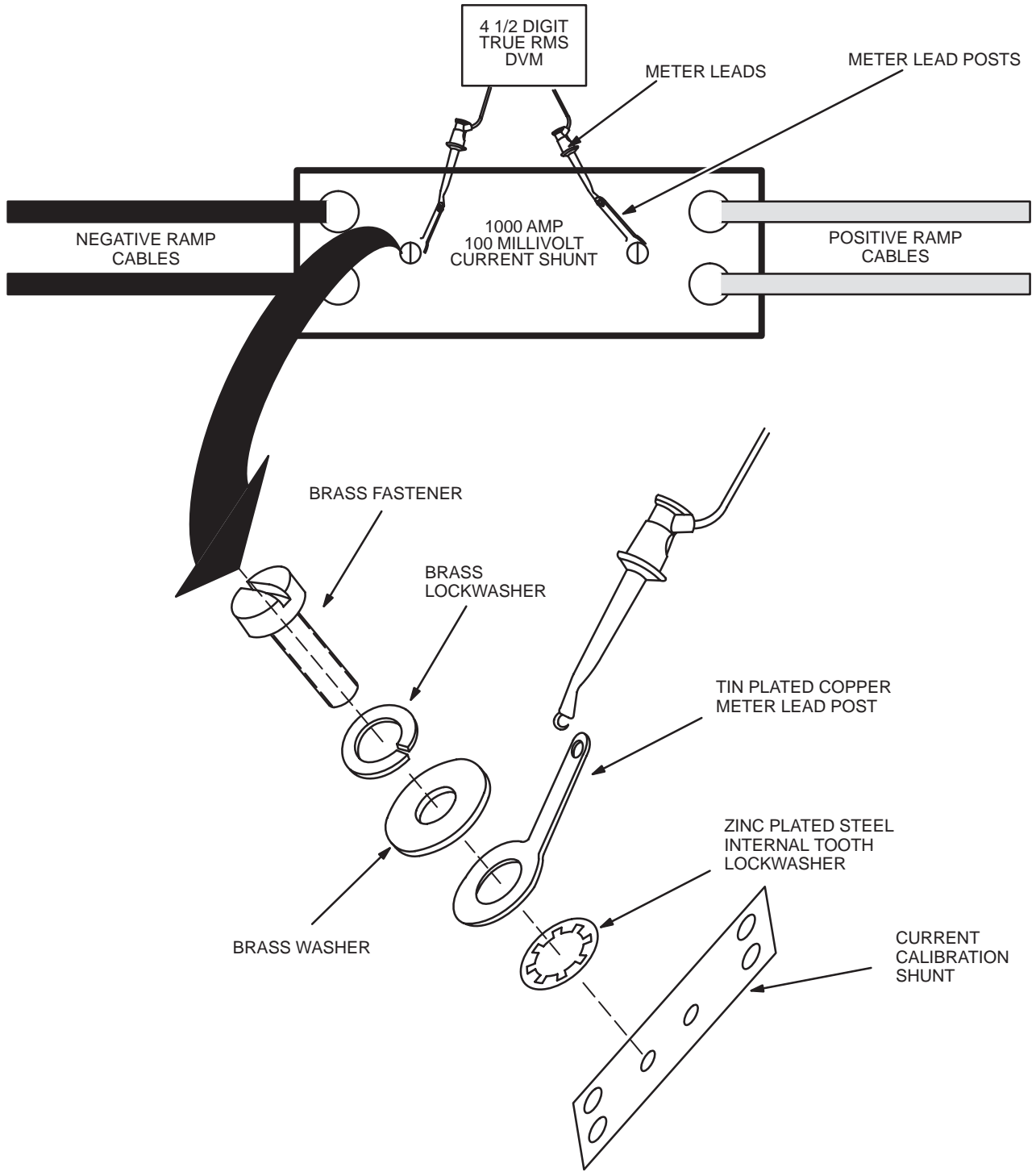
13. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL toggle switches to "0" ( off ).
14. Adjust VOLTAGE CONTROL pot to maximum ( full CW ). Make sure CURRENT ADJUST pots are set to minimum ( full CCW ).

**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.



**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 Voltmeter, 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.

## SECTION 8 – ELECTRICAL CONNECTIONS FOR RAMPING AND SHIMMING

### Description:

Main and Superconducting Shim Power Supply Input/Output Connections, called out in this procedure, have the same (P/J) designations.

Make sure that the Magnet Service Ramp and Shim Power Supplies 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.

The Main Coil Power Cables, Superconducting Shim Coil Wire Harness, Heater Wire Harness and Volt Sense Leads are located in the Magnet Cable Trough.

### Procedure:

**WARNING!**

**FOR MOBILE MAGNET SITES, TRANSVERSE AND AXIAL HEATERS MUST BE ON DURING RAMP UP, RAMP DOWN, OR FIELD ADJUSTMENT TO MINIMIZE THE POTENTIAL FOR MAGNET QUENCH.**

### 6-3 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS

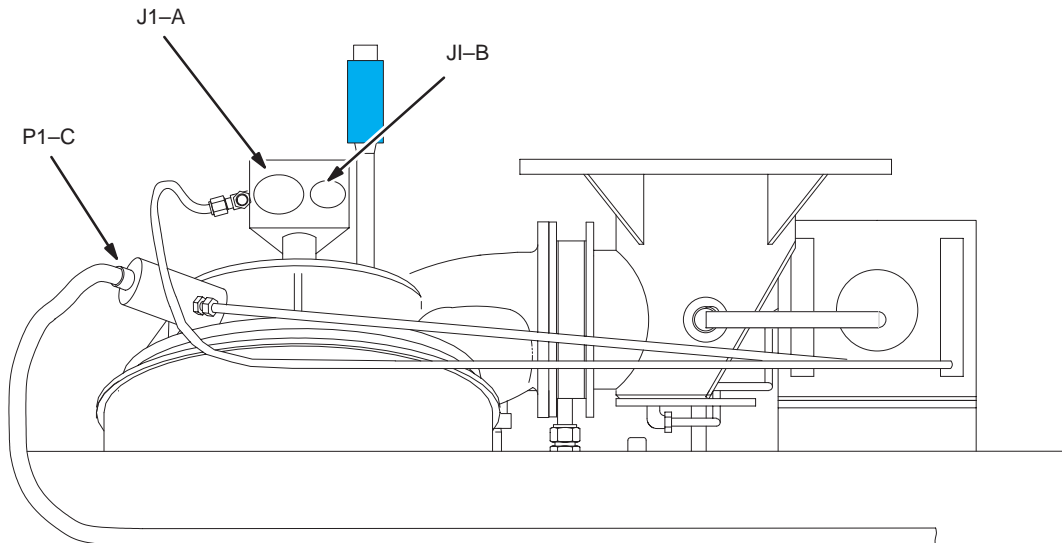
1. Verify that input power to the Superconducting Shim Coil Power Supply is disconnected.

**WARNING!**

**DO NOT CONNECT INPUT POWER TO OR TURN ON SUPERCONDUCTING SHIM COIL POWER SUPPLY UNTIL IT IS VERIFIED THAT ALL CURRENT CONTROLS ARE SET AT ZERO, FULLY COUNTERCLOCKWISE.**

2. Verify that all connectors (J1-A, J1-B, P1-C) are mated on the top of the magnet. See Illustration 8-1.

6-3 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)



MAGNET ELECTRICAL CONNECTIONS  
ILLUSTRATION 8-1



**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.**

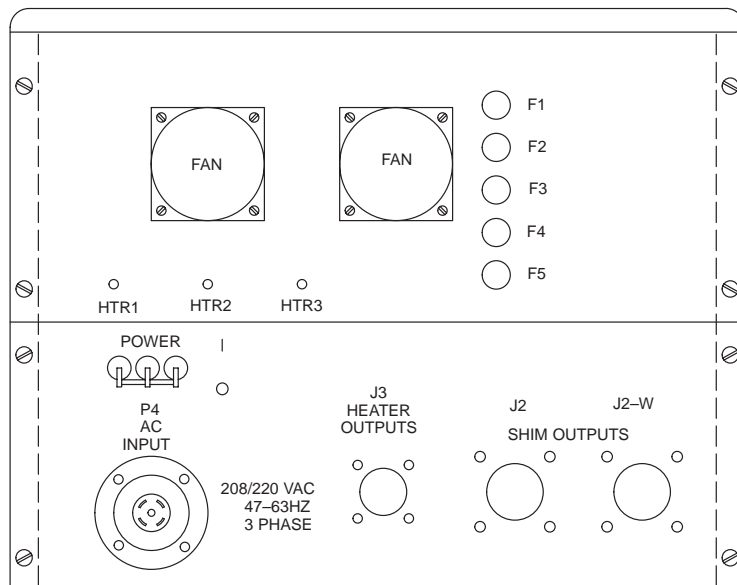
3. Connect (P2 & P2-W) of the Superconducting Shim Coil Wire Harness (RUN #603) to (J2 & J2-W) Shim Outputs on the rear of the Superconducting Shim Coil Power Supply Cabinet (MS7-A1). See Illustration 8-2.
4. Connect (J2 & J2-W) of the Superconducting Shim Coil Wire Harness (RUN #603) to (P2 & P2-W) on the Magnet Harness Terminal Box (MS1-A3, A1). See Illustration 8-3. Perform Steps 5 and 6 for Mobile Sites only.



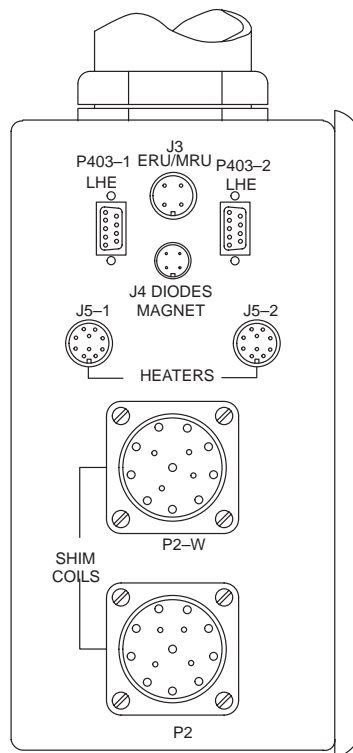
**FOR MOBILE MAGNET SITES, TRANSVERSE AND AXIAL SWITCH HEATERS MUST BE ON DURING RAMP UP, RAMP DOWN, OR FIELD ADJUSTMENT TO MINIMIZE THE POTENTIAL FOR MAGNET QUENCH. PERFORM STEPS 5 AND 6, BELOW, FOR MOBILE UNITS ONLY.**

5. Connect Heater Cable, P/N 46-260724G1 supplied in Magnet Shipping Collector, to Heater Outputs (J3) on the rear of the Shim Coil Power Supply Cabinet (MS7-A1). See Illustration 8-2.
6. Connect the other end of the Heater Cable to (J5-1 or J5-2) on the Magnet Harness Terminal Box (MS1-A3, A1). See Illustration 8-3.

6-3 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)



SHIM POWER SUPPLY OUTPUT CONNECTIONS  
ILLUSTRATION 8-2



MAGNET HARNESS TERMINAL BOX  
ILLUSTRATION 8-3

**6-4 MAIN COIL POWER SUPPLY CONNECTIONS**

1. Verify that the input power to the Main Coil Power Supply is disconnected.
2. Verify that all connectors (J1-A, J1-B, P1-C) are mated on the top of the magnet. See Illustration 8-1.
3. Connect (P703) on Heater Wire Harness (RUN #604) to Heater Outputs (J3) on the rear of the Main Coil Power Supply Cabinet (MS6-A1). See Illustration 8-4.
4. Connect (P5) on Heater Wire Harness (RUN #604) to (J5-1 or J5-2) on the Magnet Harness Terminal Box (MS1-A3, A1). See Illustration 8-3.

**Note**

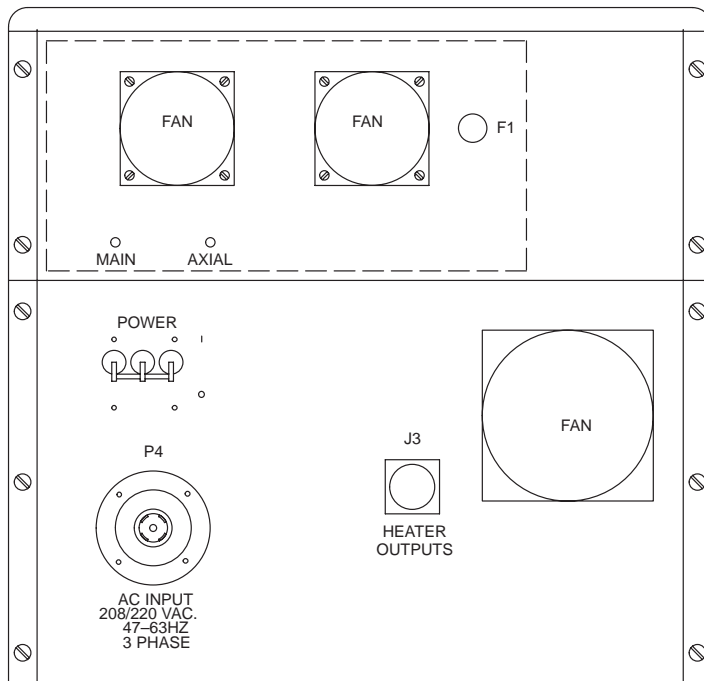
A "Scotch Brite" scouring pad can be used to clean all connections in Step 5.

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

**Note**

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

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



**MAGNET POWER SUPPLY CONNECTIONS**

ILLUSTRATION 8-4

6-4 MAIN COIL POWER SUPPLY CONNECTIONS (continued)

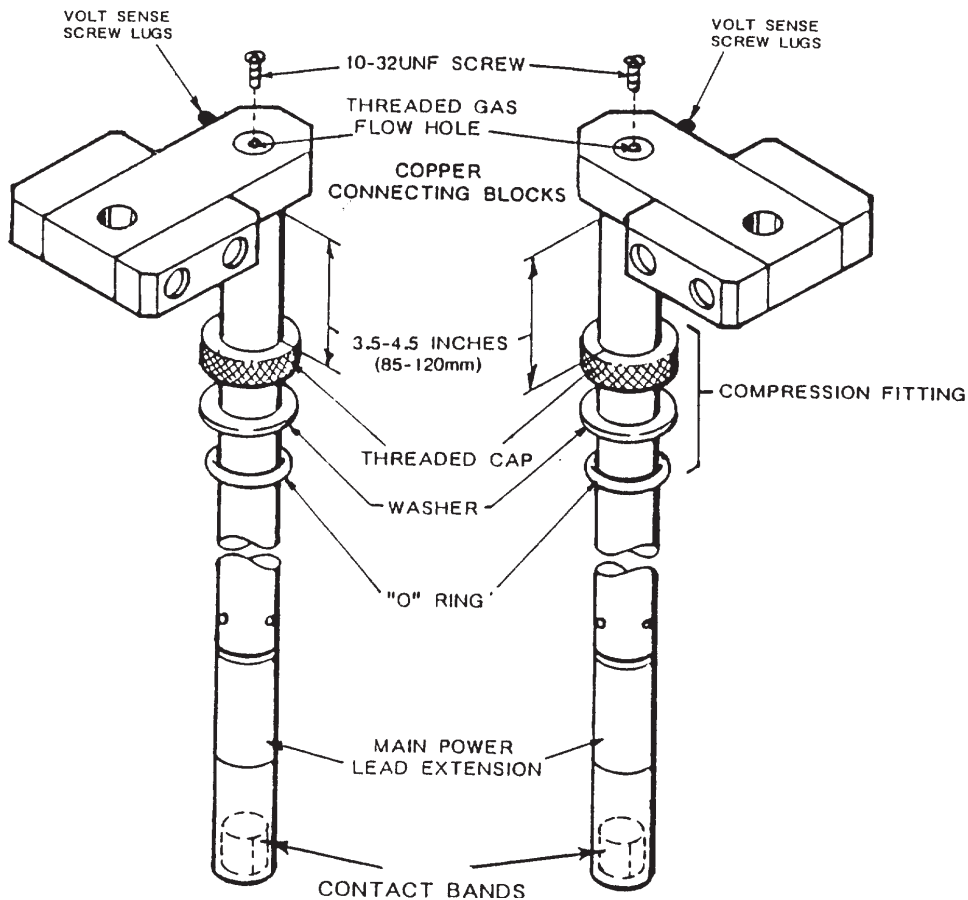


The Main Power Lead Extensions for the 1.0T magnet are different from other magnets. The 1.0T Lead Extensions can be recognized by a Helium Flow Hole as viewed from the Contact Band End of each Extension. The 1.0T Ramp Lead Extensions are also shorter than the SIII Ramp Leads. Make sure the Power Lead Extensions ( P/N 46-294204G1) are used for this procedure.

**Note**

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

9. Replace Contact Bands on Main Power Lead Extensions. Make sure gas flow holes are not blocked. See REPLACEMENT/MAINTENANCE, Section NO TAG.
10. 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

**6-4 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 ).**

**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.**

**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.**

**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**

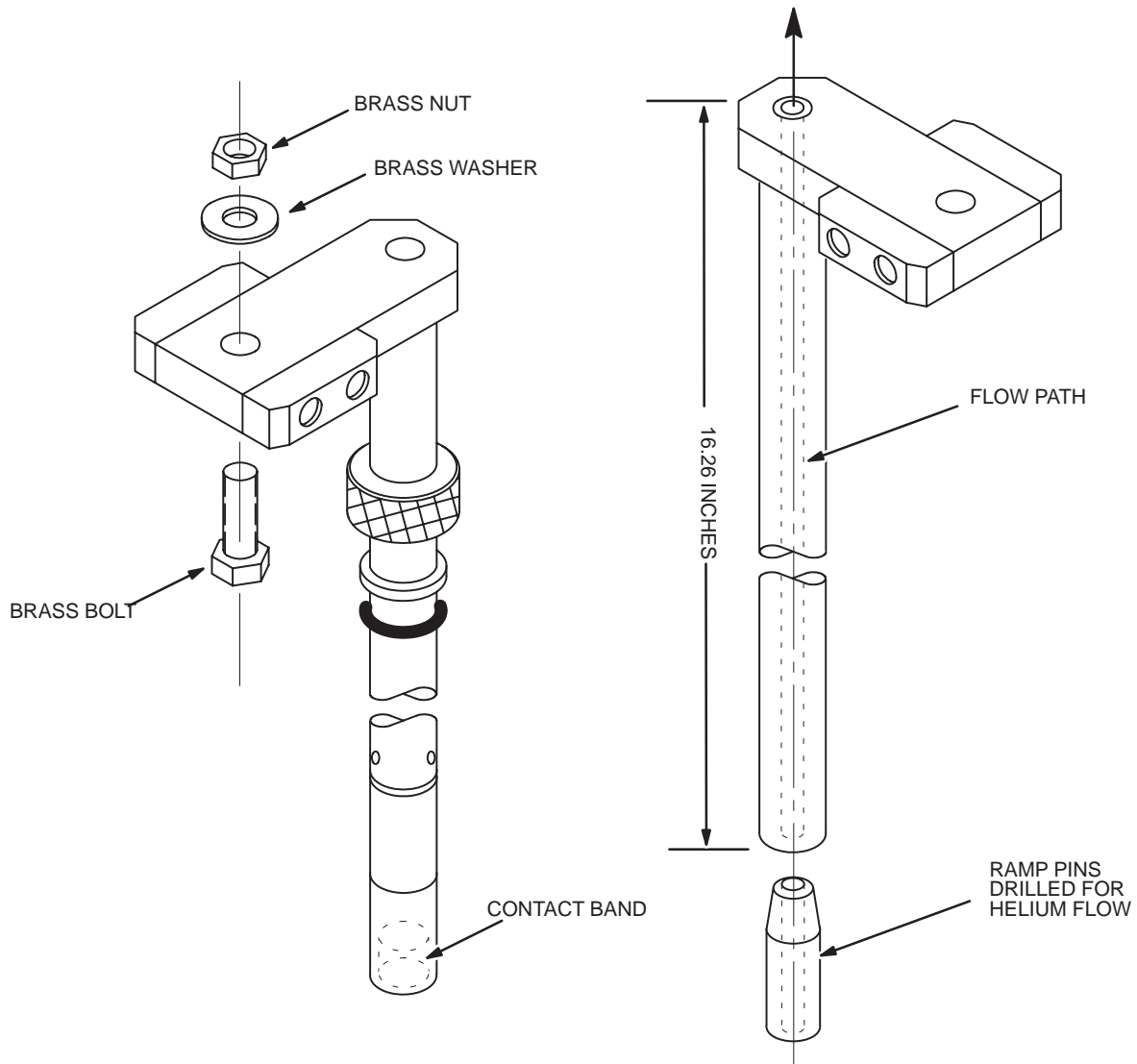
Use only Brass Washers when connecting Main Power Leads to the Main Lead Extensions to keep voltage drops to a minimum.

**CAUTION**

**Make sure the Brass Bolts in Step 11 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.**

11. 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.
12. Install the 10-32UNF Gas Flow Hole Screws into the gas flow holes on each Ramp Lead Extension. See Illustration 8-5.

6-4 MAIN COIL POWER SUPPLY CONNECTIONS (continued)



HARDWARE MOUNTING ON RAMP LEAD EXTENSIONS  
ILLUSTRATION 8-6

**Note**

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

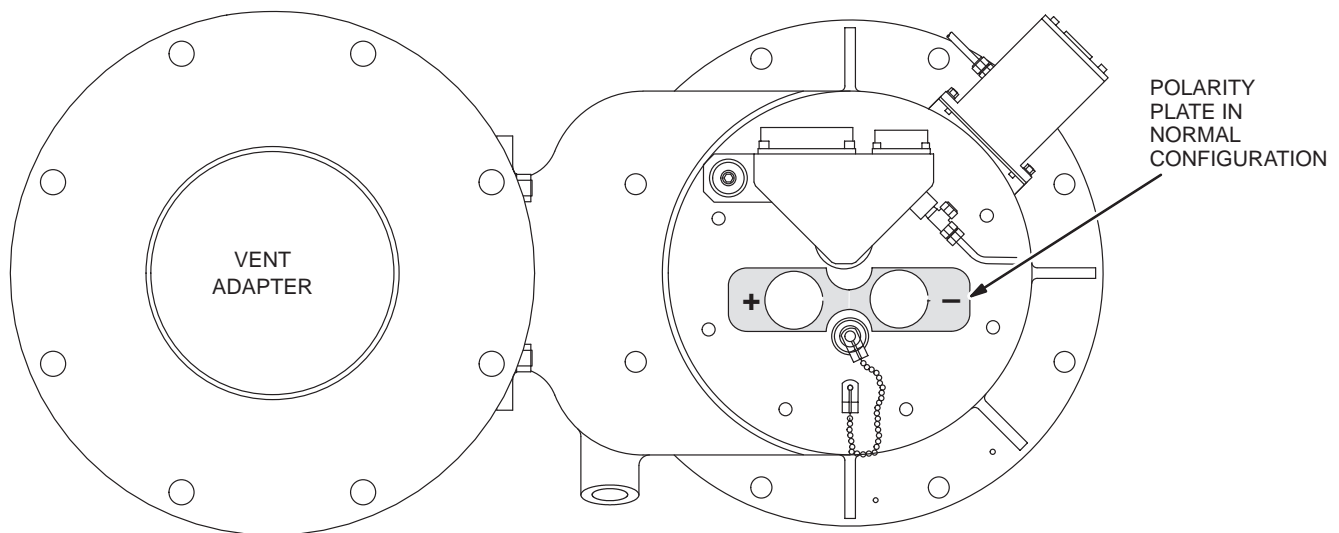
**CAUTION**

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. Make sure that the Polarity Plate properly indicates which polarity the magnet is to be ramped and the chosen ramp polarity must also be recorded in the DATA SHEET tab, Section NO TAG.

**Note**

The Ramp Polarity Plate position is changed by first venting the magnet to around 0.25 psi, then removing both Ramp Port Caps. Pull the polarity plate up over the ramp ports and reinstall the plate to indicate the chosen polarity. Replace Ramp Port Caps.

1. Set the Ramp Polarity Plate (P/N 2102687), located on the Shim Lead Assembly, to the desired Ramp Polarity. The normal Ramp Polarity is “+” on the left and “-” on the right, as viewed from the Cold Head side of the magnet. See Illustration 8-7.



**RAMP LEAD POLARITY**  
ILLUSTRATION 8-7

2. Remove the cap of the “+” Main Power Lead Extension Receptacles located on the vertical stack of the magnet. Make sure that the gasket inside the cap does not get lost. See Illustration 8-7.

**Note**

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

**6-4 MAIN COIL POWER SUPPLY CONNECTIONS (continued)**

3. Quickly insert the Positive (red cables attached) Main Power Lead Extension, about halfway, into the open receptacle. Loosely screw the Compression Nut onto the Ramp Lead Port. See Illustration 8-7 for correct connection polarities.
4. Repeat Steps 2 through 3 for the other Lead Extension.
5. Connect the volt sense leads to the Main Power Lead Extensions. See Illustration 8-8. Terminate other end of volt sense leads to a DVM or VOM placed near the Main Coil Power Supply.
6. Remove Flow Hole Screws. See Illustration 8-8.

**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.



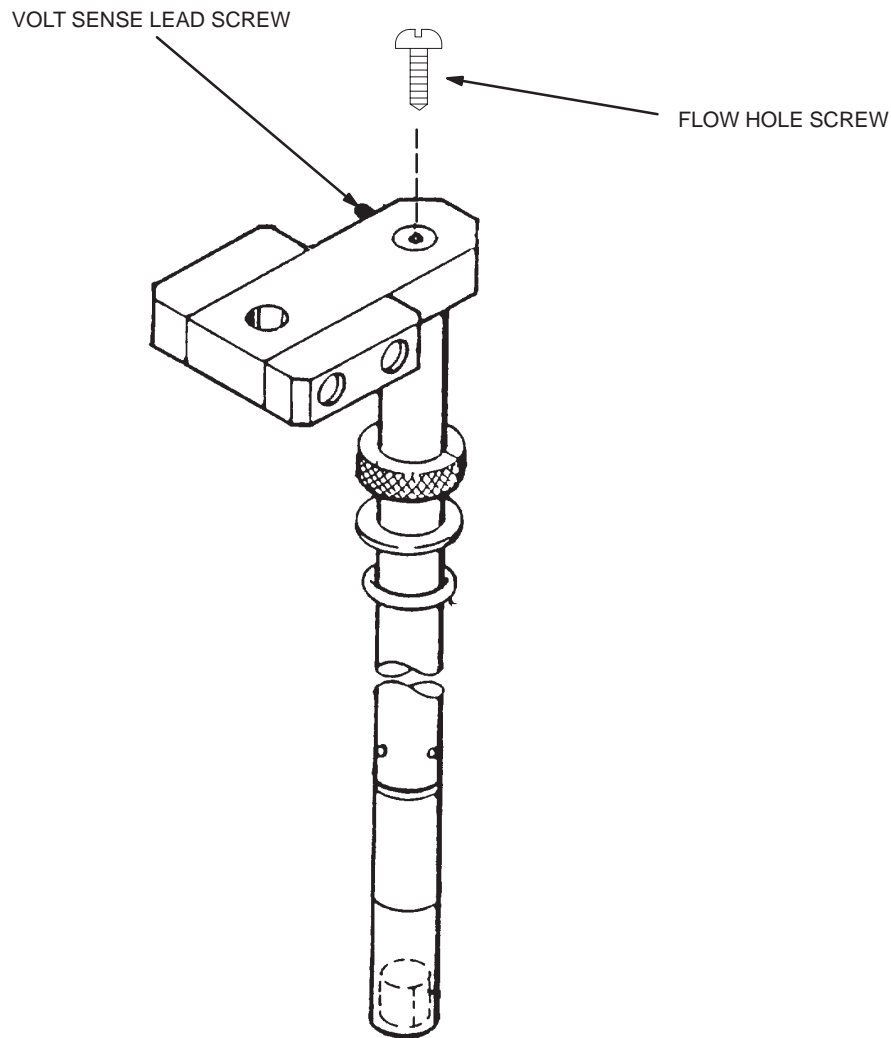
**IF THE MAGNET IS RAMPED UP, WAIT FOR THE LEAD EXTENSIONS TO COOL SUFFICIENTLY (A FOG OR WATER VAPOR FORMS AROUND THE LEAD EXTENSIONS) BEFORE FULLY ENGAGING THEM, TO PREVENT THE RISK OF QUENCHING THE MAGNET.**

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



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

6-4 MAIN COIL POWER SUPPLY CONNECTIONS (continued)



VOLT SENSE LEAD CONNECTIONS  
ILLUSTRATION 8-8



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

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

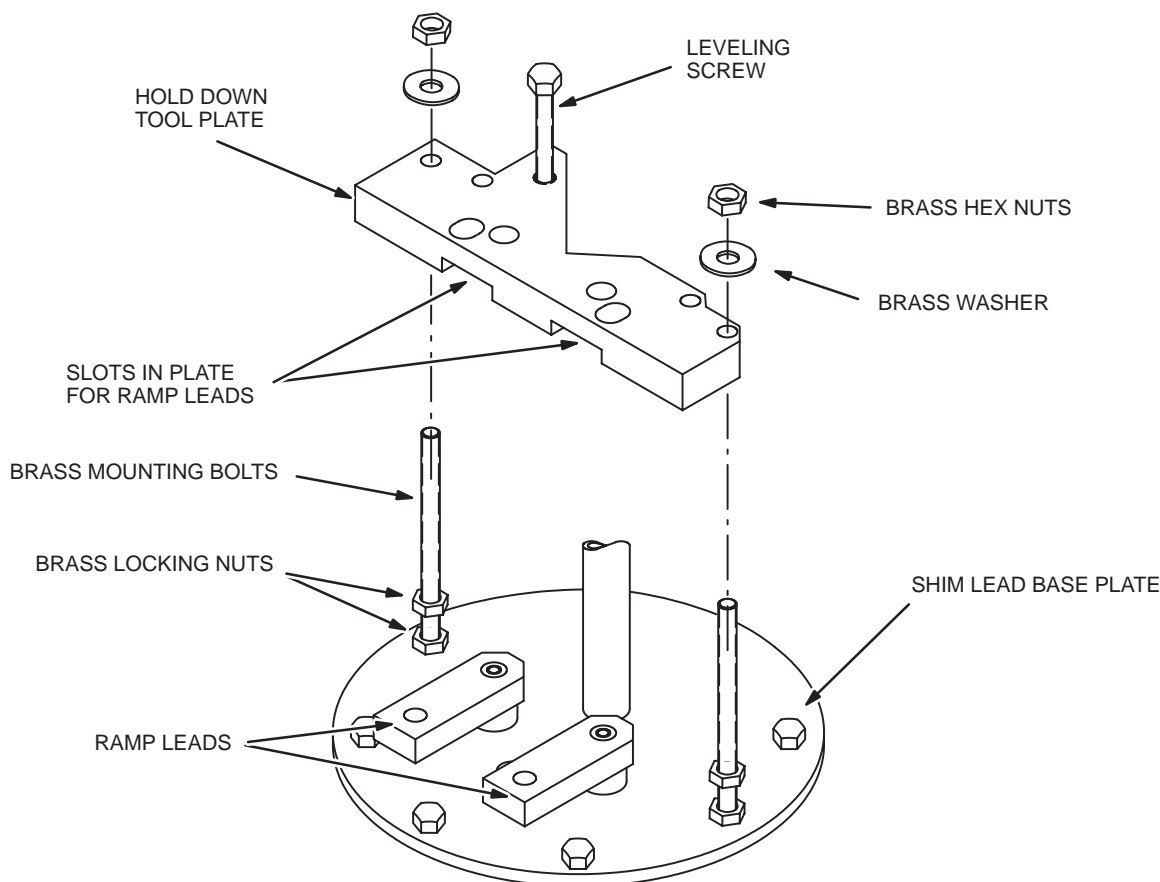
**6-4 MAIN COIL POWER SUPPLY CONNECTIONS (continued)**

9. A Ramp Lead Hold Down Tool (46-323015G1) 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.
10. Install the Hold Down Tool Plate onto the mounting bolts. Make sure that the ramp leads fit into the slots on the plate. See Illustration 8-9.



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

11. Tighten the Nuts on top of the Hold Down Tool Plate to lock the plate firmly in place and prevent lead motion. While tightening the plate nuts, adjust the leveling screw to keep the plate level. See Illustration 8-9.



**HOLD DOWN TOOL INSTALLATION**  
ILLUSTRATION 8-9



## SECTION 9 – MAGNET RAMPING

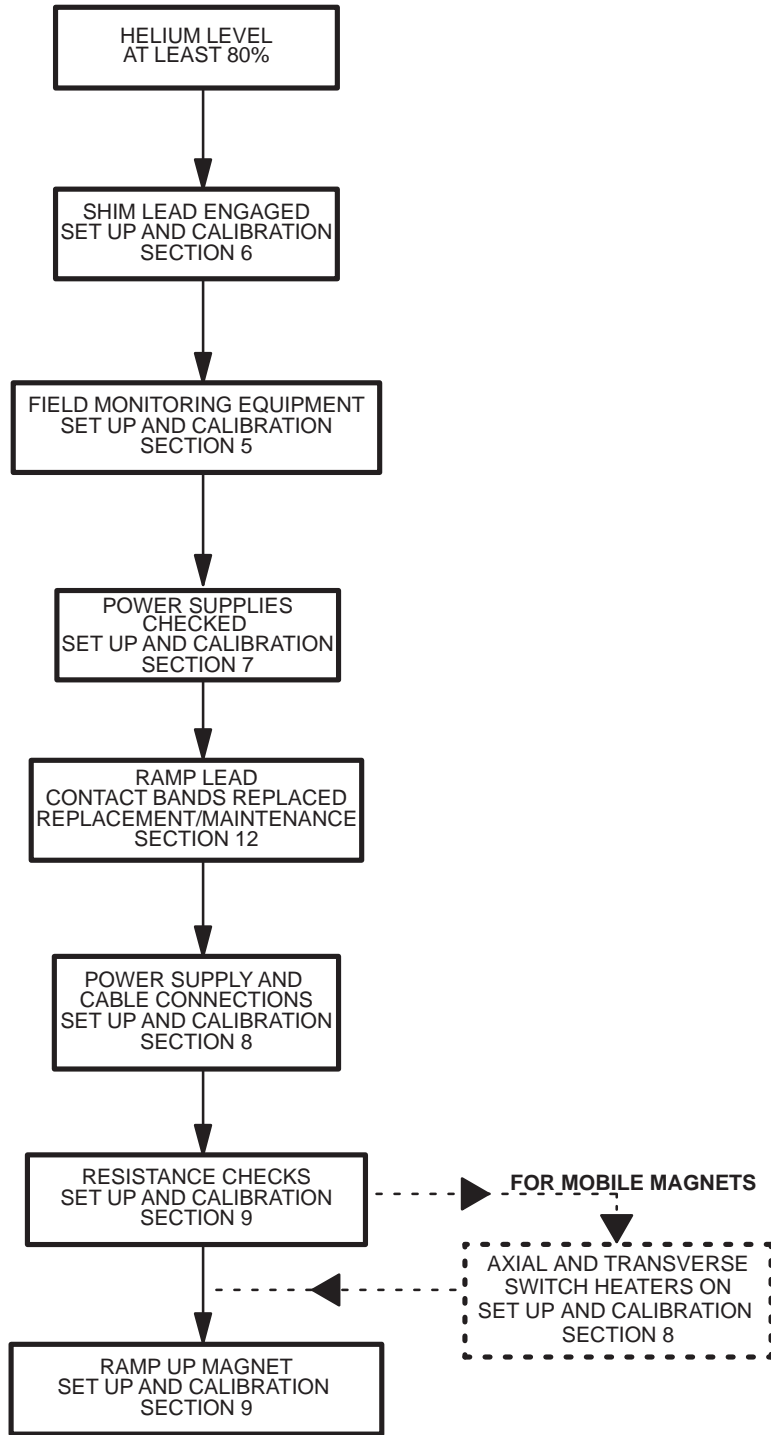
### Description

Magnet Ramping of Mobile 1.0T magnets requires the use of both the Main Service Ramp Power Supply and the Superconducting Shim Power Supply. The purpose of this is to eliminate current buildup in any of the axial or transverse shim coils during Magnet Ramping. Current buildup, in either the Transverse or Axial Shim Coils could cause a magnet quench. Two heater cables are supplied with the Mobile Shipping Collector in order to activate all axial and transverse switch heaters simultaneously.



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

- 1. MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN SAFETY MEASURES CONTAINED IN SECTION 5-3 OF THE INTRODUCTION ( CRYOGEN SAFETY ).**
- 2. NOTIFY SITE ADMINISTRATION BEFORE RAMPING THE MAGNET THAT ALL MAGNETIC SAFETY PRECAUTIONS MUST BE TAKEN.**
- 3. POST WARNING SIGNS OUTSIDE THE 5 GAUSS ZONE TO ALERT PERSONNEL WITH CARDIAC PACEMAKERS, NEUROSTIMULATORS AND OTHER BIOSTIMULATION DEVICES NOT TO PROCEED INTO THE DESIGNATED AREA. POST THESE SIGNS ON THE MAGNET ROOM LEVEL AS WELL AS AREAS BELOW THE MAGNET TO WHICH THE 5 GAUSS ZONE EXTENDS. SEE INTRODUCTION, SECTION 5.**
- 4. POST “RAMPED MAGNET” WARNING SIGN AT THE MAGNET ROOM ENTRANCE PRIOR TO RAMPING THE MAGNET. WARNING TO ALERT PERSONNEL THAT NO FERROMAGNETIC MATERIAL OR INDIVIDUALS WITH CARDIAC PACEMAKERS, NEUROSTIMULATORS OR STEEL PLATES ARE ALLOWED IN THE MAGNET ROOM WHEN THE MAGNET IS RAMPED.**
- 5. REMOVE ALL LOOSE FERROMAGNETIC MATERIAL FROM THE MAGNET ROOM. PULL THE POWER SUPPLIES AS FAR AWAY FROM THE MAGNET AS THE CABLES AND SITE GEOMETRY ALLOW. METAL OBJECTS CAN BECOME DANGEROUS PROJECTILES IN A MAGNETIC FIELD.**
- 6. MAKE SURE THAT THE MAGNET RUNDOWN UNIT IS INSTALLED AND OPERATIONAL TO ENABLE THE MAGNETIC FIELD TO BE QUICKLY DISCHARGED IN CASE OF AN EMERGENCY. SEE SET UP AND CALIBRATION, SECTION 1-5.**
- 7. MAKE SURE THAT THE MAGNET IS AT LEAST 80% FULL OF LIQUID HELIUM TO PREVENT THE LIQUID HELIUM LEVEL FROM DROPPING TO A POINT, DURING RAMPING, WHERE A QUENCH MAY OCCUR.**



RAMP FLOWCHART  
ILLUSTRATION 9-1

**9-1 PREPARATION**

1. Set up the field monitoring equipment, Teslameter and Teslameter Probe, in conformance with SET UP AND CALIBRATION, Section 5.
2. Perform Magnet Electrical Checks in conformance with FUNCTIONAL CHECKS, Section 3.
3. Make sure the magnet is at least 80% full of helium before Ramping the magnet.

**WARNING!**

**THE 1.0T 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 NO TAG. (“Electrical Connections For Ramping And Shimming”)
8. Record the Main Coil connection polarity in DATA SHEETS, Table NO TAG.
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 NO TAG.
2. Make sure CURRENT ADJUST and VOLTAGE controls on the Main Power Supply are off (full CCW).

**Note**

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

**WARNING!**

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

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

**9-2 RESISTANCE CHECKS (continued)**

4. Set HEATER 2 SHIM AXIAL switch to 1 (on) and observe current rise in ammeter (800–820 mA) to verify circuit continuity. Make sure Main Heater Switch is off.
5. Connect a Digital Voltmeter (DVM) to the end of the Voltage Sense Leads.
6. Set CURRENT ADJUST 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 500A 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.



**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.**

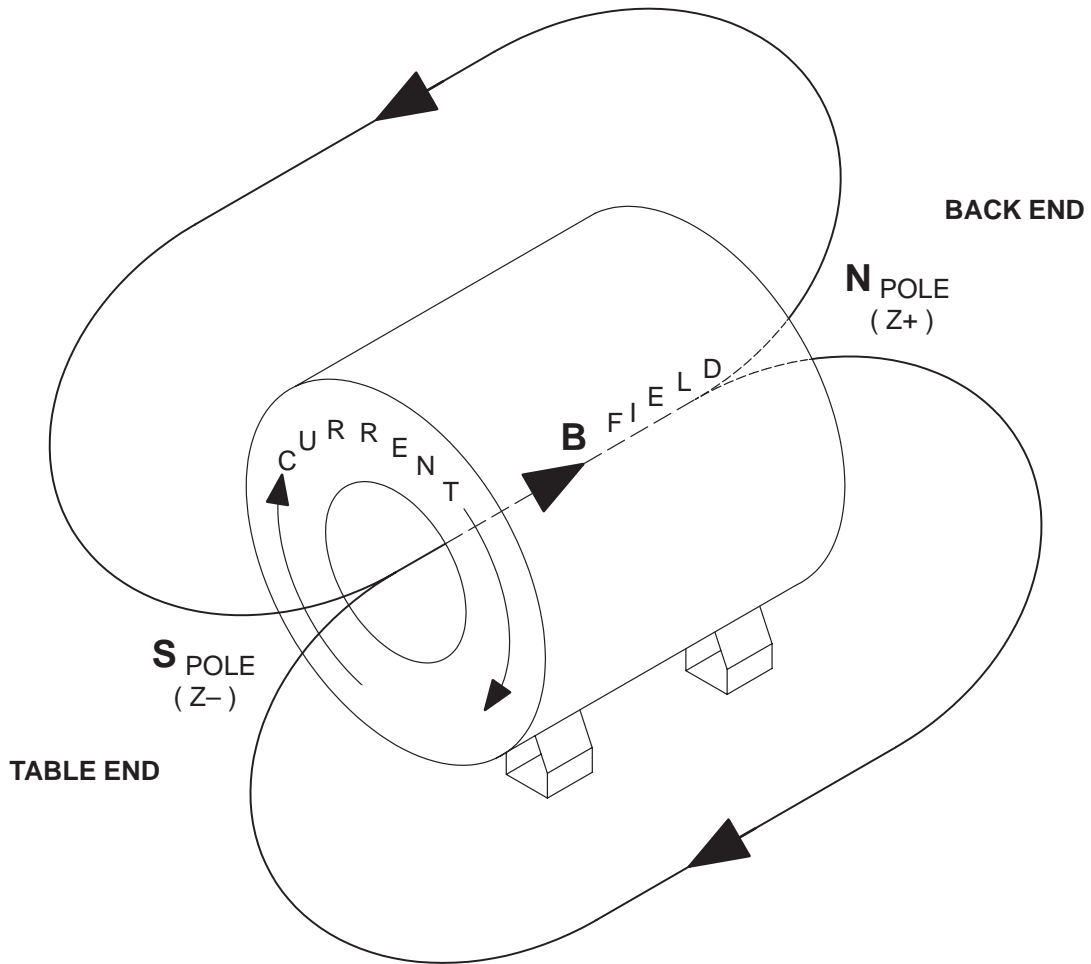
**DO NOT ATTEMPT TO IMPROVE THE DVM READING, IN STEP 8, BY INCREASING THE MAGNET CURRENT ABOVE 500 AMPS AS THIS COULD DAMAGE THE MAGNET MAIN POWER LEADS.**

9. Perform one or more of the bulleted steps below, as necessary, if the DVM voltage is greater than 150mV.
  - Wait approximately 1 minute with the current running, readings may drop as the Power Lead Extensions cool.
  - Tighten the nuts on top of the Hold Down Tool.
  - If the reading still exceeds 150 mV: turn the VOLTAGE and CURRENT ADJUST controls to zero (full CCW), turn off Magnet Power Supply input power, then check/tighten the bolts securing the Ramp Cables to the Power Supply and Ramp Leads Extensions. Lift and reseal the Ramp Leads. Repeat Steps 6 through 9.
10. Set the power supply VOLTMETER SELECT SWITCH to MAIN POWER SUPPLY position (This will display the output of the power supply monitored at the output lugs).

**Note**

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

11. Gradually 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, 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.



1.0T MAGNET POLARITY RAMPED NORMAL  
ILLUSTRATION 9-2

9-3 RAMPING

Procedure:



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.



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.



FOR MOBILE MAGNETS, MAKE SURE THE AXIAL, TRANSVERSE 1 AND TRANSVERSE 2 SWITCH HEATERS ARE ON DURING RAMPING TO MINIMIZE THE POTENTIAL FOR QUENCH.

**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).

**9-3 RAMPING (continued)**

4. Set Shim Supply MAIN POWER Switch to ON.
5. For Mobile magnets, set the Shim Power Supply HEATER 2 TRANSVERSE 1 and HEATER 3 TRANSVERSE 2 switches to 1 (on).
6. Push and hold the SET POINT button then set CURRENT ADJUST controls for a reading of 705 amps on the power supply digital CURRENT meter. This sets the parking current.
7. Release SET POINT button.
8. Set HEATER 1 MAIN switch to 1 (on). Wait 3 minutes.
9. Set the power supply VOLTMETER SELECT SWITCH to MAIN COIL position.

**Note**

The main coil driving voltage will decay from the initial setting of 4.5 V. This is normal and no attempt to readjust the power supply should be made until directed below.

10. Turn power supply VOLTAGE ADJUST control until a reading of 4.5 volts is observed on the power supply digital VOLTMETER.

**Note**

Measured inductance should be approximately 12 henrys. If the calculated value is between 11.5 – 13.5 Henries continue with the procedure. If the calculated value is outside this range, discontinue ramping and measure Main Coil Resistance (See FUNCTIONAL CHECKS, Section NO TAG). Contact the Region MAC Team Representative.

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

$$L(\text{inductance}) = 10 \times \text{Voltage/Current Change}$$

**Note**

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

**Note**

The Teslameter will lock on when magnet current rises between 450 to 500 amps (using a Range 5 Probe). This usually occurs between 0.6 and 0.7 Tesla (25.545900 MHz – 29.803550 MHz).



**THE 1.0T MAGNET CAN BE QUENCHED IF LARGE CURRENT OR VOLTAGE CHANGES OCCUR NEAR PARKING. WHEN ADJUSTING THE CURRENT IN STEP 13 BELOW, TURN THE CURRENT CONTROL IN A SLOW, CONTINUOUS MOTION. BE CAREFUL NOT TO JERK THE CURRENT CONTROL.**

12. When the magnet current reaches 705 amps, slowly turn the CURRENT ADJUST control counterclockwise, at a rate of 0.2 amps/minute, until 702 amps is displayed on the power supply digital CURRENT meter.

**9-3 RAMPING (continued)**

13. Check Teslameter and slowly adjust the CURRENT ADJUST controls, as required, to bring Magnetic Field between 1.0025 – 1.0028 Tesla (42.682690 – 42.695463 MHz). The total current will be approximately 702 amps. Allow final field to stabilize. The last two digits on the Teslameter should be the only digits changing.
14. Maintain field at final setting for 5 minutes before proceeding to Step 15.

**Note**

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

15. Turn off Main Switch Heater. Wait a minimum of 15 minutes for the switch to fully cool and go “persistent”.
16. Record current, frequency and lead extension voltage values at which the switch went “persistent” in DATA SHEETS, Table NO TAG.

**WARNING!**

**MAKE SURE THAT THE CONNECTION POLARITY AND FINAL RAMPING CURRENT ARE RECORDED IN DATA SHEETS, TABLE NO TAG. 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.

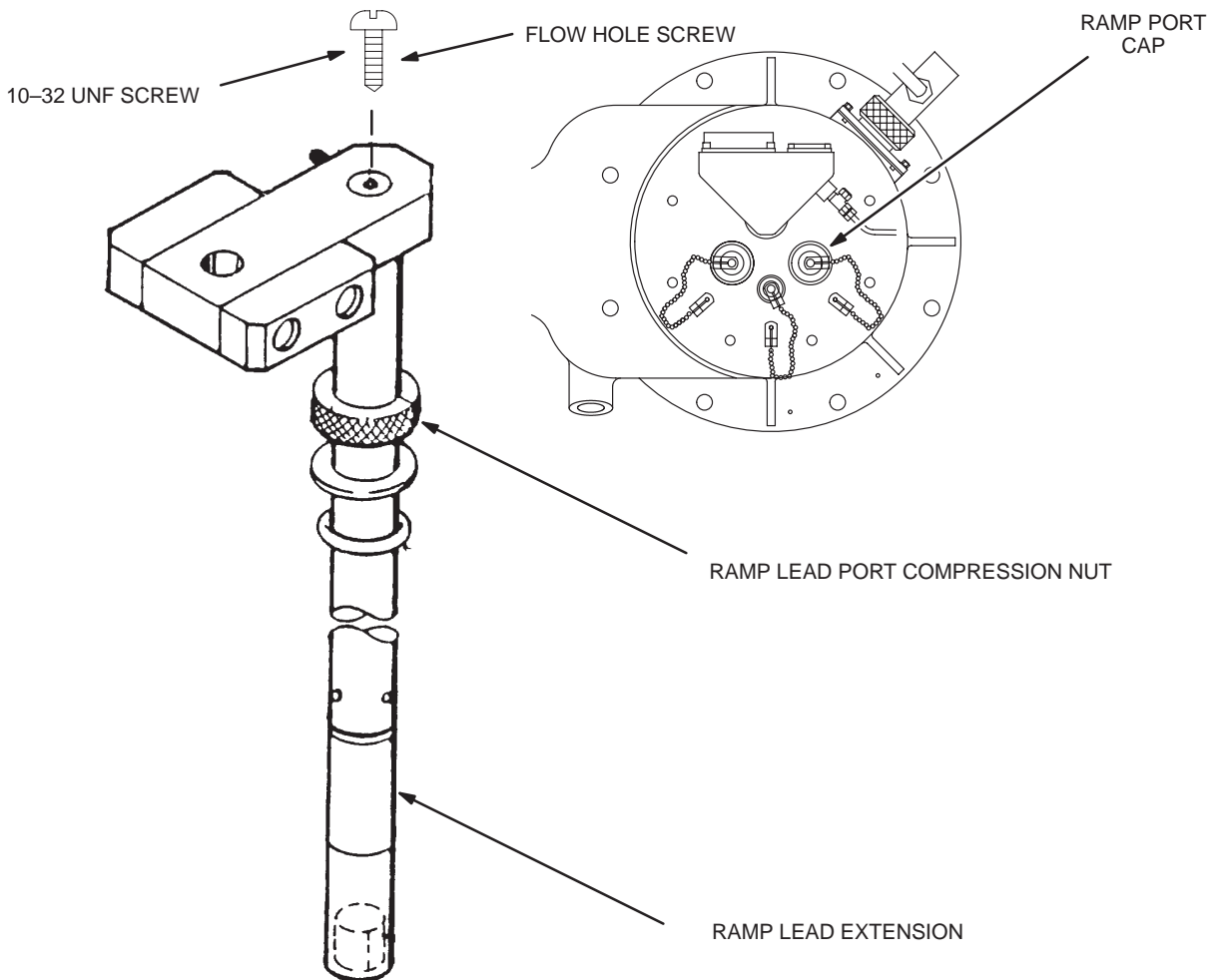
17. When the switch goes “persistent”, slowly turn the power supply VOLTAGE control to zero ( full CCW ) over a minimum of two minutes.
18. Gradually turn the CURRENT ADJUST control to zero (over a one minute period).
19. Set HEATER 2 SHIM AXIAL switch to 0 (off).
20. For Mobile magnets, set the Shim Power Supply HEATER 2 TRANSVERSE 1 and HEATER 3 TRANSVERSE 2 switches to 0 (off).
21. Set MAIN POWER AND POWER ON switches to OFF, on Main Power Supply and disconnect Input Power Cable.
22. For Mobile magnets, set the Shim Power Supply MAIN POWER switch to OFF.
23. Remove ramp lead hold down tool and replace bolts on lead assembly mounting plate.

9-3 RAMPING ( continued )



**Step 31 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.**

24. After parking the magnet and disconnecting main power supply, plug and remove one ramp extension at a time in the following sequence.
  - a ) Open valve ( V2 ) to de-pressurize the cryostat to 0.25 psig. Close V2.
  - b ) Install a screw into the flow hole of only one of the ramp lead extensions. See Illustration 9-3.
  - c ) Remove all ice around the ramp lead port compression nut on the ramp lead extension that is being removed ( i.e. the ramp lead extension that has the flow hole plugged in Step b ). See Illustration 9-3.
  - d ) Unscrew the ramp lead port compression nut and remove the ramp lead extension from the magnet. Immediately replace the cap onto the ramp lead port.
  - e ) Repeat Steps b through e for the other ramp lead extension.



RAMP LEAD EXTENSION AND RAMP PORT COMPRESSION NUT

ILLUSTRATION 9-3

**9-3 RAMPING ( continued )****Note**

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

25. 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.



**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).

26. 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.

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

## SECTION 10 – SHIMMING PREPARATION/FIELD STABILIZATION

### Description:

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

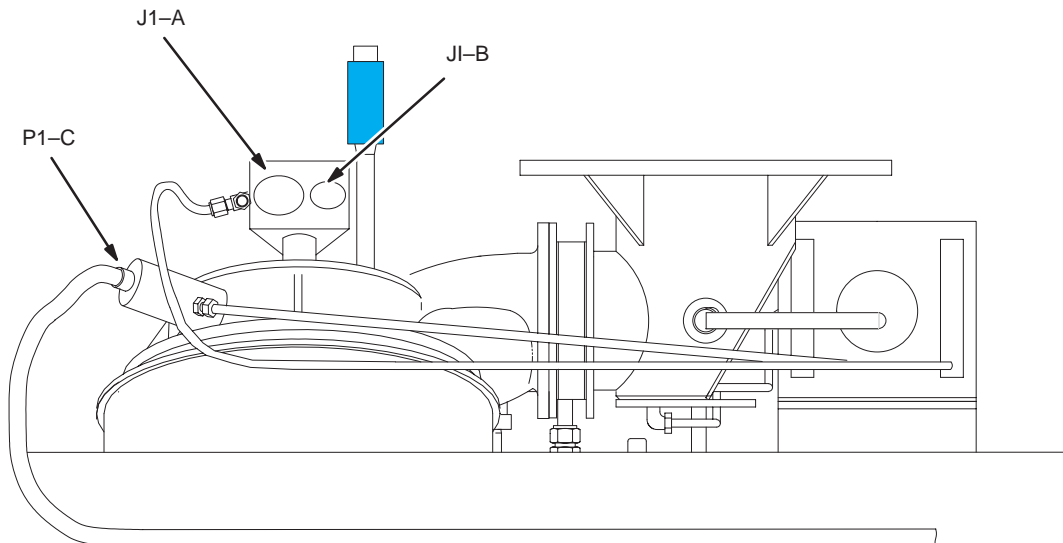
### Procedure:



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

### 6-5 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS

1. Verify that connectors ( J1-A, J1-B, P1-C ) on the top of the magnet are mated. See Illustration 10-1.



MAGNET ELECTRICAL CONNECTIONS  
ILLUSTRATION 10-1

**6-5 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)**

**Note**

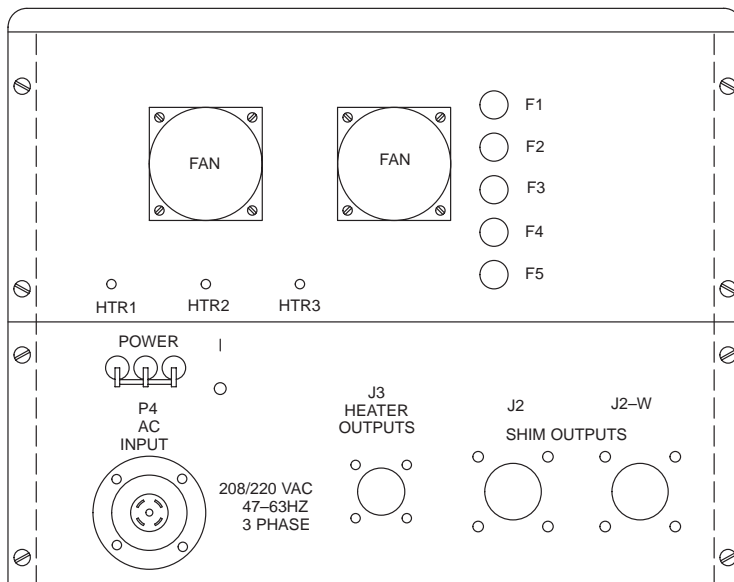
The cap on the Shim Lead Assembly Exhaust Male Run Tee must be removed before adding or dumping shim currents to prevent "Thermal Shock" which can damage the Shim Leads.

2. 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.
3. 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.
4. Verify all six Shim Power Supplies operate at both positive and negative polarities.
5. Disconnect the input power to the Superconducting Shim Coil Power Supply.



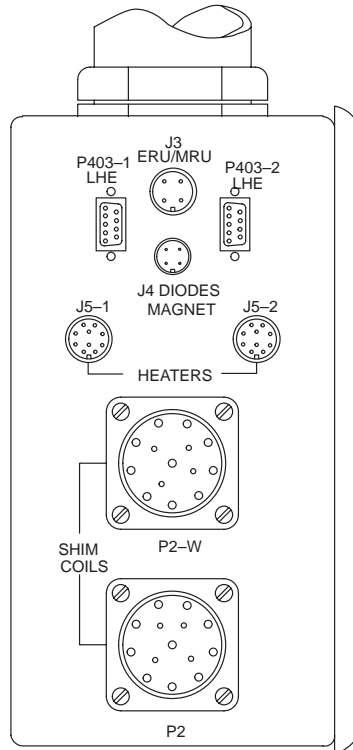
**DO NOT CONNECT THE INPUT POWER TO OR TURN ON THE SUPERCONDUCTING SHIM COIL POWER SUPPLY UNTIL IT IS VERIFIED THAT ALL CURRENT CONTROLS ARE SET AT ZERO, FULLY COUNTERCLOCKWISE. TURNING THE SUPERCONDUCTING SHIM COIL POWER SUPPLY WHEN THE CURRENT CONTROLS ARE NOT AT ZERO MAY CAUSE IRREPAIRABLE DAMAGE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

6. 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

6-5 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)



**MAGNET HARNESS TERMINAL BOX**  
ILLUSTRATION 10-3

7. Verify that (J 2 & J 2-W) on the other end of the Superconducting Shim Coil Wire Harness (RUN #603) are connected to (P2 and P2-W) on the Magnet Harness Terminal Box (MS1-A3, A1). See Illustration 10-3.
8. 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).
9. Verify that connector (P5) on Heater Wire Harness (RUN #604) is connected to (J5-1 or J5-2) on the Magnet Harness Terminal Box (MS1-A3, A1).

**6-5 SUPERCONDUCTING SHIM COIL POWER SUPPLY CONNECTIONS (continued)**

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

**6-6 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.



**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.
7. Begin magnet shimming.

## SECTION 11 – SHIMMING

### Description:

“Shimming” is the process of measuring the variations in the magnetic field over a fixed volume and using the acquired data to improve the field homogeneity through shimming programs.

The magnet is shimmed at the factory on a 45cm DSV. With these two improvements, it is normally only necessary to shim the magnet using the System Shimming process provided with the Signa System. Mechanical plotting is normally not necessary except on sites that have large amounts of steel near the magnet.

To perform mechanical shimming on the 45cm DSV Laptop software, with supporting documentation, will be needed. The Signa System is not yet set up for supporting this function. The software will soon be available and will be announced via a service note.

### IMPORTANT

**Mechanical plotting is normally not necessary except on sites that have large amounts of steel near the magnet. System shimming should be attempted first.**

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 may be used to obtain a specified homogeneity of  $\leq 12$  ppm within the specified 45cm DSV volume. 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.



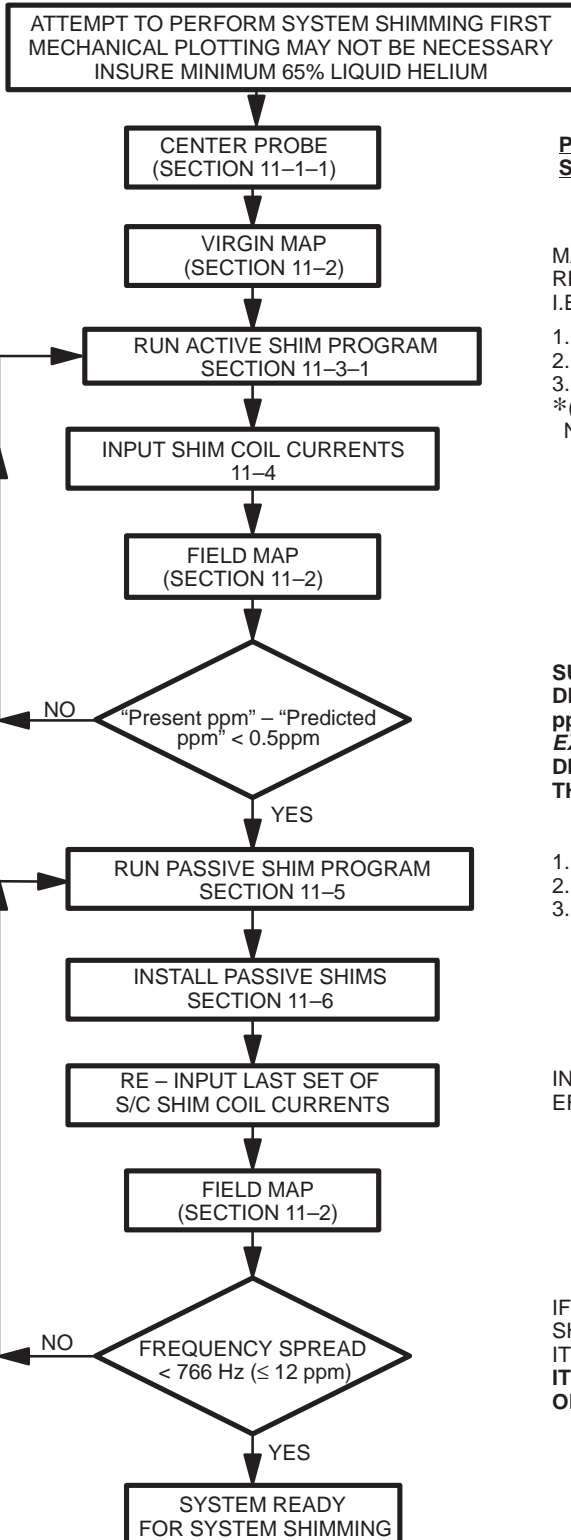
### WARNING!

**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 ).**



### CAUTION

**A minimum of 65% LHe is required for shimming. A “top off” of LHe is recommended to have a good residual LHe level for customer turnover.**



**NOTES**

**PERFORM MECHANICAL PLOT AND SHIM ONLY IF SYSTEM SHIMMING FAILS.**

MAKE SURE ALL CURRENT, IN SHIM COILS, HAS BEEN REMOVED.

I.E., 0 AMPS IN ALL COILS

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

\*(HIGH SHIM CURRENTS > 15 AMPS, INDICATES NEED FOR EXTERNAL PASSIVE SHIMS.)

**SUPERCON SHIMMING SHOULD BE CONTINUED UNTIL THE DELTA BETWEEN THE "Present ppm" AND THE "Predicted ppm", ON THE SUPERCON SHIM OUTPUT FILE, IS < 0.5ppm. EXAMPLE: IF THE PRESENT PPM IS 18.5PPM AND THE PREDICTED PPM IS 18.1, THE DELTA IS ONLY 0.4PPM. THIS IS AT THE POINT WHEN PASSIVE SHIMMING IS STARTED.**

1. LOAD FIELD MAP DATA.
2. EXECUTE SHIM PROGRAM.
3. RECORD PASSIVE SHIM VALUES.

INSERTION/REMOVAL OF PASSIVE SHIM DRAWERS WILL EFFECT S/C SHIM COIL CURRENTS.

**IF ≤ 12 PPM NOT ACHIEVED WITH 1ST PASSIVE SHIM, REPEAT ACTIVE AND PASSIVE "SHIM LOOP" ITERATIONS TO ACHIEVE ≤ 12 PPM SPEC. IT MAY BE NECESSARY TO RUN ONE FINAL PASS OF SUPERCON SHIM.**

\* 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 (> 15 AMPS) FOR THE POSSIBILITY OF EXTERNAL PASSIVE SHIMMING.

**SECTION NO TAG – 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.

**6-6-1-1 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.
- 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 (63,8XXXXX Hz) AT Z-AXIS POSITION		
	+22.5 cm	0 cm	-22.5 cm
VIRGIN PLOT			
AXIAL 1 (10 AMPS)			
PEAK DIFFERENCE	Δ	Δ	Δ

- 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.

11-1-1 Axial Probe Centering (continued)



**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.

**Note**

The magnet field could take as long as 20 minutes to stabilize before a good reading can be recorded in Step 11 below.

- 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:

$$\text{DISTANCE}(mm) = \frac{40cm \times 450mm}{(+ 22.5 cm) \Delta + (- 22.5 cm) \Delta} \quad (10 \text{ AMPS IN AXIAL \#1})$$

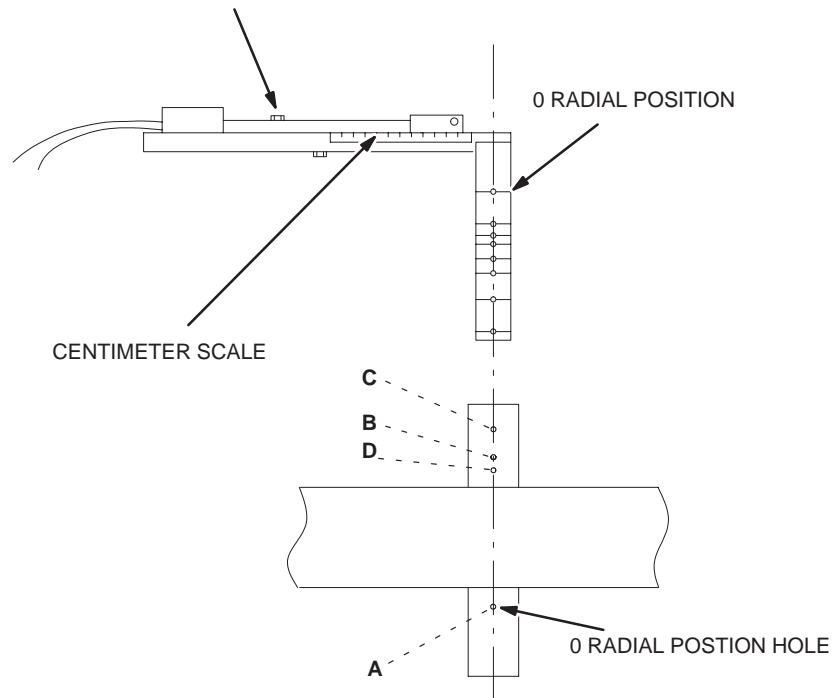
**Note**

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 3.4mm 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



**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 (314 points) are obtained by collecting frequency measurements at two data points along the Z-axis ( $R = 0$  cm), at  $Z = -22.5$  cm and at  $Z = +22.5$  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 11-4. 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.

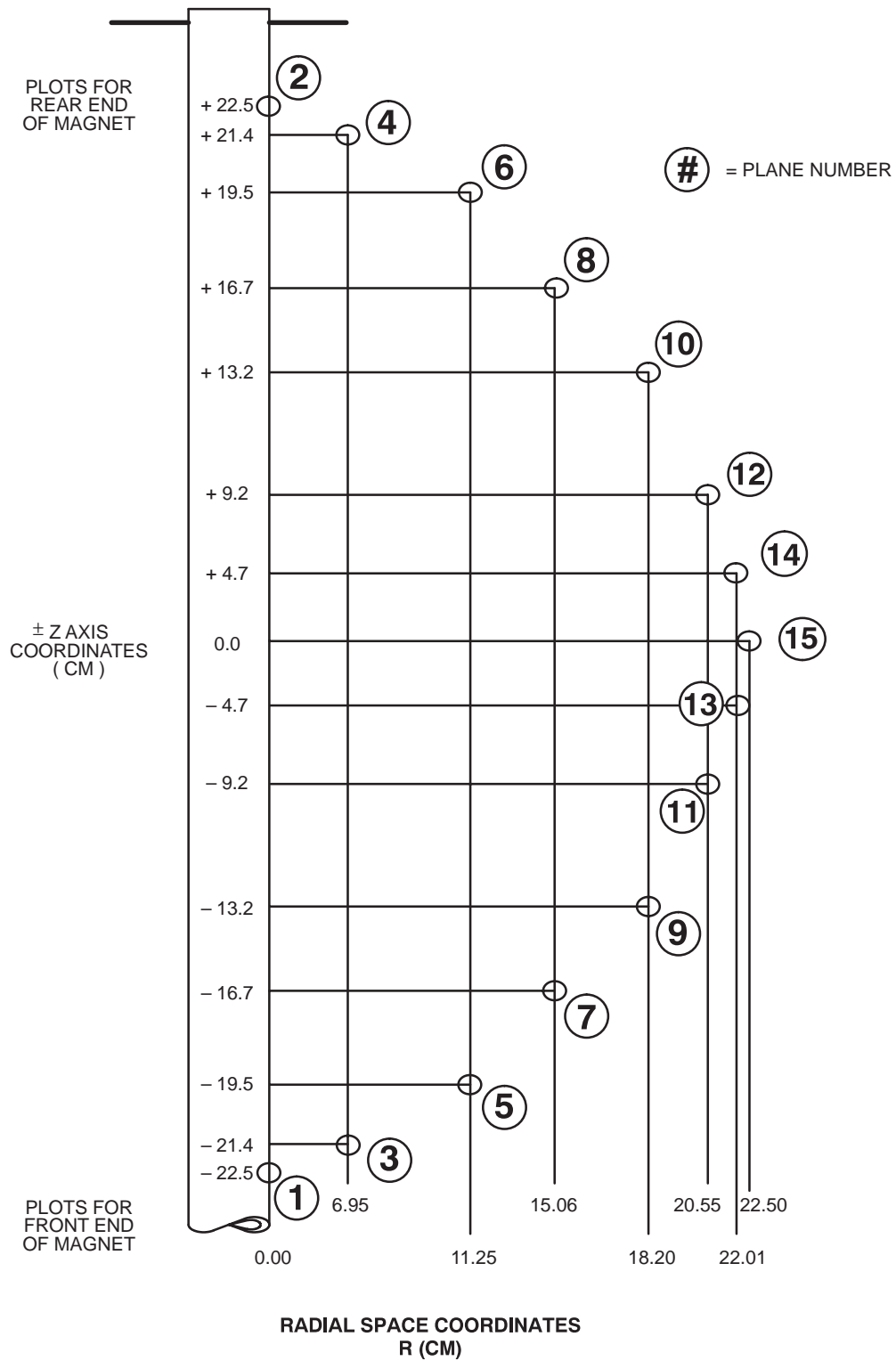
Record the variable numbers (the last 4 or 5 digits) of each displayed value in the appropriate space within the Data Sheets Table. Round the reading to the nearest 10 Hz.

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. Create field map file in conformance with SET UP AND CALIBRATION, Section 11-3-2.
5. Check data for errors using the following criteria. Retake measurement for any data point outside criteria.
  - e. FREQUENCIES OF ALL DATA POINTS SHOULD LIE WITHIN A 30 KHz BANDWIDTH.



PROBE POSITIONER LOCATIONS - 45 CM DSV  
ILLUSTRATION 11-3

DATE: \_\_\_\_\_ MAGNET: \_\_\_\_\_ LOCATION: \_\_\_\_\_ PLOT#: \_\_\_\_\_

POINT 1 ( R = 0, Z = -22.5cm ): \_\_\_\_\_ POINT 2 ( R = 0, Z = +22.5cm ): \_\_\_\_\_ BASE FREQ: \_\_\_\_\_

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz )

SHIM PLOT DATA  
ILLUSTRATION 11-4

11-9

SET UP AND CALIBRATION

**11-3 RUNNING SHIM PROGRAMS**

**Description:**

Laptop Computer System and Software Requirements:

- Non- Proprietary Shim Software ( 2160369 )
- An IBM 486 PC or compatible computer
- A minimum of 8 MB of RAM
- 4 MB of available disk space on the hard drive to load and run the shim programs.

There are two shim programs you will be using for shimming magnets. The first 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).

This program is generally used before passive shimming but can also be used after passive shims have been installed.

The second program, named PLATESHM, is used for calculating passive shim thickness and location on the shim drawers. This program allows the user to select any of the following options:

1. Perform addition only for calculating passive shims.
2. Perform addition & subtraction for calculating passive shims.
3. Request homogeneity expectation for calculation.
4. Limit the maximum thickness for placement of passive shims.

Both programs 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 (c6, 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.

<u>Filename Extension</u>	<u>Description</u>
.plo	314 pt field file
.cur	SCSHIM output file
.psm	PLATESHM output file

11-3-1 LOADING SOFTWARE ON LAPTOP

1. Boot the Laptop and Start Microsoft <sup>®</sup> Windows <sup>™</sup>.
2. Insert Non Proprietary software floppy, ( 2160369 ), into the "A" drive.
3. Type **a: install <enter>**.

**Note**

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

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).

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:\shim\data.
2. Create a map file on the laptop computer using a word processor such as MS WORD.
  - Type in the number of map points (314) 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 314 data points in one column down the page. See the example below for map file format.

*Example:*

314      63000000  
           928560  
           899840  
           924620  
           .  
           .  
           .  
           882510  
           882810  
           883530

11-3-3 Running SCSHIM

Procedure:

- 1. Change to sub-directory  
c:\shim <enter>

Note

The field map file should be located in c:\shim\data.

- 2. Start SCSHIM program.  
c:\SHIM>SCSHIM <enter>

Note

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

\*\*\*\*\*

PROGRAM SCSHIM REVISION x DATED xx / yy / zz  
( revision level and date are furnished by GE to supplier as required )

THIS PROGRAM IS PROPERTY OF GENERAL ELECTRIC  
MEDICAL SYSTEMS AND IS TO BE USE BY AUTHORIZED  
PERSONNEL ONLY.  
CONTINUE?

Press Y to continue

Press N to exit

Y <ENTER>

\*\*\*\*\*

- 3. Select the magnet type for shimming after the screen below. For example, to select a 1.5T SV 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

<u>Magnet Type</u>	<u>Shim Volume</u>
1. Prefix "G" = 1.5 T ASM SIV	45 cm dsv
2. Prefix "J" = 1.5 T ASM SV	45 cm dsv
3. Prefix "K" = 1.0 T ASM PHASE I	45 cm dsv
4. Prefix "L" = 1.0T ASM PHASE II	45 cm dsv
5. Prefix "D" = 1.5T SII or SIII	45 cm dsv

Select the appropriate option by Magnet serial number prefix and the mechanical plot volume. Enter the selection number:

\*\*\*\*\*

**Note**

After entering "2", in Step 3 above, the screen will append with the following statement. "Enter the name of the input measured field file (Maximum of 8 Chars)". This is the name of the Shim Map File that the shim code is to be run on. It must reside in the c:\shim\data directory.

**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 4. The second iteration would look like **J005\_b.plo** and so on.

- 4. Enter the name of the input measured field file (Maximum of 8 Chars and press <ENTER>. For example, **J005\_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 the output coil current file.

- 5. Enter the name of the output coil current file (Maximum of 8 Chars) and press <ENTER>. For example, **J008\_c.cur** <ENTER>.

**Note**

- 6. The screen will append with the following message: "Have there been any previous shimming iterations (Y/N)?"  
If NO skip to Step 8.  
If YES go to Step 7.

**11-3-3 Running SCSHIM (continued)**

7. Enter the name of the previous output coil current file (Maximum of 30 Chars):  
*Example: "J001\_v.cur" <enter>*
8. Please enter the maximum +/- coil current in Amps:  
Recommended limit is 15 amps  
**15 <enter>**

**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

Magnet Type  
S-II/S-III/S-IV/S-X/S-X Phase I  
0.5T Signa/Max

Magnet Type  
S-V/S-X Phase II

Coil #	Coil Name	Coil #	Coil Name
Coil 1	T1-1	Coil 1	T1-1
Coil 2	T1-2	Coil 2	T1-2
Coil 3	T1-3	Coil 3	T1-4
Coil 4	T1-4	Coil 4	T2-1
Coil 5	T1-5	Coil 5	T2-2
Coil 6	T1-6	Coil 6	T2-4
Coil 7	T2-1	Coil 7	Ax-1
Coil 8	T2-2	Coil 8	Ax-2
Coil 9	T2-3	Coil 9	Ax-3
Coil 10	T2-4	Coil 10	Ax-4
Coil 11	T2-5	Coil 11	Ax-5
Coil 12	T2-6	Coil 12	Ax-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		



DATE: \_\_\_\_\_ MAGNET SERIAL #: \_\_\_\_\_ PLOT #: \_\_\_\_\_ OUTPUT FILE: \_\_\_\_\_

POWER SUPPLY # (NAME)	TOTAL CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)	TOTAL CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)	TOTAL CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)
T1-1(C31)						
T1-2(C11+)						
T1-4(C11-)						
T2-1(S31)						
T2-2(S11+)						
T2-4(S11-)						
AX1						
AX2						
AX3						
AX4						
AX5						
AX6						
<b>GRADIENT OFFSETS</b>						
X						
Y						
Z						
<b>PREDICTED</b>						
<b>INHOMOGENEITY</b>						

CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS  
ILLUSTRATION 11-5

**11-4 Adjusting S/C Shim Coil Power Supply Currents For Active Shimming**

**Description:**

The RECOMMENDED TOTAL CURRENT (See Illustration 11-5) values calculated by the shim program must be entered into the S/C Correction Coils before performing subsequent field mapping.

