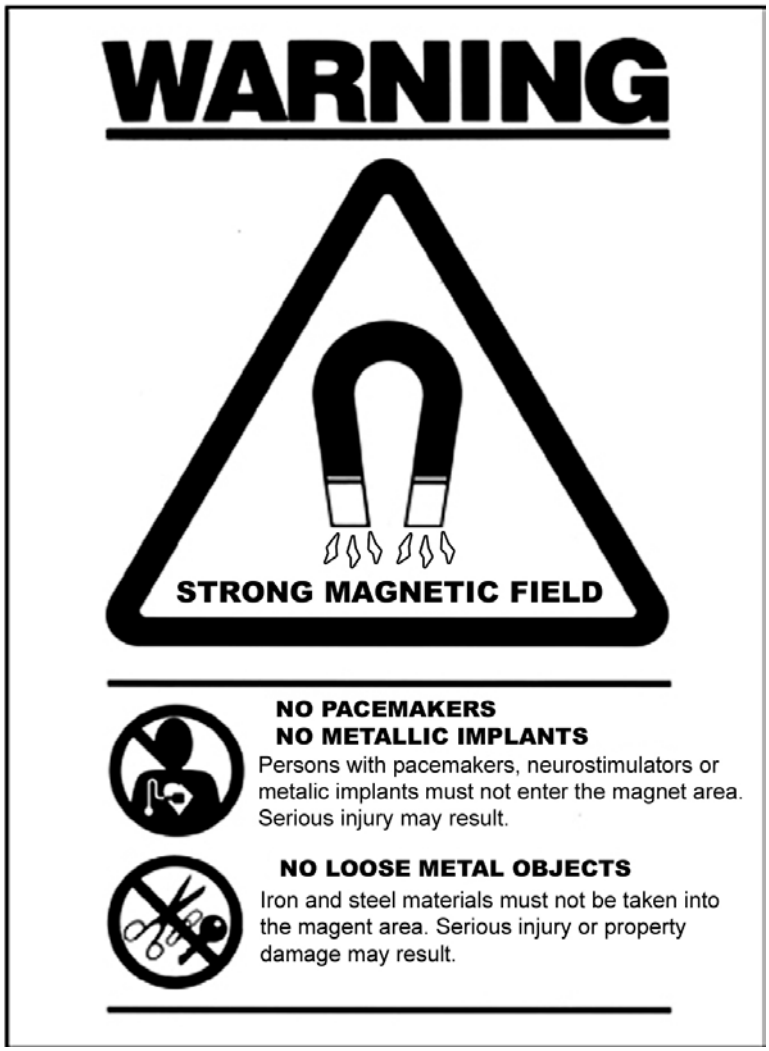
GE Medical Systems

Technical Publication

Direction 2192624
Revision 10

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

Copyright © 2006 by General Electric Company Inc.
All Rights Reserved.



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Important Information

LANGUAGE

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 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.**

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

AVISO

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

ATENÇÃO

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

AVVERTENZA

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

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

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。

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

This page left intentionally blank.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Revision History

Rev.	Date	Primary Reason(s) for Change
A	May 20, 1998	Preliminary Release
B	Jun 26, 1998	
0	Jul 31, 1998	
1	Nov 20, 1998	
2	Mar 12, 1999	
3	Jun 25, 1999	
4	Jun 16, 2000	
5	Nov 29, 2000	Update Safety Alerts; 7 psig Relief Valve plumbing assembly replacement added; Mobile Coldhead Extraction tool added
6	Jul 31, 2001	Switch to standardized MR safety section 2301164PRE; new Coldhead, Recondenser Deicing (Purge), 5 psig Relief Valve and 7 psig Relief Valve replacement procedures; expanded "Helium Vent System Pressure Drop Matrix for a 1.5T Magnet" table; added Mobile Site Service Platform/Ladder, use of low ceiling height service tools; update RENEWAL PARTS
7	Mar 27, 2002	Switch to Burst Disc 2319285; revised RuO Temperature Monitor (2171219) and RuO Sensor Checks sections; new Universal Fixed-Site Service Platform (2319156); all ice removal combined into DeIcing section, with simpler third level Recondenser Deicing; Coldhead replacement includes revised Universal Coldhead Replacement Tool Kit (2300306) and special steps for AK vans; new Preparation for Site Removal section; additional metric equivalents, subsection headings, crossreferences and part number references.
8	Jul 30, 2003	Text in entire manual enlarged, occasionally resulting in repagination; some subsection/procedure restructuring for greater clarity and/or to match same material in other manuals; cross-references updated; index added.
		FRONT MATTER: New Safety Alert Usage and Direction 2231934 application pages.
		SAFETY: 2301164PRE Revision 2.
		INTRODUCTION: New Magnet Siting, Installation & Commissioning Flow Chart & Check List table in Section 1; updated Vendor Manual Matrix.
		SET-UP AND CALIBRATION: Revised Magnet System Installation section (procedural corrections and part number additions); revised Liquid Helium Fill cryogen levels; revised electrical connections, polarity and field adjustment sections; revised Ramping section, including addition of YR & YQ Series ramping.
		FUNCTIONAL CHECKS: Revised Magnet Functional Checks; rewritten High Pressure and/or Heliem Loss Troubleshooting; deleted obsolete vacuum check section; revised Magnet Quenches.
		REPLACEMENT/MAINTENANCE: Revised Ice Removal section; revised rampdown section; revised Coldhead replacement section; new Section 18, Periodic Checks/Maintenance.
		RENEWAL PARTS: Updated Bill-of-Materials listings; includes YR & YQ Series magnets in Section 1, added Safety Signage, Cryogen Safety Wear, Magnet Tool and MetroLab Teslameter Kits in Section 4, added FRU codes where missing.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Rev.	Date	Primary Reason(s) for Change
9	Dec. 9, 2004	Conversion to GE Healthcare “CEM” (Content Engineering Management) production process, manual structure and appearance, bringing expanded parts lists, more detailed safety alerts, reworked graphics and some rewording. (G.Butler/B.Jackson/R.Hawthorne)
		“Front Matter”: Safety Alert Usage moved to Chapter 1, Section 1 and Direction Application moved to Chapter 2, Section 1.
		Chapter 1, Safety: New statement of Safety Alert Usage (Chapter 1, Section 1) under CEM; helium pressure before starting service changed to “< 0.5 psig” in 2301164PRE's Service Procedure Safety Requirements table.
		Chapter 2, Introduction: Direction Application (Chapter 2, Section 1) relocated to Introduction; YR & YQ Series magnets added to Chapter 2, Section 2, Documentation Organization; Cryogen Monitor and Pressure Controller deleted from Chapter 2, Section 3, Vendor Manual Matrix; and new Chapter 1, Section 5, Emergency Rampdown of Magnetic Field.
		Chapter 3, Set-Up and Calibration: Duplicate of Pre-Installation manual's Vent Matrix in Chapter 3, Section 1.3, Venting Installation, eliminated; System Gas Pressure Check (old Section 1-4-2) moved to Chapter 5, Section 2, Cryocooler System Gas Pressure Adjustments; added gas line & power cable run numbers and Compressor static pressures to Chapter 3, Section 1.5, Cryocooler Installation and Checkout; copper tubing no longer used in Recondenser purge (Helium Purge section of Chapter 3, Section 3.1, Nitrogen Purge-Precool); Changing Helium Gas Bottles subsection added to Chapter 3, Section 3.2, Liquid Helium Fill; added note about connecting Teslameter Probes with built-in preamplifiers in Chapter 3, Section 4, Preparations for Field Measurement; height off plenum cover of fully engaged Shim Lead 2173354 added in Chapter 3, Section 5, Shim Lead Engagement and Disengagement; Main Power Supply Test moved to Chapter 4; changed Ramping to use “Recommended Site Parking Frequency” stated in magnet ATR, to state 2 people are required for ramping and to insert flow hole screws after leads have been removed instead of before; checking the ATR for magnet-specific current settings added to Shimming; updated shim current settings and corrected accuracy value for 1.5T field frequency in Chapter 3, Section 10, Field Adjustment after Shimming.
		Chapter 4, Functional Checks: Corrected accuracy value for 1.5T field frequency in Chapter 4, Section 1, Magnet Functional Checks; power supply tests moved to Chapter 4, and on-site voltage calibration subsection removed from Chapter 4, Section 8.3, ESS7.5-1000-2-D-1236 Main Power Supply Tests
		Chapter 5, Replacement & Maintenance: System Gas Pressure Check (old Set-Up and Calibration, Section 1-4-2) moved to Chapter 5, Section 2, Cryocooler System Gas Pressure Adjustments; updated shim current settings Chapter 5, Section 6, Magnet Rampdown to Zero Field; added optional Permacel tape usage in preparing replacement Coldhead second stage, changed getter bag taping from aluminum to Permacel tape and added helium gas option (including Backfill Air Hose 5111335 and In-Line Dessicant Fliter 2391747) in Chapter 5, Section 10, Two-Stage Cryocooler Coldhead Replacement; changed Chapter 5, Section 11.1, Burst Disc (2349529) Replacement, and Chapter 5, Section 11.2, Burst Disc (2194545-7) Replacement, to have FE call before changing Burst Disc while the magnet is at field and to pressurize the vessel if cryogen refill is not to occur during the same service call as Burst Disc replacement; deleted obsolete Re-Evacuation of T-Line, Recondenser and First Stage Plumbing Ice Clearing, 5 psig Relief Valve and Copper Coil Plumbing Assembly Replacement for Magnet Assembly 2188846 and 7 psig Relief Valve Plumbing Assembly Replacement for Magnet Assembly 2188846 sections.
		Chapter 6, Schematics & Interconnects: Corrected pin labels on 2204723, 2204623 and 2128699 in 'Magnet System Wiring: Sleeve Connections', added P1-C wiring view pinouts to 'Instrumentation Box Assembly 2204623 Wiring' and added 'Shim Lead Pigtail Adapter Cable 2135362 Wiring' in Chapter 6, Section 2.1, Magnet System Wiring.
		Chapter 7, Renewal Parts: add URL of MR Service Documentation web page listing publications with gradient/enclosure spare part information; incorporate new revisions: LCC Magnet Assembly 2243832 at Rev. 16 (Chapter 7, Section 2.1, LCC Magnet Assemblies); Shim Lead Assembly 2173354 at Rev. 5 (Chapter 7, Section 2.2.1); Helium Vent Kit 46-318057G6 at Rev. 2 (Chapter 7, Section 3.2.1); MRU Kit Assembly 2128700 at Rev. 4 (Chapter 7, Section 3.4.1); Magnet Monitor Kit, Fixed TRM 2304069 at Rev. 3 (Chapter 7, Section 3.5.1); Magnet Monitor Kit, Mobile TRM 2304069-2 at Rev. 5 (Chapter 7, Section 3.5.2); Magnet Monitor Kits, Mobile BRM-CRM 2222520-2 at Rev. 5 (Chapter 7, Section 3.5.4); Core Cable Kit 2350809 at Rev. 1 (Chapter 7, Section 3.5.6); added Chapter 7, Section 3.9.1, Coldhead and Gaskets Kit 2194003, at Rev. 1; added Chapter 7, Section 3.9.2, Coldhead and Gaskets Kit 2194003-2, at Rev. 1; added Chapter 7, Section 3.9.3, Coldhead Assembly 2218465, at Rev. 4; added Chapter 7, Section 3.9.4, High Efficiency Coldhead Assembly 2218465-3, at Rev. 0; Cryocooler Replacement Gaskets Kit 2171620 at Rev. 4 (Chapter 7, Section 3.9.5); Safety Signage Kit 46-258770G4 at Rev. 3 (Chapter 7, Section 4.1.1); Lakeshore 208 Digital Thermometer Kit 46-301477G2 at Rev. 1 (Chapter 7, Section 4.2.1); Temperature Diode Box 46-317543G2 at Rev. 1 (Chapter 7, Section 4.2.4); added Chapter 7, Section 4.4.3, Hold-Down Tool Hardware Kit 2236233, at Rev. 0; added Chapter 7, Section 4.4.4, LCC Hold-Down Tool Assembly 2279142, at Rev. A; added Chapter 7, Section 4.5.3, Power Supply Calibration Kit 2101360, at Rev. 4; Metrolab Teslameter Kit 46-251865G4 at Rev. 1 (Chapter 7, Section 4.7.3); Coldhead Replacement Tool Kit 2300306-2 at REv. 1 (Chapter 7, Section 4.9.1); Coldhead & Compressor Installation & Maintenance Kit 46-281088G3 at Rev. 5 (Chapter 7, Section 4.9.2); Sav-Con & Instrumentation Lead Tool Kit 46-294872G3 at Rev. 2 (Chapter 7, Section 4.11.1)

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Rev.	Date	Primary Reason(s) for Change
10		Incorporates RA-series magnets, latching LEMO connector, remote MRU and HDe/HDx enclosures. Where appropriate, 2325852 rev. 4 HII feedback incorporated in 2192624 rev. 10: added lockout/tagout, renamed 'Shimming' as 'Shim Current Adjustment' (per HII), added procedure timings, switched to Nonmagnetic Tools Kit 46-320273G4 and use of HDx Service Platform 5155291, corrected/expanded parts lists (where applicable), corrected V2 venting pressures, Magnet Monitor alarm control and various wording enhancements/corrections. Also elaborated the Coldhead shut-down process (where applicable), updated information on other manuals and corrected drift rate formula. Uses 2005FW46 CEM DTDs.
		Chapter 1, Safety: • Helium pressure before starting service changed back to "< 0.2 psig" in the Service Procedure Safety Requirements table in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements. • Added Chapter 1, Section 3, OSHA Lockout Tagout Requirements, and Chapter 1, Section 4, LOCKOUT TAGOUT Procedure and Checklist. • Relocated Chapter 1, Section 5, Emergency Rampdown of Magnetic Field, to end of Safety chapter and corrected Emergency Rampdown Method 2.
		Chapter 2, Introduction: • Updated pre-installation manual information, removed obsolete Signa Service Manual Set text and intranet URL and made corrections to the checklists and flowchart in Chapter 2, Section 2, Documentation Organization, including renaming 'Shimming' section in this manual to 'Shim Current Adjustment' and adding mention of LV Shim procedure in appropriate Service Methods. • Moved 'Emergency Rampdown of Magnetic Field' to Safety chapter. • Added Chapter 2, Section 5, Damage In Transportation.

		Chapter 3, Set-Up and Calibration:
		• Added air-ship configuration parts tables, ground-ship configuration illustration, an on-site lifting rail storage 'Notice' and corrections/rewording to Chapter 3, Section 1.2, Conversion to Operating Configuration.
		• Chapter 3, Section 1.3, Venting Installation: added part numbers to hardware in Helium Vent Kit 46-318057G6 Assembly illustration, added vent pipe shortening 'Notice', corrected wave guide to vent pipe gap dimension, added cleanup step, 'Caution' and 'Notice' and some rewording.
		• Chapter 3, Section 1.6, Magnet Rundown Unit (MRU) Installation, rewritten to include remote MRU installation.
		• New Chapter 3, Section 1.8.1, HDx Service Platform 5155291 Set-Up, section.
		• Chapter 3, Section 7.2, Ramping Procedure:
		  • Reconfigured to eliminate redundant overhead subsections and corrected Main Lead Extension removal to insert flow hole screws after leads have been removed instead of before.
		  • Corrected amperage of probe lock-on (two places) and millivolts/amperage in resistance checks.
		  • Added Shim Power Supply 46-260777G3 to 'Tools and Test Equipment' list and to two mobile site ramping sections.
		• Reconfigured Chapter 3, Section 8, Shimming, to eliminate redundant overhead subsections and renamed as 'Shim Current Adjustment' (per HII).
		• Chapter 3, Section 9, Polarity and Functional Checks, updated for both R-series and RA-series magnets.
		• Chapter 3, Section 10, Field Adjustment after Shimming: Corrected Main Lead Extension removal to insert flow hole screws after leads have been removed instead of before; corrected resistance value.

		Chapter 4, Functional Checks: • New final parking (ATR's "Recommended Site Parking Field" ± 0.5 Gauss) magnetic field strength in Chapter 4, Section 1, Magnet Functional Checks • Added yearly checks to Chapter 4, Section 6, Magnet Rundown Unit (MRU) Checks • Changed Chapter 4, Section 9, Magnet Quenches, to emphasize reporting all quenches.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Rev.	Date	Primary Reason(s) for Change
10 (cont.)		**Chapter 5, Replacement & Maintenance**: • Modified existing Chapter 5, Section 5, Upper and Side Enclosure Removal, section to reference HDe/HDx enclosure procedures. • Corrected millivolts/amperage in resistance checks and Main Lead Extension removal to insert flow hole screws after leads have been removed instead of before in Chapter 5, Section 6, Magnet Rampdown to Zero Field. • Changed Seal-Off Operator to 46-260267P3 in Chapter 5, Section 10, Two-Stage Cryocooler Coldhead Replacement. • Added support for G10 Sleeve Assembly with Latching LEMO (5130298) and Latching LEMO Tool Kit (5158913) in Chapter 5, Section 14, Instrumentation Lead Assembly Replacement.
		Chapter 6, Schematics & Interconnects: • Added remote MRU option to Chapter 6, Section 1.1, Magnet System Interconnects • Added remote MRU option to the Sleeve Connections and the Main Coil Heater Rundown Wiring illustrations and Voltage Monitor & Switch Heaters Cable (46-260724G1) pinouts/signals in Chapter 6, Section 2.1, Magnet System Wiring
		Chapter 7, Renewal Parts: • Updated LCC Wide Open Manual Collector 2226310 to Rev. 5 in Chapter 7, Section 1.3, GE and Vendor Manuals; LCC Magnet Assembly 2243832 in Chapter 7, Section 2.1, LCC Magnet Assemblies, to Rev. 21; Chapter 7, Section 2.2.1, Shim Lead Assembly 2173354, to Rev. 7; Chapter 7, Section 2.2.2, Shim Lead Assembly, Short 2285073, to Rev. 3;Chapter 7, Section 3.2.1, Helium Vent Kit 46-318057G6, to Rev. 2 and corrected graphic; Chapter 7, Section 3.5.6, Core Cable Kit 2350809, to Rev. 2;Chapter 7, Section 3.9.3, Coldhead Assembly 2218465, to Rev. 5; Chapter 7, Section 3.9.4, High Efficiency Coldhead Assembly 2218465-3, to Rev. 1; Chapter 7, Section 4.9.1, Coldhead Replacement Tool Kit 2300306-2, to Rev. 2; and Chapter 7, Section 4.9.2, Coldhead, Compressor Service Kit 46-281088G3, to Rev. 6. • Changed 'Description' of 2218291-3 in Chapter 7, Section 3.9.4, High Efficiency Coldhead Assembly 2218465-3, to “High Efficiency Cryocooler Coldhead, Sumitomo RDK-408A2” (by dropping the “-D” shown in Sumitomo documentation) in order to match other GE Heathcare documentation. • Added HDe/HDx LCC Fixed Site Shipping Collector 5162573 Rev.1 in Chapter 7, Section 1.2, Magnet System Shipping Collectors; HDe/HDx LCC Manual Collector 5169275, in Chapter 7, Section 1.3, GE and Vendor Manuals;Chapter 7, Section 3.4.2, Remote MRU Kit 5128755, Rev. 1; Chapter 7, Section 3.5.3, Magnet Monitor Kit, Fixed BRM-CRM 2222520, Rev. 4; Chapter 7, Section 3.5.4, Magnet Monitor Kit, Mobile BRM-CRM 2222520-2, Rev. 5; Chapter 7, Section 3.8.3, SHI WC, HV Compressor Cable Kit 2274978, Rev. 0; Chapter 7, Section 4.11.2, Latching LEMO Tool Kit 5158913, at Rev. 1 within new 'Connector Tools' subsection (also containing Chapter 7, Section 4.11.1, Sav-Con, Inst. Lead Tool Kit 46-294872G3); and Chapter 7, Section 4.14.1, Nonmagnetic Tools Kit 46-320273G4, Rev. 0.
		Chapter 8, Data Sheets: Deleted duplicate 'Magnet Uncompensated Drift Log'.
		Appendices: Added enclosure procedures from Direction 5155500, *Signa HDx MR Service Methods* (System Version 14.x), as Appendix A, starting with Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table of Contents

CHAPTER 1 SAFETY 21
1 Safety Alert Usage 21
2 2301164PRE, MR Magnet -- Safety Requirements 22
2.1 Magnet Safety 22
2.1.1 Magnet Safety Considerations 22
2.1.2 Emergency Situations Description 28
2.2 Superconducting Magnets 28
2.2.1 Introduction 28
2.2.2 Cryogen Safety Requirements 29
2.2.2.1 Site Precautions 29
2.2.2.2 Equipment Handling Precautions 29
2.2.2.3 Cryogen Handling Precautions 30
2.2.2.4 Magnet Service Precautions 30
2.2.2.5 First Aid/Emergency Situations 31
2.2.3 Magnet Field Safety Requirements 31
2.2.3.1 Site Precautions 31
2.2.3.2 Ramping Precautions 32
2.2.3.3 Emergency Ramp-down of Magnet 32
2.2.4 Magnet and Cryogens Service Safety Requirements 33
2.2.5 Buddy System Requirements and Certification 35
3 OSHA Lockout Tagout Requirements 39
3.1 Scope 39
3.2 Application 39
3.3 Exceptions 39
3.4 Purpose 39
3.5 General Application 39
3.6 Definitions 40
3.6.1 Energy-isolating device: 40
3.6.2 Energy source: 40
3.6.3 Lockout: 40
3.6.4 Lockout device: 40
3.6.5 Tagout: 40

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.6.6 Tagout device: . . . 40
3.6.7 Lockout / tagout: . . . 40
3.7 Application of Control . . . 40
4 LOCKOUT TAGOUT Procedure and Checklist . . . 42
5 Emergency Rampdown of Magnetic Field . . . 44
5.1 Description . . . 44
5.2 Emergency Rampdown Procedure . . . 44
5.2.1 Method 1 . . . 44
5.2.2 Method 2 . . . 45
5.2.3 Method 3 . . . 47
5.2.4 Method 4 . . . 47

CHAPTER 2 INTRODUCTION . . . 49
1 Direction Application . . . 49
2 Documentation Organization . . . 50
2.1 Subsystem Manual (Direction 2192624) Organization . . . 50
2.2 Magnet Siting & Installation Checklist . . . 51
2.3 Magnet Commissioning Flowchart & Checklist . . . 54
3 Vendor Manual Matrix . . . 56
4 Component Designations . . . 57
4.1 Explanation of Designator System . . . 57
4.2 Component Identification . . . 58
4.2.1 MS1 Component Designations . . . 58
4.2.2 MS4 Component Designations . . . 60
4.2.3 MS5 Component Designations . . . 61
4.2.4 MS6 Component Designations . . . 62
4.2.5 MS7 Component Designations . . . 63
5 Damage In Transportation . . . 64

CHAPTER 3 SET-UP AND CALIBRATION . . . 65
1 Magnet System Installation . . . 65
1.1 Overview of Magnet System Installation . . . 65
1.2 Conversion to Operating Configuration . . . 67
1.3 Venting Installation . . . 79

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.4 System Leak Test . . . 85
1.5 Cryocooler Installation and Checkout . . . 89
1.6 Magnet Rundown Unit (MRU) Installation . . . 105
1.7 Magnet Monitor Installation . . . 116
1.8 Service Platform Set-Up . . . 117
1.8.1 HDx Service Platform 5155291 Set-Up . . . 117
1.8.2 Ladder-Platform 2319156 Set-Up . . . 123
1.8.3 Ladder-Platform 2230707 2230707-2 Set-Up . . . 127
2 Magnet Commissioning Checks . . . 134
3 Precool & Fill . . . 141
3.1 Nitrogen Purge-Precool . . . 141
3.2 Liquid Helium Fill . . . 155
4 Preparations for Field Measurement . . . 173
5 Shim Lead Engagement and Disengagement . . . 196
6 Connections for Ramping and Shimming . . . 201
7 Ramping Magnet to Field . . . 218
7.1 Ramping Overview . . . 218
7.2 Ramping Procedure . . . 220
8 Shim Current Adjustment . . . 283
9 Polarity and Functional Checks . . . 295
10 Field Adjustment after Shimming . . . 315

CHAPTER 4 FUNCTIONAL CHECKS . . . 335
1 Magnet Functional Checks . . . 335
2 Temp. Pressure and Leak Troubleshooting . . . 337
2.1 Overview . . . 337
2.2 Preliminary Requirements . . . 337
2.2.1 Tools and Test Equipment . . . 337
2.2.2 Consumables . . . 337
2.2.3 Replacement Parts . . . 338
2.2.4 Safety . . . 338
2.2.5 Required Conditions . . . 338
2.3 Procedure . . . 338
2.3.1 Troubleshooting Guide . . . 338

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.3.1.1 Chiller and Compressor Checks . . . 341
2.3.1.2 Magnet Checks . . . 342
2.3.1.3 Coldhead Checks . . . 345
2.3.2 Leak Troubleshooting . . . 347
2.3.2.1 Introduction . . . 347
2.3.2.2 Pressure . . . 349
2.3.2.3 Leak Detection . . . 349
2.3.2.4 Plumbing and O-Ring Leaks . . . 350
2.3.2.5 Leaks at Burst Disc . . . 350
2.3.3 Assistance for Florence-Manufactured Magnets . . . 350
3 Temperature Sensor Checks . . . 352
4 Field Stability Check . . . 358
5 Magnet Electrical Checks . . . 362
6 Magnet Rundown Unit (MRU) Checks . . . 367
7 Cryocooler Checks . . . 372
8 Main Power Supply Tests . . . 375
8.1 Main Power Supply Introduction . . . 375
8.2 TCR 7.5T750 Main Power Supply Tests . . . 376
8.3 ESS7.5-1000-2-D-1236 Main Power Supply Tests . . . 391
9 Magnet Quenches . . . 402

CHAPTER 5 REPLACEMENT & MAINTENANCE . . . 407
1 Periodic Checks and Maintenance . . . 407
2 Cryocooler System Gas Pressure Adjustments . . . 408
3 Helium Flexline Connections and Casing Replacement . . . 415
4 Main Lead Extension Contact Band Replacement . . . 421
5 Upper and Side Enclosure Removal . . . 424
6 Magnet Rampdown to Zero Field . . . 428
7 Cryostat Warm-Up . . . 457
8 Re-Evacuation of Cryostat . . . 470
9 Ice Removal . . . 472
9.1 Ice Removal Overview . . . 472
9.2 Ice Removal Procedures . . . 473
10 Two-Stage Cryocooler Coldhead Replacement . . . 494

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

11 Burst Disc Replacement . . . 543
11.1 Burst Disc (2349529) Replacement . . . 543
11.2 Burst Disc (2194545-7) Replacement . . . 556
12 Shim Lead and Baffle Replacement . . . 567
13 Sav-Con Connector Replacement . . . 580
14 Instrumentation Lead Assembly Replacement . . . 592
15 Preparation for Site Removal . . . 610

CHAPTER 6 SCHEMATICS & INTERCONNECTS . . . 613
1 Interconnect Diagrams . . . 613
1.1 Magnet System Interconnects . . . 613
1.2 Magnet Monitor Interface . . . 614
1.3 Cryocooler System Interconnects . . . 615
1.4 Magnet Thermal System Schematic . . . 616
2 Wiring Diagrams . . . 617
2.1 Magnet System Wiring . . . 617
2.2 RuO Circuits and Pinouts . . . 624
2.3 Magnet Monitor Cables . . . 625
3 Power Supplies . . . 633
3.1 750 Amp Main Coil Power Supply . . . 633
3.2 1000 Amp Main Coil Power Supply . . . 634
3.3 Shim Coil Power Supply . . . 635
3.4 Phase III-A Power Supply . . . 636
3.5 Power Supply Connector Pinouts . . . 637

CHAPTER 7 RENEWAL PARTS . . . 641
1 Magnet System . . . 641
1.1 Magnet Model and Assembly Numbers . . . 641
1.2 Magnet System Shipping Collectors . . . 642
1.3 GE and Vendor Manuals . . . 645
2 Magnet Components . . . 646
2.1 LCC Magnet Assemblies . . . 646
2.2 Shim Lead Assemblies . . . 652
2.2.1 Shim Lead Assembly 2173354 . . . 652

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.2.2 Shim Lead Assembly, Short 2285073 654
3 Magnet Accessories 656
3.1 Magnet Leveling Kit 46-260888G4 656
3.2 Helium Vent Kits 657
3.2.1 Helium Vent Kit 46-318057G6 657
3.2.2 Helium Vent Kit, Fixed Sites 46-318057G1 659
3.2.3 Helium Vent Kit, Mobile Sites 46-318057G2 660
3.3 Cryogen Monitor 2122498 661
3.4 Magnet Rundown Unit (MRU) 662
3.4.1 MRU Kit Assembly 2128700 662
3.4.2 Remote MRU Kit 5128755 663
3.4.3 MRU 46-294231G1 664
3.5 Magnet Monitor Kits 665
3.5.1 Magnet Monitor Kit, Fixed TRM 2304069 665
3.5.2 Magnet Monitor Kit, Mobile TRM 2304069-2 666
3.5.3 Magnet Monitor Kit, Fixed BRM-CRM 2222520 667
3.5.4 Magnet Monitor Kit, Mobile BRM-CRM 2222520-2 668
3.5.5 Global Modem Kit 2245794 669
3.5.6 Core Cable Kit 2350809 670
3.5.7 TRM Cable Kit 2350813 671
3.5.8 Mobile TRM Cable Kit 2350818 672
3.6 Ramp and Shim Cable Kit 2171719 673
3.7 Gradient Collectors 674
3.7.1 Fixed TRM Gradient Collector 2297123 674
3.7.2 Mobile TRM Gradient Collector 2297124 675
3.7.3 Fixed BRM-F Gradient Collector 2222521 676
3.7.4 Mobile BRM-F Gradient Collector 2222560 677
3.7.5 Fixed CRM-WO Gradient Collector 2230589 678
3.7.6 Mobile CRM-WO Gradient Collector 2230589-2 679
3.8 Compressor Kits 680
3.8.1 SHI Shield Cooler Compressor 2188440-2 680
3.8.2 SHI WC, HV Compressor Cable Kit 2211446 681
3.8.3 SHI WC, HV Compressor Cable Kit 2274978 682

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.9 Coldheads and Gaskets . . . 683
3.9.1 Coldhead and Gaskets Kit 2194003 . . . 683
3.9.2 Coldhead and Gaskets Kit 2194003-2 . . . 684
3.9.3 Coldhead Assembly 2218465 . . . 685
3.9.4 High Efficiency Coldhead Assembly 2218465-3 . . . 686
3.9.5 Cryocooler Replacement Gaskets Kit 2171620 . . . 687
3.10 Field Spares Kit 46-294744G5 . . . 688
3.11 Miscellaneous Items . . . 689
4 Service Tool Kits and Components . . . 690
4.1 Safety Items . . . 690
4.1.1 Safety Signage Kit 46-258770G4 . . . 690
4.1.2 Cryogen Safety Wear Kit 46-271137G1 . . . 691
4.2 Measuring and Monitoring Tools . . . 692
4.2.1 Digital Thermometer Kit 46-301477G2 . . . 692
4.2.2 RuO Temperature Monitor Kit 2183710 . . . 694
4.2.3 Temperature Diode Box 46-317543G1 . . . 695
4.2.4 Temperature Diode Box 46-317543G2 . . . 696
4.2.5 TAO Monitor 46-281406G1 . . . 697
4.2.6 Fill Line Adapter for TAO 46-281232G1 . . . 698
4.2.7 Shield Cooler Test Kit 46-318784G2 . . . 699
4.2.8 Water Tee Assembly 46-318696G1 . . . 701
4.2.9 Water Flow Meter Kit 46-294052G1 . . . 702
4.3 Cryogen Service Tools and Equipment . . . 703
4.3.1 Universal Fill Line Kit 46-294705G1 . . . 703
4.3.2 Liquid Helium Transfer Line Kit 46-294513G1 . . . 704
4.3.2.1 Dewar Stingers, Helium and Nitrogen Transfer Lines . . . 704
4.3.2.2 Helium Transfer Line Kit Renewal Parts . . . 705
4.3.3 Other Helium Transfer Service Items . . . 706
4.4 Ramping Tools and Equipment . . . 707
4.4.1 Magnet Ramping Equipment Kit 46-260703G5 . . . 707
4.4.2 2.5M Ceiling Height Kit M1060SR . . . 709
4.4.3 Hold-Down Tool Hardware Kit 2236233 . . . 710
4.4.4 LCC Hold-Down Tool Assembly 2279142 . . . 711

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.5 Power Supply Service 712
4.5.1 Main and Shim Coil Power Supplies 712
4.5.2 Power Supply Renewal Parts 713
4.5.3 Power Supply Calibration Kit 2101360 715
4.6 Cable Kits 716
4.6.1 750A Ramp Cable Kit 2135435 716
4.6.2 1000A Ramp Cable Kit with Ground 2353394 717
4.6.3 2135435 to 2353394 Upgrade Kit 2353397 718
4.6.4 Shim Cable Kit 2135558 719
4.6.5 Auxiliary Rampdown Cable 2217315 720
4.7 Field Measurement and Mapping Tools 721
4.7.1 Field Mapping Fixture 46-294060G4 721
4.7.2 Mapping Fixture Upgrade Kit 2163971 724
4.7.3 Metrolab Teslameter Kit 46-251865G4 725
4.8 Region Shim Kit 2181921 727
4.9 Coldhead Service Tools 728
4.9.1 Coldhead Replacement Tool Kit 2300306-2 728
4.9.2 Coldhead, Compressor Service Kit 46-281088G3 730
4.9.3 Fixed Site Coldhead Changeout Kit 2232674 732
4.9.4 Mobile Site Coldhead Changeout Kit 2275779 733
4.9.5 Other Coldhead, Compressor Service Items 735
4.10 Vacuum Tools and Equipment 736
4.10.1 Shield Cooler Vacuum Pump Kit 46-294047G1 736
4.10.2 Vacuum Maintenance Equipment 738
4.11 Connector Tools 739
4.11.1 Sav-Con, Inst. Lead Tool Kit 46-294872G3 739
4.11.2 Latching LEMO Tool Kit 5158913 741
4.12 Gradient Insertion Tool Kit 2164744-5 742
4.13 Service Ladder-Platform 2230707, 2230707-2 743
4.14 General Tools 745
4.14.1 Nonmagnetic Tools Kit 46-320273G4 745

CHAPTER 8 DATA SHEETS 749

1 Magnet Commissioning Log 749

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2 Liquid Helium Refill Log . . . 750
3 Helium Fill Data . . . 751
3.1 Helium Fill Data Sheet . . . 751
3.2 Fill History . . . 751
4 Volumetric Conversion of Helium Level . . . 752
4.1 Volumetric Conversion of Liquid Helium Level (Liquid Helium Meter Reading to Liquid Liters Correlation) . . . 752
4.2 Volumetric Conversion of Liquid Helium Level . . . 753
5 Magnet Ramping and Parking Current Log . . . 754
6 Magnet Uncompensated Drift Log . . . 755
7 Shim Plot Data . . . 756
8 Calculated Shim Coil Correction Currents . . . 757
9 Shim Size and Location Map . . . 758
10 Magnet Temperature and Pressure Data . . . 759

APPENDIX A MAGNET ENCLOSURES . . . 761
1 HDe/HDx Magnet Enclosure Removal/Installation . . . 761
1.1 Introduction to HDe, HDx Enclosures . . . 761
1.2 Side Cover Removal and Install . . . 762
1.3 Skirt Cover Removal and Install . . . 773
1.4 Front End Bell Removal and Install . . . 777
1.5 Front Cover Removal and Installation . . . 784
1.6 Rear End Bell Removal and Install . . . 789
1.7 Rear Cosmetic Ring Removal and Install . . . 795

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

This page left intentionally blank.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Chapter 1 Safety

1 Safety Alert Usage

The following ANSI (American National Standards Institute) Z535.4 definitions are applied to notify users of the potential for **personal** injury:



DANGER

INDICATES AN IMMINENTLY HAZARDOUS SITUATION THAT, IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS INJURY. DANGER IS LIMITED TO EXTREME SITUATIONS.



WARNING

INDICATES A POTENTIAL HAZARDOUS SITUATION THAT, IF NOT AVOIDED, COULD RESULT IN DEATH OR SERIOUS INJURY.



CAUTION

Indicates a potential hazardous situation that, if not avoided, may result in minor or moderate injury.

The following ANSI Z535.2 definition is applied to notify users of the potential for property damage only:



NOTICE

Indicates information or company policy that relates directly or indirectly to the safety of personnel or protection of property.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2 2301164PRE, MR Magnet -- Safety Requirements

2.1 Magnet Safety

2.1.1 Magnet Safety Considerations

The Magnetic Resonance Imaging (MRI) System utilizes a magnet, which can have a field strength several thousand times greater than that of the earth's magnetic field. The magnetic field surrounding the magnet is called the fringe field, and it extends form the magnet's isocenter in all dimensions. The fringe field may present a hazard to personnel and equipment within the surrounding area. 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 minimize the risk to personnel and equipment when the magnet is at field, follow the precautions listed below:

1. Post “SECURITY ZONE” signs, on both sides of any doors that lead into the magnet room to alert personnel of the high magnetic field and not to bring ferromagnetic objects into the magnet room. See Illustration 1-1 and Illustration 1-2. For Systems with field strengths less than 3.0T use part number 46-255325P1 (Illustration 1-4). For 3.0T Systems use part number 2360019 (Illustration 1-5). For a 7.0T System use part number 2360019-2. For a 9.4T System use part number 2360019-3.
2. Post “WARNING” signs, part number 46-255326P1, 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 1-3. Post these signs two days prior to the activation of the magnet for maximum impact
3. Set up the “AUTHORIZED PERSONNEL” signs, part number 2289812, at the entrance(s) to the magnet room prior to the start of magnet service procedures. See Illustration 1-6.
4. Notify responsible personnel two days prior to the activation of the magnet to allow for preparatory actions to be accomplished
5. Do not bring ferromagnetic objects (including TOOLS, pens, tape measures, and vacuum pumps) into the magnet room when the magnet is at field unless otherwise called for in the service documentation
6. Measure the gauss levels in the surrounding area and make sure the 5, 100, and 250 gauss zones are specified for the site
7. Do not bring ferromagnetic objects within the 250 gauss zone and do not bring ferromagnetic objects on wheels within the 100 gauss zone
8. Use only nonmagnetic cylinders, nonmagnetic cylinder carts, and Dewars when transferring cryogens into an energized Superconducting magnet
9. 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
10. Identify the magnetic field strength of the system before entering the Magnet Room to perform service procedures. For Systems with a magnetic field strength of 3.0T and higher the field strength is displayed on the Security Sign posted on the magnet room door
11. Do not bring the non-magnetic tool kit into the magnet room. The case has ferrous components that will result in it being attracted to the magnet in field zones > 500 gauss

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTE: The Local GE Field Service Operation will provide the signs in the primary local languages. The highly visible (orange, black, and white) security and warning signs are available from GE under the following catalog numbers:

- E8819AA: MR Warning Sign Kit (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)
- 2289812: Authorized Personnel Warning Sign, in English

Illustration 1-1: Security Sign on Outside of all Magnet Room Doors



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 1-2: Security Sign on Inside of Magnet Room Doors the Open Outward



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 1-3: Magnet Field Warning Sign (46-255326P1)



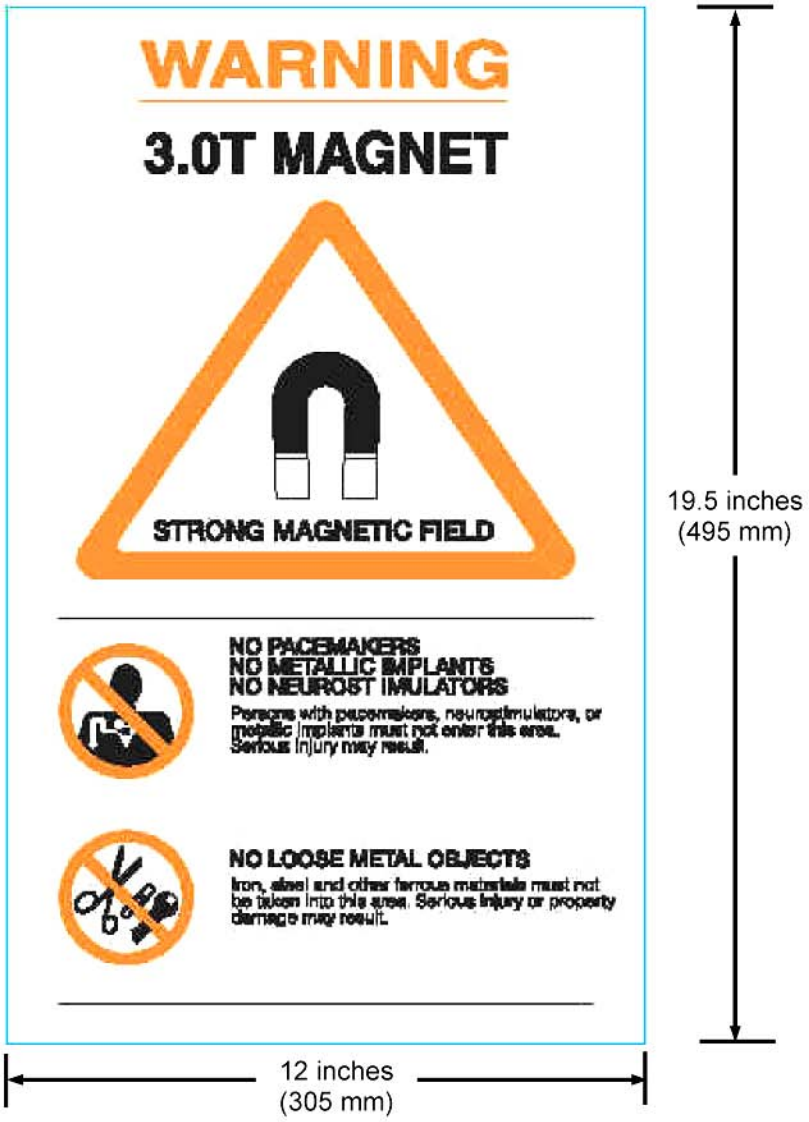
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 1-4: Magnetic Field Security Zone Sign (46-255325P1) for Magnets < 3.0T



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 1-5: Example of Magnetic Field Security Sign for Magnets 3.0T and Higher



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 1-6: Authorized Personnel Sign (2289812)



2.1.2 Emergency Situations Description

The Magnet technology used on MR Systems may vary from one product design to another. There are 3 basic magnet technologies used by suppliers today: 1) Superconducting Magnets, 2) Permanent Magnets, and 3) Resistive Magnets. Each magnet technology will have emergency response processes unique to that design. For example, If a person is pinned to the magnet by a ferromagnetic object or that object has become attached to the magnet then the Magnet technology will dictate the appropriate action to be taken. Therefore, go to the appropriate Magnet section in this document and refer to the First Aid/Emergency Situations subsection for specific actions. Revision 1 of this document addresses designs relating to Superconducting Magnets. The sections for Permanent Magnets and Resistive Magnets will be included in a future update of this document

2.2 Superconducting Magnets

2.2.1 Introduction

Superconducting magnets contain cryogenic liquids (liquid helium = -452°F, -269°C; liquid nitrogen = -320°F, -196°C) and generate a three-dimensional magnetic field several thousand times the strength of the earth's magnetic field. These conditions require safety precautions to be taken to prevent serious injury (cryogenic burns, asphyxiation, explosion, fire, shock, ferromagnetic projectiles or other magnetic field effects). The safety precautions/requirements contained in the following sections must be reviewed, understood and implemented prior to performing any service on a Superconducting Magnet. Make sure that all magnet service is performed by trained/authorized personnel and all safety equipment is in place

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

All persons working with cryogenic liquids should understand the following:

- 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

2.2.2 Cryogen Safety Requirements

2.2.2.1 Site Precautions

The Field Service Engineer is responsible to make sure the following items are in compliance:

- Review all service processes to be performed on the magnet with the facility safety officer or with the local authorities (i.e. fire department, safety council, etc.) and obtain any required permits prior to magnet commissioning and servicing.
- Magnet room venting shall be installed, tested, and operating in conformance with site planning requirements.
- A portable floor fan and exhaust duct shall be used to remove the cold nitrogen gas that stratifies at floor level, from the room to the outside, during nitrogen pre-cool.
- The magnet shall be vented in conformance with the site planning requirements. Magnet plumbing and vent system shall be inspected for leaks during magnet installation.
- The door into the magnet room must be secured in the open position prior to any service action that will result in the handling or release of cryogens from the magnet. The ceiling hatch and rear door shall be secured in the open position if in a mobile van.
- Any service actions, which release large quantities of cryogenic gas, shall have provisions for exhausting the gas through the magnet vent system.
- Make sure a second person (GE, contractor, or hospital personnel trained in these safety requirements) is present in the area during magnet service in case of emergency.
- A working phone line accessing an outside line shall be available in case of an emergency.
- Set up “Authorized Personnel Only” signs outside the magnet room door(s) prior to any magnet servicing.
- Make sure an Oxygen Monitoring device is calibrated and operating properly before beginning any magnet service.
- Always maintain a clear exit path no less than 28 inches wide.

2.2.2.2 Equipment Handling Precautions

- Do not bring any ferromagnetic equipment, Dewars or cylinders into the magnet room when the magnet is ramped. They will become dangerous projectiles in the presence of the magnetic field.
- Helium gas cylinders are pressurized to 2400 psi. Secure each helium cylinder before removing the protective cap and open the main valve very slowly to prevent any possibility of a fatal release of explosive gas. Make sure gas cylinders are stored in an upright secured position.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

- Firmly hold the unattached end of the gas hose during a purge to prevent hose's "whipping" motion.
- Keep Dewars in the vertical position at all times. Dewars should have wheels mounted at the base for transport. If wheels are not present, use a low platform dolly, which fully encompasses the Dewar's base for moving. Do not slide or roll Dewars. Use a suitable hand truck to move gas cylinders.
- Make sure the transportation route for Dewars and gas cylinders is clear of obstacles and restrictions.
- Check Dewars for high pressure and follow documented service procedures for reducing pressure prior to use.
- Check all equipment, Dewars, and gas cylinders for leaks.
- Make sure that safety relief valves and regulators are operating properly.
- Store Dewars in a well ventilated area as outlined in the room ventilation pre-installation manual.

2.2.2.3 Cryogen Handling Precautions

- Contact of liquid cryogens or their vapors with the eyes can cause severe frostbite even when contact is too brief to affect the skin. Always wear safety glasses and face shield when handling cryogens.
- Never allow any unprotected part of the body to touch cold magnet plumbing.
- Protective clothing (long sleeve shirt, long pants, protective apron/jacket) and dry, non absorbent insulated gloves shall be worn when handling or being exposed to cryogens, to prevent cold burns from contact with the cryogenic liquid or gas.
- Make sure a calibrated, functioning oxygen monitor is installed in the magnet room in conformance with site requirements or place a functioning portable oxygen monitor in the magnet room and cryogen storage area. The position of the O_2 monitor sensor should be at a level that corresponds to the cryogen product being stored or dispensed (i.e., for liquid helium the sensor should be near the ceiling; for liquid nitrogen the sensor should be near the floor).
- Smoking is prohibited in the magnet room and around cryogens. Liquid cryogens can liquefy atmospheric oxygen producing a highly enriched oxygen liquid.
- When pluming a stinger, always point the stinger toward the ceiling and away from the face at a 45 degree angle.
- Do not bring more than 1000 liters or 2 Dewars (whichever is less) of cryogens into the magnet room.
- Do not bring nitrogen and helium Dewars into the magnet room at the same time.

2.2.2.4 Magnet Service Precautions

- **RAMP MAGNET DOWN TO ZERO FIELD** prior to any service requiring opening/exposure to the helium vessel and/or cryogenic gas/liquid, except for the removal of fill and ramp lead port caps, to prevent the possibility of a magnet quench and rapid expulsion of cryogenic helium gas and liquid.
- Make sure non-ferromagnetic fiber or composition safety shoes are worn in the magnet room.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

- Observe helium vessel pressure gauge and vent the magnet down to < 0.5 psi before removing ramp/fill port caps or loosening component resulting in the release of cryogenic helium gas and liquid.
- Never allow a helium Dewar to empty during a magnet fill, resulting in a magnet quench from the introduction of warm helium gas.
- Wear proper personal protective equipment (PPE).
- Use caution when inserting ramp leads or a shim lead into a ramped magnet to prevent a quench.
- Avoid rapid head and eye movements when working near or inside the magnet bore to minimize dizziness.
- Always have a work buddy available when performing work near or inside the magnet bore.
- Never allow yourself to be positioned between the magnet and any unknown objects that may be brought into the magnet room.
- Limit the access into the magnet room before performing service in the room. This can be achieved by installing a Yellow & Black Caution tape across the door opening and placing the “Authorized Personnel” sign below it.
- Identify the type of Magnet and it’s field strength before performing service in the magnet room. The Security signs for systems with Magnetic Field Strengths 3.0T and higher are installed on the entrance doors into the magnet room. These signs indicate the field strength of the magnet that is inside the room.
- Use caution when using the non-titanium tools on magnets with a field strength of 3.0T and higher as they do have an attraction to the magnet at fields over 500 gauss.
- Do not bring the non magnetic tool kit into the magnet room. It will become attracted to the magnet if exposed to a field > 500 gauss.

2.2.2.5 First Aid/Emergency Situations

- Notify proper emergency responders.
- Do not make any rescue attempts until the environment has been verified as being safe for normal occupancy, then move persons suffering from a lack of oxygen immediately to an area with normal atmosphere and seek medical assistance.
- Use large volumes of tepid water, within the temperature range of 105°F (41°C) to 115°F (46°C), to flush frostbitten or cold burn areas and get medical attention immediately. Notify the physician that this is a cold burn.
- In case of a magnet cryogenic vent failure during a quench stay near the floor where the oxygen will be and immediately exit the magnet room.
- 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.

2.2.3 Magnet Field Safety Requirements

2.2.3.1 Site Precautions

The magnet will create a fringe field that may present a hazard to other personnel working or visiting near the MR Suite. Make sure these precautions are followed to minimize risk to personnel.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

- Measure the gauss levels in the surrounding area and make sure the 5, 100, and 250 gauss zones are specified for the site.
- Install the Security Zone signs on all doors leading into the magnet room. For magnets with a field strength of 3.0T and higher these signs will identify the field strength of the magnet inside the room. If the door swings outward from the magnet room then the signs must be installed on both sides of the door.
- Post warning signs outside the 5 gauss zone, including areas above and below the magnet room, prior to ramping the magnet to warn personnel with cardiac pacemakers, neurostimulators, steel plates or other conditions affected by a magnetic field not to proceed into the area.
- Post “Ramped Magnet” warning sign at magnet room entrance prior to ramping the magnet.
- Notify site administration before ramping the magnet.
- Remove all ferromagnetic material from the magnet room that is not properly installed on the system.
- Prior to ramping the magnet make sure that the Magnet Rundown Unit (MRU) is operating properly.
- Do not bring any ferromagnetic tools or objects into the magnet room when the magnet is ramped unless specifically called for in the service documentation.
- Do not bring ferromagnetic objects within the 250 gauss zone and do not bring ferromagnetic objects on wheels within the 100 gauss zone.
- Do not loosen any ferromagnetic components on a ramped magnet unless specifically called for in the service documentation.
- Wear leather gloves when opening or closing the coldhead motor shield.
- Use caution when opening or closing the top half of the coldhead motor shield. Never put your hand or fingers between the motor shield and mounting bracket.

2.2.3.2 Ramping Precautions

A Superconducting magnet at field is a high energy storage device capable of discharging rapidly (quenching), creating a high voltage across the main leads. Make sure the following precautions are observed when ramping a Superconducting magnet.

- When working with the main lead connections that are installed into a ramped magnet do not touch both main lead extensions at the same time or allow them to come in contact with one another.
- Allow main lead extensions to cool before fully inserting them into a ramped magnet to prevent any possibility of a quench.
- Make sure the power supply has passed all functional checks and the input power cable is disconnected before connecting it to the main power leads.
- Make sure the final magnet “parking” current and voltage polarity has been recorded and will be available if a ramp-down is required. An incorrect polarity connection will result in a magnet quench.
- Use the appropriate hold-down tool to properly secure ramp leads to the magnet.

2.2.3.3 Emergency Ramp-down of Magnet

- Make sure the Magnet Rundown Unit (MRU) has been installed in conformance with the GE magnet service manual, the batteries have been charged for 24 hours and

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

the MRU has passed the functional checks in conformance with the supplier manual before ramping the magnet.

- Make sure the ramp-down methods covered in the introduction of the GE magnet service manual are fully understood by field service engineers involved with the MR equipment.
- Hospital personal involved with the MR equipment should be familiar with the equipment operator's manual and Magnet Rundown Unit operation.