- a. Transverse Odd: (C31, C11+, C11-)
- b. Transverse Even: (S31, S11+, S11-,)
- c. Axial 1 through 6

Each group is connected on one heater circuit. For example, when the Axial Switch Heater is on, the current in all of the Axial Coils (1 through 6) is dumped. Therefore, if the only current change was in the Axial 2 coil, the complete Axial Set (1 through 6) would have to be dumped and the appropriate currents adjusted for each.

**Procedure:**



**BEFORE TURNING ON SHIM COIL POWER SUPPLY AND APPLYING SHIM CURRENTS, MAKE SURE THAT THE FOLLOWING CONDITIONS EXIST TO PREVENT IRREPARABLE DAMAGE TO THE VAPOR COOLED SHIM LEADS:**

- a. **THE CAP ON THE SHIM LEAD VENT IS REMOVED.**
- b. **THE SHIM LEAD EXTENSION IS FROSTED.**
- c. **THE POWER SUPPLY CURRENT CONTROLS ARE SET TO ZERO (FULL CCW).**

- 1. Remove Shim Lead Vent Cap. Do not proceed with adding currents until the escaping vapor has frosted the Shim Lead.

**Note**

The cryostat pressure could decrease to approximately zero psig after the Shim Lead Vent Cap is removed in Step 1. Shutting off the Cold Head Compressor, while inputting Shim Currents, may help build cryostat pressure.

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

Transverse 1  
 Transverse 2  
 Axials

For each of these groups, follow the instructions below:

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

**11-4 Adjusting S/C Shim Coil Power Supply Currents For Active Shimming (continued)**

4. Match the existing current in these Shim Coils with the knobs on the Shim Power Supply as follows:

FIRST ITERATION – there are no currents in the Shim Coils – Set the power supply knobs to zero amps (full CCW).

SUBSEQUENT ITERATIONS – Set the polarity toggle switches as required for positive or negative current. Then set the power supply coarse and fine control knobs to the current level existing in the coils.



**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 then can be adjusted to the required new levels after the heaters are activated.**

5. 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.
6. Adjust the appropriate Shim Power Supplies to the RECOMMENDED TOTAL CURRENT values listed by the shim program (TABLE 8-1 OF DATA SHEETS).
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.

**Note**

If repeated iterations of shim program call for the same current in a shim coil – indicating Shim Switch not going resistive: a) make sure heater current is set properly or b) set 20 AMPS in coil then lower current to the required value. Either of these two steps may help to drive the Shim Switch resistive.

**Note**

Adjust slightly as required. 1mA high is better than 1mA low.

**Note**

Failure to accurately set the power supply currents and polarity can greatly increase the number of plotting iterations (i.e., time to shim the magnet).

**11-4 Adjusting S/C Shim Coil Power Supply Currents For Active Shimming (continued)****Note**

In some cases, the Teslameter frequency in Step 8 could vary as much as 100 Hz. Shutting off the Cold Head Compressor, during the mapping process, may help reduce the frequency change.

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).

**Note**

The Switch Heater referred to in Step 9 below is performed for the last Heater that was turned ON.

9. Once the field is stable (see Step 8), turn off Switch Heater and allow the heater to cool for 5 minutes.
10. Turn all the Shim Power Supplies back down to zero amperes (full CCW).
11. Repeat Steps 1 through 10 for Transverse 2 then Axial Coil Groups.
12. Make a quick check of the Minimum and Maximum points (determined from the last shim plot data) to determine if homogeneity has improved. This is determined by subtracting the Minimum and Maximum points, then dividing by the Base Frequency. If homogeneity has not improved, troubleshoot. Refer to Set Up and Calibration, Section 12, (Polarity and Functional Checks).
13. When all currents are set, turn off the power supply, then disconnect all leads between the magnet and Shim Power Supply (P2, P2W, Heater Cable).
14. Replace the Shim Lead Vent Cap.



**Make sure that the cap is replaced and does not leak and result in GHe loss and frosting.**

## 11–5 PASSIVE SHIMMING

### Description:

The Passive Shim Program, named PLATESHM, is used for calculating passive shim thickness and location on the shim drawers. This program allows the user to select any of the following options:

1. Perform addition only for calculating passive shims.
2. Perform addition & subtraction for calculating passive shims.
3. Request homogeneity expectation for calculation.
4. Limit the maximum thickness for placement of passive shims.

The Passive Shim 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 (c6, 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.

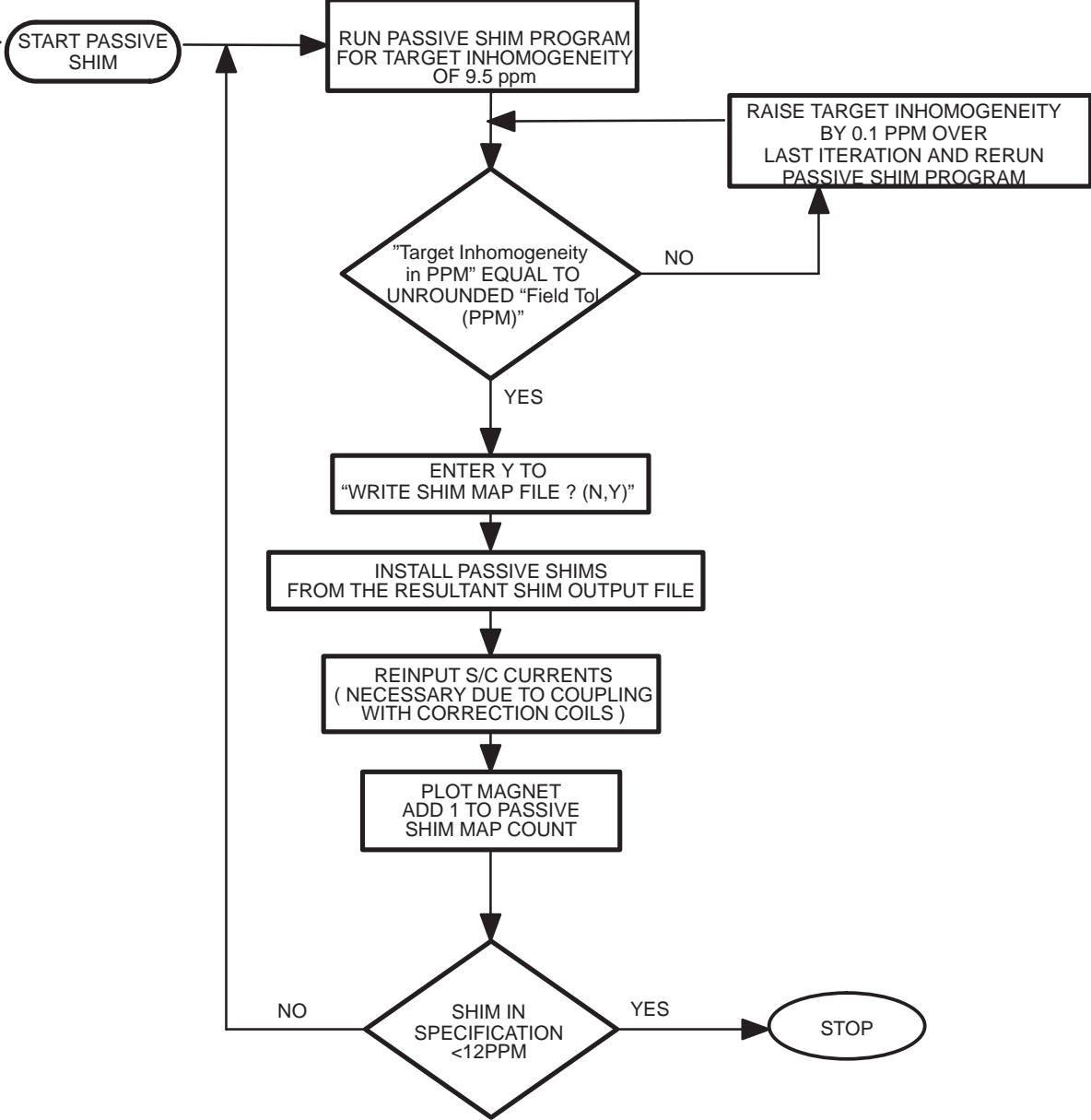
Follow the Flowchart in Illustration 11–6 for Passive Shimming.

### IMPORTANT

**It May Be Necessary To Do An Iteration Of Super Con Shim After Passive Shimming To Bring The Magnet Into Spec.**

11-5 PASSIVE SHIMMING

SUPERCON SHIM AS LOW AS POSSIBLE



PASSIVE SHIM FLOWCHART ILLUSTRATION 11-6

11-5-1 Running PLATESHM

Procedure:

Procedure:

At DOS prompt c:\

- 1. Change to sub-directory  
c: cd \shim <enter>
- 2. Start PLATESHM program .  
C:\SHIM> PLATESHM <enter>

Note

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

\*\*\*\*\*

PROGRAM PLATESHM REVISION x DATED xx / yy / zz  
( revision level and date are furnished by GE to supplier as required )

THIS PROGRAM IS PROPERTY OF GENERAL ELECTRIC  
MEDICAL SYSTEMS AND IS TO BE USE BY AUTHORIZED  
PERSONNEL ONLY.  
CONTINUE?

Press Y to continue

Press N to exit

Y <ENTER>

\*\*\*\*\*

11-5-1 Running PLATESHM (continued)

Note

If Y is entered the following screen will appear.

\*\*\*\*\*

PASSIVE SHIM OPTIONS MENU

<u>Options</u>	<u>Present Option Settings</u>
1. Analysis option	SHIM ADDITION ONLY (First pass only)
2. Expected Tolerance in PPM	9.5
3. Maximum shim thickness	225.0 MILS

Do you want to change the Option settings ? (Y/N) **"your choice"** <enter>

\*\*\*\*\*

- 3. Change any or all of the options, in the above menu, as needed.

Note

If you choose to change Option 1 (Analysis option), the following choices will then be available:

- 1. Shim addition only (first pass only)
- 2. Shim addition only (old file exists)
- 3. Shim addition and subtraction (need old file)
- 4. Shim subtraction only (need old file)

Note

The following is an example of the display format if you answer yes. Follow recommended shimming procedures contained in the magnet manual for appropriate analysis option or ppm request.

Enter option number to change: *Example:* **2** <enter>

Enter the expected tolerance in PPM: *Example* **7.5** <enter>

Note

The new settings will be displayed, see example below:

PASSIVE SHIM OPTIONS MENU

<u>Options</u>	<u>Present Option Settings</u>
1. Analysis option	SHIM ADDITION ONLY (First pass only)
2. Expected Tolerance in PPM	7.5
3. Maximum shim thickness	225.0 MILS

Do you want to change the Option settings ? (Y/N) **n** <enter>

Note

You may change other options or enter N to continue.

11-5-1 Running PLATESHM (continued)

Note

After finishing with the options settings the screen will be appended with the following:

\*\*\*\*\*

MAGNET TYPE & SHIM VOLUME CONFIGURATION MENU

<u>Magnet Type</u>	<u>Shim Volume</u>
1. Prefix "G" = 1.5 T ASM SIV	45 cm dsv
2. Prefix "J" = 1.5 T ASM SV	45 cm dsv
3. Prefix "K" = 1.0 T ASM PHASE I	45 cm dsv
4. Prefix "L" = 1.0T ASM PHASE II	45 cm dsv
5. Prefix "D" = 1.5T SII or SIII	45 cm dsv

Select the appropriate option by Magnet serial number prefix and the mechanical plot volume. Enter the selection number:

\*\*\*\*\*

- 4. Select the magnet type being used from the above menu. The program will automatically select the appropriate cal file. For example, if number 2 is selected, the prompt will change to "C:\shim\JS45P.CAL. The cal file is JS45P.CAL.

Note

After entering "2", in Step 3 above, the screen will append with the following statement. "Enter the name of the input measured field file (Maximum of 8 Chars not including the extension). This is the name of the Shim Map File that the shim code is to be run on. It must reside in directory: c:\shim\data.

- 5. Enter the name of the input measured field file (Maximum of 8 Chars and press <ENTER>. For example, J005\_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 the passive shims and starting the shimming process from scratch.

Note

The screen will append with a prompt to enter the output coil current file.

- 6. Enter the name of the output shim location file (Maximum of 8 Chars) and press <ENTER>. For example, J008\_c.psm <ENTER>.

**11-5-1 Running PLATESHM (continued)**

- 7. Enter the name of the output shim location file (Maximum of 8 Chars). For example, J008\_c.psm

**Note**

After entering the information in Step 7 the screen will be appended with the following information

The initial average field is 15030.000000 Gauss.  
The initial field tolerance is 7.928091 PPM.

Execution begins...

```
ITER=    10
ITER=    20
ITER=    30
ITER=    40
ITER=    50
```

PROGRAM EXECUTION COMPLETED OR TERMINATED BY USER

C:\SHIM>

**Note**

The Passive shim output file will reside in directory: c:\shim\data. To view the contents of the file output file enter **cd \shim\data**, then “ **type filename | more**” command.

**Note**

See Section 11-5-2 for an example of an PLATESHM output file.

11-5-2 PLATESHM OUTPUT FILE

Example of a PLATESHM output file.

PASSIVE SHIM OUTPUT FILE

INPUT FIELD FILE : J008\_c.plo

OUTPUT FILE : J008\_c.psm

CALIBRATION FILE : [BOSTONIMAGING.SHIMCODES]SVPCAL.SP45

ANALYSIS OPTION: SHIM ADDITION ONLY (FIRST TIME SHIMMING)

MINIMIZATION TECHNIQUE : ABSOLUTE

	ROUNDED TO 1 MIL	ROUNDED TO 0.2 MIL
	-----	-----
Total Number of Shims	13	14
Total Shim Thickness (Mils)	49	45.6
Maximum Shim Thickness (Mils)	10	10.2
Field Tolerance (PPM)	4.714	4.562
AVERAGE FIELD (Gauss)	Initial= 15030.00	
	Final= 15029.98	
FIELD TOLERANCE (PPM)	Initial	= 7.928
	Requested	= 4.500
	Final Before Rounding	= 4.500

NUMBER OF LP ITERATIONS = 50

11-5-2 PLATESHM OUTPUT FILE (continued)

TOTAL SHIM MAP – ROUNDED TO 1 MIL

Z	0	30	60	90	120	150	180	210	240	270	300	330
1	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	4.0	-	-	-
8	2.0	-	-	-	-	-	-	1.0	-	-	7.0	-
9	2.0	5.0	-	-	-	-	-	-	-	-	-	6.0
10	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-
16	-	3.0	3.0	-	-	1.0	-	-	-	-	2.0	10.0
17	-	-	-	-	-	-	3.0	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-

\*\*\*\*\*  
 \* \*  
 -> \* TOTAL Shim map \* <-  
 \* ----- \*  
 \*\*\*\*\*

11-5-2 PLATESHM OUTPUT FILE (continued)

TOTAL SHIM MAP – ROUNDED TO 0.2 MIL

Z	0	30	60	90	120	150	180	210	240	270	300	330
1	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	3.8	-	-	-
8	1.4	-	-	-	-	-	-	0.8	-	-	6.8	-
9	1.6	5.0	-	-	-	-	-	-	-	-	-	5.6
10	-	-	-	-	0.2	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-
16	-	2.4	3.4	-	-	0.4	-	-	-	-	1.6	10.2
17	-	-	-	-	-	-	2.4	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-

\*\*\*\*\*  
 \* \*  
 -> \* TOTAL Shim map \* <-  
 \* ----- \*  
 \*\*\*\*\*

11-6 PASSIVE SHIM INSTALLATION

**Description:**

This Section gives the procedures for removing Shim Drawers and adding Shims to the Drawers. Refer to Section 11-5 for description of shims. If more Shim Stock is needed, for subsequent shimming operations, a Shim Kit P/N 46-318832G1 can be ordered.

**Procedure:**

- 1. Determine from the Passive Shim Output File, which Shim Drawers require Shims. Shim Drawers are numbered clockwise (CW) 1 to 12, viewed from the Table End (FRONT) of the Magnet. See Illustration 11-7.

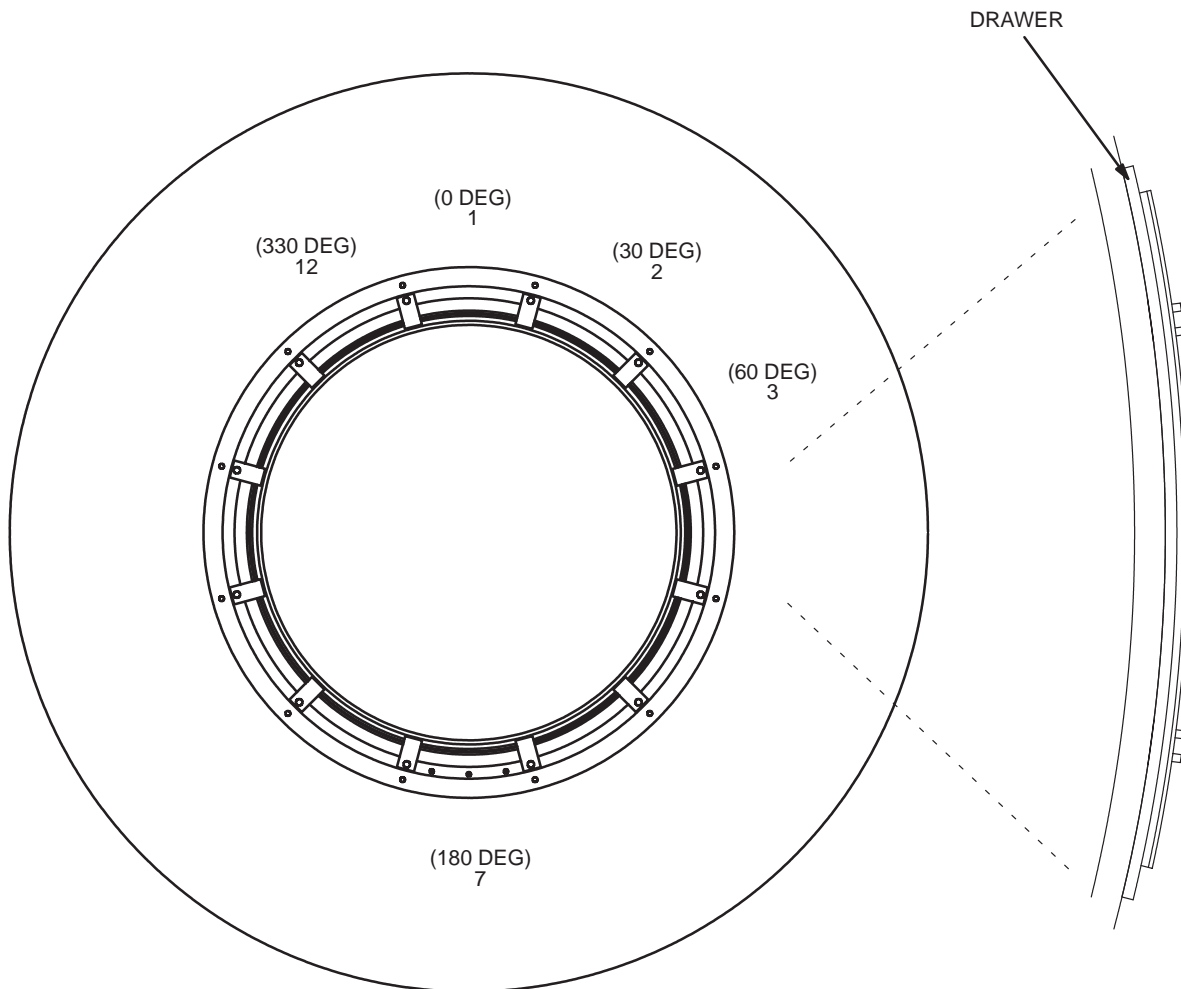
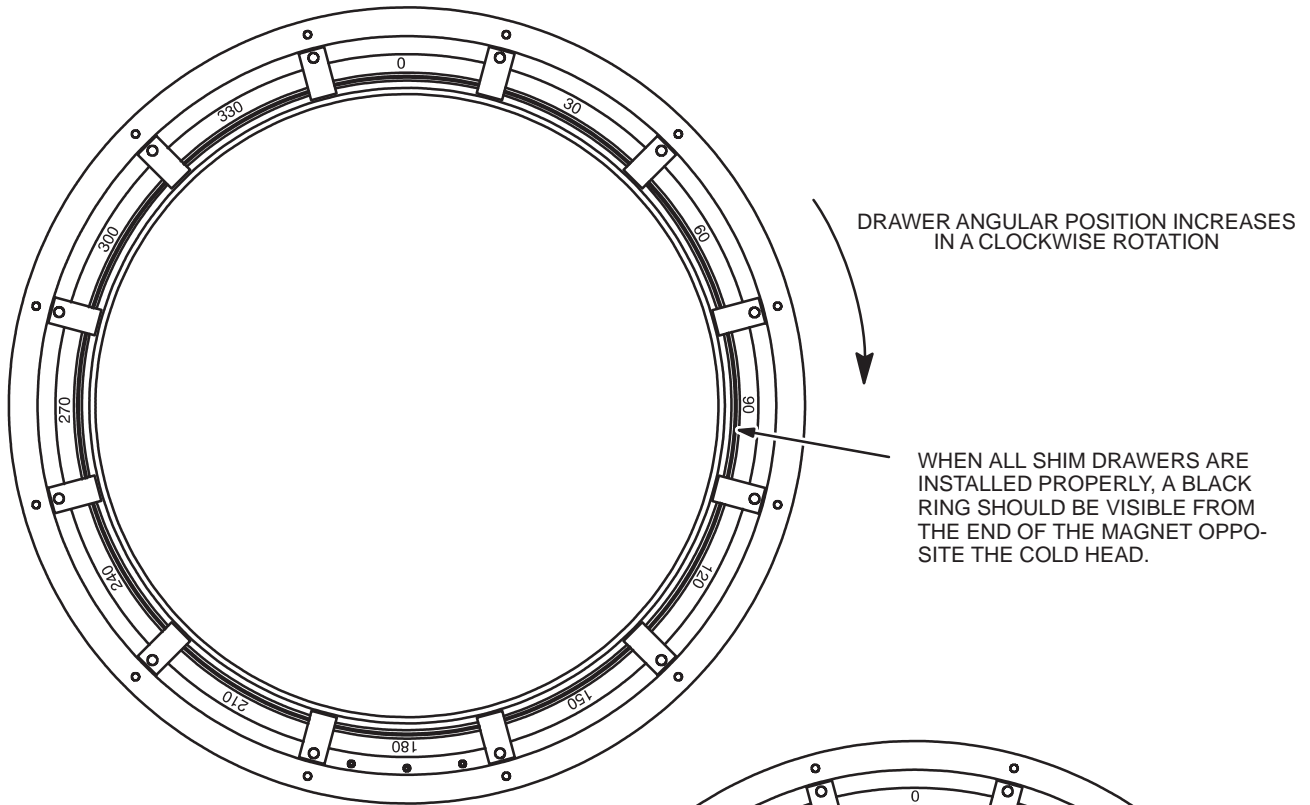
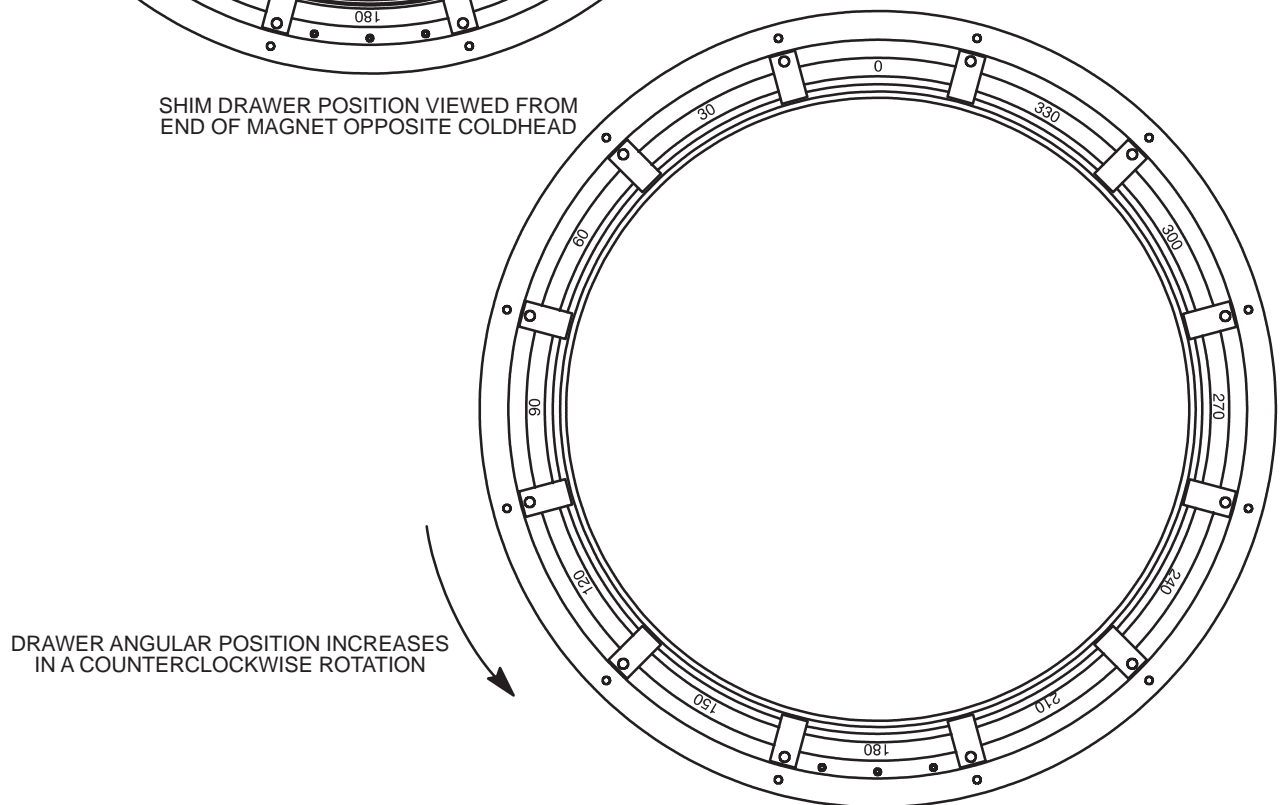


TABLE END  
SHIM DRAWER LOCATION  
ILLUSTRATION 11-7



SHIM DRAWER POSITION VIEWED FROM END OF MAGNET OPPOSITE COLDHEAD



SHIM DRAWER ANGULAR POSITIONING  
SHIM DRAWER POSITION VIEWED FROM COLDHEAD END OF MAGNET  
ILLUSTRATION 11-11

## 11-6 PASSIVE SHIM INSTALLATION (continued)



STEEL SHIMS ARE SUBJECT TO A MAGNETIC FORCE IN A MAGNETIC FIELD, WHICH IS PROPORTIONAL TO THE MASS OF STEEL AND THE FIELD STRENGTH. BECAUSE OF THIS, THE FOLLOWING FORCES MAY BE ENCOUNTERED ON SHIM DRAWERS:

1. AN ATTRACTING AND / OR REPELLING FORCE MAY BE PRESENT, WHICH WILL VARY IN STRENGTH AND DIRECTION, DURING THE INSERTION AND REMOVAL OF SHIM DRAWERS IN THE MAGNET.
2. A FORCE LOADING MAY EXIST ON SHIM DRAWERS MOUNTED IN THE MAGNET WHICH WILL PROPEL THEM OUT OF THE MAGNET WHEN THE STOP PLATES ARE REMOVED. THESE ARE IDENTIFIED ON UNITS SHIPPED FROM THE FACTORY BY YELLOW ARROWS ON THE FRONT AND BACK END FLANGES OF THE MAGNET WHICH POINT TO THE DRAWER. SEE ILLUSTRATION 11-9.

THE ABOVE FORCES CAN RESULT IN PERSONAL INJURY IF PROPER PRECAUTIONS ARE NOT TAKEN.

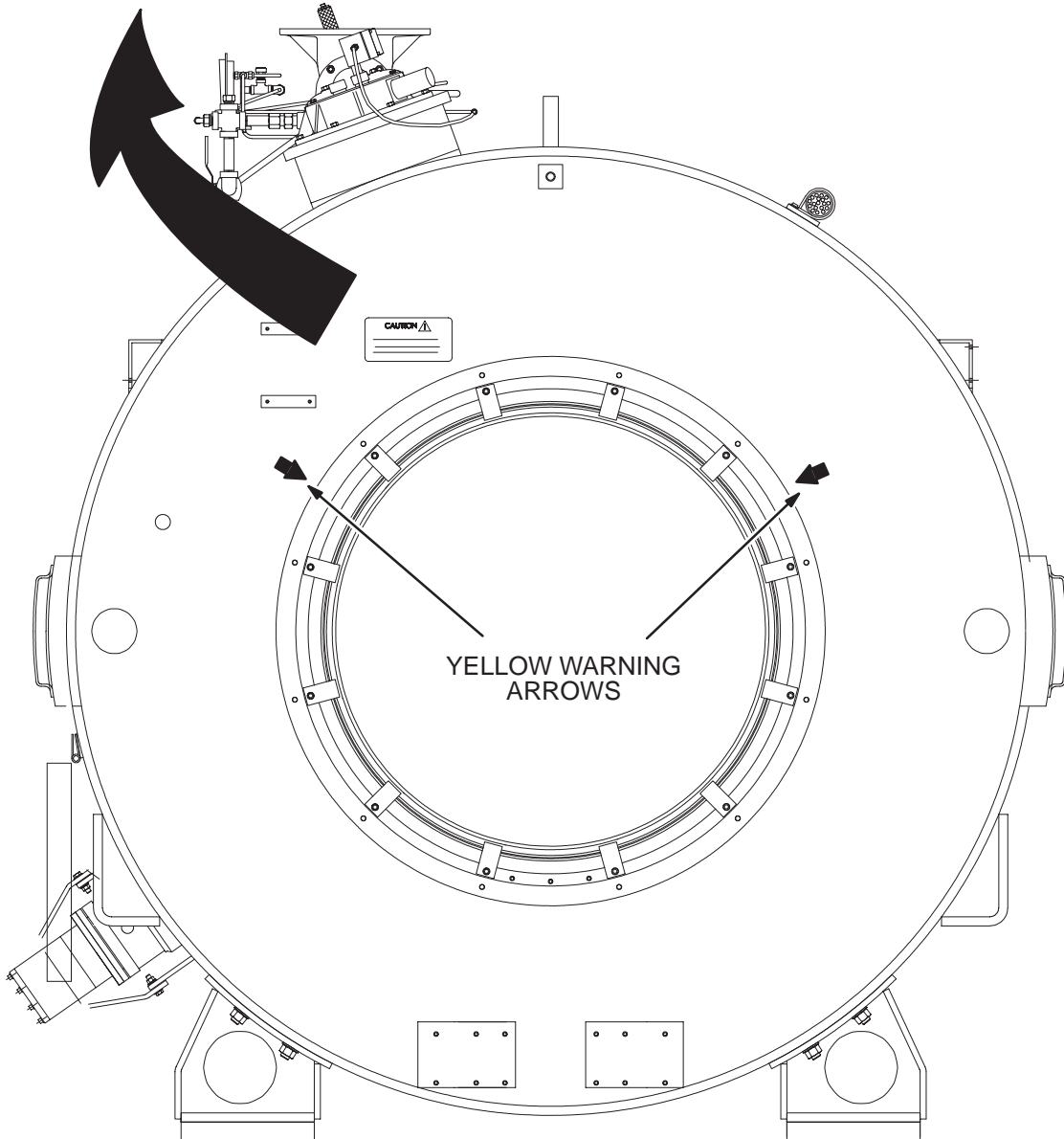
USE THE FOLLOWING PRECAUTIONS WHEN REMOVING OR REPLACING SHIM DRAWERS:

1. WEAR SAFETY GLASSES AND DO NOT FACE DIRECTLY IN FRONT OF THE DRAWER.
2. FIRMLY HOLD SHIM DRAWERS WHEN REMOVING STOP PLATES.
3. RESTRAIN OUTWARD MOVEMENT AND USE EXTREME CAUTION WHEN REMOVING STOP PLATES FROM SHIM DRAWERS IDENTIFIED WITH YELLOW ARROWS.
4. USE DRAWER EXTRACTOR TOOL TO REMOVE AND REPLACE SHIM DRAWERS.
5. REMOVE AND REPLACE DRAWERS WITH A GRADUAL MOTION, RESTRAIN THE IMPACT OF THE MAGNETIC FORCES.

11-6 PASSIVE SHIM INSTALLATION (continued)

**CAUTION** 

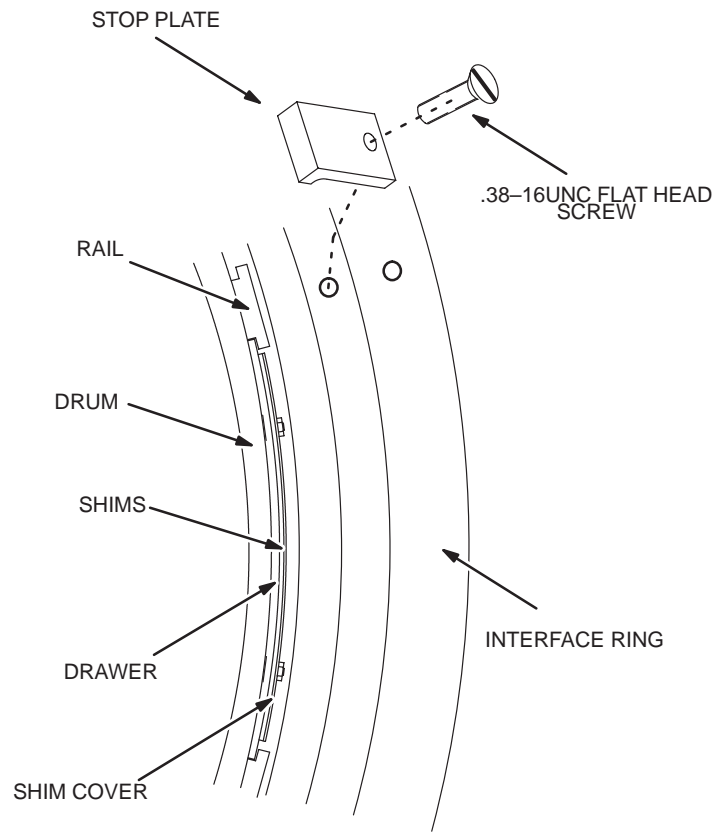
Shim Drawers may cause injury during removal. Restrain Drawers before removing Stop Plate Screws.  
Wear Safety Glasses.  
Read Service Manual before shimming.



**SHIM DRAWER ARROWS**  
ILLUSTRATION 11-9

11-6 PASSIVE SHIM INSTALLATION (continued)

- 2. Remove Drawer Stop Plates at Table end of magnet with a 7/32 Hex Head Wrench. See Illustration 11-10.



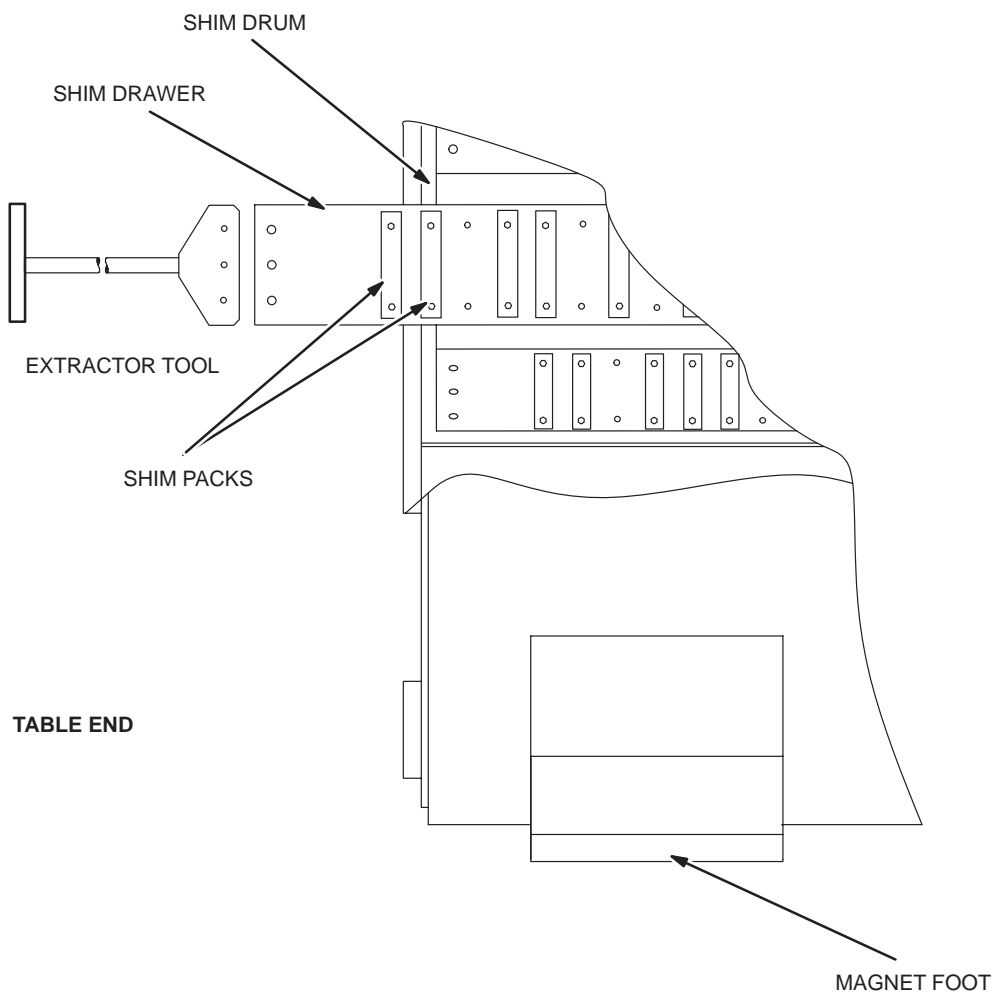
SHIM DRAWER HARDWARE  
ILLUSTRATION 11-10

11-6 PASSIVE SHIM INSTALLATION (continued)

**Note**

Remove drawers from Table End of Magnet. Remove Table to gain access to lower shim drawers. Reinstall table prior to mapping Magnet.

- 3. Insert Extractor Tool into the 3 hole(s) at the edge of the Drawer. Remove the Drawer by hand once the Drawer is out far enough using the Extractor Tool. Remove and replace drawers with a gradual motion. See Illustration 11-11.



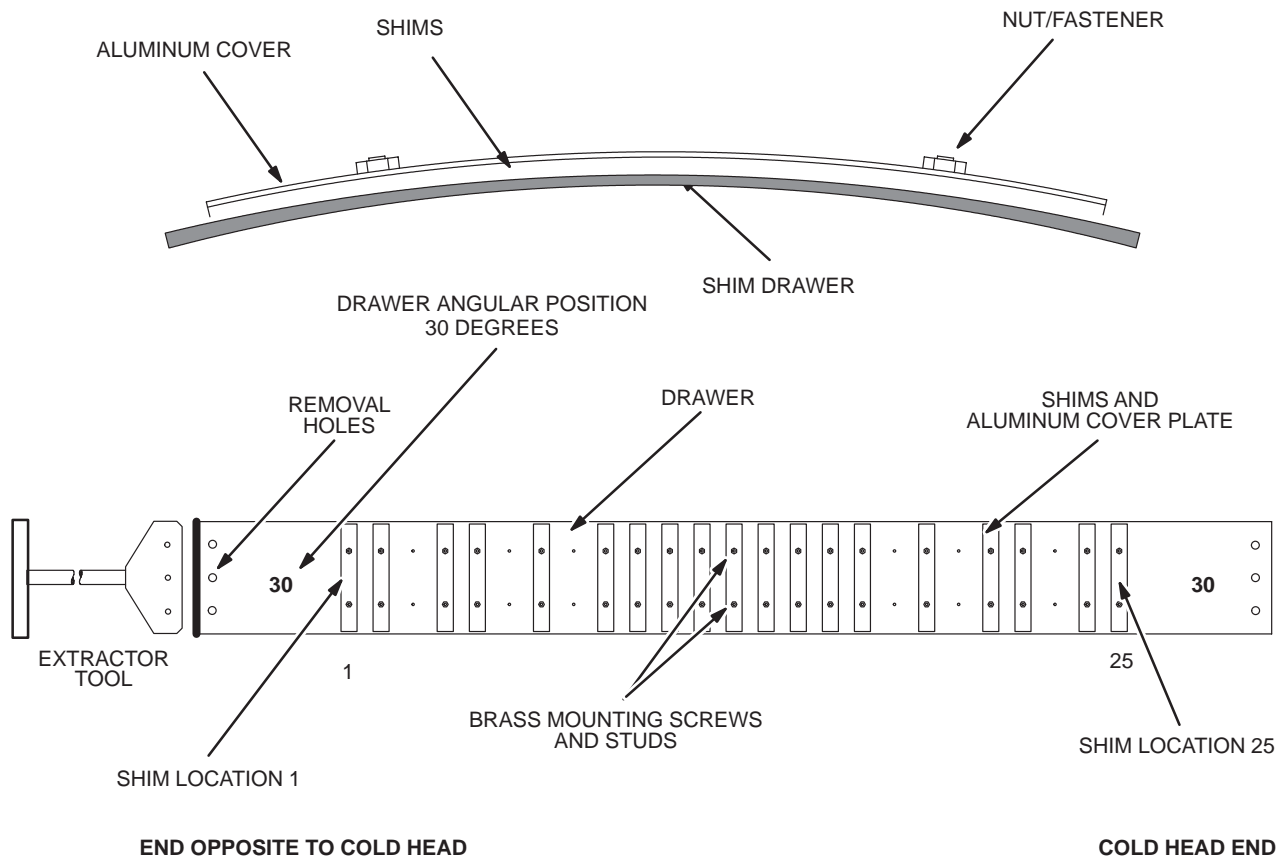
**UNSEATING AND REMOVING DRAWERS**  
ILLUSTRATION 11-11

11-6 PASSIVE SHIM INSTALLATION (continued)

**Note**

Each set of shim mounting holes shown in Illustration 11-12, below, are drilled 1 inch apart. Only the shim locations which are numbered 1 through 25 are to be used in the field. The hole locations between these numbered locations are used for permanent shims, if needed, at the factory only.

- 4. Determine the location of the Shim(s) to be added. Refer to DATA SHEETS, Table 9-1. See Illustration 11-13. Shims are numbered from the Table End (FRONT) of the Drawer (1 to 25). See Illustration 11-12.



**DRAWER SHIM LOCATIONS**  
ILLUSTRATION 11-12

- 5. Add Shims in numerical order. To add a Shim, loosen and remove two #6 brass nuts. Then remove the aluminum Shim Cover. See Illustration 11-12.

Z (NO)	ROTATION (DEGREES)											
	0	30	60	90	120	150	180	210	240	270	300	330
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												

SHIM SIZE/LOCATION (MILLS)  
ILLUSTRATION 11-13

**11-6 PASSIVE SHIM INSTALLATION (continued)****Note**

Normal shimming requires either adding shims at a certain location or removing all shims and starting the entire Mechanical Shim process over. Removing only some shims can result in loss of ability to shim.

Place 1 mil shims towards the bottom, at each location, and the thicker shims on top.

6. Place Shim of proper thickness on the studs with curvature facing in. Replace the aluminum Shim Cover and the #6 brass nuts. See Illustration 11-12.



**In Step 7 below, if any of the studs in the shim drawer are protruding to the magnetic bore, then take the drawer from the installation room and clip-off the stud with a wire cutter. This procedure will eliminate the appearance of a corduroy artifact after the passive shimming of X2 – Y2 and XY.**

7. Once the specified number of shims have been added, reinsert the Shim Drawer. Make sure the Shim Drawers are inserted in same location it was removed from and with Shim Position 1 at the end of the magnet opposite the cold head. The edges of the Shim Drawers opposite the cold head end of the magnet are colored black. When all Shim Drawers are reinstalled, after each Passive Shim iteration, a quick visual check can be made from the end of the magnet opposite the cold head to determine if any drawers have been installed backwards.



**Make sure that all Shims were inserted in the proper order and that the Shim Drawer is reinserted in the direction from which it was removed to prevent shimming discrepancies and increased shimming time.**

8. Replace Drawer Stop Plates.
9. Repeat the above steps for all Drawers requiring Shim modification.
10. Save unused Shims for possible future use.
11. Re-input last set of Superconducting Shim Currents after each passive shim iteration.
12. Re-map magnet in conformance with Section 11-2, Field Mapping.
13. Rerun Passive shim program in conformance with Section 11-5-1, Running Plateshm.
14. Make sure that the center frequency ( $Z = 0, R = 0$ ) is within specification at the completion of shimming.

## 11-7 Shim Description

Two classes of shims are supplied with the Magnet: INTEGER and FRACTIONAL.

1. Integer Shims are one inch wide and come in four thickness (0.010 inch, 0.003 inch, 0.001 inch). These are stacked to provide the required composite shim stack thickness to the 1.0 mil (0.001 inch) level. Integer Shims are utilized to shim the Magnet to the lowest possible homogeneity after convergence is achieved with the larger shims.
2. Fractional Shims are 0.001 inch thick and have two widths (0.2 inch and 0.4 inch). These fractional shim widths produce an effective shim thickness of (0.0002 inch and 0.0004 inch) respectively. These are stacked in combination with the Integer Shims to provide the required composite shim stack thickness to the 0.2 mill (0.0002 inch) level. Fractional Shims are utilized in combination with Integer Shims, if needed, to shim the Magnet below specification.



## 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 NO TAG (“Magnet Electrical Checks”) for troubleshooting if problems are encountered.

### Note

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

### 6-7 AXIAL CORRECTION COIL

1. Connect the Superconducting Shim Power Supply and Cable in conformance with SET UP AND CALIBRATION, Section 12.
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 ( $Z=0\text{cm}$ ) in Table 12-1.
6. Move the probe along the z-axis and record the virgin magnetic field at  $-20\text{ cm}$  and  $+20\text{ cm}$ .
7. Turn on the Axial and Transverse Switch Heaters. Allow the heaters to warm up for 2 minutes.

6-7 POLARITY AND FUNCTIONAL CHECKS (continued)

TABLE 12-1  
AXIAL COIL DATA

S/C COIL	GAUSS READING (10,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			



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

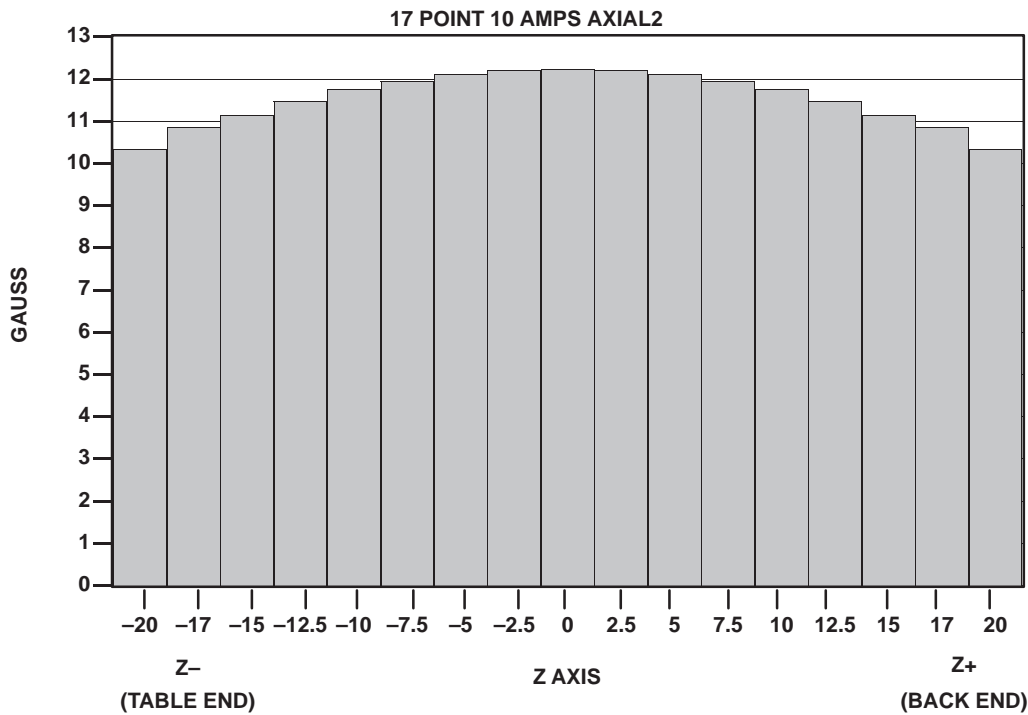
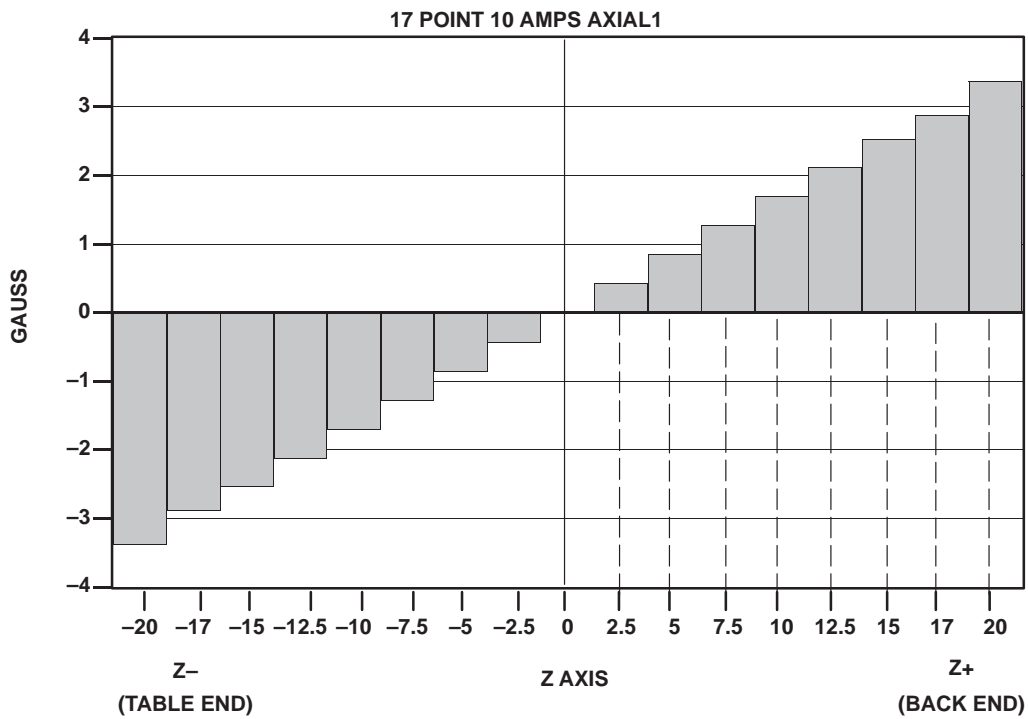
8. Apply 10 A to the Axial-1 coil (i.e. set Axial-1 Power Supply to 10 A).
9. Turn off the Axial and Transverse S/C Switch Heaters. Allow the heaters to cool for 2 minutes.
10. Ramp the Axial - 1 S/C Power Supply to 0 A after the Switch Heaters have cooled down for 2 minutes.
11. Move the probe to the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

**Note**

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

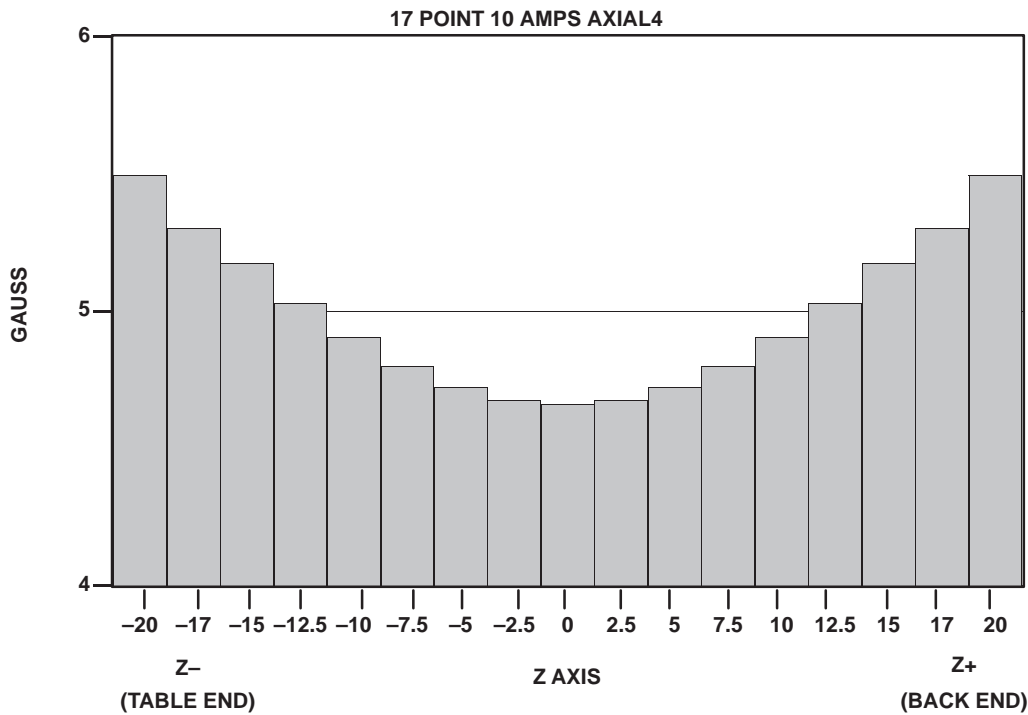
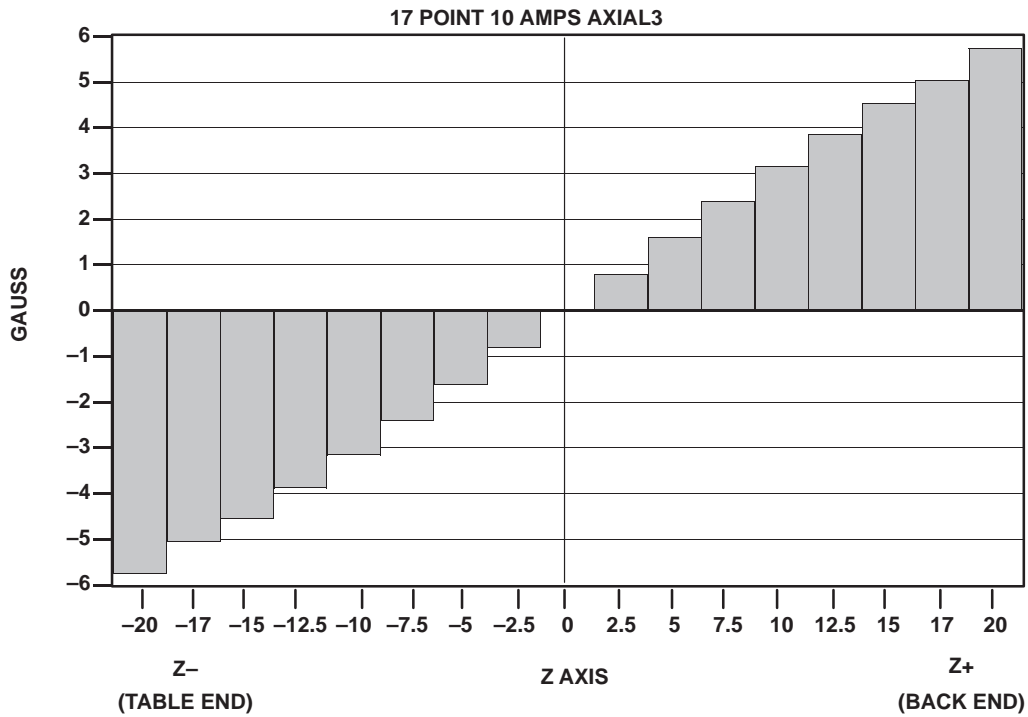
14. Repeat Steps 6 through 13 for each of the Axial S/C Coils (Axial-2 through Axial-6). Compare the gauss differences with the plots in Illustrations 12-1 and 12-2 Rewire connectors on the Magnet Terminal Box (MS1-A3,A1) or change the Polarity Switch on the particular power supply as appropriate (i.e.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

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



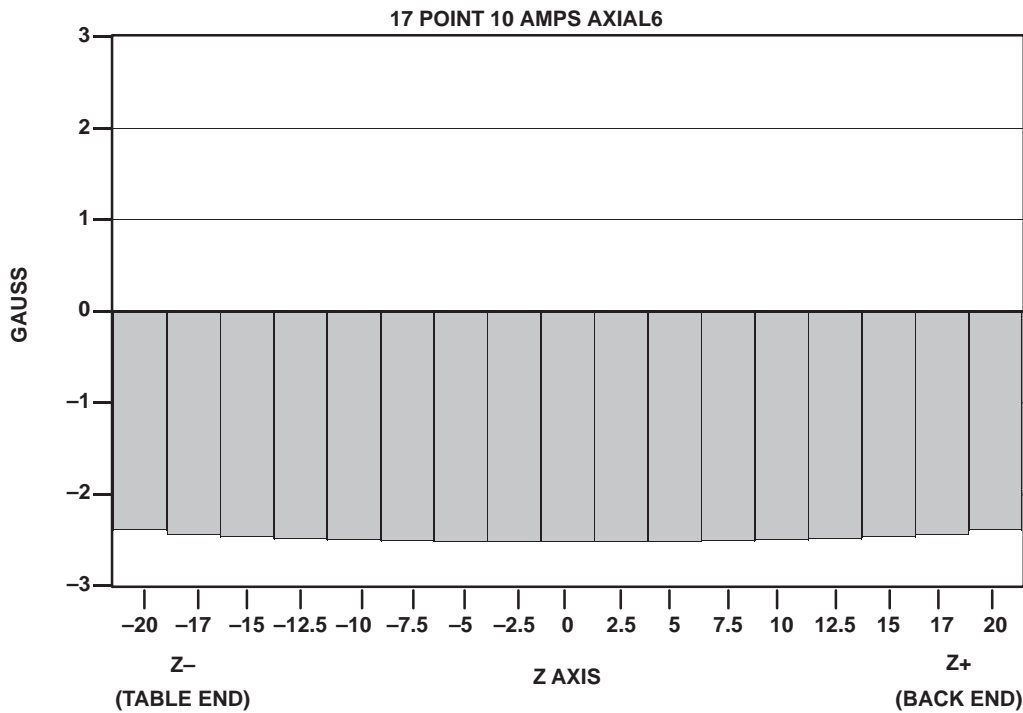
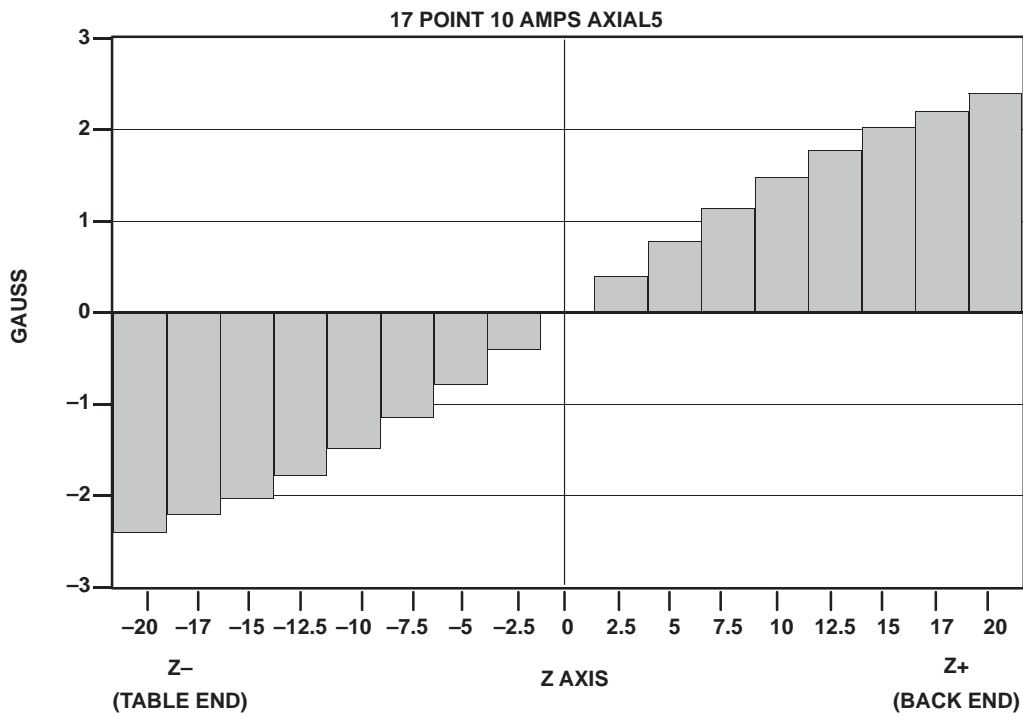
AXIAL 1 AND AXIAL 2 CORRECTION COIL PLOTS  
ILLUSTRATION 12-1

**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

**6-8 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, 135, 180, 225, 270 and 315 degrees in Table 12-2.
12. Record the data at the same rotational degrees recorded in Step 11, with the probe at 0cm and then at +20cm along the z-axis.
13. Take the data collected at each of these points (i.e., 0, 45, 90, 135, 180, 225, 270 and 315 degrees) and subtract the corresponding virgin field value from each point.
14. Compare the gauss **differences** with the plots in Illustrations 12-4 through 12-9.

**Note**

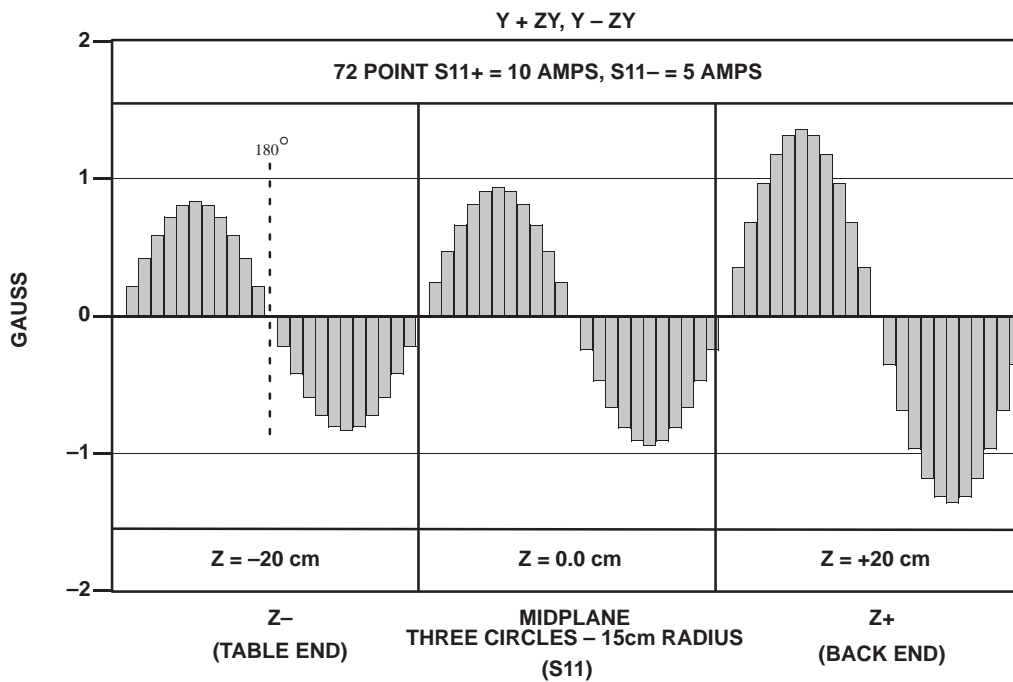
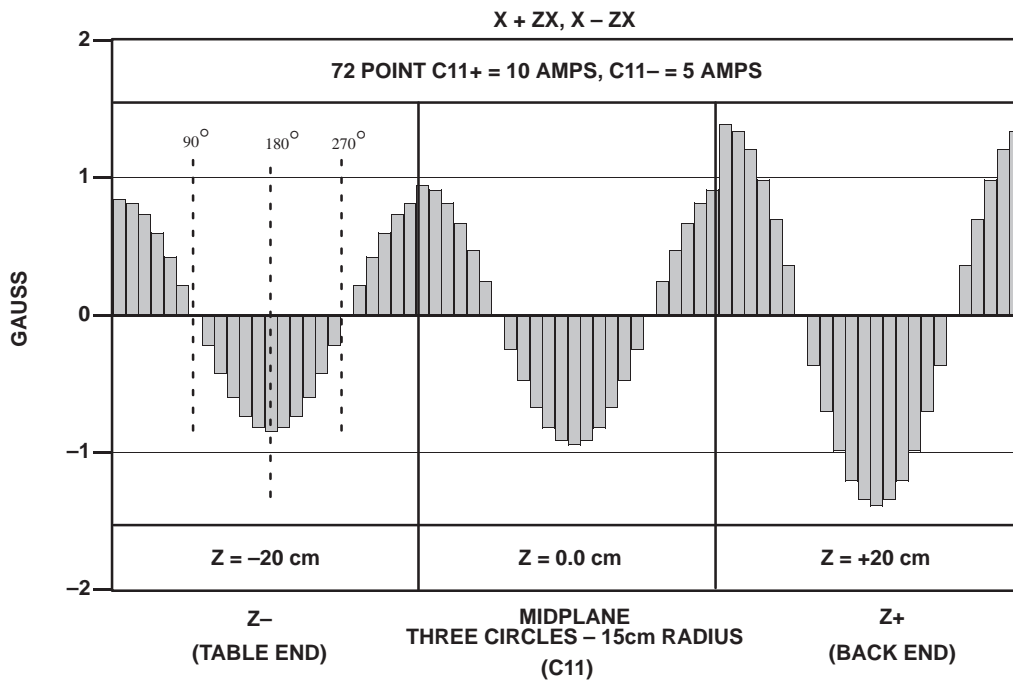
The lead connections for any individual coil could be reversed or could be interchanged with another coil. See Illustrations 12-10 and 12-11 for determining where wiring problems could occur.

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

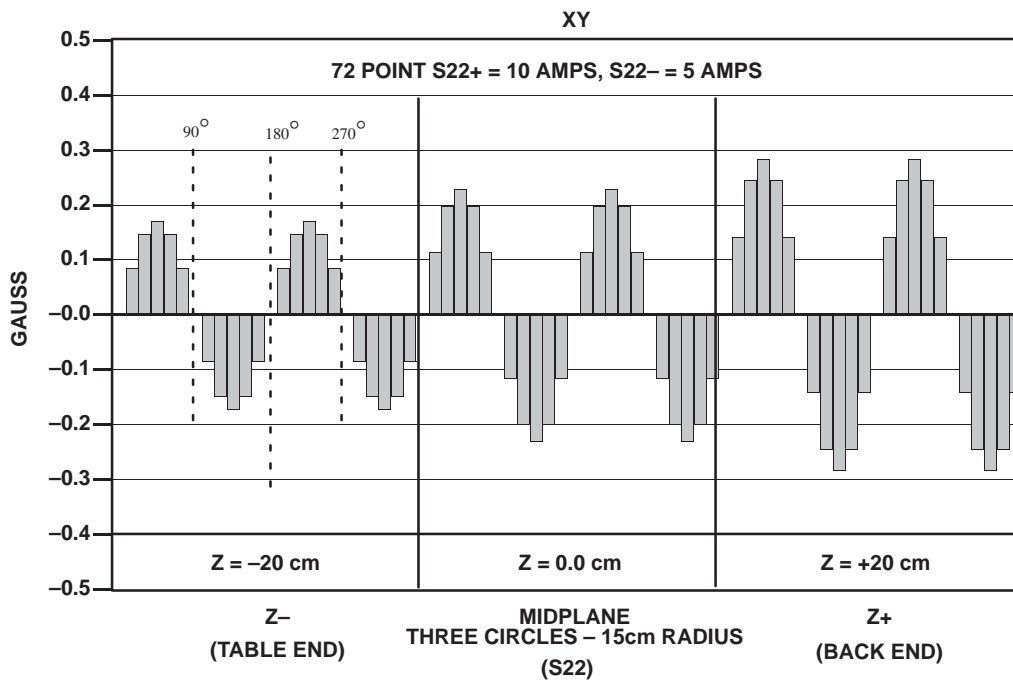
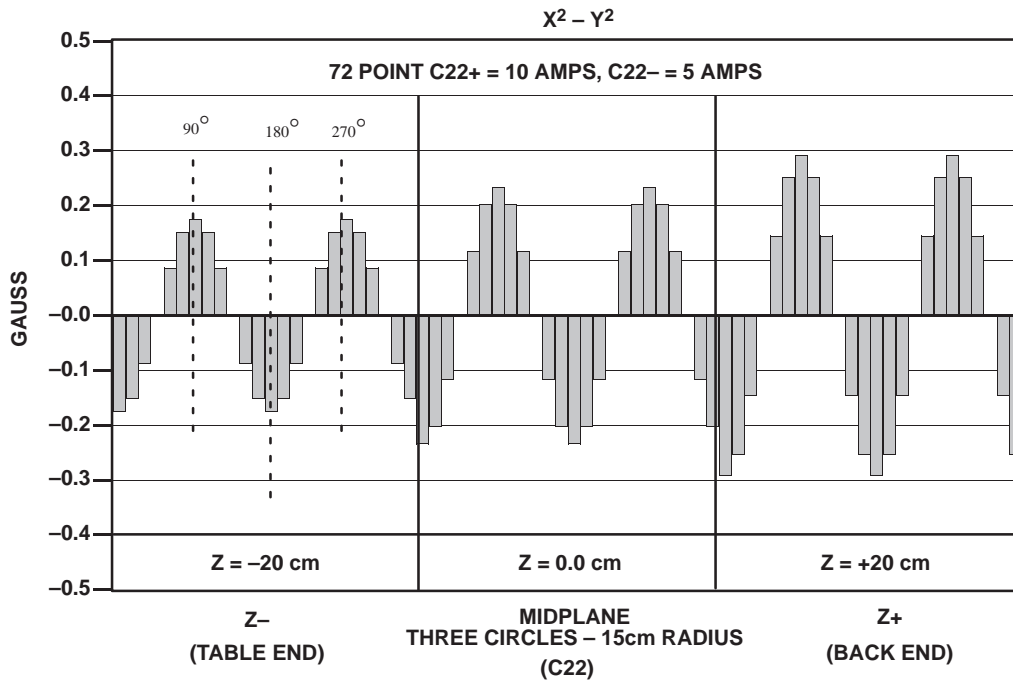
CORRECTION COIL (CURRENT INPUT)	Z-AXIS	GAUSS READING (15.XXX.X)							
		0	45	90	135	180	225	270	315
VIRGIN (0AMPS)	+20cm								
	0cm								
	-20cm								
T1-2(C11+) = 10 AMPS	+20cm								
	0cm								
	-20cm								
T1-4(C11-) = 5 AMPS	+20cm								
	0cm								
	-20cm								
T2-2(S11+) = 10 AMPS	+20cm								
	0cm								
	-20cm								
T2-4(S11-) = 5 AMPS	+20cm								
	0cm								
	-20cm								
T1-3(C22+) = 10 AMPS	+20cm								
	0cm								
	-20cm								
T1-5(C22-) = 5 AMPS	+20cm								
	0cm								
	-20cm								
T2-3(S22+) = 10 AMPS	+20cm								
	0cm								
	-20cm								
T2-5(S22-) = 5 AMPS	+20cm								
	0cm								
	-20cm								
T1-1(C31) = 10 AMPS	+20cm								
	0cm								
	-20cm								
T2-1(S31) = 10 AMPS	+20cm								
	0cm								
	-20cm								
T1-6(C33) = 10 AMPS	+20cm								
	0cm								
	-20cm								
T2-6(S33) = 10 AMPS	+20cm								
	0cm								
	-20cm								

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



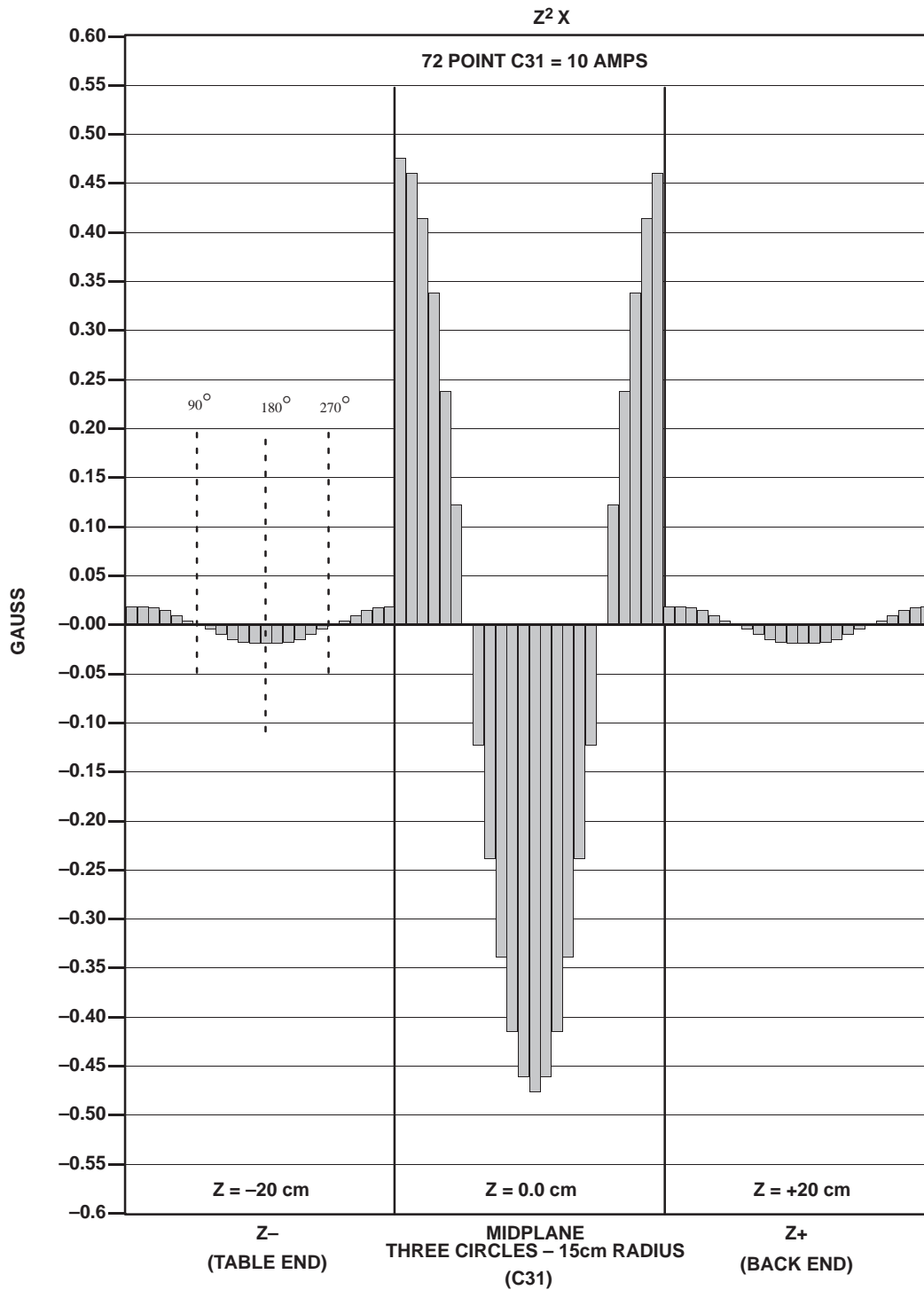
**TRANSVERSE CORRECTION COIL PLOTS C11 AND S11**  
ILLUSTRATION 12-4

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



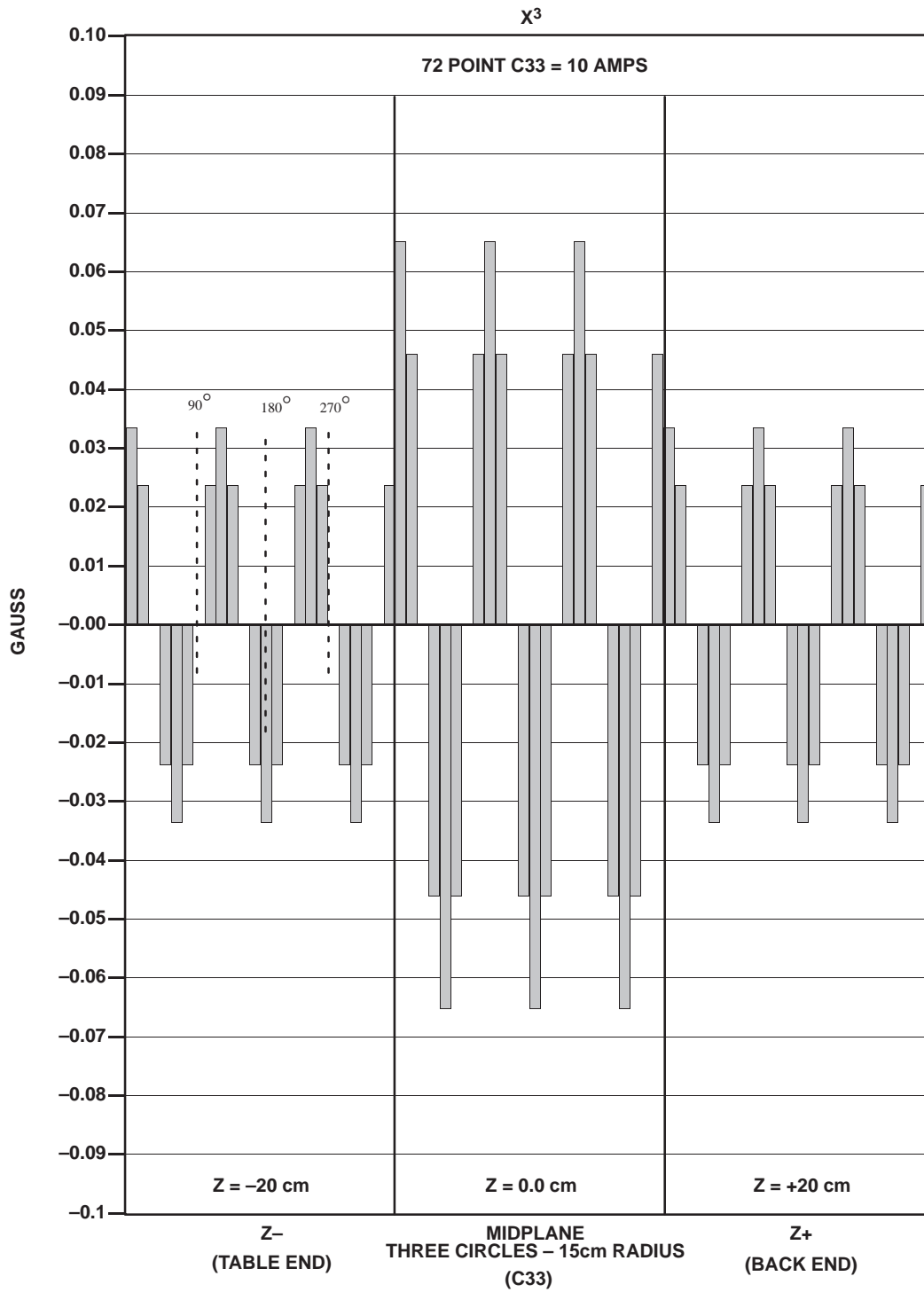
TRANSVERSE CORRECTION COIL PLOTS C22 AND S22  
ILLUSTRATION 12-5

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



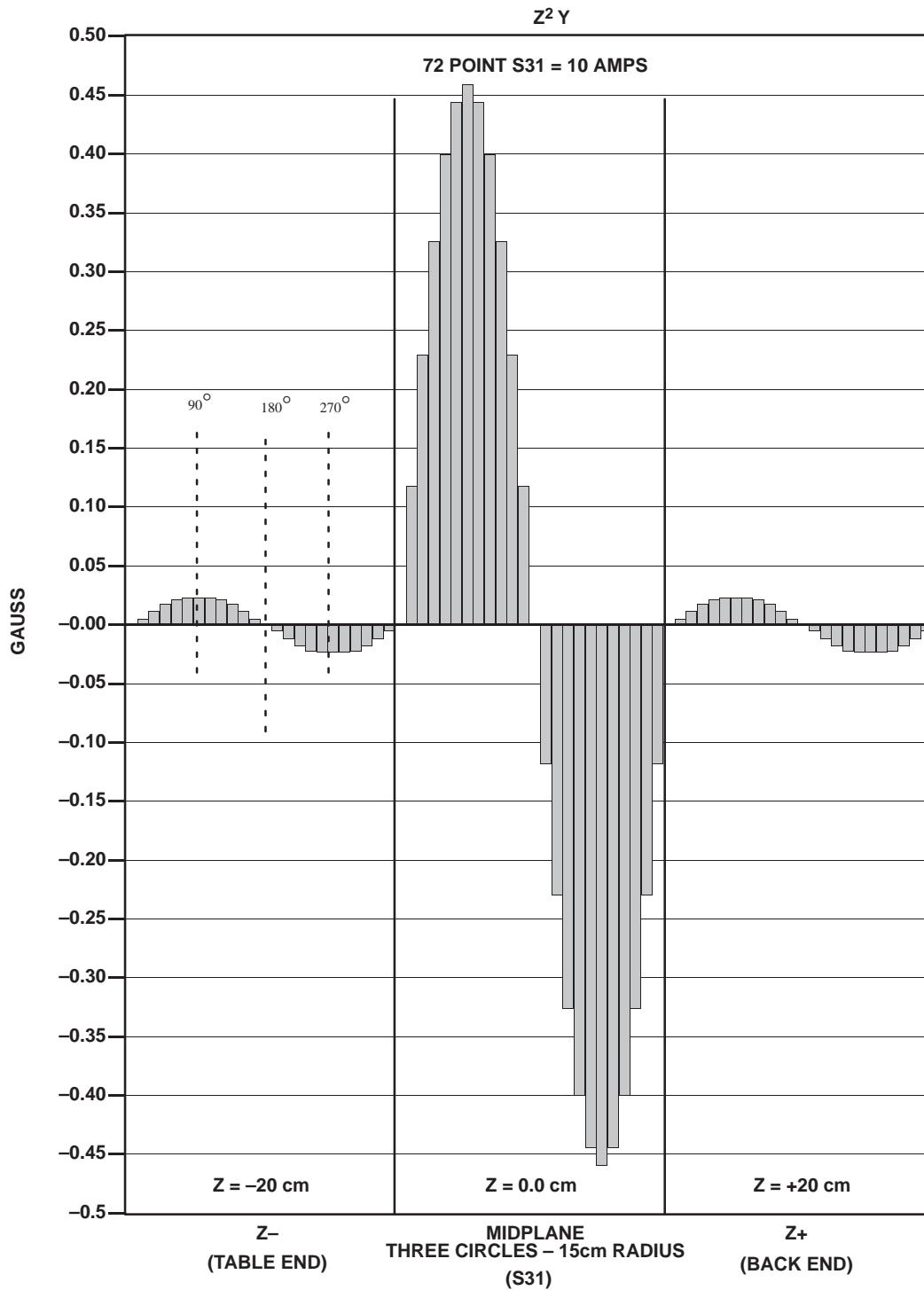
TRANSVERSE CORRECTION COIL PLOT C31  
ILLUSTRATION 12-6

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



TRANSVERSE CORRECTION COIL PLOT C33  
ILLUSTRATION 12-7

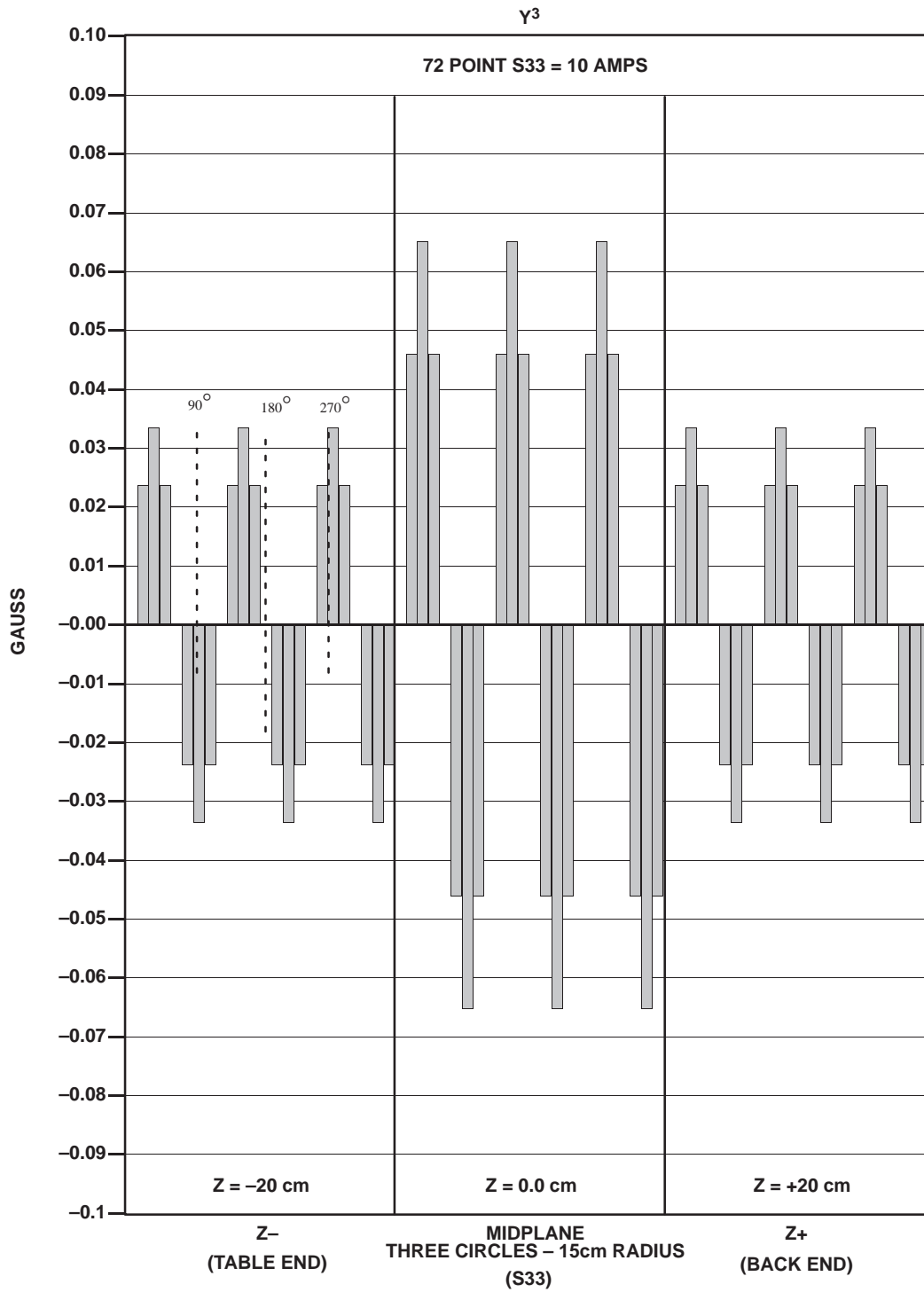
NOTE: PLOTS REPRESENT NORMAL RAMPED MAGNET WITH POSITIVE SHIM COIL CURRENTS.