2.2.4 Magnet and Cryogens Service Safety Requirements

Illustration 1-7: Service Procedure Safety Requirements

Safety Requirement	Service Procedure (X = Required Item For Procedure)													
	De-transiting GEMS/O Magnet & Vacuum	Conversion to Operating Configuration	Venting Installation	Nitrogen Precool / Purge	Helium Precool / Warm-Up	Helium Fill / Top-Off	Magnet Ramping	Magnet S/C Shim	Magnet P-Shim	Burst Disk / Plumbing Component Replacement	Magnet / Recondenser De-Icing	Shim Lead Replacement	Baffle / Instrumentation Lead Replacement	Cryo-cooler Service
1. Cryogenic vent system installed per requirements.	-	-	-	X	X	X	X	X	-	X	X	X	X	X
2. Special permits obtained, if required by local authorities, for use of inert gasses / cryogens during magnet commissioning and service procedures.	X	X	-	X	X	X	X	-	X	X	X	X	X	X
3. Mobile van ceiling hatch secured open.	X	X	X	X	X	X	X	X	-	X	X	X	X	X
4. Room ventilation fan tested and running (room exhaust at ceiling).	-	X	X	-	X	X	X	X	-	X	X	X	X	X
5. Room ventilation fan tested and running (room exhaust at floor).	-	-	-	X	-	-	-	-	-	-	-	-	-	-
6. Vent magnet and inspect exhaust.	X	X	X	X	X	X	X	X	-	-	X	X	X	X
7. Second person on site and trained in safety practices for procedure being performed.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
8. Fully functional land-line telephone (with emergency response numbers clearly posted beside it) in known and immediately available location near Magnet Room.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
9. Magnet Room doors secured open to assist in room ventilation. Ensure cross ventilation to outside or other large volume non-workspace.	X	X	X	X	X	X	X	X	-	X	X	X	X	X
10. O_2 Monitor on site, tested and functional for both visual and audible alarms, whenever cryogens are being stored or dispensed. Portable device 2287000 for magnets up to and including 3.0T.	X	X	X	X	X	X	X	X	-	X	X	X	X	X
11. Cryogen Safety Kit (46-271137G1) on site for use. Kit includes cryogen gloves, face shield and goggles.	X	X	X	X	X	X	X	X	-	X	X	X	X	X
12. Nonferrous safety shoes.	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Continued

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 1-8: Service Procedure Safety Requirements (Continued)

Safety Requirement	Service Procedure (X = Required Item For Procedure)													
	De-transiting GEMS/O Magnet & Vacuum	Conversion to Operating Configuration	Venting Installation	Nitrogen Precool / Purge	Helium Precool / Warm-Up	Helium Fill / Top-Off	Magnet Ramping	Magnet S/C Shim	Magnet P-Shim	Burst Disk / Plumbing Component Replacement	Magnet / Recondenser De-Icing	Shim Lead Replacement	Baffle / Instrumentation Lead Replacement	Cryo-cooler Service
13. Secure area and display signs alerting of intended process.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
14. Verify dewar transportation path is clear.	-	-	-	X	X	X	X	-	-	-	-	-	-	-
15. Dewars stored in a ventilated area.	-	-	-	X	X	X	X	X	-	-	-	-	-	-
16. Not-in-use gas cylinders secured to wall with protective cap in place.	X	-	-	X	X	X	X	X	-	X	X	X	X	X
17. Before removing protective cap on gas cylinder, secure to wall or nonmagnetic cart.	X	-	-	X	X	X	X	X	-	X	X	X	X	X
18. Move gas cylinders / Dewars without wheels using hand trucks designed for purpose. (Nonmagnetic gas cylinder cart: 46-306717G1)	X	-	-	X	X	X	X	X	-	X	X	X	X	X
19. Keep gas cylinders / Dewars in upright position at all times.	X	-	-	X	X	X	X	X	X	-	-	-	-	-
20. Keep ferromagnetic equipment / objects out of magnet room when magnet is ramped.	-	-	-	-	-	X	X	X	X	X	X	X	X	X
21. Use only non-magnetic tools in the magnet room when the magnet is ramped (46-320273G4). Note: The Cast Bronze tools contain 3% iron, which make the tools more attractive to higher field strength magnets. Do not bring the tool kit into a field > 500 gauss.	-	-	-	-	-	X	X	X	X	X	X	X	X	X
22. Wear long-sleeve shirt and apron designed for cryogenic servicing.	-	-	-	X	X	X	X	X	-	X	X	X	X	X
23. Inspect all pressure regulators for proper functioning.	X	-	-	X	X	X	X	X	-	X	X	X	X	X
24. Inspect all pressure relief valves and ensure proper configuration to achieve recommended pressure (e.g., 20 psi).	X	-	-	X	X	X	X	X	-	X	X	X	X	X
25. Inspect all valves and fittings for leaks.	X	-	-	X	X	X	X	X	-	X	X	X	X	X
26. MRU installed and tested prior to magnet ramp.	-	-	-	-	-	-	X	X	X	X	X	X	X	X
27. Post “Ramped Magnet” warning signs included in kit 46-258770G4.	-	-	-	-	-	-	X	-	-	-	-	-	-	-
28. Install the Security Zone Sign, at eye level, on all doors leading into the magnet room. Install the sign on both sides of the door if the door opens outward from the magnet room.							X							

Continued

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 1-9: Service Procedure Safety Requirements (Continued)

Safety Requirement	Service Procedure (X = Required Item For Procedure)													
	De-transiting GEMS/O Magnet & Vacuum	Conversion to Operating Configuration	Venting Installation	Nitrogen Precool / Purge	Helium Precool / Warm-Up	Helium Fill / Top-Off	Magnet Ramping	Magnet S/C Shim	Magnet P-Shim	Burst Disk / Plumbing Component Replacement	Magnet / Recondenser De-Icing	Shim Lead Replacement	Baffle / Instrumentation Lead Replacement	Cryo-cooler Service
29. Post "Authorized Personnel Only" signs (2289812) at entrance to MR suite.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
30. Notify Hospital Administrator when magnet is ramping.	-	-	-	-	-	-	X	-	-	-	-	-	-	-
31. Remove all ferromagnetic material from Magnet Room before ramping or shimming magnet.	-	-	-	-	-	X	X	X	X	-	-	-	-	-
32. Use only single Dewar connection (i.e., no daisy-chain connections)	-	-	-	X	X	X	X	X	-	-	-	-	-	-
33. Identify and label Dewars as "full" or "empty"; label Dewar storage area.	-	-	-	X	X	X	X	-	-	-	-	-	-	-
34. Remove frost from valve operators on magnet after each Dewar change.	-	-	-	X	X	X	X	-	-	-	-	-	-	-
35. Notify hospital engineering personnel prior to use of any equipment (i.e., heat guns, propane torches, welding equipment, etc.) that could set off the fire alarm system.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
36. Identify and understand the properties and operation of the site's fire suppression system (i.e., water sprinkler, halon, CO_2, etc.) and how to respond to alarms.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
37. Reduce magnet helium vessel pressure to 0.2 psig before performing service.	-	X	-	-	-	X	X	X	-	X	X	X	X	-
38. Use product-defined tools and personal protective equipment (such as gloves, goggles and protective clothing) when removing or installing passive shim material / assemblies.	-	-	-	-	-	-	-	-	X	-	-	-	-	-
39. Measure the gauss levels in the surrounding area and make sure the 5, 100, & 250 gauss levels are specified for the site.							X							

2.2.5 Buddy System Requirements and Certification

The Buddy System (second person on site) is required whenever service is performed on the Superconducting magnet subsystem. It is critical that a "Buddy" is always present to ensure your safety. A "Buddy" is more than just a second person that is "around" while you are working. A "Buddy" is someone who will maintain communication with you at all times and sound the alarm in case of an emergency and may even assist in performing the service procedure, if qualified.

All individuals selected to perform the task of either "Work Assistant" or "Work Observer" must comply with the prerequisite training and complete the certification form located in Table 1-1, Worker Certification/Agreement Form. A signed copy of the certification must remain on file at the customer site

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Worker Certification/Agreement Form



NOTICE

All individuals selected to perform the task of either “Work Assistant” or “Work Observer” must comply with the prerequisites training and complete the certification. Do not allow a person to function as a buddy (second person) until all the Mandatory requirements are completed for the category being performed

Instructions: is to be completed by the individual that is being certified to function as either a Work Assistant or Work Observer

Instructions: Illustration 1-10 and Illustration 1-11 are to be completed by the Field Engineer responsible to perform any of the listed service procedures. He or she must certify the capabilities of the “Second Person” either by interview or training, and initial the appropriate “Assistant” or “Observer” column to show they have been certified

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 1-10: SECOND PERSON – BUDDY REQUIREMENTS

Safety Requirement	Work Assistant	Work Observer	Initialed by Second Person When Complete	Comments
1. Must have completed all required EHS training.	MANDATORY			
2. Completed and have on file the medical clearance form "Magnetic Resonance Employee Questionnaire For Metallic Foreign Body and Electronic Devices," available from the GEMS Medical department.	MANDATORY	MANDATORY		
3. Must have completed the magnet and cryogen safety training portion of MR 508, Principles of MRI, or MR 512, Magnet & Cryogen Safety (CD-ROM).	MANDATORY	MANDATORY		
4. Must know how to wear the proper PPE for the procedure being performed as described in the service documentation and/or demonstrated by the Site FE performing the qualification process.	MANDATORY			
5. Needs to be a FE, GE employee, or magnet-knowledgeable person.	MANDATORY			
6. Know how to evacuate the area (Emergency escape route) as demonstrated by the primary FE	MANDATORY	MANDATORY		
7. Know how to notify emergency responders as per site emergency process.	MANDATORY	MANDATORY		
8. Will not attempt a rescue until the atmosphere is determined safe by use of a calibrated instrument designed for measuring atmospheric air quality.	MANDATORY	MANDATORY		
9. Know how to control and operate the valves on the gas cylinders / regulators and cryogenic Dewars.	MANDATORY			
10. Know how to terminate the cryogen transfil operation on both the Dewars and the magnet in the event of a problem.	MANDATORY			
11. Know how and when to perform an emergency run down procedure as defined in the service documentation.	MANDATORY	MANDATORY		
12. Know how and when to initiate 'Emergency OFF' as defined in the service documentation.	MANDATORY	MANDATORY		
13. Know how to respond to an oxygen monitor alarm.	MANDATORY	MANDATORY		
14. Know what to do during a quench.	MANDATORY	MANDATORY		
				Continued

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 1-11: Second Person – Buddy Requirements (Continued)

Safety Requirement	Work Assistant	Work Observer	Initialed by Second Person When Complete	Comments
15. Know the physical changes or indicators of working in an oxygen deficient atmosphere.	MANDATORY	MANDATORY		**Your buddy MUST:** • Listen for changes in your voice; it will be higher than usual when working with helium. • Watch for physical indicators; you may begin staggering or slur your speech when working with nitrogen. • Notify the emergency response team when necessary.
16. Identify and understand the properties and operation of the site's fire suppression system (i.e., water sprinkler, halon, CO_2, etc.) and how to respond to alarms.	MANDATORY	MANDATORY		

Table 1-1: Certification Agreement

I understand and will comply with the MR Buddy System Requirements (Print) Name of Buddy: Signature: Date:
I certify the person above meets or exceeds the MR Buddy System Requirements for the selected category/procedures. (Print) Name of FE: Signature: Date:
The Primary Field Engineer must keep the completed forms on site

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3 OSHA Lockout Tagout Requirements

The following are the contents of the lock out/tag out kit:

- Personal Lock: 46-194427P320
- Transition Lock: 2387081
- LOTO Tag: 46-194427P322
- Transition Tag: 2393064
- Multi Locking Device: 46-194427P313
- Line cord plug cover: 46-194427P231

3.1 Scope

This standard covers the servicing and maintenance of machines and equipment in which the unexpected energization, or start-up, of the machine or equipment could cause injury to employee.

3.2 Application

This standard applies to the control of energy during servicing and/or maintenance of machines or equipment.

3.3 Exceptions

Minor adjustments and other minor service activities, which take place during normal operation, are not covered by this standard if they are routine, repetitive, and integral to the use of the equipment for operation, provided the work is performed using alternative measures that provide effective protection.

This standard does not apply to work on cord and plug-connected electric equipment. Exposure to the hazards of unexpected energization, or start-up, of such equipment is controlled by the unplugging of the equipment from the energy source, and by the plug being under the exclusive control of the employee performing the servicing or maintenance.

3.4 Purpose

Require employers to establish a program, and use procedures for affixing appropriate lockout devices, or tagout devices, to energy-isolating devices, and to otherwise disable machines or equipment to prevent unexpected energization, start-up, or release of stored energy in order to prevent injury to an employee.

3.5 General Application

If an energy-isolating device is not capable of being locked out, use a tagout device. Such device shall be attached at the same location that the lockout device would have been attached.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.6 Definitions

3.6.1 Energy-isolating device:

Mechanical device that physically prevents the transmission or release of energy (i.e., manually operated electrical circuit breaker or disconnect switch).

3.6.2 Energy source:

Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

3.6.3 Lockout:

: Placement of a lockout device on an energy-isolating device, in accordance with an established procedure, ensuring that the energy-isolating device and the equipment being controlled cannot be operated until the lockout device is removed. It is also necessary to attach a tagout device to the lockout device.

3.6.4 Lockout device:

A device that uses a positive means such as a lock (either a single key or combination type) to hold an energy-isolating device in the safe position.

NOTE: Any lock that uses a key to lockout a device must have only ONE key assigned to the lock owner.

3.6.5 Tagout:

Placement of a tagout device on an energy-isolating device, in accordance with an established procedure, to indicate that the energy-isolating device and the equipment being controlled may not be operated until the tagout device is removed.

3.6.6 Tagout device:

A prominent warning device, such as a tag and a means of attachment, that can be securely fastened to an energy-isolating device in accordance with an established procedure, to indicate that the energy- isolating device, and the equipment being controlled, may not be operated until the tagout device is removed.

3.6.7 Lockout / tagout:

If an energy-isolating device is not capable of being locked out, the site energy control program shall use a tagout system.

3.7 Application of Control

The established procedure for the application of energy control shall cover the following:

- Preparation for shutdown.
- Machine or equipment shutdown.
- Machine or equipment isolation
- Lockout or tagout devise application
- Verification of isolation

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Basic rule: All equipment shall be locked out or tagged to protect against accidental or inadvertent operation when such operation could cause injury to personnel.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4 LOCKOUT TAGOUT Procedure and Checklist

This checklist should be used any time you are preparing to perform a LOTO or a system restart.

Name of Equipment:	
Number of Locks:	

Title(s) of Employees Authorized to Perform LOTO:	
Title(s) of Affected Employees and How to Notify:	Hospital Personnel, Verbal Communication.

Energy Source	Yes	No	Location of Energy Isolating Means	Magnitude of Energy
Electrical				
Pneumatic				
Hydraulic				
Gas/Water/Steam				
Chemical				
Mechanical Motion				
Gravity				
Springs				
Thermal				
Stored Energy				
Air Under Pressure				
Oil Under Pressure				
Water Under Pressure				
Gas Under Pressure				
Steam				
Other				

Type(s) of Equipment and/or Method(s) Selected to Dissipate or Isolate Stored Energy:

Type(s) of Equipment and/or Method(s) Used to Ensure Disconnection's:

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Name of Equipment:	

Sequence	Lockout/Tagout Procedure
1	Prepare for shutdown of equipment. Notify affected personnel working in the area that LOTO is being performed.
	Verify isolation: zone energy
	Service/repair equipment.
	Notify affected personnel that equipment will be re-energized and LOTO devices are being removed.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5 Emergency Rampdown of Magnetic Field

5.1 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 Chapter 5, Section 6, Magnet Rampdown to Zero Field.

If an emergency rampdown of the magnet is required (for example, a person is trapped between a ferromagnetic object and the magnet), use the following procedure to rapidly ramp the magnet down to zero field.



NOTICE

Follow the sequence stated in the procedure to minimize magnet damage resulting from the ramp down! Methods 2 through 4 (in Section 5.2.2 - Section 5.2.4) are back-up and normally will not be required.



WARNING

ASPHYSIATION HAZARD!
A MAGNET QUENCH WHILE PERFORMING AN EMERGENCY RAMPDOWN OF THE MAGNET'S MAGNETIC FIELD COULD RESULT IN RAPID EXPULSION OF HELIUM GAS THROUGH THE VENT SYSTEM. IF THE VENT SYSTEM FAILS, THAT GAS WILL RAPIDLY FILL THE ROOM
MAKE SURE THE MAGNET VENTING SYSTEM IS INSTALLED, THE MAGNET ROOM EXHAUST FAN IS TURNED ON — OR THE HATCH IS OPENED IF A MOBILE VAN — AND THE MAGNET ROOM DOORS ARE SECURED OPEN PRIOR TO STARTING AN EMERGENCY RAMPDOWN OF THE MAGNET'S MAGNETIC FIELD.



NOTICE

Review and follow the Ramping precautions found in Section 2, 2301164PRE, MR Magnet — Safety Requirements.

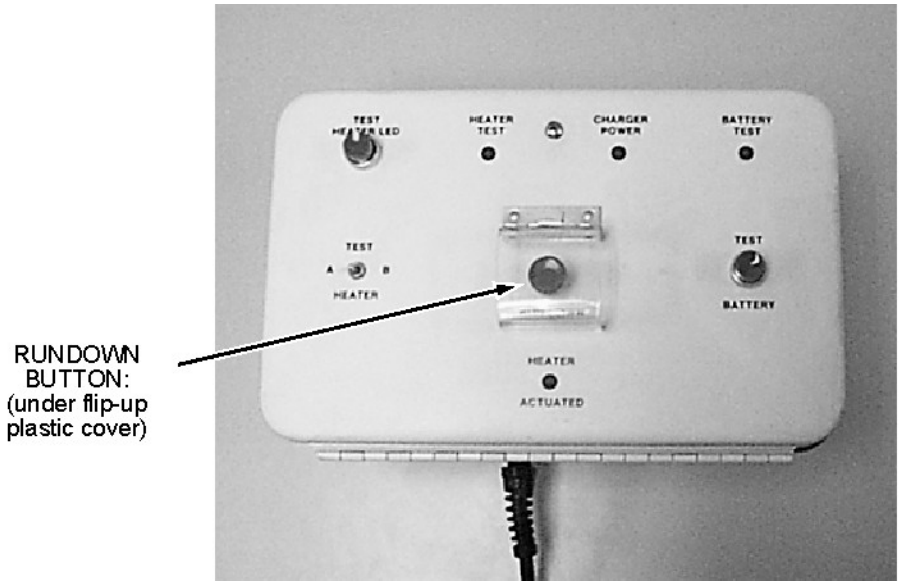
5.2 Emergency Rampdown Procedure

5.2.1 Method 1

1. Open the plastic cover on the Magnet Rundown Unit and firmly depress the red “RUNDOWN" switch. See Illustration 1-12. The switch will stay depressed for approximately 30 seconds as the magnetic field is collapsed.
2. If the magnet does not quench, continue with Section 5.2.2, Method 2.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 1-12: Magnet Rundown Unit



NOTE: The following emergency rampdown methods should not be used until after trying Method 1.

NOTICE

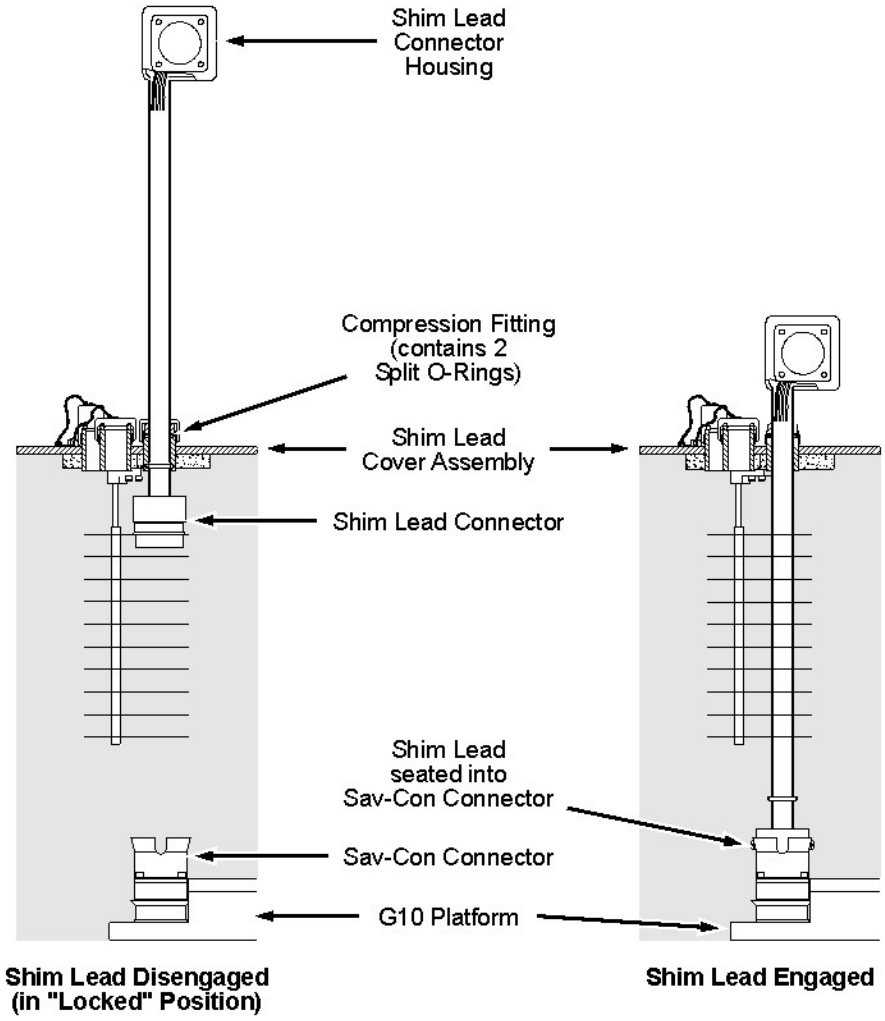
If the cables or power supply required for Methods 2 or 3 are not readily available, ramp the magnet down using Method 4 (Section 5.2.4).

5.2.2 Method 2

1. Unlock the Shim Lead Assembly from its disengaged position, then rapidly lower and engage the Shim Lead Assembly in the Sav-Con Connector. See Illustration 1-13.
2. If the Shim Lead cannot be engaged, go to Method 3 in Section 5.2.3.
3. Connect Switch Heater Cable 46-260724G1 from connector J3 on the back of the Main Power Supply to connector J5-1 on the Shim Lead. See Illustration 1-14.
4. Energize the Main Switch Heater.

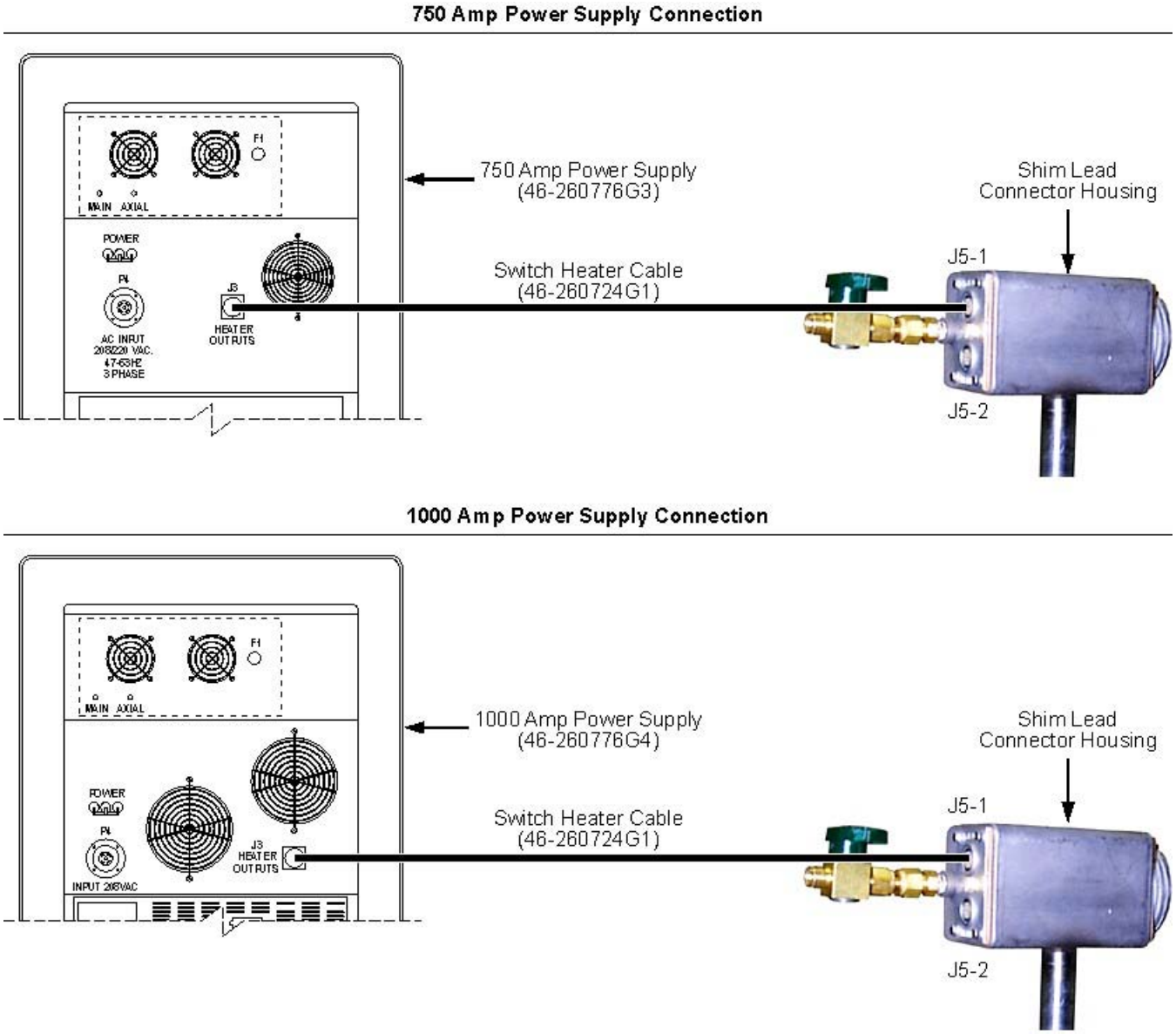
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 1-13: Shim Lead in Disengaged and Engaged Positions



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 1-14: Switch Heater Cable Connection for Emergency Rampdown



5.2.3 Method 3

NOTE: Do not use this emergency rampdown method unless the Shim Lead cannot be engaged.

1. Ramp the magnet down using Auxiliary Rampdown Cable 2128699 shown in Chapter 6, Section 2.1, Magnet System Wiring, to energize the Main Switch Heater.
2. If the magnet does not quench, continue with Section 5.2.4, Method 4.

5.2.4 Method 4

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 before brought back to operating condition. The minimum time to restore the magnet to service will be one month.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Connect the Vacuum Break Tool (46-260852G3) to a seal-off valve on the magnet's Pump-Out Port.
2. Break magnet vacuum to ramp the magnet down.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Chapter 2 Introduction

1 Direction Application

Direction 2192624 covers the set-up, commissioning and service of GE Superconducting Magnet Models 1.5T LCC and 1.0T LCC.

This magnet has superconducting coils immersed in a liquid helium vessel which is surrounded by an insulating cryostat. The coils are ramped to a magnetic field strength of 1.5 or 1.0 Tesla — depending on model — at a nominal, continuous coil current of 730 amperes. Once the magnet is ramped, no external power is required to maintain the magnetic field.

The magnet is used in Magnetic Resonance Imaging (MRI) systems and is designated as Class I equipment per IEC (International Electrical Code) Standard 60601. MR system components and connections are covered in the MR Systems (Signa) Pre-Installation manual.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2 Documentation Organization

NOTICE

The latest release of this manual can be obtained through your GE Healthcare Field Service Representative.

NOTE: All electrical installations preliminary to positioning equipment at the site prepared for it 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; 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.

2.1 Subsystem Manual (Direction 2192624) Organization

NOTE: Direction 2192624, *GE1.5T & 1.0T LCC Active Shield Magnet and Cryogens Subsystem*, covers 1.5T and 1.0T Magnet Systems used on 1.5T and 1.0T Signa products. Applicable magnet Model and Assembly numbers shown in Table 2-1.

Table 2-1: Magnet Model & Assembly Numbers

Magnet	Magnet Model Number	Magnet Assembly Number	
1.5T LCC, Fixed Site	2226300 (YR Series: 2226300-2)	2188843	2243832
1.5T LCC, Mobile Site	2226322 (YR Series: 2226322-2)		
1.0T LCC, Fixed Site	2226333 (YQ Series: 2226333-2)		
1.0T LCC, Mobile Site	2226334 (YQ Series: 2226334-2)		

NOTE: An overview of the entire Siting, Installation and Commissioning process is shown in Section 2.2, Magnet Siting & Installation Checklist, and Section 2.3, Magnet Commissioning Flowchart & Checklist.

- **Introduction:** Documentation organization and system and component identification are in this chapter.
- **Set-Up and Calibration:** Magnet system installation, commissioning, adjustment, and calibration procedures are in this chapter. Procedures from supplier manuals are referenced where applicable.
- **Functional Checks:** Procedures for performing subsystem diagnostic and maintenance checks are in this chapter, as well as magnet resistance values and guideline tables.
- **Replacement & Maintenance:** Procedures and illustrations to aid in subsystem maintenance and component replacement are in this chapter.
- **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 chapter.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

- **Renewal Parts:** Renewal part identification views for the Magnet & Cryogen Subsystem and tables cross-referencing GE part number to supplier renewal parts are in this chapter.
- **Data Sheets:** This chapter contains logs, charts and tables for helium fill, ramping and shimming.
- **Appendix:** The Appendix contains procedures from other GE Healthcare MR service documentation duplicated here for convenient access. Always refer to the original publication for the latest material.