TRANSVERSE CORRECTION COIL PLOT S31

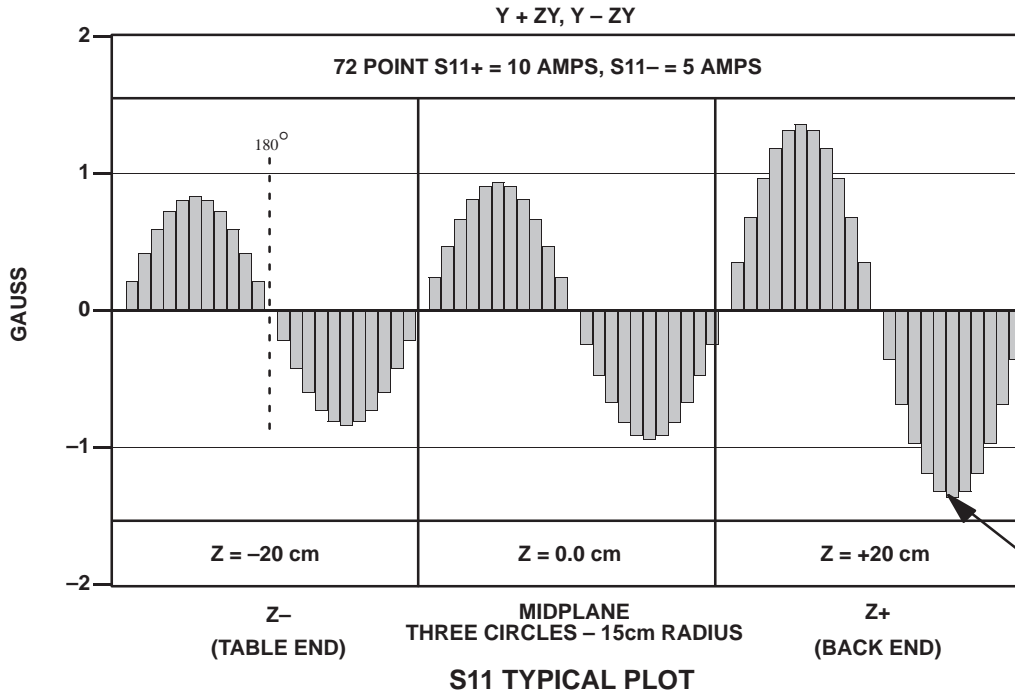
ILLUSTRATION 12-8

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

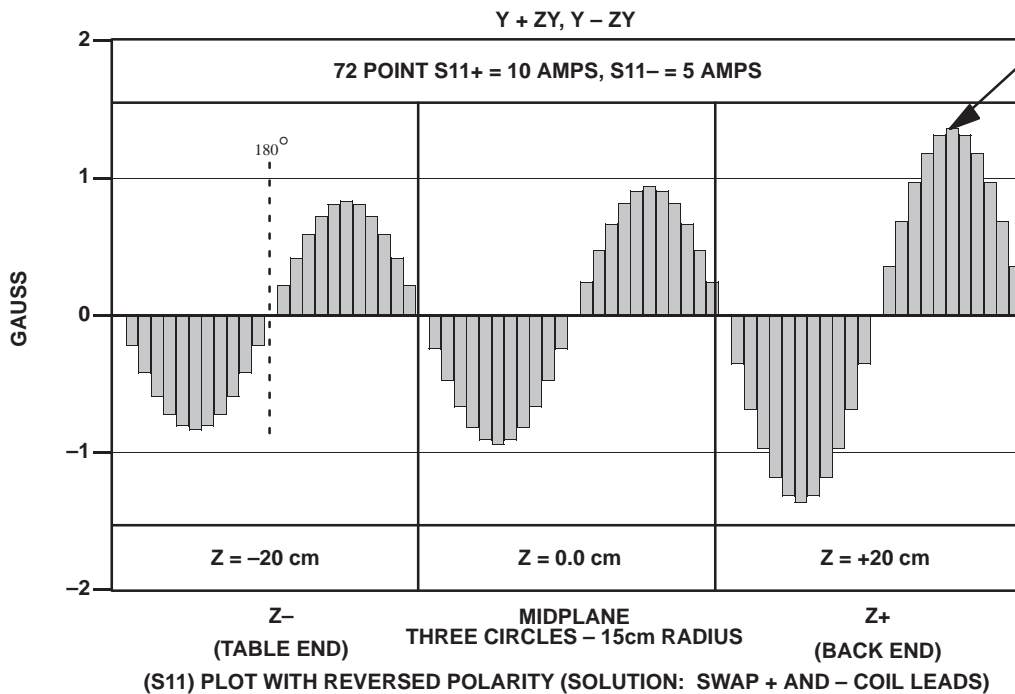


TRANSVERSE CORRECTION COIL PLOT S33  
ILLUSTRATION 12-9

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



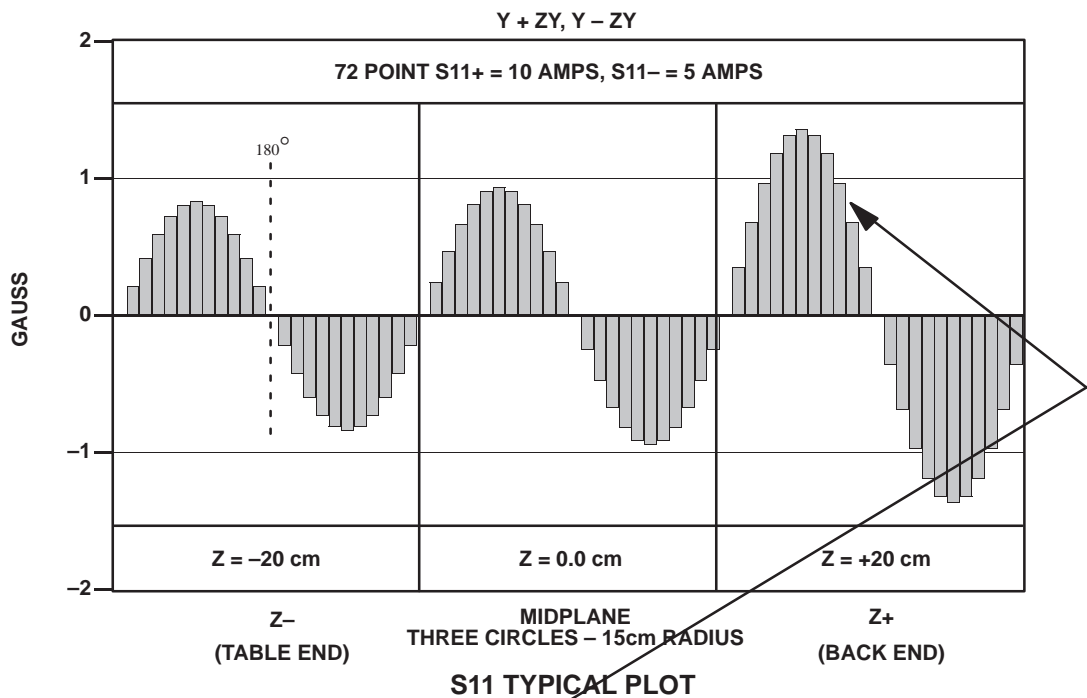
NOTE: PEAKS OF SAME AMPLITUDE BUT OUT OF PHASE BY 180 DEGREES



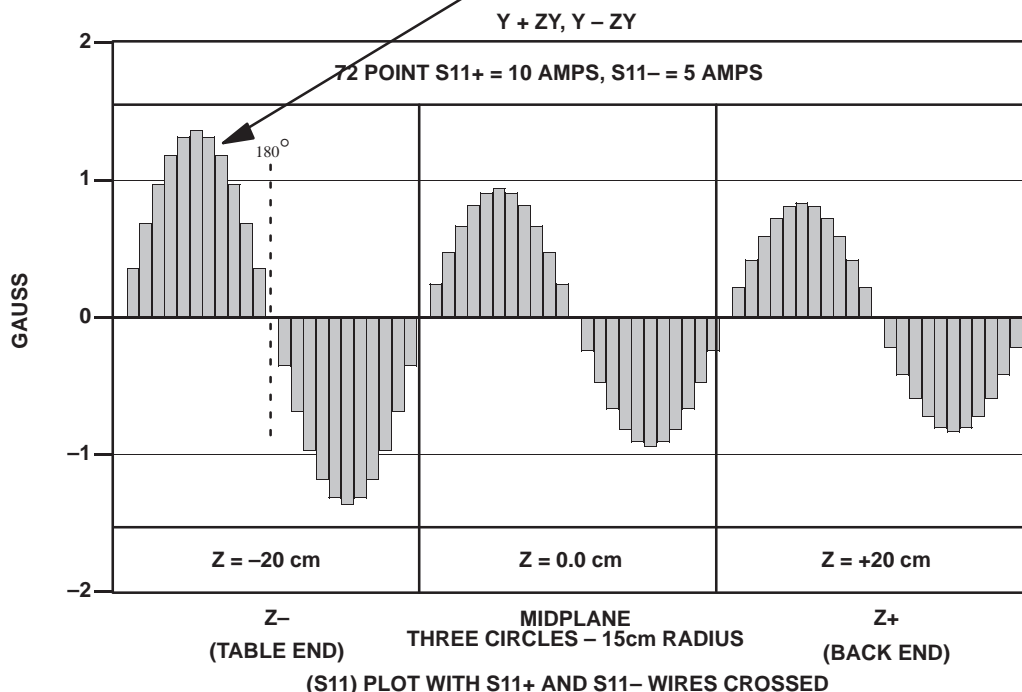
**CORRECTION COIL WIRING PROBLEMS**

ILLUSTRATION 12-10

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



NOTE: MIRROR IMAGE OF S11 TYPICAL PLOT (E.G., THE Z = +20CM WAVEFORM BECOMES THE Z = -20CM WAVEFORM)



**CORRECTION COIL WIRING PROBLEMS**

ILLUSTRATION 12-11



## SECTION 13 – FIELD ADJUSTMENT AFTER SHIMMING

### Description:

If the magnetic field is outside the range of 1.002 – 1.003 TESLA (42.6625 MHz – 42.7051 MHz) after performing “Quickshim”, the following field adjustment is required. If the field is in the specified range, adjust flow rates in conformance with Section 13-4 of this procedure.

If the Shim Supply can be powered simultaneously with the Ramp Supply, then the axial shim currents can be dialed in and held constant throughout the Field Adjustment procedure. In this case, Section 6-9 below can be skipped. For Mobile Magnets do not skip Section 13-1, as a Magnet Quench may result.



**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 80% 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.**

### 6-9 REMOVING TRANSVERSE AND AXIAL SHIM CURRENTS

1. “Top” fill magnet, to greater than 80% helium level, before continuing with this procedure.
2. Replace Ramp Lead Extension Contact Bands in conformance with REPLACEMENT/MAINTENANCE, Section NO TAG.

**6-9 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. 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.
6. Make sure the input power cables for the power supplies are disconnected.
7. Subtract the desired Center Frequency from the present Magnet Base Frequency. Record this "Delta Frequency: \_\_\_\_\_ Hz. For example, if the desired Center Frequency is 42.6838MHz and the present Magnet Base Frequency is 42.6820MHz, the Delta Frequency is negative 1.8KHz.
8. Connect the Shim Power Supply to the magnet in conformance to SET UP AND CALIBRATION, Section 6-4.
9. Connect the input power cable to the Shim Power Supply.
10. Remove the Shim Lead Vent Cap and allow frost to appear on the Shim Lead Connector Housing before removing Shim Currents.
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. Allow five minutes for the heater to drive the switches resistive.
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. Replace the Shim Lead Vent Cap.
19. Disconnect Heater Cable from Shim Power Supply. For Mobile units, leave Heater Cable from Shim Power Supply connected.

**6-10 RESISTANCE CHECKS**

1. Perform the Service Ramp Supply Test in conformance with SET UP AND CALIBRATION, Section 7.
2. Retrieve the Main Coil Connection Polarity recorded in the DATA SHEET tab, Table 6-1.

**6-10 RESISTANCE CHECKS (continued)**

3. Connect the Main Power Supply and Main Lead Extensions to the magnet by making all cable connections in conformance with SET UP AND CALIBRATION, Section NO TAG. (“Electrical Connections For Ramping And Shimming”). Make sure the lead extensions are connected to the magnet with the polarity in Step 2 above.
4. Set all Main Power Supply heater switches to the OFF position.
5. Set CURRENT ADJUST controls and VOLTAGE control to 0 (full CCW).
6. 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.**

7. Turn on Main Power Supply Input Power.
8. Turn on Axial Shim Heaters and observe current rise in ammeter (800–820mA) to verify circuit continuity. If 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.
9. Connect a Digital Voltmeter (DVM) to the end of the Voltage Sense Leads.
10. Set the power supply voltmeter toggle switch to MAIN COIL position.
11. Set CURRENT ADJUST COARSE control on power supply to maximum (full CW).
12. 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.
13. Record the voltage reading on the (DVM) in the 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 FIELD ADJUSTMENT.**

**DO NOT ATTEMPT TO IMPROVE THE DVM READING, IN STEP 8, BY INCREASING THE MAGNET CURRENT ABOVE 500 AMPS AS THIS COULD DAMAGE THE MAGNET MAIN POWER LEADS AND/OR QUENCH THE MAGNET.**

**6-10 RESISTANCE CHECKS (continued)**

14. Perform one or more of the bulleted steps below, as necessary, if the DVM voltage is greater than 150mV.
  - Wait approximately 1 minute with the current running, readings may drop as the Power Lead Extensions cool.
  - Repeated failing of the contact resistance check indicates a need to replace the Ramp Lead Extension Contact Bands. See REPLACEMENT/MAINTENANCE, Section NO TAG, or damaged Ramp Leads.
  - If the reading still exceeds 150 mV: turn the VOLTAGE and CURRENT controls to zero (full CCW), turn off Magnet Power Supply input power, then check/tighten the bolts securing the Main Power Cables to the Power Supply and Ramp Leads Extensions. Lift and reseal the Ramp Leads. Repeat Steps 9 – 14.
15. Set the power supply VOLTMETER SELECT SWITCH to MAIN POWER SUPPLY position (This will display the output of the power supply monitored at the output lugs).

**Note**

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

16. 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, then check/tighten the bolts securing the Ramp Cables to the Power Supply and Ramp Lead Extensions.
17. Turn the CURRENT ADJUST and VOLTAGE ADJUST controls off (full CCW) and continue with the MAIN FIELD ADJUSTMENT Procedure after completion of Step 16.

## 6-11 MAIN FIELD ADJUSTMENT

**WARNING!**

THE 1.0T MAGNET CAN BE QUENCHED IF THE MAGNET POWER SUPPLY EXPERIENCES LARGE OUTPUT VOLTAGE FLUCTUATIONS AND/OR EXCESSIVE RIPPLE. MAKE SURE THE POWER SUPPLY IS REGULARLY CALIBRATED WITH AN APPROVED FACILITY.

**WARNING!**

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

**WARNING!**

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

**CAUTION**

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

**6-11 MAIN FIELD ADJUSTMENT (continued)****Note**

The Center Frequency will change by about 60.8 KHz per amp change in Main Coil current.

**Note**

The main field will have either increased or decreased by the amount recorded in Step 7 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).

1. Retrieve the Delta Frequency recorded in Step 7, Section 13-2, SET UP AND CALIBRATION. Calculate the amount of magnet current change needed by dividing the Delta Frequency by 60.8kHz. For example, if the Delta Frequency is -40kHz, the amount of magnet current change required is -0.66 amps. The magnet current, in this case, would have to be decreased by 660 milliamps.



**FOR MOBILE MAGNETS, MAKE SURE THE AXIAL, TRANSVERSE 1 AND TRANSVERSE 2 SWITCH HEATERS ARE ON DURING MAIN FIELD ADJUSTMENT TO MINIMIZE THE POTENTIAL FOR QUENCH.**

**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, while a on the Shim Supply as this will increase boil off.

2. For Mobile units, make sure Shim Power Supply is powered up. Set Axial, Transverse1, and Transverse 2 Switch Heaters to 1 (on).
3. Make sure the Axial Shim Heater is on and Ramp Leads are connected with the polarity recorded in the DATA SHEET tab, Table 6-1.
4. Set the Main Service Power Supply voltmeter toggle switch to MAIN COIL position.
5. Set VOLTAGE ADJUST control on power supply to full clockwise (maximum).

**Note**

Setting the CURRENT ADJUST FINE control to the center of its range will make it easier to achieve the final field in Step 10 below.

6. Set the CURRENT ADJUST FINE control to the center of its range (10 turn potentiometer).
7. Adjust CURRENT ADJUST controls to set magnet current at the Parking Current recorded in the DATA SHEET tab, Table 6-1.
8. Turn on the Main Switch Heater.

**6-11 MAIN FIELD ADJUSTMENT (continued)**

9. Allow approximately 3 minute for the Main Switch to go normal.
10. When the Main Switch is normal, slowly adjust power supply CURRENT ADJUST controls until the main field is adjusted by the Delta in conformance with Step 1 above.
11. Allow six minutes for field to stabilize before turning off Main Switch Heater.
12. Turn off Main Switch Heater. Wait a minimum of 8 minutes, for the switch to fully cool and go “persistent”, before touching the CURRENT ADJUST controls.
13. Record current value at which the switch went “persistent” in DATA SHEETS, Table 6-1.



**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.

14. When the switch goes “persistent”, slowly turn the power supply CURRENT ADJUST controls to zero over a one minute period (Full CCW).
15. Turn off the Axial Shim Heaters on the Main Service Ramp Supply.
16. Turn off Transverse 1 and Transverse 2 Heaters on the Shim Supply (used for mobile only).
17. Gradually turn the VOLTAGE ADJUST control to zero (full CCW), over a one minute period.

**Note**

The ramp leads are not disconnected from the magnet at this time as readjustment of the magnet field might be needed after the shim currents are inserted.

**6-12 INPUT SHIM CURRENTS**

1. Reconnect the Shim Power Supply to the magnet in conformance to SET UP AND CALIBRATION, Section 6-4.
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 12 below:

4. Set the Shim Group Select Switch to the appropriate group (T1, T2, or Axial).
5. Make sure the Shim Lead Connector Housing is frosted before continuing with this procedure.
6. Dial in all last recorded Shim Currents from DATA Sheets, Section 8 into the Shim Supply. Make sure the Current polarities are correct.



**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.**

7. 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.
8. 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.
9. Check the frequency reading on the Teslometer 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).
10. Once the field is stable (see Step 8), turn off Switch Heater and allow the heater to cool for 5 minutes.
11. Turn the Shim Power Supply back down to zero amperes (full CCW).
12. Repeat Steps 4 through 11 for Transverse 2 then Axial Coil Groups.
13. When all currents are set turn off the power supply, then disconnect all leads between the magnet, and Shim Power Supply.
14. Replace the Shim Lead Vent Cap.

6-12 INPUT SHIM CURRENTS (continued)



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

- 15. 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.

- 16. Open Vent Valve (V2) to de-pressurize the Cryostat to 0.25 psig. Close V2.
- 17. If the magnet field is out of spec (1.002 – 1.003 TESLA, 42.6625 MHz – 42.7051 MHz), readjust main field in conformance with SET UP AND CALIBRATION, Section 11.
- 18. Turn off Main Power Supply and disconnect power supply input power.
- 19. 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.
- 20. Add liquid helium to magnet if necessary.



**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).

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

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

**Note**

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



## SECTION 1 – 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	1.002 – 1.003 TESLA 42.6625 MHz – 42.7051 MHz	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	<6.3 PPM S/C SHIMMING (C6 VOL – 30cm X 40cm)	AFTER MECH. SHIMMING, ENVIRONMENT CHANGES OR IMAGE DEG- RADATION.
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	710mA ± 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 SHIM 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 VAULES ARE STEADY STATE AFTER PASSING LEAK CHECK
SHIM LEAD FLOW (F1)	1.8 – 2.2 SCFH	
BOIL OFF	< 0.2 LITER/Hr. (AVE.)	
HELIUM LEVEL	<u>80% FOR RAMP UP, RAMP DOWN OR FIELD ADJUSTMENT</u> 60% MINIMUM	<u>BEFORE RAMP UP, RAMP DOWN, FIELD ADJUSTMENT</u> ON GOING
FILL CONDITIONS	V2 OPEN, DEWAR < 3.5 CRYOSTAT < 1.5 PSIG	HELIUM FILL/REFILL
SHIELD COOLER	1ST STAGE 32 – 60K 2ND STAGE 7 – 17K	HIGH PRESSURE/BOIL OFF

## SECTION 2 – MAGNETIC FIELD STABILITY

### Description:

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

### Procedure:



**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 5, (“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 6-3.
6. Remove all Shim Currents in conformance with SET UP AND CALIBRATION, Section 6-9,
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:

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

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  $\pm 5$  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.



**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 6-1 in order to obtain resistance data.

1. Place Shim Lead Assembly in the “Engaged” position in conformance with SET UP AND CALIBRATION, Section 6-1.
2. Locate the Connector Pins using Table 3-1 and SCHEMATICS/INTERCONNECTS, Illustration 2-3.
3. Use a digital meter to measure the resistance across the identified Connector Pins.
4. Measure the resistances and record them in Table 3-1, comparing them to “ACCEPTABLE RANGE”.

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

FUNCTION	CONNECTOR	PIN #	RESISTANCE (OHMS)	
			TYPICAL VALUES	MEASURED
MAIN COIL	MAIN COIL POWER LUGS OR J5-1	+ -  9,10	< 6 OHMS	
SUPERCONDUCTING SHIM COILS	CANNON (P1-A) AT MAGNET VERTICAL STACK			
Z1		1,19	0.5	
Z2		2,20		
Z3		3,21		
Z4		4,22		
Z5		5,23		
Z6		6,24		
C11+		16,19		
C11-		17,20		
C22+		14,21		
C22-		15,22		
S11+		9,19		
S11-		10,20		
S22+		7,21		
S22-		8,22		
C31		13,23		
S31		11,23		
C33		18,24		
S33	↓	12,24	↓	
SUPERCONDUCTING SWITCH HEATERS MAIN SWITCH	J 5-1 & J 5-2 ON MAGNET TERMINAL BOX 9MS1-A3,A1)	1,2	22 - 27	
AXIAL SHIMS		5,6	25.5 - 31.0	
TRANSVERSE 1		7,6	10	
TRANSVERSE 2	↓	8,6	10	

TABLE 3-1 (CONTINUED)

**NOTE:** THIS TABLE PROVIDES AN ALTERNATE LOCATION FOR CHECKING SUPERCONDUCTING SHIM COIL RESISTANCES FROM P1-A (I.E., AT THE MAGNET TERMINAL BOX).

MAGNET TERMINAL BOX CONNECTORS P2 AND P2W			RESISTANCE (OHMS)	
SUPERCONDUCTING SHIM COILS	CONNECTOR	CONNECTOR PINS	TYPICAL RESISTANCE	MEASURED RESISTANCE
Z1	P2	A,* (K,L)	0.6	
Z2	P2W	A, (K,L)		
Z3	P2	B, (M,N)		
Z4	P2W	B, (M,N)		
Z5	P2	C, P		
Z6	P2W	C, P		
C11+	P2	F, (K,L)		
C11-	P2W	F, (K,L)		
C22+	P2	G, (M,N)		
C22-	P2W	G, (M,N)		
S11+	P2	H, (K,L)		
S11-	P2W	H, (K,L)		
S22+	P2	J, (M,N)		
S22-	P2W	J, (M,N)		
C31	P2	D, P		
S31	P2	E, P		
C33	P2W	D, P		
S33	P2W	E, P		

\* PARENTHESIS INDICATE PINS WIRED TOGETHER.

## SECTION 4 – CRYOSTAT VACUUM CHECK



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



**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  $1 \times 10^{-4}$  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.



**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.

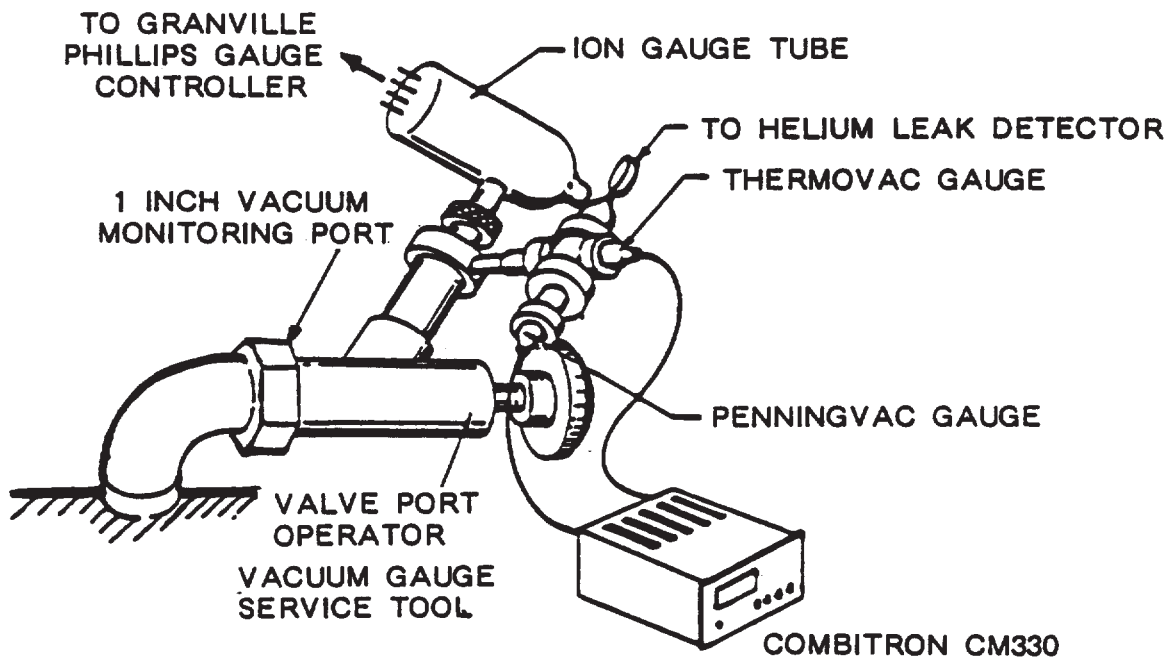
**Note**

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  $1 \times 10^{-1}$  ., (100 microns).



CRYOSTAT VACUUM MONITORING SET-UP  
ILLUSTRATION 4-1

## SECTION 5 – MAGNET RUNDOWN UNIT (MRU)



**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 estimate can be calculated by using the following equations:

$$\begin{aligned}\text{BOIL OFF RATE (LITERS/HOUR),} &= F1+F2 \times 0.10 \\ \text{BOIL OFF RATE (SCFH)} &= F1+F2 \times 2.70\end{aligned}$$

Where:

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

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

### Note

Flow meter locations are shown in SET UP AND CALIBRATION, Illustration 1-5.

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

### Note

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

3. Calibrate Cryogen Monitor at 6 month intervals in conformance *Direction 15494*, Signa Advantage 1.5T & 0.5T PM Manual; and whenever the helium boil off rate, calculated in Step 2. has shown a significant increase/ decrease.

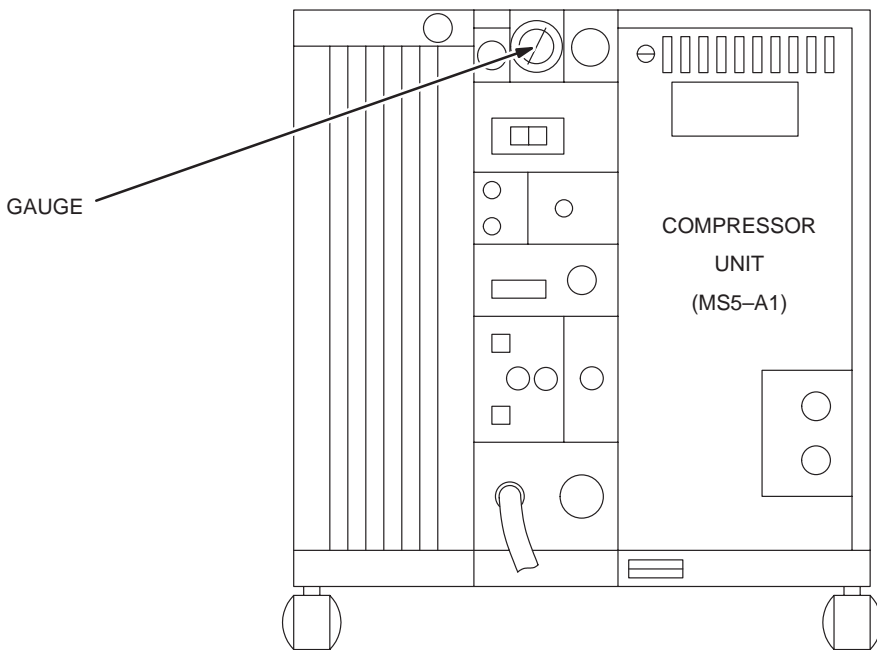
## SECTION 7 – SHIELD COOLER CHECKS

### 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 (1402 KPa) and 232 psig (1498 KPa). 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. Ensure that there is a minimum flow rate of 1.0 gallons per minute (gpm) available at the supply and the water temperature at the supply is between 40°F (5°C) and 80°F (27°C).
5. Check oil level glass inside the Compressor. The oil should completely fill the sight glass when the compressor isn't operating. When the Compressor is running, the oil level should be 1/2 to 3/4 full and must never fall below 1/5 full during operation.
6. Check Shield Cooler temperatures. See Set Up and Calibration, Section 1-4-7 (Monitoring Shield Temperatures) for the correct procedure.
7. Read and record "First Stage" and "Second Stage" Shield Temperatures in Table 1-1, DATA SHEETS Tab.

**GUIDELINES:**

First Stage Temperature (32K-50K).  
Second Stage Temperature (7K-17K).

8. Compare these readings to Guidelines and initial recorded readings obtained at equilibrium. Refer to SET UP AND CALIBRATION, Section 1-4-7.
9. If any Shield Temperature is out of range or differs drastically (> 10K First Stage, > 5K Second Stage) from the previous equilibrium temperatures, check the eight mounting bolts of the Shield Cooler Cold Head and ensure that they are not loose. See REPLACEMENT/MAINTENANCE, Section 3 (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 80% 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. Replace Burst Disk P/N 46-252838P6 and two Gaskets P/N 46-252839P2.
2. Order and replace LHe ASAP.

**Note**

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

3. Check for ice build up in Vertical Stack. Remove ice in conformance with service manual.
4. Inspect Vent System. Clear out any debris from a ruptured Burst Disc and/or disintegrated Shim Lead Baffles. Notify Site Administration of any damage to Vent System.
5. Order and replace Baffle Assembly ( 46 – 294431G1 ) if baffles are disintegrated. Replace and return Shim Lead Assembly(46 – 294769G1) 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 3 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 FLOWMETER (F2) FLOW RATE = 0.8 – 1.2 SCFH  
 SHIM LEAD FLOWMETER (F1) FLOW RATE = 1.8 – 2.2 SCFH

**Note**

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

**SECTION 8 – MAGNET QUENCHES ( continued )**

**QUENCH RECOVERY**

**TABLE 8-1**  
MAGNET QUENCH RECOVERY PARTS AND TOOL REQUIREMENTS

<b>SX MAGNET QUENCH RECOVERY PARTS AND TOOLS</b>			
<b>PART</b>	<b>GE NUMBER</b>	<b>TOOL</b>	<b>GE NUMBER</b>
Baffle Assembly	46-294431G1	Magnetometer ( Teslameter )	46-251865G2
Styrofoam Insulator Kit	2120128	Ramp Supply	46-260776G3
Shim Lead Assembly	2102086	Shim Supply	46-260777G3
Pressure Gauge	46-281282P1	Ramp Equipment	46-260703G2
Burst Disk	46-252838P6	Ramp Cable Kit	2135435
Burst Disk Gasket ( 2 Req'd. )	46-252839P2	Power Supply Calibration Kit	2101360
		Shim Cable Kit	2135558
		Universal Fill Line Kit	46-294705G1
		Dewar Stinger 250L	46-294511P1
		Dewar Stinger 500L	46-294511P2
		Transfill Line 12 ft.	46-294512P1
		Low Pressure Regulator Kit	46-306734G1
		Cryogen Safety Kit	46-271137G1

## SECTION 1 – ICE PLUG REMOVAL

### Description:

Ice Plugs can form in the Instrumentation Lead Assembly, Shim Lead Assembly, Fill Port or Gas Plumbing, because of 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:



**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 ).**

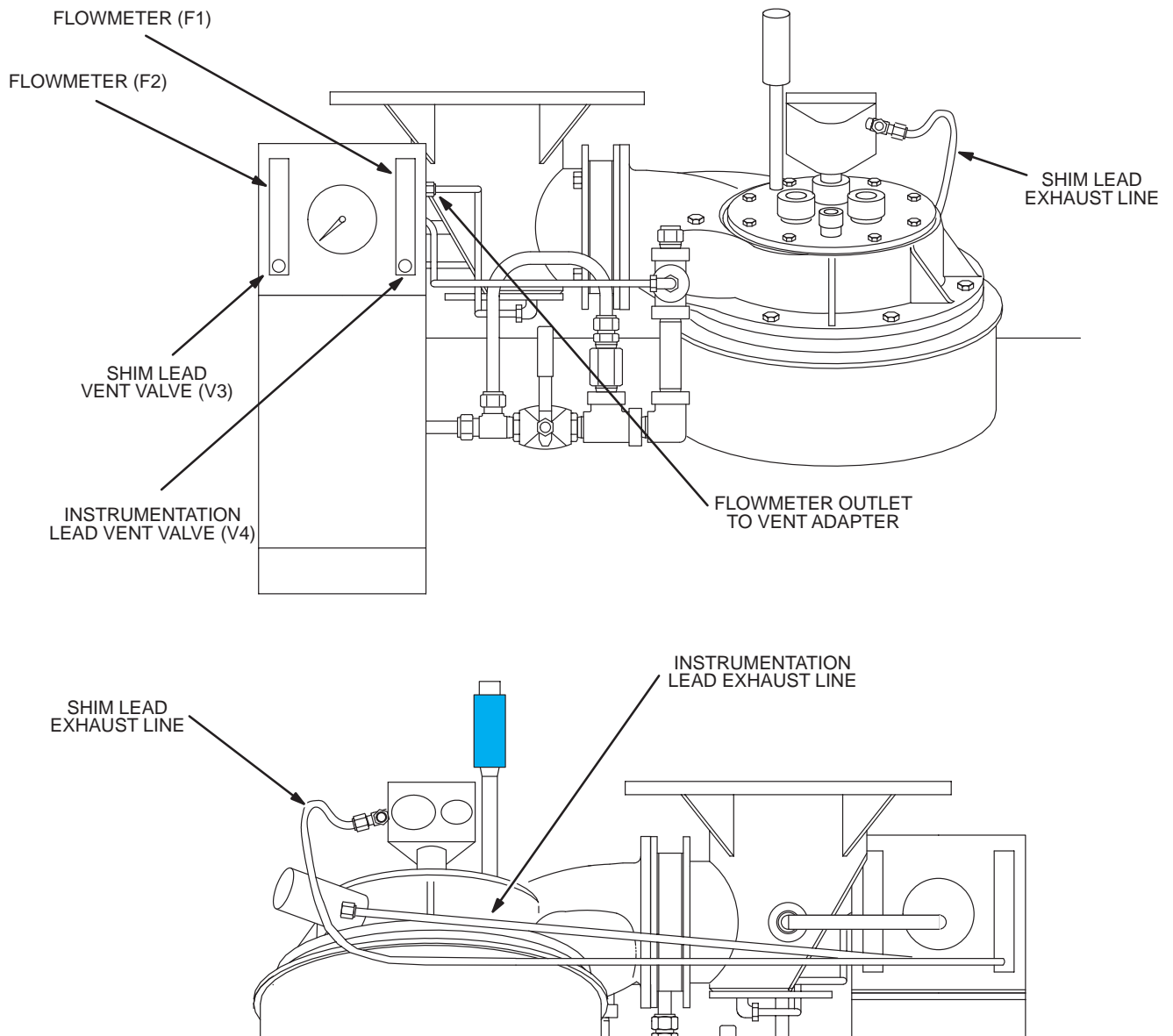
**RAPID EXHAUSTING OF COLD HELIUM GAS MAY BE ENCOUNTERED DURING THE FOLLOWING PROCEDURES. WEAR NON ABSORBENT GLOVES AND GOGGLES OR FACE SHIELD WHEN PERFORMING THESE PROCEDURES.**

**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 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.



1/4 INCH EXHAUST PLUMBING  
ILLUSTRATION 1-1

**1-1 BLOCK IN 1/4 INCH EXHAUST SYSTEM (continued)**

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.

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.
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 NO TAG 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.

**1-1 BLOCK IN 1/4 INCH EXHAUST SYSTEM (continued)**

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 the 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 NO TAG 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 NO TAG.
11. Remove Shim Lead Assembly from Exam Room and thaw. Reassemble in conformance with REPLACEMENT/MAINTENANCE, Section NO TAG.
12. When flow is restored, remove protective cap, if applied and reconnect and leak test all Exhaust Plumbing.



**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:

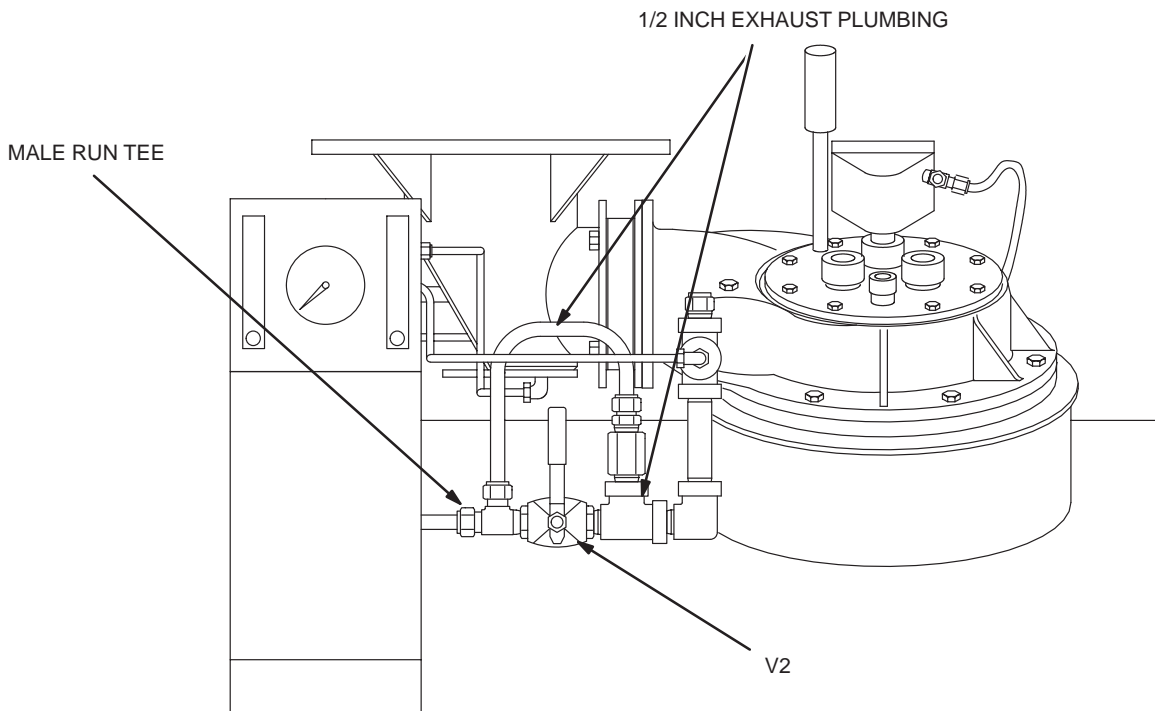
- INSTRUMENTATION FLOWMETER (F2) = 0.8 – 1.2 SCFH
- SHIM LEAD FLOWMETER (F1) = 1.8 – 2.2 SCFH
- CRYOSTAT GAUGE PRESSURE = 0.25 – 0.50 psig

**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.

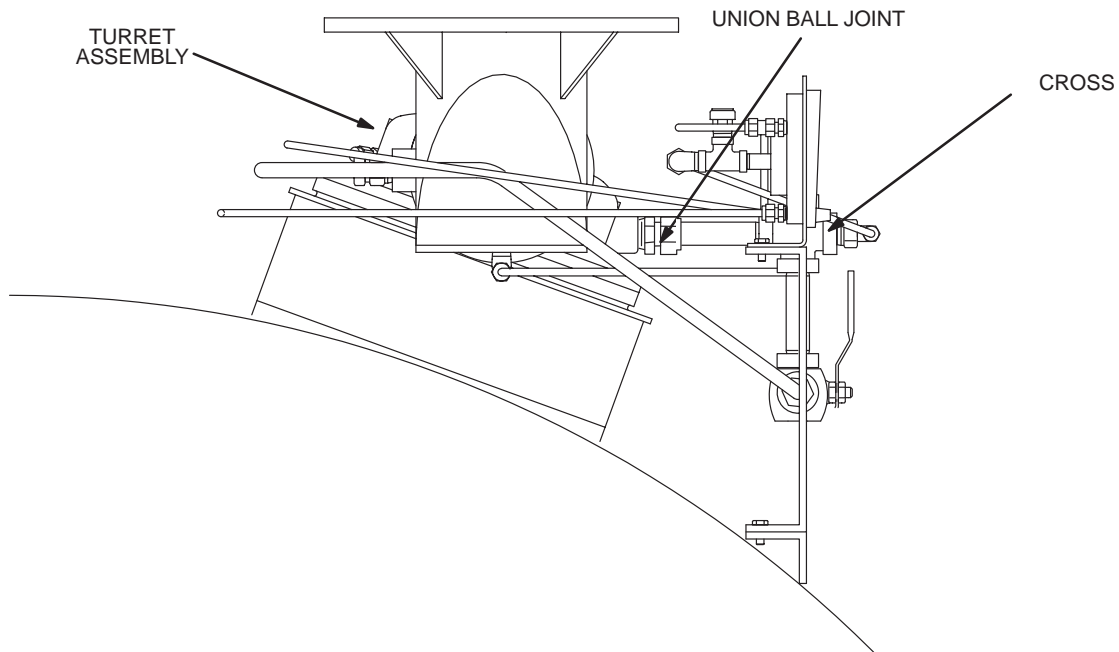
**1-2 BLOCK IN 1/2 INCH HELIUM VENT SYSTEM (continued)**

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.



**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 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



## SECTION 2 – MAGNET RAMPDOWN (DECREASE TO ZERO)

### Description

Magnet Ramping of Mobile 1.0T magnets requires the use of both the Main Service Ramp Power Supply and the Superconducting Shim Power Supply. The purpose of this is to eliminate current buildup in any of the axial or transverse shim coils during Magnet Rampdown. Current buildup, in either the Transverse or Axial Shim Coils could cause a magnet quench. Two heater cables are supplied with the Mobile Shipping Collector in order to activate all axial and transverse switch heaters simultaneously.



### 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 ).**

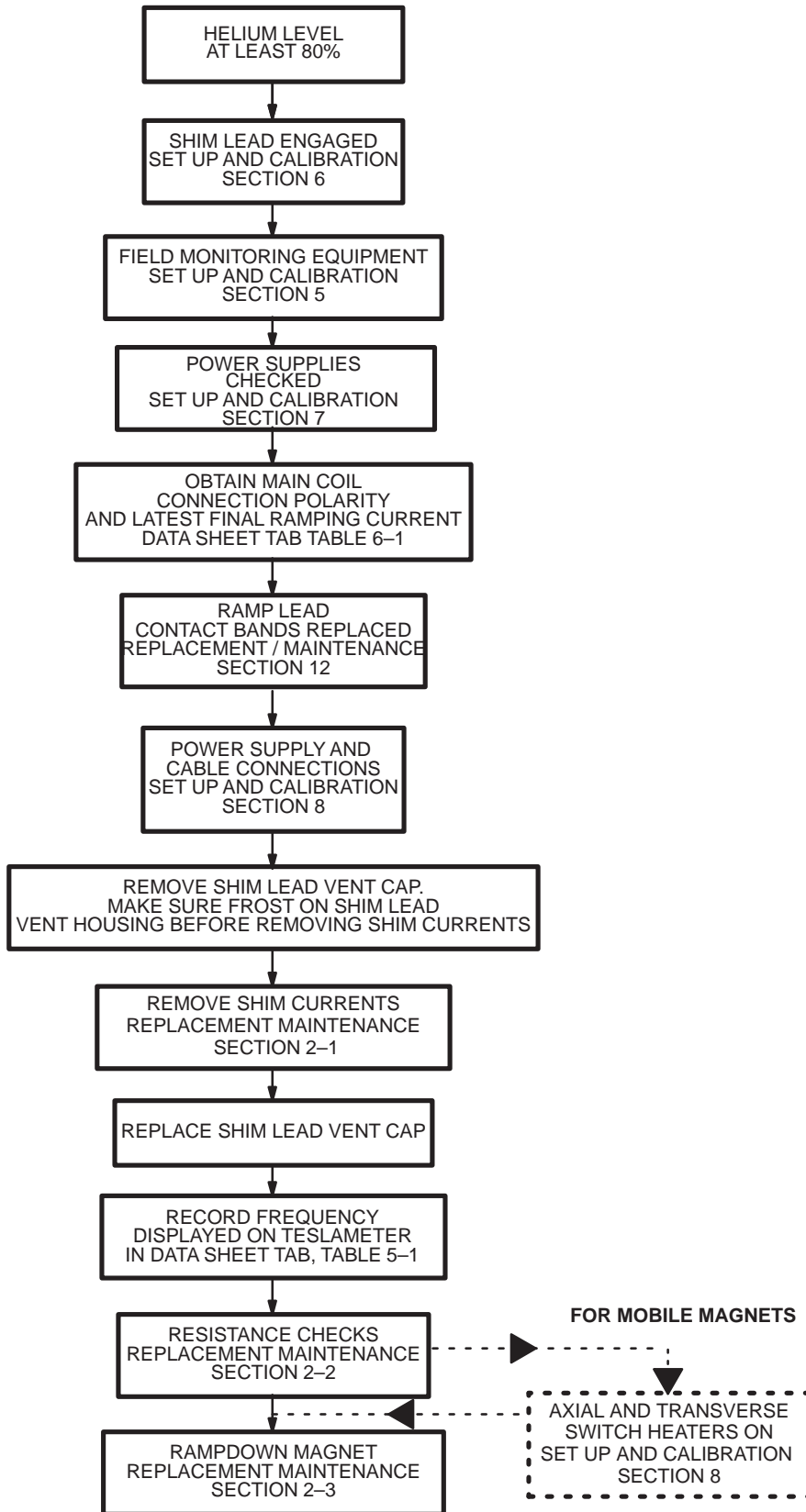
**A SUPERCONDUCTING MAGNET AT FIELD IS AN ENERGY STORAGE DEVICE CAPABLE OF DISCHARGING RAPIDLY DURING A QUENCH AND CREATING A DC VOLTAGE OF 100V OR MORE ACROSS THE MAIN LEADS AND EXTENSIONS.**

**NEVER TOUCH THE MAIN LEAD EXTENSIONS SIMULTANEOUSLY WHEN THE MAGNET IS AT “FIELD” AS A FATAL SHOCK AND/OR BURNS MAY RESULT IF A QUENCH OCCURS.**

**ENSURE INPUT POWER TO MAIN POWER SUPPLY IS DISCONNECTED WHEN CONNECTING MAIN POWER LEADS.**

**SECURE MAGNET ROOM DOORS IN THE OPEN POSITION BEFORE CHANGING MAGNETIC FIELD.**

**MAKE SURE THAT THE MAGNET IS AT LEAST 80% FULL OF LIQUID HELIUM TO PREVENT THE LIQUID HELIUM LEVEL FROM DROPPING TO A POINT, DURING RAMPING, WHERE A QUENCH MAY OCCUR.**



RAMPDOWN FLOWCHART ILLUSTRATION 2-1

**2-1 PREPARATION FOR RAMP DOWN**

1. "Top" fill the magnet to at least 80% helium level before continuing with this procedure.
2. Make sure Shim Lead Assembly is "Engaged" in conformance with SET UP AND CALIBRATION, Section 6. 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 2-1.
3. Set up the field monitoring equipment Probe and Teslameter in conformance with SET UP AND CALIBRATION, Section 5.
4. Perform Ramp Power Supply checks in conformance with SET UP AND CALIBRATION, Section 7. Verify Shim Supply Heater currents are set at  $710 \text{ mA} \pm 10 \text{ mA}$ .
5. Make sure that the Input Power Cables for the Power Supplies are disconnected.
6. Replace the Ramp Lead Contact Bands in conformance to REPLACEMENT/MAINTENANCE, Section 12.
7. Connect the Shim Power Supply to the magnet by making all cable connections In conformance with SET UP AND CALIBRATION, Section NO TAG.
8. Remove the Shim Lead Vent Cap and allow frost to appear on the Shim Lead Connector Housing before removing shim currents.
9. Connect the input power supply cable to the Shim Power Supply.

**Note**

This section allows one to remove all shim currents and 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.



**BEFORE CONTINUING THE RAMP DOWN PROCEDURE, THE MAGNET CRYOGEN LEVEL SHOULD BE NO LESS THAN 80% 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.**

10. Set the MAIN POWER Switch (Shim Power Supply) to the ON position.
11. Dial in all last recorded Transverse 1 Currents from DATA SHEETS, Section 8 into the Shim Supply. Make sure the Current polarities are correct.
12. Set Transverse 1 Heater Switch (Shim Power Supply) to 1 (on). Verify that the heater current is  $810 \text{ mA} \pm 10 \text{ mA}$ . 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.

13. Slowly adjust all Shim CURRENT controls to zero.
14. Set Heater Switch to 0 (off).
15. Repeat Steps 11 through 14 for Transverse 2 and Axial Shim Coils.



**FOR MOBILE MAGNETS, THE AXIAL, TRANSVERSE 1, AND TRANSVERSE 2 SWITCH HEATERS MUST BE ON DURING THE RAMPDOWN PROCEDURE TO MINIMIZE THE POTENTIAL FOR QUENCH.**

16. Set the MAIN POWER Switch (Shim Power Supply) to OFF and disconnect all cables. For Mobile Magnets leave the Shim Power Supply on and connected to the magnet.

**Note**

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

17. Record the frequency displayed on the Teslameter in the DATA SHEET Tab, Table 6-1.
18. 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**

1. Make sure that Input Power Cable for the Magnet Power Supply is disconnected.
2. 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")
3. Set HEATER 1 MAIN and HEATER 2 SHIM AXIAL switches to the 0 (off) position.
4. Set CURRENT ADJUST and VOLTAGE controls to 0 (full CCW).
5. Connect the Input Power Cable for the Magnet Power Supply.



**MAKE SURE MAIN HEATER SWITCH IS OFF DURING THE RESISTANCE CHECKS. SETTING THE MAIN HEATER SWITCH TO 0 (ON), DURING THE RESISTANCE CHECKS, WILL CAUSE A MAGNET QUENCH.**

6. Set the MAIN POWER and POWER ON switches to ON.
7. 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.
8. Connect a Digital Voltmeter (DVM) to the end of the Voltage Sense Leads.
9. Set CURRENT ADJUST controls on Magnet Power Supply to maximum (full CW).
10. 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.
11. Record the voltage reading on the (DVM) in DATA SHEET Tab, Table 6-1.

**2-2 RESISTANCE CHECKS (continued)**

**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.**

**DO NOT ATTEMPT TO IMPROVE THE DVM READING, IN STEP 8, BY INCREASING THE MAGNET CURRENT ABOVE 500 AMPS AS THIS COULD DAMAGE THE MAGNET MAIN POWER LEADS**

12. 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 reseal the Ramp Leads. Repeat Steps 6 through 8.
13. Continue to Step 15 after the DVM voltage is less than 150mV.
14. 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 12 above.
15. 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 12 for adjusting contact resistance.
16. 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)



THE 1.0T 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.



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



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.

**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 ) ( continued )****WARNING!**

**FOR MOBILE MAGNETS, THE AXIAL, TRANSVERSE 1, AND TRANSVERSE 2 SWITCH HEATERS MUST BE ON DURING THE RAMPDOWN PROCEDURE TO MINIMIZE THE POTENTIAL FOR QUENCH.**

**Note**

Two Heater cables are supplied for mobile magnet for Rampdown. The shim supply is used to energize the Transverse 1 and Transverse 2 switch heaters, while the Service Ramp Supply is used to energize the Axial Switch Heater. Do not use the Shim Supply Axial Heater, in this section, as boiloff will increase.

1. Make sure Shim Supply MAIN POWER Switch is set to ON ( Mobile Magnets only ).
2. For Mobile magnets, set the Shim Power Supply HEATER 2 TRANSVERSE 1 and HEATER 3 TRANSVERSE 2 switches to 1 ( on ).
3. Retrieve the Main Coil Connection Polarity and latest final ramping current in the DATA SHEET Tab, Table 6-1.

**Note**

The Axial Shim Heater must remain on throughout the Rampdown procedure.

4. Make sure the Axial Shim Heater is on and Ramp Leads are connected with the polarity indicated in step 3.
5. Set the power supply VOLTMETER SELECT SWITCH to MAIN COIL position.
6. Set CURRENT ADJUST controls on power supply to maximum ( full clockwise ).
7. Set VOLTAGE control to adjust power supply output current to the Parking Current value obtained in Step 3 above.
8. Set the HEATER 1 MAIN Switch to 1 ( on ).
9. Allow approximately 1 minute for the Main Switch to go normal.
10. When the Main Switch is normal, adjust the VOLTAGE control to obtain a voltage of  $-0.3$  volts across the main coils. Do not exceed  $-0.3$  volts. Adjust the VOLTAGE control as necessary to maintain  $-0.3$  volts across the main coils.

**Note**

The VOLTAGE control in Step 11 can be adjusted continually to maintain negative 2.0 volts across the main coils. Once the VOLTAGE control reaches the full counterclockwise ( minimum ) position, the CURRENT ADJUST controls can be adjusted, counterclockwise, to maintain a negative 2.0 volts across the main coils.

11. When the main coil current decreases to 690 amps, adjust the VOLTAGE control until negative 2.0 volts (  $-2.0$  V ) is observed across the Power Supply Voltmeter ( Main Coil Position ). Do not exceed  $-2.0$  volts.
12. When the main coil current decreases to 500 amps, decrease the VOLTAGE ADJUST controls to minimum ( full CCW ).
13. After performing Step 12, decrease the CURRENT ADJUST controls to minimum ( full counterclockwise ) or until  $-4.5$  volts is observed on the power supply voltmeter. Do not exceed  $-4.5$  volts.

**2-3 MAGNET RAMPDOWN (DECREASE TO ZERO) (continued)**

14. 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.
15. When the magnet is full discharged, set the HEATER 1 MAIN and THE HEATER 2 SHIM AXIAL Switches to 0 (off).
16. Set the MAIN POWER and POWER ON Switches to OFF.
17. Disconnect input power cable from Magnet Power Supply.
18. For Mobile units, set the Transverse Heater switches to 0 (off), then turn off Shim Power Supply.



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

19. Open Vent Valve (V2) to de-pressurize the Cryostat to 0.25 psig. Close V2.
20. Disconnect the Main Power Leads on the top of the magnet and remove the Main Power Lead Extensions. Immediately replace caps on Main Power Lead Extension Receptacles.



**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).

21. 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

**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.



**Do not warm up the Magnet if it is to be shipped from the site!**

**Procedure:**

**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.**



**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 NO TAG.
3. Connect the Lakeshore Cryotonic 208 Thermometer Kit (46-301477G1) to monitor silicon diode temperature in conformance with SET-UP AND CALIBRATION, Section 2-2-1.
4. Obtain 2 large (235 SCF) full aluminum helium cylinders.

**WARNING!**

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

5. Connect standard high pressure GHe regulator and hose assembly to valve outlet (CGA 580) on GHe cylinder.
6. Connect Helium Gas Line Adapter to Purge/Precool Adapter then connect Helium Gas Line to Adapter. See Illustration 3-1.
7. Make sure that regulator adjusting handle is fully backed out, then slowly open GHe Cylinder Valve.
8. Observe Regulator High Pressure Gauge. Make sure indicated pressure is approximately 2000 psig indicating full cylinder.

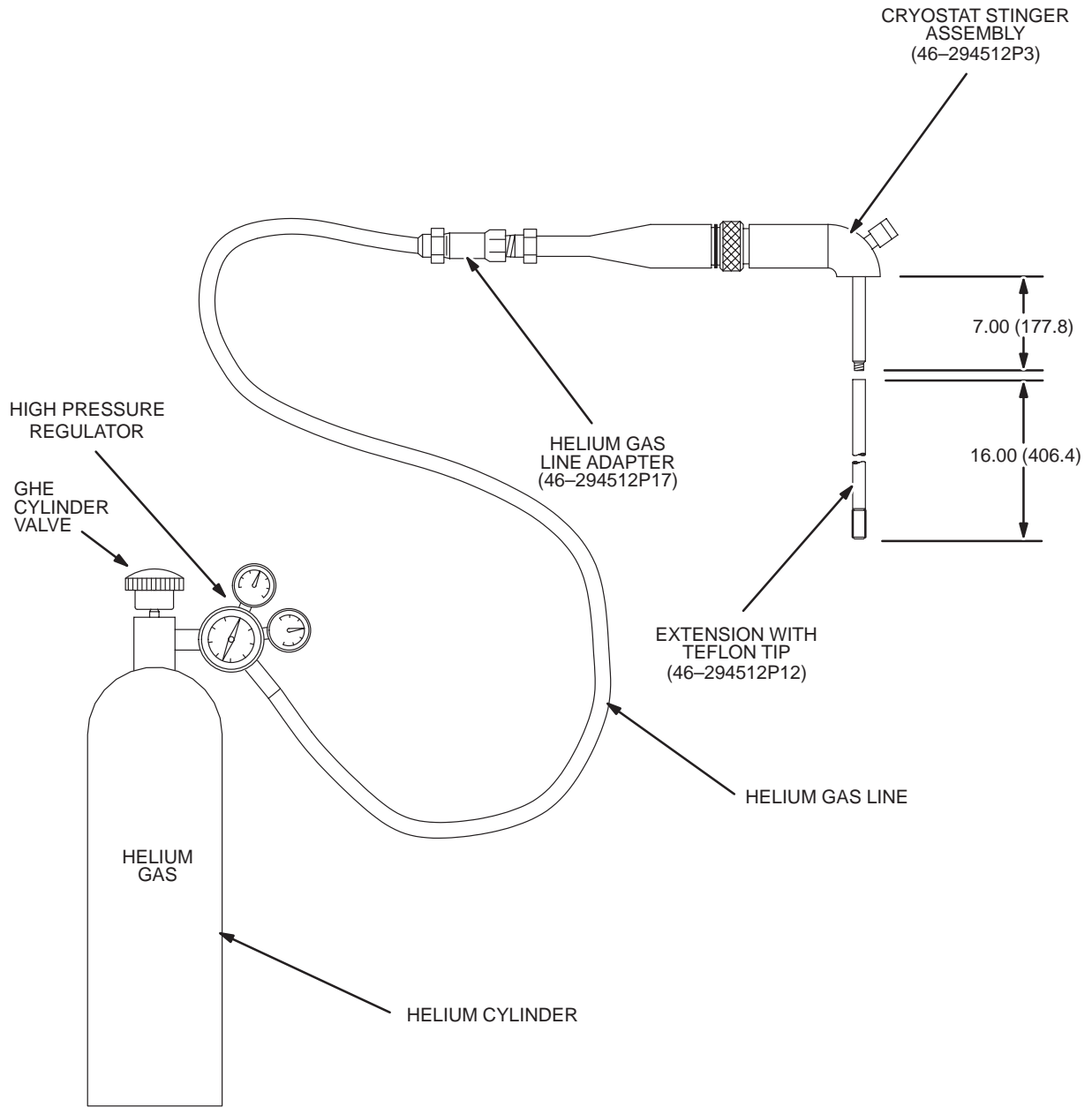
**WARNING!**

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

9. Purge regulator and gas line assembly by alternately turning regulator handle fully in and out 3 times. Upon completion of purge, back regulator out until minimal flow is felt exiting the Purge/Precool Adapter.
10. Adjust regulator outlet pressure to 5 psig.

3-1 WARMING UP CRYOSTAT (continued)

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)



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).

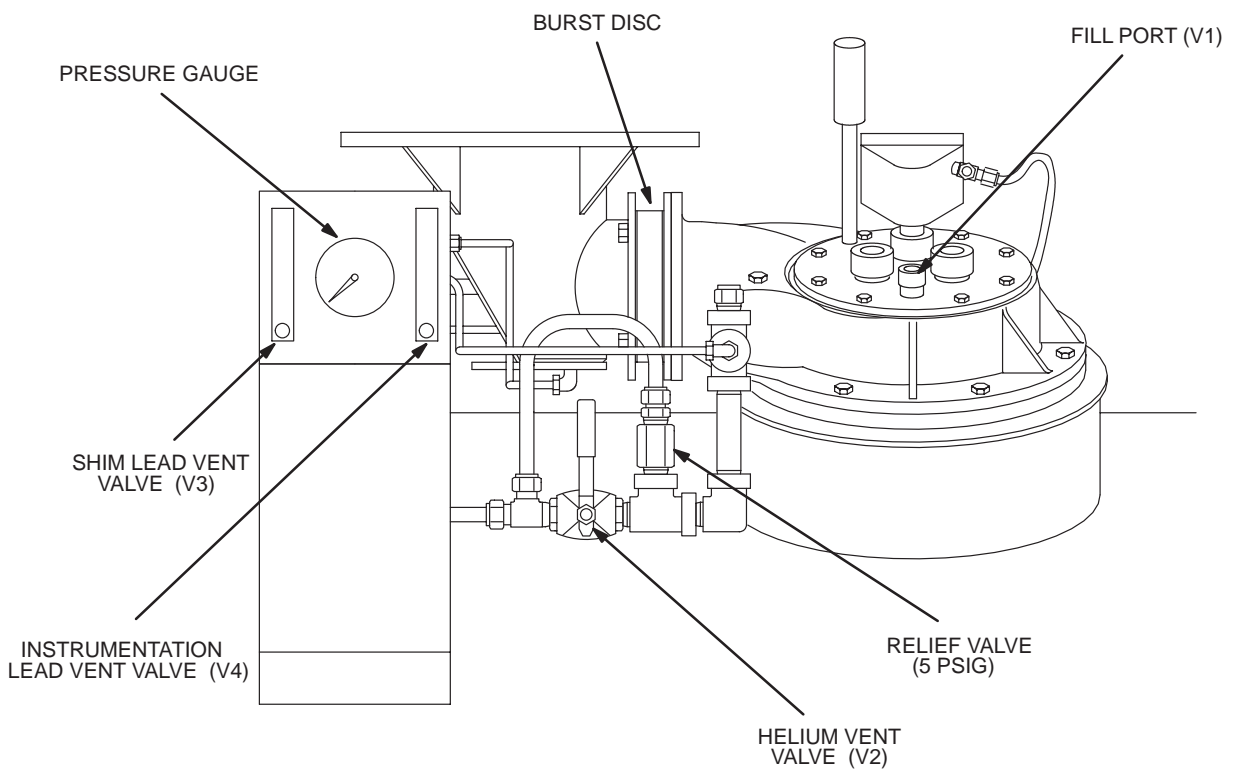
**Note**

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.



**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.**

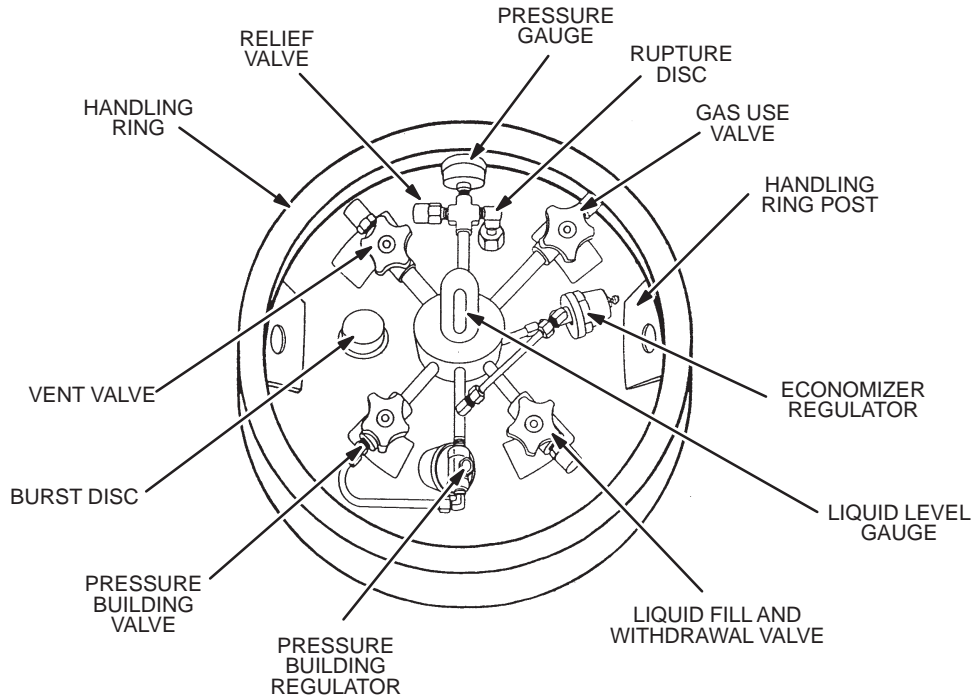
17. Obtain a full Liquid Nitrogen Dewar (PLC-230A). Verify that all valves are in the closed position.

**Note**

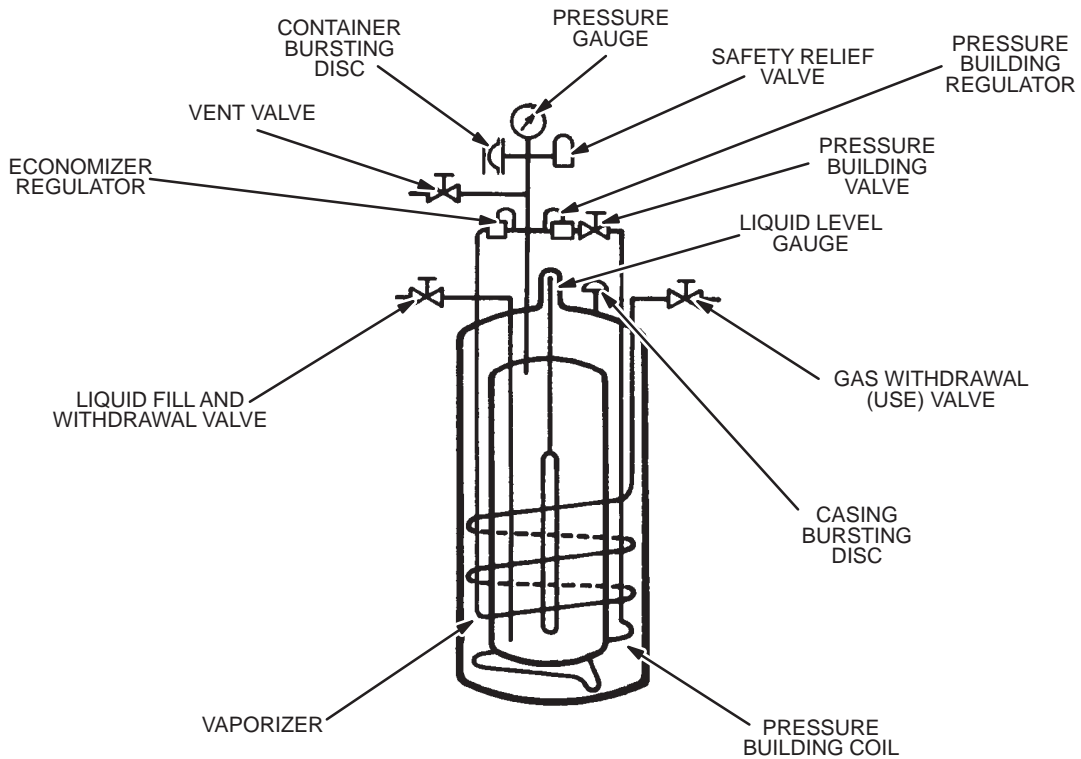
Other sources of gaseous nitrogen may be used with appropriate setup apparatus.