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 2192624.

NOTICE

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

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

2.2 Magnet Siting & Installation Checklist

Table 2-2: Magnet Siting & Installation Checklist

	Function	Responsibility	Reference Document	Complete
1	Magnet Room Requirements: • Safety (Room Ventilation & Cryogenic Venting) • Magnet Anchoring • Power & Cooling	GE Installation Specialist, Shield Room Vendor & Customer	The appropriate Pre-Installation manual: • Direction 2223170, *Signa MR/i & CV/i Pre-Installation* [a] **OR** • Direction 2294003, *Signa 1.5T TwinSpeed Pre-Installation* [a] **OR** • Direction 5133301, *Signa EXCITE HD 1.5T Pre-Installation* [a] **OR** • Direction 5133302, *Signa EXCITE HD 1.5T TwinSpeed Pre-Installation* [a] **OR** • Direction 5133304, *Signa EXCITE HD 1.5T Upgrades Pre-Installation* [a] **OR** • Direction 5143464, *Signa HDe 1.5T Pre-Installation* [a] **OR** • Direction 5159901, *Signa HDx 1.5T Pre-Installation* [a] **OR** • Direction 5159902, *Signa HDx 1.5T TwinSpeed Pre-Installation* [a] • Direction 5159904, *Signa HDx 1.5T Upgrades Pre-Installation* [a]	Yes? ☐

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 2-2: Magnet Siting & Installation Checklist (cont'd)

	Function	Responsibility	Reference Document	Complete
2	Environmental Steel Survey	GE Installation Specialist	The appropriate Pre-Installation manual: • Direction 2223170, *Signa MR/i & CV/i Pre-Installation* [a] **OR** • Direction 2294003, *Signa 1.5T TwinSpeed Pre-Installation* [a] **OR** • Direction 5133301, *Signa EXCITE HD 1.5T Pre-Installation* [a] **OR** • Direction 5133302, *Signa EXCITE HD 1.5T TwinSpeed Pre-Installation* [a] **OR** • Direction 5133304, *Signa EXCITE HD 1.5T Upgrades Pre-Installation* [a] **OR** • Direction 5143464, *Signa HDe 1.5T Pre-Installation* [a] **OR** • Direction 5159901, *Signa HDx 1.5T Pre-Installation* [a] **OR** • Direction 5159902, *Signa HDx 1.5T TwinSpeed Pre-Installation* [a] • Direction 5159904, *Signa HDx 1.5T Upgrades Pre-Installation* [a]	Yes? ☐
3	Preinstallation Checklist Completed	GE Installation Specialist	The appropriate Pre-Installation manual: • Direction 2223170, *Signa MR/i & CV/i Pre-Installation* [a] **OR** • Direction 2294003, *Signa 1.5T TwinSpeed Pre-Installation* [a] **OR** • Direction 5133301, *Signa EXCITE HD 1.5T Pre-Installation* [a] **OR** • Direction 5133302, *Signa EXCITE HD 1.5T TwinSpeed Pre-Installation* [a] **OR** • Direction 5133304, *Signa EXCITE HD 1.5T Upgrades Pre-Installation* [a] **OR** • Direction 5143464, *Signa HDe 1.5T Pre-Installation* [a] **OR** • Direction 5159901, *Signa HDx 1.5T Pre-Installation* [a] **OR** • Direction 5159902, *Signa HDx 1.5T TwinSpeed Pre-Installation* [a] • Direction 5159904, *Signa HDx 1.5T Upgrades Pre-Installation* [a]	Yes? ☐
4	Site Delivery Review: • Access & Route • Clearances	GE Field Engineer & Rigger	The appropriate Delivery & Installation manual: • Direction 2192625, *GE 1.0T & 1.5T LCC Active Shield Magnet Delivery & Installation* [b] **OR** • Direction 2226318, *GE 1.0T & 1.5T LCC Magnet Delivery & Installation* [a] **OR** • Direction 5154839, *GE HDe & HDx 1.5T LCC Magnet Delivery & Installation* [a]	Yes? ☐

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 2-2: Magnet Siting & Installation Checklist (cont'd)

	Function	Responsibility	Reference Document	Complete
5	Magnet Delivery	Rigger	The appropriate Delivery & Installation manual: • Direction 2192625, *GE 1.0T & 1.5T LCC Active Shield Magnet Delivery & Installation* [b] **OR** • Direction 2226318, *GE 1.0T & 1.5T LCC Magnet Delivery & Installation* [a] **OR** • Direction 5154839, *GE HDe & HDx 1.5T LCC Magnet Delivery & Installation* [a]	Yes? ☐
6	Magnet Component Checks: • Physical • Electrical	GE Field Engineer	The appropriate Delivery & Installation manual: • Direction 2192625, *GE 1.0T & 1.5T LCC Active Shield Magnet Delivery & Installation* [b] **OR** • Direction 2226318, *GE 1.0T & 1.5T LCC Magnet Delivery & Installation* [a] **OR** • Direction 5154839, *GE HDe & HDx 1.5T LCC Magnet Delivery & Installation* [a]	Yes? ☐
7	Move Magnet to MR Suite	Rigger	The appropriate Delivery & Installation manual: • Direction 2192625, *GE 1.0T & 1.5T LCC Active Shield Magnet Delivery & Installation* [b] **OR** • Direction 2226318, *GE 1.0T & 1.5T LCC Magnet Delivery & Installation* [a] **OR** • Direction 5154839, *GE HDe & HDx 1.5T LCC Magnet Delivery & Installation* [a]	Yes? ☐
8	Magnet Leveling & Bolt-Down	Rigger	The appropriate Delivery & Installation manual: • Direction 2192625, *GE 1.0T & 1.5T LCC Active Shield Magnet Delivery & Installation* [b] **OR** • Direction 2226318, *GE 1.0T & 1.5T LCC Magnet Delivery & Installation* [a] **OR** • Direction 5154839, *GE HDe & HDx 1.5T LCC Magnet Delivery & Installation* [a]	Yes? ☐

Continue with Table 2-3, Magnet Commissioning Checklist

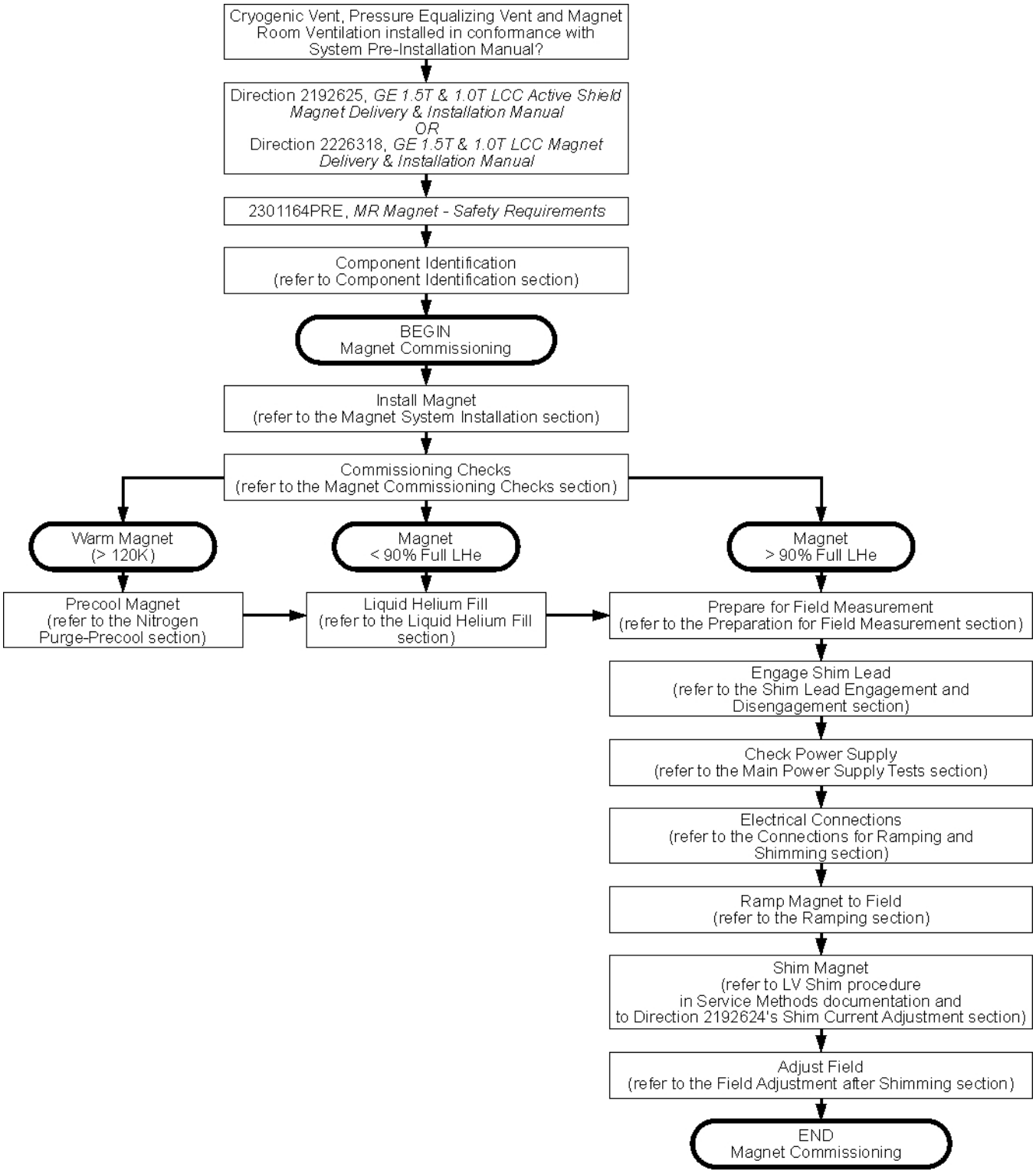
[a] Available at http://www.gehealthcare.com/company/docs/siteplanning.html#mr.

[b] The latest revision of this document is available through your GE Healthcare Field Service Representative.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.3 Magnet Commissioning Flowchart & Checklist

Illustration 2-1: Magnet Commissioning Flowchart



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 2-3: Magnet Commissioning Checklist

	Function	Responsibility	Reference Document	Complete
From Table 2-2, Magnet Siting & Installation Checklist				
1	MR Magnet Safety Document 2301164PRE Review & Compliance	GE Field Engineer	2301164PRE, *MR Magnet — Safety Requirements* [b] (reproduced in this document as Chapter 1, Section 2)	Yes? ☐
2	Magnet Conversion to Operating Configuration AND Immediate Vent Installation	GE Field Engineer	Direction 2192624, Chapter 3, Section 1.2, Conversion to Operating Configuration, AND Chapter 3, Section 1.3, Venting Installation	Yes? ☐
3	Magnet System Components Installation & Functional Checks: • Cryocooler • MRU • Magnet Monitor	GE Field Engineer	Direction 2192624, Chapter 3, Section 1.5, Cryocooler Installation and Checkout; Chapter 3, Section 1.6, Magnet Rundown Unit (MRU) Installation; and Chapter 3, Section 1.7, Magnet Monitor Installation (respectively)	Yes? ☐
4	Magnet Commissioning Checks	GE Field Engineer	Direction 2192624, Chapter 3, Section 2, Magnet Commissioning Checks	Yes? ☐
5	Connect Magnet Monitor	GE Field Engineer	Direction 2230681, *GEMS Magnet Monitoring Hardware (SHEM) Installation* [b]	Yes? ☐
6	Magnet Precool & Fill	GE Field Engineer	Direction 2192624, Chapter 3, Section 3.1, Nitrogen Purge-Precool, and Chapter 3, Section 3.2, Liquid Helium Fill	Yes? ☐
7	Ramp Magnet	GE Field Engineer	Direction 2192624, starting with Chapter 3, Section 7.1, Ramping Magnet to Field	Yes? ☐
8	Shim Magnet	GE Field Engineer	Direction 2192624, Chapter 3, Section 8, Shim Current Adjustment, and the LV Shim procedure in the appropriate Service Methods: • Direction 2333500, *Signa EXCITE 1.5T MR Service Methods, Signa Releases, 10.x and 11.x* [b], • Dir 5133315, *Signa EXCITE HD 1.5T MR Service Methods, Signa Release 12.x* [b], or • Direction 5155500, *Signa HDx MR Service Methods, System Version 14.x* [b]	Yes? ☐
9	Main Field Adjustment after Ramping	GE Field Engineer	Direction 2192624, Chapter 3, Section 10, Field Adjustment after Shimming	Yes? ☐
Hand Off to System Calibration				

[b] The latest revision of this document is available through your GE Healthcare Field Service Representative.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3 Vendor Manual Matrix

Equipment	Vendor	GE Model Number (Vendor Model Number)	GE Manual Number (Vendor Manual Number)
Cryocooler Coldhead and Compressor	Sumitomo Heavy Industries (SHI)	4K Coldhead: 2218465-3 (RDK-408A2)	2262271 (CD32ZZ-055D)
		Water-Cooled High Voltage Compressor: 2188440-2 (CSW-71D)	
Main Coil Service Power Supply Cabinet	Electronics Measurements, Inc. (EMI)	750 Amp: 46-260776G3 (452-62-1)	750 Amp: 46-294439P6 (83-452-010)
		1000 Amp: 46-260776G4 (452-62-1-ESS)	1000 Amp: 46-294439P15 (83-452-025)
Superconducting Shim Coil Service Power Supply Cabinet		46-260777G3 (452-62-2)	46-294439P7 (83-452-011)
Magnet Rundown Unit	American Magnetics, Inc. (AMI)	46-494231G1 (GE-MRU)	Service: 46-318393
			Operation: 46-318394
Magnet Monitor	Advantek	2209000	Hardware Installation: 2230681
			Operation: 2229090-100

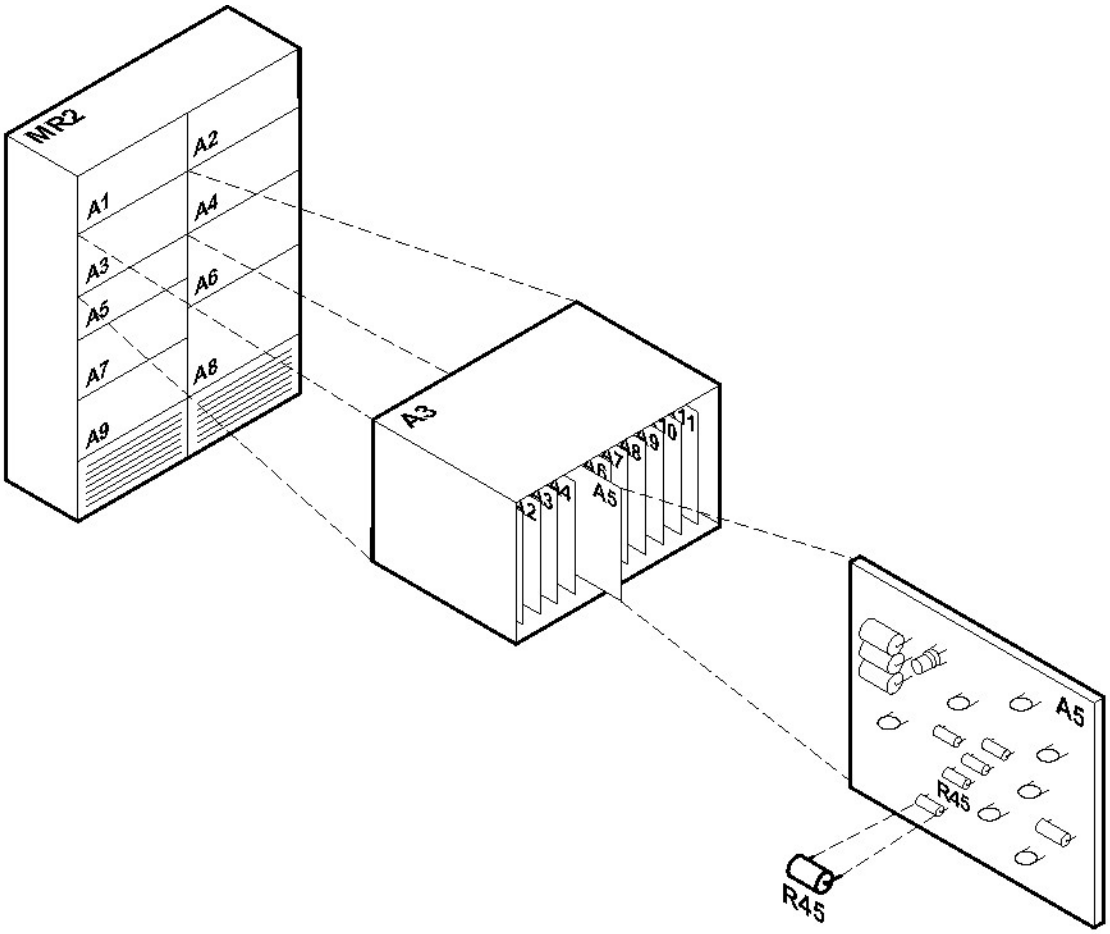
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4 Component Designations

4.1 Explanation of Designator System

The Component Designator System identifies all system components consistently throughout this manual. See Illustration 2-2 for an explanation of the system.

Illustration 2-2: Component Designator System



MR2 - A3 , A5 , R45

- MR2: Major Unit Designation
- Location
- A3: Major or Subassembly Designation
- A5: Circuit Board Designation
- R45: Component Designation (a resistor here) or Jack (e.g., J1-)

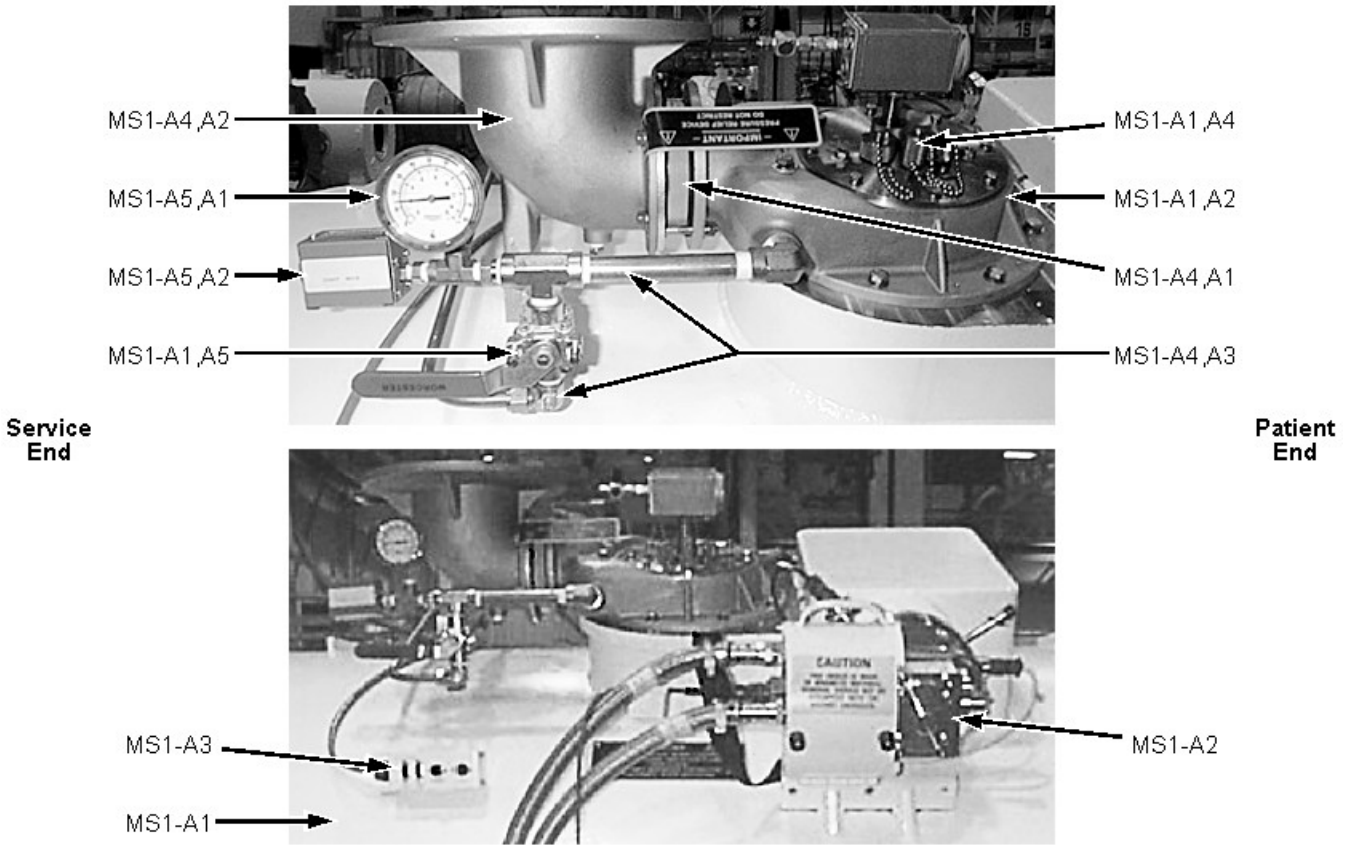
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2 Component Identification

This manual covers the major components shown in Section 4.2.1 through Section 4.2.5.

4.2.1 MS1 Component Designations

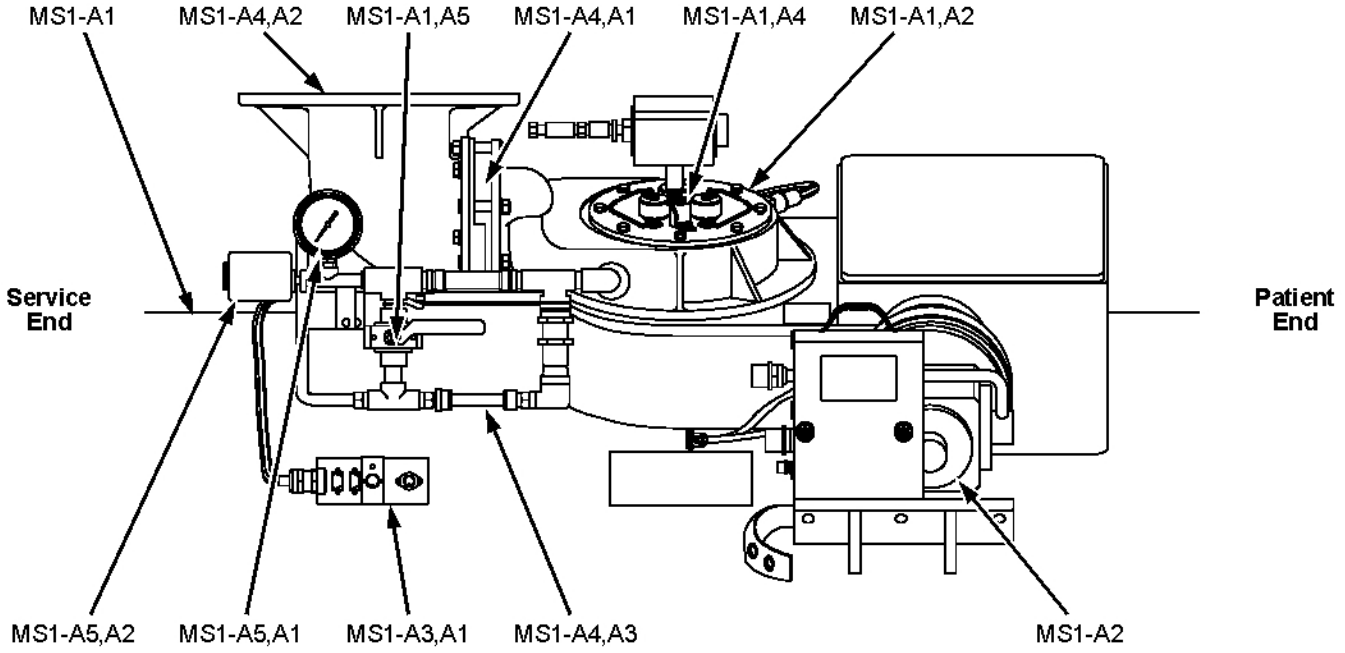
Illustration 2-3: Superconducting Magnet/Cryostat Assembly 2188846



Designator	Description		Designator	Description
MS1-A1	Cryostat		MS1-A4	Helium Vent System
MS1-A1,A2	Service Turret		MS1-A4,A1	Burst Disc
MS1-A1,A4	Helium Fill Port V1		MS1-A4,A2	Vent Adapter
MS1-A1,A5	Helium Vent Valve V2		MS1-A4,A3	Vent Plumbing
MS1-A2	Cryocooler Coldhead		MS1-A5	Service Gauges
MS1-A3	Magnet Instrumentation Connector Box		MS1-A5,A1	Pressure Gauge
			MS1-A5,A2	Pressure Transducer

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 2-4: Superconducting Magnet/Cryostat Assembly 2243832

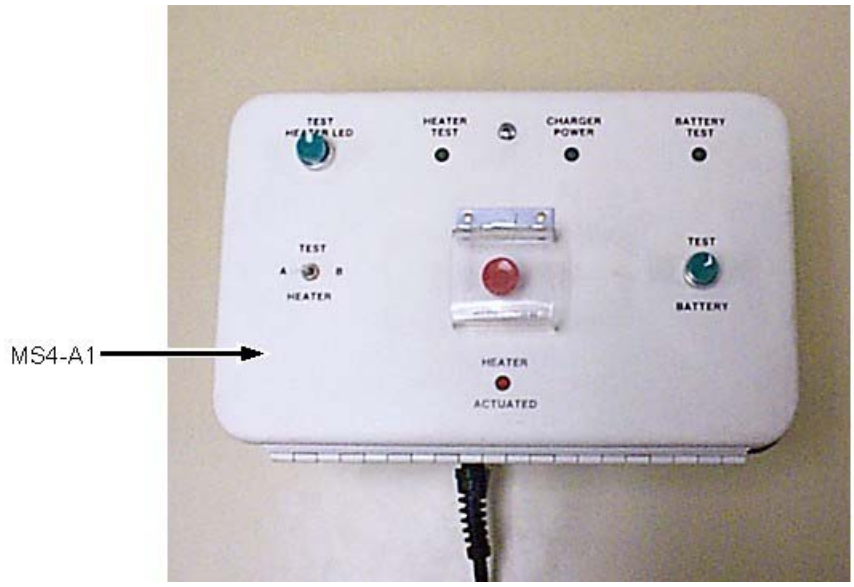


Designator	Description		Designator	Description
MS1-A1	Cryostat		MS1-A4	Helium Vent System
MS1-A1,A2	Service Turret		MS1-A4,A1	Burst Disc
MS1-A1,A4	Helium Fill Port V1		MS1-A4,A2	Vent Adapter
MS1-A1,A5	Helium Vent Valve V2		MS1-A4,A3	Vent Plumbing
MS1-A2	Cryocooler Coldhead		MS1-A5	Service Equipment
MS1-A3	Magnet Electric Harness		MS1-A5,A1	Pressure Gauge
MS1-A3,A1	Magnet Instrumentation Connector Box		MS1-A5,A2	Pressure Transducer
			MS5-A5,A1	Water Flow & Temperature Sensor
			MS5-A6	Remote Connector

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2.2 MS4 Component Designations

Illustration 2-5: Magnet Rundown Unit (MRU) Kit 2128700

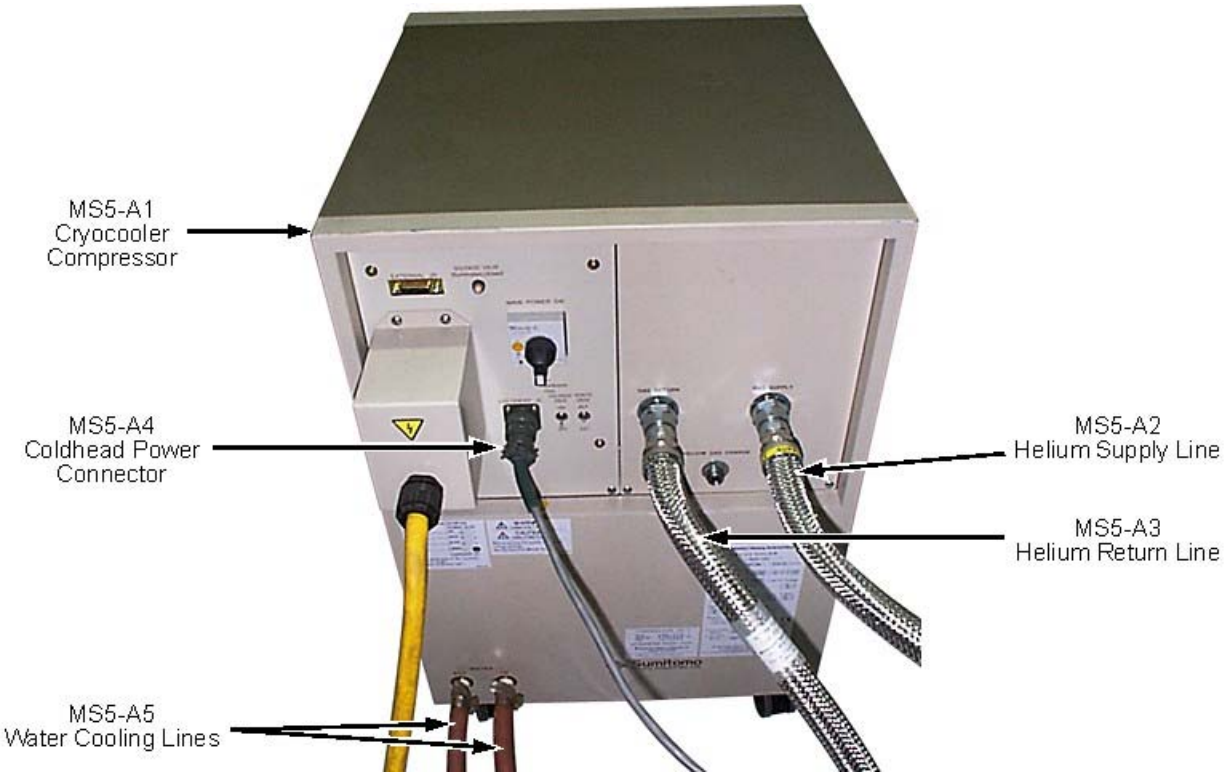


Designator	Description
MS4-A1	Magnet Rundown Unit 46-294231G1
MS4-A2	Magnet Rundown Unit Cable 2128699 (Run 606)

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2.3 MS5 Component Designations

Illustration 2-6: Cryocooler Compressor

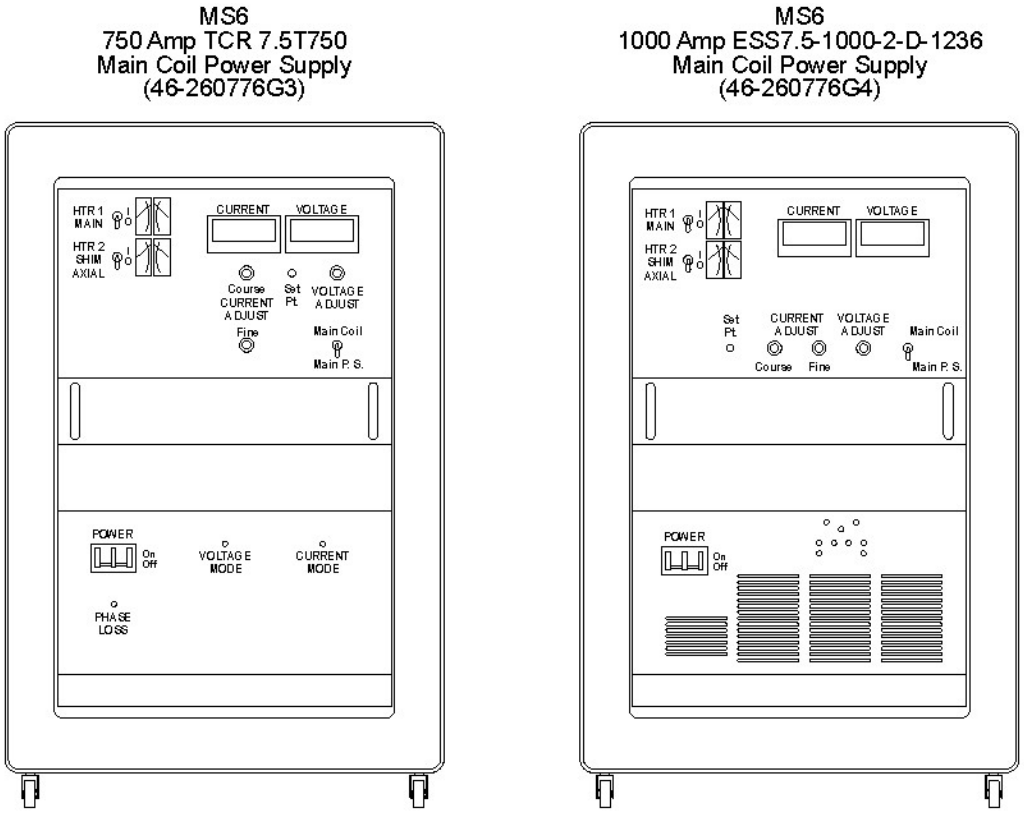


Designator	Description
MS5-A1	Cryocooler Compressor
MS5-A2	Helium Supply Line
MS5-A3	Helium Return Line
MS5-A4	Coldhead Power Connector
MS5-A5	Water Cooling Lines

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2.4 MS6 Component Designations

Illustration 2-7: Main Coil Service Power Supplies

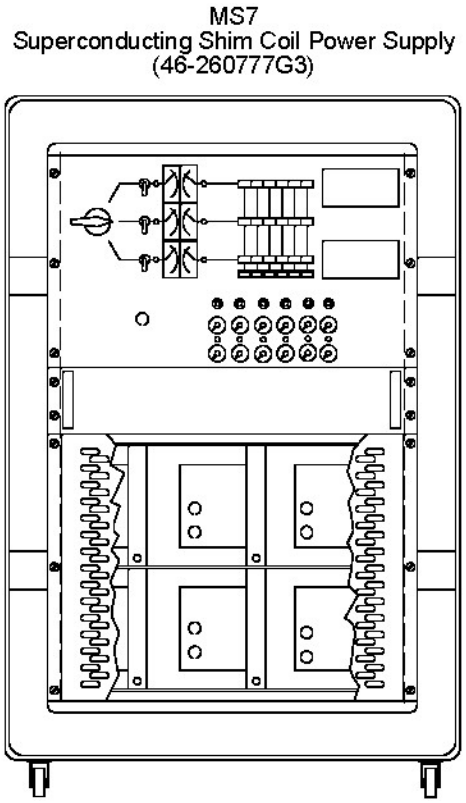


Designator	Description
MS6-A1	Main Coil Service Power Supply Cabinet
MS6-A2	Power Supply Leads
MS6-A3	Input Power Cord

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2.5 MS7 Component Designations

Illustration 2-8: Shim Coil Power Supply



Designator	Description
MS7-A1	Superconducting Shim Coil Service Power Supply Cabinet
MS7-A2	Superconducting Shim Coil Wire Harness
MS7-A3	Heater Wire Harness
MS7-A4	Input Power Cord

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5 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 1–800–548–3366 and use option 8.
- Contact your local service coordinator for more information on this process.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Chapter 3 Set-Up and Calibration

1 Magnet System Installation

1.1 Overview of Magnet System Installation



WARNING

POTENTIAL ASPHYXIATION HAZARD
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
BEFORE BRINGING THE MAGNET INTO THE MAGNET ROOM, VERIFY THAT BOTH THE MAGNET ROOM AND MAGNET VENTING SYSTEMS ARE INSTALLED IN CONFORMANCE WITH THE APPLICABLE PRE-INSTALLATION MANUAL'S CRYOGENIC VENTING AND ROOM VENTING SECTIONS.



WARNING

POTENTIAL ASPHYXIATION HAZARD
A CRYOGENIC VENT SYSTEM THAT DOES NOT MEET THE SPECIFICATIONS FOUND IN THE MAGNET'S PRE-INSTALLATION MANUAL COULD FAIL IF THE MAGNET QUENCHES, ALLOWING DANGEROUS LEVELS OF HELIUM GAS TO RAPIDLY ENTER THE MAGNET ROOM. GASEOUS HELIUM IS AN INVISIBLE, ODORLESS GAS THAT CAN CAUSE ASPHYXIATION BY DEPLETING THE AMBIENT OXYGEN SUPPLY.



WARNING

POTENTIAL INJURY
STANDING DIRECTLY ON THE MAGNET IS DANGEROUS! INJURY MAY RESULT FROM FALLING.
DO NOT STAND ON TOP OF MAGNET! PERFORM ALL SERVICE ACTIONS REQUIRING ACCESS TO TOP OF MAGNET FROM THE LADDER-PLATFORM SUPPLIED WITH THE MAGNET.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



NOTICE

- **Room and cryogen venting requirements and safety issues are specified in:**
  - **Direction 2223170, *Signa MR/i Pre-Installation*;**
  - **Direction 2294003, *Signa 1.5T TwinSpeed Pre-Installation*;**
  - **Direction 5133301, *Signa EXCITE HD 1.5T Pre-Installation*;**
  - **Direction 5133302, *Signa EXCITE HD 1.5T TwinSpeed Pre-Installation*;**
  - **Direction 5143464, *Signa HDe 1.5T Pre-Installation*;**
  - **Direction 5159901, *Signa HDx 1.5T Pre-Installation*;**
  - **Direction 5159902, *Signa HDx 1.5T TwinSpeed Pre-Installation*; or**
  - **Direction 5159904, *Signa HDx 1.5T Upgrades Pre-Installation*.**

  Pre-Installation manuals are available at http://www.gehealthcare.com/company/docs/siteplanning.html#mr.
  Check the Exhaust Fan Testing Report (room venting) and the Cryogenic Venting Inspection Report (magnet venting) before installing the magnet.
- **Procedures for moving the magnet into the magnet room and leveling the magnet are covered in:**
  - **Direction 2192625, *GE 1.5T & 1.0T LCC Active Shield Magnet Delivery and Installation*;**
  - **Direction 2226318, *GE 1.5T & 1.0T LCC Magnet Delivery and Installation*; or**
  - **Direction 5154839, *GE HDe & HDx 1.5T LCC Magnet Delivery & Installation*.**

  Delivery and Installation manuals are available at http://www.gehealthcare.com/company/docs/siteplanning.html#mr.
  It is essential that the magnet is in its permanent location and leveled before commencing Magnet System Installation.
- **Before initiating magnet installation review the following sections of this manual:**
  - **Chapter 1, Section 2, 2301164PRE, *MR Magnet — Safety Requirements*;**
  - **Chapter 2, Section 4.1, Explanation of Designator System; and**
  - **Chapter 2, Section 4.2, Component Identification.**
- **A helium gas cylinder, regulator, gas hose and heat gun should be available at the site to use in case any ice/frost needs to be cleared in the magnet. Helium gas will be required later during cryogen fill.**

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.2 Conversion to Operating Configuration

1.2.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	2 hours	Included in 'Procedure'

1.2.2 Overview

The magnet arrives at the installation site in a shipping configuration and requires the actions covered in the Conversion to Operating Configuration procedure to convert it to the operating configuration. Ground shipments (over land) are made with all Helium vent plumbing installed on the magnet and the Vent Adapter covered (Illustration 3-1). Air and ocean shipments (Illustration 3-2, Table 3-1 and Table 3-2) are made with:

- The Vent Adapter removed,
- A Blanking Plate with 4 Relief Valves installed in place of the Burst Disc,
- A .50 Inch (12.7 mm) Plumbing Plug in a plastic bag attached to the plumbing and
- A 17.5 psia Relief Valve installed at termination of shield vent plumbing and heat exchanger tubing.

NOTE:
- Convert ground-shipped magnets to operating configuration in conformance with Section 1.2.4.1.
- Convert air-shipped and ocean-shipped magnets to operating configuration in conformance with Section 1.2.4.2.

NOTE: Conversion to operating configuration is performed using the HDx Service Platform 5155291. If ≥ 30 inches (762 mm) is available to the left of the magnet, then Universal Service Ladder/Platform 2319156 (fixed sites) or the Service Ladder/Platform (Fixed Site: 2230707; Mobile Site: 2230707-2) can be used. See Section 1.8.1, HDx Service Platform 5155291 Set-Up; Section 1.8.2, Ladder-Platform 2319156; and Section 1.8.3, Ladder-Platform 2230707 2230707-2 Set-Up, for assembly and adjustment instructions.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-1: Ground Ship Configuration of Upper Magnet

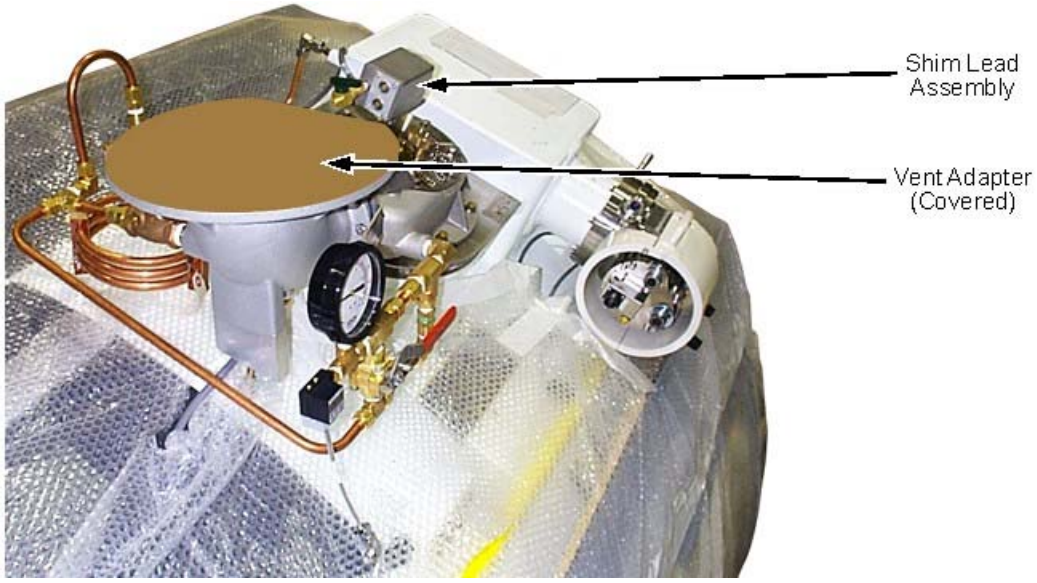
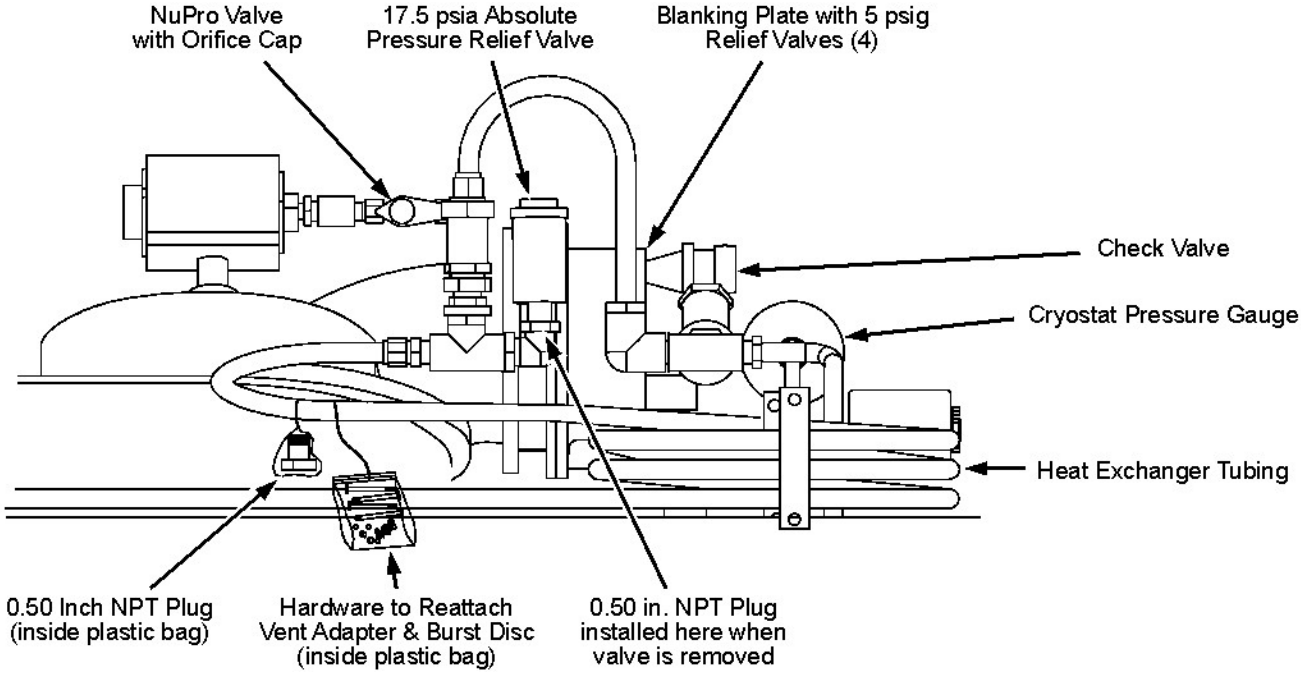


Illustration 3-2: Air Ship Configuration of Magnet Plumbing



NOTE: For air shipments, the removed Vent Adapter, Burst Disc and other large items (see Table 3-1) are placed either in Box 1 if the magnet ships with system components or in a box in the magnet bore if the magnet ships alone. The other removed items are shipped in plastic bag(s) attached to the magnet plumbing (see Table 3-2).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 3-1: Large Items Air-Shipped in a Box*

Part Number	Quantity	Description
2253376	1	Vent Adapter, Cast
2245511	1	Burst Disc Flange
2349529	1	Rupture Disc, 10 psig
46-281101P8	1	4.739 inch (120 mm) I.D. Vent Adapter Flange O-Ring
46-281162P11	4	Belleville Washer, .375 in. nominal, SS
46-252532P2	4	.375-16UNC x .625 Hex Hd. Bolt, SS
* If the magnet ships alone, a box containing these items ships in the magnet bore. Box 1 contains these items when the magnet ships with system components.		

Table 3-2: Small Items Air-Shipped in Plastic Bag(s) Attached to Magnet Plumbing

Part Number	Quantity	Description
2349683	6	.375-16 Hex Hd. Bolt, SS
46-252635P9	6	Flat Washer, .375 in. nominal, SS
46-281387P15	6	Belleville Washer, .375 in. nominal, SS
2349677	6	.375-16 Hex Nut
46-252552P4	1	.5 in. NPT Pipe Plug, Brass

1.2.3 Preliminary Requirements

1.2.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Heat Gun	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Helium Regulator and Hose Kit	1	-	46-306734G1	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

1.2.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
230 cu. ft. Helium Gas Cylinder	1	-	-	-
Vacuum Grease	1	-	46-252065P24	-

1.2.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
Rupture Disc, 10 psig (part of PED Certified Plumbing Assembly 2340678-2; detached and boxed for air shipment)	1	-	2349529	-
Burst Disc Flange (part of PED Certified Plumbing Assembly 2340678-2; detached and boxed for air shipment)	1	-	2245511	-
Vent Adapter, Cast (part of PED Certified Plumbing Assembly 2340678-2; detached and boxed for air shipment)	1	-	2253376	-
4.739 inch (120 mm) I.D. Vent Adapter Flange O-Ring (part of PED Certified Plumbing Assembly 2340678-2; detached and boxed for air shipment)	1	-	46-281101P8	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Belleville Washer, .375 in. nominal (part of PED Certified Plumbing Assembly 2340678-2; detached and boxed for air shipment)	4	-	46-281162P11	-
.375-16UNC x .625 Hex Hd. Bolt, SS (part of PED Certified Plumbing Assembly 2340678-2; detached and boxed for air shipment)	4	-	46-252532P2	-

1.2.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE BEGINNING TO CONVERT THE MAGNET TO OPERATING CONFIGURATION.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR CONVERSION TO OPERATING CONFIGURATION IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE CONVERTING THE MAGNET TO OPERATING CONFIGURATION.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE BEGINNING TO CONVERT THE MAGNET TO OPERATING CONFIGURATION.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.2.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before beginning to convert the magnet to operating configuration.	Chapter 1, Section 2	-

1.2.4 Procedure

1.2.4.1 Ground Shipped Magnets

1. Read and record the Cryostat Pressure Gauge (Illustration 3-2) reading in Chapter 8, Section 1, Magnet Commissioning Log.



WARNING

FERROMAGNETIC MATERIAL
MAGNET LIFTING RAILS ARE MADE OF FERROMAGNETIC MATERIAL. LOOSE FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.
ONLY REMOVE/MOVE LIFTING RAILS WHILE THE MAGNET HAS ZERO MAGNETIC FIELD STRENGTH.

2. Remove the Magnet Lifting Rails from the Magnet Feet and store on site. Inform the customer of storage requirements. Notify the customer that the Lifting Rails are part of the magnet and need to be stored in an accessible place for future use.

3. If the magnet **WILL** be ramped within 5 days, leave the Shim Lead inserted to prevent Shim Lead icing. If the magnet **WILL NOT** be ramped within 5 days, retract the Shim Lead Assembly and lock into position in conformance with Section 5, Shim Lead Engagement and Disengagement.

1.2.4.2 Air or Ocean Shipped Magnets



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE CONVERSION TO OPERATING CONFIGURATION PROCEDURE. WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN CONVERTING THE MAGNET TO OPERATING CONFIGURATION.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ASPHYXIATION HAZARD!
PROCEDURE GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR.
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE BEGINNING TO CONVERT THE MAGNET TO OPERATING CONFIGURATION.



WARNING

POTENTIAL COLD BURN OR ASPHYXIATION HAZARD
INTERNAL CRYOSTAT PRESSURE BUILD-UP TO > 5.25 PSIG WILL OPEN 5.25 PSIG RELIEF VALVE.
BEFORE REMOVING EITHER RAMP OR FILL PORT CAPS OR LOOSENING ANY COMPONENT RESULTING IN THE RELEASE OF CRYOGEN PRESSURE:

1. **OBSERVE THE INTERNAL CRYOSTAT PRESSURE GAUGE READING,**
2. **SET MAGNET MONITOR PRESSURE TO 0.5 PSIG AND**
3. **VENT CRYOSTAT DOWN TO 0.2 PSIG THROUGH VENT VALVE V2.**

NOTE: If the site has Magnet Monitor proprietary software, connect to Magnet Monitor and turn off the alarm for vessel pressure. Then turn the vessel pressure control to a high value of .5 psig and a low value of .4 psig.

1. Read and record the Cryostat Pressure Gauge (Illustration 3-2) reading in Chapter 8, Section 1, Magnet Commissioning Log.

2. Verify that the Cryostat Pressure Gauge reading is comparable to the Pressure Controller's digital meter and to the Magnet Monitor's pressure display. Resolve all issues related to readings that aren't comparable before continuing.



WARNING

POTENTIAL COLD BURN OR ASPHYXIATION HAZARD
A PLUME OF COLD HELIUM GAS WILL EXHAUST FROM THE CHECK VALVE WHEN VENT VALVE V2 IS OPENED.
MAKE SURE NO PERSON IS NEAR THE PLUME PATH.

3. If the pressure reading in Step 1 is > 0.2 psig, slowly open Vent Valve V2 until the pressure is 0.2 psig. Then close V2.

4. Remove the 17.5 psia Pressure Relief Valve from the shield vent plumbing Heat Exchanger tubing and immediately install the 0.50 in. NPT Plug in its place.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTE: Step 5 - Step 12 reinstall items removed for air shipment. These items ship in a box (see Table 3-1 for box's shipping location and for box contents itemization) and in two plastic bags attached to the plumbing (contents itemized in Table 3-2).

5. Unpack the 10 psig Burst Disc from the box it ships in (Table 3-1) and inspect it for visible damage (nicks/scratches). Make sure the Burst Disc is part number 2349529 and its rating plate is marked 10 psig.

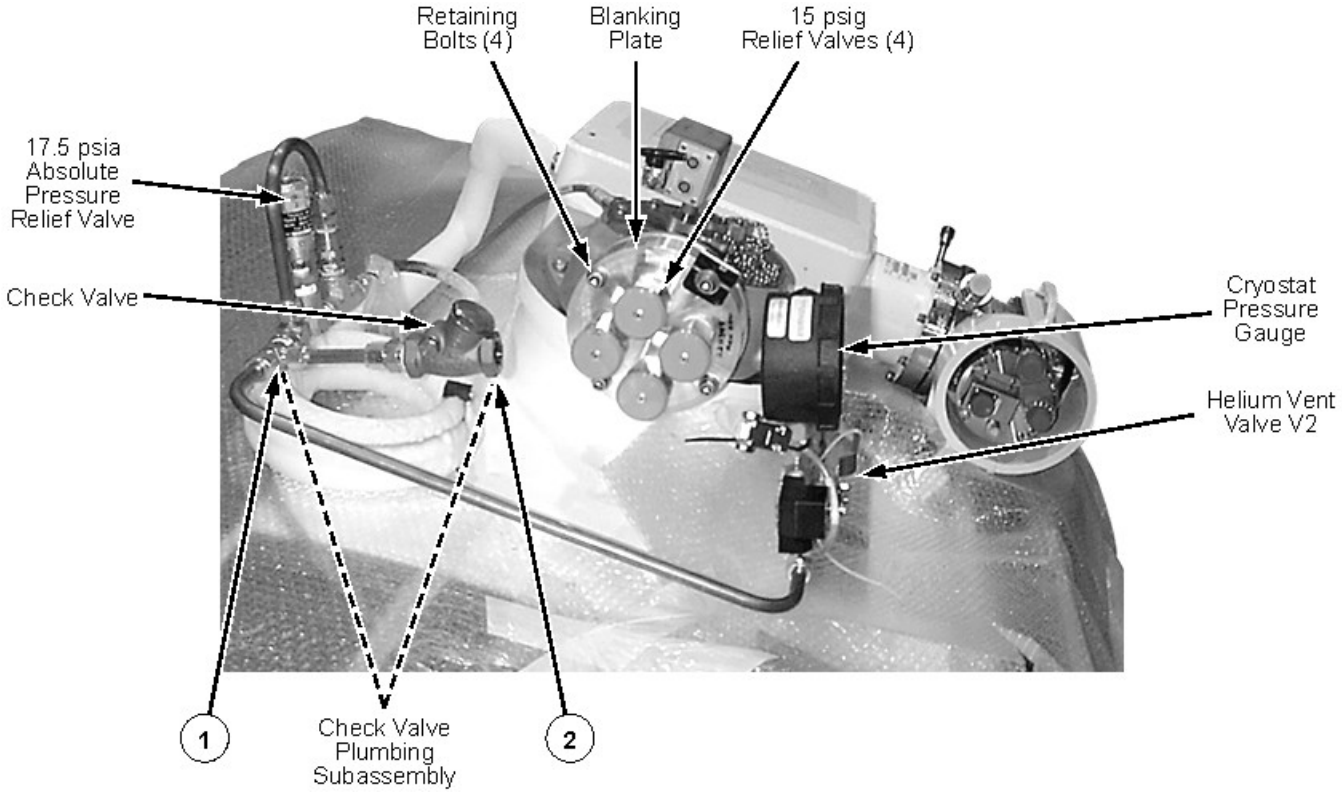
NOTICE

Perform Step 6 - Step 13 rapidly to prevent condensation and icing within the Vertical Penetration. The plastic bag attached to the vent plumbing contains four bolts that can be used to quickly attach the Vent Adapter and Burst Disc if the Blanking Plate bolts are difficult to remove.