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

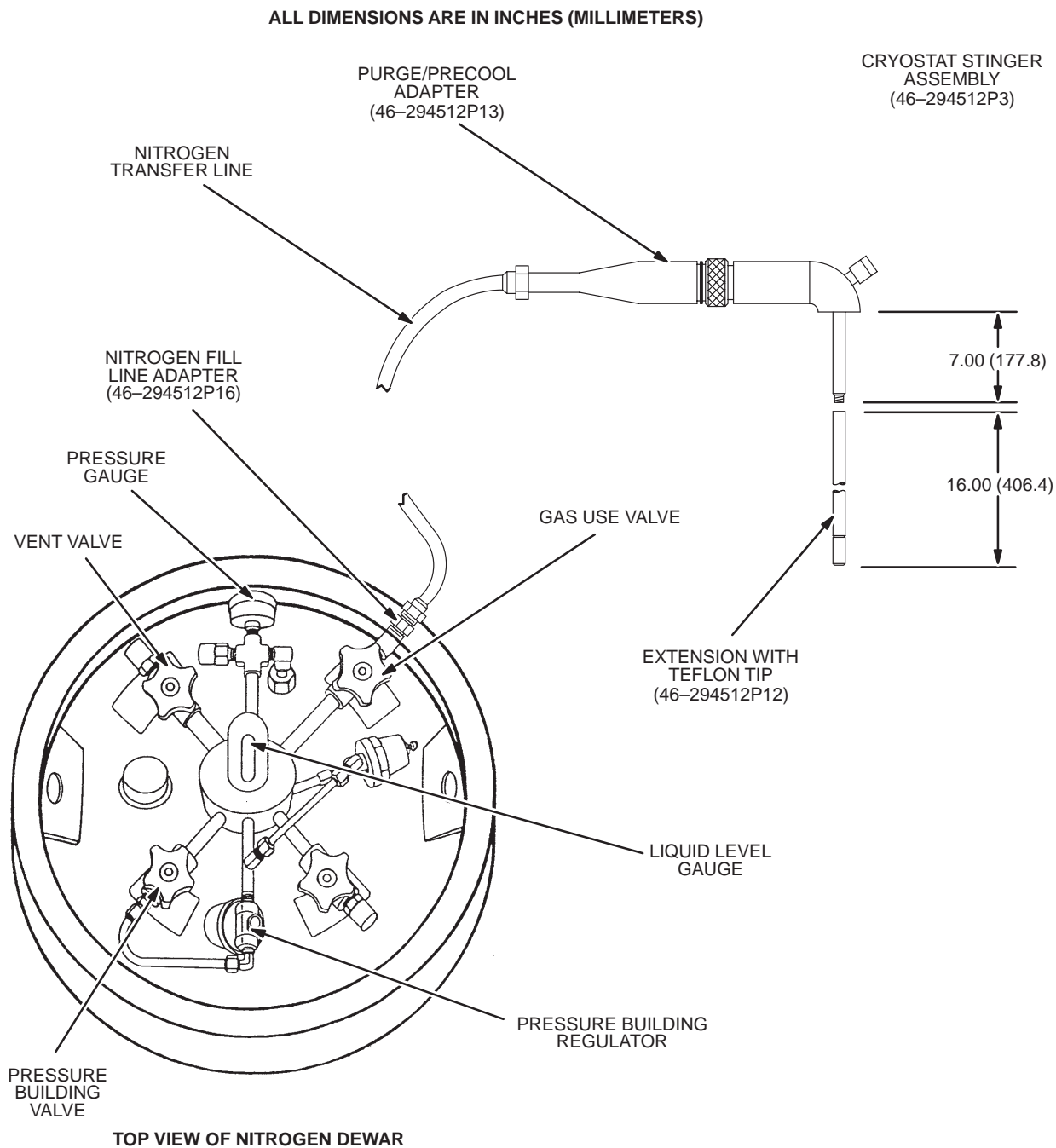


NITROGEN GAS/LIQUID DEWAR

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.



**NITROGEN PURGE/PRECOOL ADAPTER  
ILLUSTRATION 3-4**

3-1 WARMING UP CRYOSTAT (continued)

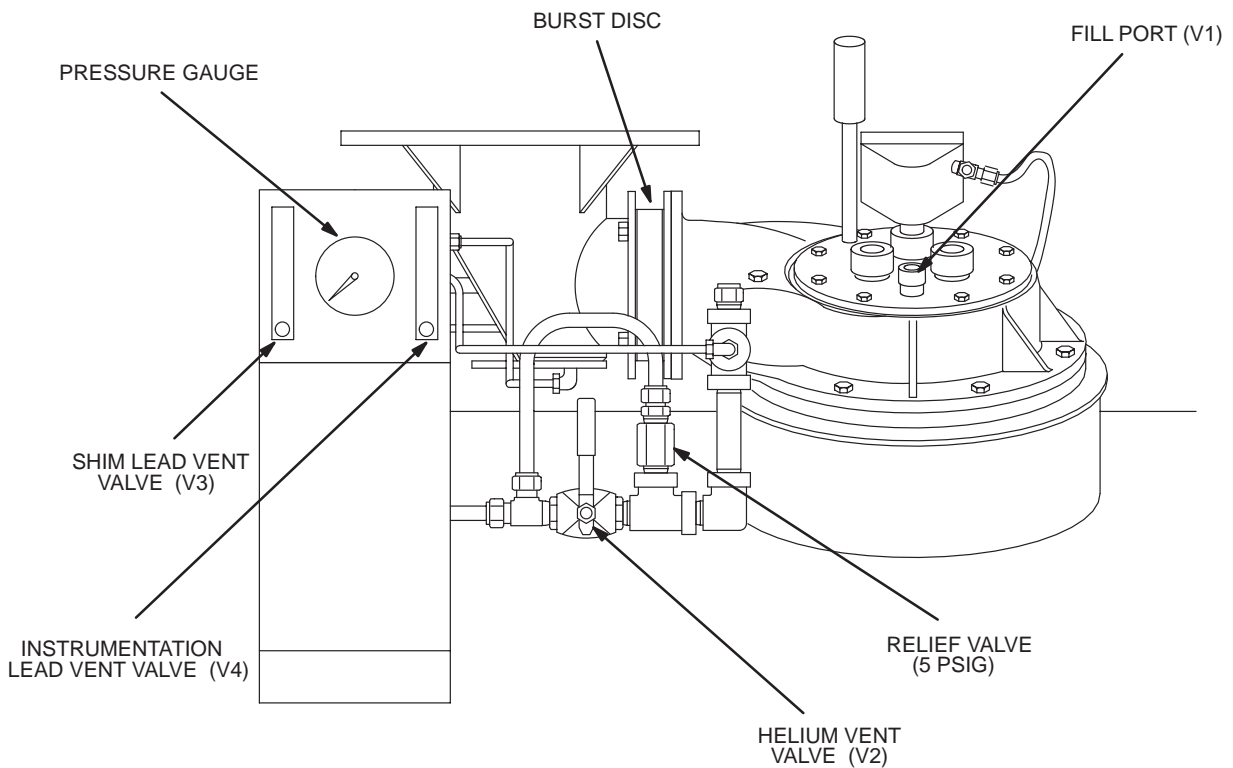


**Make sure that Cryostat Stinger Extension (16 inch) and Teflon Tip are firmly secured during installation to prevent it from loosening and falling into magnet.**

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

**Note**

If ceiling height prevents insertion of Cryostat Stinger in Step 9, remove Extension from Cryostat Stinger and partially insert into Fill Port V1, before attaching it to the Cryostat Stinger.



**VALVE/VENT LOCATIONS**  
ILLUSTRATION 3-5

**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.



**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

### 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:



**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.**

**CLAMP OR TIE NON-SELF-SUPPORTING HELIUM EXHAUST VENT TO PREVENT VENT SEPARATION PRIOR TO REMOVING VENT ADAPTER.**

**MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD TO PREVENT ANY POSSIBILITY OF A QUENCH.**



**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.

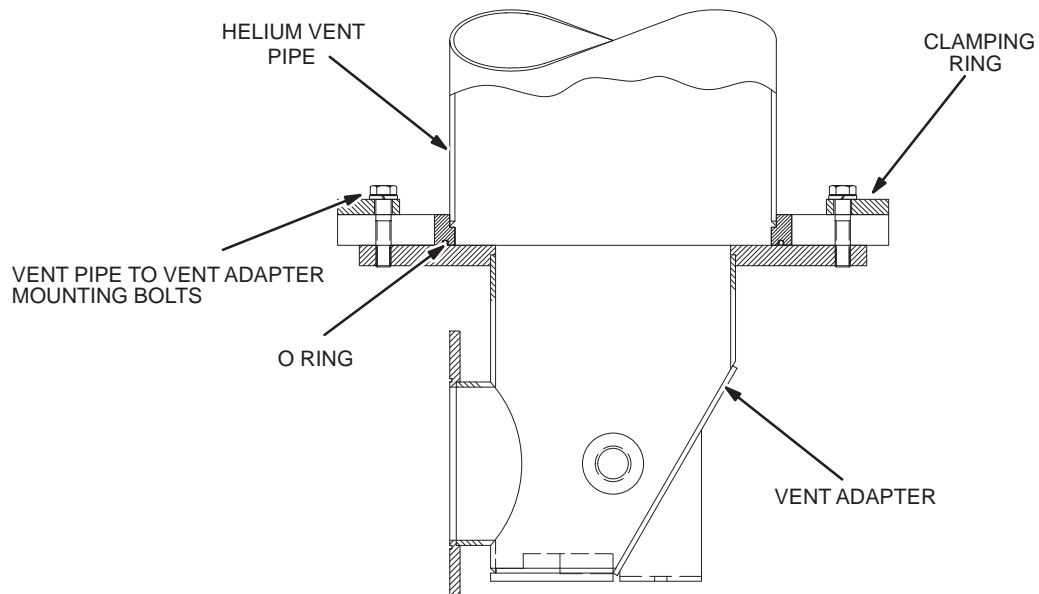
#### Note

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

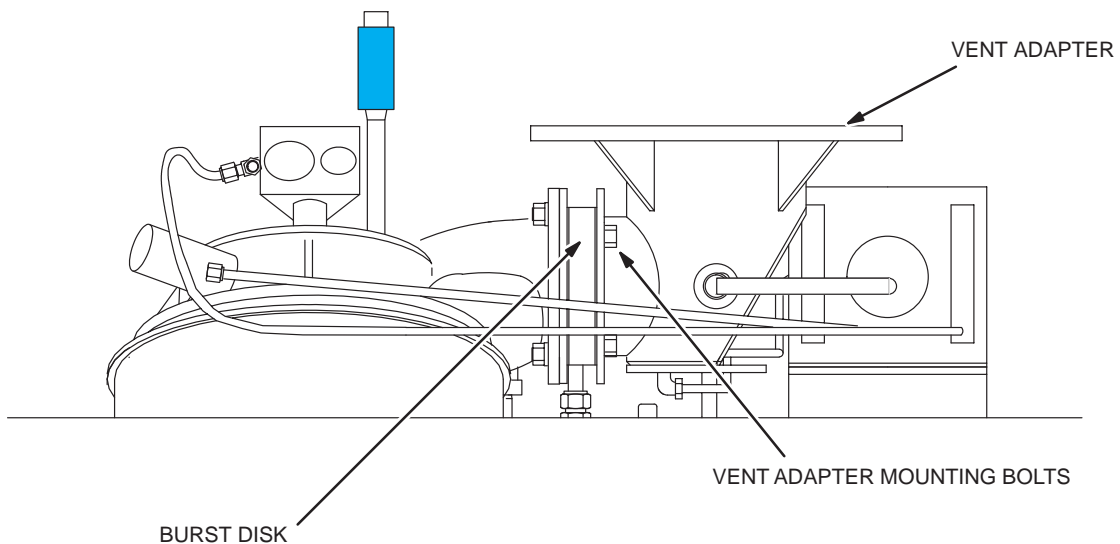
2. Loosen and remove magnet vent plumbing from Vent Adapter.

**SECTION 4 – BURST DISK REPLACEMENT (continued)**

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



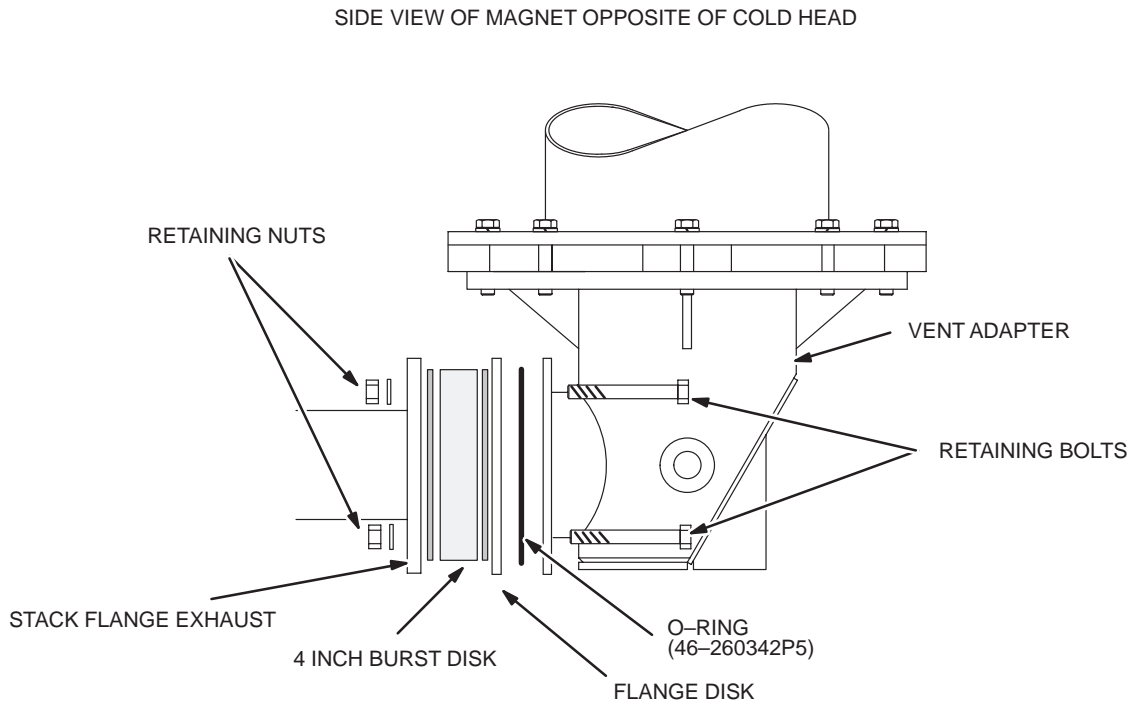
**VENT ADAPTER CROSS-SECTIONAL VIEW**  
ILLUSTRATION 4-1



**BURST DISC LOCATION**  
ILLUSTRATION 4-2

**SECTION 4 – BURST DISC REPLACEMENT (continued)**

4. Remove the four 3/8 inch Retaining Nuts. Use a 5/16 hex head wrench to hold the Socket Head Retaining Bolts in place during removal of Retaining Nuts. See Illustration 4-3.
5. Pull Retaining Bolts and Vent Adapter back far enough to remove the Burst Disc.



**BURST DISC ASSEMBLY**  
ILLUSTRATION 4-3

6. Remove ruptured Burst Disc and clean any fragments out of vent system.
7. Unpack and inspect new Burst Disc for nicks and scratches. Assure that Burst Disc is undamaged and has proper part number and 20 psi rating on the rating plate.
8. Install new Burst Disc with fiat face towards the Vent Adapter.

**Note**

Assure that the Burst Disc is fully sandwiched between the two rubber gaskets, i.e. the gaskets are fiat and the Burst Disc is not in contact with the flanges.

9. Assemble and tighten the four Retaining Bolts sufficiently to prevent leakage around the gaskets.
10. Reassemble Vent Adapter.
11. Reassemble Helium Exhaust Vent.

**SECTION 4 – BURST DISC REPLACEMENT (continued)**

**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.**

12. Disconnect Instrumentation Lead Assembly Plumbing at Flowmeter (F1).
13. 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.
14. If ice block present, follow procedure in Replacement/Maintenance, Section 1.

## SECTION 5 – SHIM LEAD/BAFFLE ASSEMBLY REMOVAL/REPLACEMENT



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. Engage Shim Lead Assembly in conformance with SET-UP AND CALIBRATION, Section 6.
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 & J1-B) 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 6.



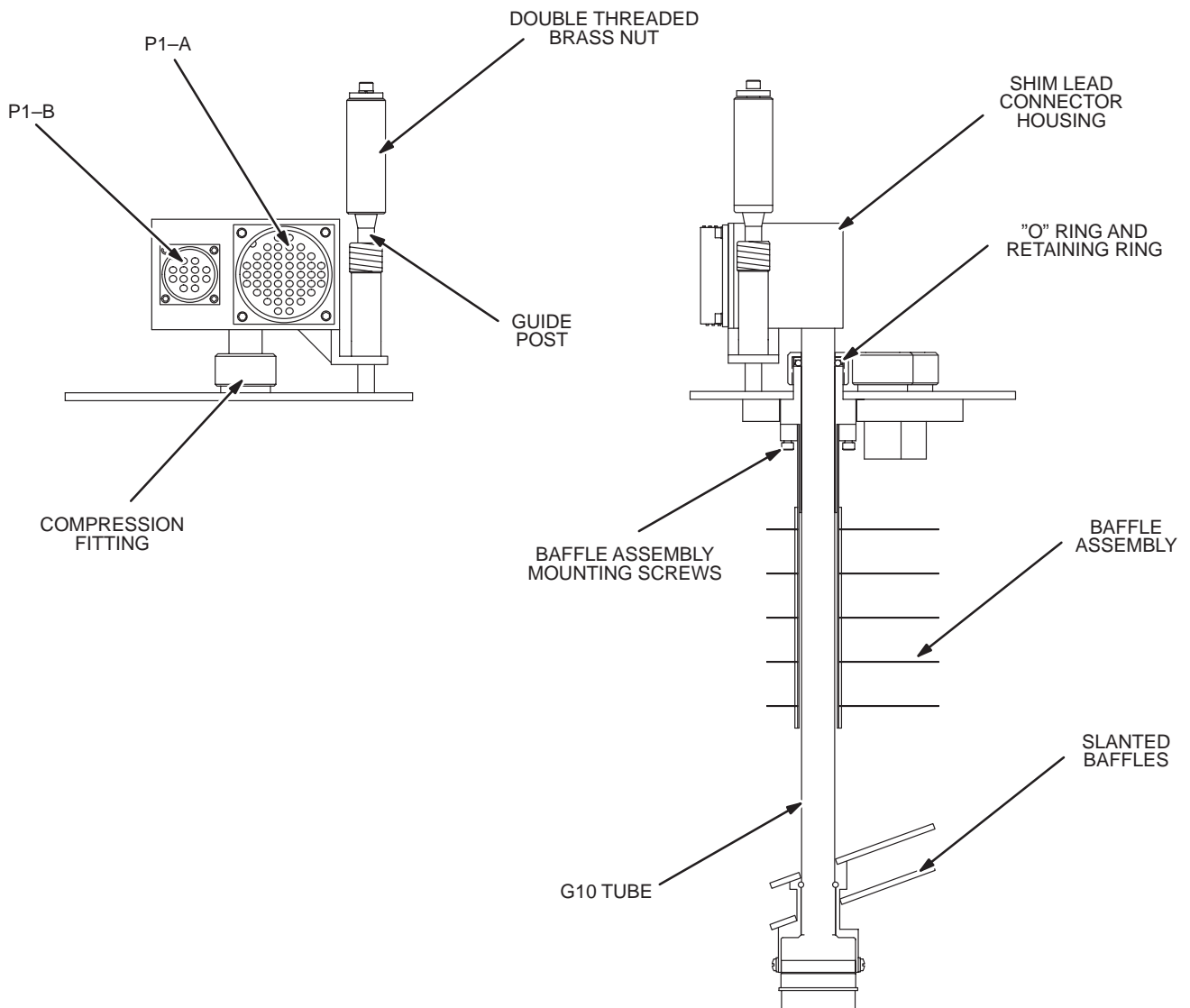
**Perform Steps 7 and 8 rapidly to prevent cryopumping of air into the Vertical Stack. Make sure that the Lexan Cover Plate P/N 46-294765G1 is on the service platform before removing the Shim Lead Assembly.**

**Note**

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

7. Loosen and remove the eight 1/4 – 20 Retaining Bolts and remove the Shim Lead Assembly.
8. Immediately cover the Vertical Stack with the Lexan Cover Plate. Align the Lexan Plate Scribe mark to the Vent Adaptor. See Illustration 5-2.
9. Secure the Lexan Cover Plate onto the Vertical Stack with the eight 1/4-20 Retaining Bolts removed in step7.
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, (i.e., Guide Post Screw is threaded all the way into the Double Threaded Brass Nut).



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

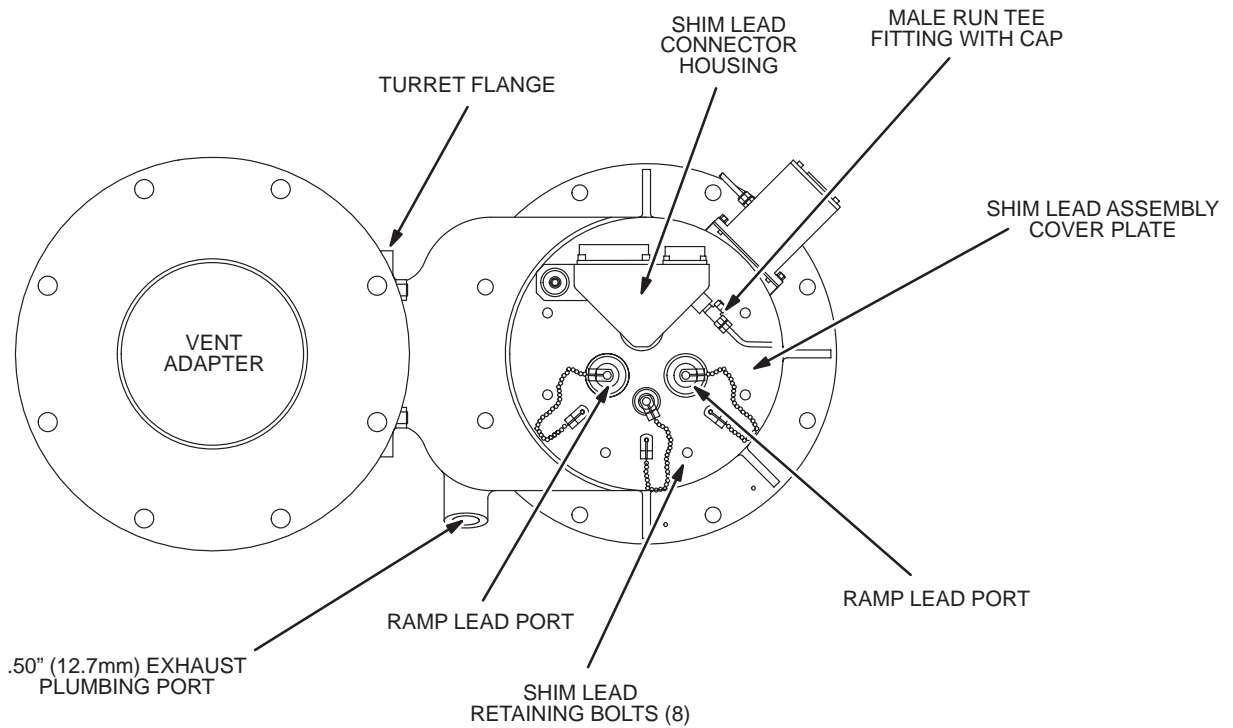
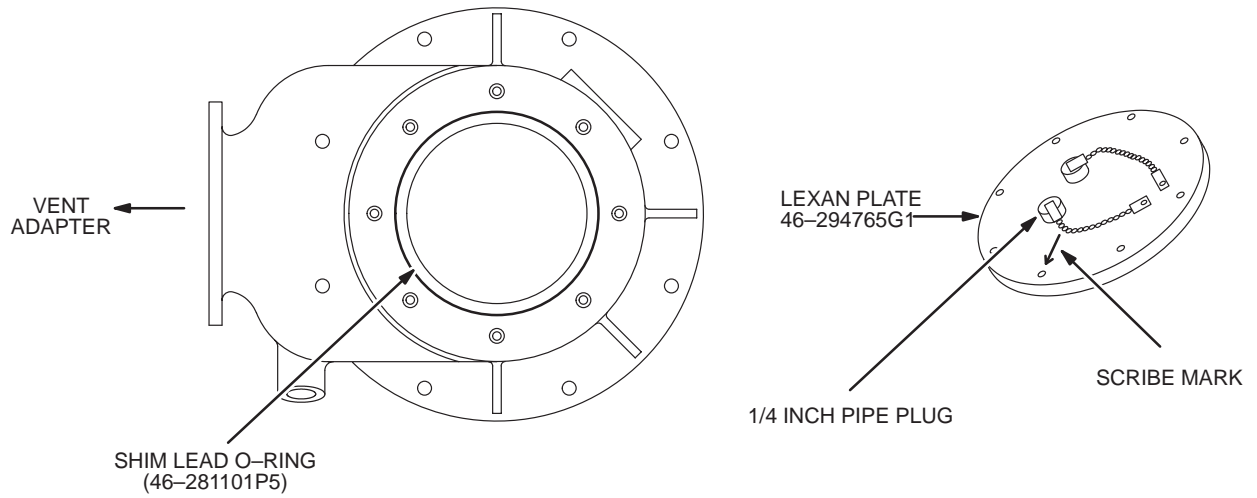
5. Loosen and remove the eight 1/4 – 20 Retaining Bolts and remove the Lexan Cover Plate.



**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 Bustik ( 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 6.
16. Make sure the Connectors (J1-A and J1-B) are connected to the Shim Lead Receptacle Box.
17. Ramp the magnet to field in conformance with SET UP AND CALIBRATION, Section NO TAG.



**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 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.



**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.**

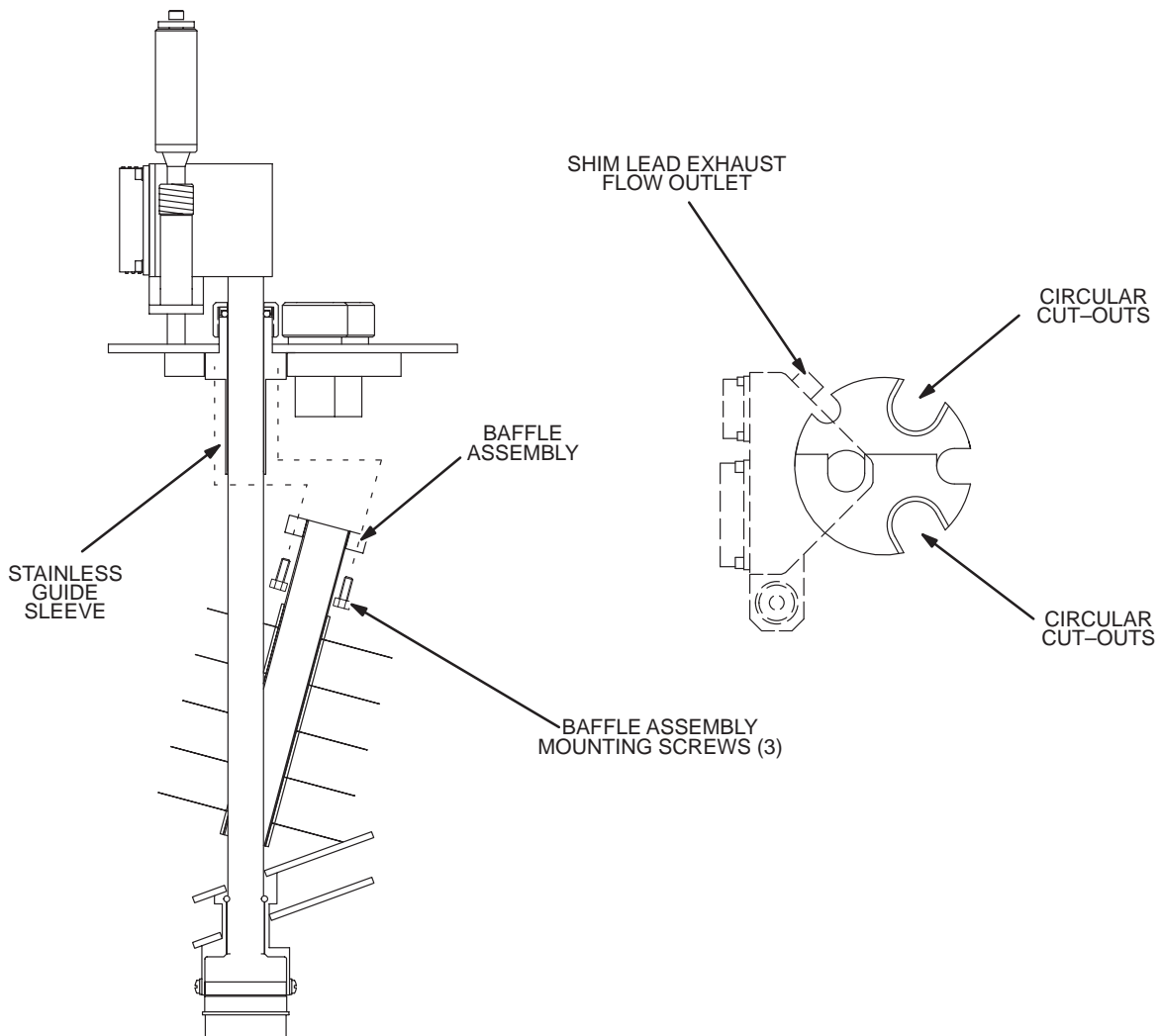
5. Install the Baffle Assembly (46-294431G1) by carefully lifting up near the slit of each baffle while simultaneously pushing Baffle Assembly onto the Shim Lead Assembly, as in Illustration 5-3. Starting from the bottom of the Baffle Assembly and working towards the top; continue this process until 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 NO TAG 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



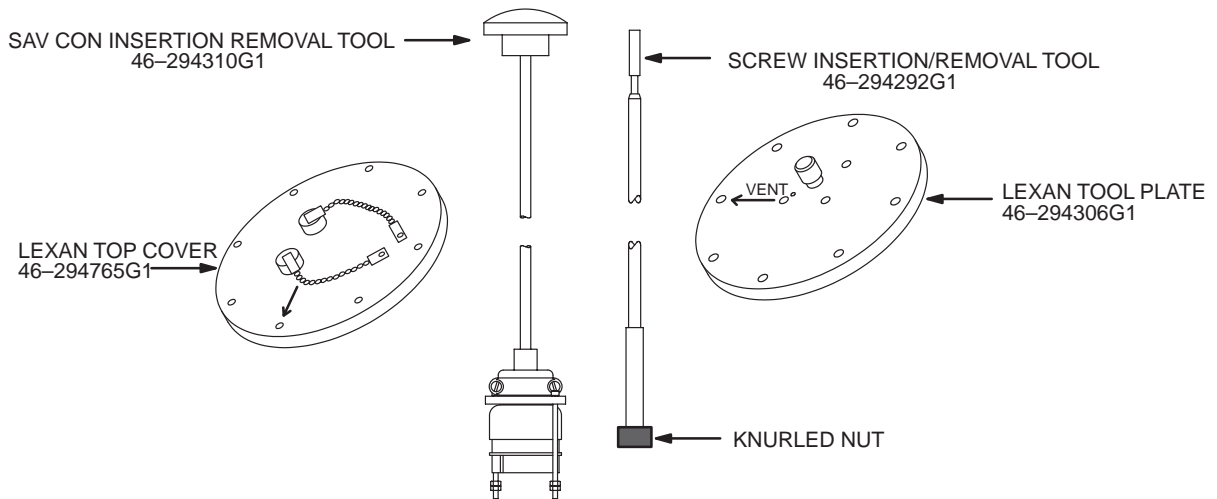
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN 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.

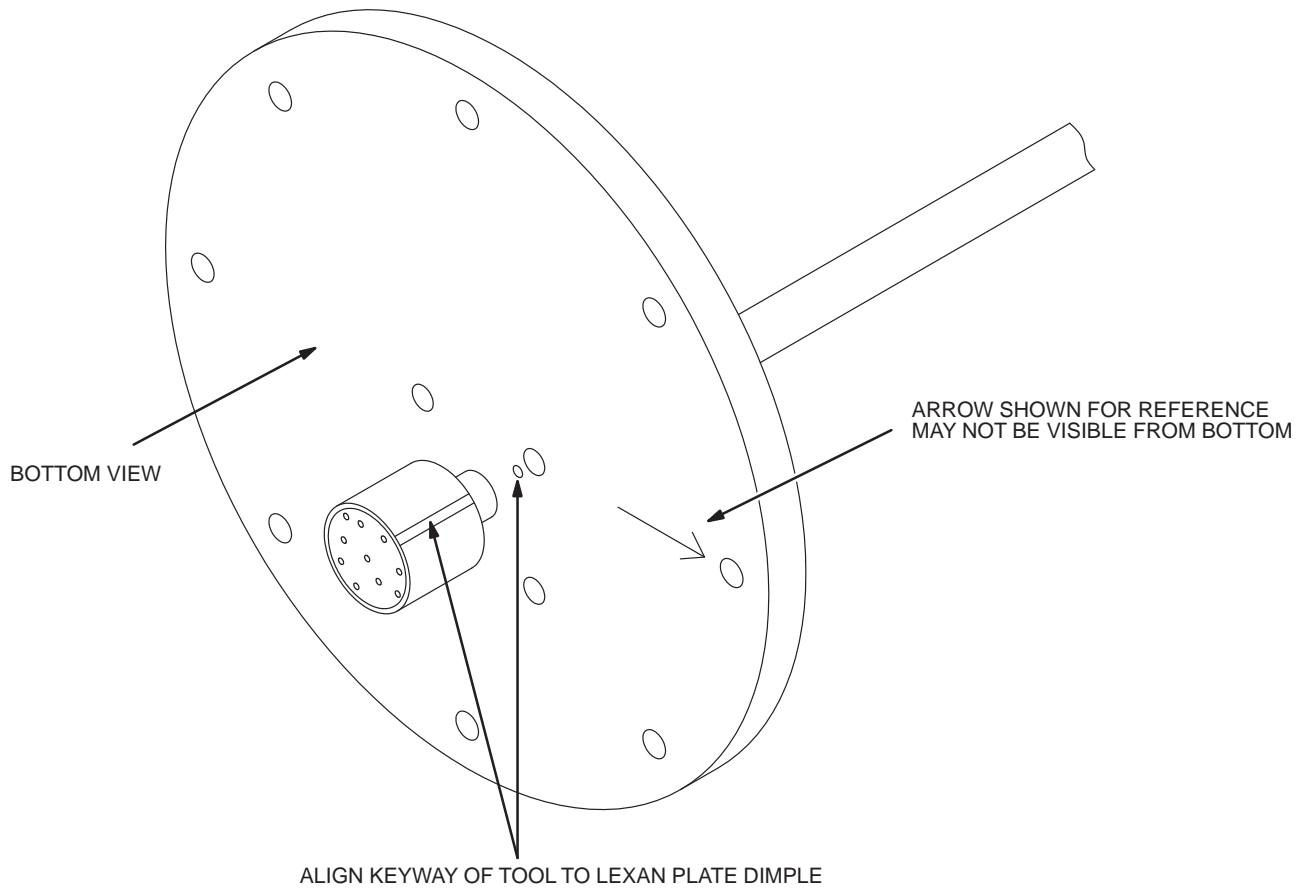
READ AND UNDERSTAND THIS PROCEDURE AND HAVE ALL REQUIRED TOOLS AND EQUIPMENT ON HAND INCLUDING: TOOL KIT P/N 46-294743G1, HELIUM GAS, HEAT GUN, WRENCHES, FLASHLIGHT, SNOOP, SAFETY FACE SHIELD AND GLOVES BEFORE STARTING.



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

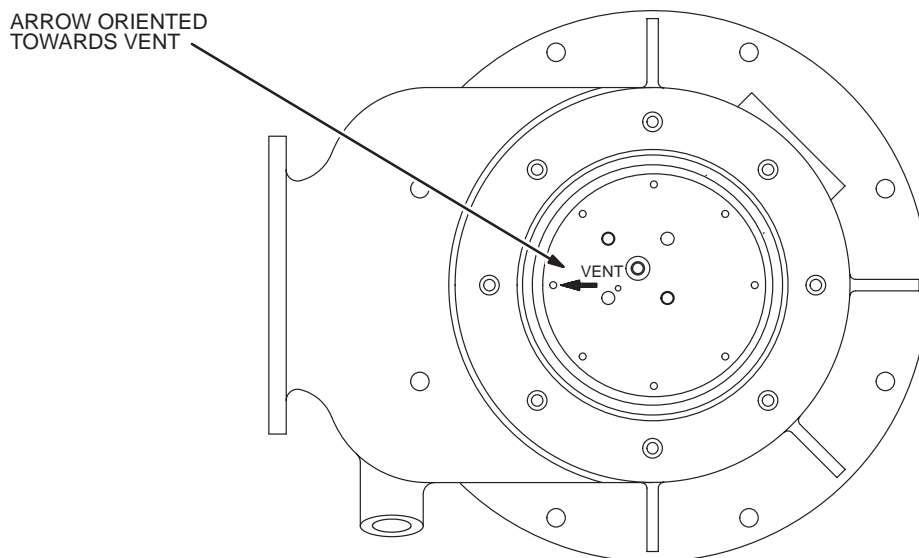
**6-1 SAV CON CONNECTOR REMOVAL (continued)**

**Note**

Quickly place this assembly onto the Vertical Penetration upon removal of Shim Lead Assembly to prevent icing.

Always replace Shim Lead “O” – Ring when performing this procedure.

5. Remove Shim Lead Assembly in conformance with REPLACEMENT/MAINTENANCE, Section 5 and store carefully.
6. Immediately position Lexan Tool Plate/Tool assembly onto Vertical Penetration; orient scribe mark as shown in Illustration 6-3.



**SAV CON TOOL ASSEMBLY ALIGNMENT TO TURRET**  
ILLUSTRATION 6-3

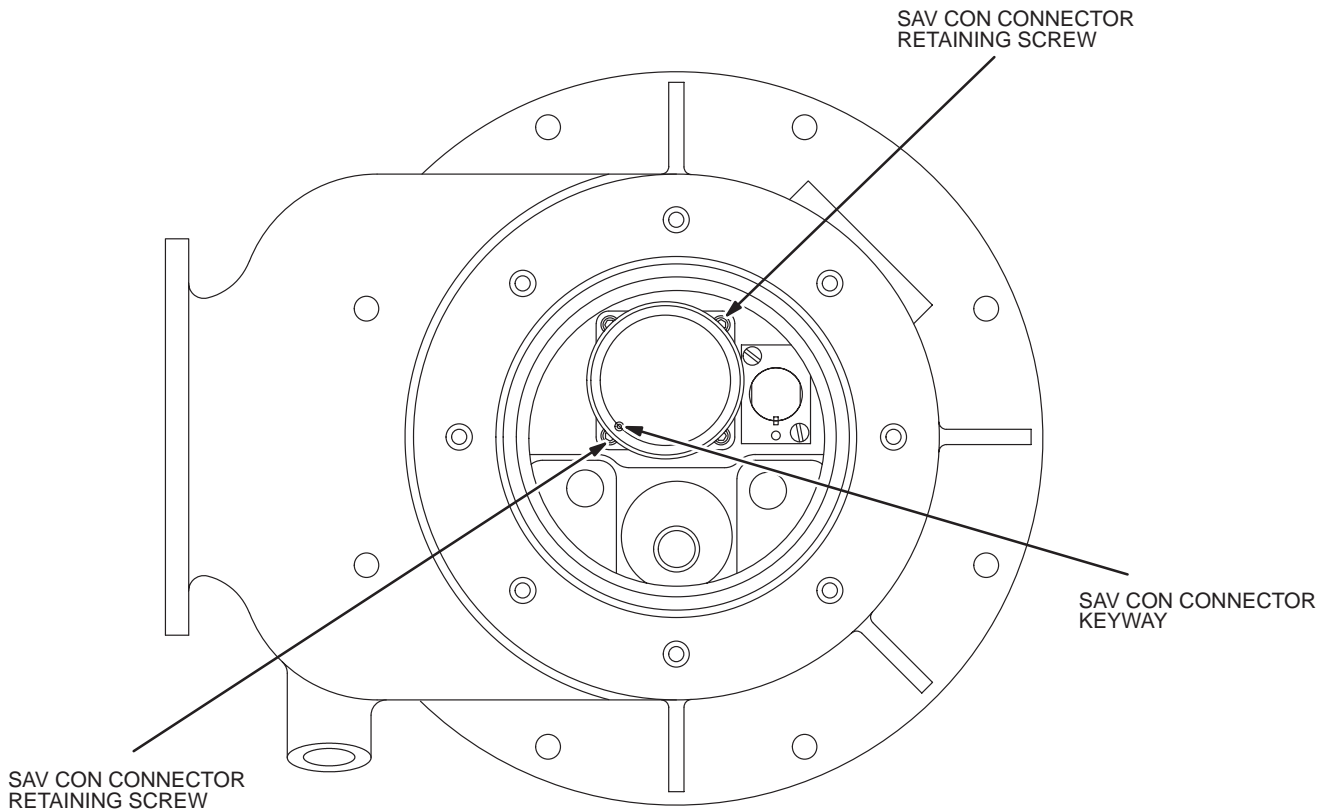
7. Allow flow of helium gas exiting through holes in Lexan Tool Plate to subside.
8. Make sure Shim Lead “O” – Ring on top of Vertical Penetration is in its groove and firmly sandwiched between the Lexan Tool Plate and Vertical Penetration. Bolt Lexan Plate in place using bolts removed in step 5.

**Note**

If ice builds up on connector or associated hardware during procedure, Insert Helium Gas Tube through one of the holes in the Lexan Tool Plate to the ice point. Blow warm helium gas at 15 psi to remove ice, then allow flow of helium gas to subside.

**6-1 SAV CON CONNECTOR REMOVAL (continued)**

9. Shine flashlight through Lexan Tool Plate and locate Sav Con Connector and its Retaining Screws. Check for any ice build up.
10. Locate the two Sav Con Connector Retaining Screws, location should be directly below insertion holes on Lexan Tool Plate. See Illustration 6-4.



**SAV CON CONNECTOR RETAINING SCREW LOCATION**  
ILLUSTRATION 6-4

**Note**

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

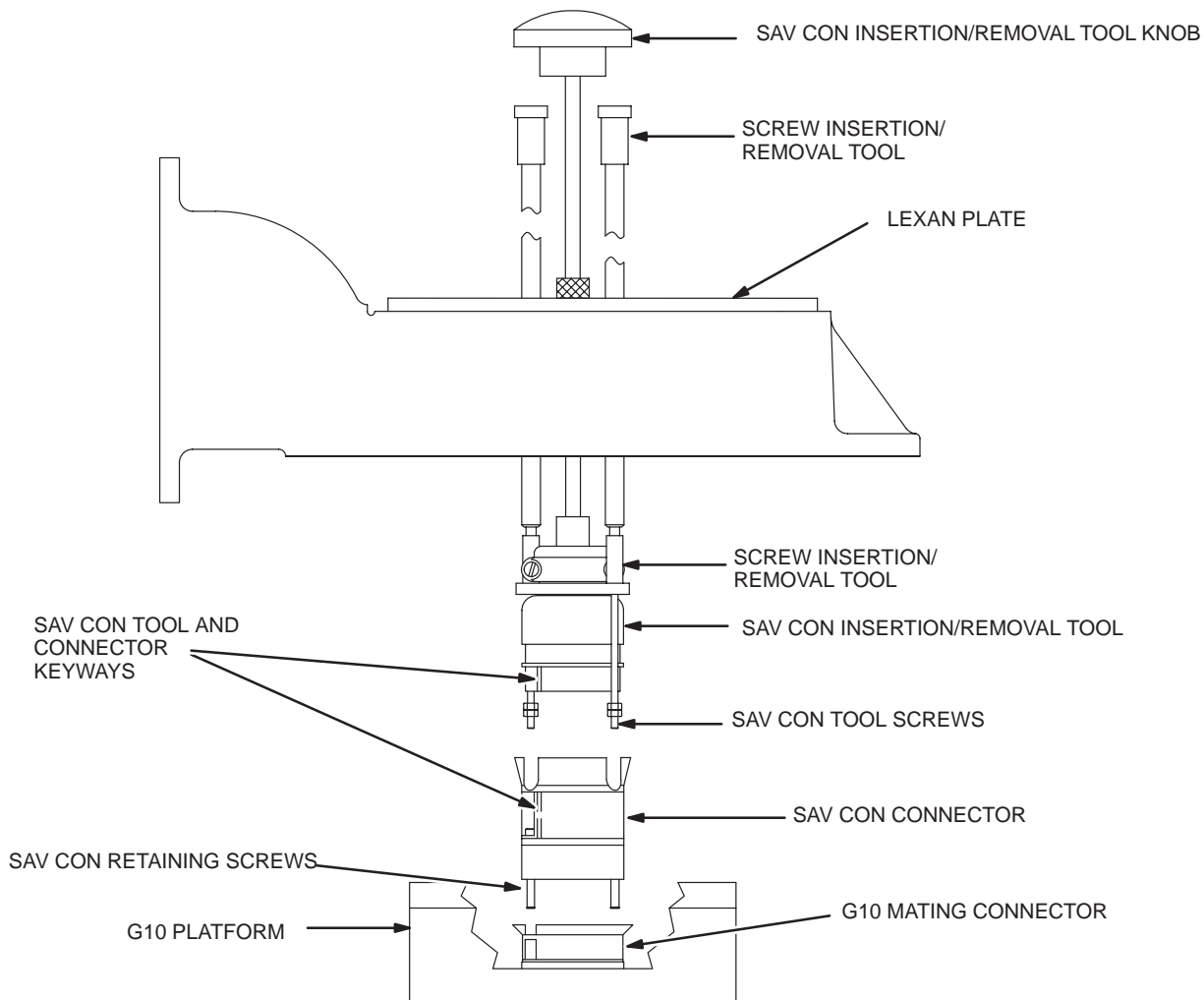
11. Lower the Screw Insertion Tool through one of the two appropriate holes to contact the Allen head on either Retaining Screw.
12. Push downward to engage Screw Insertion Tool with Sav Con Retaining Screw, loosen each screw.
13. Withdraw the Screw Insertion/Removal Tools.

6-1 SAV CON CONNECTOR REMOVAL (continued)



Make sure the key ways of the Sav Con Connector and the G10 mating connector are lined up before connecting the two together. Forcing the Sav Con Connector onto the G10 mating connector can result in bending of the G10 connector pins.

- 14. Loosen knurled nut holding the Sav Con Insertion/Removal Tool. Push downward and carefully align key ways of the two mating connectors, then seat the Sav Con Insertion/Removal Tool onto the Sav Con Connector. See Illustration 6-5.



SAV CON TOOL ASSEMBLY AND CONNECTOR MATING

ILLUSTRATION 6-5

**6–1 SAV CON CONNECTOR REMOVAL (continued)****Note**

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

15. Insert the Screw Insertion/Removal Tool through the appropriate holes in the Lexan Tool Plate and engage each screw on the Sav Con Connector Tool.
16. Carefully thread the Sav Con Tool Screws into the threaded bolt heads of the Sav Con Connector and tighten lightly. Remove Screw Insertion/Removal Tools.
17. Pull upward with the Sav Con Tool to remove the Sav Con Connector from the G10 Connector Platform. Tighten the knurled nut to secure tool.
18. Remove Lexan Tool Plate and Sav Con Tool Assembly. Quickly replace with Lexan Top Cover (46–294765G1)

**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 6–1.

**Note**

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

4. Loosen knurled nut and lower Sav Con Connector/Tool Assembly. Carefully engage Sav Con Connector into mating G10 platform connector.
5. Locate Sav Con Connector Retaining Screws. Location should be directly below insertion holes on Lexan Plate.
6. Lower the Screw Insertion/Removal Tool to contact Allen head on Retaining Screws.
7. Engage and hand tighten Sav Con Retaining Screws. Withdraw Screw Insertion/Removal Tools.
8. Unscrew Sav Con Tool screws from the Sav Con Connector. Disengage, pull Sav Con Tool upward, and secure in place with knurled nut.
9. Remove Sav Con Tool Assembly from the Vertical Penetration and replace with Lexan Top Cover.
10. Check for ice and remove before reinstalling the Shim Lead Assembly.
11. Reinstall Shim Lead Assembly and Shim Lead Exhaust plumbing. Engage Shim Lead before Ramping.
12. Check Vertical Penetration and Shim Lead plumbing for leaks before Ramping.
13. Ramp Magnet in conformance with SET UP AND CALIBRATION, Section NO TAG.

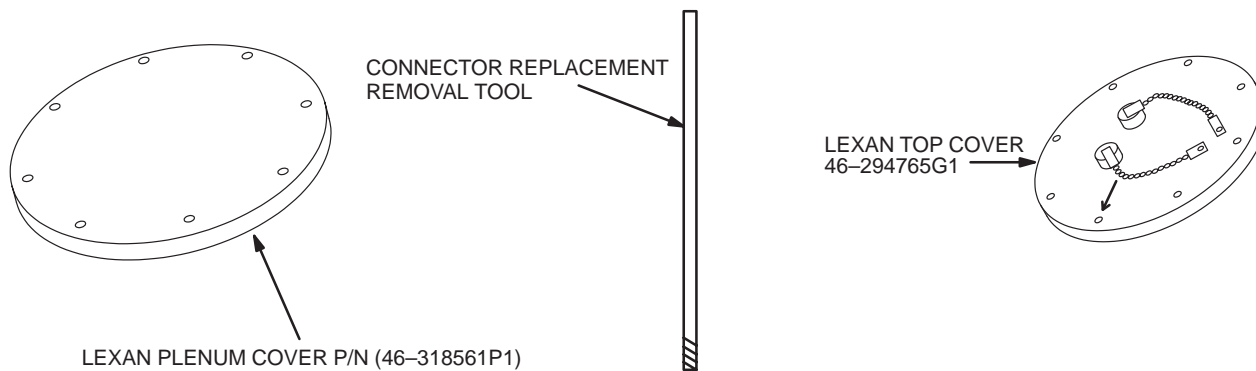
## SECTION 7 – INSTRUMENTATION LEAD ASSEMBLY REMOVAL/REPLACEMENT

**Description:**

The Instrumentation Lead Assembly (46-318341G1) 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 (46-318341G1)
- Teflon “O” – Ring (46-281101 P9) – Instrumentation lead Connector Port
- Teflon “O” – Ring (46-281101P5) – Shim Lead
- Teflon “O” – Ring (46-281101P6) – Turret
- Teflon Tape (46-252065P1)
- Heat Gun (46-306830G3)
- Lexan Top Cover with 1/4 inch Pipe Plugs (46-294765G1)
- Lexan Plenum Cover (46-318561P1)
- Connector Removal Tool (46-281934P1)



**INSTRUMENTATION REMOVAL/REPLACEMENT TOOLS**  
ILLUSTRATION 7-1

It is recommended that the Instrumentation Lead Assembly replacement be performed by the Mac Team Representative. The procedure must be performed quickly to avoid excessive Boiloff and frost/ice formation in the Vertical Penetration.

Ramp Magnet down to zero field in conformance with REPLACEMENT/MAINTENANCE, Section 2, before starting this procedure.

7-1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL/REPLACEMENT

Procedure:

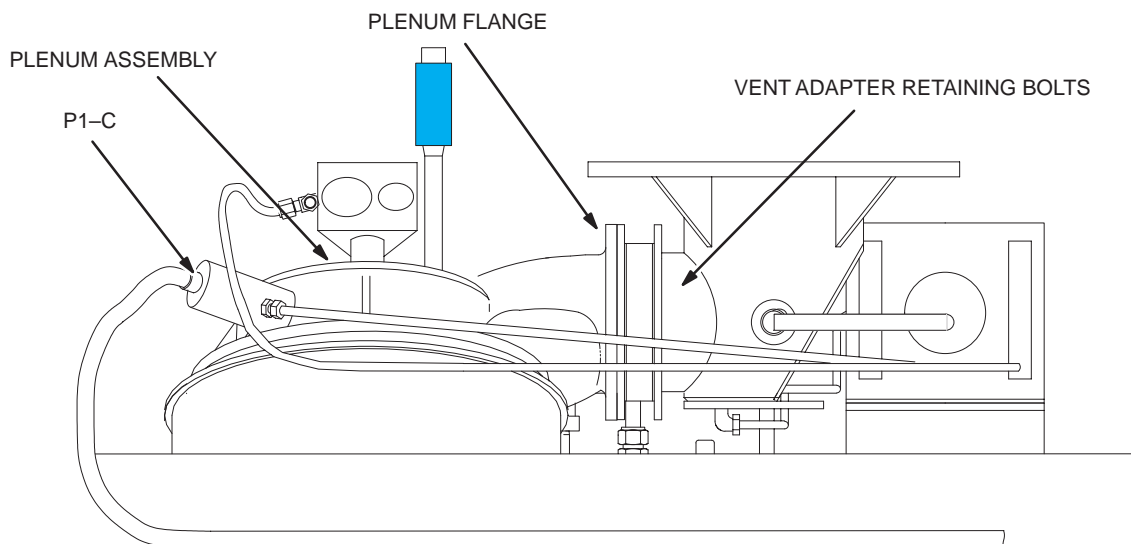


MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON, OR THE HATCH IS OPENED IF A MOBILE VAN, BEFORE STARTING THIS PROCEDURE. THIS IS REQUIRED TO EXHAUST THE ODORLESS AND INVISIBLE HELIUM GAS GENERATED DURING THIS PROCEDURE AND PREVENT OXYGEN DISPLACEMENT IN THE MAGNET ROOM. REVIEW AND FOLLOW CRYOGEN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

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

MAKE SURE THAT THE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE STARTING THIS PROCEDURE. A MAGNET QUENCH DURING THE PROCEDURE COULD RESULT IN THE RAPID EXPULSION OF COLD HELIUM GAS/LIQUID OUT OF THE VERTICAL PENETRATION.

1. Turn off all level sensor, diode and main heater sources and disconnect P1-C. See Illustration 7-2.



INSTRUMENTATION LEAD CONNECTOR LOCATION  
ILLUSTRATION 7-2

**7-1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL/REPLACEMENT (continued)**

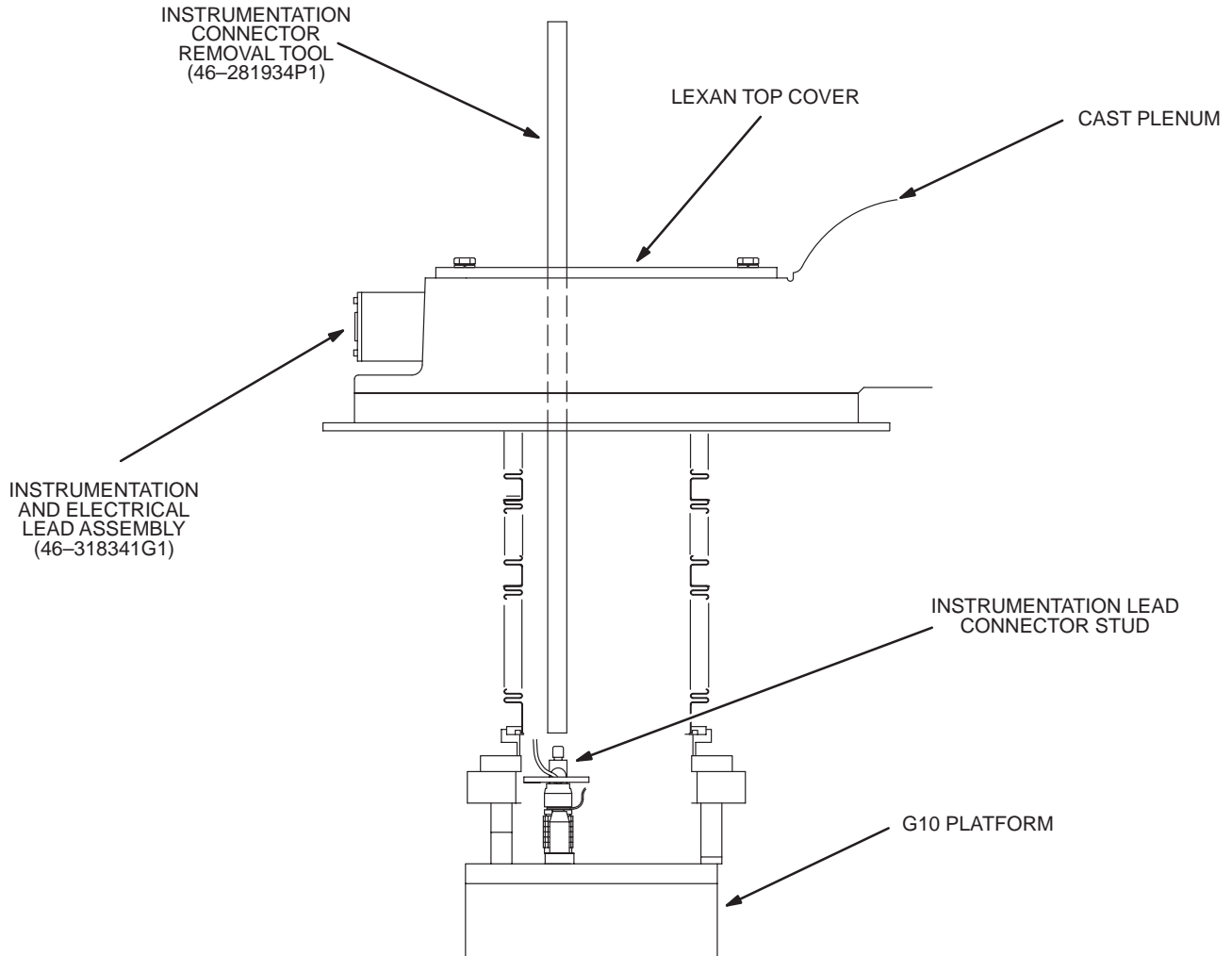
2. Make sure that the Lexan Top Cover (P/N 46-294765G1) is present, that 1/4 inch (5.1mm) Pipe Plugs are installed and the cover is immediately accessible for mounting on the Vertical Penetration when the Shim Lead Assembly is removed.
3. Open Vent V2 to depressurize Cryostat between 0.25 and 0.30 psig. 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. Align Scribe Mark on Lexan Top Cover towards the Vent and Immediately place Lexan Top Cover over opening and secure with the eight bolts removed in Step 5. Tighten finger tight.
7. Locate the Connector Removal Tool (46-281934P1). Warm with heat gun to remove any moisture.



**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.**

8. Shine flashlight through Lexan Top Cover and inspect the Instrumentation Lead Assembly Connector for frost. Remove visible frost by temporarily removing the right 1/4 inch Pipe Plug from the Top Cover Plate, to insert Helium Gas hose, and blowing warm Helium Gas at 15 psi on location of frost.
9. Insert the Instrumentation Lead Connector Tool through the right hole in the Lexan top Cover.
10. Shine a flashlight through the cover and align the end of the tool with the threaded top on the connector P101 at the bottom of the Vertical Stack. See Illustration 7-3.

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



ATTACHING THE CONNECTOR REMOVAL TOOL  
ILLUSTRATION 7-3

**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.

11. Thread the tool onto the connector (clockwise) until snug and back off 1/4 turn (counter clockwise). Pull upward on tool until connector disengages.

**Note**

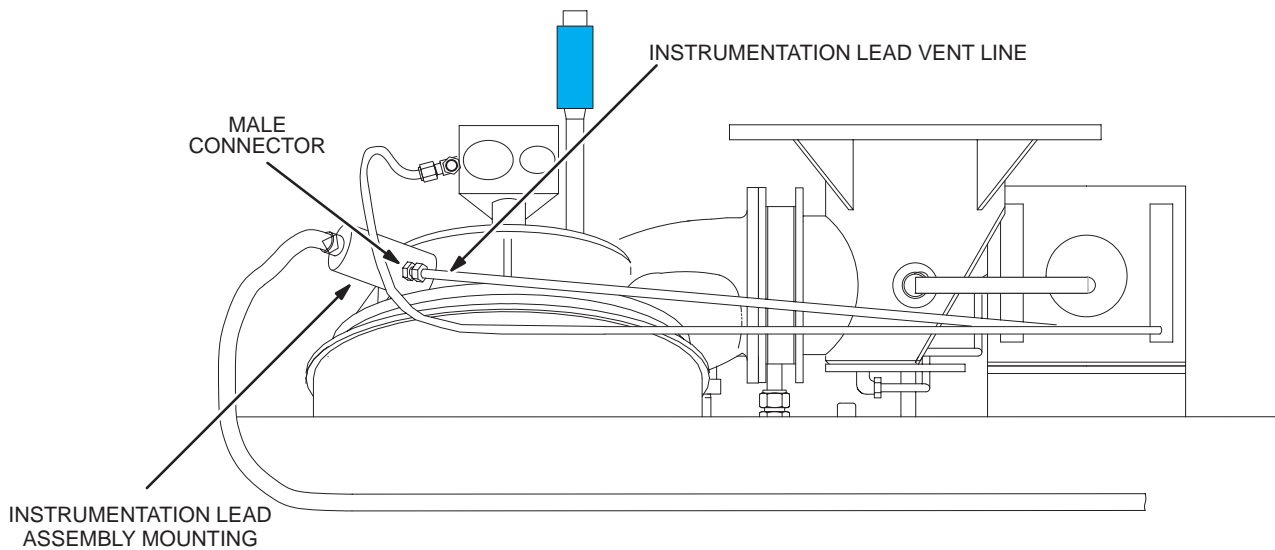
The Connector Removal Tool cannot be easily removed at this time. The Tool and Instrumentation Lead Assembly will be removed upon removal of the Plenum Assembly.

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



**These procedures must be performed rapidly to prevent cryopumping and frost build up.**

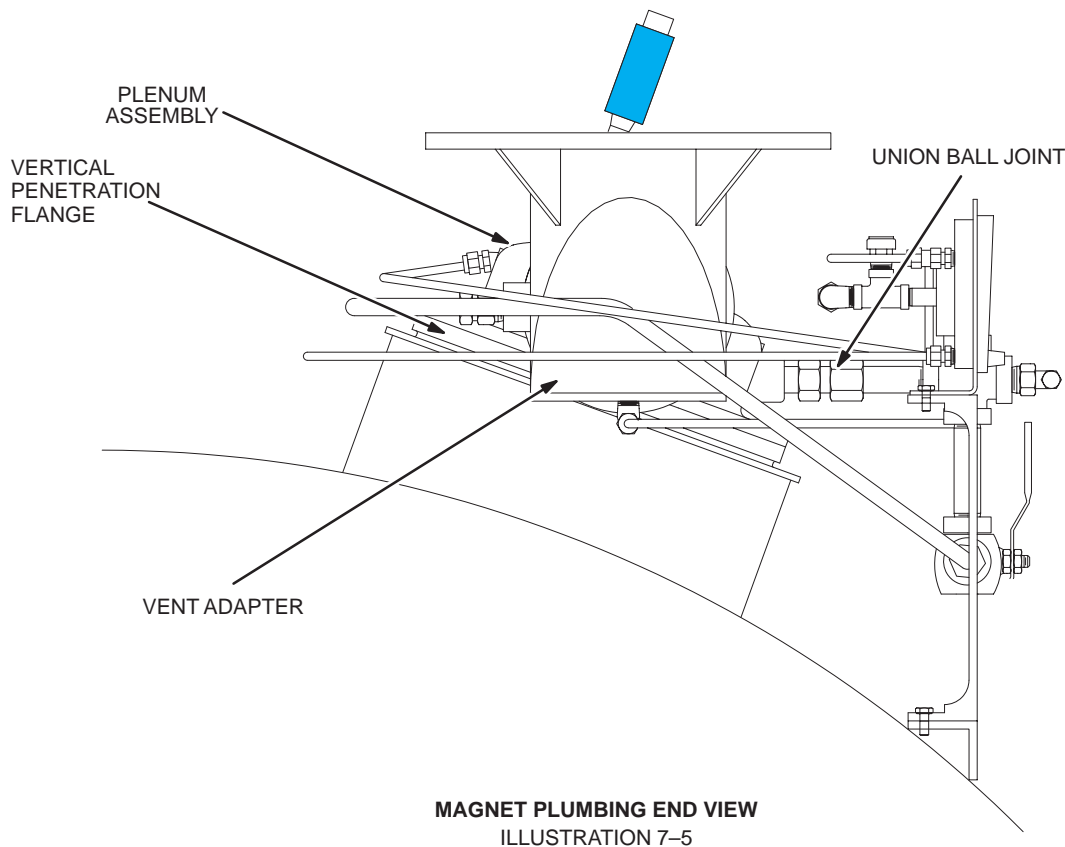
- 12. Disconnect 1/4" (5.1mm) copper Instrumentation Lead Vent Line from Male Connector on side of Instrumentation Lead Assembly mounting. Use 1/4 inch cap to blank off Port. See Illustration 7-4.



**INSTRUMENTATION LEAD MALE CONNECTOR LOCATION**  
ILLUSTRATION 7-4

**7-1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL/REPLACEMENT (continued)**

13. Disconnect "UNION BALL JOINT" on the 1/2 inch plumbing from the Plenum Assembly. See Illustration 7-5.
14. Remove the eight bolts securing the Plenum Assembly to the Vertical Penetration Flange then remove the Plenum Assembly.
15. Immediately place Lexan Plenum Cover (46-318561P1) over Vertical Penetration Flange and secure with bolts removed above.
16. Loosen and remove the Male Connector from the side of the defective Instrumentation Lead Assembly Mounting. See Illustration 7-4.

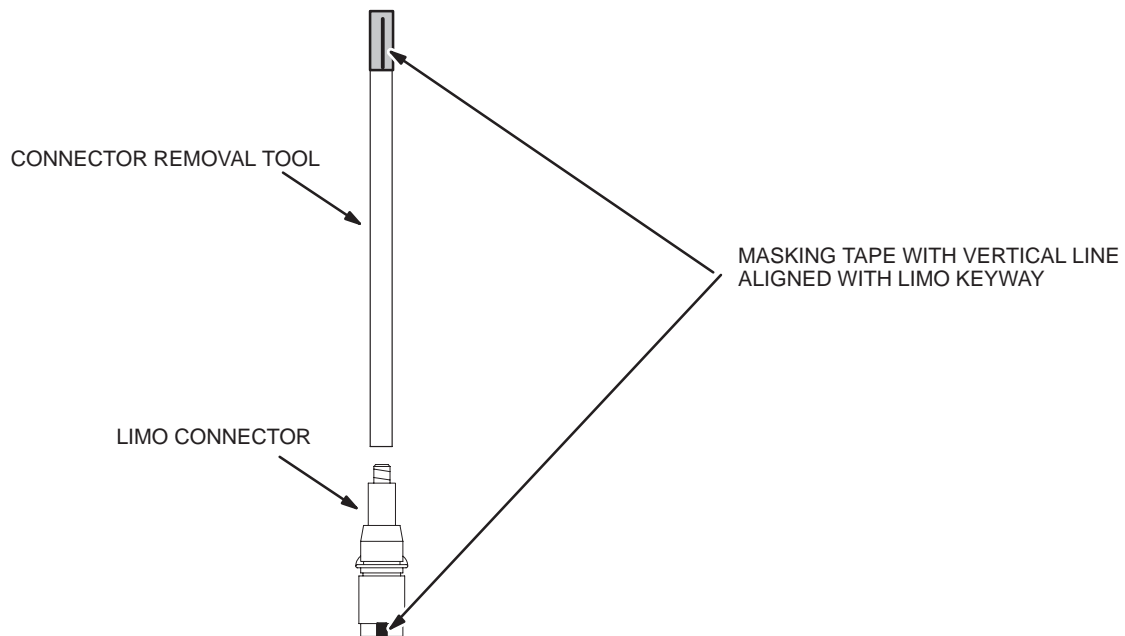


**Note**

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

**7-1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL/REPLACEMENT (continued)**

17. Remove the four hex bolts holding the Instrumentation Lead Assembly to the Plenum Assembly. Remove defective Instrumentation Lead from Plenum Assembly.
18. Install new "O" – Ring (46-281101P9) on new Instrumentation Lead Assembly. Use Vacuum Grease when installing new "O" – Ring.
19. Insert the new Instrumentation Lead Assembly into the Plenum Assembly.
20. Secure the new Instrumentation Lead Assembly to the Plenum Assembly with the four hex bolts removed in Step 17.
21. Clean the threads of the Male Connector ( removed in Step 16 ) and wrap with Teflon Tape. Install Male Connector on new Instrumentation Lead Assembly Mounting and tighten until snug. Adjust for proper orientation of 1/4 inch copper Vent Line connection.
22. Warm the insertion end of the Instrumentation Lead Assembly and the Extraction Tool to remove any moisture.
23. 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.
24. Screw the Connector Removal Tool onto the new Limo Connector through the Lexan Top Cover ( Lexan Top Cover was installed on the Plenum Assembly in Step 6). Place a mark on the masking tape to indicate the location of the Limo Connector key way. See Illustration 7-6.



**LIMO CONNECTOR KEYWAY IDENTIFICATION**  
ILLUSTRATION 7-6

**7-1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL/REPLACEMENT (continued)**

**Note**

Apply Vacuum grease to “O” – Ring before replacement.

- 25. Remove Lexan Plenum Cover and Quickly replace Plenum “O” – Ring and Mount Plenum Assembly with new Instrumentation Lead Assembly onto Vertical Penetration Flange using bolts remove from Step 14.
- 26. Reconnect Union Ball Joint.

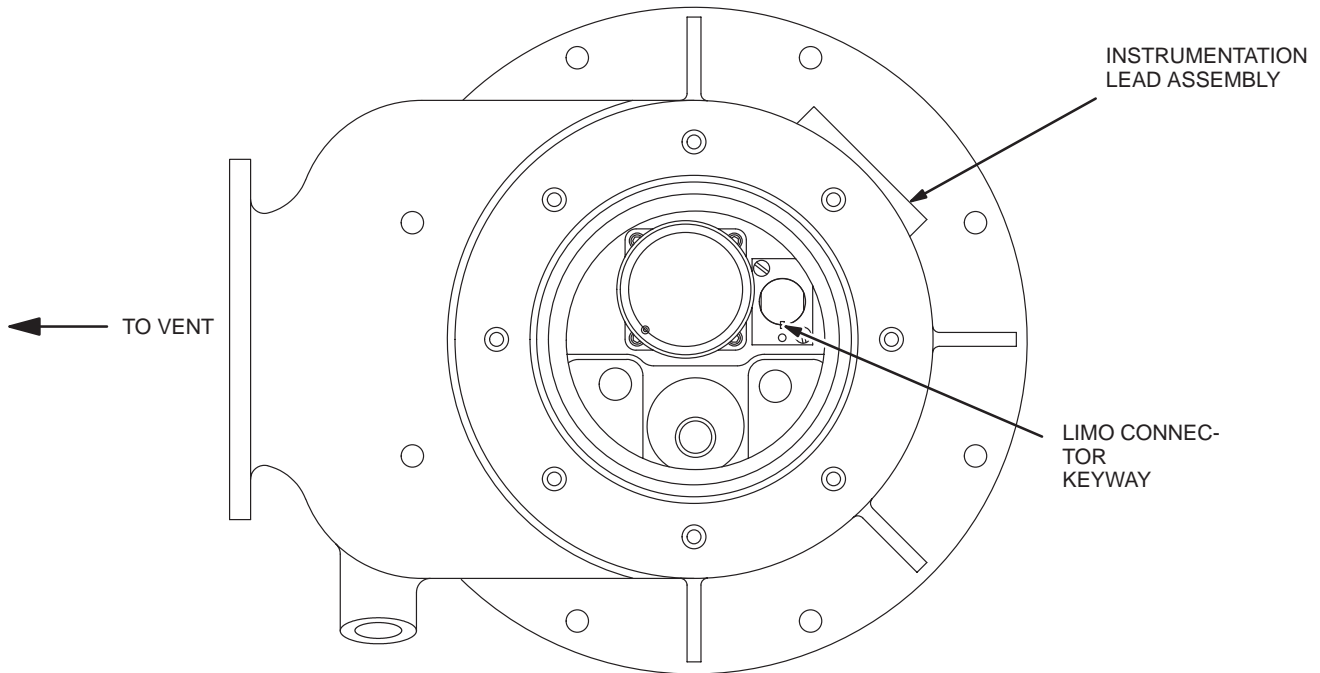
**Note**

Before connecting P101, make sure there is no ice buildup on J101.

**Note**

Study the location of the key ways on the Instrumentation Lead Limo Connector and J101 for easy installation.

- 27. 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 7-7 for alignment of key ways.



**POSITION OF LIMO CONNECTOR KEY WAY**  
ILLUSTRATION 7-7

- 28. Unscrew tool from connector and remove. Replace 1/4 inch Pipe Plug in Lexan Top Cover. Clean and wrap the remaining threads on the Male Run Tee with Teflon Tape. Attach the 5.1 mm(1/4”) copper Vent Line removed earlier.

**7-1 INSTRUMENTATION LEAD ASSEMBLY REMOVAL/REPLACEMENT (continued)**

29. Prepare the Shim Lead Assembly by removing old "O" – Ring and installing new "O" – Ring (46- 281101P5 ). Use Vacuum Grease when installing "O" – Ring.



**Lower Shim Lead Assembly into Vertical Stack carefully to prevent damage to baffles.**

**Note**

Shim Lead Assembly must be in the "Retracted" position (i.e., the Guide Post must be completely screwed into the Double Threaded Brass Screw before installing).

**Note**

Check for ice buildup on the Shim Lead Assembly mating connector J100, before installing Shim Lead Assembly.

30. Remove Lexan Top Cover and 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.
31. Rewrap Male Run Tee on Shim Lead Receptacle Box with Teflon tape.
32. Reconnect 1/4 inch Exhaust Plumbing to side of the Shim Lead Receptacle Box.
33. Reconnect the Vent Adaptor to the Plenum Assembly with the bolts removed from Step4.
34. 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.
35. Reconnect P1-C to J1-C and perform checks as outlined in Section 3, FUNCTIONAL CHECKS.
36. Reengage Shim Lead Assembly according to Section 6-1, REPLACEMENT MAINTENANCE.
37. Ramp Magnet back up to field as described in Section 9, SET UP AND CALIBRATION.
38. Re-Shim the Magnet in conformance with Section 11, SET UP AND CALIBRATION.
39. 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)**

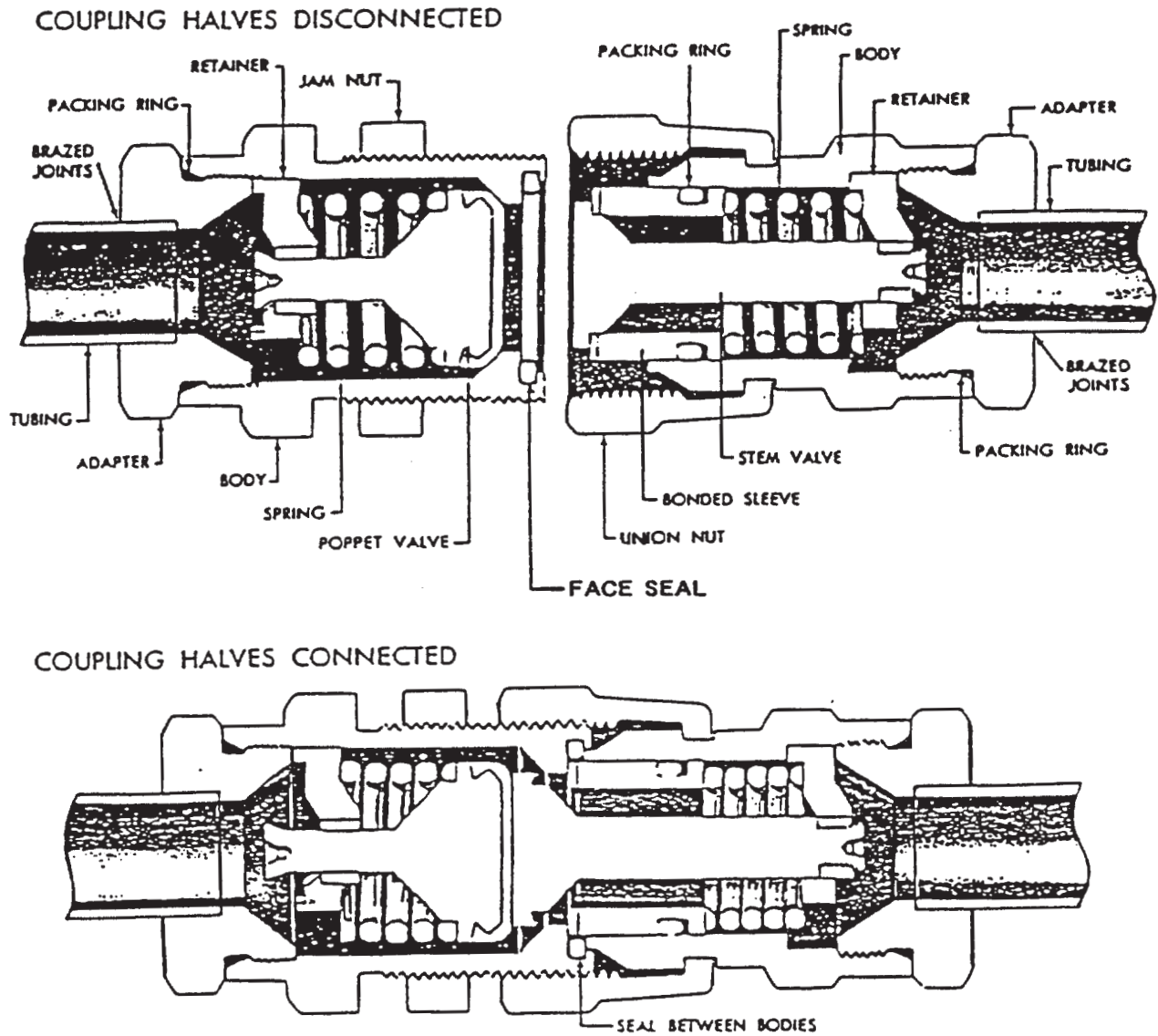
4. To disconnect the gas line at the compressor, turn the union nut on the female coupling while holding the stationary part of female coupling with a second wrench. Since the male coupling is mounted to compressor front panel with a lock washer, the male coupling should not rotate from its adapter while 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)

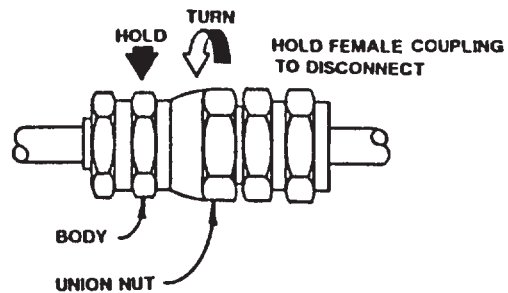
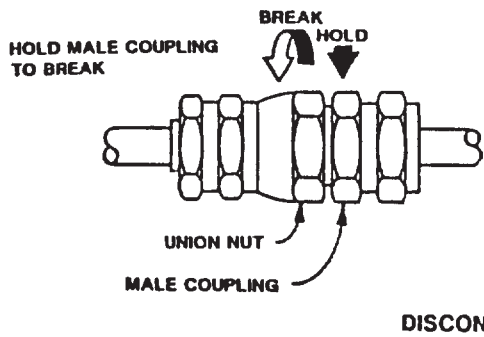
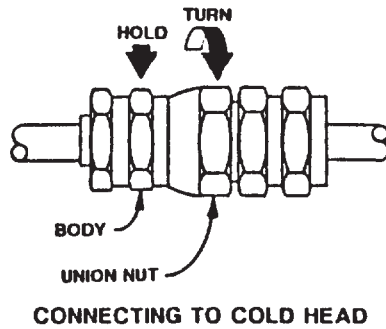
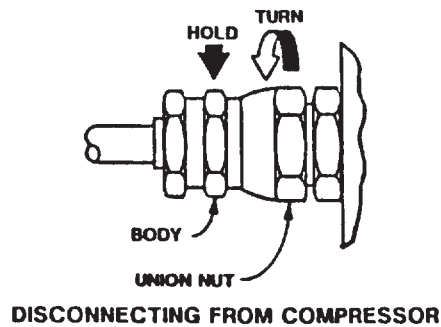
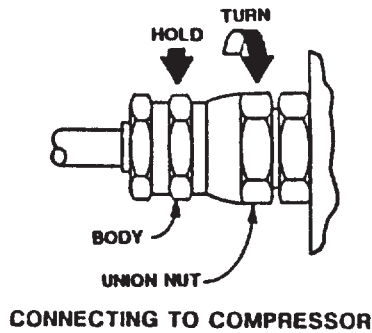


VIEW OF DISCONNECTED AND CONNECTED SELF-SEALING (AEROQUIP)  
ILLUSTRATION 10-1

SECTION 10 – CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS (continued)

NOTES:

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



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

## SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT

### Description:

Shield Cooler Cold Heads require replacement for periodic maintenance and when out of spec, temperatures cannot be corrected by the actions in FUNCTIONAL CHECKS, Section 7 (Shield Cooler Checks).