NOTE: Make sure the Belleville washers are present and that their orientation is maintained when they are reinstalled. See Illustration 3-4.

6. Loosen and remove the hex head retaining bolts securing the 15 psig Relief Valves and the Blanking Plate to the Plenum Flange while holding the Blanking Plate and Flange Disc. See Illustration 3-3.

Illustration 3-3: Valve, Blanking Plate & Bolt Locations



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL COLD BURN HAZARD
RAPID EXHAUSTING OF COLD HELIUM GAS MAY BE ENCOUNTERED WHEN REPLACING THE HELIUM VENT PLUMBING AND BURST DISC.
DO NOT ALLOW EXHAUST TO COME IN CONTACT WITH YOUR FACE, HANDS OR SKIN DURING VENT ADAPTER AND BURST DISC INSTALLATION. WEAR NONABSORBANT GLOVES, GOGGLES, LONG-SLEEVE SHIRT AND LONG PANTS WHEN PERFORMING THESE OPERATIONS.

7. Remove the Blanking Plate with the four 15 psig Relief Valves.



NOTICE

Be careful when removing the Blanking Plate and inserting the new Burst Disc. Make sure not to dislodge the Plenum Flange O-Ring or scratch the sealing surface of the flange. Make sure the Captured Burst Disc Flange is assembled to the Vent Adapter.

NOTE: Refer to Illustration 3-4 and Illustration 3-5 for Step 8 through Step 14.

8. Install the 4.739 inch (120 mm) I.D. Vent Adapter Flange O-Ring (46-281101P8) — shipped in the box itemized in Table 3-1 — in the groove of the Vent Adapter.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-4: Helium Vessel Burst Disc Assembly

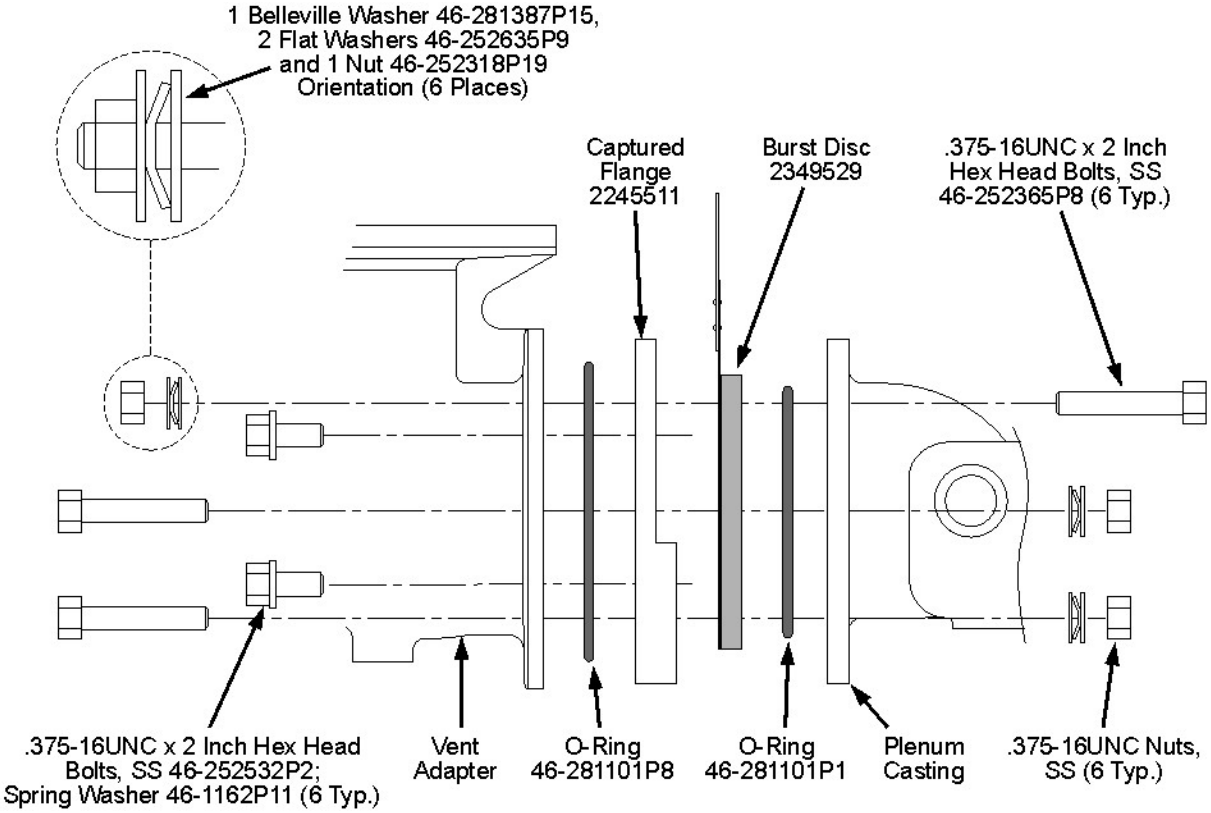
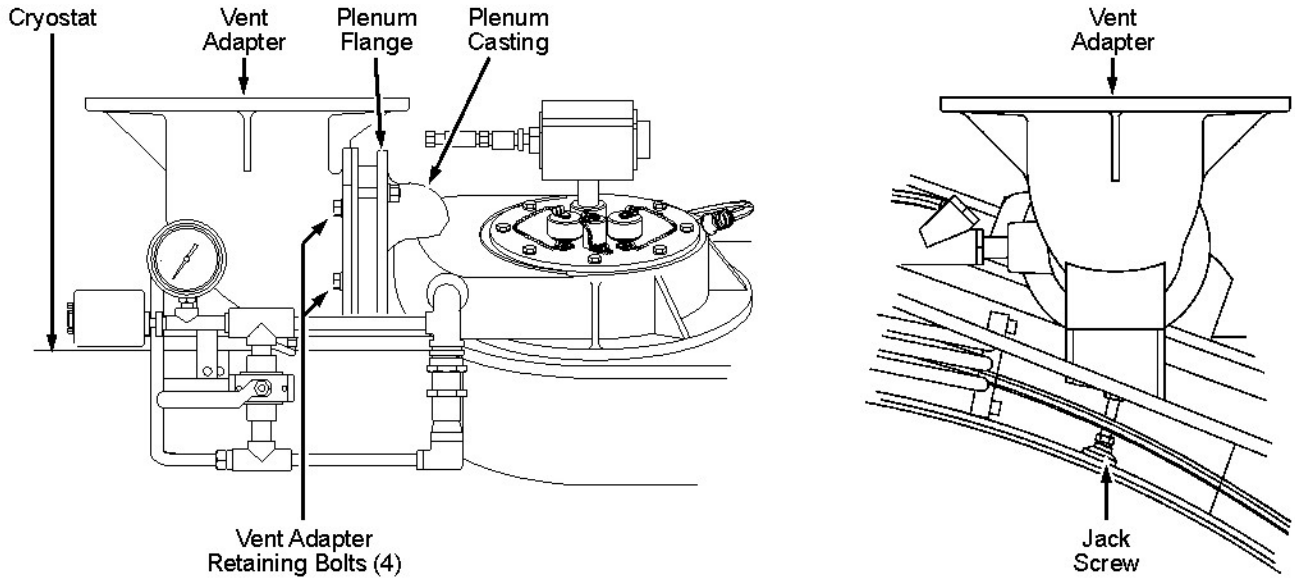


Illustration 3-5: Vent Adapter & Plumbing Connections



9. Install the Captured Burst Disc Flange (2245511) to the Vent Adapter using the bolts shipped in the plastic bag of small hardware items (itemized in Table 3-2).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTE: If the o-ring dislodges in Plenum Flange during installation, coat the o-ring with vacuum grease and reinstall.

10. Align the Vent Adapter and the flange to the holes in the Plenum.

11. Install Burst Disc 2349529 (with the Garlok gasket facing the Vent Adapter) in conformance with Chapter 5, Section 11.1, Burst Disc (2349529) Replacement. See Illustration 3-4. Use the bolts provided in the plastic bag of small hardware items (itemized in Table 3-2).

12. Tighten all four bolts until the Belleville washers are flattened.

13. Attach the Check Valve to the Vent Adapter as follows:

    a. Disconnect the Check Valve Plumbing Subassembly at point 1 in Illustration 3-3.

    b. Remove the cap from the end of the Check Valve.

    c. Connect the loose Check Valve Plumbing Subassembly to the Vent Adapter at point 2 in Illustration 3-3.

    d. Reconnect the plumbing at point 1 with the Check Valve oriented as shown in Illustration 3-3.

14. Adjust the Jack Stud (Illustration 3-5) at the base of the Vent Adapter so that it is in contact with the cryostat.

15. Remove all four 15 psig Relief Valves from the Blanking Plate. Pack and return the 17.5 psia and 15 psig Relief Valves to:

GE Healthcare

3001 W. Radio Drive

Florence, South Carolina 29501

Attn: Materials Group



WARNING

FERROMAGNETIC MATERIAL
MAGNET LIFTING RAILS ARE MADE OF FERROMAGNETIC MATERIAL. LOOSE FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.
ONLY REMOVE/MOVE LIFTING RAILS WHILE THE MAGNET HAS ZERO MAGNETIC FIELD STRENGTH.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



NOTICE

Make sure the magnet lifting rails are stored on site. Moving a magnet without the use of lifting rails can damage the magnet and potentially cause serious personal injury. Any future moving of the magnet will require use of the lifting rails.

16. Remove the Magnet Lifting Rails from the Magnet Feet and store on site. Inform the customer of storage requirements. Notify the customer that the Magnet Lifting Rails are part of the magnet and need to be stored in an accessible place for future use.

17. If the magnet **WILL** be ramped within 5 days, leave the Shim Lead inserted to prevent Shim Lead icing. If the magnet **WILL NOT** be ramped within 5 days, retract the Shim Lead Assembly and lock into position in conformance with Section 5, Shim Lead Engagement and Disengagement.

1.2.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.3 Venting Installation

1.3.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	1.25 hours	Included in 'Procedure'

1.3.2 Overview

In the Venting Installation procedure the magnet's Vent Adapter is connected to the site's cryogenic vent system.

NOTE: Large quantities of helium gas are exhausted from the magnet if a magnet quench occurs. Installation must be done in conformance with the pressure and RF requirements of the Venting Installation procedure.

1.3.3 Preliminary Requirements

1.3.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Hand Drill	1	-	-	-
#17 (4.4 mm) Drill Bit	1	-	-	-
#10-16 x 1.00 inch Self-Tapping Sheet Metal Screws	2	-	-	-
Portable Vacuum Cleaner with crevice nozzle	1	-	-	-
Warning Sign & Label Kit (magnets with magnetic fields ≤ 1.5T)	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one per person	1	-	46-271137G1	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Nonmagnetic Tool Kit, Inch/Metric (46-320273G4) (magnets with magnetic fields ≤ 1.5T only); one kit — Note: Do not use these tools in the magnet room of magnets with magnetic fields > 1.5T, whether the magnet is ramped or not.	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

1.3.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Vacuum Grease	1	-	46-252065P24	-
Duct Tape, roll	2	-	-	-
Clean rags	5	-	-	-

1.3.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
Helium Vent Kit	1	-	46-318057G6	-

1.3.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THIS VENTING INSTALLATION PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR VENTING INSTALLATION IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING THIS VENTING INSTALLATION PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THIS VENTING INSTALLATION PROCEDURE.



WARNING

POTENTIAL PROJECTILE HAZARD
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.
NEVER BRING FERROMAGNETIC MATERIAL INTO THE MAGNET ROOM. MAKE SURE ALL EQUIPMENT AND TOOLS USED IN THE MAGNET ROOM ARE NON-FERROMAGNETIC.

1.3.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting the Venting Installation procedure.	Chapter 1, Section 2	-

1.3.4 Procedure



WARNING

POTENTIAL ASPHYXIATION HAZARD
A CRYOGENIC VENT SYSTEM THAT DOES NOT MEET THE SPECIFICATIONS FOUND IN THE MAGNET'S PRE-INSTALLATION MANUAL COULD FAIL IF THE MAGNET QUENCHES, ALLOWING DANGEROUS LEVELS OF HELIUM GAS TO RAPIDLY ENTER THE MAGNET ROOM. GASEOUS HELIUM IS AN INVISIBLE, ODORLESS GAS THAT CAN CAUSE ASPHYXIATION BY DEPLETING THE AMBIENT OXYGEN SUPPLY.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

The 24-inch long flanged vent pipe supplied in this system's Helium Vent Kit may be shortened if necessary, but it must never be lengthened. 24 inches is the maximum length enabling Field Engineer access to the vent glass joint from the Service Platform Ladder provided with the magnet.

1. Make sure to wear the following personal protective equipment (PPE) during the vent pipe installation process: safety glasses, gloves and safety shoes.

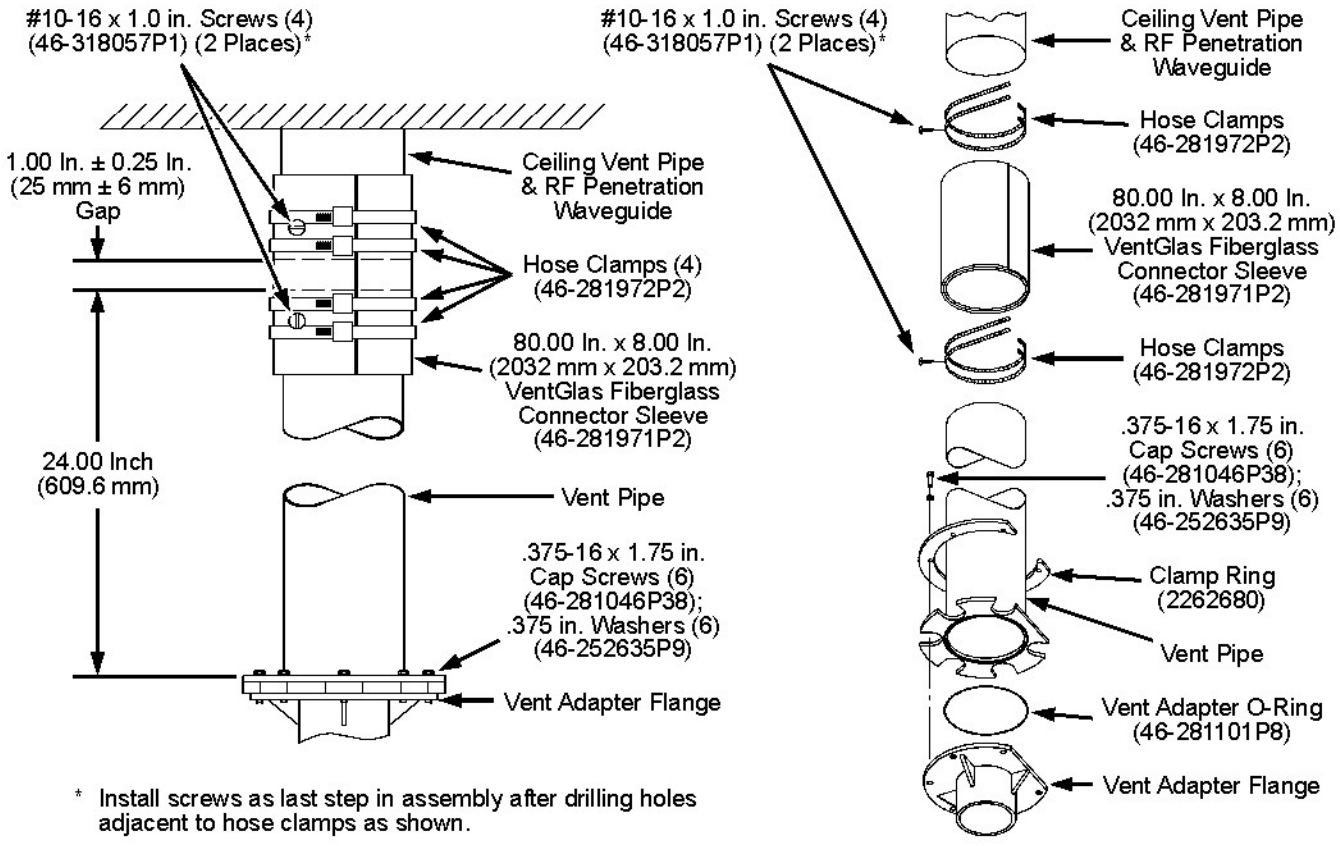
NOTICE

Appropriate protection must be provided for any portion of the cryogenic vent system which may drip condensation on personnel or ceiling components.

2. Measure and cut the Vent Pipe for a proper 1.00 inch ± .25 inch (25 mm ± 6 mm) gap where the Vent Pipe meets the Ceiling Vent Pipe. See Illustration 3-6.

NOTE: The Ceiling Vent Pipe is the pipe coming out of the ceiling into the magnet room.

Illustration 3-6: Helium Vent Kit 46-318057G6 Assembly



* Install screws as last step in assembly after drilling holes adjacent to hose clamps as shown.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. Apply vacuum grease 46-252065P24 to the surface of Vent Adapter O-Ring 46-281101P8 and install the o-ring on top of the Vent Adapter Flange. See Illustration 3-6.

4. Place the Clamp Ring (2262680) around the Vent Pipe as shown in Illustration 3-6.

5. Place a pair of hose clamps (46-281972P2) on the Vent Pipe and a second pair on the Ceiling Vent Pipe. Make sure the clamps are at least 4 inches (100 mm) from each pipe's edge.

6. Loosely connect the Vent Pipe to the Vent Adapter using the 6 mounting bolts supplied.

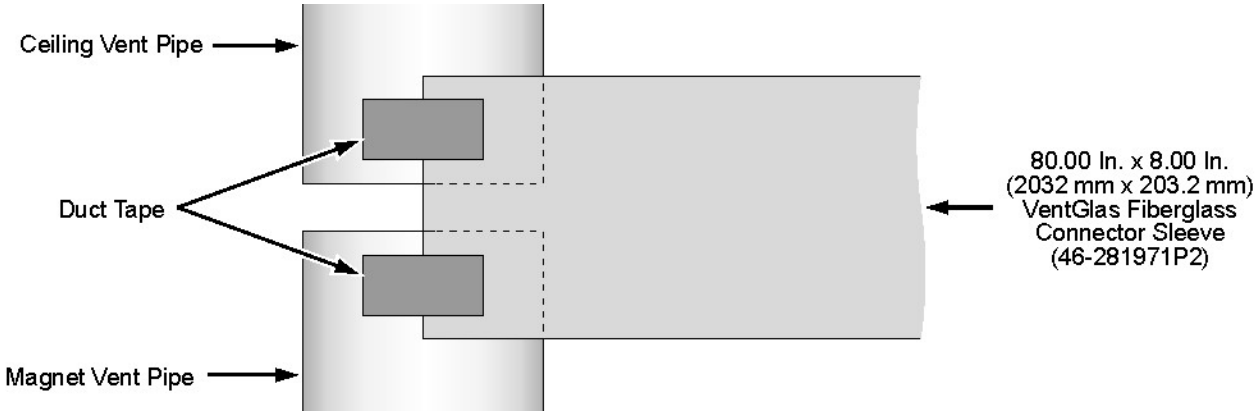
7. Adjust the Vent Pipe to Ceiling Vent Pipe alignment by moving the Vent Pipe at the Vent Adapter flange.

NOTE: The Vent Pipe can be adjusted radially 1 inch (25 mm) in any direction to align with the Ceiling Vent Pipe.

8. Tighten the 6 mounting bolts installed in Step 6 in an alternating pattern.

9. Tape one end of the VentGlas Fiberglass Wrap (46-281971P2), using 2 pieces of duct tape as shown in Illustration 3-7, over the gap between the Vent Pipe and the Ceiling Vent Pipe.

Illustration 3-7: VentGlas Wrap Installation



10. Wrap the entire roll of VentGlas wrap tightly around the joint.

11. Install two hose clamps (46-281972P2) on each side of the joint to hold VentGlas Wrap in position. Space the clamps about 0.5 inch (12 mm) apart and about 1 inch (25 mm) from the joint. See Illustration 3-6.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

12. Drill two starter holes, using a #17 drill bit (4.4 mm), for the sheet metal screws shown in Illustration 3-6. Drill these holes close enough to the hose clamps that the screw heads will seat onto the clamps when tightened.

13. Install two #10-16 x 1.00 inch self-tapping sheet metal screws into the drilled holes. Make sure the head of the each screw is firmly seated onto the adjoining hose clamp.



CAUTION

Loose metal filings produced during drilling could become a health hazard. Make sure to clean up after drilling.



NOTICE

Loose metal filings produced during drilling could become a source of spike noise. Make sure to clean up after drilling.

14. Clean up using a vacuum cleaner any metal filings produced during drilling.

1.3.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.4 System Leak Test

1.4.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	With PICO: 1 hours; without PICO: 2 hours	Included in 'Procedure'

1.4.2 Overview

It is important to identify and eliminate any leak at installation, after the magnet has been converted to its operating condition.

NOTE: Cryostat pressure can increase up to 5 psig during operation, thereby increasing any leakages. A leak will slowly deplete the helium supply, possibly causing cryopumping or icing, and may interfere with Recondenser operation.

1.4.3 Preliminary Requirements

1.4.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
PICO™ Helium Leak Detector (optional)	1	-	2361919-2	-
Portable Leak Detector (optional)	1	-	2270571	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Nonmagnetic Tool Kit, Inch/Metric (46-320273G4) (magnets with magnetic fields ≤ 1.5T only); one kit	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

1.4.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Leak detection fluid (e.g., Snoop, Bird Dog Quart Spray (p/n DOG-1Q), Big Blue (p/n Rt100S or Rt100G) or Leak-Tec)	1	-	-	-

1.4.3.3 Replacement Parts

No replacement parts required.

1.4.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE SYSTEM LEAK TEST PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THE SYSTEM LEAK TEST PROCEDURE IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING THE SYSTEM LEAK TEST PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE SYSTEM LEAK TEST PROCEDURE.



WARNING

POTENTIAL ASPHYXIATION HAZARD
CRYOGEN EXPOSURE WILL BE ENCOUNTERED ON AIR- AND OCEAN-SHIPPED MAGNETS.

1.4.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting the System Leak Test procedure.	Chapter 1, Section 2	-

1.4.4 Procedure

1. Allow the cryostat to build pressure prior to operating the cryocooler coldhead.

2. When the cryostat pressure reaches 5 psig, check the following areas for leaks using a “Snoop" or leak detector liquid:

   - All plumbing joints
   - Vertical Turret and Instrumentation Lead cover
   - Ramp Lead and Fill Port caps
   - All 360 degrees around the Burst Disc to Plenum contact
   - Pressure gauge and relief valves
   - Shim Lead collar/cap

NOTE: Commercial leak detector fluids or instruments available through HVAC distributors can be used to determine small leaks in the helium plumbing and venting.

3. Repair any leaks found prior to commissioning the magnet.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.4.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.5 Cryocooler Installation and Checkout

1.5.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	1.5 hours	Included in 'Procedure'

1.5.2 Overview

The Cryocooler comes with a Coldhead already installed on the magnet and a separate Compressor unit, which will be located in the equipment room. A power cable and gas supply and return lines connect the two units. Installation/checkout of these components are performed in this Cryocooler Installation and Checkout procedure.

NOTE: Prior to installation, locate and read the vendor manual(s) supplied with the system. Become thoroughly familiar with the configuration and procedures of the system. Compressor installation instructions are covered in the Compressor vendor's manual.

NOTE: The Cryocooler Interconnect Diagram is shown in Chapter 6, Section 1.3, Cryocooler System Interconnects.

1.5.3 Preliminary Requirements

1.5.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Leather Gloves; one pair per person	1	-	-	-
Digital Voltmeter (DVM), Volt-Ohm Meter (VOM) or non-contact voltage tester	1	-	-	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
Coldhead/Compressor Installation & Maintenance Kit	1	-	46-281088G3	-
RuO Temperature Monitor (included in RuO Temperature Monitor Kit 2183710)	1	-	2171219	-
High Pressure Helium Regulator (included in Coldhead/Compressor Installation & Maintenance Kit 46-281088G3)	1	-	46-2940009P1	-
Helium Line Adapter Hose (included in Coldhead/Compressor Installation & Maintenance Kit 46-281088G3)	1	-	46-294002P1	-
Gas Charging Tool	1	-	5102120	-
Portable Leak Detector (optional)	1	-	2270571	-
Nonmagnetic Tool Kit, Inch/Metric (46-320273G4) (magnets with magnetic fields ≤ 1.5T only); one kit	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.5.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Leak detection fluid (e.g., Snoop, Bird Dog Quart Spray (p/n DOG-1Q), Big Blue (p/n Rt100S or Rt100G) or Leak-Tec)	1	-	-	-
Bronze Wool; package	1	-	46-318068P1	-
99.999% (“five nines”) Helium Gas, 235 SCF Nonmagnetic Cylinder	1	-	-	-

1.5.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
Sumitomo CSW-71D Shield Cooler Compressor 2188440-2	1	-	2188440-2	-
SHI Water-Cooled, High Voltage Compressor Cable Kit 2211446	1	-	2211446	-
Corrugated Plastic Gas Line Raceway Tubing, 50 feet (15.24 M)	2	-	2251611	-

1.5.3.4 Safety



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.

1.5.3.5 Required Conditions

No required conditions.

1.5.4 Procedure

1.5.4.1 Cryocooler Compressor Installation

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR.

1. Unpack and install the Compressor in conformance with the Compressor vendor's service manual. Note any visible damage and notify the shipper. Lockout/tagout input power to the Compressor immediately after unpacking the Compressor. Verify that no voltage is present by using a DVM or equivalent measuring device.

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

3. Remove lockout/tagout and connect the input power cable in conformance with the vendor manual and the local electrical code.

NOTE: Do NOT connect the flexlines until the system gas pressure check is performed to prevent line contamination.

1.5.4.2 System Gas Pressure Check

1. Check and adjust the Cryocooler system static gas pressure in conformance with Chapter 5, Section 2, Cryocooler System Gas Pressure Adjustments.

1.5.4.3 Cooling Water Supply Connection



WARNING

POISON HAZARD
ANTIFREEZE IS POISONOUS TO AQUATIC, ANIMAL AND HUMAN LIFE. BECAUSE OF ITS SWEETNESS, ANIMALS ARE DRAWN TO IT. CONSEQUENTLY, IT IS CLASSIFIED AS HAZARDOUS BOTH FOR SHIPMENT AND AS A WASTE. THEREFORE, IT IS NOT SHIPPED BY UNTRAINED PEOPLE.
CRYOCOOLER COMPRESSORS WHICH CONTAIN ANTIFREEZE MUST BE DRAINED BEFORE BEING RETURNED TO THE SUPPLIER. MAKE ARRANGEMENTS WITH THE HOSPITAL MAINTENANCE DEPARTMENT FOR DISPOSAL.

1. Verify that the cooling water supply meets all requirements specified in the vendor's service manual.

2. Connect the water supply hose to the cooling water inlet connection. Secure with a worm-drive screw-type hose clamp or similarly secure connection.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. Similarly connect and secure the water return hose to the cooling water outlet connection of the Compressor.

4. Turn on the cooling water supply and allow air to purge from the system.

5. Check the system for water leaks.

1.5.4.4 Flexible Gas Line Installation

1.5.4.4.1 Flexible Gas Line Shielding and Routing

NOTICE

Helium gas lines and Coldhead power cables are marked with two run numbers: one for Cryocooler applications and the other for Shield Cooler applications. Before installing Coldhead gas lines and power cables, mark out with a black pen the run number on the label at each end of the line/cable that does not apply. See Table 3-3.

1. Mark out the Shield Cooler run numbers on all gas lines, keeping visible those numbers listed in Table 3-3.

Table 3-3: Coldhead/Compressor Gas Line & Power Cable Run Numbers

	Gas Lines		Power Cables	
	Supply Line	Return Line	Coldhead to Penetration Panel	Compressor to Penetration Panel
Run Number	621	622	624	623

NOTICE

When routing gas lines make sure there's sufficient slack at both ends and that any excess length is not coiled to less than 12 inches (300 mm) radius to prevent bending force on Aeroquip fittings and strain that may cause “chirping" noise on the line.

2. Feed the gas supply line through the designated 55 mm (2.17 inch) port in the Penetration Panel. Position the line to have one end at the Compressor and the other at the Coldhead on the magnet.

NOTE: See Chapter 5, Section 3, Helium Flexline Connections and Casing Replacement, for proper connection of Aeroquip fittings.

3. Feed the gas return line through the other port in the Penetration Panel and route in parallel with the supply line.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4. Adjust the slack on the Helium supply and return flex lines for the most suitable length on both sides of the Penetration Panel. Loosely coil excess line length in the equipment room.

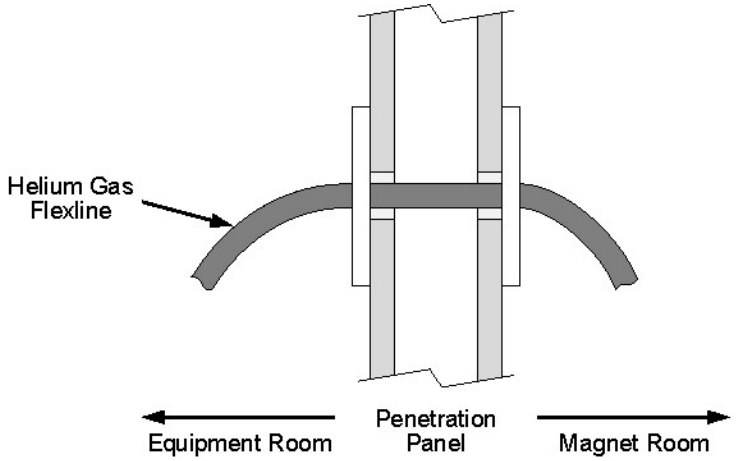
NOTE: RF shielding of flexlines as they pass through the Penetration Panel is performed from the equipment room side of the Panel. Use the following procedure for both the Helium supply and return lines. See Illustration 3-8.

5. Install RF shielding around each gas line as it passes through the Penetration Panel (Illustration 3-8):

   a. Insert Bronze Wool (46-318068P1) around the Helium supply line (top and bottom) over the thickness of the Penetration Panel.

   b. Insert Bronze Wool (46-318068P1) around the Helium return line (top and bottom) over the thickness of the Penetration Panel.

Illustration 3-8: Flexline at Penetration Panel



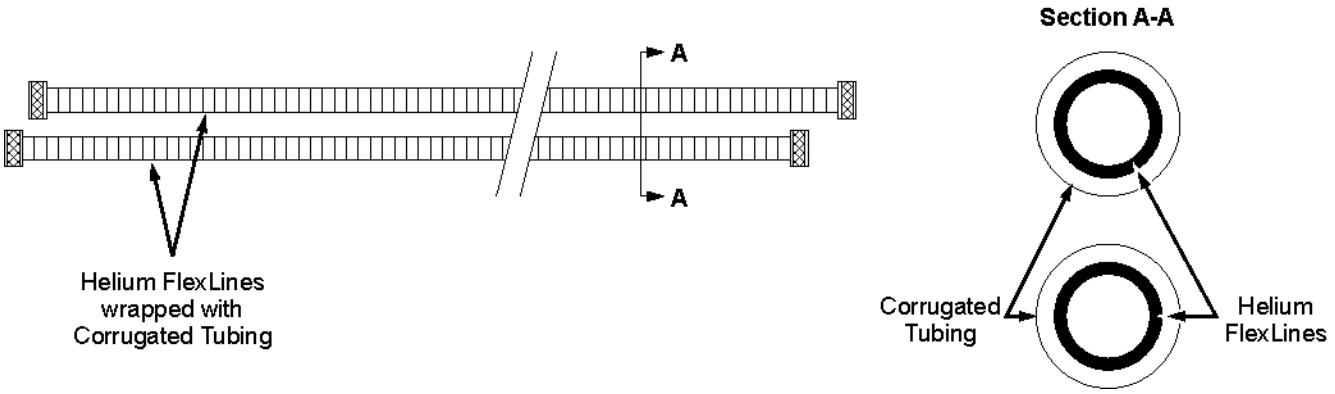
NOTICE

Corrugated plastic tubing is used to isolate helium gas lines from each other and from ground to prevent spike noise. If the supplied tubing does not fully cover the helium gas lines, order additional tubing to fully cover the lines.

6. If Corrugated Plastic Tubing (2251611) does not already cover the length of each flexline, then cover both flexlines completely with Corrugated Plastic Tubing (2251611) from the Penetration Panel where the lines exit the magnet room to the helium line fittings at the Coldhead. See Illustration 3-9.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-9: Helium Line Casing Insulation



1.5.4.4.2 Flexible Gas Line Connections

WARNING

POTENTIAL INJURY HAZARD!
FLEXLINES WITH BROKEN AEROQUIP FITTINGS MAY DISCONNECT AND MOVE ERRATICALLY.
DO NOT PUT ANY BENDING FORCE ON AEROQUIP FITTINGS WHILE CONNECTING/DISCONNECTING HELIUM FLEXLINES. A BENDING FORCE CAN RESULT IN BENDING OR BREAKAGE OF THE AEROQUIP STEMS.

NOTICE

DO NOT put any bending force on Aeroquip fittings while connecting/disconnecting helium flexlines. A bending force will create difficulty in the rapid engagement/disengagement required to prevent helium loss and system contamination. DO support the gas lines when connecting or disconnecting to the Coldhead at the top of the magnet or to the Compressor.

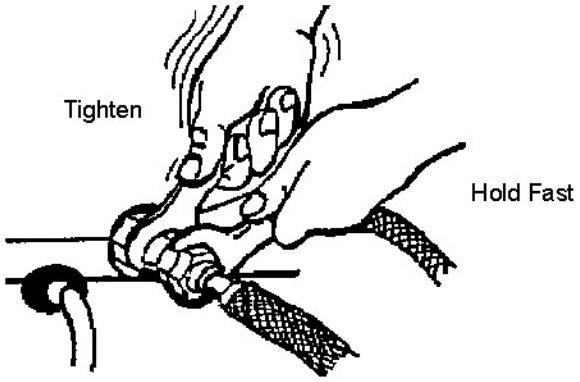
NOTICE

Order and technique are important when connecting helium flexlines to prevent inoperative Coldheads and system contamination.

1. Connect both helium flexlines to the Compressor using appropriate Aeroquip connection wrenches. Always use two wrenches: one to “hold fast" and one to tighten. The “hold fast" wrench helps keep the back-side adapter connection undisturbed, thus making gas leaks in the system less likely. See Illustration 3-10 and Chapter 5, Section 3, Helium Flexline Connections and Casing Replacement.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-10: Proper 2-Wrench Connection Technique for Aeroquip Coupling



2. Observe the Compressor pressure gauge readings after connecting the gas lines. Readings should remain constant.

NOTE: Lower pressure gauge readings indicate either the gas lines were not fully charged when received or one line could be leaking. If a leak is suspected, go to Section 1.4, System Leak Test.

NOTICE

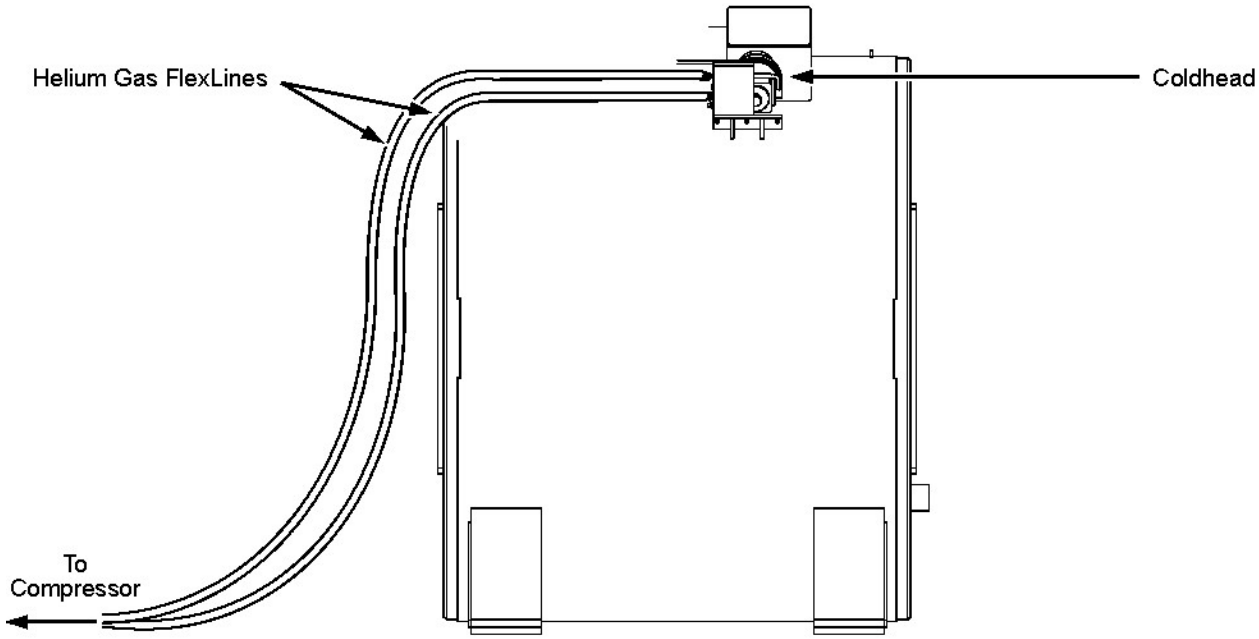
When routing gas lines make sure there's sufficient slack at both ends and that any excess length is not coiled to less than 12 inches (300 mm) radius to prevent bending force on Aeroquip fittings and strain that may cause “chirping" noise on the line.

3. Route the gas lines through the magnet's rear flange and then in a wide arc to the vicinity of the Coldhead. See Illustration 3-11.

NOTE: Do not connect the gas lines to the Coldhead until the lines are secured to the Cryocooler Safety Strap.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-11: Flexible Gas Line Routing at the Magnet

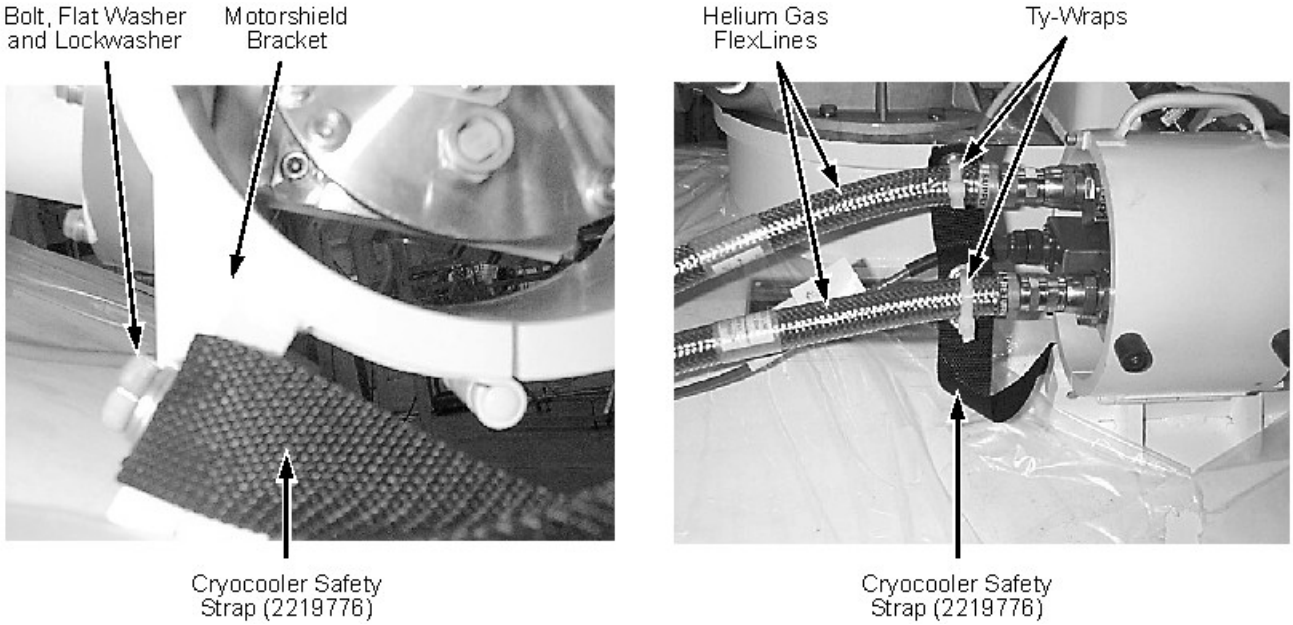


4. Position the gas lines in a gentle curve toward the center of the magnet and adjust line slack and angles to keep the lines from kinking and to minimize tension and noise (chirping), as shown in Illustration 3-11.

5. Verify that the Cryocooler Safety Strap (2219776) is secured onto the Motorshield Bracket by a .50-13UNC x 1.25 in. stainless steel bolt (46-260950P46), flat washer (46-252635P11) and lockwasher (46-281162P13). See Illustration 3-12.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-12: Cryocooler Safety Strap (2219776) Connected to Motorshield Bracket



6. Using ty-wraps, first secure the gas return line to the Cryocooler Safety Strap, and then the gas supply line. See Illustration 3-12.

NOTICE

Make sure the helium gas lines are connected to the Coldhead in the sequence given in Step 7. Gas back pressure may prevent the Coldhead from starting if gas lines are connected in the reverse sequence.

Order and technique are important when connecting helium flexlines to prevent inoperative Coldheads and system contamination. Read and follow Chapter 5, Section 3, Helium Flexline Connections and Casing Replacement, when connecting or disconnecting Aeroquip fittings.

7. Connect the gas return line (green mark) to the Coldhead first. Then connect the gas supply line (yellow mark) to the Coldhead. See Illustration 3-12.

8. Make sure the flexible gas lines are still routed across the magnet approximately as shown in Illustration 3-11.

9. Observe the readings of the Compressor pressure gauges:

   - Constant pressure readings, at the Two-Stage Coldhead specification: No leakage is suspected.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

- Readings above the Two-Stage Coldhead specification given in Table 3-4: Vent the pressure down in conformance with Chapter 5, Section 2, Cryocooler System Gas Pressure Adjustments.
- Readings below the Two-Stage Coldhead specification given in Table 3-4: Increase the helium gas charge in the complete system by supplying helium gas through the Compressor supply fitting in conformance with Chapter 5, Section 2, Cryocooler System Gas Pressure Adjustments. Also, suspect a leak (see Section 1.5.4.5, Cryocooler Leak Test).

Table 3-4: Compressor Static Pressures

	Static Gas Pressure at 20°C (68°F)		
	MPa	kgf / cm^{2}G	psig
RDK-408 4K Two-Stage Coldhead	1.60 - 1.65	16.3 - 16.8	232 - 239

1.5.4.5 Cryocooler Leak Test

1. If helium pressure continues to drop after increasing the helium charge, remove the flexlines from the Compressor using the two-wrench technique shown in Illustration 3-10.

NOTE: Lines suspected of leaking may be tested using a regulator, charging line and manifold.

2. Connect a regulator, charging line and manifold and purge in conformance with Chapter 5, Section 2, Cryocooler System Gas Pressure Adjustments.

3. Connect one of the flexlines to the appropriate fitting on the manifold and pressurize to approximately 100 psig.

4. Reduce the supply pressure using the regulator control and observe whether the reduced pressure is maintained on the manifold pressure gauge. If the pressure continues to drop, then that line may have a gas leak.

NOTE: If the Compressor pressure gauge readings drop and stay constant, then the charge may have been low. Recharge the system.

5. Maintain 100 psig with the regulator and check the line with a liquid soap solution or a commercial leak-testing solution such as Leak-Tec.

6. If the line has a leak, notify GE Magnet Systems at 843-664-1715 to obtain a replacement. Leave a message if no one answers.

7. Repeat Step 3 - Step 6 for the other gas line.

1.5.4.6 Cryocooler Electrical Cable Connections

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

Helium gas lines and Coldhead power cables are marked with two run numbers: one for Cryocooler applications and the other for Shield Cooler applications. Before installing Coldhead gas lines and power cables, mark out with a black pen the run number on the label at each end of the line/cable that does not apply. See Table 3-5.

Do NOT cut through the power cable insulation when removing a nonapplicable run number label.

1. Mark out the Shield Cooler run numbers on all gas lines, keeping visible those numbers listed in Table 3-5.

Table 3-5: Coldhead/Compressor Gas Line & Power Cable Run Numbers

	Gas Lines		Power Cables	
	Supply Line	Return Line	Coldhead to Penetration Panel	Compressor to Penetration Panel
Run Number	621	622	624	623

2. After the Penetration Panel is installed:

WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR.

a. Disconnect and lockout/tagout input power to the Compressor. Verify that no voltage is present by using a DVM or equivalent measuring device.

NOTICE

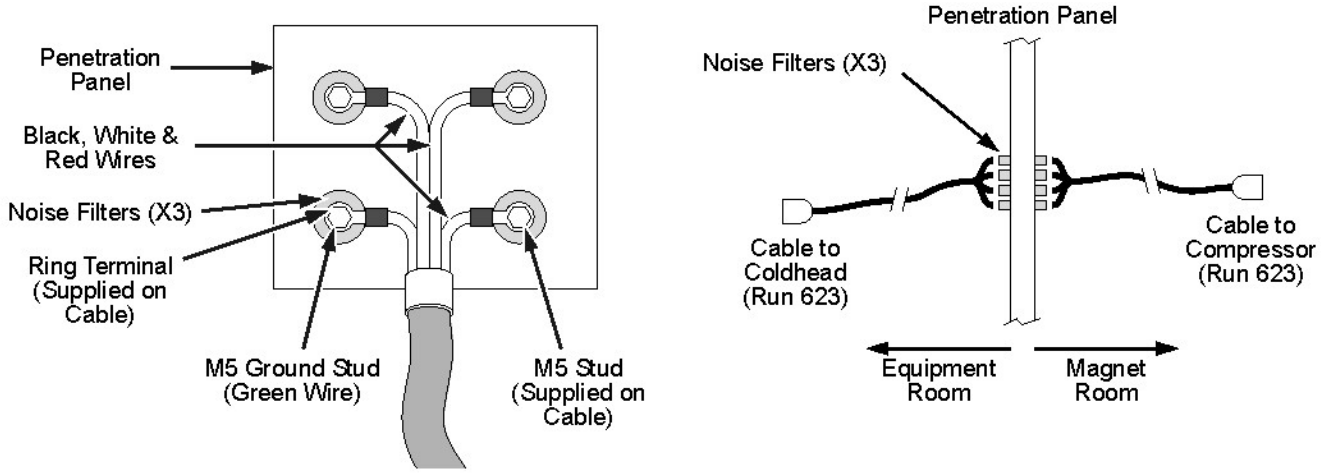
Make sure the wire code (color and number) is properly matched on the noise filter studs on both sides of the Penetration Panel to prevent improper operation/damage.

b. Connect the Coldhead Power Cables (Runs 623 and 624) as shown in Illustration 3-13 when the Penetration Panel is installed.

NOTE: The factory-supplied power cables may be connected to a terminal block to facilitate Cryocooler operation prior to Penetration Panel installation. If the terminal block is not present, connect the ring terminals via screws or the terminal block of the same wire color to allow the Cryocooler to operate prior to Penetration Panel installation.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-13: Cryocooler Electrical Cable Connections at the Penetration Panel



c. Connect the Run 623 Coldhead cable to the Compressor and the Run 624 cable to the Coldhead. See Chapter 6, Section 1.3, Magnet Cryocooler Interconnects.

d. Remove lockout/tagout and connect the Cryocooler Compressor input power cable.

1.5.4.7 Cryocooler Functional Checks

1. Turn on the main power.

2. Turn the Compressor's power switch on. The Coldhead motor should begin operating.

3. Perform the Cryocooler System functional checks covered in the vendor's manual.

1.5.4.8 Monitoring Cryocooler Temperatures

The RuO Temperature Monitor (2171219; included in Chapter 7, Section 4.2.2, RuO Temperature Monitor Kit 2183710) is used to monitor the second stage RuO temperature and the mating Recondenser surface temperature on a Cryocooler Coldhead during installation and troubleshooting of the Coldhead. During operation second stage Coldhead temperature is monitored indirectly by monitoring the silicone diode temperature of the Recondenser at the system monitor cabinet. First stage Coldhead temperature is monitored indirectly by monitoring the silicone diode Coldhead Sleeve temperature at the system monitor cabinet.

NOTE: Magnet Monitor 2209000 can be used to monitor cooldown and temperature trends but does not give accurate temperature readings at 4.2K.

1. Connect the test plug to temperature monitor's cables to confirm calibration.

2. Connect the temperature monitor's cables to the magnet's connectors as shown in Illustration 3-14 and Illustration 3-15.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-14: RuO Temperature Monitor (2171219) Connections

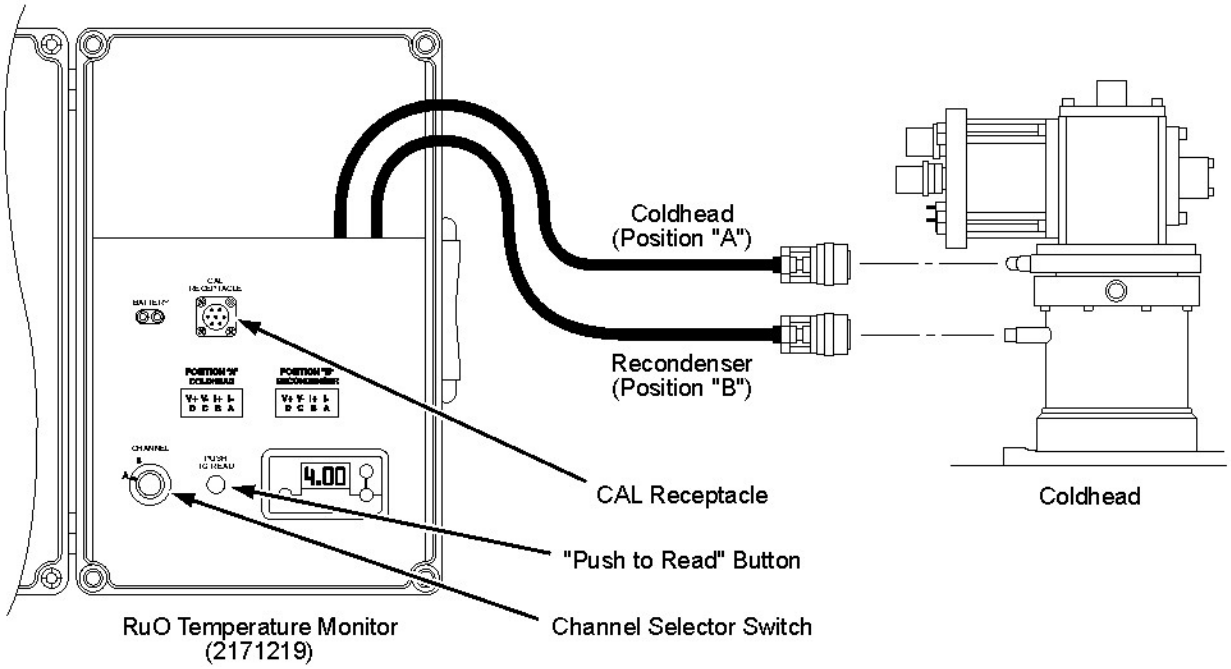
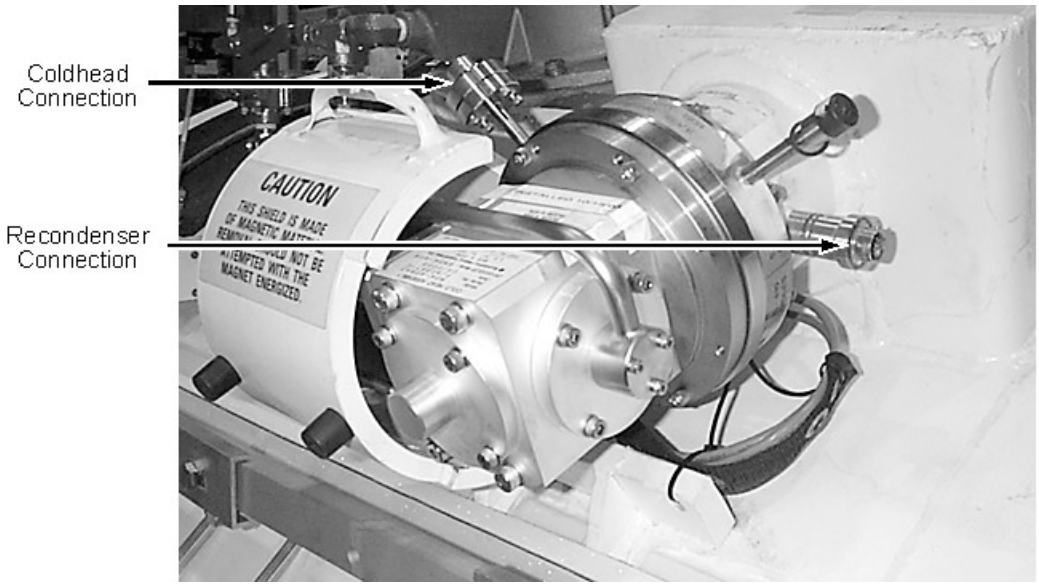


Illustration 3-15: RuO Temperature Monitor (2171219) Connections at Coldhead



3. Set the Channel Selector Switch to the desired channel (A or B), and depress the button to read the temperature on that channel.