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

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

- Reconditioned and Tested replacement Cold Head.
- Full Helium Gas Cylinder (99.9995% pure).
- Helium Transfer equipment indicated in RENEWAL PARTS, Section 4.
- Shield Cooler Maintenance Kit (46-281088G2).
- Heat Gun Kit (46-306830G1/G2)
- Field Vacuum Pump Kit (46-294047G1)

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



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

**RAMP MAGNET DOWN TO ZERO FIELD BEFORE STARTING THIS PROCEDURE.**

**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)**

**Note**

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

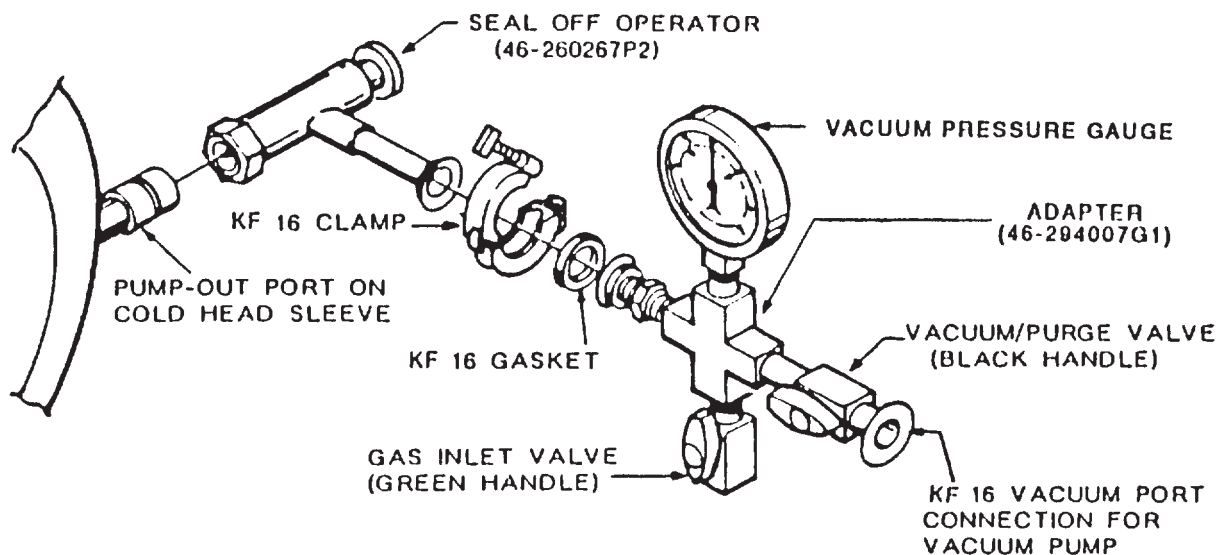
**Procedure:**

1. Turn off unit and disconnect the electrical cable from the Cold Head.
2. Disconnect the gas lines at the Cold Head with the wrenches provided in the Shield Cooler Maintenance Kit. See REPLACEMENT MAINTENANCE, Section 10 (CONNECTING AND DISCONNECTING AEROQUIP COUPLINGS).
3. Signa Magnets have a magnetic shield around the Cold Head Motor. Remove the four bolts securing the shield and remove and save the shield and securing bolts.

**Note**

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

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



**COLD HEAD GAS/VACUUM SERVICE APPARATUS**  
ILLUSTRATION 11-1

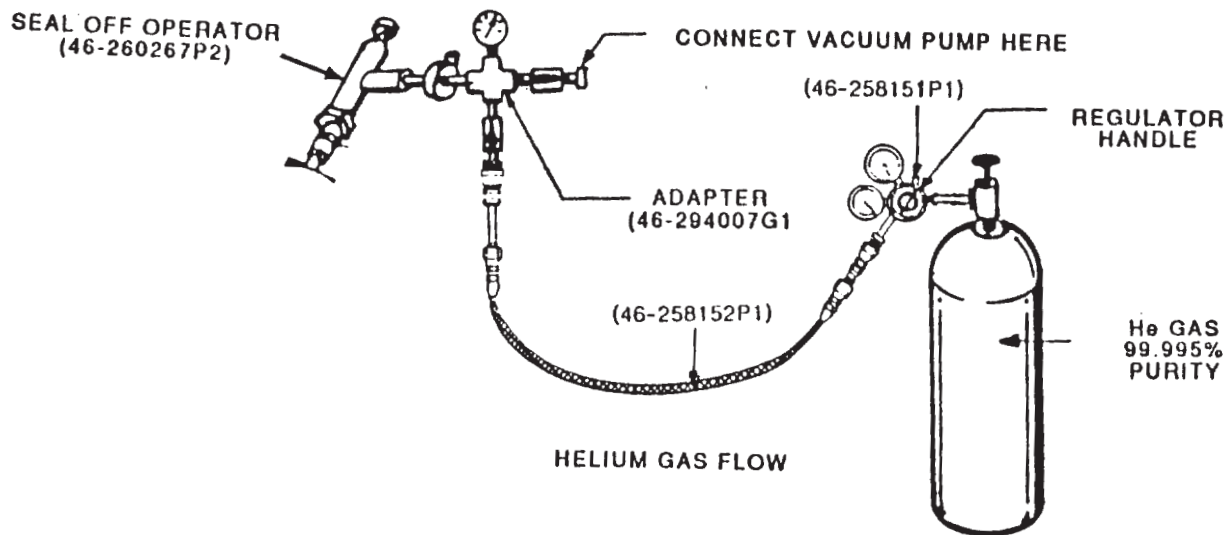
**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)**

6. Connect Helium Gas Regulator (46-258151 P1) to the Helium Gas Cylinder (99.9995% pure) then to Flexible Hose (46-258152P1). Connect the hose to the Adapter Inlet Valve (green handle). See Illustration 11-2.
7. Make sure the Regulator Handle is backed out counterclockwise (CCW) to avoid regulator damage, then open the gas cylinder slowly, the high pressure gauge should indicate 2100-2400 psig if the cylinder is full.

**Note**

A full gas cylinder is required for this procedure.

8. Open Inlet Valve and set a low pressure gas flow ( 1 psig) as indicated by the gauge on the Adapter.
9. Open the Vacuum Port Valve (black handle) on the Adapter and allow gas to flow out for one minute to purge the assembly of air.
10. Close the Vacuum Port Valve and Inlet Valve.
11. Push in and rotate the Black Handle of the Seal Off Operator clockwise (CW) to engage the plug in the Pump Out Port. When the handle is engaged, pull the handle out to open the Pump Out Port.



**HELIUM GAS CONNECTION**  
ILLUSTRATION 11-2

**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)**

**Note**

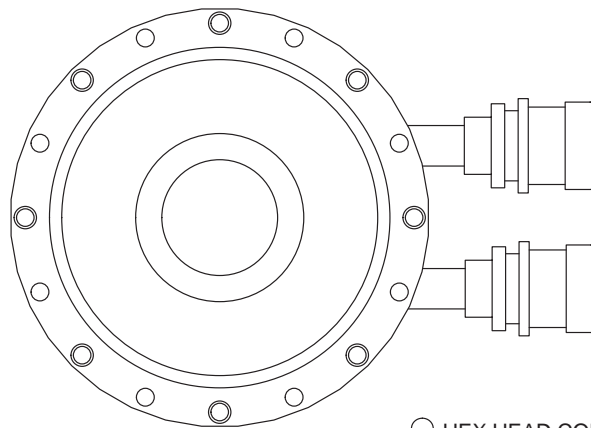
When the handle is pulled out, the gauge on the Adapter should indicate a vacuum.

- 12. Open the Gas Inlet Valve (green handle) and fill the vacuum space in the sleeve with Helium Gas at a small positive pressure ( $\approx 1$  psig).

**Note**

Save the bolts and washers removed in Step 13, leaving the same number of washers on each bolt. These will be used to mount the new Cold Head and will make sure that the proper interface spacing is maintained.

- 13. Remove six of the eight Hex Head Bolts with Bellville Washers securing the Cold Head, leaving the remaining two bolts in to prevent the Cold Head from sliding out. See Illustration 11-3.



○ HEX HEAD COLD HEAD MOUNTING BOLTS (8)

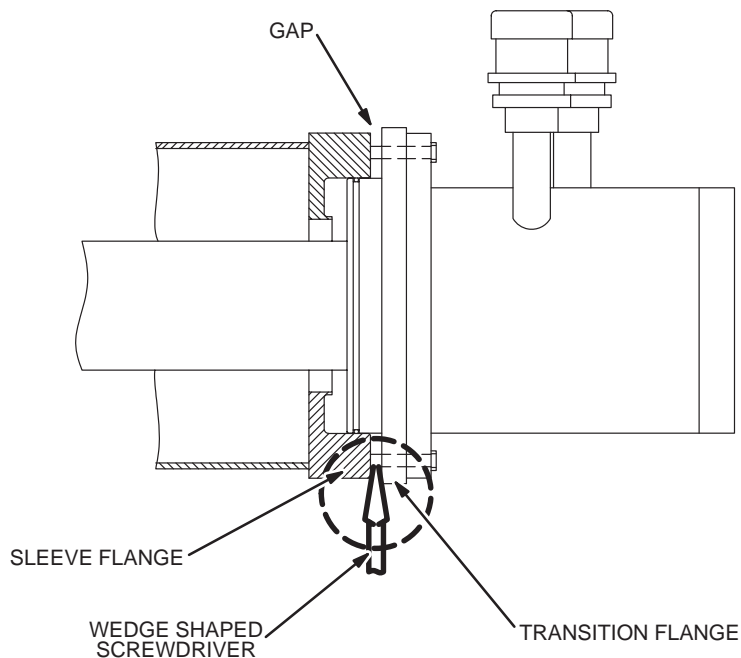
⊙ TRANSITION FLANGE MOUNTING CAP SCREWS (8)

**COLD HEAD MOUNTING**

ILLUSTRATION 11-3

**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)**

14. Loosen the remaining two bolts to produce a 6mm (1/4 inch) gap under the bolt head.
15. Carefully insert a large screwdriver or other similar wedge shaped tool in the gap between the Cryostat Sleeve Flange and Transition Flange. Gradually pry the Transition Flange away from the Cryostat Sleeve Flange by tapping the end of a screwdriver or wedge while moving it around the circumference of the gap. See Illustration 11-4.



**SEPARATION OF TRANSITION FLANGE-SLEEVE FLANGE**  
ILLUSTRATION 11-4

**Note**

It will be evident when the Cold Head “pops” away from the first stage contact in Step 15.

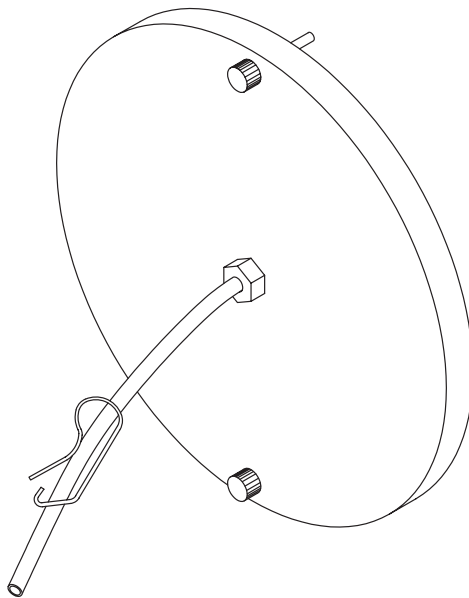


**Make sure Helium Gas is flowing through the Pump-out Port connection and the Plexiglass Cover plate (46-294010G1) is on hand before performing Step 16. When cold head is removed, immediately cover hole with plexiglas cover plate to prevent contamination.**

**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)**

The Cold Head weighs approximately 45 pounds and will require lifting straight out to prevent binding. Make sure there is adequate reach and support for its weight before lifting it out.

16. When the Cold Head “Pops” free, remove the remaining two bolts. Lift the Cold Head straight out of the Cold Head sump and place the Cold Head on padded surface for protection.
17. Immediately install the Plexiglas Cover Plate onto the Sleeve Flange of the Cryostat with the thumb screws provided on the cover. Make sure that Helium Gas is continuing to flow out of the slit in the tubing (1 psig) while the cover plate remains on Sleeve Flange. See Illustration 11-5.



**PLEXIGLAS COVER PLATE (46-294010G1)**  
ILLUSTRATION 11-5

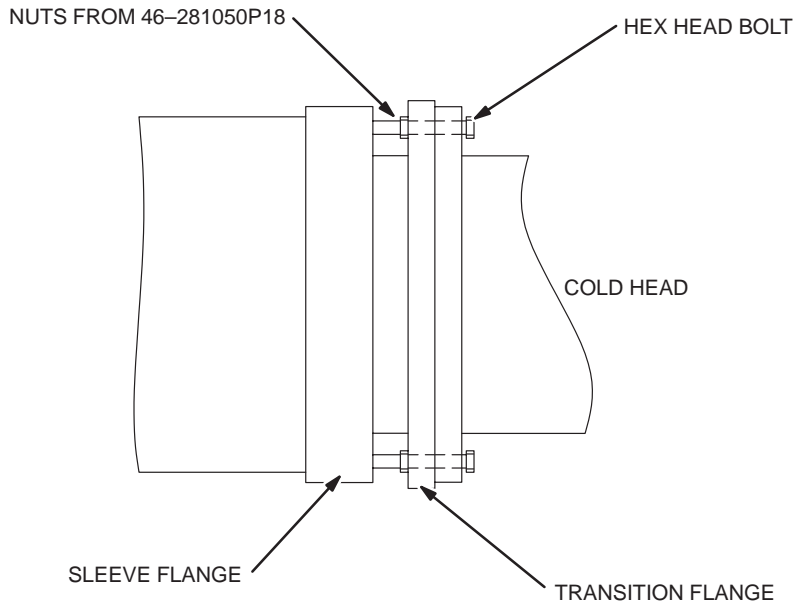
**Note**

If Cold Head does not pull free in Step 16, Perform Steps 18 through 21 to loosen the cold Head then repeat Step 16 and 17. If the Cold Head has been removed and the Plexiglas cover plate installed in Steps 16 and 17 go to Step 22.

18. Insert two Hex Head Bolts through the bolt holes in the Transition Flange, 180 degrees apart. Remove the Bellville Washers temporarily from two bolts before inserting them.
19. Remove the two nuts from the underside of the Plexiglas Cover Plate. Insert them into the gap between the Transition Flange and Cryostat Sleeve Flange and thread them onto the two Hex Head Bolts inserted in Step 18. See Illustration 11-6.

**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)**

- 20. Thread the Hex Head Bolts into the Threaded Holes in the Cryostat Sleeve Flange for approximately two turns.
- 21. Turn the nuts counterclockwise (CCW) on the Hex Head Bolt while holding the bolt head, turning each nut one turn at a time in succession, until the force of the nuts against the Transition Flange separates the second stage contact, then repeat Step 16.



**NUT/BOLT MOUNTING FOR FLANGE SEPARATION**  
ILLUSTRATION 11-6

**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)**

22. Inspect the inside of the Sleeve Cylinder through the Plexiglas Cover Plate using a flashlight. Make sure that no Indium Gasket Material is present on the copper surfaces of the Heat Station. Determine the number of indium Gaskets on the First and Second Stage Stations of the removed Cold Head. This information is required for the gasket replacements in Steps 35 and 36.



**If indium removal in Step 23 is required, do not keep the Sleeve Flange uncovered for an extended period of time (over 1 minute) to minimize icing.**

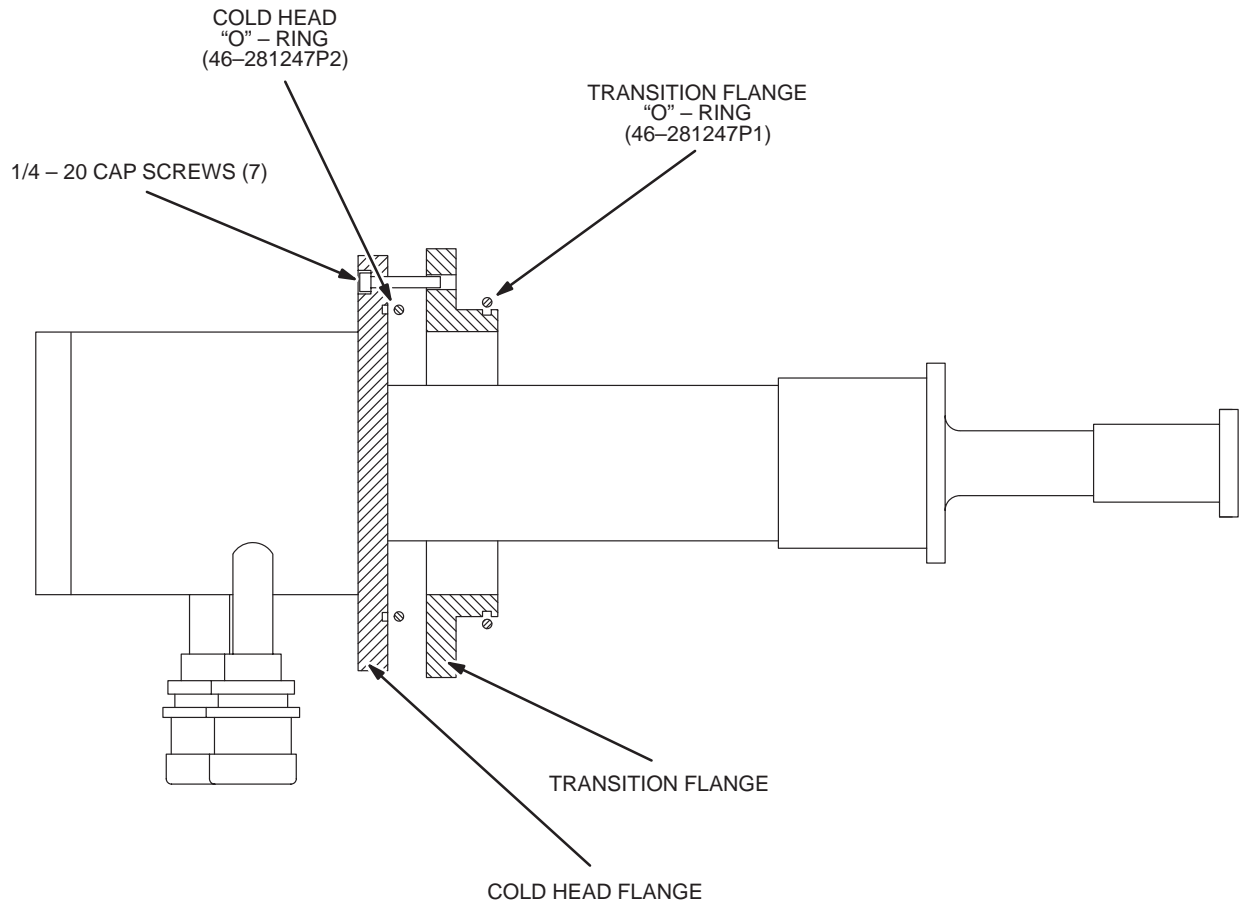
23. Continue the helium gas purge. If indium material is present, remove one of the thumb screws securing the cover plate and pivot the cover plate out on the remaining screw allowing access to the contaminated surface with a long handle screwdriver. Remove indium material with the screwdriver and pivot the cover plate over the Sleeve Flange.

**Note**

Wear cotton gloves (46-252065P64) when performing Steps 24 through 50.

24. Remove Heat Gun (46-306830G1/G2) for the Cold Head Sump and assemble in conformance with the instructions provided with the kit.
25. Clean all components of the Heat Gun with lint free cloth to make sure no contamination is present.
26. Loosen the thumb screws and remove the Lexan Cover Plate.
27. Carefully insert the Heat Gun into the Cold Head Sleeve and mount onto the Cold Head Sleeve Flange.
28. Close the Gas Inlet Valve (green handle) on the Pump Out Adapter and connect Helium Gas source to the Heat Gun.
29. Connect power and operate Heat Gun. Leave Heat Gun in place while preparing the new Cold Head.
30. Monitor Cold Head Diode temperatures while the Heat Gun is installed. Maintain the temperature between 285 and 300K. Do not allow the temperature to exceed 300K.
31. Remove the new Cold Head from the box and place in an upright position. Clean all surfaces to be placed into the sleeve with a lint free cloth/towel and Freon or other commercially available non-residue forming degreaser.
32. Remove "O" – Ring (46-281247P2) from the Poly-bag attached to the Cold Head and wipe with a dry, lint free cloth/towel. Inspect the "O" – Ring for nicks or cuts.

**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)**

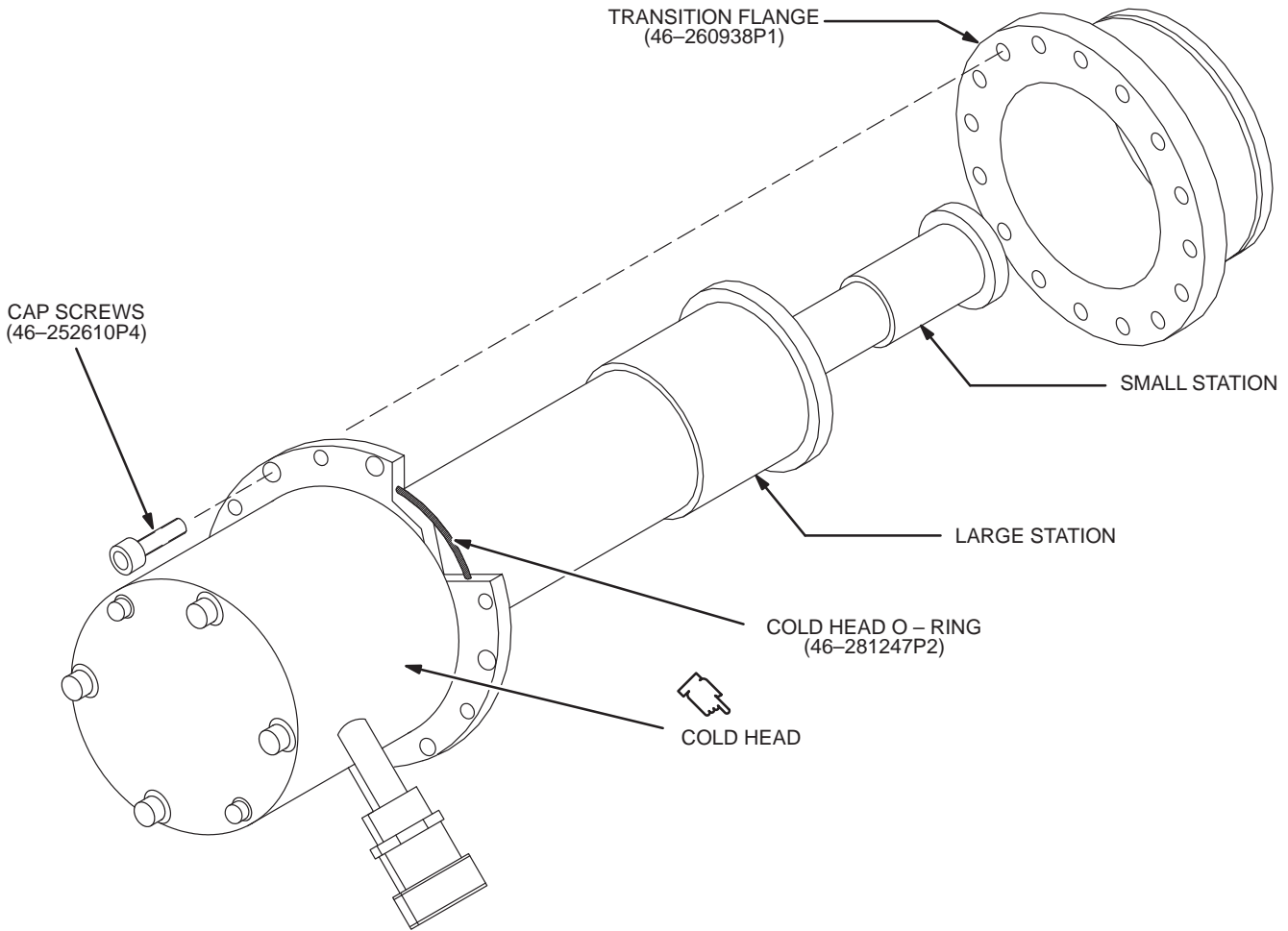


**COLD HEAD O – RING PLACEMENT**  
ILLUSTRATION 11-7

33. Coat the entire surface of the “O” – Ring with a thin film of Vacuum Grease and place the “O” – Ring into the groove on the Cold Head Flange. Apply a thin film of Vacuum Grease to the top surface of the “O” – Ring and groove. See Illustration 11-7.
34. Remove the Transition Flange (46-260938P1) from the removed Cold Head. See Illustrations 11-3 and 11-7. Save the seven Socket Head Cap Screws for installation of the flange on the new Cold Head.
35. Remove the “O” – Ring from the Transition Flange and clean the entire flange using the same materials as in Step 31.

**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)**

36. Apply a thin film of Vacuum Grease to the flat surface of the flange which contacts the “O” – Ring on the Cold Head Flange.
37. Slide the Transition Flange over the first and second stages of the Cold Head and rest the flange on the Cold Head “O” – Ring. See Illustration 11-8.
38. Align the bolt hole pattern of the Transition Flange and Cold Head Flange.
39. Insert the seven 1/4-20 Cap Screws (46-252610P4) through the bolt holes into Cold Head. Pull the Transition Flange flush to the Cold Head and hand tighten the Cap Screws until the Transition Flange is evenly sealed around the Cold Head “O” – Ring. Tighten each Cap Screw uniformly until the Transition Flange is tightly assembled against the Cold Head. See Illustration 11-8.



**TRANSITION FLANGE MOUNTING**  
ILLUSTRATION 11-8

**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)****Note**

Cold Head “O” – Ring (46-281247P2) and Transition Flange “O” – Ring (46-281247P1) are approximately the same size. Make sure proper “O” – Ring (46-281247P1) is used in the following steps.

40. Inspect new “O” – Ring (46-281247P1) for cuts and nicks. Clean the “O” – Ring with a lint free cloth/towel and apply a thin film of Vacuum Grease to the entire surface of the “O” – Ring.
41. Slide the lubricated “O” – Ring over the two stations of the Cold Head and place in the groove of the Transition Flange. See Illustration 11-8.

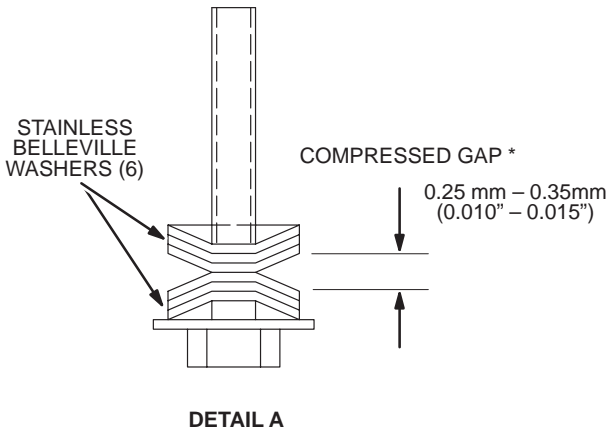
**Note**

Assemble the same number of new Indium Gaskets on the First and Second stage stations of the Cold Head that were on the same stations of the removed Cold Head. See Step 22. Handle the gaskets only with clean hands or cloth gloves.

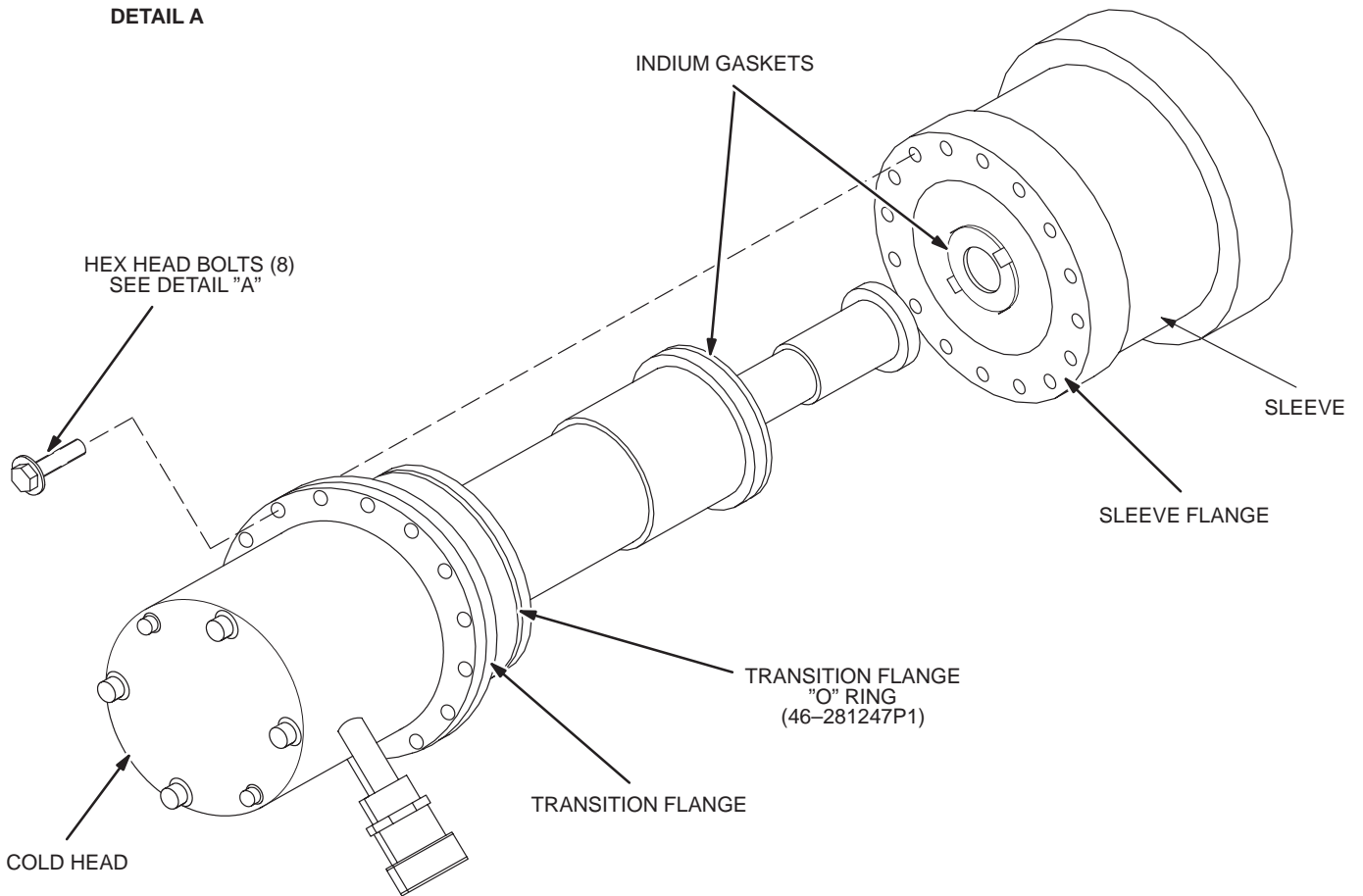
If number of gaskets are in question, consult the Acceptance Test Report included in the Data Sheet Section.

42. Place the required number of small Indium Gaskets (46-281241 P2) on the small Copper Station of the Cold Head. Fold the tabs on the gasket over the station to keep the gasket in place. See Illustration 11-9.
43. Place the required number of large Indium Gaskets (46-281241 P1) on the large Copper Station of the Cold Head. Secure the gaskets to the surface of the station by putting pressure on the gaskets forcing Indium into the small inside diameter of the station.
44. Apply a thin film of Anti-seize Compound to the eight Hex Head Bolts that were removed in Steps 13-16. Make sure that all bolts have the same number and orientation of the washers noted in Step 13. Generally, the number and orientation of washers will be as shown in Illustration 11-9.

SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)



NOTE:  
SET COMPRESSION GAP WHILE TIGHTENING BOLT. DO NOT SET GAP WHEN LOOSENING BOLT.



COLD HEAD MOUNTING BOLT GAP SETTING  
ILLUSTRATION 11-9

**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)**

45. Temporarily remove the Bellville Washers from three bolts, leaving the fiat washers on the bolts. These will be used to insert the new Cold Head.
46. After the Cold Head Sleeve Diodes have reached 285–300K, Discontinue Operation of the Heat Gun.
47. Detach and remove the Heat Gun from the Cold Head Heater to the Cold Head Flange.
48. When cool, return Heat Gun to case for future use.
49. Clean all surfaces within the Flange using a lint free cloth/towel and alcohol or other commercially available non-residue forming substance.



**Do not rotate the Cold Head from its normal insertion position in Step 50 to prevent damaging the indium Gasket. Be careful not to damage or displace the indium Gaskets during Cold Head insertion.**

50. Carefully insert the Cold Head into the sleeve on the Cryostat until the “O” – Ring contacts the opening of the sleeve.



**Do not attempt to insert the Cold Head by hand beyond the point of “O” – Ring contact as “O” – Ring damage will result.**

51. Insert the three bolts, with Bellville Washers removed in Step 45, equally spaced at 120 degree increments, in the mounting holes of the Cold Head Flange.

**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)**

52. Thread and lighten each bolt 1/2 turn at a time, in a rotational pattern, to evenly tighten until the “O” – Ring is fully captured into the sleeve.
53. Assemble and tighten the remaining 5 bolts with Bellville Washers. checked in Step 44, through the mounting holes in the Cold Head Flange.
54. Remove the three bolts inserted in Step 51; reassemble the Bellville Washers with the proper orientation; insert and tighten through the mounting holes in the Cold Head Flange.
55. Tighten all eight bolts evenly (hand tight).
56. Connect the Mechanical Vacuum Gauge on the Operator. Open the Vacuum Valve (black handle) and operate the Vacuum Pump for ten minutes to evacuate the sleeve space. Close the vacuum Valve. See illustration 11-1.
57. Observe the Vacuum Gauge on the operator for five minutes. If the vacuum reading remains steady, the sealing is “OK”.

**Note**

If sealing problem exists, a new Cold Head “O” – Ring (46-281247P2) is required and the Cold Head removal/replacement will have to be repeated using the same Cold Head.

58. When sealing “OK”, close the Pump Out Port Operator by pushing in on the knob and gently rotating it clockwise (CW). Then rotate the knob counterclockwise (CCW) until the Knob Extension is fully disengaged from the Pump Out Port and pull the knob out approximately 50mm (2 inches).
59. Turn off and remove Gas Supply, close Vacuum Valve (black handle), turn off Vacuum pump, open Gas Inlet Valve (green handle) to vent system and disconnect and remove apparatus.
60. Install Gas Flex Lines and Power Cable. Turn on Compressor and check out System. See SET UP AND CALIBRATION, Section 1-3.
61. Place the removed Cold Head in the New Cold Head Carton and return for servicing per instructions in carton. Make sure Cold Head is properly packaged and secure in the carton.

**SECTION 11 – SHIELD COOLER COLD HEAD REPLACEMENT (continued)**

62. Monitor the Cold Head First and Second Stage Temperatures in conformance with the Magnet Service Manual, Section 1-4-7 of SET UP AND CALIBRATION (“Monitoring Cold Head Temperatures”).
63. Liter the Cold Head has cooled down for approximately four hours, tighten the Cold Head Mounting Bolts hand tight in a “CW” rotational pattern.
64. Continue to hand tighten the Cold Head Mounting Bolts in the above manner, at approximately four hour intervals, until the First and Second Stage Temperatures have stabilized.
65. When temperatures have stabilized, tighten all Cold Head Mounting Bolts evenly, in a “CW” rotational pattern, to result in the Bellville Washer Gap Setting shown in Illustration 11-9.

**Note**

First and Second Stage Temperature may decrease farther, after setting the Bellville Washer Gap.

**Note**

Differences in diode mounting techniques and diode lead heat stationing used to intercept heat propagated down the leads from the outside the magnet, have produced increased variation in shield cooler diode temperature readings. Because of this condition, the acceptable diode temperature range (magnet operating with boil-off in specification) has exceeded the original temperature range established for field reference, for a small number of magnets. It is important to identify acceptable diode temperature readings which exceed the field reference range, as the “diagnostic threshold” for proper shield cooler operation. Diode temperature reading values are recorded on the Acceptance Test Report ( ATR ) sent with each magnet. Where the recorded value exceeds the field reference range documented in the above note, use the recorded value as the nominal value for proper shield cooler operation on the referenced magnet. Acceptable ranges around these nominal values are:

$\pm 10$  K FIRST STAGE       $\pm 5$  K SECOND STAGE

Starting March 1, 1993 all diode temperature reading values which exceed the field reference range will be recorded on a label attached to the coldhead sleeve, in addition to being recorded on the ATR.

66. Establish if the stabilized temperatures are within range (32-60K First Stage, 7-17K Second Stage). The temperatures that were found for your magnet in the factory are recorded in the Acceptance Test Report (ATR). If temperatures are higher than those values, perform the tests listed in FUNCTIONAL CHECKS, Section 7 of this manual.



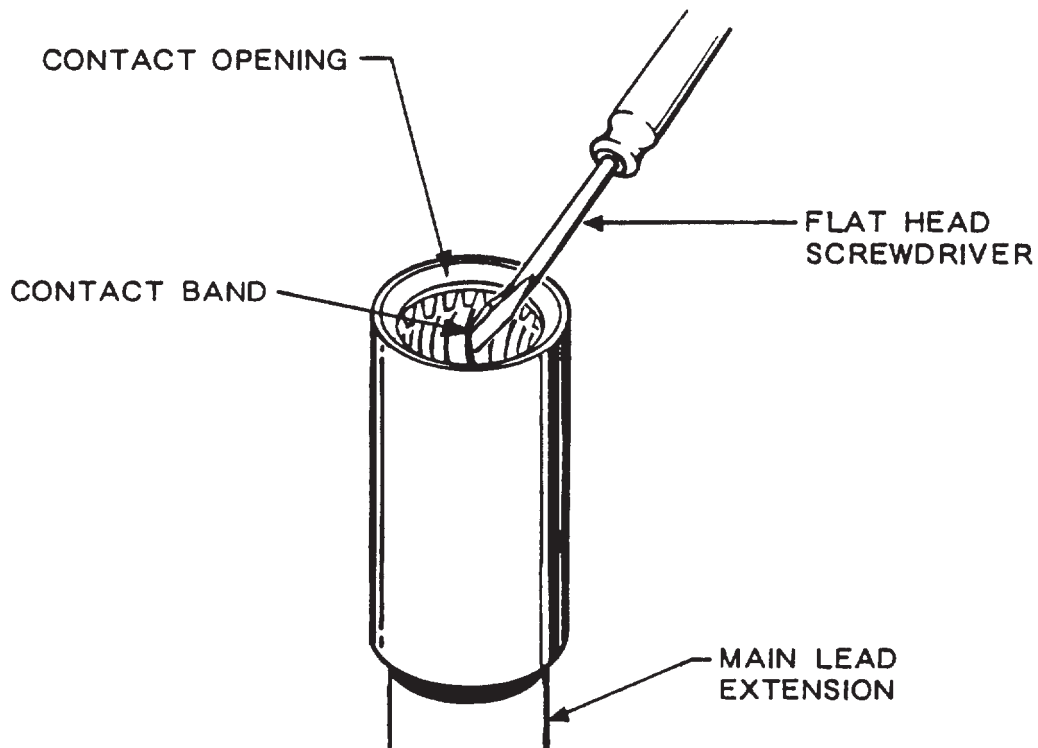
## SECTION 12 – MAIN LEAD EXTENSION CONTACT BAND REPLACEMENT

1. Insert flat head screwdriver into 1/2 inch contact opening on end of Main Lead Extension. See Illustration 12-1.
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.



**The contact area, on which the Contact Band seats, is silver plated and must be cleaned with a non-abrasive cloth and cleaning solution.**

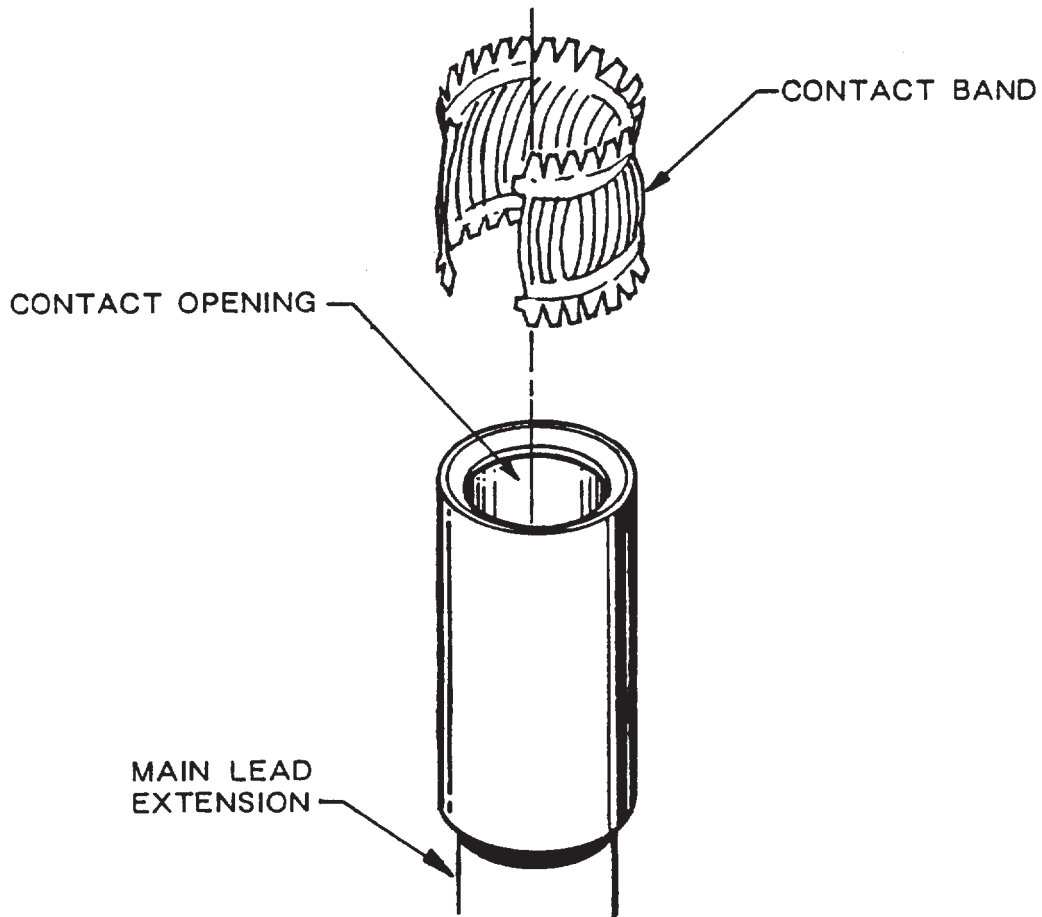
3. Clean the Ramp Lead cavity in which the Contact Band seats with a cloth and a decreasing solution such as trichlorethylene.
4. Obtain and inspect new Contact Band (46-281256P1).



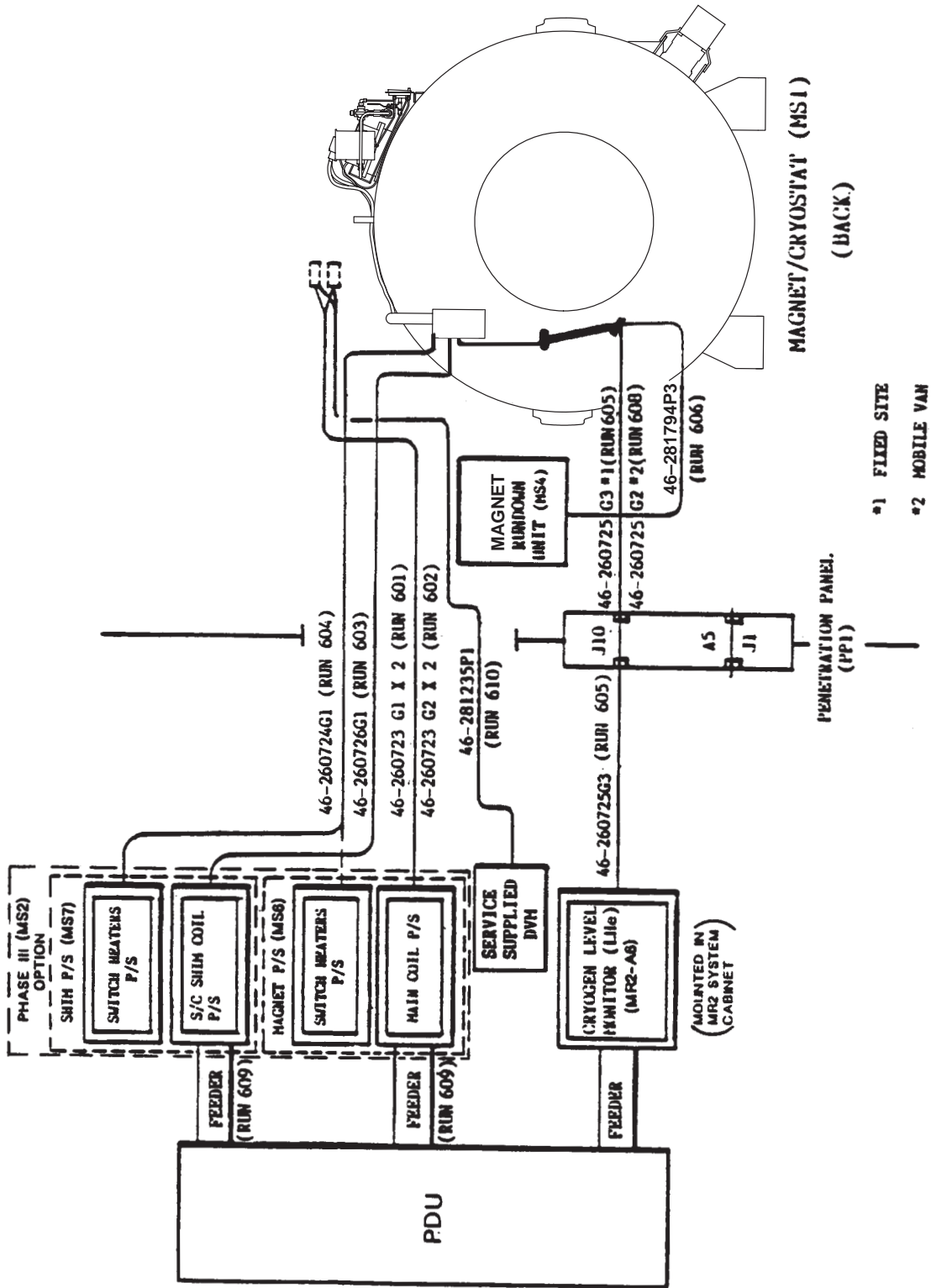
**CONTACT BAND REMOVAL**  
ILLUSTRATION 12-1

**12-1 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 12-2.
- 6. Make sure Contact Band has expanded against walls of the Contact opening and is fully seated below rim on Contact opening.

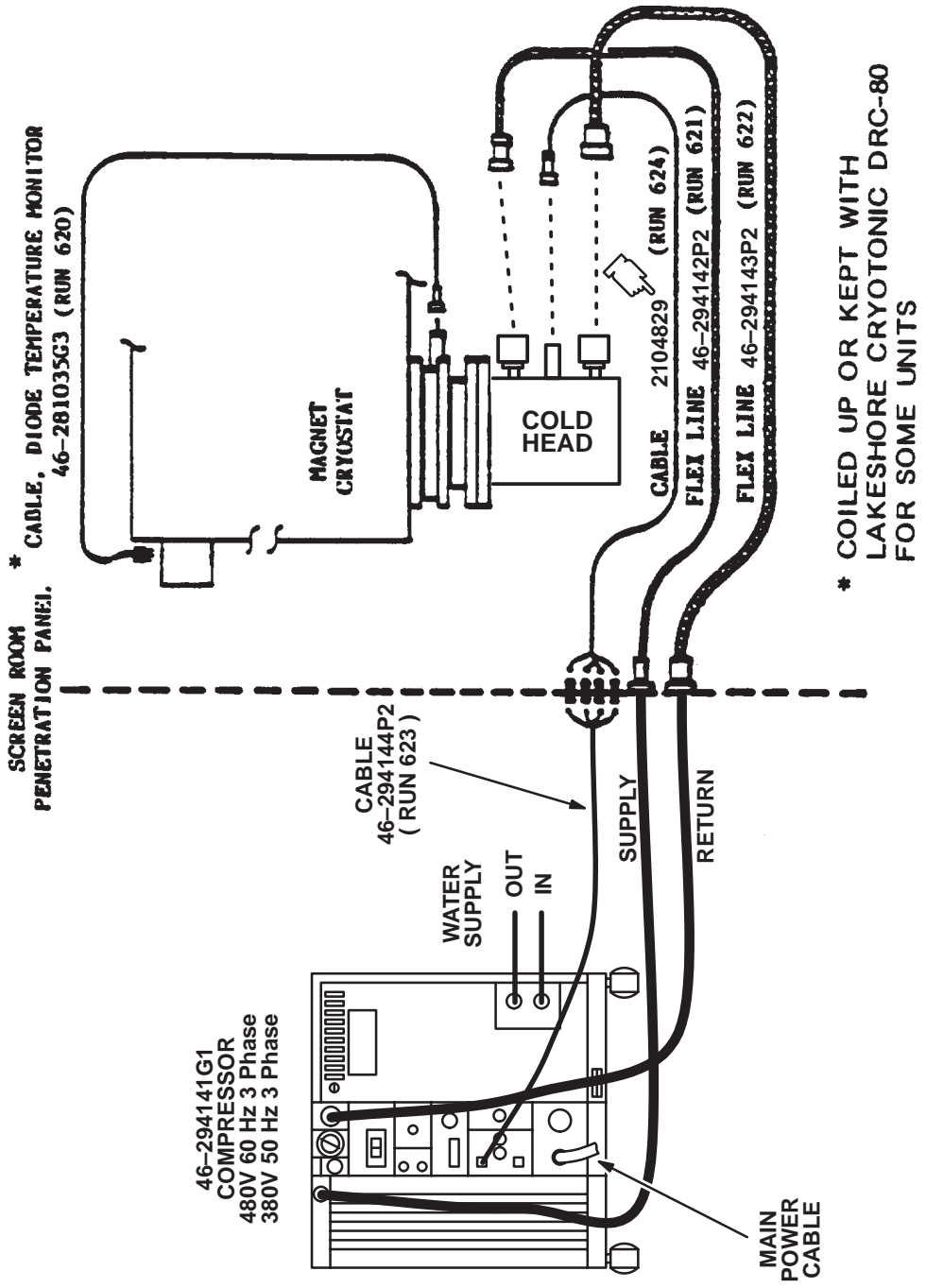


**CONTACT BAND REMOVAL**  
ILLUSTRATION 12-2



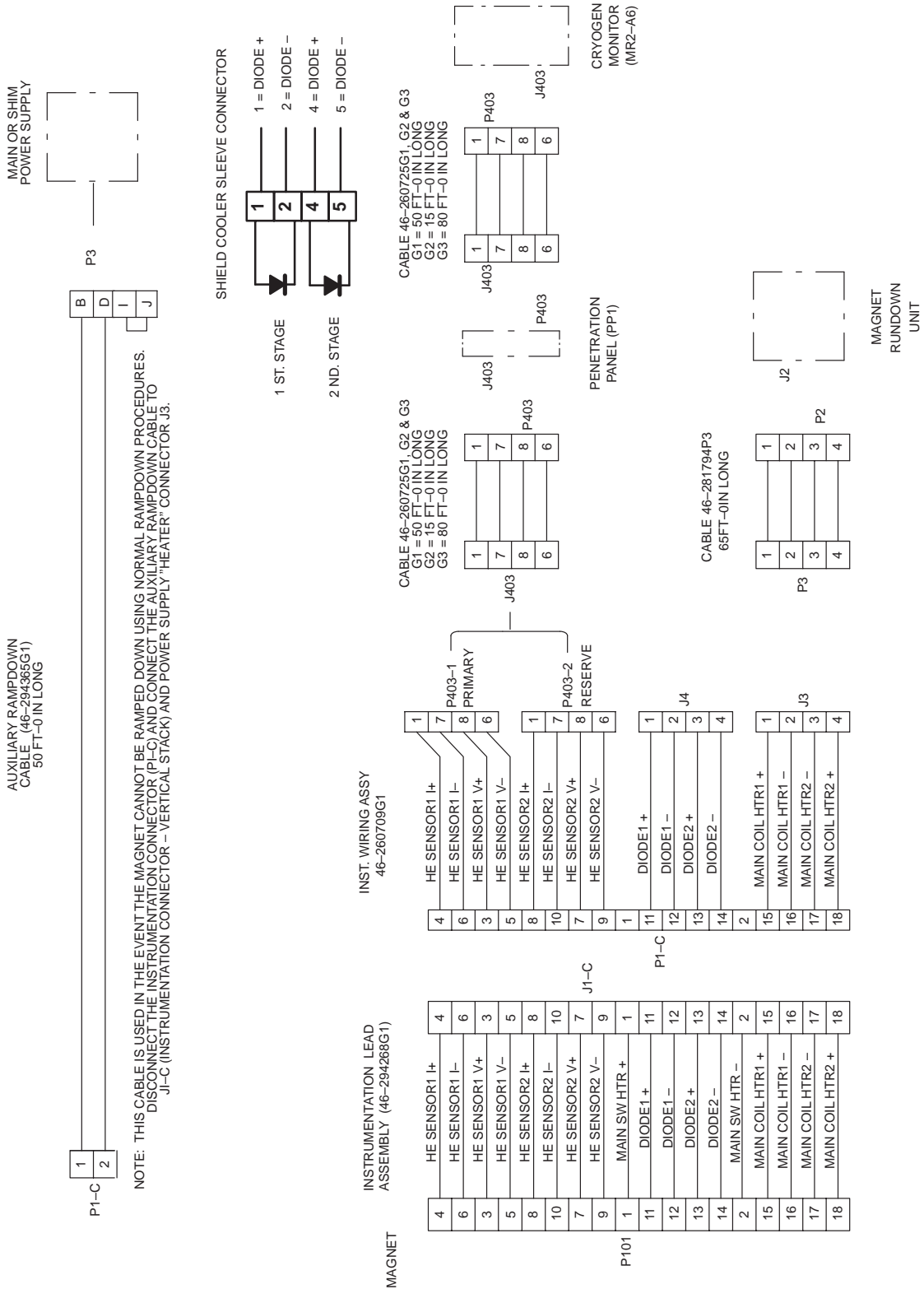
MAGNET SYSTEM INTERCONNECT DIAGRAM

ILLUSTRATION 1-1

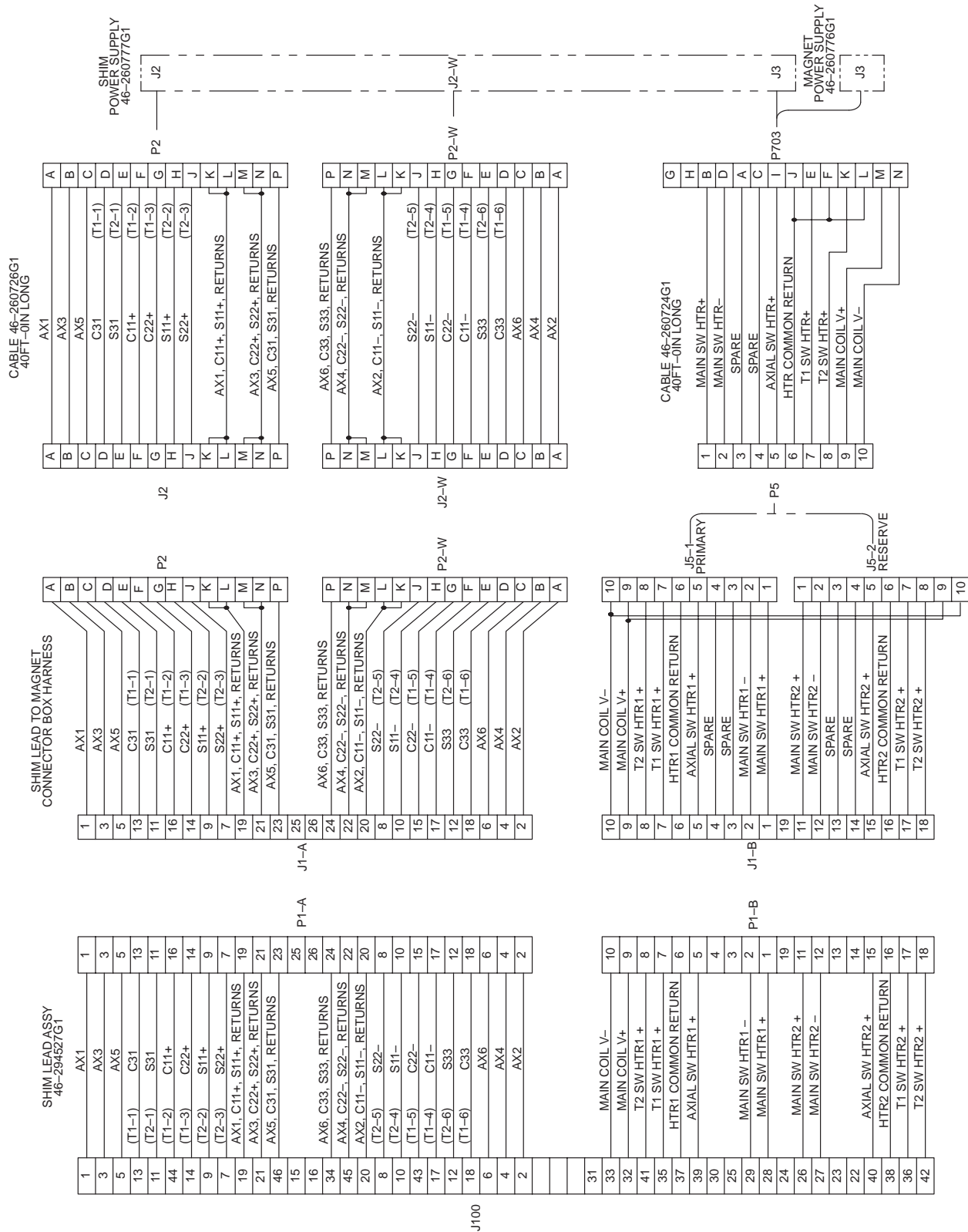


MAGNET SHIELD COOLER INTERCONNECT DIAGRAM

ILLUSTRATION 1-2

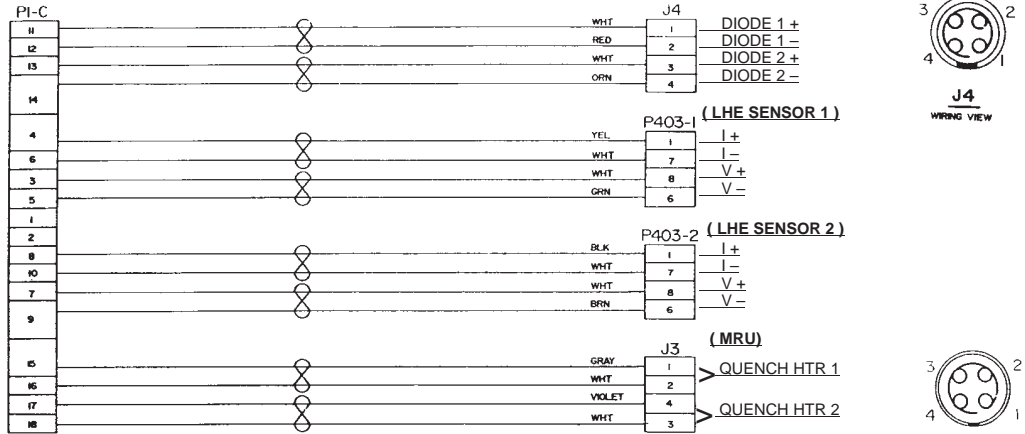
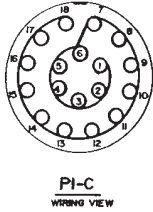


MAGNET SYSTEM WIRING DIAGRAM ILLUSTRATION 2-1

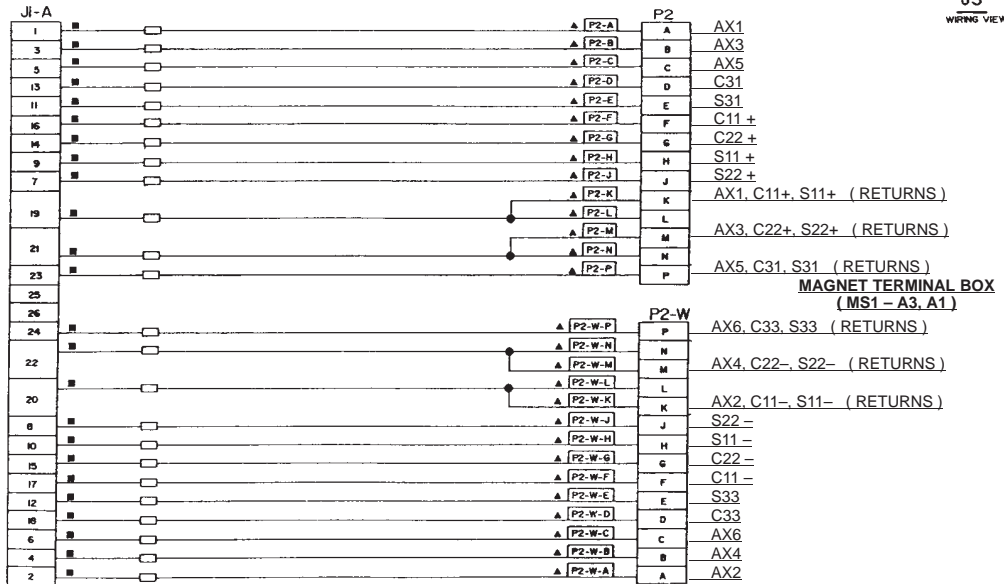


MAGNET SYSTEM WIRING DIAGRAM (continued)

ILLUSTRATION 2-2



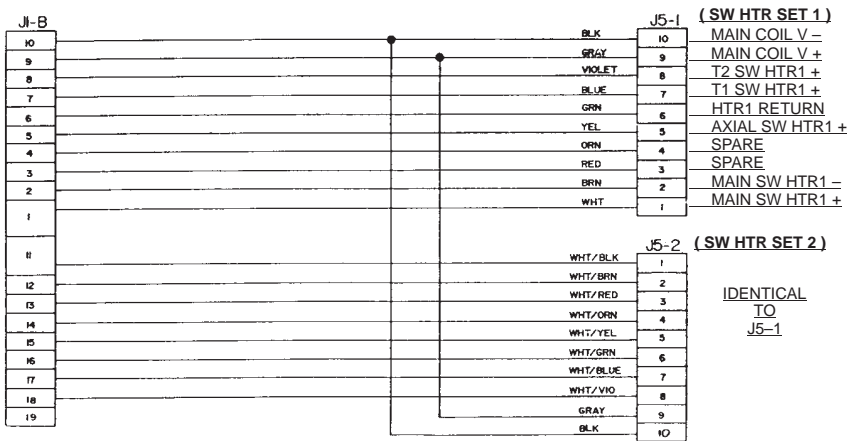
PENETRATION END



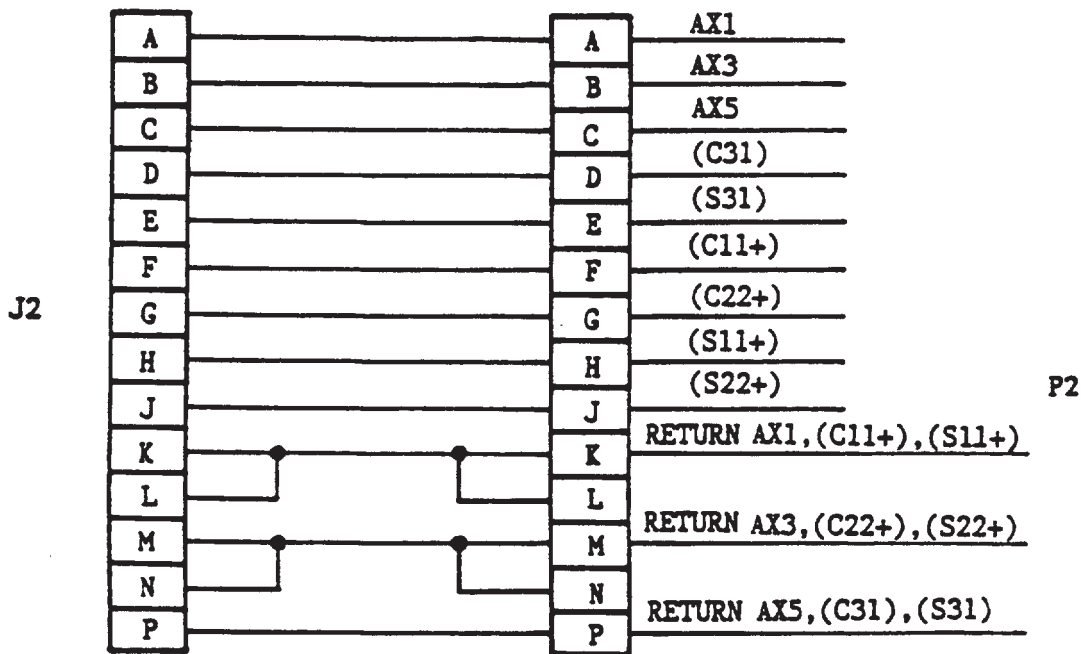
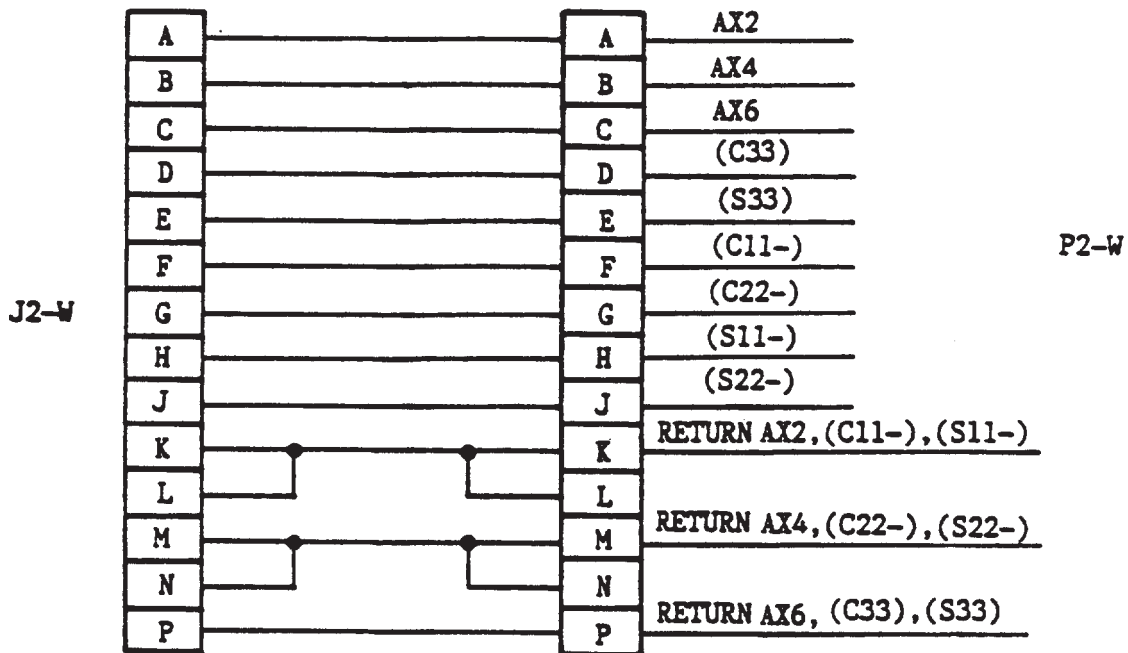
LEGEND

ALL TWISTED PAIR WIRING TO BE 22 AWG.

- ▲ DENOTES 10 AWG HOOK-UP WIRE.
- DENOTES 14 AWG HOOK-UP WIRE 6 TO 8 INCHES LONG.
- INDICATES SPLICE.
- [XX-X] INDICATES WIRE IDENTIFICATION TAGS.



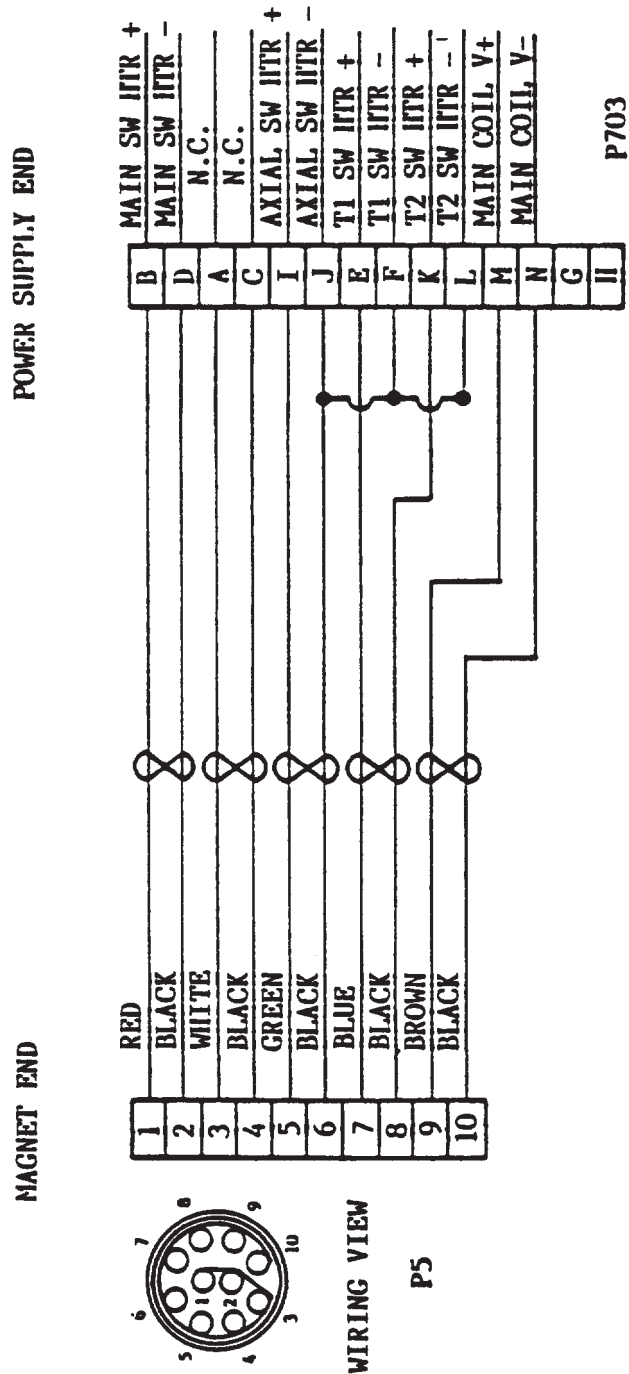
WIRING DIAGRAM  
MAGNET CABLE 46-260709G1  
ILLUSTRATION 2-3



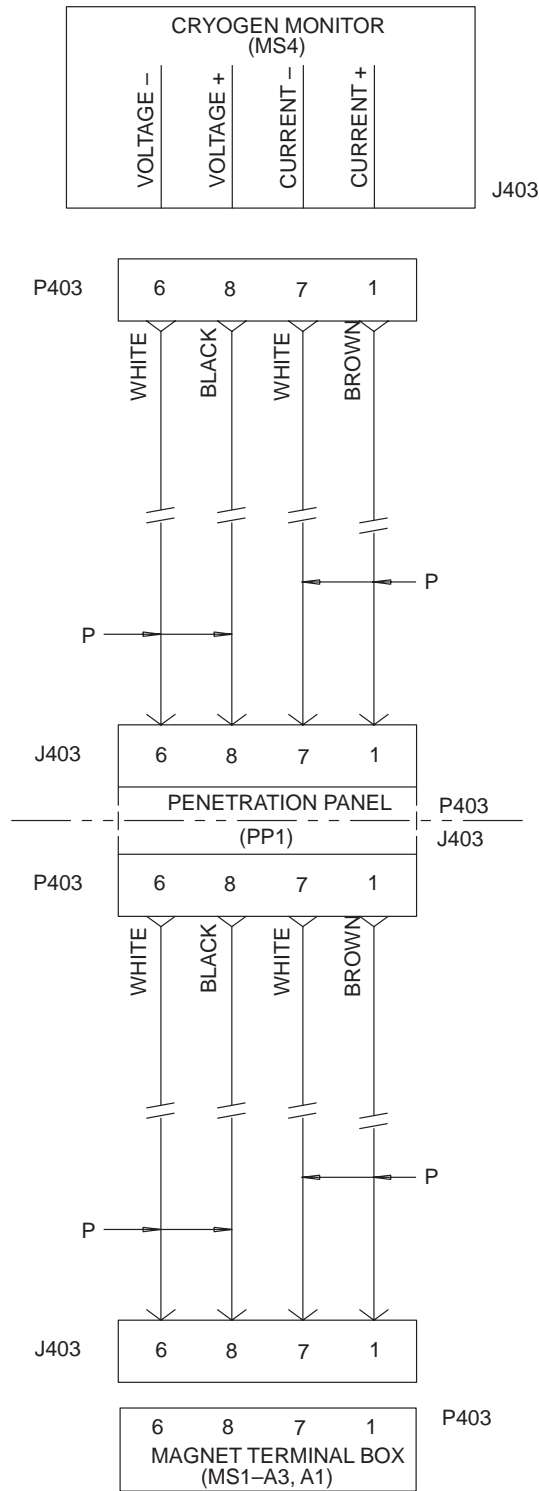
MAGNET END

POWER SUPPLY END

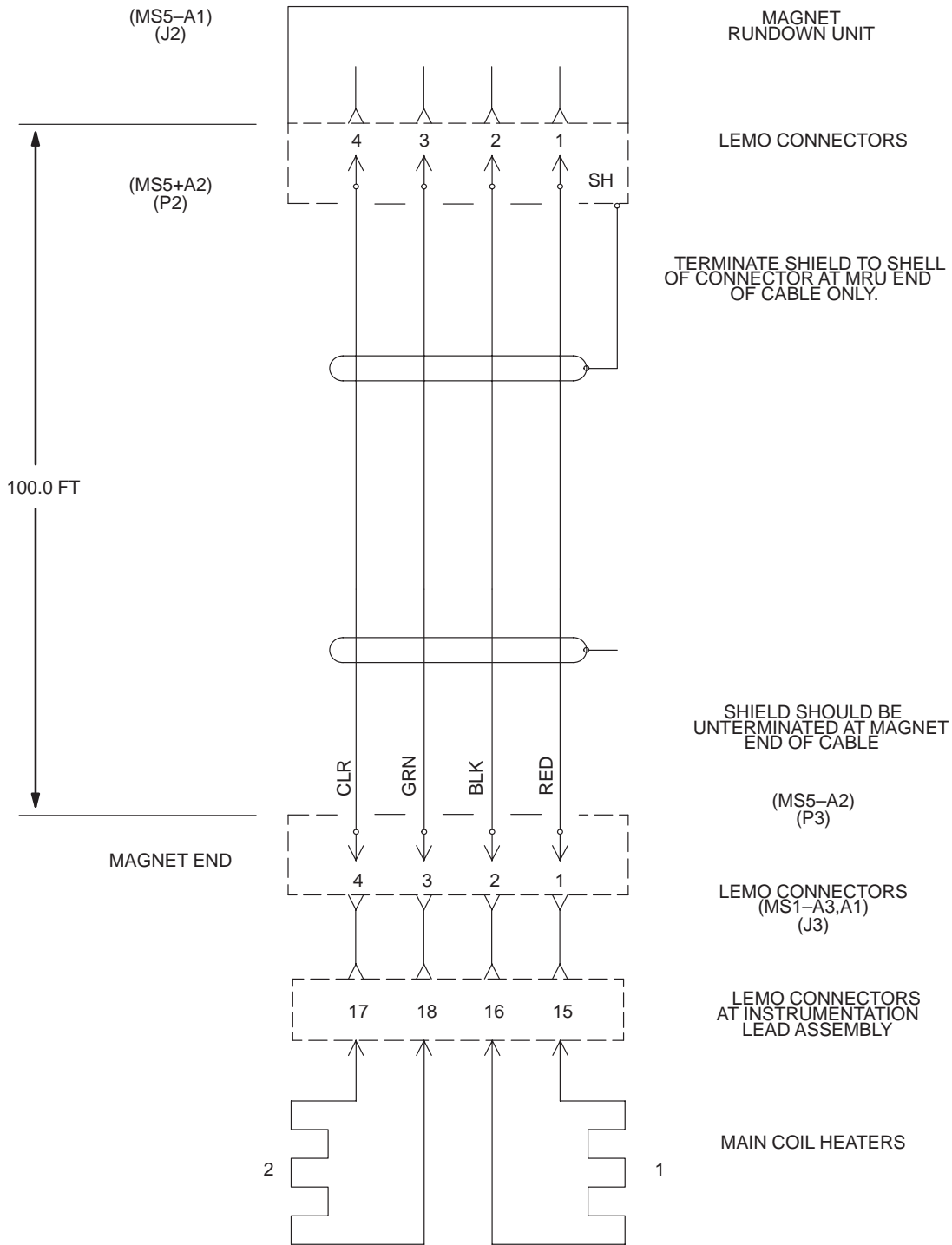
WIRING DIAGRAM  
S/C SHIM COIL CABLE 46-260726G1  
ILLUSTRATION 2-4



WIRING DIAGRAM  
VOLTAGE MONITOR & SWITCH HEATERS CABLE 46-260724G1  
ILLUSTRATION 2-5

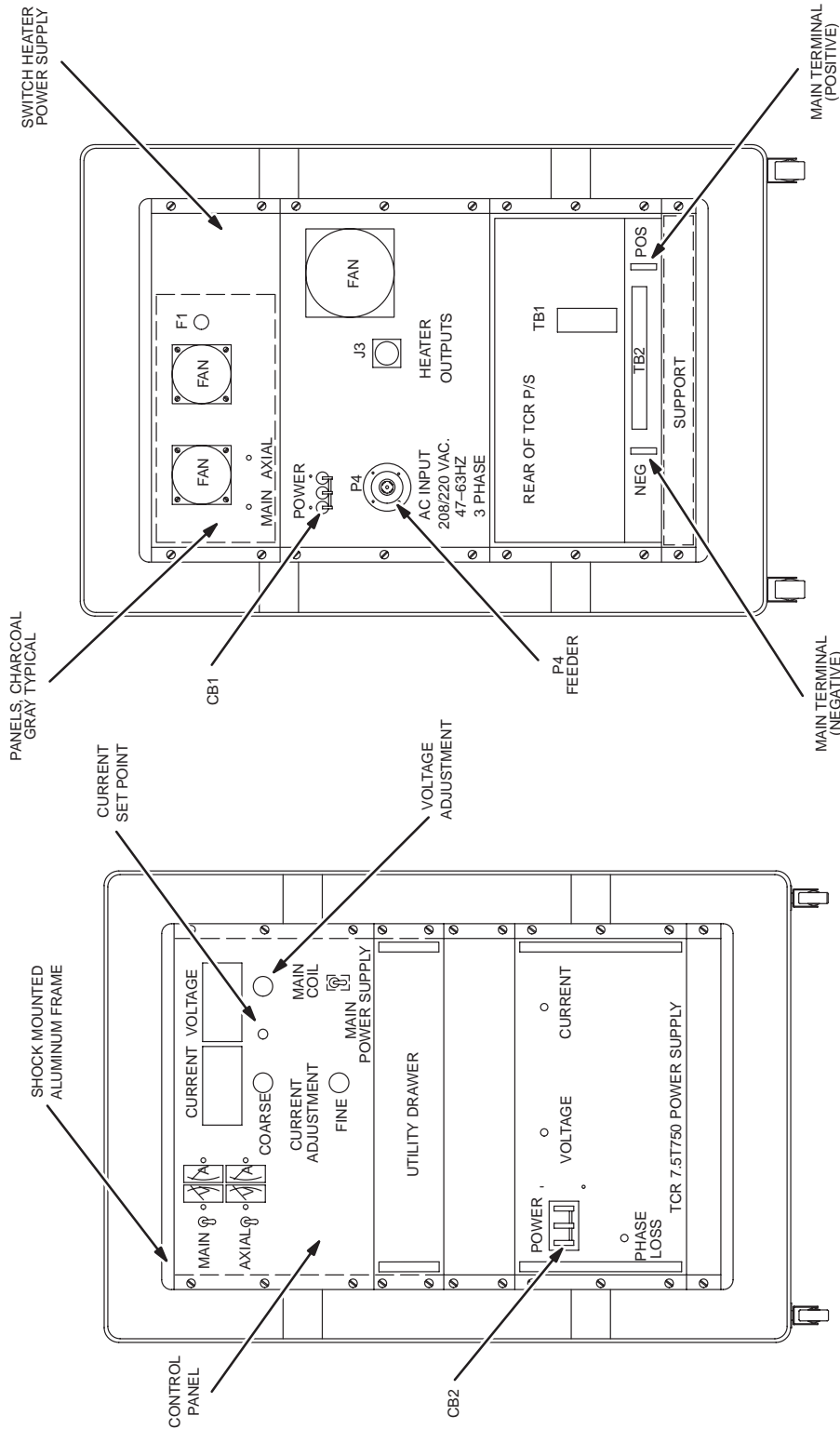


**WIRING DIAGRAM**  
**LIQUID HELIUM MONITOR CIRCUIT**  
 ILLUSTRATION 2-6



**WIRING DIAGRAM**  
**MAGNET RUNDOWN SYSTEM FOR MAIN COIL HEATERS**  
 ILLUSTRATION 2-7



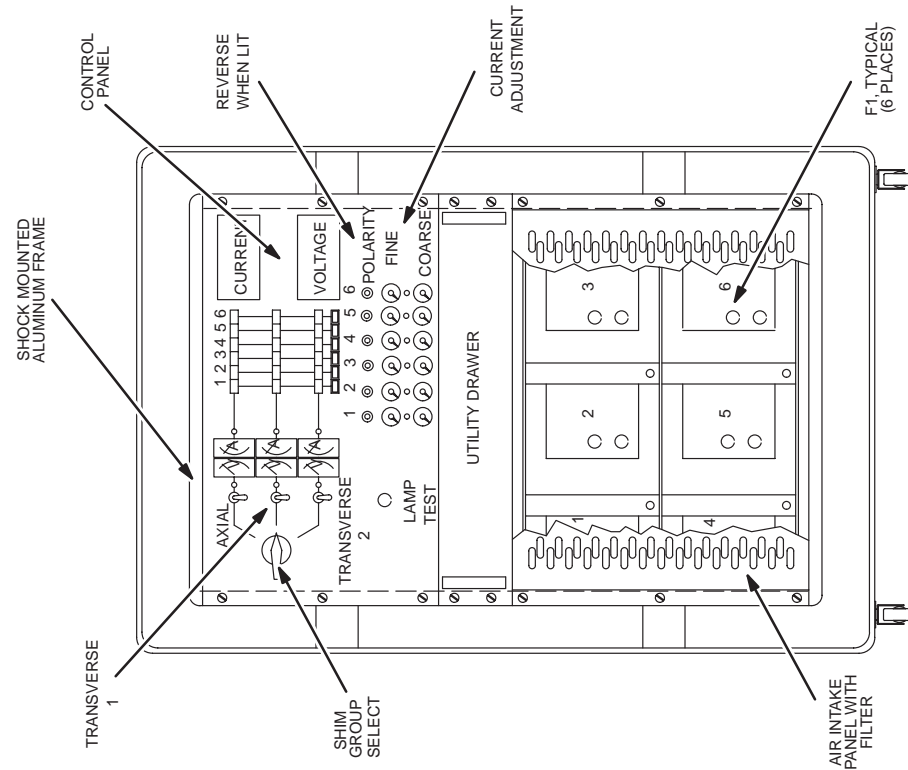
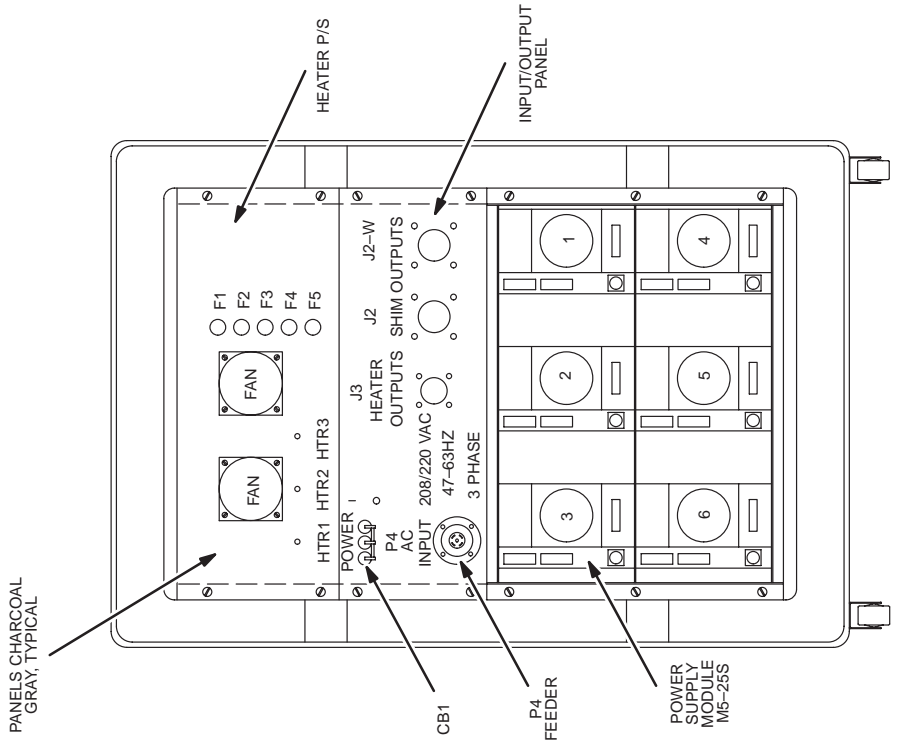


**SUPERCONDUCTING MAIN COIL SERVICE POWER SUPPLY CABINET**

ILLUSTRATION 3-1

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

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

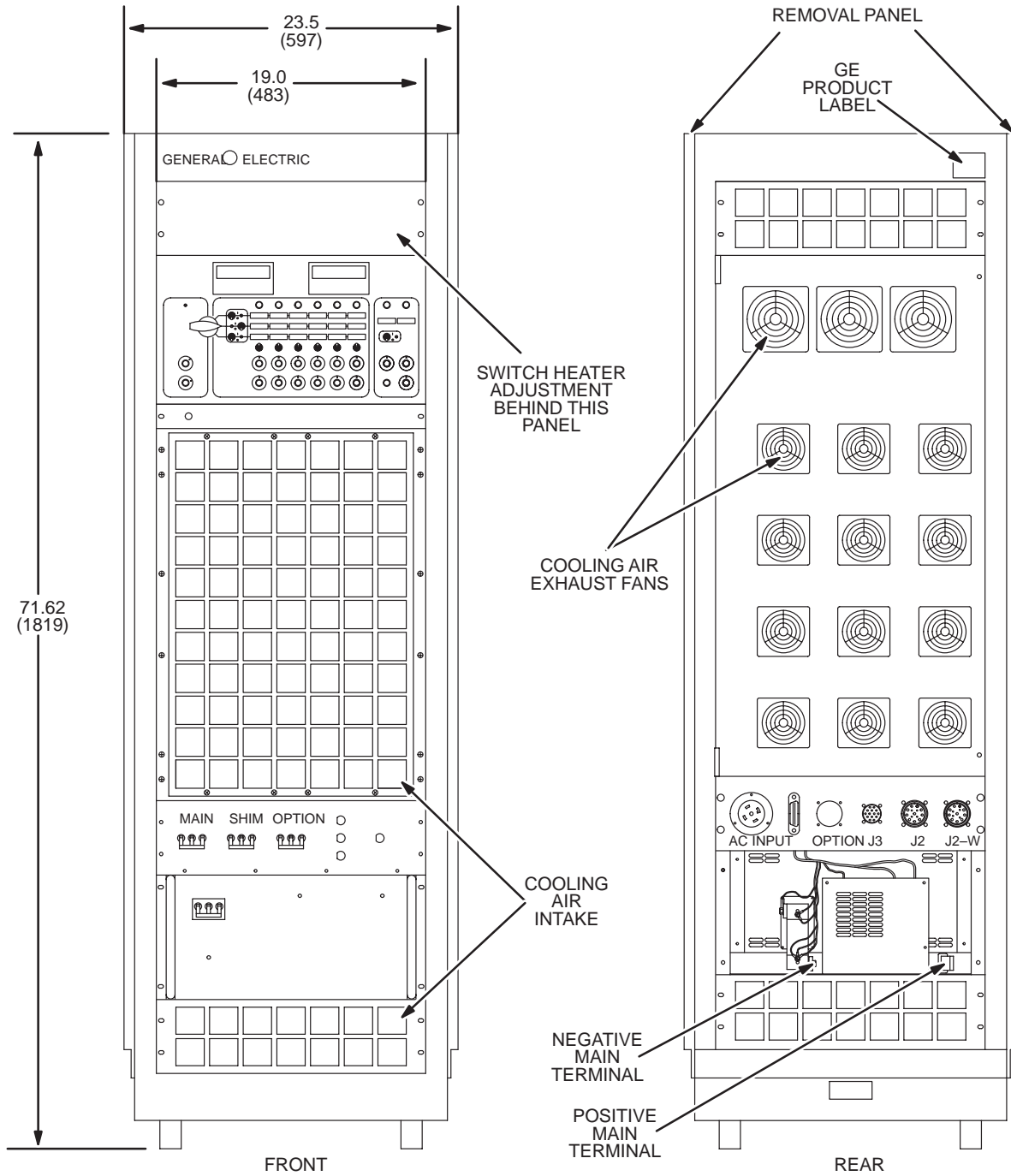


INPUT POWER		
DESIGNATOR	RATING AND TYPE	
P4	208/220 VAC, 50/60 HZ.	
OUTPUT CONNECTIONS		
DESIGNATOR	RATING AND TYPE	CONNECTION
J2	25 A, MS3012A28-20S	S/C SHIM COIL WIRE HARNESS (MS3-A4) P1
J2-W	25 A, MS3012A28-20SW	S/C SHIM COIL WIRE HARNESS (MS3-A4) P2
J3	1 A, MS3106A20-27P	HEATER WIRE HARNESS (MS3-A5) P3

FUSES AND CIRCUIT BREAKERS	
DESIGNATOR	RATING AND TYPE
CB1	3 POLE, 25 A, 250VAC
F1, F5	6.25 A, 250 V, MDA
F2, F3, F4	4 A, 250 V, MDA
	1 A, 250 V, MDA

**SUPERCONDUCTING SHIM COIL SERVICE POWER SUPPLY CABINET**

ILLUSTRATION 3-2



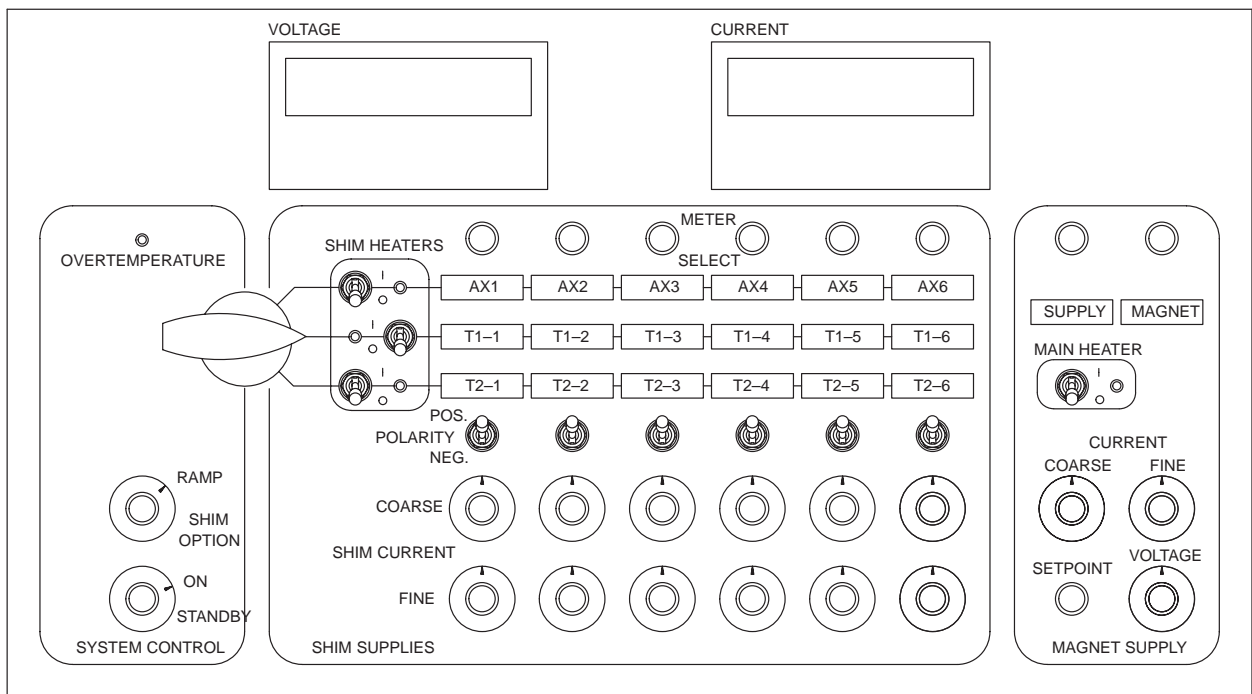
**SPECIFICATIONS**

WEIGHT: 750 LBS MAX      AC - INPUT REQUIREMENTS: 208 VAC +/- 10%  
 30 A  
 55 +/- 8 HZ  
 THREE PHASE / Y

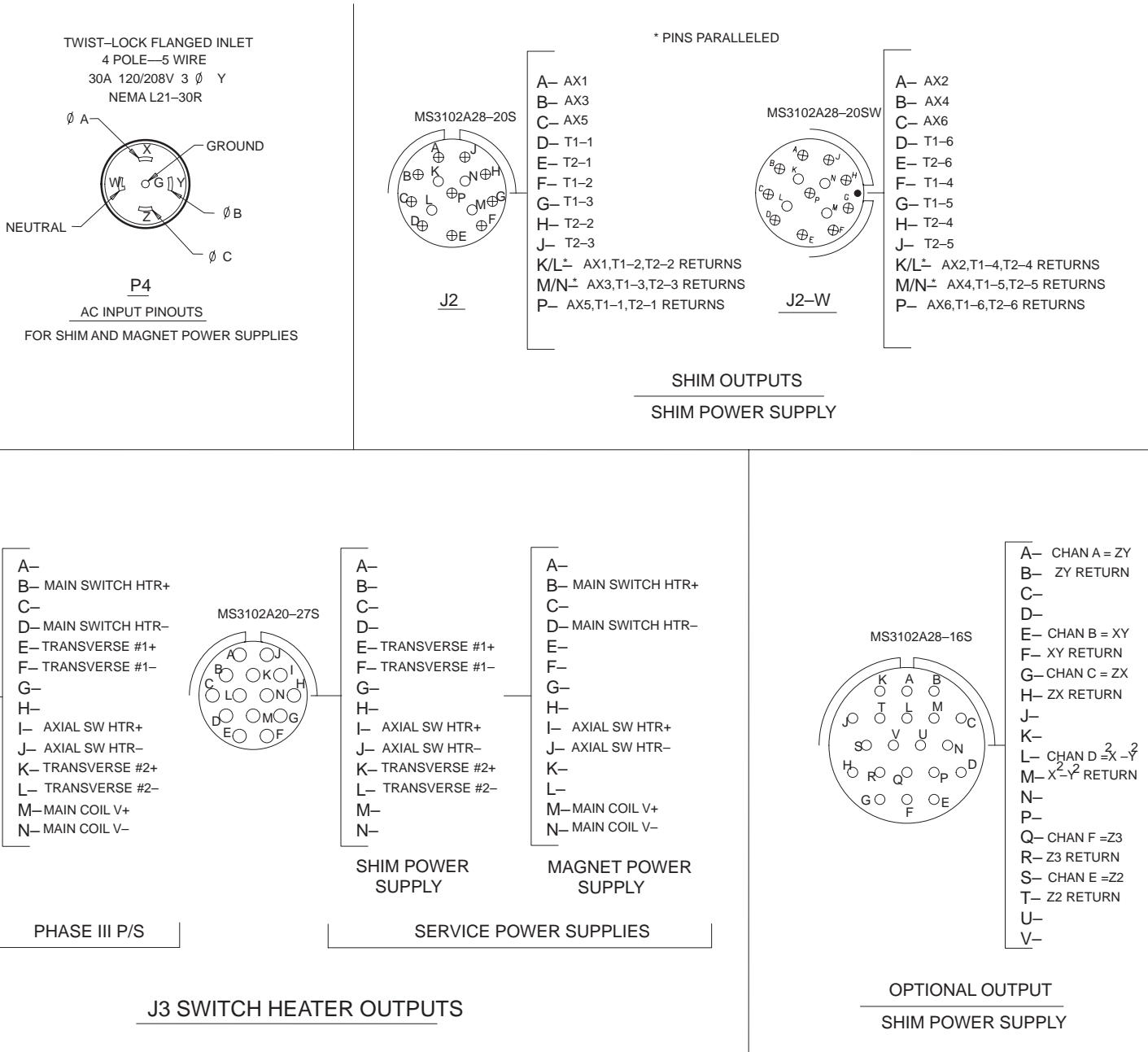
SYSTEM COMPONENTS:  
 MAGNET SUPPLY 0 - 7.5 VDC, 0 - 750 A  
 SHIM SUPPLY (6) 5 VDC, 0 - 25 A

**MAGNET/SHIM PHASE III-A POWER SUPPLY SYSTEM**

ILLUSTRATION 3-3



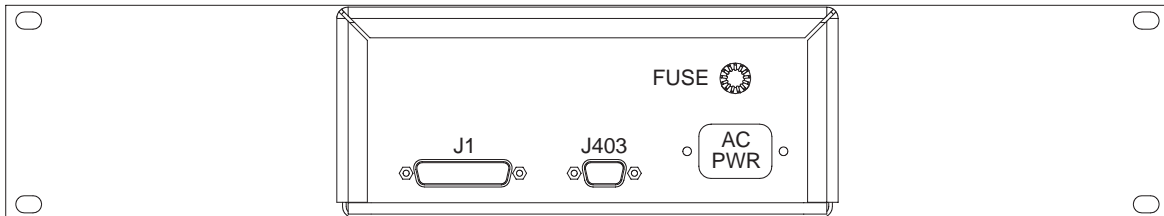
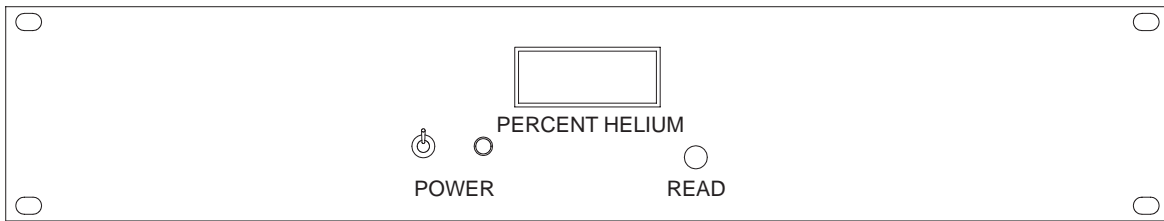
MAGNET/SHIM PHASE III-A POWER SUPPLY CONTROL PANEL  
ILLUSTRATION 3-4



POWER SUPPLY INPUT/OUTPUT CONNECTOR PINOUTS

ILLUSTRATION 3-5





**CRYOGEN MONITOR PANEL**  
ILLUSTRATION 4-1



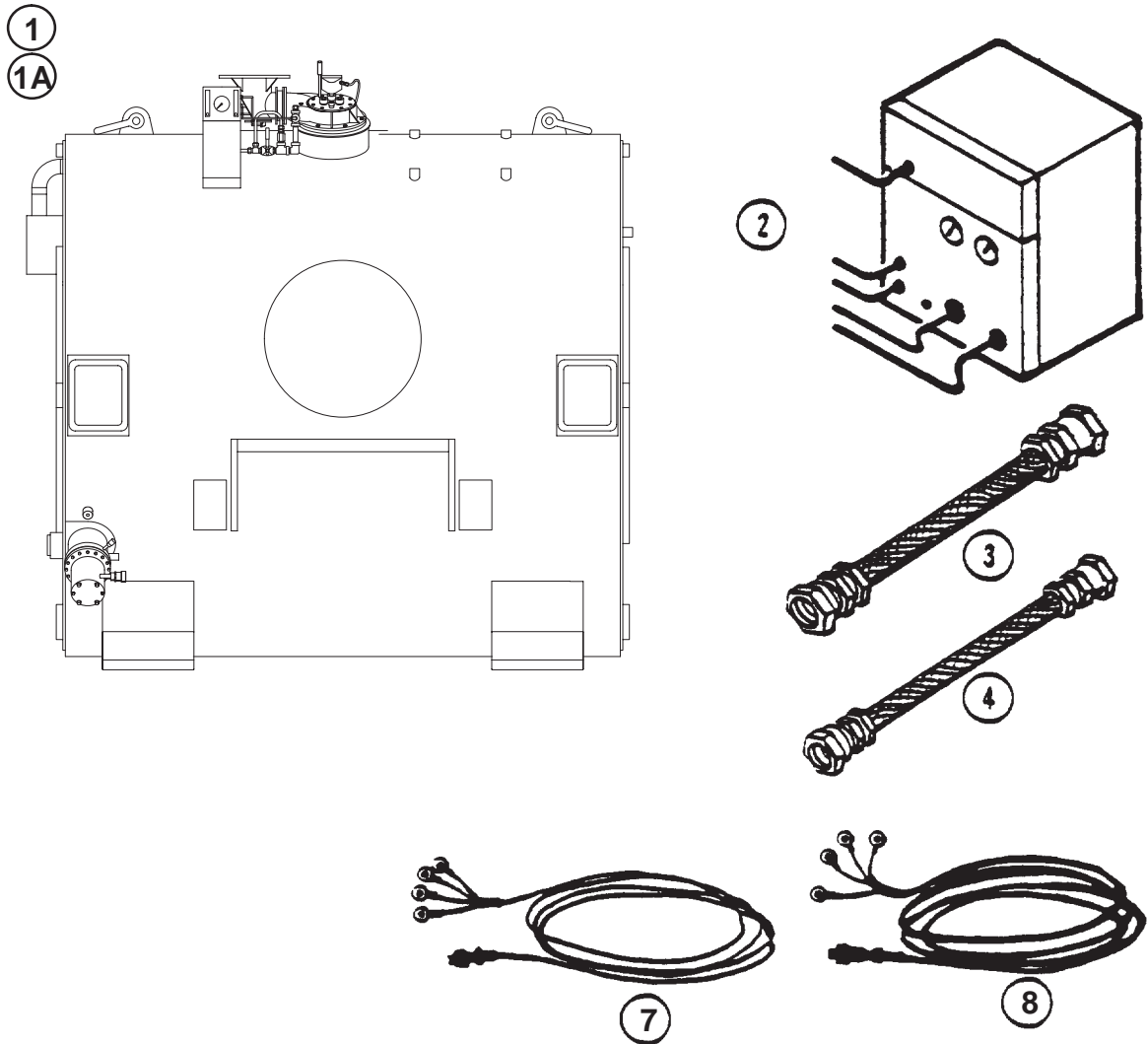
## SECTION 1 – MAGNET SYSTEM

**Description**

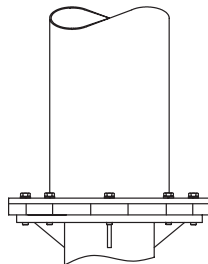
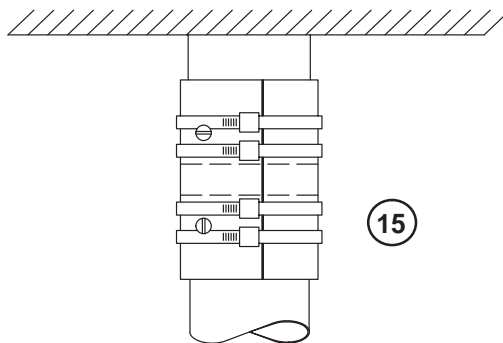
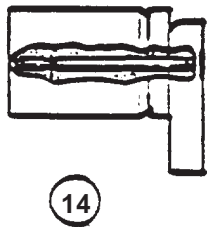
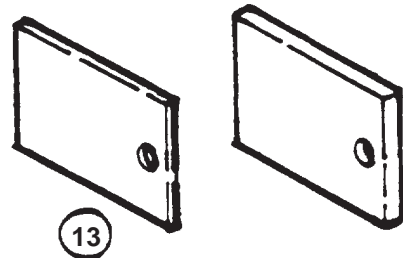
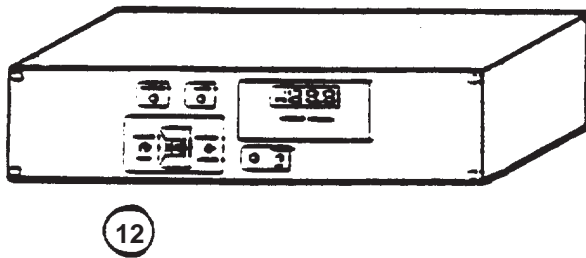
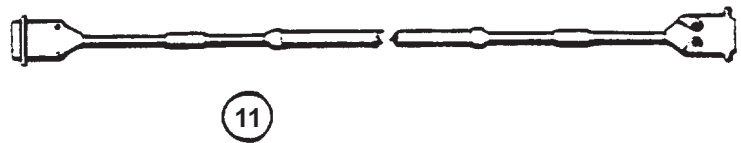
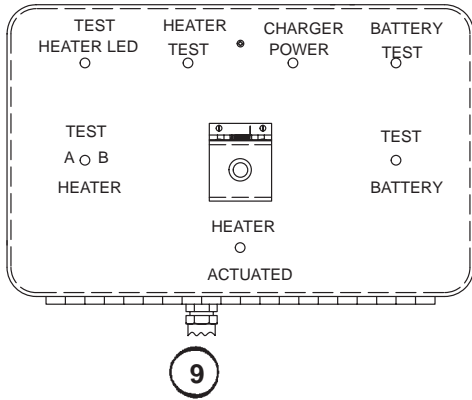
MAGNET MODEL / ASSEMBLY NUMBERS

MAGNET MODEL NUMBER	MAGNET ASSEMBLY NUMBER
46-318864G1 ( Fixed Site )	46-318865G1 ( Fixed Site )
46-318864G2 ( Fixed Site )	46-318865G2 ( Fixed Site )
46-318755G1 ( Mobile )	46-318746G1 ( Mobile )
46-318755G2 ( Mobile )	46-318746G2 ( Mobile )

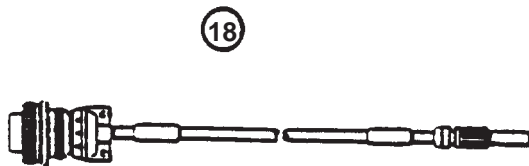
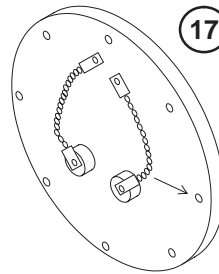
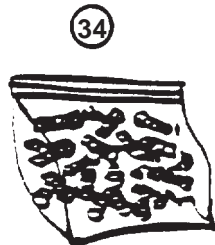
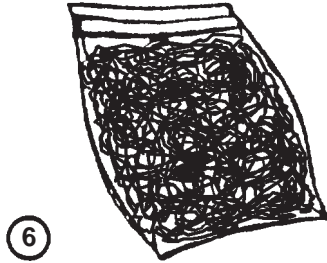
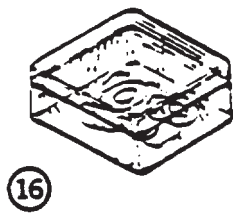
1-1 MAGNET SYSTEM



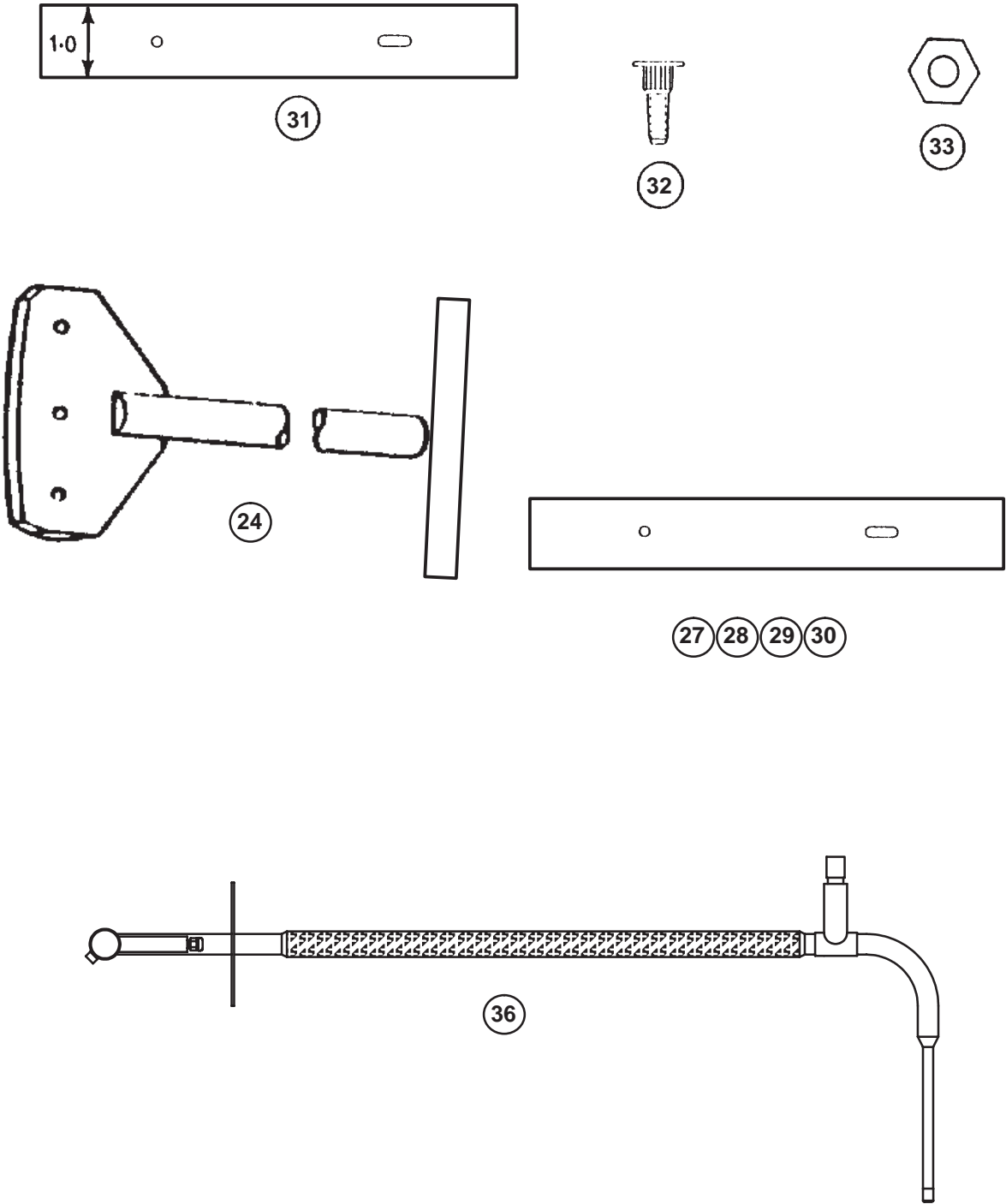
1-1 MAGNET SYSTEM ( continued )



1-1 MAGNET SYSTEM ( continued )



1-1 MAGNET SYSTEM ( continued )



1-1 MAGNET SYSTEM ( continued )

■ 1-1 MAGNET SYSTEM 46-294495G1, 46-318754G1, 2143603, 2143607 SIGNA 1.0T MGT. SYS.

Item	Part Number	FRU	Name	Quantity	Description ( Remarks )
1	46-318748G1	N	MAGNET	1	GE 1.0T SIGNA MAGNET – PHASE I
1A	46-318864G1, G2	N	MAGNET	1	GE 1.0T SIGNA MAGNET – PHASE II ( FIXED SITE )
1B	46-318755G1, G2	N	MAGNET	1	GE 1.0T SIGNA MAGNET – PHASE II ( MOBILE )
2	46-294141G1	1	COMPRESSOR	1	LEYBOLD SHIELD COOLER COMPRESSOR
*3	46-294142P1	1	He GAS LINE	1	LEYBOLD HELIUM SUPPLY LINE ( 20' LONG )
3A	46-294142P2	1	He GAS LINE	1	LEYBOLD HELIUM SUPPLY LINE ( 70' LONG )
*4	46-294143P1	1	He GAS LINE	1	LEYBOLD HELIUM RETURN LINE ( 20' LONG )
4A	46-294143P2	1	He GAS LINE	1	LEYBOLD HELIUM RETURN LINE ( 70' LONG )
5	NOT USED				
6	46-318068P1	1	WOOL	1	BRONZE WOOL
7	2104829	1	CABLE	1	COLD HEAD TO PENETRATION PANEL ( 50' LONG )
*7A	2104829-2	1	CABLE	1	COLD HEAD TO PENETRATION PANEL ( 20' LONG )
8	46-294144P2	1	CABLE	1	COMPRESSOR TO PENETRATION PANEL ( 50' LONG )
*8A	46-294144P3	1	CABLE	1	COMPRESSOR TO PENETRATION PANEL ( 20' LONG )
9	46-294231G1	1	MRU	1	MAGNET RUNDOWN UNIT
10	46-281794P3	1	CABLE	1	FOR MAGNET RUNDOWN UNIT
11	46-260725G3	1	CABLE	2	FOR CRYOSTAT INSTRUMENTATION ( 80' LONG )
12	2122498	N	MONITOR	1	CRYOGEN MONITOR ASSEMBLY
13	46-260888G1	1	KIT	1	MAGNET LEVELING KIT
14	46-260852G3	1	TOOL	1	VACUUM TOOL
15	46-318057G1	1	KIT	1	HELIUM VENTILATION KIT
16	46-294744G2	N	KIT	1	FIELD SPARE PARTS KIT
17	46-294765G1	N	FLANGE	1	TURRET COVER FLANGE ASSEMBLY
*18	46-294365G1	N	CABLE	1	FOR BACKUP RAMPDOWN
19	46-258770G4	N	KIT	1	WARNING SIGN AND LABEL KIT
■ 20	2163409	2	SPACER	200	MYLAR SPACER
21	NOT USED				
22	NOT USED				
23	2136376	N	KIT	1	TOOL TRAY KIT
24	46-318765G1	N	TOOL	1	SHIM DRAWER PULLER TOOL
27	46-294126P901	1	SHIM	75	CARBON STEEL – 1.00" WIDE X .001" THICK
28	46-294126P903	1	SHIM	75	CARBON STEEL – 1.00" WIDE X .003" THICK
29	46-294126P910	1	SHIM	50	CARBON STEEL – 1.00" WIDE X .010" THICK
30	46-294127P1	N	SHIM	5	CARBON STEEL – 1.00" WIDE X .040" THICK
31	46-294128P2	1	COVER	50	ALUMINUM SHIM COVER – 1.00" WIDE X .062" THICK
32	46-294125P2	1	FASTENER	100	#6 – 32 UNC BROACHING TYPE X .50" LONG
33	46-252320P9	1	NUT	100	#6 – 32 UNC, BRASS
34	46-294410P1	1	SCREW	12	.25 – 20 UNC CONE POINT, BRASS SET SCREW
35	46-318036G1	N	KIT	1	RAMP CABLE KIT
*35A	46-318036G2	N	KIT	1	RAMP CABLE KIT
*36	2100867	2	He GAS LINE	1	VACUUM INSULATED HELIUM TRANSFER LINE
37	46-318042P1	1	CABLE	1	METER CABLE, COLD HEAD SLEEVE TO REAR PEDESTAL
38	46-320489G1	N	HINGE ASSY.	1	RIGHT SIDE, FRONT COVER HINGE MOUNTING ASSEMBLY
39	46-320489G2	N	HINGE ASSY.	1	LEFT SIDE, FRONT COVER HINGE MOUNTING ASSEMBLY
40	2156980	2	KIT	1	SPIKE NOISE INSULATION KIT
41	46-260724G1	2	CABLE	1	SWITCH HEATER CABLE

\* USED ON 46-318755 ( MOBILE ) ONLY

1-2 MANUALS

46-318808G1

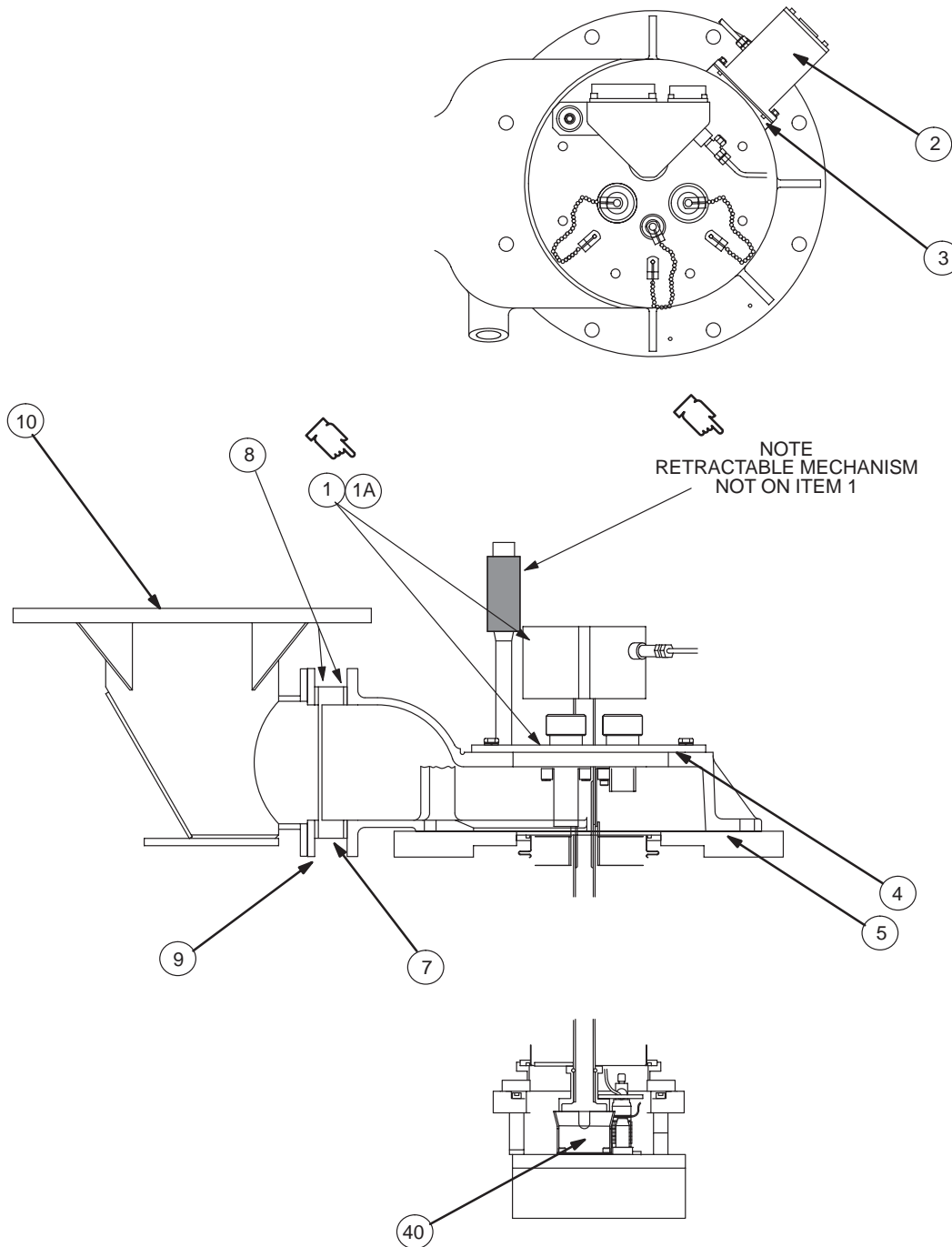
GE & VENDOR SERVICE MANUALS

<u>Item</u>	<u>Part Number</u>	<u>FRU</u>	<u>Name</u>	<u>Quantity</u>	<u>Description ( Remarks )</u>
1	46-015537	N	MANUAL	1	GE 1.0T SIGNA MGT. / CRY. SUBSYSTEM SERVICE MANUAL
2	46-294439P1	N	MANUAL	1	HELIUM LEVEL MONITOR OPER / MAINT MANUAL
3	46-318393	N	MANUAL	1	MAGNET RUNDOWN UNIT ( MRU ) SERVICE MANUAL
4	46-318394	N	MANUAL	1	MAGNET RUNDOWN UNIT ( MRU ) OPERATION MANUAL
5	46-294439P4	N	MANUAL	1	LEYBOLD COLD HEAD & COMPRESSOR MANUAL

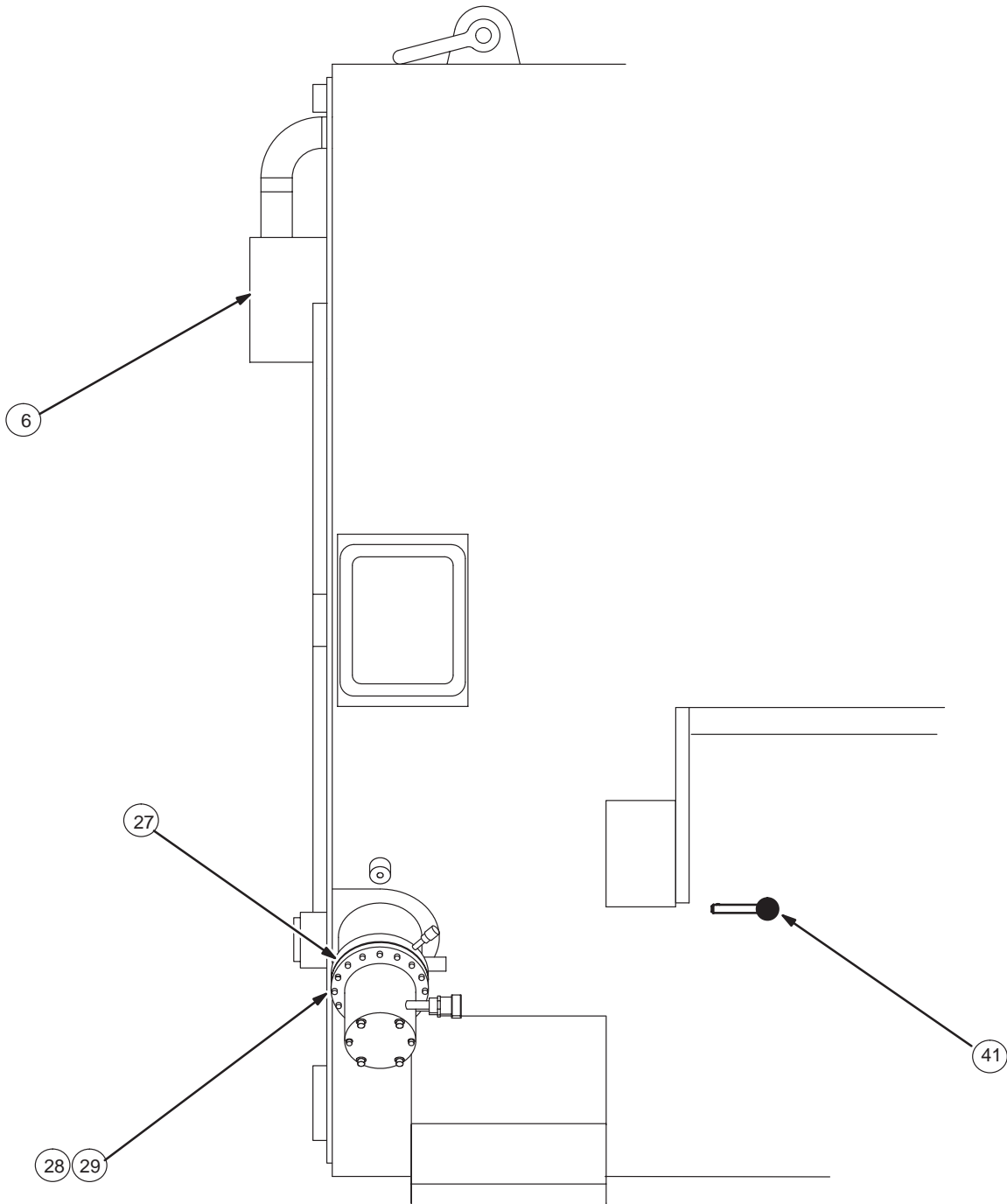


## SECTION 2 – MAGNET COMPONENTS

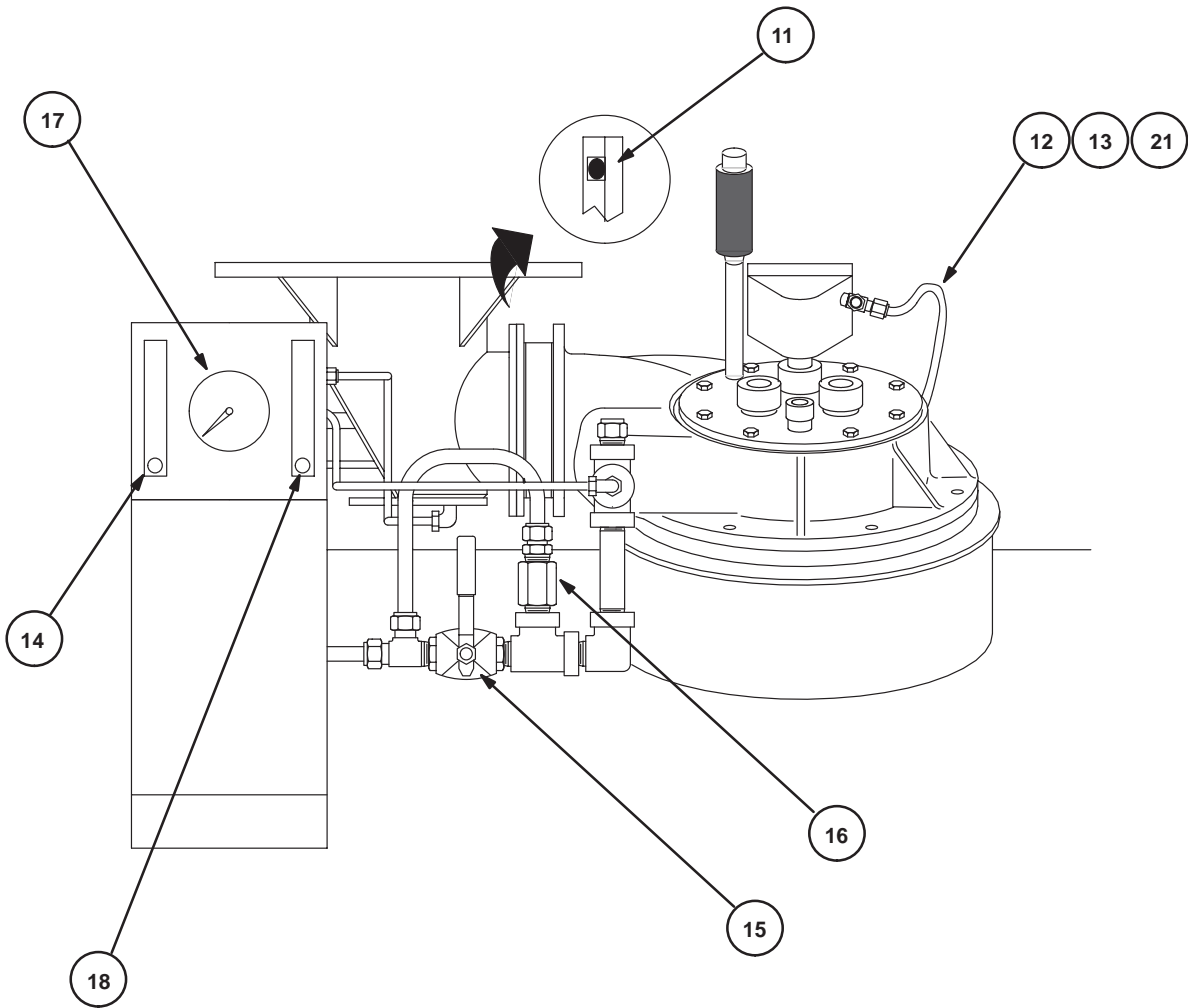
### 2-1 MAGNET COMPONENTS



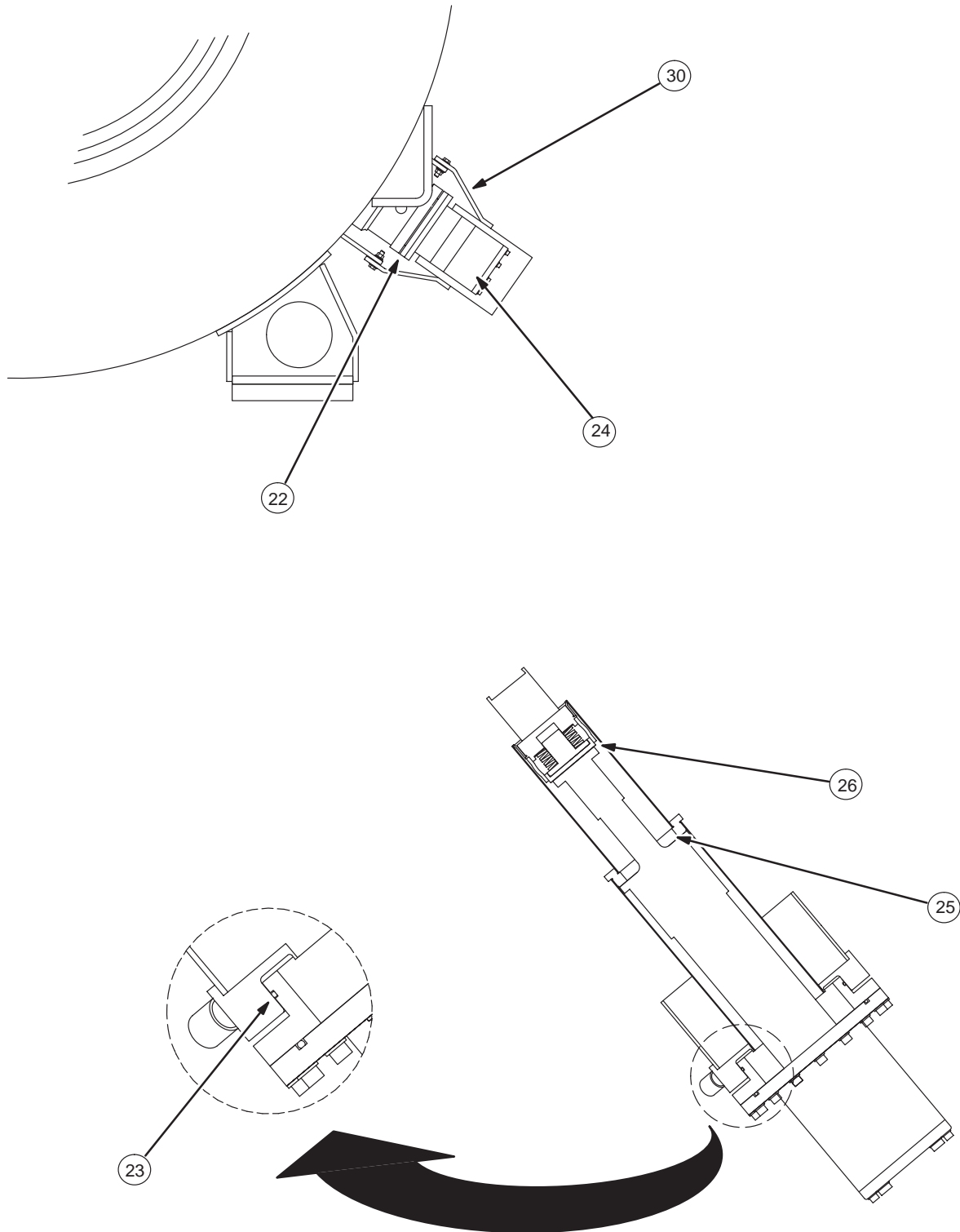
2-1 MAGNET COMPONENTS ( continued )



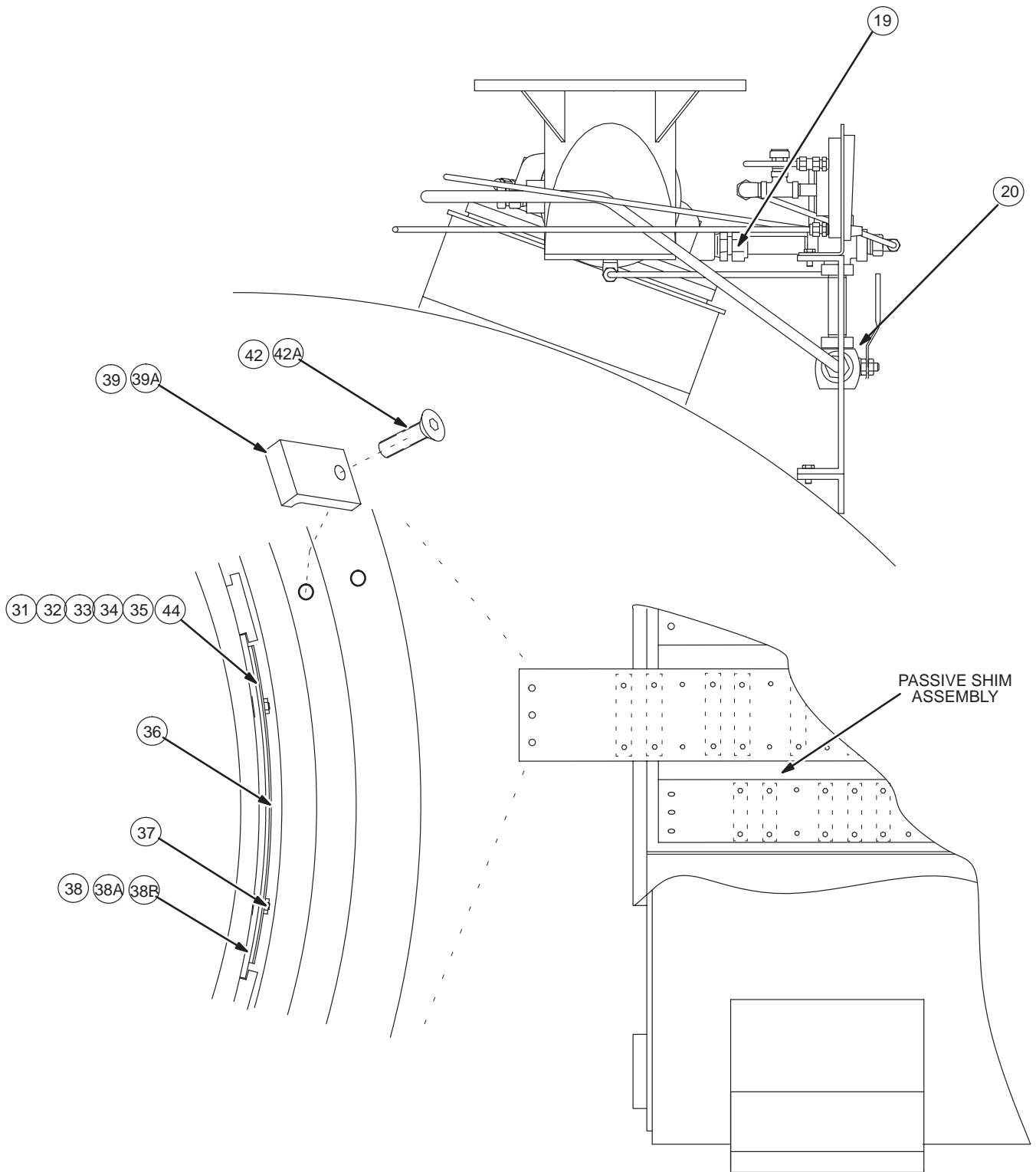
2-1 MAGNET COMPONENTS ( continued )



2-1 MAGNET COMPONENTS ( continued )



2-1 MAGNET COMPONENTS ( continued )



2-1 MAGNET COMPONENTS ( continued )

MGT. COMP. 46-318745G2, 46-318865G1 & G2, 46-318746G1 & G2 GE 1.0T SIGNA MAGNET COMP.

Item	Part Number	FRU	Name	Quantity	Description ( Remarks )
1	2119738	1	SHIM LEAD	1	SHIM LEAD AND TOP PLATE ASSEMBLY
*1A	2102086	1	SHIM LEAD	1	SHIM LEAD AND TOP PLATE ASSEMBLY
2	2116520	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	46-318665G1	2	ENCLOSURE	1	INSTRUMENT AND MAGNET WIRING ASSEMBLY
7	46-252838P6	1	BURST DISC	1	20 PSIG 4 INCH BURST DISC (USED WITH CAST PLENUM)
8	46-252839P2	1	GASKET	2	NEOPRENE GASKET, 4.25" I.D. X5.25" O.D.
9	46-260420P2	N	FLANGE DISC	1	USED WITH BURST DISC
10	46-318712G1	N	VENT ADP. ASSY.	1	VENT ADAPTER ASSEMBLY 4 INCH
11	46-281101P8	2	O-RING	1	TEFLON O-RING, 4.739" I.D. X .070" THK.
12	46-260924P5	N	UNION	1	.25" BRASS TUBE UNION
13	46-294849P1	2	TUBE	1	.25" TUBE FROM SHIM FLOWMETER TO FLEX HOSE
14	46-294352P2	2	FLOWMETER	1	FOR SHIM LEAD, 0.5 - 5.0 SCFH AIR
15	46-252223P1	2	BALL VALVE	1	.50" NPT CRYOGENIC BALL VALVE
16	46-252405P1	2	RELIEF VALVE	1	.50" NPT BRASS, 5 PSIG RELIEF VALVE
17	46-281282P1	2	GAUGE	1	.25" NPT DUAL SCALE, 0 - 5 PSI / KPA
18	46-294352P3	2	FLOWMETER	2	FOR INSTRUMENTATION LEAD, 0.20 - 2.00 SCFH AIR
19	46-260897P2	N	UNION	1	.50" NPT BRASS UNION BALL JOINT
20	46-260829P2	2	RELIEF VALVE	1	.25" NPT, 5 PSIG RELIEF VALVE
21	46-260455P2	2	HOSE	1	.25" ODT X 36.00" LG. FLEXIBLE HOSE
22	46-260938P1	N	FLANGE	1	COLD HEAD TRANSITION FLANGE
23	46-281247P1	1	O-RING	1	BUNA O-RING, 4.987" I.D. X .103" THK.
24	2100832	1	COLD HEAD	1	LEYBOLD SHIELD COOLER COLD HEAD ASSEMBLY
25	46-281241P1	1	GASKET	1	3.37" O.D. INDIUM GASKET
26	46-281241P2	1	GASKET	1	1.75" O.D. INDIUM GASKET
27	46-252610P4	N	CAP SCREW	8	STN. STL. SOC. HD., .25-20UNC X .75" LG.
28	46-252361P11	N	BOLT	8	STN. STL. HEX HD., .25-20UNC X 1.75" LG.
29	46-281387P1	1	WASHER	48	.25" NOM. STN. STL. BELLEVILLE WASHER
30	46-318789G1	N	GUARD	1	LEYBOLD COLD HEAD MOTOR GUARD
*30A	2100329	N	GUARD	1	LEYBOLD COLD HEAD MOTOR GUARD ( HINGED )
31	46-294126P201	2	SHIM	200	CARBON STEEL, .200" WIDE X .001" THICK
32	46-294126P401	2	SHIM	200	CARBON STEEL, .400" WIDE X .001" THICK

\* MOBILE APPLICATION ONLY: 46-318746G1 & G2

2-1 MAGNET COMPONENTS ( continued )

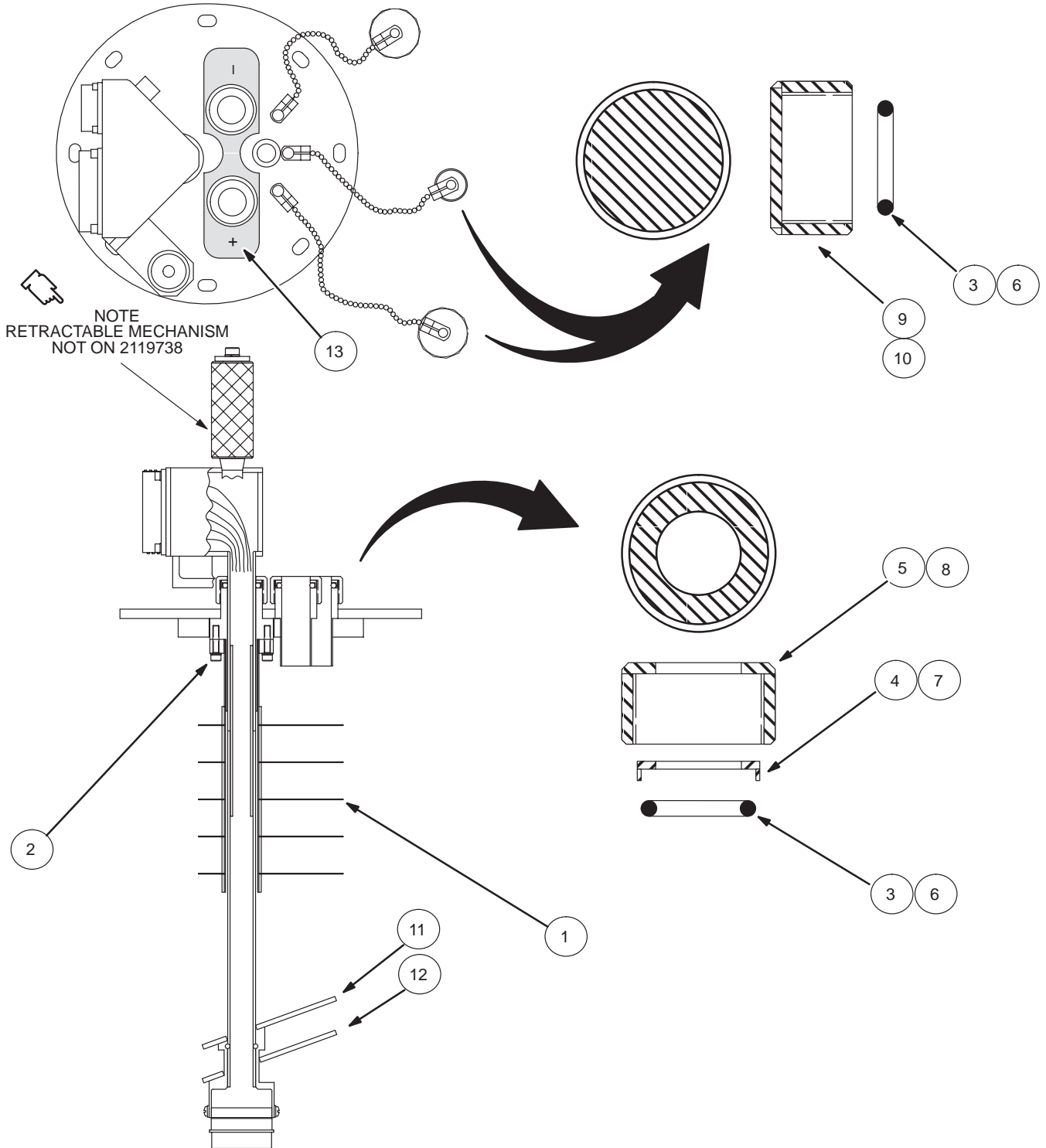
MGT. COMP. 46-318745G2, 46-318865G1 & G2, 46-318746G1 & G2 GE 1.0T SIGNA MAGNET COMP.

Item	Part Number	FRU	Name	Quantity	Description ( Remarks )
33	46-294126P901	2	SHIM	300	CARBON STEEL, 1.00" WIDE X .001" THICK
34	46-294126P903	2	SHIM	200	CARBON STEEL, 1.00" WIDE X .003" THICK
35	46-294126P910	2	SHIM	50	CARBON STEEL, 1.00" WIDE X .010" THICK
36	46-294128P2	2	SHIM COVER	150	ALUMINUM, 1.00" WIDE X .062" THICK
37	46-294125P2	2	FASTENER	300	PHOS. BRNZ., #6-32UNC BROACHING TYPE X .50" LG.
38	46-318660G1	N	DRAWER	12	FIBER RE-INFORCED PLASTIC SHIM DRAWER
38A	46-318876G1	N	DRAWER	12	FIBER RE-INFORCED PLASTIC SHIM DRAWER
38B	2106085	N	DRAWER	12	FIBER RE-INFORCED PLASTIC SHIM DRAWER
39	46-318659P1	2	DRAWER STOP	24	DRAWER STOP PLATE
39A	2102185	2	DRAWER STOP	24	DRAWER STOP PLATE
40	46-318060P1	1	CONNECTOR	1	SAV-CON CONNECTOR
41	2102714	2	LOCKING PIN	2	BALL HANDLE LOCKING PIN - .50" DIA. NOM. S
42	46-318704P1	2	BRASS SCREW	24	.38-16UNC FLAT HEAD SOCKET CAP SCREW
42A	46-260756P106	2	BRASS SCREW	24	.38-16UNC FLAT HEAD MACHINE SCREW
43	2102891	N	HINGE	2	REVERSIBLE PLATFORM HINGE
44	46-294127P1	2	SHIM	50	CARBON STEEL, 1.00" WIDE X .040" THICK WITH BLACK OXIDE COATING

2-2 SHIM LEAD COMP.

2102086, 2119738

SHIM LEAD AND TOP PLATE ASSEMBLY



2-2 SHIM LEAD COMPONENTS ( continued )

■ 2-2 SHIM LEAD COMP.                      2102086, 2119738                      SHIM LEAD AND TOP PLATE ASSEMBLY

<u>Item</u>	<u>Part Number</u>	<u>FRU</u>	<u>Name</u>	<u>Quantity</u>	<u>Description ( Remarks )</u>
1	46-294431G1	1	BAFFLE ASSY.	1	REMOVABLE BAFFLE ASSEMBLY
2	46-252546P6	N	SCREW	3	BRASS, SOC. HD., #8-32UNC X .62" LG.
3	46-260389P3	1	O-RING	4	BUNA-N O-RING, .736" I.D. X .103" THK.
4	46-294105P1	2	RING	3	BRASS RETAINING RING X 1.109" O.D.
5	46-294104P1	2	NUT	3	KNURLED BRASS 1.187-20UNC COUPLING NUT
6	46-260342P9	1	O-RING	2	BUNA-N O-RING, .489" I.D. X .625" O.D.
7	46-260272P1	2	RING	1	STN. STL. RETAINING RING X .687" O.D.
8	46-318619P1	2	NUT	1	KNURLED BRASS .75-20UNEF COUPLING NUT (EXTENDED)
9	46-294769P33	2	CAP	2	BRASS .75" TUBE CAP
10	46-318618P1	2	CAP	1	BRASS .50" TUBE CAP (EXTENDED)
11	2102421	2	BAFFLE	1	TOP, SLANTED BAFFLE
12	2102422	2	BAFFLE	1	BOTTOM, SLANTED BAFFLE

NOTE: ITEM 13 ( 2102687 ) IS THE POLARITY PLATE.



**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
15	200-80-418	2	.6A CIRCUIT BREAKER	46-294150P20

\* VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL.

**3-2 FIELDSPARE KIT 46-294744G2**

Item	Part Number	FRU	Name	Quantity	Description
1	46-294431G1	1	BAFFLE ASM	1	SHIM LEAD BAFFLE ASSEMBLY
2	46-252838P6	1	BURST DISK	1	20 PSI BURST DISK 4 INCH (FOR 4 INCH CAST PLENUM)
3	46-252839P2	1	GASKET	2	4.25" ID X 5.25" OD NEOPRENE
4	46-281101P9	1	O-RING	2	1.487" ID X 0.103" THK. #2-137
5	46-281101P5	1	O-RING	2	5.737" ID X 0.103" THK. #2-162
6	46-281101P6	1	O-RING	2	9.487" ID X 0.103" #2-177
8	46-260389P1	1	O-RING	4	SILICONE, PARKER #2-116
9	46-260389P2	1	O-RING	2	SILICONE, PARKER #2-014

**3-3 MAGNET RUNDOWN UNIT 46-294231G1**

Item	Vendor Part #	FRU	Description	GE Part Number
1	EF1001	1	FUSE, F1, 110VAC .400 GDCTIME LAG	46-294231P1
2	EF1002	1	FUSE, F1, 220VAC .125GDC TIME LAG	46-294231P2
3	EF1008	1	FUSE, F2, 2.5A GDC TIME LAG	46-294231P3
4	GS4063	1	FUSE, F3/F4, 1.25A GDB	46-294231P4
5	GS4063	1	BATTERY, GEL CEL 6V 1.2AH YUSA NP1.2-6	46-294231P5
6	EC1140	1	CAPACITOR, CI, 470uF, 50V,	46-294231P6

**3-4 CRYOGEN MONITOR 46-281811G1, 2122498**

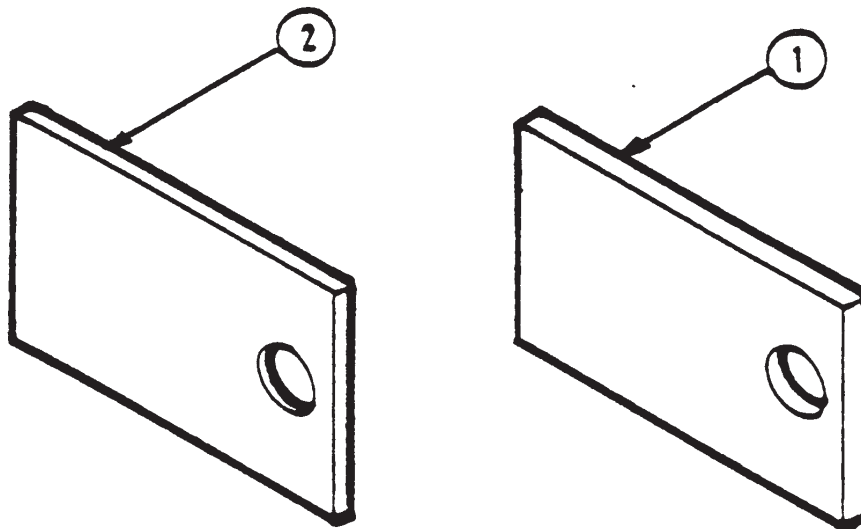
Item	Vendor Part #	FRU	Description	GE Part Number
1	EF-1000	1	0.3A FUSE	46-281025P1
2	EL-1000	2	RED LED	46-281025P4
3	ES-1000	2	FRONT PANEL TOGGLE SWITCH	46-281025P6
4	EL-1010	2	YELLOW LED	46-281025P5
5	ES-1010	2	FRONT PANEL PUSHBUTTON SWITCH	46-281025P7
6	EX-1015	2	POWER TRANSFORMER	46-281025P11
7	ES-1025	2	FRONT PANEL THUMBWHEEL SWITCH	46-281025P8
8	ET-1110	2	POWER TRANSISTOR	46-281025P10
9	EM-1525	2	PERCENT LEVEL DISPLAY	46-281025P9
10	EM / 133/GE / PCB	2	MAIN PC BOARD	46-281025P2
11	EM / 133/GE / PSB	2	POWER SUPPLY BOARD	46-281025P3
** 12	EF-1000	1	FUSE, 0.3A, 250V, 3AG, 100-115 VAC	2122500-2
** 13	EF-1002	1	FUSE, 0.2A, 250V, 3AG, 200-230 VAC	2122500-3
** 14	BM / 111GE / PCB	2	MAIN PRINTED CIRCUIT BOARD	2122500-4
** 15	EM-1015	2	DISPLAY METER	2122500-5

\* VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL.

\*\* USED ON 2122498 ONLY

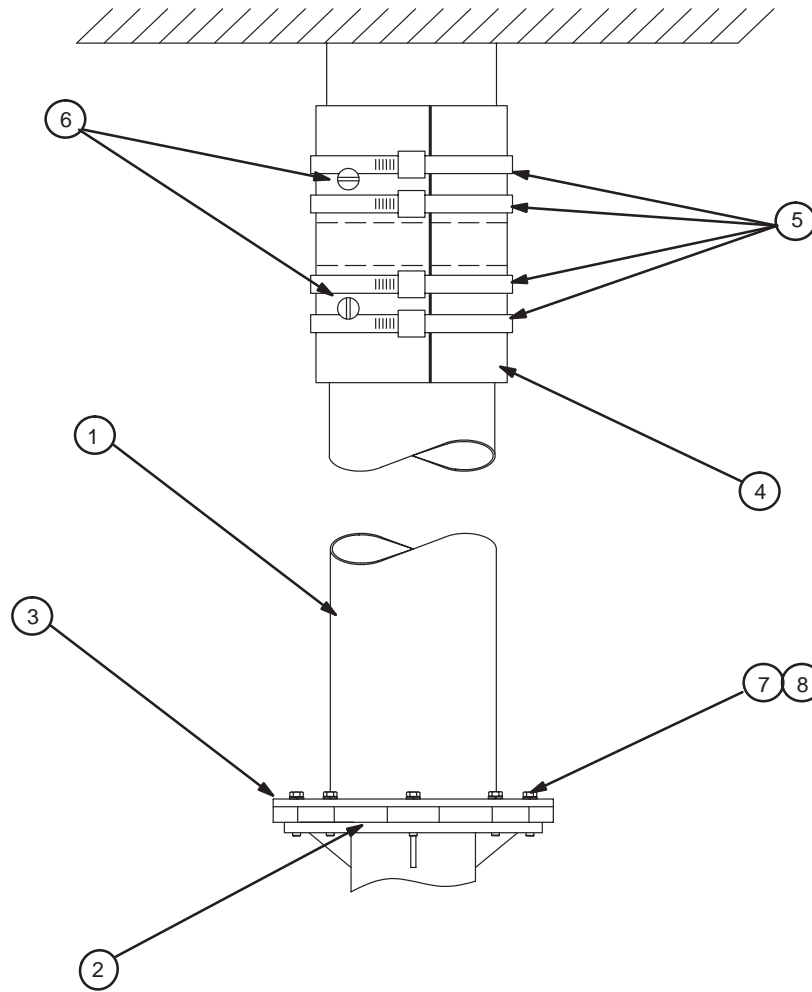
**3-5 MAGNET LEVELING KIT 46-260888G1**

Item	Part Number	FRU	Name	Quantity	Description
1	46-260886P2	2	SHIM PLATE	12	.062" THICK AL. ALLOY PLATE
2	46-260886P3	2	SHIM PLATE	8	.020" THICK AL. ALLOY PLATE



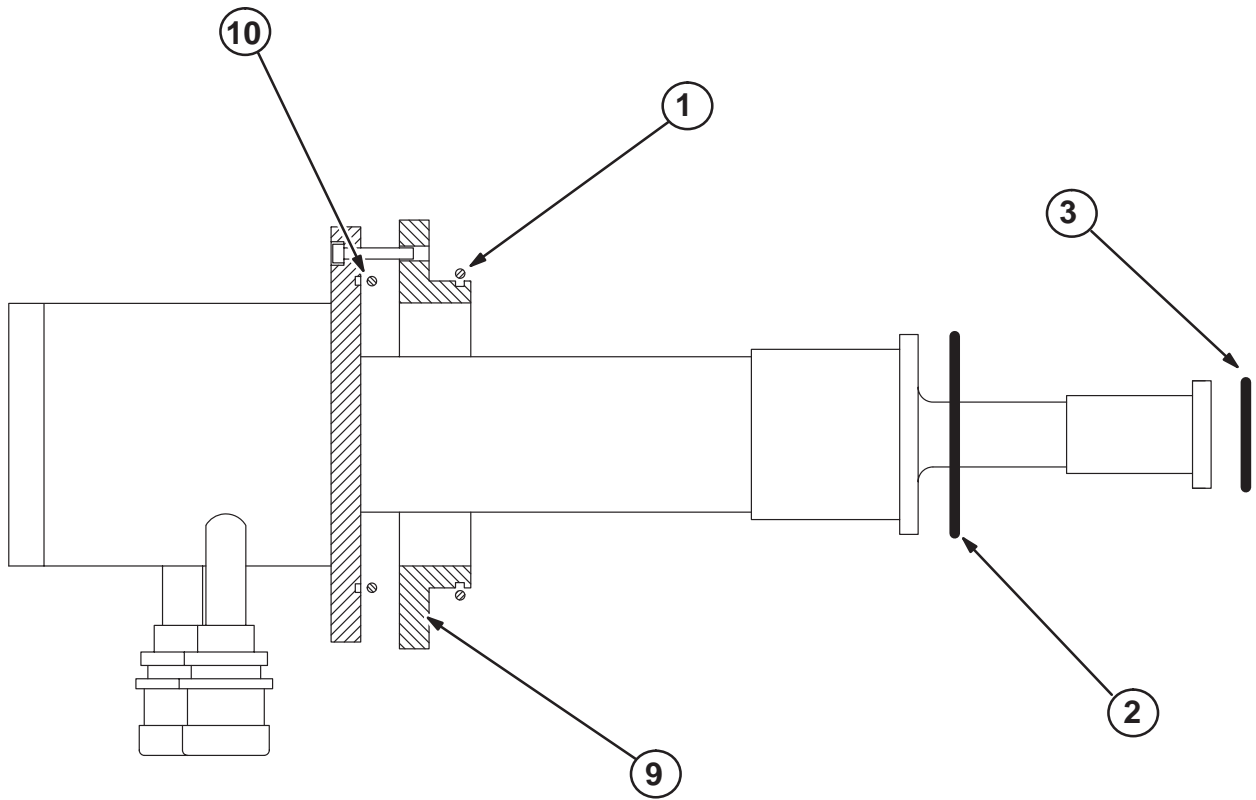
3-6 HELIUM VENT KIT 46-318057G1

Item	Part Number	FRU	Name	Quantity	Description
1	46-318051G1	2	PIPE	1	8" O.D. VENT PIPE ASSEMBLY
2	46-281101P2	2	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	2	CONNECTOR	1	FIBERGLASS CONNECTOR SLEEVE 80.00" X 8.00"
5	46-281972P2	2	CLAMP	4	STN STL. HOSE CLAMP
6	46-318057P1	2	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	2	SCREW	8	.375-16 X 1.75 LG. BRASS, HEX HD. CAP SCREW



**3-7 SHIELD COOLER COLD HEAD ASSEMBLY COMPONENT ( SLEEVE MOUNT )  
LEYBOLD ( 2100832 )**

Item	Part Number	FRU	Name	Quantity	Description
1	46-281247P1	1	O-RING	1	BUNA, 4.987 I.D. X .103 THICK
2	46-281241P1	1	GASKET	2	INDIUM GASKET, 3.37 O.D.
3	46-281241P2	1	GASKET	2	INDIUM GASKET, 1.75 O.D.
4	46-281387P1	1	WASHER	48	.25 I.D. BELLEVILLE WASHER, STN. STL.
5	46-294151P7	N	COMPOUND	1	ANTI-SIEZE COMPOUND, 4 OZ. CAN
6	46-252065P24	N	GREASE	1	VACUUM GREASE
7	46-252065P64	N	GLOVES	1	COTTON, ONE PAIR
8	46-260932P20	2	PLUG	1	VACUUM PORT PLUG ( ON COLD HEAD SLEEVE )
9	46-260938P1	2	FLANGE	1	TRANSITION FLANGE
10	46-281247P2	1	O-RING	1	BUNA, 5.237 I.D. X .103 THICK



3-8 RAMP CABLE KIT 46-318036G1, G2

SIGNA RAMPING CABLE KIT

Item	Part Number	FRU	Name	Quantity	Description ( Remarks )
1	46-260723G1	1	CABLE	2	MAIN POWER CABLE, POSITIVE 4/0
2	46-260723G2	1	CABLE	2	MAIN POWER CABLE, NEGATIVE 4/0
3	46-260724G1	1	CABLE	1*	SWITCH HEATER CABLE ASSEMBLY
4	46-260726G1	1	CABLE	1	SHIM COIL CABLE ASSEMBLY
5	46-281235P1	1	LEAD	1	VOLTAGE SENSE LEAD X 40' LONG
6	46-294104P1	1	NUT	2	QUICK COUPLING VACUUM NUT
7	46-294105P1	1	RING	2	QUICK COUPLING RETAINING RING

\* 46-318036G2 CONTAINS 2 OF THIS ITEM

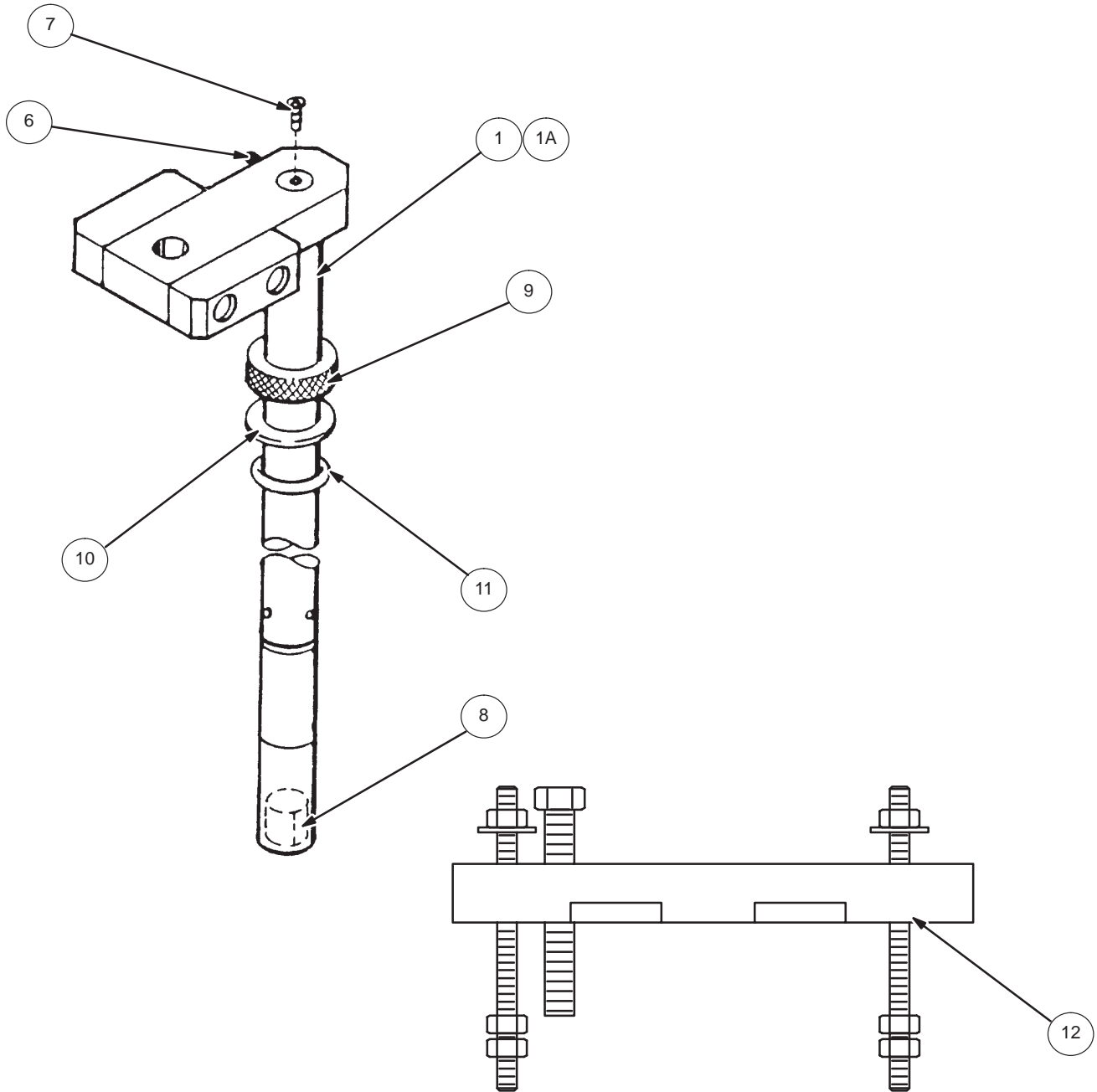


### SECTION 4 – SERVICE TOOL KITS / COMPONENTS

**Note**

The Service Tools Section contains tools used on different GE magnets. Please refer to Magnet Tool Matrix, Section 4-28, to determine which tools are used for each magnet type.

#### 4-1 MAGNET RAMPING EQUIPMENT KIT 46-260703G2



**4-1 MAGNET RAMPING EQUIPMENT KIT 46-260703G2**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-260817G3	SII, SIII, & MAX MAIN LEADS	2	VAPOR COOLED MAIN LEAD EXTENSIONS
1A	46-294204G1	SIV AS MAIN LEADS	2	VAPOR COOLED MAIN LEAD EXTENSIONS
2	46-252366P4	CAP SCREW	3	3/8-16 X 1.00 CAP SCREW
3	46-252320P19	NUT	6	3/8-16 BRASS NUT
4	46-252322P8	WASHER	12	3/8 BRASS WASHER
5	46-281046P35	CAP SCREW	3	3/8-16 X 1.250 BRASS CAP SCREW
6	46-252351P2	#10 SCREW	4	BRASS SCREW RD HD #10-24 X .500
7	46-252351P51	#10 SCREW	4	BRASS SCREW RD HD #10-32 X .438
8	46-281256P1	CONTACT BAND	20	CONTACT BANDS FOR MAIN LEAD EXTENSIONS
9	46-294104P1	RETAINING NUT	4	KNURLED BRASS RETAINING NUT
10	46-294105P1	RETAINING RING	4	S/S RETAINING RING
11	46-260389P1	"O" RING	8	SILICON "O" RING
12	46-323015G1	RAMPING FIXTURE	1	HOLD DOWN TOOL FOR RAMP LEADS
13	46-294236G1	CASE/FOAM	1	CASE FOR RAMPING ITEMS

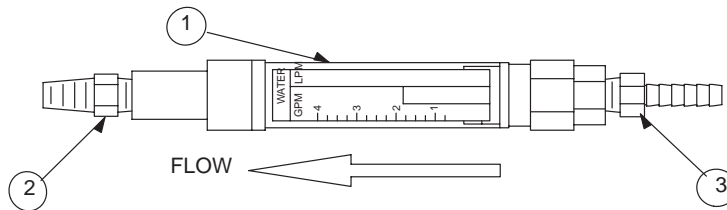
**4-2 POWER SUPPLIES**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-260776G3	MAIN P/S	1	MAIN COIL POWER SUPPLY
2	46-260777G3	SHIM P/S	1	SHIMMING POWER SUPPLY

**4-3 RAMP CABLE / CART ASSEMBLY 46-318833G1**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-318833G1	RAMP ASSEMBLY	1	RAMP CABLE / CART ASSEMBLY

**4-4 WATER FLOW METER KIT 46-294052G1**



Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-294052P1	FLOW METER	1	INLINE FLOW METER
2	46-294052P2	HEX NIPPLE	1	BRASS, .50 NPT X .50 NPT
3	46-294052P3	HOSE CONNECTOR	1	BRASS, .50 NPT X .50 I.D. HOSE

**4-5 RAMPING SUPPLY AND EQUIPMENT 46-294998G1**

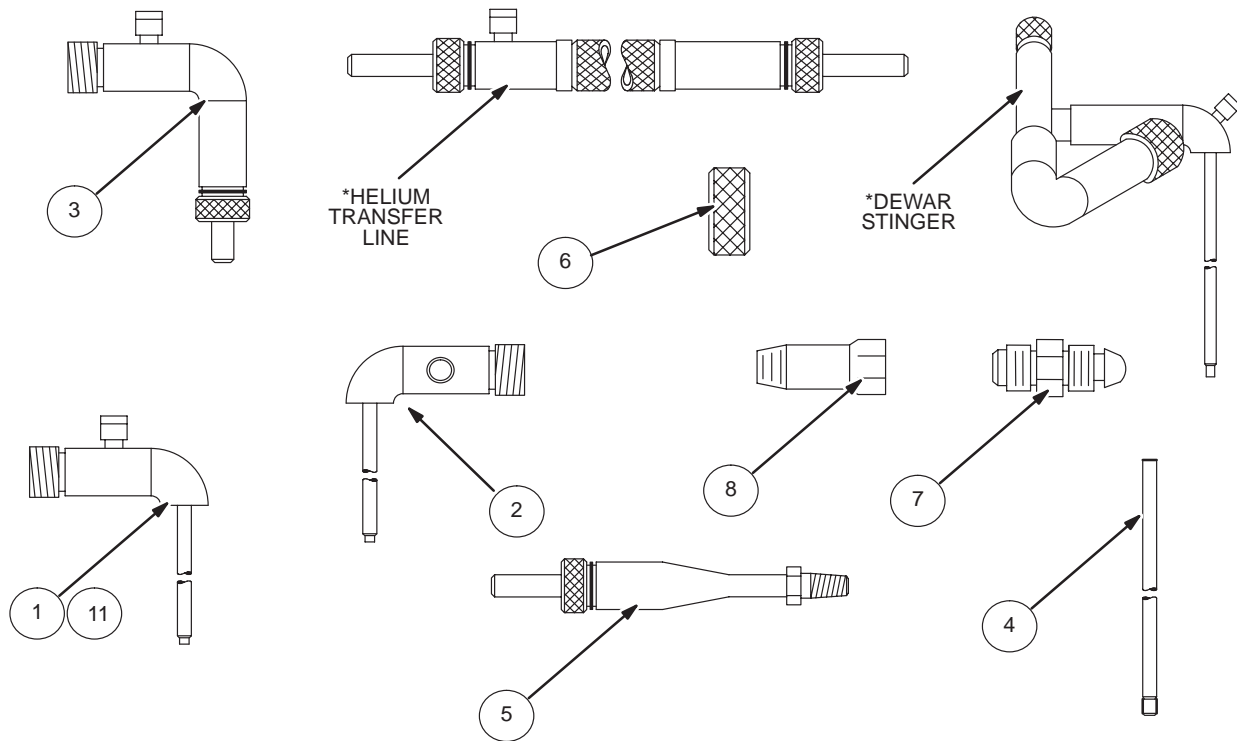
Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-260703G2	RAMP EQUIPMENT	1	MAIN FIELD RAMPING
2	46-260776G3	MAIN P/S	1	MAIN COIL POWER SUPPLY

**4-6 SERVICE POWER SUPPLY RENEWAL PARTS 46-260776G3 & 46-260777G3**  
**\* ( VENDOR RENEWAL PARTS CROSS REFERENCE )**

Item	Vendor Part Number	Description ( Remarks )	GE Part Number
1	12-452-028	PANEL, CONTROL ASSEMBLY	46-281468P1
2	12-452-026	HEATER, P/S, HEATER & 24 VDC PS	46-281468P2
3	25-611-000	PANEL, INPUT/OUTPUT CONNECT	46-281468P3
4	00-467-498	TCR 7.5T750, MAIN COIL PS	46-281468P4
5	51-001-001	FAN, 3.12", 115V	46-260219P12
6	58-005-010	FUSE, MDA, 4A, 250V	46-281468P5
7	20-292-002	PWB, PRINTED CIRCUIT ASSY	46-281468P6
8	20-230-000	PWB, +24 & ±15 PS ASSY	46-281468P7
9	71-024-000	DIAL TURNS COUNTING	46-260219P27
10	66-065-006	VOLTMETER, ANALOG, 0-36 VDC	46-281468P8
11	62-062-009	AMMETER, ANALOG, 0-1 ADC	46-281468P9
12	66-082-007	VOLTMETER, DIGITAL 3.5 DIGIT	46-281468P10
13	66-082-008	AMMETER, DIGITAL 5.5 DIGIT	46-281468P11
14	67-055-007	POT, 10 TURN, 5K, WW	46-281468P12
15	68-012-005	SWITCH, PUSH BUTTON, MOM, WHT	46-260219P33
16	68-004-001	SWITCH, DPDT TOGGLE	46-281468P13
17	68-008-003	SWITCH, DPDT, LOCKING TOGGLE	46-281468P14
18	20-354-000	PWP, PCB P-SET AMPLIFIER	46-281468P15
19	58-006-010	FUSE, MDV, 0.125A, 250V	46-281468P16
20	58-001-008	FUSE, AGC, 2A, 250V	46-281468P17
21	20-137-087	PCB, A100, CONTROL	46-281468P18
22	54-072-002	CAPACITOR, 350 KMF/10V	46-281468P19
23	61-011-001	SCR, DUAL PACK	46-281468P20
24	56-069-004	BREAKER, 3 POLE, 30A	46-281468P21
25	51-002-002	FAN, 468" SQ, 220V	46-260219P2
26	67-023-005	RESISTOR, 3 OHM, 25W	46-281468P22
27	63-004-001	INDICATOR, LED, RED 46-281468P23	
28	51-009-001	FAN, BISCUIT	46-281468P24
29	51-002-001	FAN, 4.68 SW. 115V	46-260219P20
30	56-001-002	BREAKER, 3 POLE, 30A	46-281468P25
31	12-452-027	PANEL, CONTROL ASSEMBLY	46-281469P1
32	58-005-013	FUSE, MDA, 6.25A, 250A	46-281469P2
33	12-452-025	SUPPLY SWITCH HEATER & INTERNAL POWER	46-281469P3
34	25-612-000	PANEL, INPUT/OUTPUT	46-281469P4
35	00-452-084	MODULE, SHIM P/S #1 THRU #6	46-281469P5
36	58-005-006	FUSE, MDA, 1A, 250V	46-281469P11
37	60-010-001	DIODE, DUAL PAK, 600V, 15A	46-281469P12
38	20-292-001	PWB, A700, PCB ASSY	46-281469P13
39	65-047-001	RELAY, DPDT, 24VDC	46-281469P14
40	66-082-012	VOLTMETER, DIGITAL, 4 1/2 DIGIT	46-281469P15
41	66-082-011	AMMETER, DIGITAL, 4 3/4 DIGIT	46-281469P16
42	68-037-007	SWITCH, *8PL, 6STN, SELECT	46-281469P17
43	67-055-011	POT, 2000 OHM, 10 TURN	46-281469P18
44	65-024-007	RELAY, 4PDT, 25A	46-281469P19
45	68-008-001	T'STAT N/O 195 DEGREES F	46-281469P20
46	62-005-020	TRANSISTOR, 2N5685	46-281469P21
47	62-005-014	TRANSISTOR, MJ2955	46-281469P22
48	68-002-002	T'STAT N/C, 210 DEGREES F	46-281469P23
49	20-350-001	PWB, A100 ASSY	46-281469P24
50	67-055-005	POT, 20K, 10 TURN, 2W	46-281469P25

\* VENDOR PARTS SHOWN IN VENDOR SERVICE MANUAL

4-7 UNIVERSAL FILL LINE KIT 46-294705G1

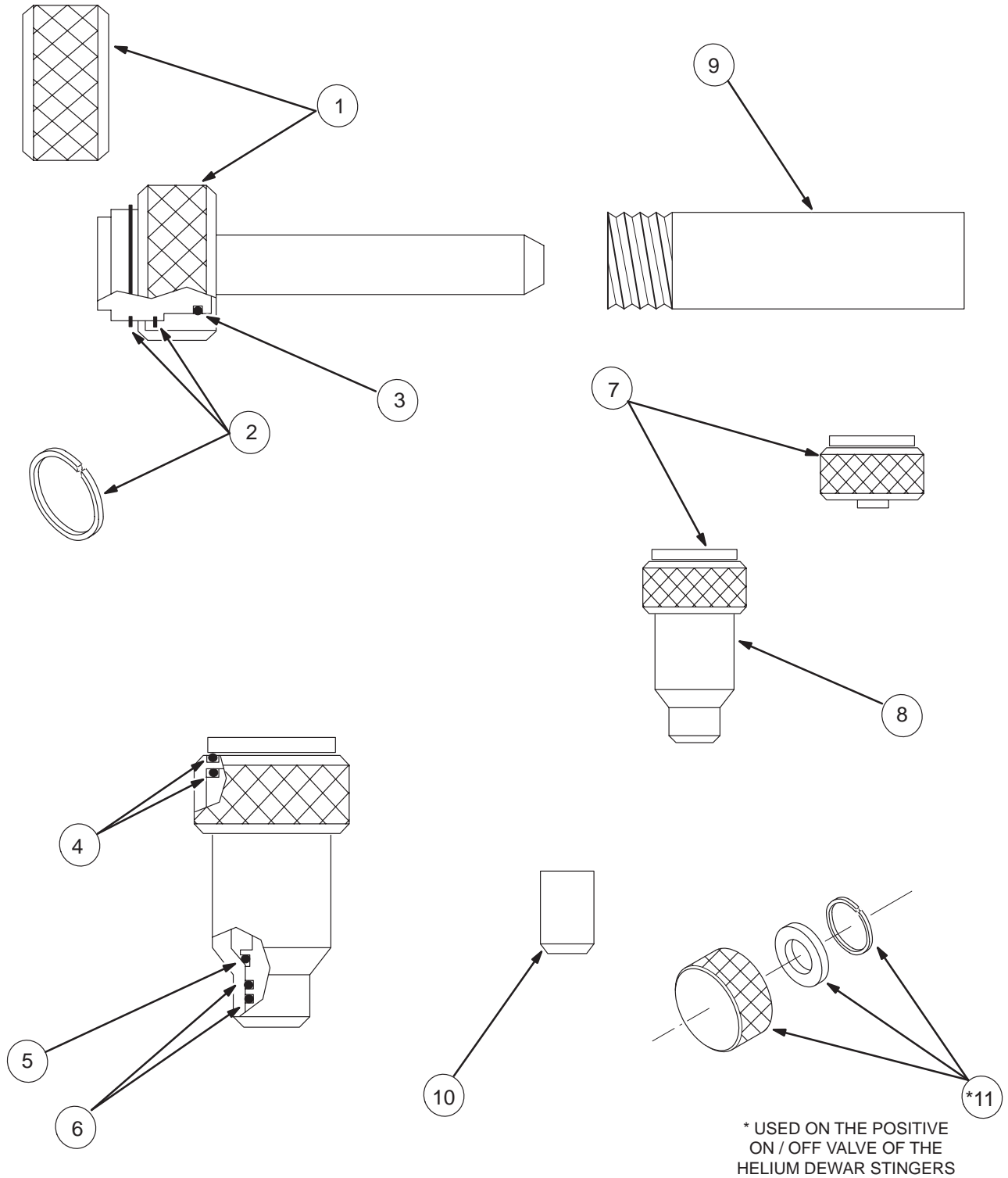


\* ITEMS ARE NOT INCLUDED IN UNIVERSAL FILL LINE KIT

4-7 UNIVERSAL FILL LINE KIT 46-294705G1

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-294512P3	7" STINGER	1	7" CRYOSTAT STINGER AIR PRODUCTS# CSA-7
2	46-294512P4	14.75" STINGER	1	14.75 CRYOSTAT STINGER AIR PRODUCTS #CSA-14
3	46-294512P5	3" MALE BAYONET	1	.50" X 300" MALE BAYONET AIR PRODUCTS #MBR-6-3
4	46-294512P12	16" STINGER EXT. TIP	1	16" CRYOSTAT STINGER AIR PRODUCTS #CSE-16
5	46-294512P13	ADAPTER	1	PURGE/PRECOOL ADAPTER AIR PRODUCTS #PPA-1
6	46-294512P15	BLANKING CAP	1	BRASS BLANKING CAP 1.5" OD AIR PRODUCTS #BBC-1.5
7	46-294512P16	NITROGEN ADAPTER	1	NITROGEN FILL LINE ADPTR AIR PRODUCTS #FLA-1
8	46-294512P17	HELIUM ADAPTER	1	HELIUM FILL LINE ADPTR AIR PRODUCTS #GLA-1
9	46-294512P14	CASE/FOAM	1	BLACK CARRYING CASE AIRPRODUCTS #PCC-27
10	46-294512P25	17" STINGER	1	17" MAGNET STINGER AIR PRODUCTS #CSE-17

4-8 HELIUM TRANSFER LINE KIT RENEWAL PARTS



\* USED ON THE POSITIVE ON / OFF VALVE OF THE HELIUM DEWAR STINGERS

**4-8 HELIUM TRANSFER LINE KIT RENEWAL PARTS**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-294512P6	COUPLING NUT	1	MALE BAYONET COUPLING NUT AP#BCN-1
2	46-294512P7	RETAINER RING	1	MALE BAYONET NUT RETAINER RING AP#BRR-1
3	46-294512P8	O-RING	1	MALE BAYONET O-RING AP#BOR-1
4	46-294512P9	O-RING	2	VAC PORT AND RELIEF VALVE O-RING AP#VPOR-1
5	46-294512P10	O-RING	1	VAC PORT AND RELIEF VALVE O-RING AP#VPOR-2
6	46-294512P11	O-RING	2	VAC PORT AND RELIEF VALVE O-RING AP#VPOR-3
7	46-294512P18	CAP	1	VAC PORT CAP AP#VPC-1
8	46-294512P19	VALVE	1	VAC PORT VALVE AP#VPV-1
9	46-294512P20	PROTECTOR	1	BAYONET PROTECTOR AP#BP-PVC
10	46-294512P21	TEFLON TIP	1	TEFLON TIP AP#STT-1
11	46-294512P22	VALVE STEM REP	1	VALVE STEM AP#VSC-K

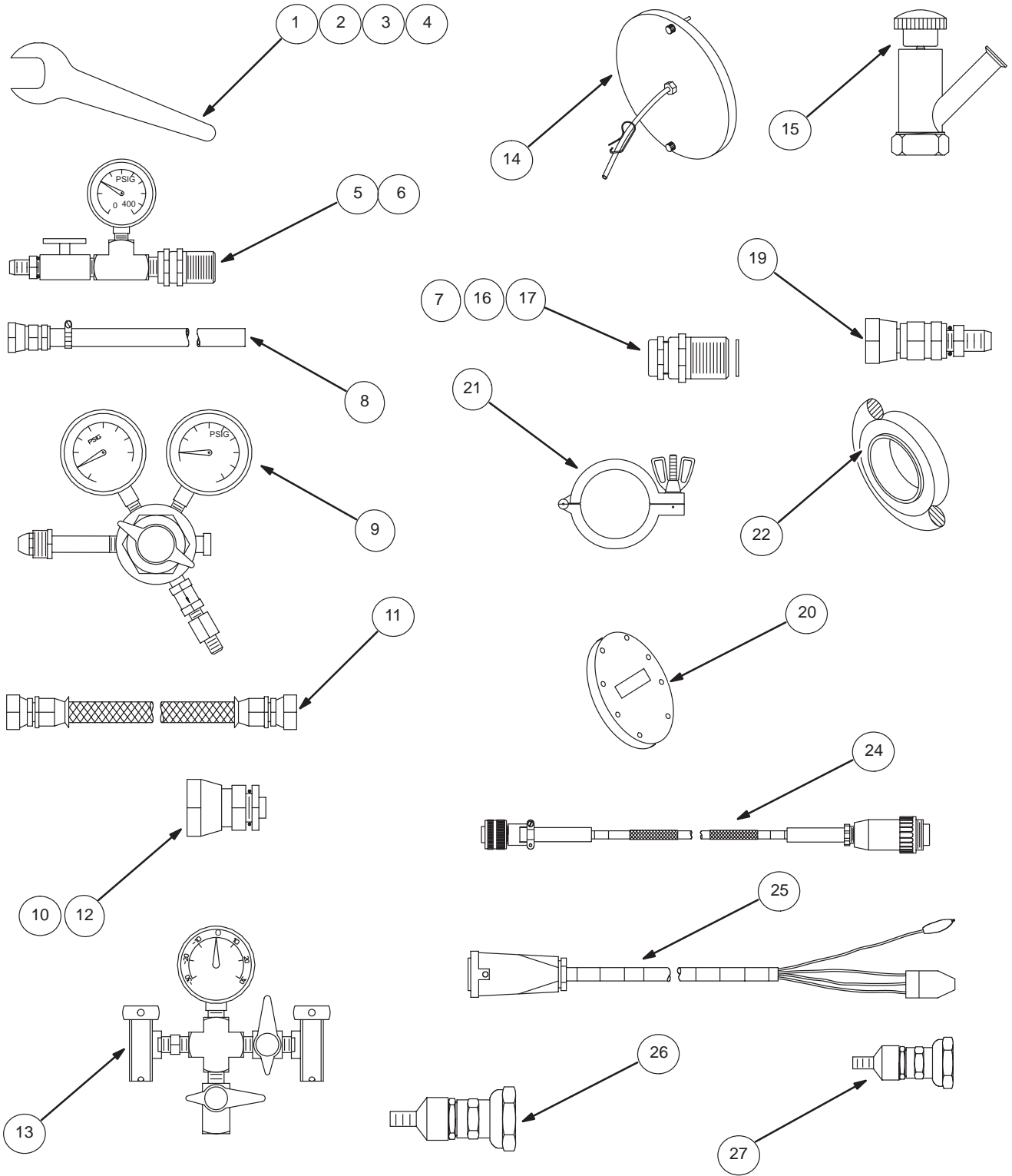
**4-9 DEWAR STINGERS, HELIUM AND NITROGEN TRANSFER LINES**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-294511P1	DEWAR STINGER	1	250 LITER DEWAR STINGER AIR PRODUCTS #DSA-59
2	46-294511P2	DEWAR STINGER	1	500 LITER DEWAR STINGER AIR PRODUCTS #DSA-64
3	46-294512P1	TRANSFER LINE	1	12' HELIUM TRANSFER LINE AIR PRODUCTS #FS-12-2B6
4	46-294512P2	TRANSFER LINE	1	8' HELIUM TRANSFER LINE AIR PRODUCTS #FS-8-2B6
5	46-252805P2	TRANSFER LINE	1	10' NITROGEN TRANSFER LINE
6	46-252805P3	TRANSFER LINE	1	15' NITROGEN TRANSFER LINE
7	46-271135P1	FLEX HOSE	1	FLEX HOSE WITH NPT FITTINGS FOR HE BOTTLE

**4-10 OTHER HELIUM TRANSFER SERVICE ITEMS**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-271137G1	SAFETY KIT	1	SAFETY FACE SHIELD KIT AIR PROD. #295-A-MRK500
2	46-265286G1	HEL. RES. BOX	1	GE MAGNET HELIUM RES BOX
3	46-306734G1	REGULATOR KIT	1	HELIUM HIGH PRESS. REG.AND HOSE KIT
4	46-258150P1	HELIUM CART	1	NON-MAGNETIC CYLINDER CART

4-11 COLD HEAD / COMPRESSOR INSTALLATION / MAINTENANCE KIT 46-281088G3



**4-11 COLD HEAD/COMPRESSOR INSTALLATION / MAINTENANCE KIT 46-281088G3**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-294150P14	WRENCH	1	1 3/16" OPEN END WRENCH, LEYBOLD #722-81-019
2	46-294150P13	WRENCH	1	1" OPEN END WRENCH, LEYBOLD #722-81-018
3	46-294150P15	WRENCH	1	1 3/8" OPEN END WRENCH, LEYBOLD #722-81-020
4	46-294150P16	WRENCH	2	1 5/8" OPEN END WRENCH, LEYBOLD #722-81-021
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	COUPLING WITH TUBE ADPT.
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	COUPLING WITH TUBE ADPT.
11	46-294002P1	LINE ADAPTER	1	LINE ADAPTER HOSE
12	46-294006G1	DISCHARGE TOOL	1	#12 DISCHARGE FITTING
13	46-294007G1	BACKFILL PMPDWN	1	COLD HEAD CHANGE 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	46-281989G1	COVER	1	COLDHEAD PORT COVER
21	46-294026P1	KF 16 CLAMP	1	KF 16 CLAMP
22	46-294030G1	CENTERING RING	1	O-RING CENTERING RING
23	46-294939G50	CASE / FOAM ASM.	1	CARRYING CASE FOR TOOLS
24	46-318911P1	POWER CABLE	1	BALZERS CLDHD TO COMP.
25	46-318910P1	POWER CABLE	1	LEYBOLD CLDHD TO COMP.
26	2100316	LARGE ADAPTER	1	AEROQUIP FIT. TO HE LINE
27	2100317	SMALL ADAPTER	1	AEROQUIP FIT. TO HE LINE
28	2102476DDW	INSTRUCTIONS	1	CLD. HD. / COMP. INSTALL. / MAINT. KIT
29	2102181	TOOL KIT LABEL	1	CLD. HD. / COMP. INSTALL. / MAINT. KIT

**4-12 EXTRA EQUIPMENT NEEDED TO SERVICE COLD HEAD AND COMPRESSOR**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-306734G1	HELIUM TANK	1	REGULATOR KIT REGULATOR AND HOSE
2	46-294047G1	VACUUM PUMP KIT	1	SHIELD COOLER

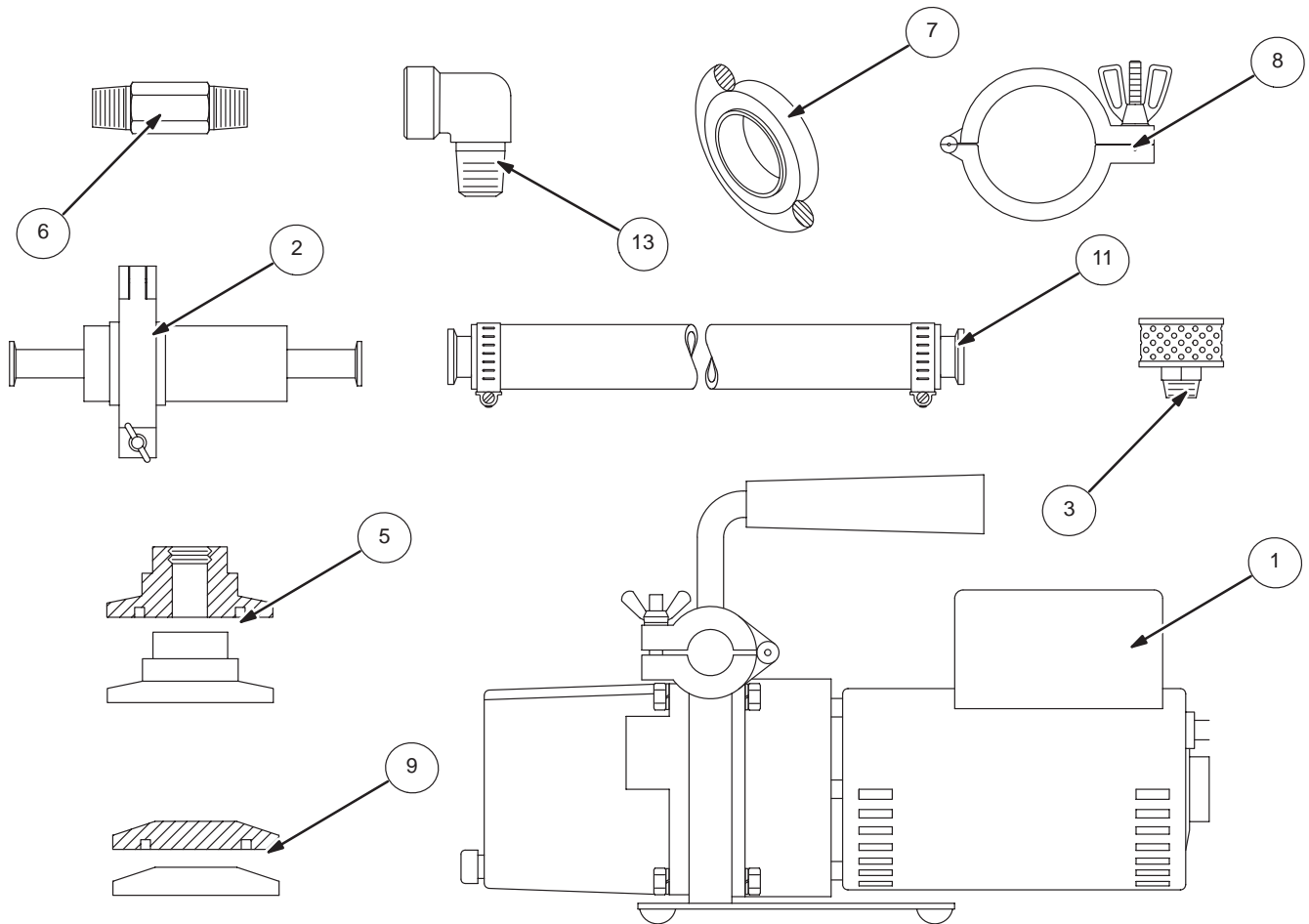
**4-13 LAKESHORE 208 THERMOMETER KIT 46-301477G1**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-301453P6	CASE	1	14 X 103/4 X 53/4
2	46-301618P1	INSERT, FOAM	1	TOP - CONVOLUTING FOAM
3	46-301618P2	NSERT, FOAM	1	BOTTOM - 2 LAYERS
4	46-301478P1	THERMOMETER	1	LAKESHORE MODEL 208
5	46-301619P1	CABLE, DIODES	1	INTERCONNECT TO DIODES
6	46-301620P1	CABLE, MAGNET	1	INTERFACE TO GE MAGNET
7	46-301621P1	LABEL	1	"GE MEDICAL SYSTEMS LAKESHORE THERMOMETER AND INTERFACE CABLE 46-301477G1"

**4-14 LOW COST SHIELD TEMPERATURE DIODE BOX 46-317543G1**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-317537P1	METER	1	CURRENT SOURCE METER
2	46-317537P2	CABLE	1	METER CABLE
3	46-317537P3	CASE	1	CARRYING CASE

4-15 SHIELD COOLER VACUUM PUMP KIT 46-294047G1



4-15 SHIELD COOLER VACUUM PUMP KIT 46-294047G1

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-294041P1	VAC. PUMP	1	SARGENT-WELCH PUMP
2	46-294041P3	OIL TRAP(INLET)	1	INLET FORELINE TRAP
3	46-294041P2	EXHAUST FILTER	1	EXHAUST FILTER
4	46-294041P4	CARTRIDGE FOR OIL	1	TRAP REPLACEMENT TRAP
5	46-294027P1	INLET ADAPTER	1	KF16 TO .25 NPT ADAPTER
6	46-294029P1	NIPPLE	1	2"NIPPLE
7	46-294030G1	CENTERING RING	1	CENTER AND O RING

**4-15 SHIELD COOLER VACUUM PUMP KIT 46-294047G1 ( continued )**

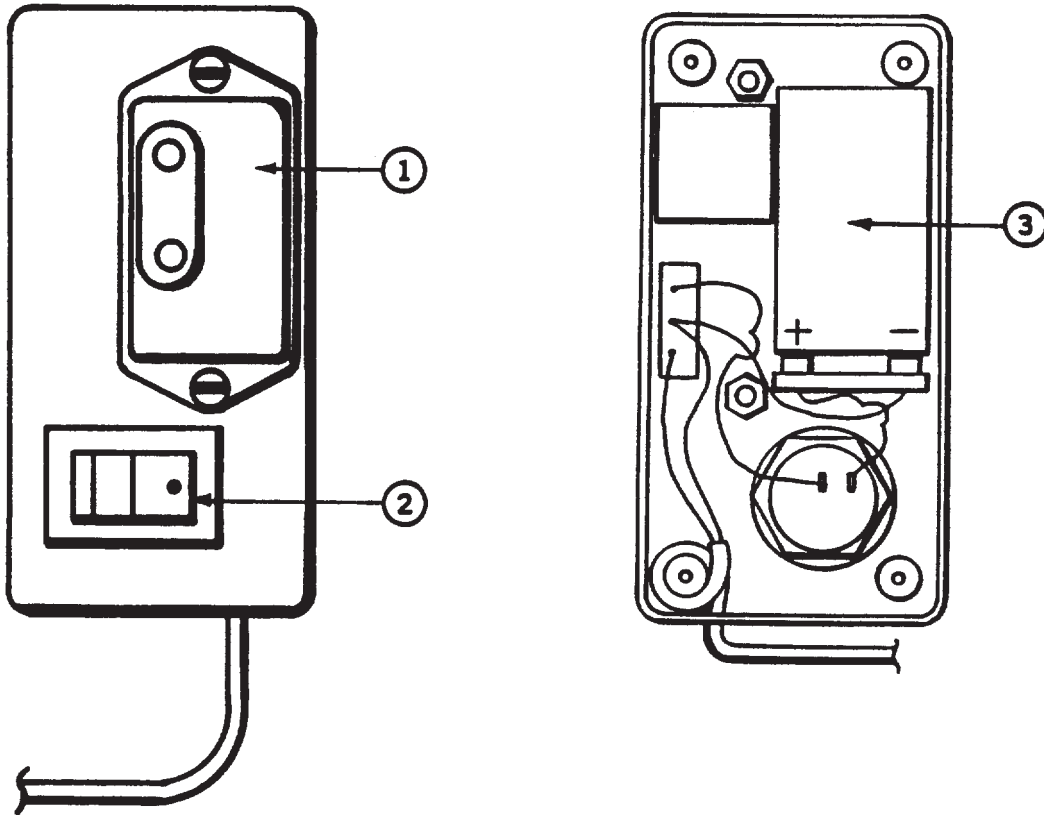
<b>Item</b>	<b>Part Number</b>	<b>Name</b>	<b>Quantity</b>	<b>Description ( Remarks )</b>
8	46-294026P1	KF 16 CLAMP	1	KF 16 HOSE CLAMP
9	46-294028P1	BLANK KF FLANGE	1	KF 16 BLANKING FLANGE
10	46-294041P5	OIL FOR VAC PUMP	1	ONE QUART OIL
11	46-294040G1	HOSE FOR PUMP	1	HOSE AND KF 16 ADAPTERS
12	46-294837G50	CASE AND FOAM		
13	46-252557P2	90 ELBOW		
* 14	46-XXXXXXX	CAP FOR EXHAUST		

\*Parts in development

**4-16 VACUUM MAINTENANCE EQUIPMENT**

<b>Item</b>	<b>Part Number</b>	<b>Name</b>	<b>Quantity</b>	<b>Description ( Remarks )</b>
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

4-17 TAO MONITOR 46-281406G1

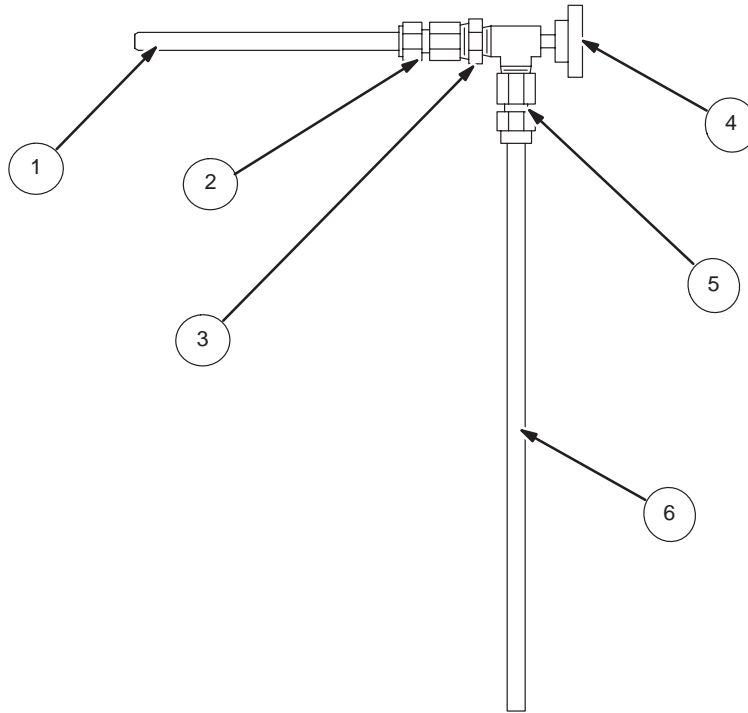


4-17 TAO MONITOR 46-281406G1

Item	Part Number	Name	Quantity	Description ( Remarks )
* 1	46-281406P2	TRANSDUCER	1	TRANSDUCER, LOW PRESSURE DIFFERENTIAL TYPE, RANGE 0-27.68 INCHES H2O 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.

4-18 FILL LINE ADAPTER FOR TAO MONITORING 46-281232G1

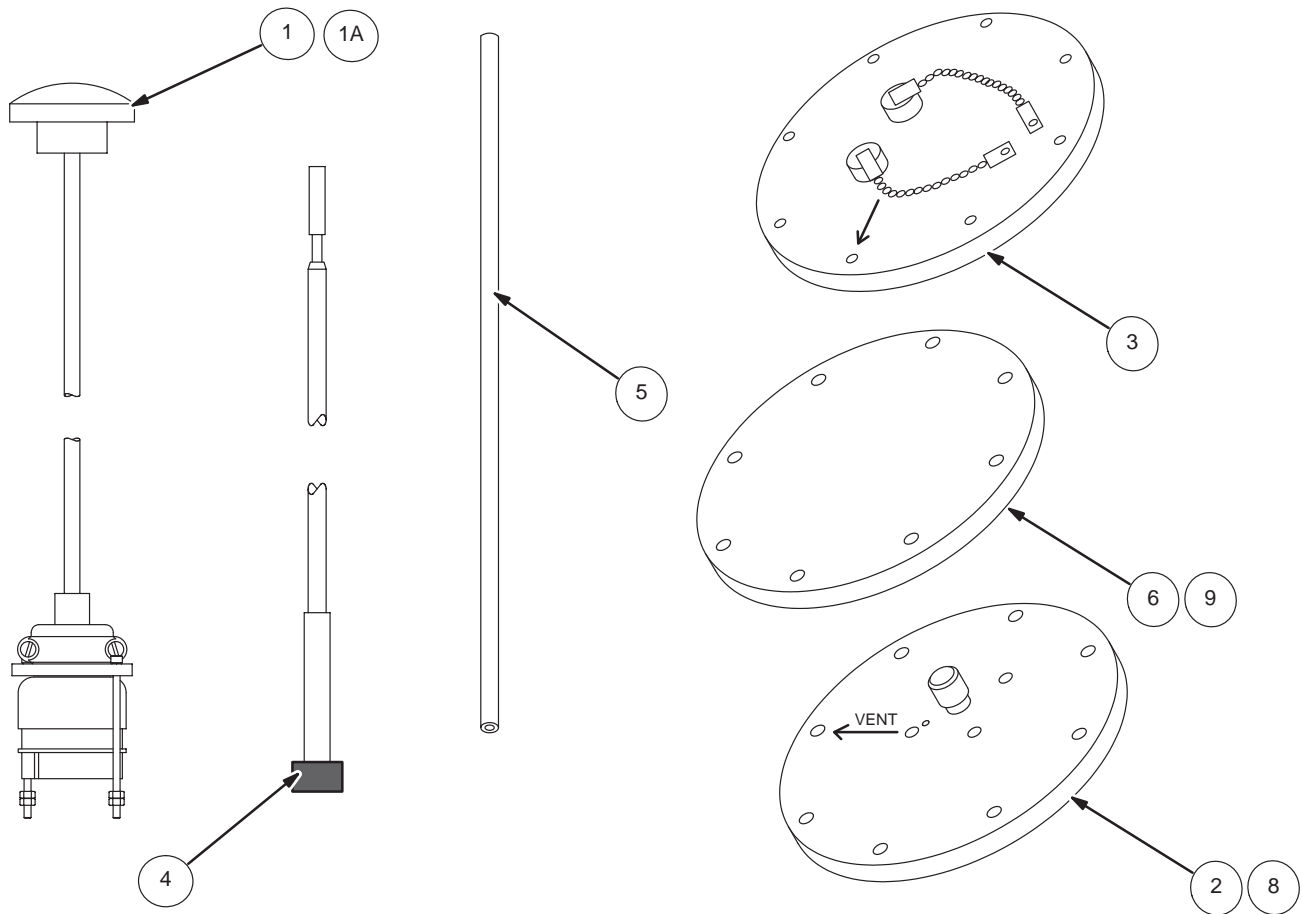


4-18 FILL LINE ADAPTER FOR TAO MONITORING 46-281232G1

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-281232P1	TUBE	1	STN. STL. TUBING .5 OD X .049 WALL THICK
2	46-260912P1	CONNECTOR	1	1/2 OD X 1.5 NPT BRASS FEMALE CONNECTOR
3	46-252204P3	BUSHING	1	2" - 1" NPT BRASS REDUCTION BUSHING
4	46-281109P1	VALVE	1	ANGLE - FILL LINE DAMPENER VALVE
5	46-281169P1	CONNECTOR	1	.25 ODT X .25 NPT BRASS FEMALE CONNECTOR
6	46-252065P45	TUBING	1	TUBING POLYETHYLENE, 1/4 OD X .040 WALL, IMPERIAL CAT. # 44-P NATURAL

\*\* AVAILABLE AS AN ASSEMBLY ONLY

4-19 SAV-CON AND INSTRUMENTATION LEAD INSTALLATION / REMOVAL KIT 46-294872G2

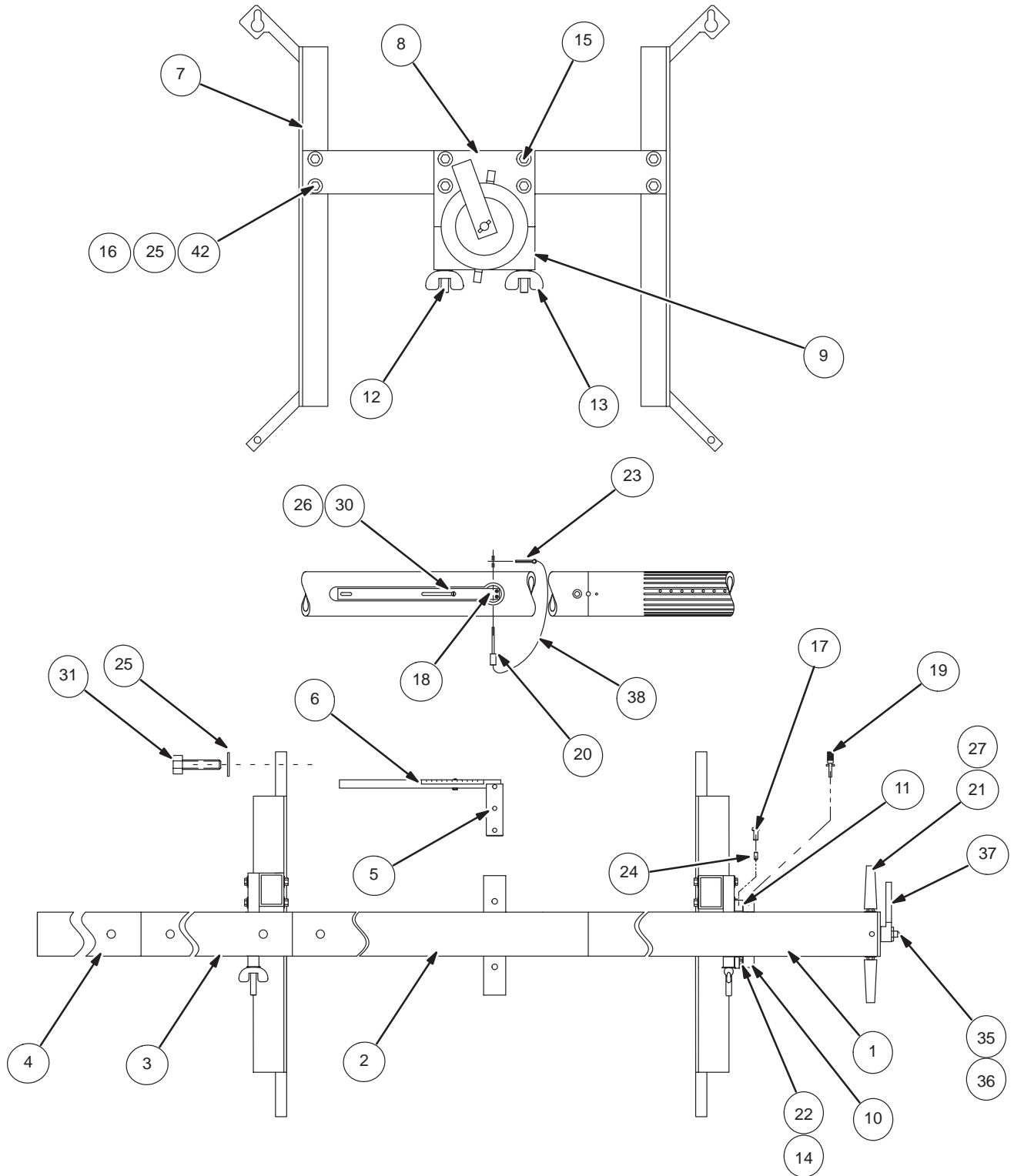


4-19 SAV-CON AND INSTRUMENTATION LEAD INSTALLATION / REMOVAL KIT 46-294872G2

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-294310G1	SAV CON TOOL	1	SAV CON INSTALLATION/REMOVAL TOOL
1A	46-294310G2	SAV CON TOOL	1	SAV CON INSTALLATION/REMOVAL TOOL
2	46-294306G1	LEXAN PLATE	1	CLEAR PLATE TO GUIDE TOOLS (SIV)
3	46-294765G1	LEXAN PLATE	1	PLATE FOR PURGING VERT. PEN. WITH HE GAS (SIV)
4	46-294292G1	EXTENDED ALLEN	1	TOOL TO REMOVE ALLEN HEAD SCREWS IN SAV CON
5	46-281934P1	TAPPED G-10 ROD	1	INSTR. LEAD REMOVAL TOOL
6	46-318561P1	TURRET COVER	1	VERT. PENETRATION COVER-SIV
7	46-318612G50	CASE/FOAM	1	CASE AND FOAM ASSEMBLY
8	46-318241G1	LEXAN PLATE	1	PLATE TO GUIDE TOOLS *
9	46-260963P2	LEXAN PLATE	1	LEXAN TURRET COVER *

\* MAX AND SIGNA III ONLY

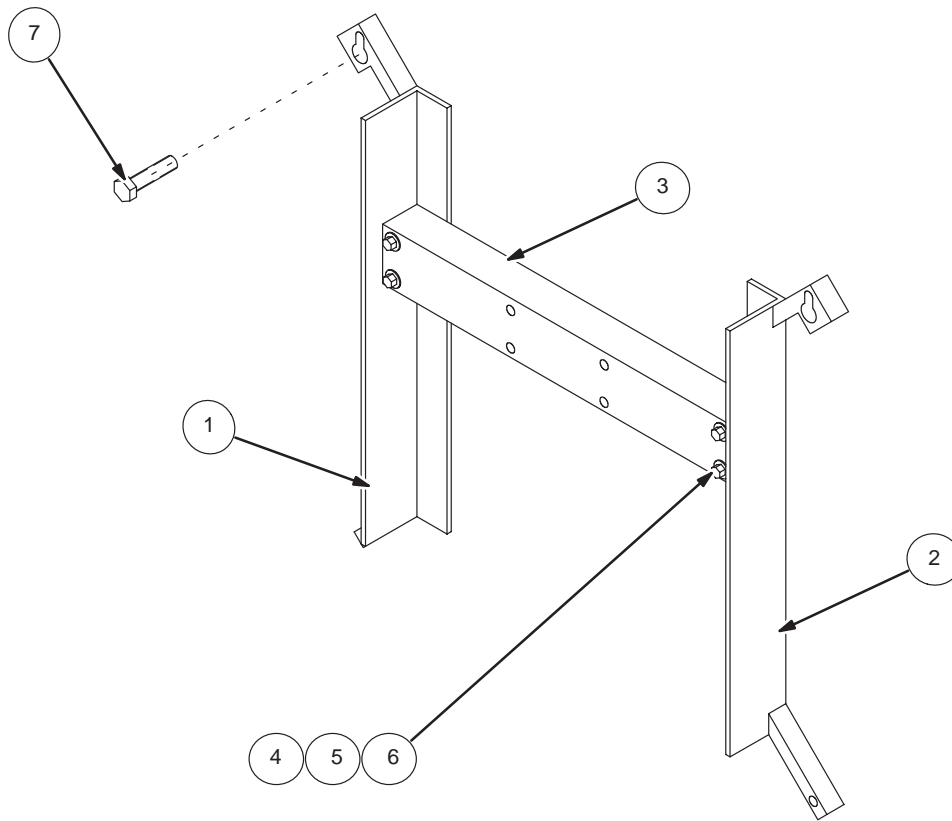
4-20 SERVICE TOOL MAPPING FIXTURE 46-294060G2



4-20 SERVICE TOOL MAPPING FIXTURE 46-294060G2

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-294054G1	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	46-294137G1	RADIAL SLIDER	1	RADIAL SLIDER
6	46-281418P1	MAGT. SUPPORT	1	MAGNETOMETER SUPPORT
7	46-294553G1	H-FRAME ASSM.	2	H-FRAME ASSEMBLY
8	46-281408P1	BEARING	2	TOP HALF BEARING
9	46-281437P1	BEARING	2	BOTTOM HALF BEARING
10	46-294056P1	AXIAL POS. RING	1	AXIAL POSITIONING RING
11	46-281330P1	PLUNGER RING	1	PLUNGER RING
12	46-252188P5	BRASS ROD	4	6IN BRASS THREADED ROD
13	46-281435P7	WING NUT	5	.5-13 WING NUT
14	46-252322P10	BRASS WASHER	5	BRASS WASHER
15	46-281046P71	CAP SCREW	10	3/8-16 X3.5 BOLT
16	46-252320P19	BRASS NUT	12	3/8-16 BRASS NUT
17	46-281046P31	CAP SCREW	1	3/8-16 X .74 BRASS SCREW
18	46-252338P9	#6 SCREW	3	6-32 X .812 LONG FLAT HEAD
19	46-294058G1	PIN	2	PIN
20	46-281334P2	RADIAL PIN	1	RADIAL POSITIONING PIN
21	46-294167P1	HANDLE	2	TUBE HANDLE
22	46-281046P36	CAP SCREW	6	3/8-16 CAP SCREW
23	46-260422P3	COTTER PIN	1	.078 DIA COTTER PIN
24	46-252065P57	BALL PLUNGER	1	STN ST BALL PLUNGER
25	46-252322P8	WASHER	30	WASHERS
26	46-252320P13	BRASS NUT	1	10-24 BRASS HEX NUT
27	46-252188P6	THREADED RODS	2	3/8-16 X 2 IN THREADED ROD
28	46-281464P1	CENTER LABEL	1	CENTER LINE LABEL
29	46-281465P1	SCALE LABEL	1	SCALE LABEL
30	46-252352P24	SCREW	1	10-24 X 2IN SCREW
31	46-281046P31	BRASS SCREW	10	3/8-16 X .75 BRASS SCREW
32	46-294019P1	BAR	2	TORQUING BARS
33	46-252065P65	NOALOX	1	8 OZ. BOTTLE NOALOX
34	46-294059P1	SPACER RINGS	5	.010 THICK NYLON RINGS
35	46-294057P1	THREADED ROD	1	.75 BRASS THREADED ROD
36	46-252322P12	BRASS WASHER	1	.750 BRASS WASHER
37	46-294072P1	BARNUT	1	.75-10 BARNUT
38	46-294167P2	STRETCH CORD	1	.042 DIA STRETCH CORD
39	46-294048G1	CRATE	1	CRATE
40	46-294059P2	SPACER	8	NYLON SPACER SHIM
41	46-294168P1	ASSEMBLY INST.	1	ASSEMBLY INSTRUCTIONS
42	46-281046P70	BRASS SCREW	2	3/8 X 2.75IN BRASS SCREW
43	46-252320P19	BRASS NUT	2	3/8-16 BRASS NUT
44	46-252322P8	WASHER	2	WASHER

4-21 MAPPING FIXTURE H-FRAME 46-294553G1



4-21 MAPPING FIXTURE H-FRAME 46-294553G1

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-294553P1	H-FRAME	1	LEFT MOUNTING BAR
2	46-294553P2	H-FRAME	1	RIGHT MOUNTING BAR
3	46-294553P3	H-FRAME	1	CROSS BAR
4	46-281046P70	BRASS SCREW	4	CROSS BAR SCREW 375 X 2.75 LG BRASS
5	46-252320P19	BRASS NUT	4	.375-16 BRASS NUT
6	46-252322P8	WASHER	8	WASHER
7	46-281046P37	BRASS SCREW	4	3/8-16 X 1.5LG BRASS SCREW

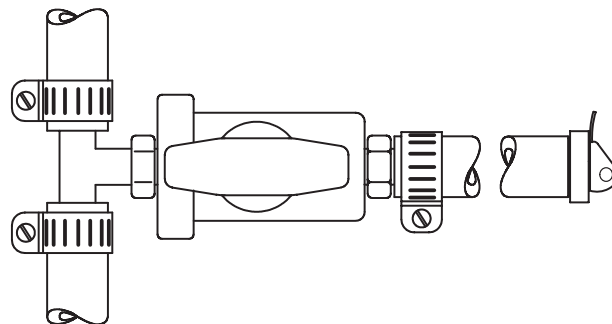
**4-22 SPECIALTY TOOLS FOR SPECIFIC MAGNET TYPES**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-281847G1	3" VALVE OPERATOR	1	ADD ON SHIELD EXTENDED 3" VALVE OPERATOR
2	46-281050P4	COLD HEAD TOOL	1	SECOND STAGE ASSEMBLY TOOL FOR WELDED IN COLD HEAD
3	46-281967G1	CENTERING KIT	1	ADD ON SHIELD CENTERING KIT
4	46-281935P1	LEXAN PLATE	1	LEXAN COVER FOR INSTRUMENTATION LEAD FOR COMPACT MAGNET
5	46-281936G1	LEXAN PLATE	1	LEXAN COVER FOR VERTICAL STACK OF COMPACT MAGNET
6	46-260705G1	SAV CON TOOLS	1	SAV CON TOOLS FOR SI MAGNET
7	46-260192P1	LEXAN PLATE	1	LEXAN COVER FOR P3 PLUG
8	46-252065P29	THREADED RODS	3	THREADED RODS FOR P3 PLUG REMOVAL
9	46-281432G1	TAO DAMPER KIT	1	TAO DAMPER KIT FOR SI MAGNET
10	46-294052G1	WATER FLOW KIT	1	WATER FLOW METER KIT

**4-23 MAGNET CENTERING / VERIFICATION KIT 46-281967G1**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-281962P1	SCALE	1	12" STAINLESS STEEL STARRET CAT. NO. 1604R-12
2	46-281965P1	RATCHET	1	1/2" DRIVE RATCHET MCMASTER CARR NO. 5523A23
3	46-281964P1	EXTENSION	1	5 1/2" EXTENSION MCMASTER CARR NO. 5523A28
4	46-281966P1	SOCKET	1	1 1/8" SOCKET MCMASTER CARR NO. 5545A65
5	46-281966P2	SOCKET	1	1 1/2" SOCKET MCMASTER CARR NO. 5545A94
6	46-294182G1	CASE	1	TOOL CASE WITH LABEL

**4-24 WATER TEE ASSEMBLY 46-318696G1**

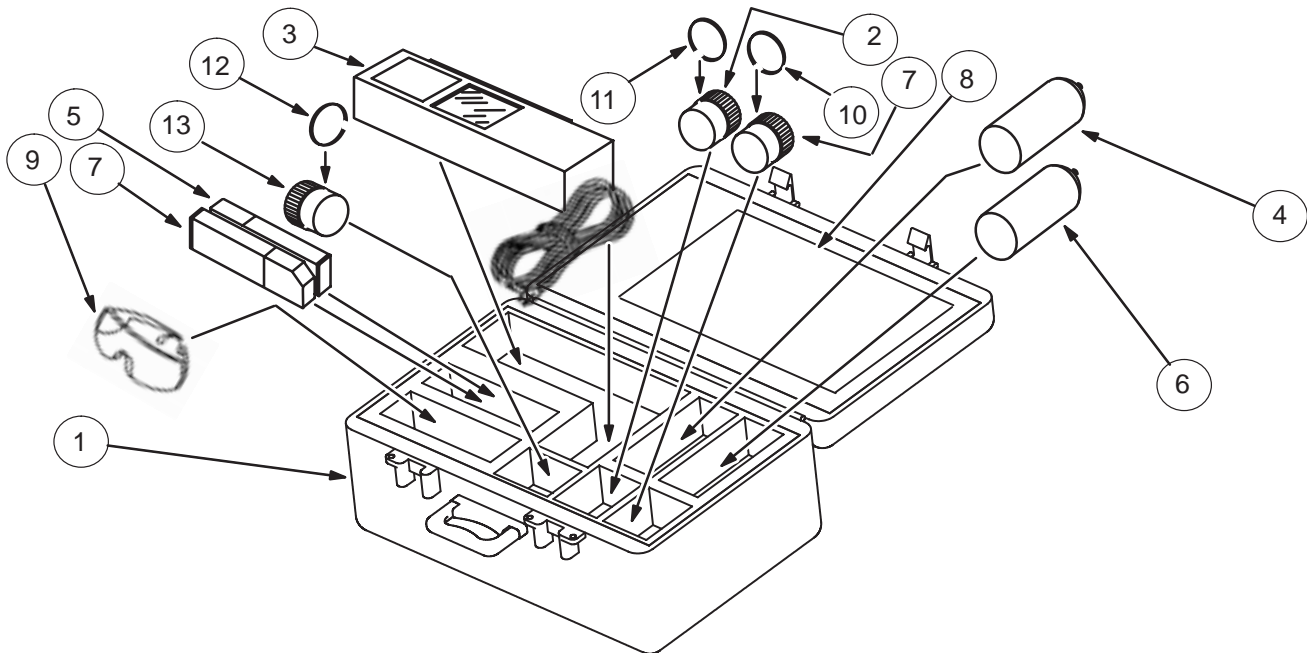


Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-318696G1	WATER TEE	1	WATER TEE ASSEMBLY

**4-25 REGION SHIM KIT 2181921**

Item	Part Number	Name	Quantity	Description ( Remarks )
1	46-318830P1	CASE	1	CASE FOR KIT ASSEMBLY
2	46-294126P201	SHIM	75	.200" WIDE X .001" THICK, CARBON STEEL
3	46-294126P401	SHIM	75	.400" WIDE X .001" THICK, CARBON STEEL
4	46-294126P901	SHIM	75	1.00" WIDE X .001" THICK, CARBON STEEL
5	46-294126P903	SHIM	75	1.00" WIDE X .003" THICK, CARBON STEEL
6	46-294126P910	SHIM	50	1.00" WIDE X .010" THICK, CARBON STEEL
7	46-294128P2	SHIM COVER	25	1.00" WIDE X .062" THICK, ALUMINUM
8	46-294125P3	FASTENER	100	#6-32UNC BROACHING TYPE X .44" LONG
9	46-252320P9	HEX NUT	100	#6-32UNC, BRASS
10	46-294410P1	SET SCREW	12	.25-20UNC CONE POINT

**4-26 SHIELD COOLER TEST KIT 46-318784G2**



Item	Part Number	Name	Quantity	Description ( Remarks )
1.	2100644	CASE ASSEMBLY	1	KIT CASE ASSEMBLY
2.	2100660	CONTAINER	1	SPECIMEN CONTAINER
3.	2100976	UV LIGHT	1	UV LIGHT & LABEL
4.	2100661	SOLUTION	1	FOR SOLIDS
5.	46-318649P1	TESTER	1	DISSOLVED SOLIDS
6.	2100662	SOLUTION	1	FOR PH
7.	46-318648P1	METER	1	PH METER
8.	2101994APR	INSTRUCTIONS	1	KIT OPERATING
9.	46-318649P1	GOGGLES	1	UV LIGHT SAFETY
10.	2101986	LABEL	1	SAMPLE, ADHESIVE BACKING
11.	2101987	LABEL	1	SOLIDS, ADHESIVE BACKING
12.	2101988	LABEL	1	PH, ADHESIVE BACKING
13.	2100660	SAMPLE	1	EMPTY - FOR SAMPLES

**4-27 OXYGEN MONITORS**

<b>Item</b>	<b>Part Number</b>	<b>Name</b>	<b>Quantity</b>	<b>Description ( Remarks )</b>
1	2107184	KIT	1	ENMET OXYGEN MONITOR KIT
	KIT CONTENTS:	OXYGEN MONITOR	1	46-317271G1
		SUPPLIER MANUAL	1	46-294439P5
		SERVICE MANUAL	1	46-015336
2	2106236	MONITOR	1	CONNECTICUT ANALYTICAL PORTABLE OXYGEN MONITOR (PREFERRED MODEL)
3	2106237	MONITOR	1	MCNEILL INTERNATIONAL PORTABLE OXYGEN MONITOR (ALTERNATE MODEL)

4-28 MAGNET TOOL MATRIX

SERVICE TOOLS	SIII	SIV SX	MR MAX 0.5T	VECTRA	VMX	MRT
MAGNET RAMPING EQUIPMENT KIT 46-260703G2	X	X	X	X	X	
MAIN POWER SUPPLY 46-260776G3	X	X	X	X	X	
SHIM POWER SUPPLY 46-260777G3	X	X	X			
RAMPING SUPPLY AND EQUIPMENT 46-294998G1	X	X	X	X	X	
UNIVERSAL FILL LINE KIT 46-294705G1	X	X	X	X	X	
250 LTR DEWAR STINGER 46-294511P1	X	X	X	X	X	
500 LTR DEWAR STINGER 46-294511P2	X	X	X	X	X	
DEWAR LEVEL TOOL KIT 46-306812G1	X	X	X	X	X	
12 FT He TRANSFER LINE 46-294512P1	X	X	X	X	X	
8 FT He TRANSFER LINE 46-294512P2	X	X	X	X	X	
10 FT NITROGEN TRANSFER LINE 46-252805P2	X	X	X	X	X	
15 FT NITROGEN TRANSFER LINE 46-252805P3	X	X	X	X	X	
SAFETY KIT 46-271137G1	X	X	X	X	X	
He RESISTANCE BOX 46-265286G1	X	X	X	X	X	
HIGH PRESSURE REGULATOR KIT 46-306734G1	X	X	X	X	X	
NONMAGNETIC HELIUM CART 46-258150P1	X	X	X	X	X	
SHIELD COOLER INST. / MAINT. KIT 46-281088G3	X	X	X	X	X	
SHIELD COOLER VACUUM PUMP KIT 46-294047G1	X	X	X	X	X	
LAKESHORE THERMOMETER KIT 46-301477G1	X	X	X	X	X	

4-28 MAGNET TOOL MATRIX ( continued )

SERVICE TOOLS	SIII	SIV SX	MR MAX 0.5T	VECTRA	VMX	MRT
LOW COST SHIELD TEMP BOX 46-317543G1	X	X	X	X	X	
3 IN. VALVE OPERATOR 46-252210P1	X	X	X	X	X	
3 IN. VALVE OPERATOR 46-281847G1	MAGNI- SHIELD					
He LEVEL METER 46-265273G1	X	X	X	X	X	
MAIN VACUUM PUMP DOWN KIT 46-251867G1	X	X	X	X	X	
N <sub>2</sub> PRECOOL SYPHON 46-260201P1	X	X	X	X	X	
TAO MONITOR 46-281406G1	X	X	X	X	X	
FILL LINE ADAPTER FOR TAO MONITORING 46-281232G1	X	X	X			
MAPPING FIXTURE 46-281420G2	X		X			
MAPPING FIXTURE 46-294238G1				X	X	
SERVICE MAPPING FIXTURE 46-294060G2	X	X	X			
H-FRAME ADAPTER KIT 46-294842G1 ( UPGRADES 46-294060G1 TO G2 )	X	X	X			
SAV-CON / INSTRUMENTATION LEAD SERVICE KIT 46-294872G2	X	X	X			
LEXAN / ALUMINUM BELLOWS COVER 2119965					X	
LEXAN COVER VERT STACK 2117683				X	X	
LEXAN COVER VERT. STACK 46-281936G1				X	X	
LEXAN COVER FOR P3 PLUG 46-260192P1						
ENMET OXYGEN MONITOR KIT 2107184	X	X	X	X	X	
CONNECTICUT ANALYTICAL PORTABLE OXYGEN MONITOR - 2106236	X	X	X	X	X	
McNEIL INTERNATIONAL PORTABLE OXYGEN MONITOR - 2106237	X	X	X	X	X	

4-28 MAGNET TOOL MATRIX ( continued )

SERVICE TOOLS	SIII	SIV	MR MAX 0.5T	VECTRA	VMX	MRT
LEXAN COVER INSTR. LEAD 46-281935P1				X		
SECOND STAGE ASSEMBLY TOOL 46-281050P4 ( FOR WELDED IN COLD HEAD )			X			
MAGNISHIELD CENTERING KIT 46-281967G1	X					
SAV-CON KIT 46-260705G1						
THREADED RODS 46-252065P29						
TAO DAMPER KIT 46-281432G1						
RAMP CABLE HOLDER 46-318314G2	X	X	X	X	X	
RAMP CABLE HOLDER 46-318833G1	X	X	X	X	X	
WATER FLOW METER KIT 46-294052G1	X	X	X	X	X	
MAGNET CENTERING / VERIFICATION KIT 46-281967G1	MAGNI- SHIELD					
WATER TEE ASSEMBLY 46-318696G1	X	X	X	X	X	
SIV REGION SHIM KIT 46-318832G1		X				
SHIELD COOLER TEST KIT 46-318784G2	X	X	X	X	X	
WRENCH KIT ( FERROUS ) 2103333	X	X	X	X	X	
WRENCH KIT ( NON-FERROUS ) 46-294804G1	X	X	X	X	X	
BELL GAUSSMETER KIT 46-306801G1	X	X	X	X	X	
1.00" VACUUM CHECK TOOL 46-228192P1	MAGNI- SHIELD					
50 Hz HEAT GUN 46-306830G11	X	X	X	X	X	X
60 Hz HEAT GUN 46-306830G12	X	X	X	X	X	X

4-28 MAGNET TOOL MATRIX ( continued )

SERVICE TOOLS	SIII	SIV SX	MR MAX 0.5T	VECTRA	VMX	MRT
METROLAB TESLAMETER KIT 46-251865G2	X	X	X	X	X	
He DEWAR ADAPTER KIT 46-271136G1	X	X	X	X	X	
He MECHANICAL GAS FLOWMETER 46-306781G1	X	X	X	X	X	
ALUMINUM PLATFORM LADDER 46-307476G1	X	X	X	X	X	
ENMET OXYGEN MONITOR CALIBRATION KIT 46-328021G1	X	X	X	X	X	
LARGE SHIM LEAD CAPS 42102831	X	X	X			
SMALL SHIM LEAD CAPS 2102832		X				
COMPACT REGION SHIM KIT 46-318831G1				X		
TESLAMETER 46-251865G2	X	X	X	X	X	
THERMOCOUPLE ADAPTER AND K PROBE 46-194427P285	X	X	X	X	X	
POWER SUPPLY CALIBRATION 2101360	X	X	X	X	X	
ADAPTER FITTING 2122261						X
HEAT EXCHANGER COUPLING 2115923						X
TEST PLUG - DB25 PIN 2122539						X
TEST PLUG - DB9 PIN 2122540						X
VACUUM ASSEMBLY COMPONENTS 2123165	X	X	X	X	X	X
PORTABLE TEMPERATURE INDICATOR 2125073						X
1.00" VALVE OPERATOR 2135559	X	X	X	X	X	X
MAPPING FIXTURE 2115039						X
HEAT EXCHANGER COVER PLATE 2132223						X























CHART 5-1  
**VOLUMETRIC CONVERSION OF LIQUID HELIUM LEVEL**  
 \*LEVEL PERCENTAGE TO LIQUID LITERS CORRELATION\*

<u>PERCENT</u>	<u>LITERS</u>	<u>PERCENT</u>	<u>LITERS</u>
0	409.0	51	1082.0
1	425.4	52	1095.0
2	441.8	53	1108.0
3	458.2	54	1121.0
4	474.6	55	1134.0
5	491.0	56	1146.6
6	506.0	57	1159.2
7	521.0	58	1171.8
8	536.0	59	1184.4
9	551.0	60	1197.0
10	566.0	61	1212.4
11	579.6	62	1227.8
12	593.2	63	1243.2
13	606.8	64	1258.6
14	620.4	65	1274.0
15	634.0	66	1283.6
16	646.6	67	1293.2
17	659.2	68	1302.8
18	671.8	69	1312.4
19	684.4	70	1322.0
20	697.0	71	1335.0
21	710.0	72	1348.0
22	722.0	73	1361.0
23	734.0	74	1374.0
24	746.0	75	1387.0
25	758.0	76	1401.2
26	770.0	77	1415.4
27	782.0	78	1429.6
28	794.0	79	1443.8
29	806.0	80	1458.0
30	818.0	81	1474.2
31	830.2	82	1490.4
32	842.4	83	1506.6
33	854.6	84	1522.8
34	866.8	85	1539.0
35	879.0	86	1561.8
36	891.4	87	1584.6
37	903.8	88	1607.4
38	916.2	89	1630.2
39	928.6	90	1653.0
40	941.0	91	1676.6
41	953.6	92	1700.2
42	966.2	93	1723.8
43	978.8	94	1747.4
44	991.4	95	1771.0
45	1004.0	96	1791.0
46	1017.0	97	1811.0
47	1030.0	98	1831.0
48	1043.0	99	1851.0
49	1056.0	100	1871.0
50	1069.0		











DATE: \_\_\_\_\_ MAGNET: \_\_\_\_\_ LOCATION: \_\_\_\_\_ PLOT#: \_\_\_\_\_

POINT 1 ( R = 0, Z = -20cm ): \_\_\_\_\_ POINT 2 ( R = 0, Z = +20cm ): \_\_\_\_\_ BASE FREQ: \_\_\_\_\_

TABLE 7-1  
SHIM PLOT DATA

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz )

DATE: \_\_\_\_\_ MAGNET: \_\_\_\_\_ LOCATION: \_\_\_\_\_ PLOT#: \_\_\_\_\_

POINT 1 ( R = 0, Z = -20cm ): \_\_\_\_\_ POINT 2 ( R = 0, Z = +20cm ): \_\_\_\_\_ BASE FREQ: \_\_\_\_\_

TABLE 7-1  
SHIM PLOT DATA (continued)

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz )

DATE: \_\_\_\_\_ MAGNET: \_\_\_\_\_ LOCATION: \_\_\_\_\_ PLOT#: \_\_\_\_\_

POINT 1 ( R = 0, Z = -20cm ): \_\_\_\_\_ POINT 2 ( R = 0, Z = +20cm ): \_\_\_\_\_ BASE FREQ: \_\_\_\_\_

TABLE 7-1  
SHIM PLOT DATA (continued)

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz )

DATE: \_\_\_\_\_ MAGNET: \_\_\_\_\_ LOCATION: \_\_\_\_\_ PLOT#: \_\_\_\_\_

POINT 1 ( R = 0, Z = -20cm ): \_\_\_\_\_ POINT 2 ( R = 0, Z = +20cm ): \_\_\_\_\_ BASE FREQ: \_\_\_\_\_

TABLE 7-1  
SHIM PLOT DATA (continued)

ROTATION COORD. (DEGREES)	PLANE												
	3	4	5	6	7	8	9	10	11	12	13	14	15
0°													
15°													
30°													
45°													
60°													
75°													
90°													
105°													
120°													
135°													
150°													
165°													
180°													
195°													
210°													
225°													
240°													
255°													
270°													
285°													
300°													
315°													
330°													
345°													

FREQUENCY – 63,xxxxx0 Hz (Round Off To Nearest 10 Hz )

DATE: \_\_\_\_\_ MAGNET SERIAL #: \_\_\_\_\_ PLOT #: \_\_\_\_\_ OUTPUT FILE: \_\_\_\_\_

TABLE 8-1  
CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS

POWER SUPPLY # (NAME)	TOTAL	+	=	TOTAL	+	=	TOTAL	+	=
	CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)		CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)		CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)	
T1-1(C31)									
T1-2(C11+)									
T1-3(C22+)									
T1-4(C11-)									
T1-5(C22-)									
T1-6(C33)									
T2-1(S31)									
T2-2(S11+)									
T2-3(S22+)									
T2-4(S11-)									
T2-5(S22-)									
T2-6(S33)									
AX1									
AX2									
AX3									
AX4									
AX5									
AX6									
<b>GRADIENT OFFSETS</b>									
X									
Y									
Z									
<b>PREDICTED</b>									
<b>INHOMOGENEITY</b>									

TABLE 8-1  
CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS (continued)

POWER SUPPLY # (NAME)	TOTAL	+	=	TOTAL	+	=	TOTAL	+	=
	CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)		CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)		CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)	
T1-1(C31)									
T1-2(C11+)									
T1-3(C22+)									
T1-4(C11-)									
T1-5(C22-)									
T1-6(C33)									
T2-1(S31)									
T2-2(S11+)									
T2-3(S22+)									
T2-4(S11-)									
T2-5(S22-)									
T2-6(S33)									
AX1									
AX2									
AX3									
AX4									
AX5									
AX6									
<b>GRADIENT OFFSETS</b>									
X									
Y									
Z									
<b>PREDICTED</b>									
<b>INHOMOGENEITY</b>									

DATE: \_\_\_\_\_ MAGNET SERIAL #: \_\_\_\_\_ PLOT #: \_\_\_\_\_ OUTPUT FILE: \_\_\_\_\_

REV 0  
GE MEDICAL SYSTEMS

GE 1.0T MAGNET & CRYOGENS SUBSYSTEM  
DIRECTION 46-015537

TABLE 8-1  
CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS (continued)

POWER SUPPLY # (NAME)	TOTAL	+	=	TOTAL	+	=	TOTAL	+	=
	CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)		CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)		CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)	
T1-1(C31)									
T1-2(C11+)									
T1-3(C22+)									
T1-4(C11-)									
T1-5(C22-)									
T1-6(C33)									
T2-1(S31)									
T2-2(S11+)									
T2-3(S22+)									
T2-4(S11-)									
T2-5(S22-)									
T2-6(S33)									
AX1									
AX2									
AX3									
AX4									
AX5									
AX6									
<b>GRADIENT OFFSETS</b>									
X									
Y									
Z									
<b>PREDICTED</b>									
<b>INHOMOGENEITY</b>									

DATE: \_\_\_\_\_ MAGNET SERIAL #: \_\_\_\_\_ PLOT #: \_\_\_\_\_ OUTPUT FILE: \_\_\_\_\_

TABLE 8-1  
CALCULATED CORRECTION CURRENTS FOR S/C SHIM COILS (continued)

POWER SUPPLY # (NAME)	TOTAL	+	=	TOTAL	+	=	TOTAL	+	=
	CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)		CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)		CURRENT(AMPS)	$\Delta$ CHANGE (AMPS)	
T1-1(C31)									
T1-2(C11+)									
T1-3(C22+)									
T1-4(C11-)									
T1-5(C22-)									
T1-6(C33)									
T2-1(S31)									
T2-2(S11+)									
T2-3(S22+)									
T2-4(S11-)									
T2-5(S22-)									
T2-6(S33)									
AX1									
AX2									
AX3									
AX4									
AX5									
AX6									
<b>GRADIENT OFFSETS</b>									
X									
Y									
Z									
<b>PREDICTED</b>									
<b>INHOMOGENEITY</b>									

TABLE 4-1  
HELIUM FILL DATA SHEET

1	DATE	
2	FILLED BY	
3	FILL LINE NUMBER	
4	DEWAR SERIAL NUMBER	
5	DEWAR TARE WEIGHT	
6	DEWAR WEIGHT FULL	
7	DEWAR WEIGHT EMPTY	
8	HELIUM VOLUME LBS. (LINE 6 – LINE 7)	
9	HELIUM VOLUME LITERS (LINE 8 x 3.63)	
10	END% VOLUME (FROM TABLE BELOW)	
11	START % VOLUME (FROM TABLE BELOW)	
12	ACTUAL HE. TRANSFER VOLUME (LINE 10 – LINE 11)	
13	TRANSFER EFFICIENCY (LINE 12 / LINE 9)	
14	FILL TIME FROM FILL HISTORY (T! – T1 )	

VOLUMETRIC CONVERSION OF LIQUID HELIUM LEVEL PROVIDED IN GRAPH 3 AND CHART 3

FILL HISTORY

	START TIME	START %	GAS PSI	MAGNET PSI
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
END T!				

FOR YOUR INFORMATION: \* Predicted Meter Reading  
\*\* Volume of Helium Gas Used

\* USE STARTING METER READING. LOOK UP HELIUM LITER LEVEL ON TABLE. SUBTRACT LINE 5 FROM LINE 6. MULTIPLY LEVEL. RECORD METER PERCENT THAT REFLECTS THIS LEVEL AS YOU PREDICTED METER READING.

\*\* RECORD AND NOTE THE AMOUNT OF HELIUM GAS USED BY THE PRESSURE LEVEL GAUGE ON THE HELIUM GAS TANKS.

TABLE 4-1  
HELIUM FILL DATA SHEET

1	DATE	
2	FILLED BY	
3	FILL LINE NUMBER	
4	DEWAR SERIAL NUMBER	
5	DEWAR TARE WEIGHT	
6	DEWAR WEIGHT FULL	
7	DEWAR WEIGHT EMPTY	
8	HELIUM VOLUME LBS. (LINE 6 – LINE 7)	
9	HELIUM VOLUME LITERS (LINE 8 x 3.63)	
10	END% VOLUME (FROM TABLE BELOW)	
11	START % VOLUME (FROM TABLE BELOW)	
12	ACTUAL HE. TRANSFER VOLUME (LINE 10 – LINE 11)	
13	TRANSFER EFFICIENCY (LINE 12 / LINE 9)	
14	FILL TIME FROM FILL HISTORY (T! – T1 )	

VOLUMETRIC CONVERSION OF LIQUID HELIUM LEVEL PROVIDED IN GRAPH 3 AND CHART 3

FILL HISTORY

	START TIME	START %	GAS PSI	MAGNET PSI
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
END T!				

FOR YOUR INFORMATION: \* Predicted Meter Reading  
\*\* Volume of Helium Gas Used

\* USE STARTING METER READING. LOOK UP HELIUM LITER LEVEL ON TABLE. SUBTRACT LINE 5 FROM LINE 6. MULTIPLY LEVEL. RECORD METER PERCENT THAT REFLECTS THIS LEVEL AS YOU PREDICTED METER READING.

\*\* RECORD AND NOTE THE AMOUNT OF HELIUM GAS USED BY THE PRESSURE LEVEL GAUGE ON THE HELIUM GAS TANKS.

TABLE 4-1  
HELIUM FILL DATA SHEET

1	DATE	
2	FILLED BY	
3	FILL LINE NUMBER	
4	DEWAR SERIAL NUMBER	
5	DEWAR TARE WEIGHT	
6	DEWAR WEIGHT FULL	
7	DEWAR WEIGHT EMPTY	
8	HELIUM VOLUME LBS. (LINE 6 – LINE 7)	
9	HELIUM VOLUME LITERS (LINE 8 x 3.63)	
10	END% VOLUME (FROM TABLE BELOW)	
11	START % VOLUME (FROM TABLE BELOW)	
12	ACTUAL HE. TRANSFER VOLUME (LINE 10 – LINE 11)	
13	TRANSFER EFFICIENCY (LINE 12 / LINE 9)	
14	FILL TIME FROM FILL HISTORY (T! – T1 )	

VOLUMETRIC CONVERSION OF LIQUID HELIUM LEVEL PROVIDED IN GRAPH 3 AND CHART 3

FILL HISTORY

	START TIME	START %	GAS PSI	MAGNET PSI
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
END T!				

FOR YOUR INFORMATION: \* Predicted Meter Reading  
\*\* Volume of Helium Gas Used

\* USE STARTING METER READING. LOOK UP HELIUM LITER LEVEL ON TABLE. SUBTRACT LINE 5 FROM LINE 6. MULTIPLY LEVEL. RECORD METER PERCENT THAT REFLECTS THIS LEVEL AS YOU PREDICTED METER READING.

\*\* RECORD AND NOTE THE AMOUNT OF HELIUM GAS USED BY THE PRESSURE LEVEL GAUGE ON THE HELIUM GAS TANKS.

TABLE 4-1  
HELIUM FILL DATA SHEET

1	DATE	
2	FILLED BY	
3	FILL LINE NUMBER	
4	DEWAR SERIAL NUMBER	
5	DEWAR TARE WEIGHT	
6	DEWAR WEIGHT FULL	
7	DEWAR WEIGHT EMPTY	
8	HELIUM VOLUME LBS. (LINE 6 – LINE 7)	
9	HELIUM VOLUME LITERS (LINE 8 x 3.63)	
10	END% VOLUME (FROM TABLE BELOW)	
11	START % VOLUME (FROM TABLE BELOW)	
12	ACTUAL HE. TRANSFER VOLUME (LINE 10 – LINE 11)	
13	TRANSFER EFFICIENCY (LINE 12 / LINE 9)	
14	FILL TIME FROM FILL HISTORY (T! – T1 )	

VOLUMETRIC CONVERSION OF LIQUID HELIUM LEVEL PROVIDED IN GRAPH 3 AND CHART 3

FILL HISTORY

	START TIME	START %	GAS PSI	MAGNET PSI
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
END T!				

FOR YOUR INFORMATION: \* Predicted Meter Reading  
\*\* Volume of Helium Gas Used

\* USE STARTING METER READING. LOOK UP HELIUM LITER LEVEL ON TABLE. SUBTRACT LINE 5 FROM LINE 6. MULTIPLY LEVEL. RECORD METER PERCENT THAT REFLECTS THIS LEVEL AS YOU PREDICTED METER READING.

\*\* RECORD AND NOTE THE AMOUNT OF HELIUM GAS USED BY THE PRESSURE LEVEL GAUGE ON THE HELIUM GAS TANKS.

TABLE 9-1  
SHIM SIZE/LOCATION (MILS)

Z (NO)	ROTATION (DEGREES)											
	0	30	60	90	120	150	180	210	240	270	300	330
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												

TABLE 9-1  
SHIM SIZE/LOCATION (MILS) (continued)

Z (NO)	ROTATION (DEGREES)											
	0	30	60	90	120	150	180	210	240	270	300	330
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												

TABLE 9-1  
SHIM SIZE/LOCATION (MILS) (continued)

Z (NO)	ROTATION (DEGREES)											
	0	30	60	90	120	150	180	210	240	270	300	330
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												

TABLE 9-1  
SHIM SIZE/LOCATION (MILS) (continued)

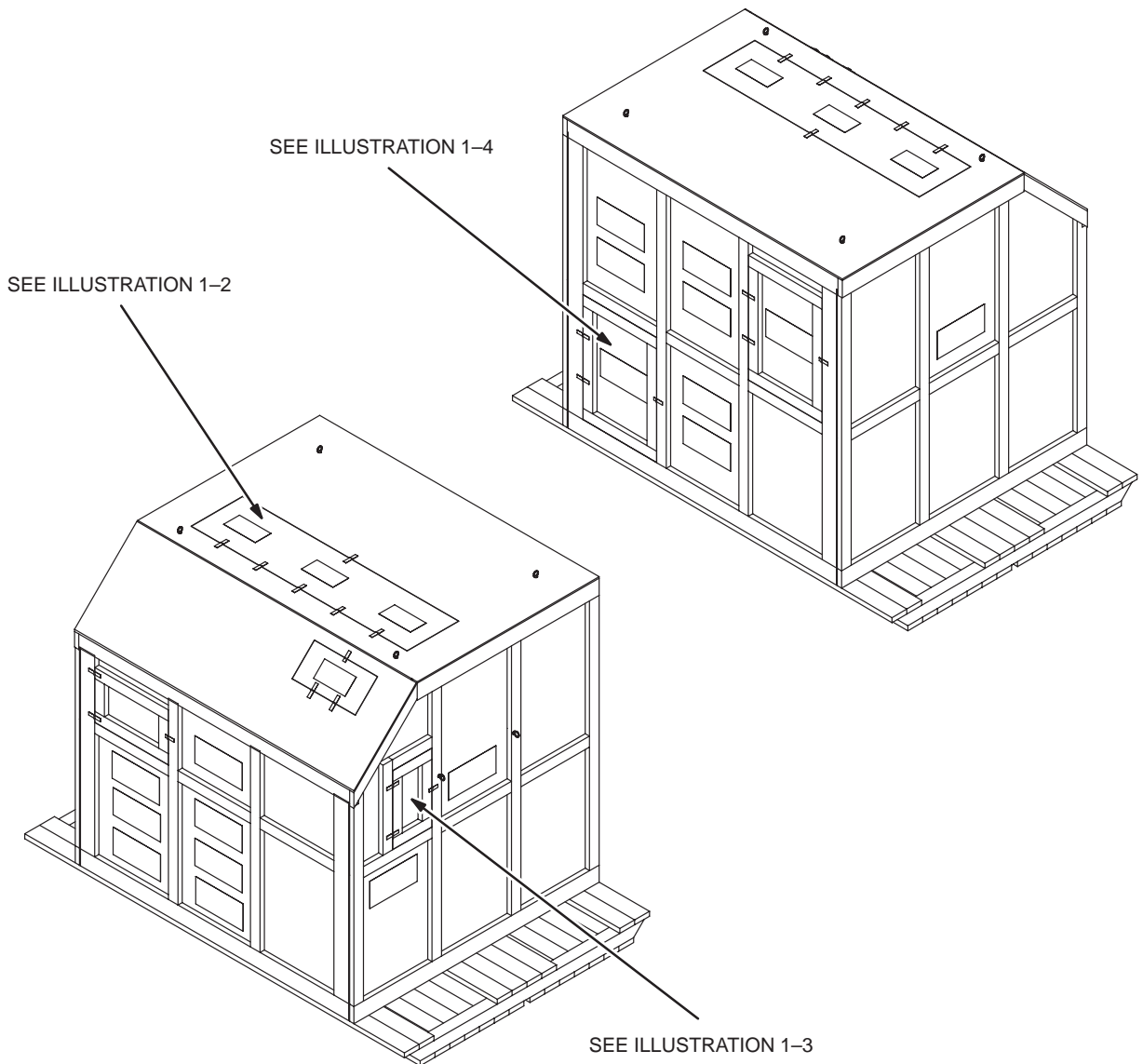
Z (NO)	ROTATION (DEGREES)											
	0	30	60	90	120	150	180	210	240	270	300	330
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												

# SECTION 1 – SHIPPING / DELIVERY INSTRUCTIONS

## 1-1 INTRANSIT SERVICE

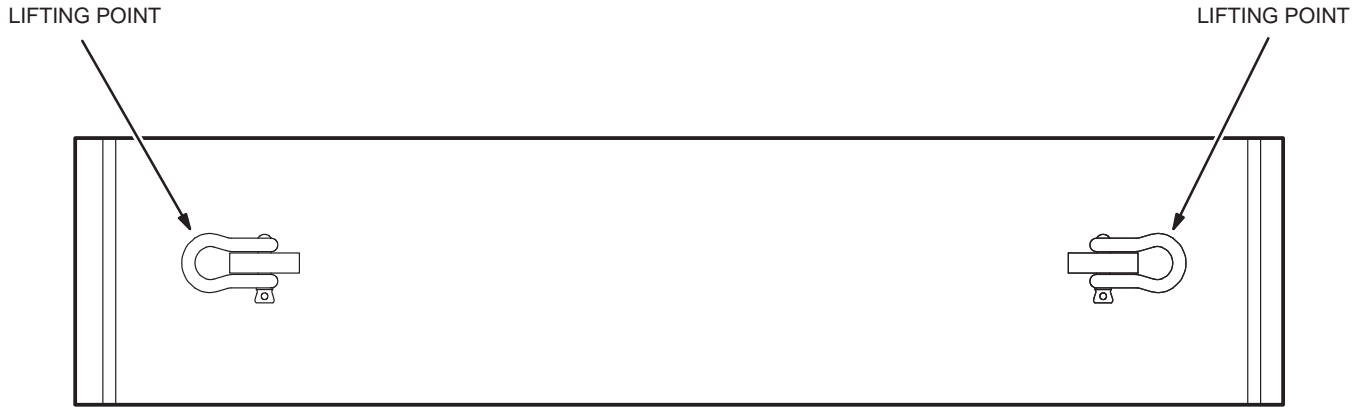
### Note

The following information outlines provisions for filling and electrical / temperature checks while magnet is still in shipping crate. This will enable required service to be performed in transit based upon magnet shipping date. The following Illustrations ( 1-1 through 1-4 ) show the magnet configuration behind each shipping crate access door. Access doors and hinges not shown for clarity.

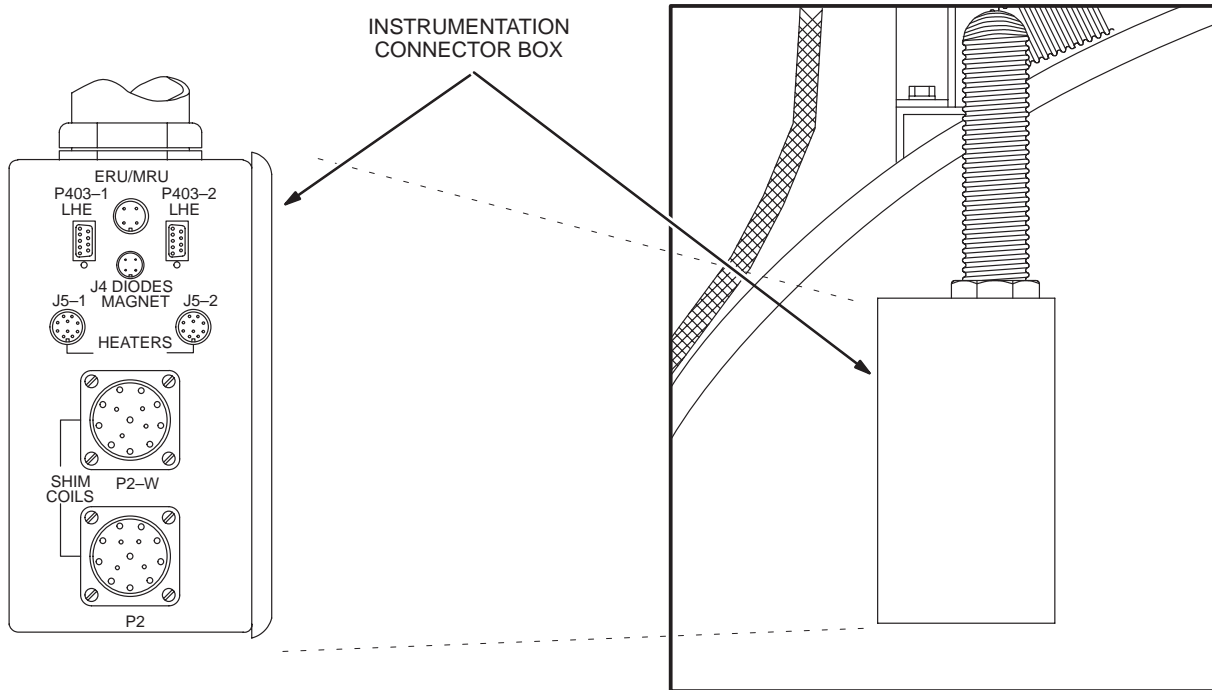


**ACCESS DOOR LABELING ON CRATE**  
ILLUSTRATION 1-1

1-1 INTRANSIT SERVICE ( continued )

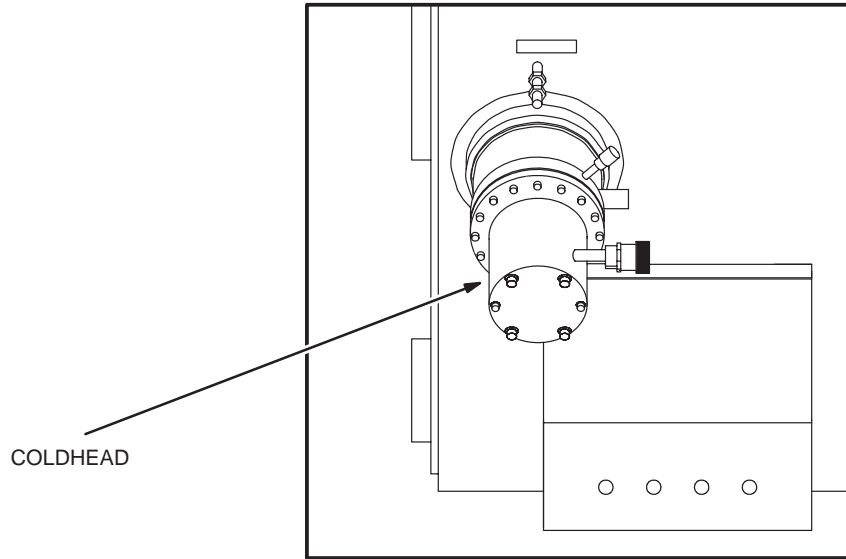


TOP ACCESS DOOR LABELED "LIFTING POINT"  
ILLUSTRATION 1-2



FRONT ACCESS DOOR LABELED "INSTRUMENT CONNECTOR"  
ILLUSTRATION 1-3

1-1 INTRANSIT SERVICE ( continued )



LEFT SIDE ACCESS DOOR LABELED "COLD HEAD ACCESS"  
ILLUSTRATION 1-4

1-2 SHIPPING / HANDLING



Shipping and handling guidelines are provided in Table 1.

These guidelines must be followed to prevent any potential damage to the magnet during shipping and handling.

Review guidelines with Shipper / Riggers prior to transporting magnet.

TABLE 1-1  
MAGNET SHIPPING AND HANDLING INFORMATION

MAGNET	* MAXIMUM WEIGHT	** MAXIMUM TILT	(1) ALLOWABLE SHIPPING MODES	(2) FORKLIFT CAPABILITY
1.0T Fixed Site	16,500 lbs.	30 deg.	A, T, Tr, B	Yes
1.0T Mobile Site	19,500 lbs.	30 deg.	A, T, Tr, B	Yes

MAGNET	SHIPPING CAPABILITY	(3) MAXIMUM TRANSIT TIME	MAXIMUM SHOCK LOADS	COMMENTS
1.0T Fixed or Mobile	Cold	21 days	2 G's	See Notes

\* Add 2200 lbs for shipping crate (if used).

\*\* Tilt allowed when suspended by Lifting Shackles.

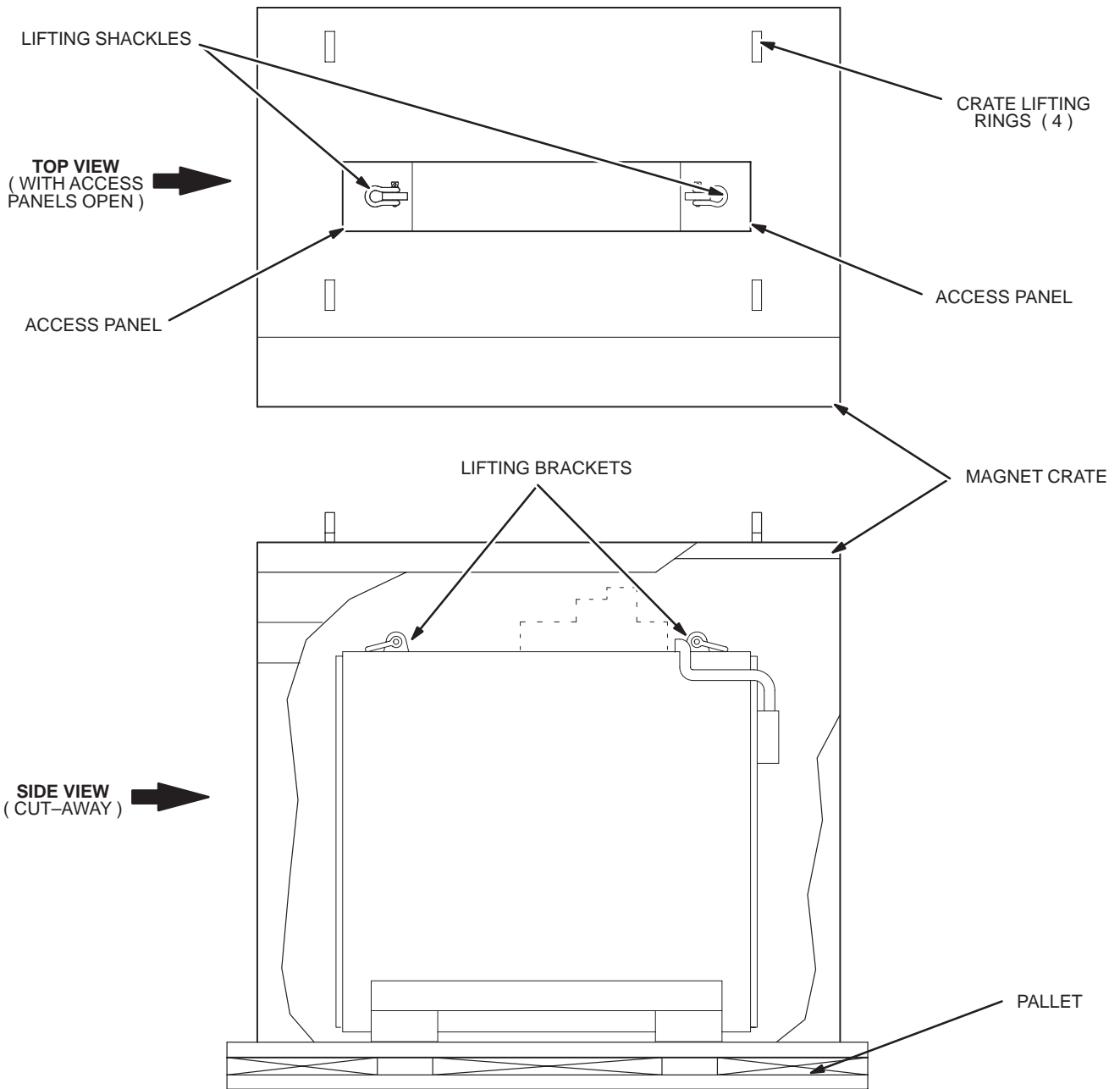
**Notes:**

- Key for Shipping mode symbols:
  - “A” Airplane ( including any plane that has fuselage openings large enough to accept a magnet )
  - “T” Air ride Trailer ( Any magnet transported on a non-air ride trailer must be identified and never used in a Mobile trailer. )
  - “Tr” Train
  - “B” Boat or ocean going ship
- Extreme care must be exercised during forklift. The magnet crate must be picked up from the sides only. The forks MUST be placed directly under the four ( 4 ) feet of the magnet. The magnet feet can be identified by the steel plates attached to the pallet.
- The elapsed time begins when the magnet leaves the Florence loading dock.

1-3 UNLOADING / LOADING MAGNET AND CRATE

Note

Lifting Shackles and Brackets are provided for magnet unloading / loading. See Illustration 1-5. Shackle / Bracket access panels are provided, as shown in Illustration 1-5, for crated magnets.



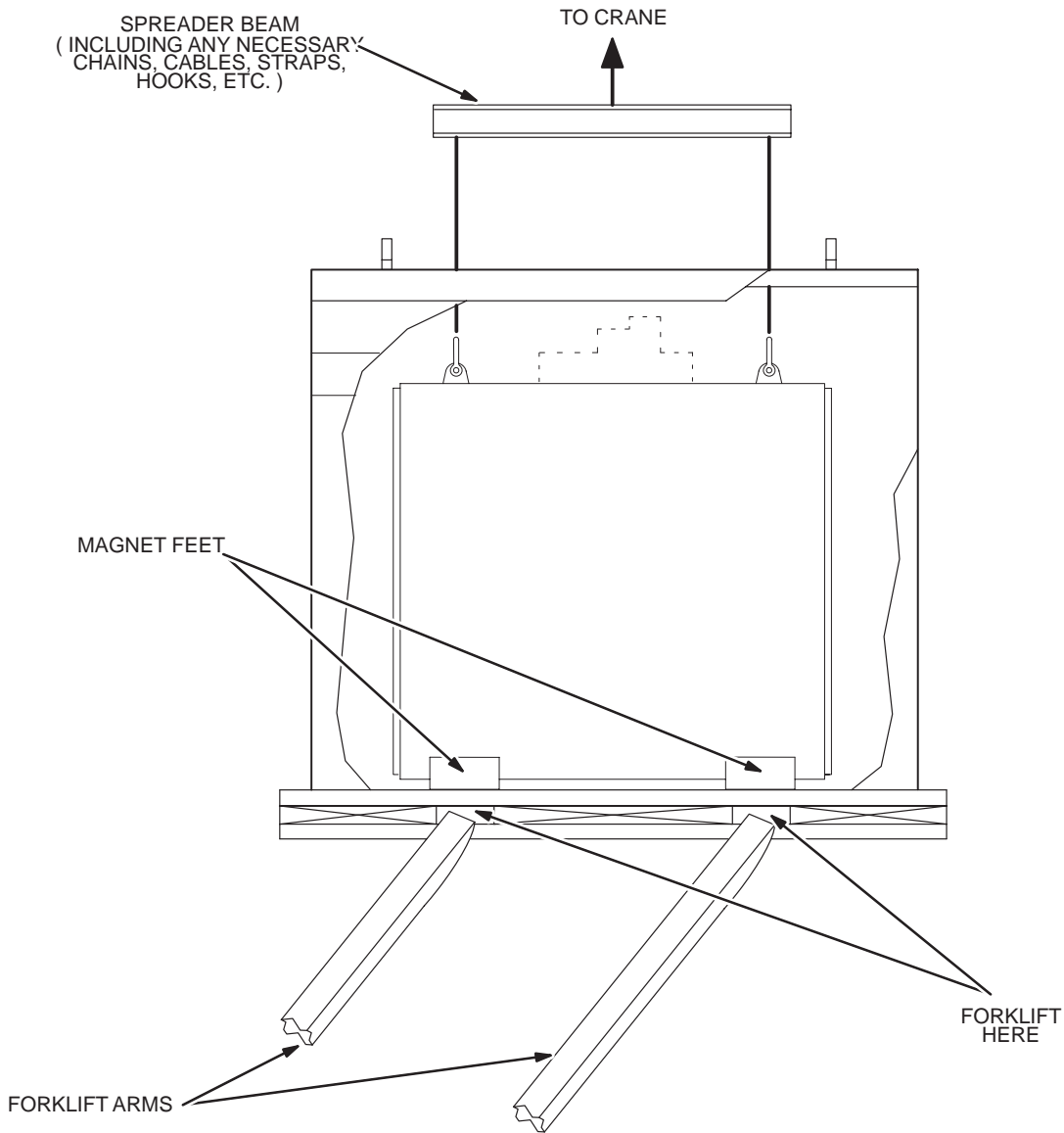
ACCESS PANEL, SHACKLE AND BRACKET LOCATIONS

ILLUSTRATION 1-5

1-3 UNLOADING / LOADING MAGNET AND CRATE ( continued )



Extreme care must be exercised during forklift operations. The magnet crate must be picked up from the sides only. The forks **MUST** be placed directly under the four ( 4 ) feet of the magnet. The magnet feet can be identified by the steel plates attached to the pallet. Do not lift crate with straps fed through the pallet. This will crush the crate.



FORKLIFT / CRANE LIFTING OPERATIONS  
ILLUSTRATION 1-6

**1-3 UNLOADING / LOADING MAGNET AND CRATE ( continued )**

1. Position the Crane Hook centrally over the crated magnet to ensure a vertical lift force on the Lifting Brackets.



**It is important to lift the magnet smoothly to avoid impact or jolts to the system which may damage the magnet.**

2. Attach the rigging to the lifting shackles at each end of the crated magnet.

**Note**

Any combination of spreader beam, shackles and/or slings, 6 foot ( 1829 mm ) minimum length, which can support a minimum of 19,300 pounds ( 8,754 Kg ) may be used.

3. Lift crated magnet with crane to clear trailer.
4. Lower the crated magnet onto a flat surface.

**1-4 PRE-DELIVERY INSTRUCTIONS**



**Make sure ALL site requirements / conditions, identified for the magnet in the site planning manual, are met before scheduling magnet delivery.**

**This will prevent installation delays, cryogen loss and resultant ongoing magnet quenches, potential damage, environmentally related problems and increased costs.**



**THE OXYGEN MONITOR MUST BE INSTALLED AND FUNCTIONAL BEFORE BRINGING THE MAGNET INTO THE EXAM ROOM. THIS MONITOR MUST GIVE AN AUDIO AND VISUAL WARNING WHEN THE OXYGEN LEVELS IN THE ROOM FALLS BELOW 18% TO NOTIFY PERSONNEL OF ANY POSSIBILITY OF ASPHYXIATION. REFER TO DIRECTION 15336 FOR OXYGEN MONITOR INSTALLATION INSTRUCTIONS.**

1. Visit magnet site with rigging foreman before magnet delivery to plan the move.
2. Caution rigger that the magnet is extremely fragile. Sudden jolts can damage the magnet. Riggers aware of the cost of a magnet and its replacement usually use more care while handling magnet.
3. Make sure all roads and paths leading to exam room are level and free from obstacles and holes. Rigger will be required to construct platforms where needed.
4. If Roller Dollies are to be used, have rigger bring eight steel plates, 96in. x 24in. x 0.50 in. ( 2438mm x 610mm x 12.7mm ), to place along delivery route.
5. Mark the magnet location on the floor before delivery. Refer to architectural drawings.



## SECTION 2 – UNCRATING MAGNET SYSTEM

1. Remove all subsystem crates from low-boy trailer using a crane or forklift. Inspect all crates for visible damage.
2. Move subsystem crates to a receiving location protected from the weather, preferably in proximity of the examination room and on the same level.

### Note

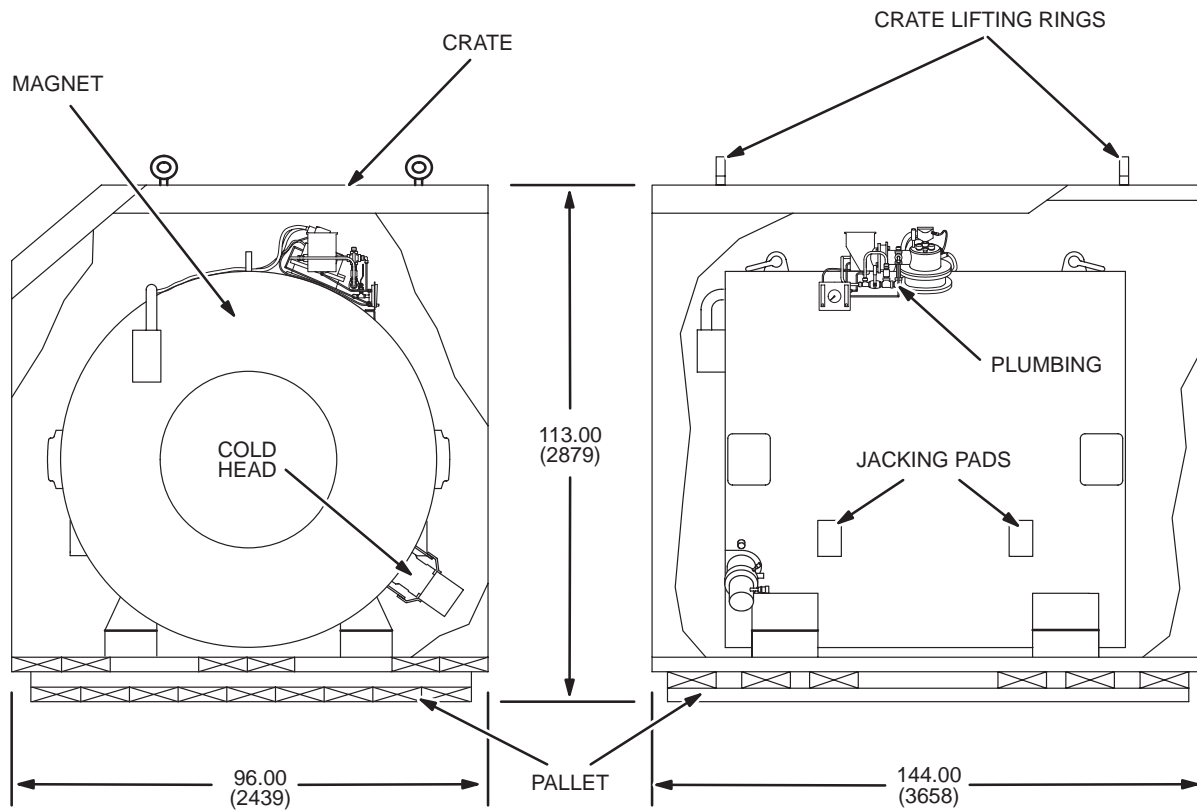
Domestic shipments are made with a tarp covering on the magnet instead of a crate. See Illustration 2-1 for magnet weight (domestic and international shipments). For domestic shipments, skip to RIGGING, Section 3.

3. Inspect the crate containing the magnet and identify the crate side marked, "REMOVE THIS SIDE FIRST". This designated side is to be removed first. See Illustration 2-1 for crate dimensions.
4. Position crane centrally over this designated crate side.
5. Connect crane to the two lifting rings located near the top of the crate side marked "Remove This Side First" using a sling and shackles supplied by riggers. Tighten the sling snug. See Illustration 2-2.
6. Remove lag screws securing the face of the crate marked "REMOVE THIS SIDE FIRST" See Illustration 2-2.
7. Lift crate side with crane and clear from the area.
8. Secure four one ton (900 Kg) working load slings, minimum 6 foot length (1829mm), to four lifting rings assembled to the top corners of crate. Using one ton (900 Kg) anchor shackles.
9. Position crane centrally over top section of the crate and attach slings to crane hook.
10. Remove lag screws only from the bottom portions of the three remaining crate sides. See Illustration 2-3.
11. Lift crate carefully using crane and clear crate from shipping skid containing magnet.



**Make sure that the crate does not swing and hit the Magnet Cold Head, Vertical Penetration or Plumbing during the lifting process.**

ALL DIMENSIONS ARE IN INCHES ( MILLIMETERS )

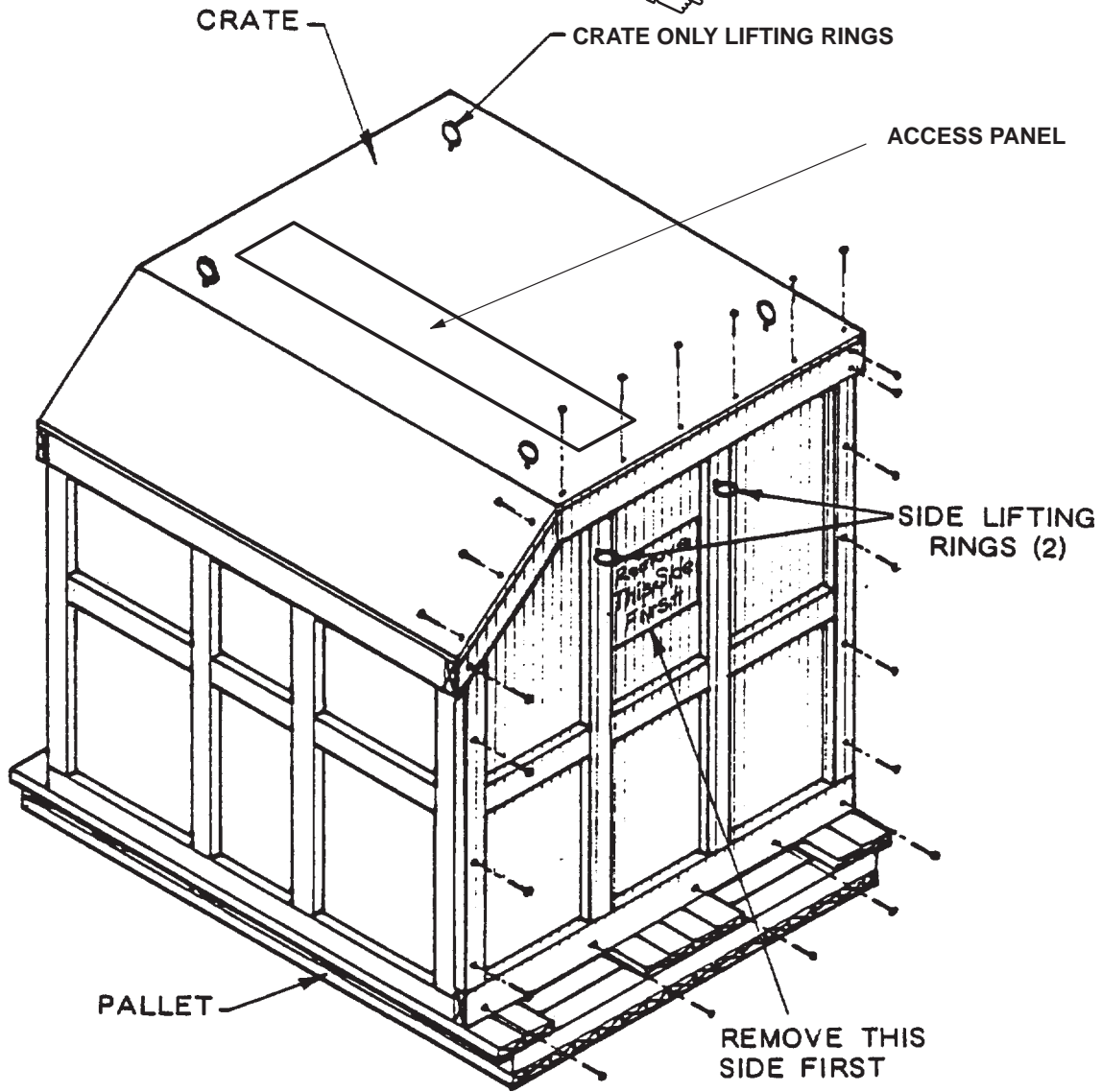


MAGNET CRATE  
ILLUSTRATION 2-1

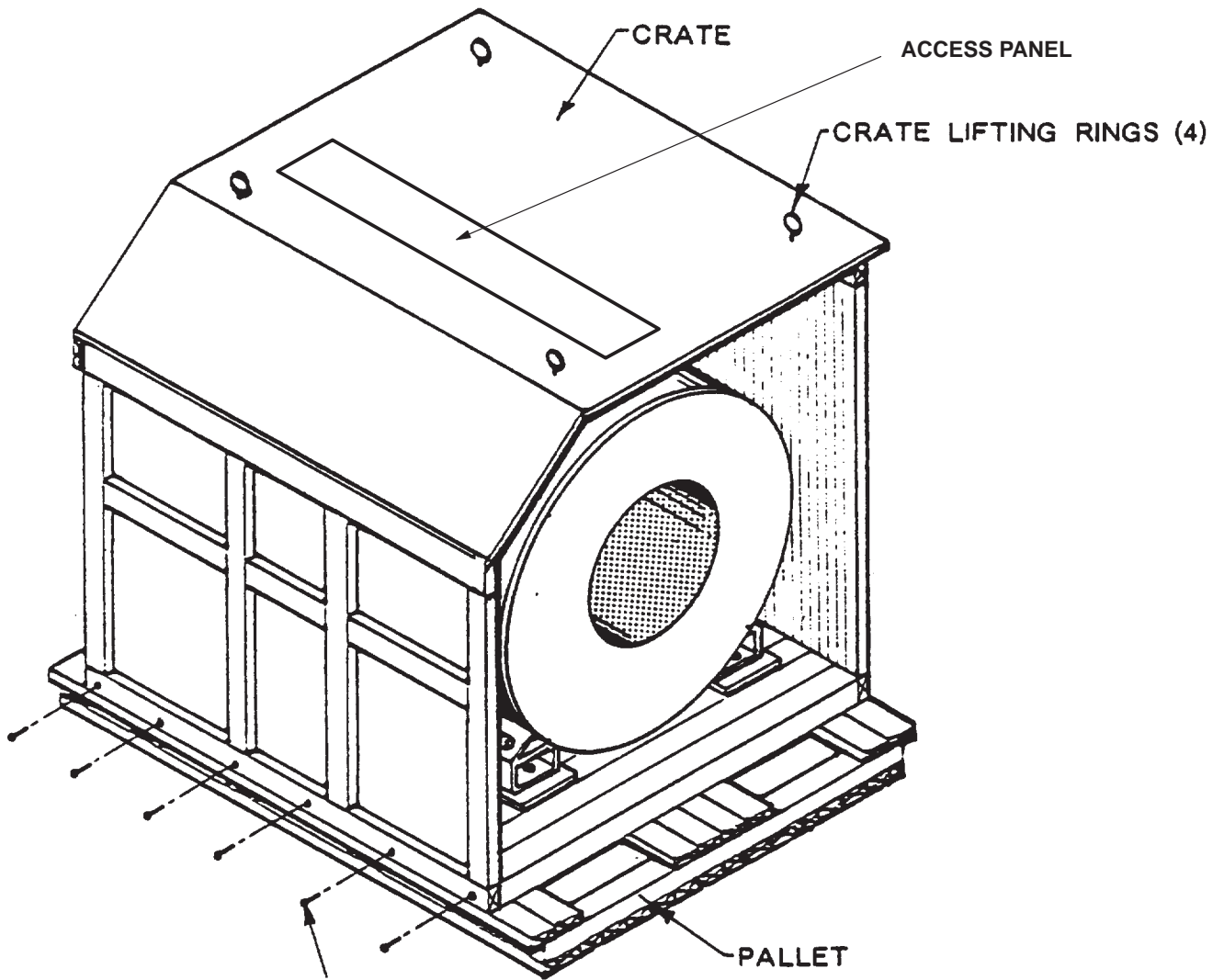


**NOTE:**

**MAGNET LIFTING SHACKLES  
ARE LOCATED UNDER THE  
ACCESS PANEL DOOR**



**MAGNET CRATE FACE LAG SCREW REMOVAL  
ILLUSTRATION 2-2**



REMOVE ALL BOLTS FROM THE BASE OF REMAINING THREE SIDES.

MAGNET CRATE BOTTOM LAG SCREW REMOVAL  
ILLUSTRATION 2-3

## SECTION 3 – MAGNET SYSTEM COMPONENT CHECK

### Note

Shipment of magnet system components to the installation site may occur as a complete system or a drop shipment of major system components. Verify that all required magnet system components are present at the site to assure a complete and timely installation.

1. Locate the Pre-Delivery Information Package shipped with the magnet which contains the (Bill of Material) for the magnet system delivered. Check that all boxes indicated are present.
2. Check the contents of each box against its packing list when the boxes are brought into the MR Site.
3. Inspect the magnet for physical damage and icing/condensation on the body. If no problem found, unload magnet.

### Note

Because of the higher Boiloff and helium gas flow through the vertical penetration, some frost on the Vertical Penetration is normal during periods when cold head has been shut off.

4. If icing or condensation present on the body or the bore of the magnet, check Liquid Helium level before unloading. See Set Up and Calibration, Section 1-6 for Cryogen Monitor set up.

### Note

If magnet has been sitting for a period of time with the Cold Head inoperative, the Magnet may be depleted of Cryogenes.

5. Refer to SET UP AND CALIBRATION, Section 2-2-3 for Cryostat Cooling /Filling Requirements. If pressure in vacuum cavity is greater than  $1 \times 10^{-6}$  Torr., contact MAC Team Leader before installing magnet.



**It is important to establish if any damage was sustained by the magnet or its system components during delivery or if any components are missing. This will result in the fast, proper follow-up of any problems and a timely installation.**

6. Perform the Magnet Circuits Resistance Checks identified in Table 3-1, "MAGNET CIRCUITS RESISTANCE CHECK COLD (4.2 K)" and Table 3-2 "SHIM LEAD CHECKS". If any problems are found the Shim Lead can be "retracted" to isolate the shorts from the shim coils.
7. Report any damage found in compliance with the "Damage In Transportation" note on the back side of the Service Manual Title Page.
8. Report all problems found to the Regional Magnet & Cryogenics (MAC) Team Leader. Report all missing components to the person identified on the Magnet Component Bill of Material.

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

FUNCTION	CONNECTOR	PIN #	RESISTANCE (OHMS)	
			TYPICAL VALUES	MEASURED
MAIN COIL	MAIN COIL POWER LUGS OR J5-1	+ -  9,10	< 6 OHMS	
SUPERCONDUCTING SHIM COILS	CANNON (P1-A) AT MAGNET VERTICAL STACK			
Z1		1,19	0.5	
Z2		2,20		
Z3		3,21		
Z4		4,22		
Z5		5,23		
Z6		6,24		
C11+		16,19		
C11-		17,20		
C22+		14,21		
C22-		15,22		
S11+		9,19		
S11-		10,20		
S22+		7,21		
S22-		8,22		
C31		13,23		
S31		11,23		
C33		18,24		
S33	↓	12,24	↓	
SUPERCONDUCTING SWITCH HEATERS MAIN SWITCH	J 5-1 & J 5-2 ON MAGNET TERMINAL BOX 9MS1-A3,A1)	1,2	22 - 27	
AXIAL SHIMS		5,6	25.5 - 31.0	
TRANSVERSE 1		7,6	10	
TRANSVERSE 2	↓	8,6	10	

**NOTE:** THIS TABLE PROVIDES AN ALTERNATE LOCATION FOR CHECKING SUPERCONDUCTING SHIM COIL RESISTANCES FROM P1-A (I.E., AT THE MAGNET TERMINAL BOX).

MAGNET TERMINAL BOX CONNECTORS P2 AND P2W			RESISTANCE (OHMS)	
SUPERCONDUCTING SHIM COILS	CONNECTOR	CONNECTOR PINS	TYPICAL RESISTANCE	MEASURED RESISTANCE
Z1	P2	A,* (K,L)	0.6	
Z2	P2W	A, (K,L)		
Z3	P2	B, (M,N)		
Z4	P2W	B, (M,N)		
Z5	P2	C, P		
Z6	P2W	C, P		
C11+	P2	F, (K,L)		
C11-	P2W	F, (K,L)		
C22+	P2	G, (M,N)		
C22-	P2W	G, (M,N)		
S11+	P2	H, (K,L)		
S11-	P2W	H, (K,L)		
S22+	P2	J, (M,N)		
S22-	P2W	J, (M,N)		
C31	P2	D, P		
S31	P2	E, P		
C33	P2W	D, P		
S33	P2W	E, P		

\* PARENTHESIS INDICATE PINS WIRED TOGETHER.

**TABLE 3-2**  
**SHIM LEAD CHECKS**

**LEAD TO LEAD SHORTS**

PINS P1A Connector Vertical Stack	MAGNET CONNECTOR BOX (OPTIONAL LOCATION)	ACCEPTABLE RANGE	MEASURED
19 to 20	**P2 – ( K,L ) to P2W – ( K,L )	Greater Than 16 k ohms	
19 to 21	P2 – ( K,L ) to P2 – ( M,N )		
19 to 22	P2 – ( K,L ) to P2W – ( M,N )		
19 to 23	P2 – ( K,L ) to P2 – ( P )		
19 to 24	P2 – ( K,L ) to P2W – ( P )		
20 to 21	P2W – ( K,L ) to P2 – ( M,N )		
20 to 22	P2W – ( K,L ) to P2W – ( M,N )		
20 to 23	P2W – ( K,L ) to P2 – ( P )		
20 to 24	P2W – ( K,L ) to P2W – ( P )		
21 to 22	P2 – ( M,N ) to P2W – ( M,N )		
21 to 23	P2 – ( M,N ) to P2 – ( P )		
21 to 24	P2 – ( M,N ) to P2W – ( P )		
22 to 23	P2W – ( N,M ) to P2 – ( P )		
22 to 24	P2W – ( N,M ) to P2W – ( P )	↓	
23 to 24	P2 – ( P ) to P2W – ( P )	Greater Than 16 k ohms	

**LEAD TO GROUND SHORTS**

PINS P1A Connector Vertical Stack	MAGNET CONNECTOR BOX (OPTIONAL LOCATION)	ACCEPTABLE RANGE	MEASURED
19 to *GROUND	P2 – ( K,L ) to GROUND	Greater Than 16 k ohms	
20 to *GROUND	P2W ( K,L ) to GROUND		
21 to *GROUND	P2 ( M,N ) to GROUND		
22 to *GROUND	P2W ( M,N ) to GROUND		
23 to *GROUND	P2 ( P ) to GROUND	↓	
24 to *GROUND	P2W ( P ) to GROUND	Greater Than 16 k ohms	

**\* GROUND DEFINED AS SHIM LEAD COVER**

**\*\* CONNECTOR P2 PINS K AND/OR L TO CONNECTOR P2W PINS K AND/OR L.  
PINS IN PARENTHESIS ARE CONNECTED TOGETHER INSIDE THE MAGNET CONNECTOR BOX**

## SECTION 4 – REMOVING THE MAGNET FROM THE SHIPPING SKID



**The magnet must be moved as smoothly as possible at all times. If severe jolting is encountered, internal damage may result.**

1. Unbolt and remove the four 1 inch bolts which secure the base frame to the magnet.
2. Position the Crane Hook centrally over the magnet to ensure a vertical lift force on the Lifting Brackets.



**It is important to lift the magnet smoothly to avoid impact or jolts to the system which may damage the magnet and its installation.**

3. Attach the rigging to the lifting shackles at each end of the magnet.

### **Note**

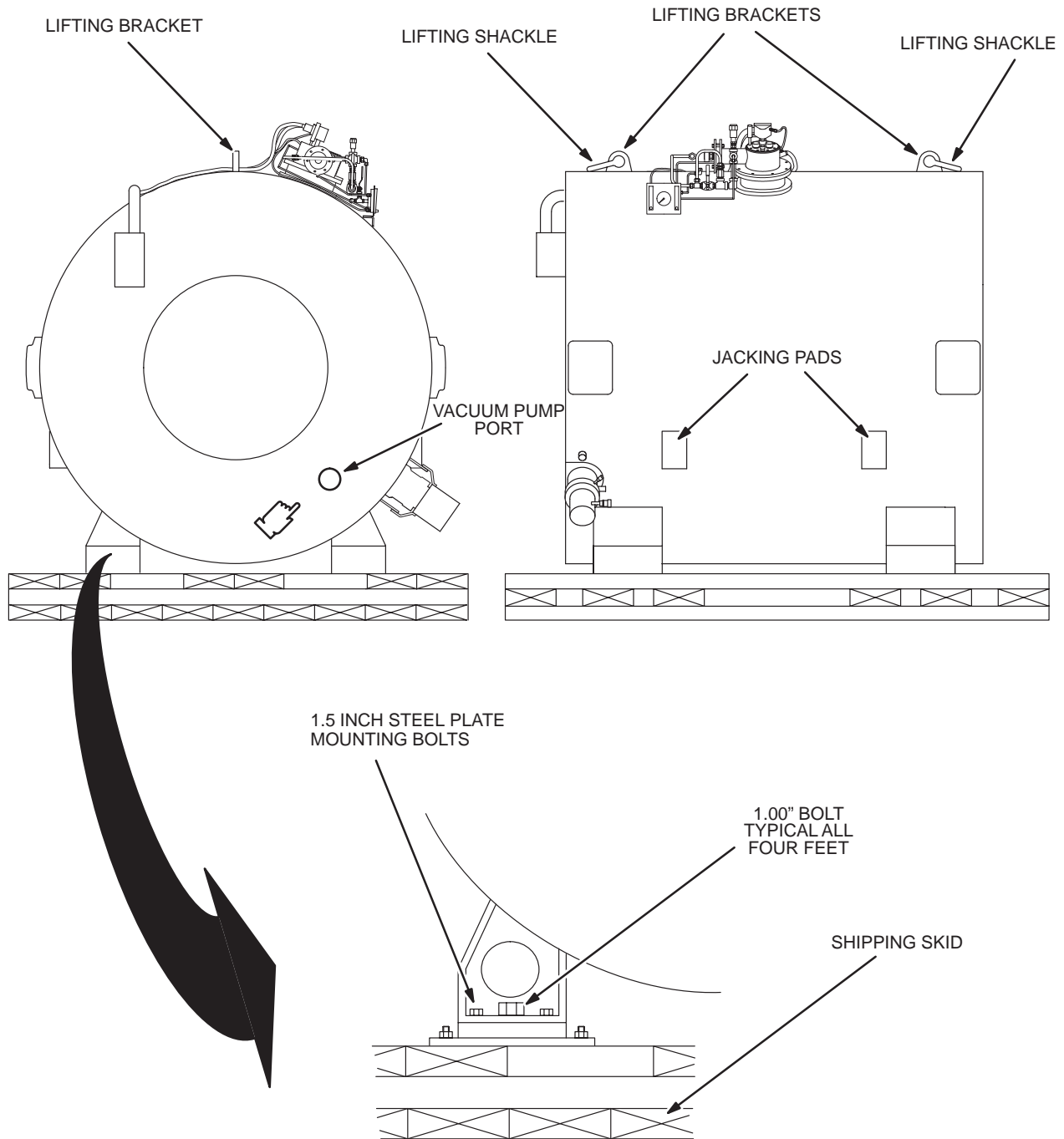
Any combination of spreader beam, shackles and/or slings, 6 foot ( 1829mm ) minimum length, which can support a minimum of 19,300 pounds ( 8,754 Kg ) may be used.

4. Lift magnet with crane to clear shipping skid and trailer.



**When lowering the magnet, be careful not to shock the magnet which could result in overstressing the internal magnet support members.**

5. Lower the magnet onto a flat surface.



**MAGNET MOUNTING ON SHIPPING SKID**  
ILLUSTRATION 4-1

## SECTION 5 – MOVING MAGNET TO EXAM ROOM

### Note

Roller Dollies are recommended for moving magnet into the examination room as shown in Illustration 5-1. If Roller Dollies are used, place steel floor plates along the magnet delivery route.



**Use the Jacking Pads located on the magnet to raise the magnet for Roller Dolly installation.**

**The magnet cannot be tipped by more than 30 degrees, end to end or side to side, during jacking or transport.**

**Use shims when rolling magnet with Roller Dolly over door thresholds and other inclines.**

### Note

The magnet location in the examination room must be marked. Use tape to mark the four corners of magnet on the examination room floor. Refer to architectural drawings to determine the exact location of magnet within the examination room.

1. Push magnet to exam room. If using a motorized tow vehicle, attach chains around the magnet base support pads and pull magnet.
2. If there are turns in the delivery route, adjust Roller Dollies to appropriate positions to negotiate turns.
3. Move Magnet into the Exam Room. If there is not enough vertical clearance for the Magnet, remove the 1.5 inch plates from the bottom of the magnet or the Vent Adapter from the Vertical Penetration to obtain additional clearance. If more clearance is still needed call the MAC Team Representative for further removal of Vertical Penetration components.
4. Position magnet on the examination room floor. If ceiling is in place, drop a plumb bob from the center of the vent hole and mark the floor at the location where the plumb bob points. This corresponds to the location of the center of the Vent Adapter on the Magnet.

### Note

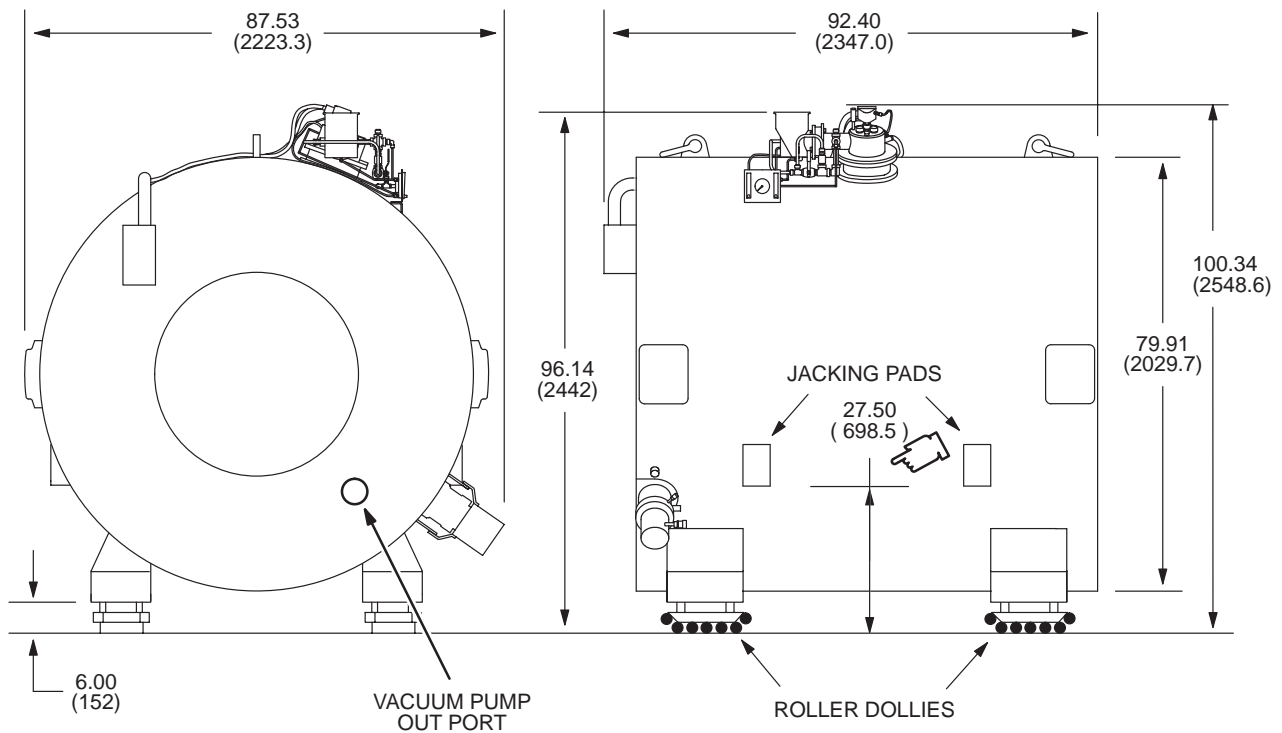
Table end of magnet (See Introduction, Illustration NO TAG) must be oriented away from rear wall of exam room.



**Keep magnet level at all times. Uneven jacking of corners could result in shifting of magnet on jacks.**

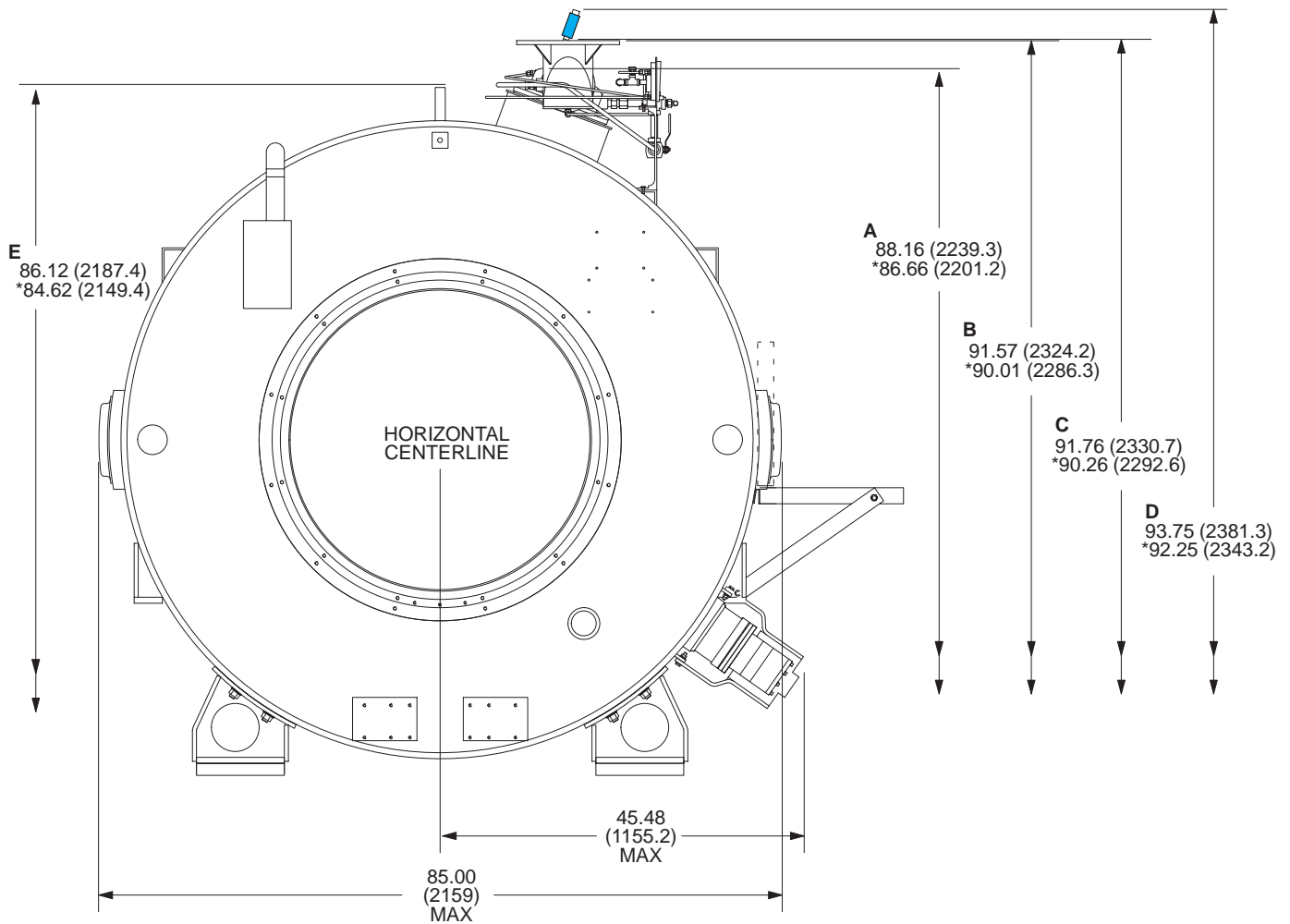
- 5. Jack the magnet up sufficiently, at the 4 jacking pads, and remove the 4 Roller Dollies.
- 6. Slowly lower magnet onto the exam room floor.

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)  
\* DIMENSIONS INCLUDE 1.50 (38.1) PLATES ON BOTTOM OF EACH FOOT.



**MAGNET WITH ROLLER DOLLIES ATTACHED**  
ILLUSTRATION 5-1

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS)  
 \* DIMENSIONS SHOWN WITHOUT FOOT BLOCKS ATTACHED TO MAGNET FEET.



- A: DISTANCE TO UPPERMOST POINT ON TURRET COVER PLATE.
- B: DISTANCE TO TOP OF VENT ADAPTER.
- C: DISTANCE TO TOP OF SHIM LEAD CONNECTOR BOX.
- D: DISTANCE TO TOP OF SHIM LEAD BRASS KNURLED NUT.
- E: DISTANCE TO TOP OF LIFTING LUG

**Note**

Minimum height for service clearance is 102.68 inches (2608mm). This clearance is needed for Ramp Lead, Shim Lead, and Fill Line installation.

**MAGNET CLEARANCE DIMENSIONS**  
 ILLUSTRATION 5-2



## SECTION 6 – LEVELING MAGNET

1. Fill a 25 foot (7.6m) x 0.5 inch (12.7mm) section of transparent tubing 3/4 full with water.
2. Position the ends of the tube adjacent to the 3mm deep grooves, located on the end flanges of the magnet, at the horizontal center. Assure that there is sufficient water in the tube so that the water level is above the groove height. See Illustration 6-1.
3. Measure the difference between the groove and water level height in the tube. There should be no more than 0.04 inch (1 mm) difference between any of the four measurements (four corners of the magnet).
4. If there is more than a 0.04 inch (1 mm) difference, jack up magnet and insert an aluminum shim plate under the appropriate corner of the Magnet Base Frame.

**Note**

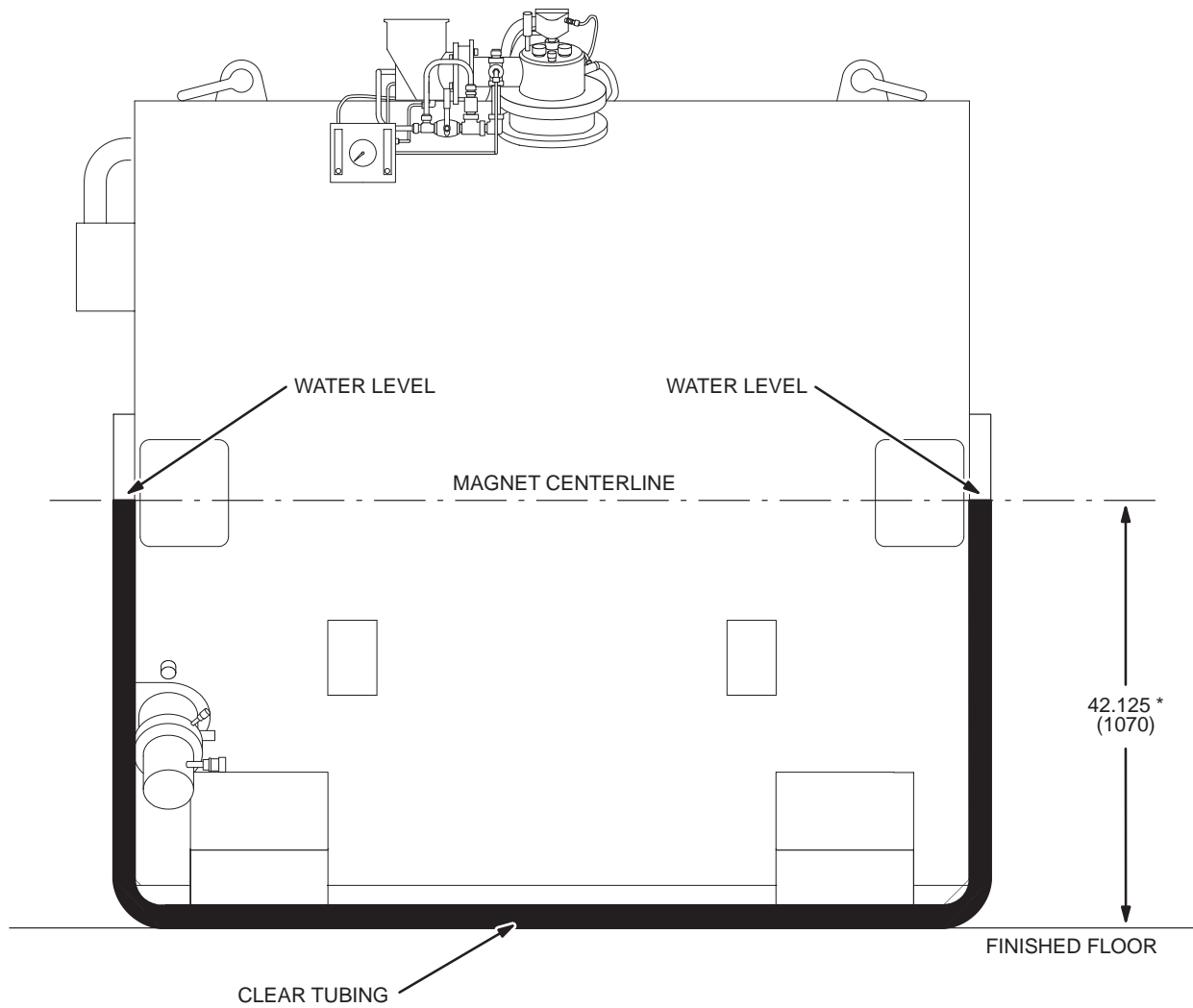
A Magnet Leveling Kit (46-260888G1), containing 12 – 0.062 inch (1.57mm) and 8 – 0.020 inch (0.5mm) shim plates, is shipped with the magnet.

5. Lower magnet onto shim plate and recheck the level.

**Note**

Repeat Steps 2 through 5 until the magnet is level (i.e., there is no more than a 0.04 inch (1mm) difference between any of the four measurements).

6. Allow magnet to settle on exam room floor for approximately 12 hours and recheck magnet level.
7. Bolt magnet to floor using Magnet Bolt Down Installation Kit P/N 2104219, for normal installations. For Seismic installations, use Magnet Bolt Down Installation Kit P/N 2105959.



\* MINIMUM DISTANCE BETWEEN MAGNET CENTERLINE AND FINISHED FLOOR IS 42.125 (1070) FOR FRONT AND REAR SHROUD CLEARANCE.

**CHECKING MAGNET LEVEL**  
ILLUSTRATION 6-1