4. Make sure the first and second stage Coldhead temperatures are cooling down.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.5.4.9 Setting Coldhead Tension

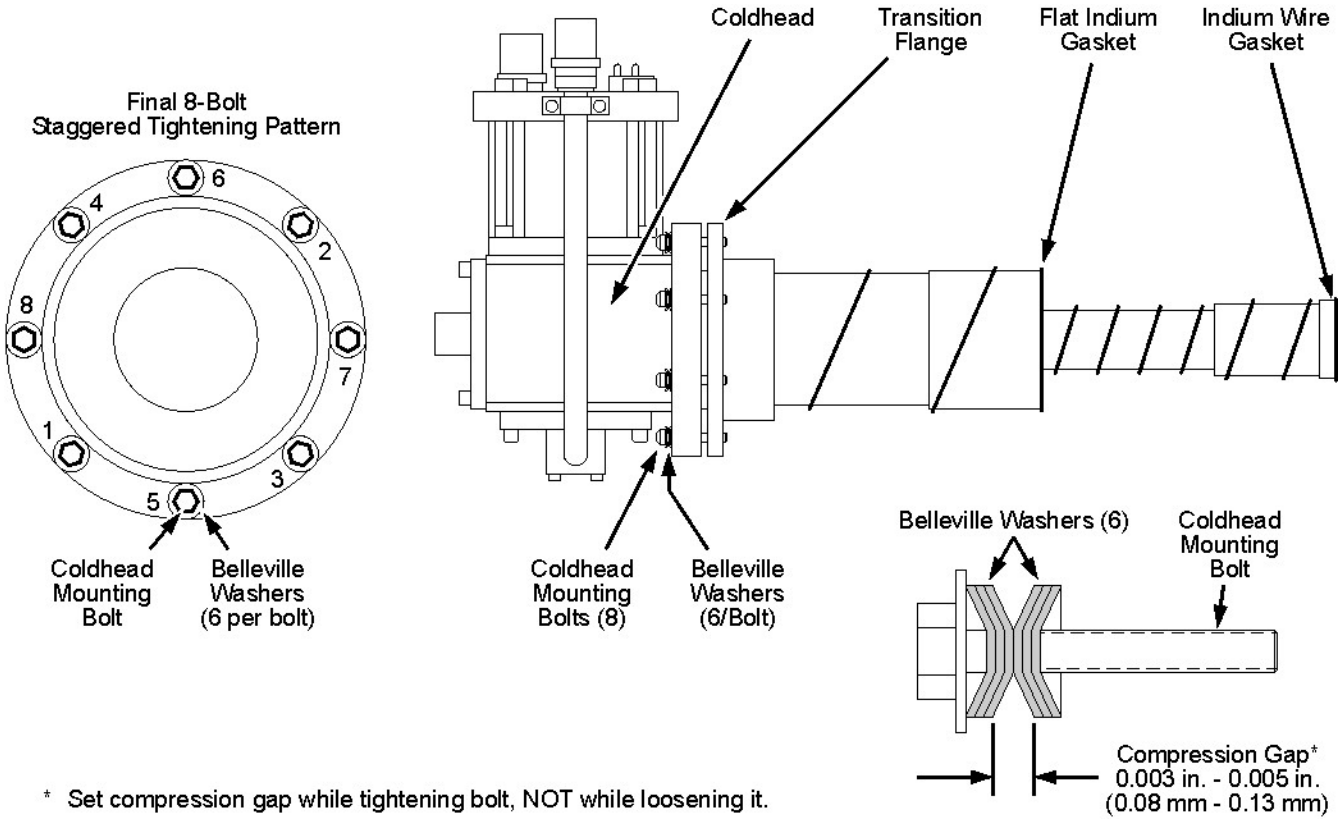
NOTE: When the Cryocooler Coldhead cools down during magnet installation — or when it is turned on after being shut off for weeks — it will contract within the Coldhead Sleeve, and the mounting bolts will need checking for tightness to make sure sufficient contact is made at the First and Second Stage Heat Stations.

1. Monitor the Cryocooler Coldhead first and second stage heat station temperatures in conformance with Section 1.5.4.8 until they stabilize.

2. Check the Coldhead mounting bolts during cooldown. Make sure they are hand tight.

3. When Coldhead temperatures have stabilized, verify that the Belleville washer gap settings are within the specified range of 0.003 in. - 0.005 in. (0.08 mm - 0.13 mm). See Illustration 3-16.

Illustration 3-16: Coldhead Mounting Bolt Gap Setting



4. If Belleville washer gaps are greater than 0.005 inches (0.13 mm), tighten the Coldhead mounting bolts in the staggered bolt pattern shown in Illustration 3-16 until even gaps within specification are set for all bolts. Make sure an even gap is maintained between the Transition and Sleeve Flanges around the full circumference.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5. Record final temperatures:

Final First Stage Temperature:	Final Second Stage Temperature:	Final Recondenser Temperature:

6. Make sure the final temperature readings on the RuO Temperature Monitor (2171219) are within the following limits:
   - Recondenser: < 4.0K - 4.5K
   - ΔT [Recondenser$_{(\text{at position B})}$ - Coldhead$_{(\text{at position A})}$] $\leq$ 0.2K

NOTE: Second stage Coldhead RuO temperature may show a small oscillation (0.0K - 0.2K) on the temperature monitor. This is a result of the displacer motion inside the second stage and the sampling rate of the monitor. Record the average temperature for all checks:

Second stage temperarure = $(T_{max} + T_{min}) / 2$

7. If temperature limits are exceeded, perform the Coldhead Interface Adjustment procedure in Chapter 5, Section 10, Two-Stage Cryocooler Coldhead Replacement.

1.5.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.6 Magnet Rundown Unit (MRU) Installation

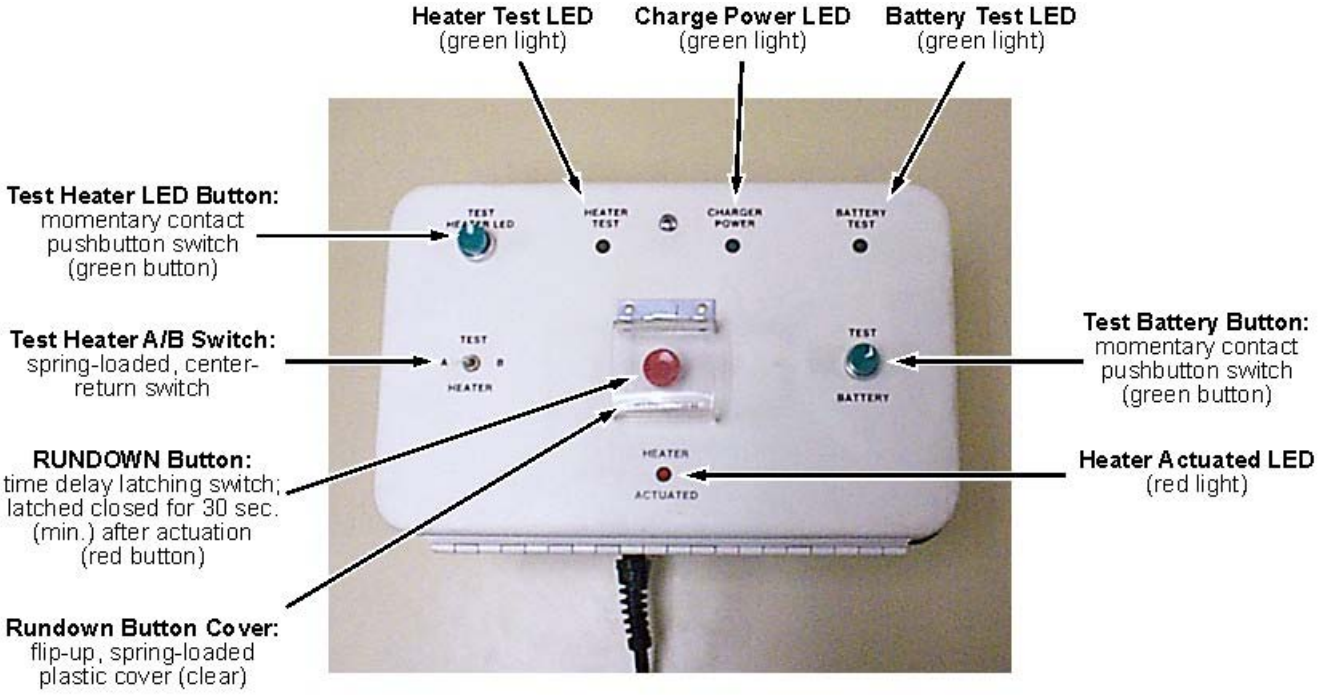
1.6.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	1 MRU: 1 hours; 2 MRUs: 2.5 hours	Included in 'Procedure'

1.6.2 Overview

A Magnet Rundown Unit (MRU) (Illustration 3-17) is required to rapidly ramp down the magnet in an emergency situation. The Primary MRU is installed in the Magnet Room where the magnetic field is ≤ 200 gauss. If a Secondary MRU is installed, it is located and installed as dictated by local codes and where the magnetic field is ≤ 200 gauss.

Illustration 3-17: MRU Front Panel Layout, Labeling & Control Function Descriptions



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.6.3 Preliminary Requirements

1.6.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Gloves (electrically insulating); one pair per person	1	-	-	-
Safety Glasses; one per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
3.5-Digit Digital Voltmeter (Note: Do not use a Volt-Ohm Meter.)	1	-	-	-
Power Drill with 0.25 in. or 6 mm Drill Bit	1	-	-	-
Stud Finder	1	-	-	-
Vacuum Cleaner	1	-	-	-
6 in. (150 mm) Level	1	-	-	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
Magnet Rundown Unit (MRU) Service Manual 46-318393 (included in the manual collector)	1	-	46-318393	-
Magnet Rundown Unit (MRU) Operation Manual 46-318394 (included in the manual collector)	1	-	46-318394	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Nonmagnetic Tool Kit, Inch/Metric (46-320273G4) (magnets with magnetic fields ≤ 1.5T only); one kit	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156)	-

1.6.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Cable Ty-Wraps; 20 minimum	20	-	-	-
Isopropyl Alcohol; bottle	1	-	-	-
Clean rags	5	-	-	-

1.6.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
MRU Kit Assembly	1	-	2128700	-
Remote MRU Kit (only for sites installing a second MRU)	1	-	5128755	-
0.25 in. or 6 mm dia. MRU mounting hardware (bolts, wall anchors, etc. depending on mounting location), each capable of supporting 32 pounds (14.5 kg); per MRU	4	-	-	-
0.25 in. or 6 mm dia. Flat Washers; per MRU	4	-	-	-

1.6.3.4 Safety

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH MRU WIRING WHILE POWER IS SUPPLIED CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE CONNECTING INPUT POWER WIRES TO THE MRU. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.



CAUTION

Potential Injury
Material being drilled will scatter and drill bits could slip from the location being drilled or break during drilling operations.
Wear appropriate personal protective equipment (PPE) — gloves, safety glasses and safety shoes — during drilling operations.

1.6.3.5 Required Conditions

Condition	Reference	Effectivity
Verify that magnetic field strength where the Primary MRU and optional Remote MRU will be installed will be ≤ 200 gauss and that the Remote MRU location is in compliance with local codes.	-	-

1.6.4 Procedure



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH MRU WIRING WHILE POWER IS SUPPLIED CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE CONNECTING INPUT POWER WIRES TO THE MRU.

1. Lockout/tagout (LOTO) the power feed to all MRUs being installed (Primary MRU only or Primary and Remote MRUs). Verify that no voltage is present by using a DVM or equivalent measuring device.



CAUTION

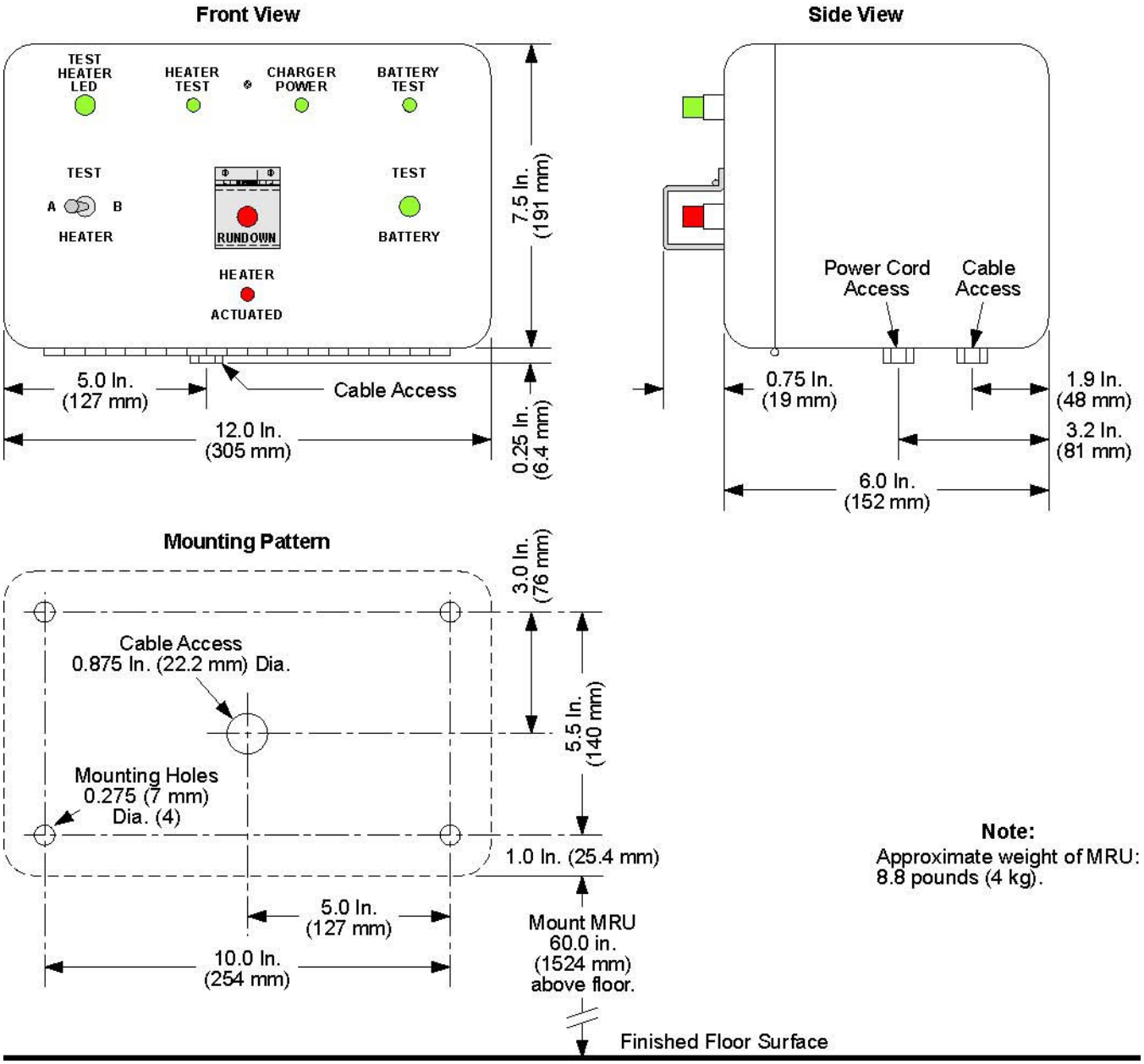
Potential Injury
Material being drilled will scatter and drill bits could slip from the location being drilled or break during drilling operations.
Wear appropriate personal protective equipment (PPE) — gloves, safety glasses and safety shoes — during drilling operations.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2. Mount the Primary MRU inside the magnet room and the Remote MRU in the equipment room, each 60 inches (1524 mm) above the floor, in conformance with the vendor's manual in the location called out in the site drawing. Illustration 3-18 may be used for reference.

NOTE: MRUs are shipped wired for 115V AC at 50 Hz - 60 Hz. Refer to the vendor's service manual to handle local requirements.

Illustration 3-18: MRU Mounting Dimensions



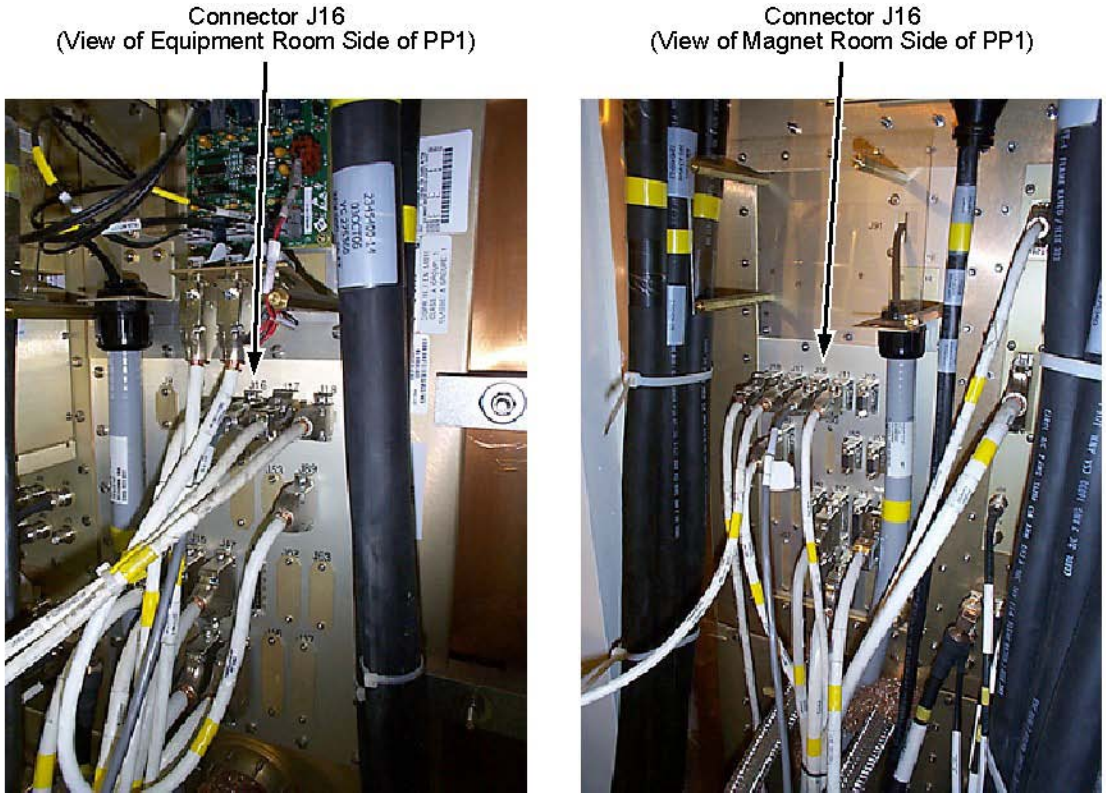
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. Route Cable 2128699 (Run 606) between the Primary MRU and the magnet, with the 4-pin Lemo Connector (P2) at the MRU end and the 5-pin Switchcraft connector (P3) at the magnet end. See Illustration 3-20 or the wiring diagram in Chapter 6, Section 1.1, Magnet System Interconnects. **DO NOT** connect Run 606 to the MRU's connector J2 at this time.

4. Route Cable 5128149 (Run 1266) between the Remote MRU and the equipment room side of the Penetration Panel (PP1) at J16 (Illustration 3-19). Make sure the 4-pin Lemo Connector (P2) end of Run 1266 is at the MRU. Do **NOT** connect Run 1266 to the MRU's connector J2 at this time.

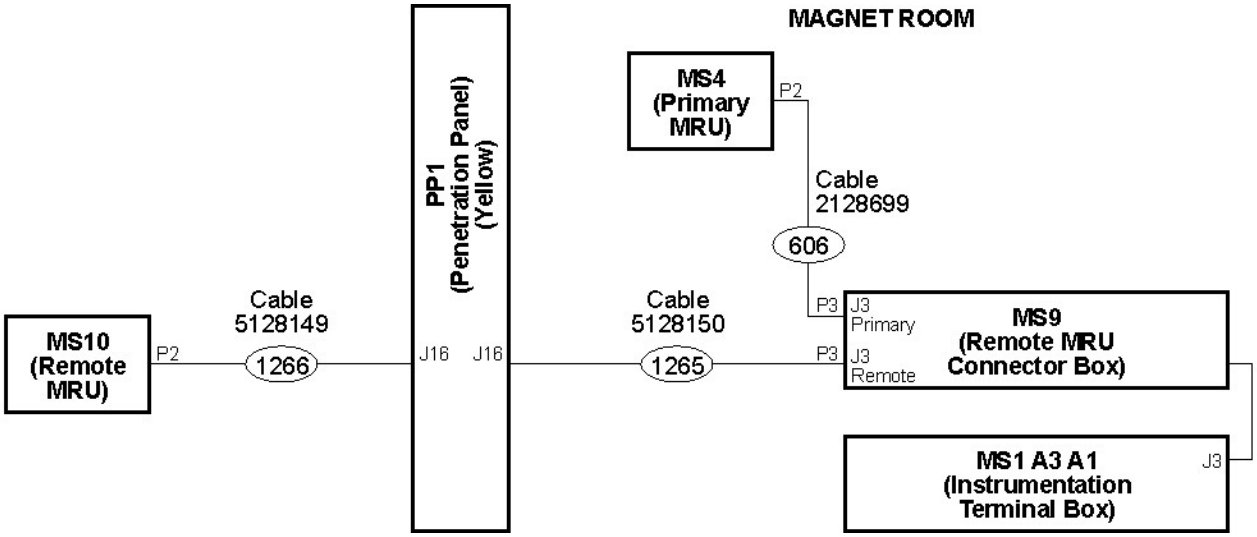
NOTE: A block diagram of dual MRU cabling is shown in Illustration 3-20. The wiring diagram for both single and dual MRU installations is shown in Chapter 6, Section 2.1, Magnet System Wiring.

Illustration 3-19: Remote MRU Penetration Panel Connections



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-20: Primary and Remote MRU Connection Block Diagram



5. Route Cable 2128150 (Run 1265) between the magnet room side of the Penetration Panel at J16 and the magnet. Make sure the 5-pin Switchcraft connector (P3) is at the magnet.

6. Remove lockout/tagout from both MRUs.

7. Energize the both MRUs.

NOTICE

Verify that the batteries in each MRU are fully charged before connecting the MRU to the magnet in Step 11. Charge the batteries for 24 hours, if recharging is required.

8. Perform functional and battery checks of each MRU in conformance with the vendor service manual. Fully recharge batteries as required.

NOTE: A fuse (Fuse F2) is shipped with each MRU to prevent the batteries from discharging in transit. Installation of the fuse is covered in the MRU service manual.

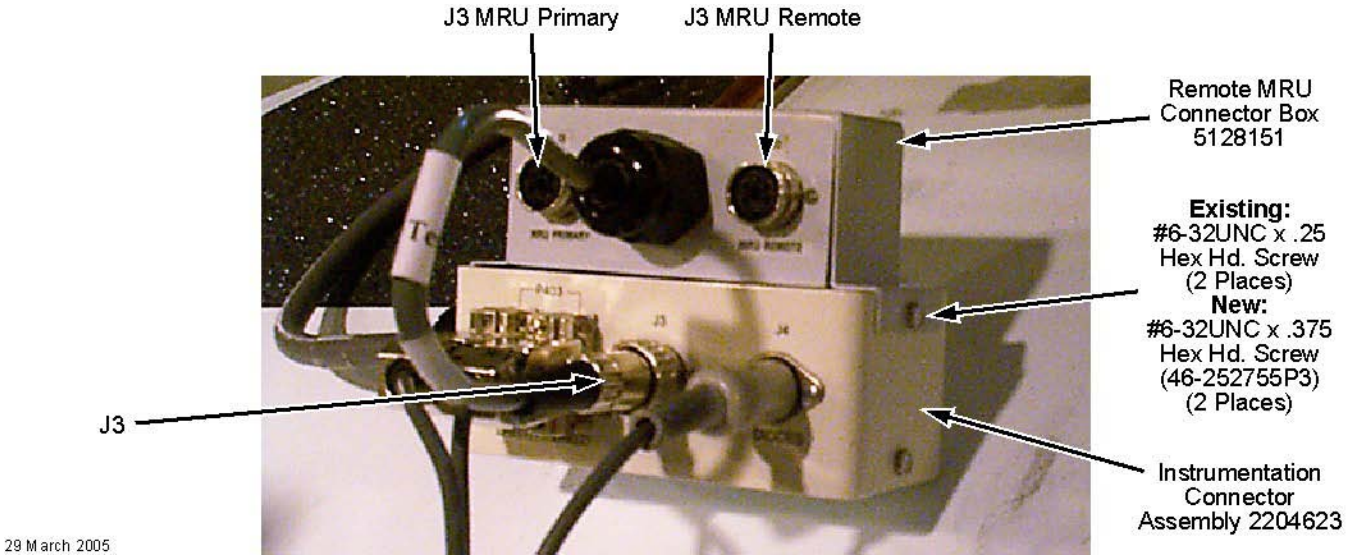
NOTE: In this manual functional checks of MRU operation are covered in Chapter 4, Section 6, Magnet Rundown Unit (MRU) Checks.

9. If installing both a Primary MRU and a Remote MRU, install Remote MRU Connector Box 5128151 at Instrumentation Connector Assembly 2204623 on the magnet:

   a. Remove the top two #6-32UNC x .25 Hex Hd. Screws securing the Instrumentation Connector Assembly cover, one screw on each end. See Illustration 3-21.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-21: Installing Remote MRU Connector Box 5128151 on Instrumentation Connector Assembly 2204623

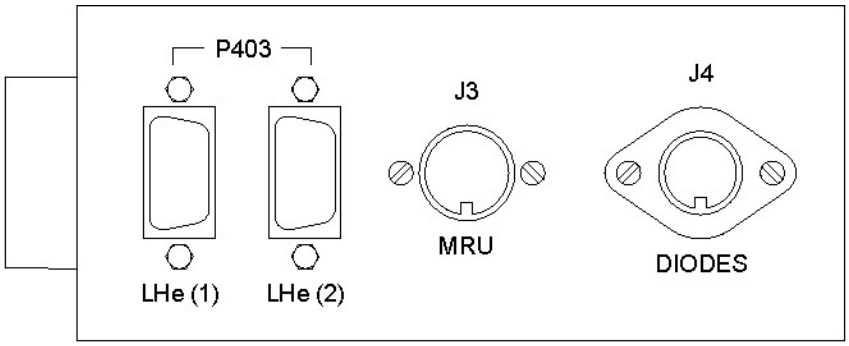


b. Secure Remote MRU Connector Box 5128151 to the Instrumentation Connector Assembly cover using two replacement screws (#6-32UNC x .375 screws: 46-252755P3) from the Remote MRU Kit. See Illustration 3-21.

NOTE: Remote MRU Kit 5128755 contents are itemized in Chapter 7, Section 3.4.2, Remote MRU Kit 5128755.

c. Plug the Remote MRU Connector Box's cable into the Instrumentation Connector Assembly's 'J3' connector. See Illustration 3-21 and Illustration 3-22.

Illustration 3-22: Instrumentation Connector Assembly 2204623 (MS1-A3,A1)



Instrumentation Connector Assembly 2204623
(MS1-A3, A1)

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



⚠ WARNING

POTENTIAL MAGNET QUENCH!
MAKE SURE POWER TO EACH MRU IS ON AND THAT NEITHER MRU RELAY IS CLOSED ('RUNDOWN' BUTTON DEPRESSED) BEFORE CONNECTING MRU TO THE MAGNET.



⚠ WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH IF THE “RUNDOWN” BUTTON ON EITHER MRU IS ACTIVATED < 3 MINUTES AFTER EITHER MRU HAS RECEIVED AC POWER.
DO NOT ACTIVATE THE “RUNDOWN” BUTTON WHILE CONNECTING CABLES TO THE MRU.



⚠ WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH IF 'P2' IS CONNECTED TO 'J2' < 3 MINUTES AFTER ANY MRU BEING INSTALLED HAS RECEIVED AC POWER
DO NOT CONNECT 'P2' TO 'J2' WITHIN 3 MINUTES OF POWERING ON EITHER MRU.

10. Verify that input power to all MRUs is connected and turned on. Wait **at least** three minutes before connecting any other cables to either MRU to allow any depressed 'Rundown' button relay to disengage.

11. Make cable connections:

    a. If a Remote MRU is installed, connect the 4-pin Lemo Connector (P2) end of Cable 5128149 (Run 1266) to the Remote MRU's J2, located behind the MRU's cover.

NOTE: Illustration 3-20 and Chapter 6, Section 2.1, Magnet System Wiring, may be used as reference.

    b. Connect the 4-pin Lemo Connector (P2) end of Cable 2128699 (Run 606) to the Primary MRU's J2, located behind the MRU's cover.

    c. If only a Primary MRU is installed, connect the 5-pin Switchcraft connector (P3) end of Cable 2128699 (Run 606) to J3 on Instrumentation Connector Assembly 2204623 at the magnet.

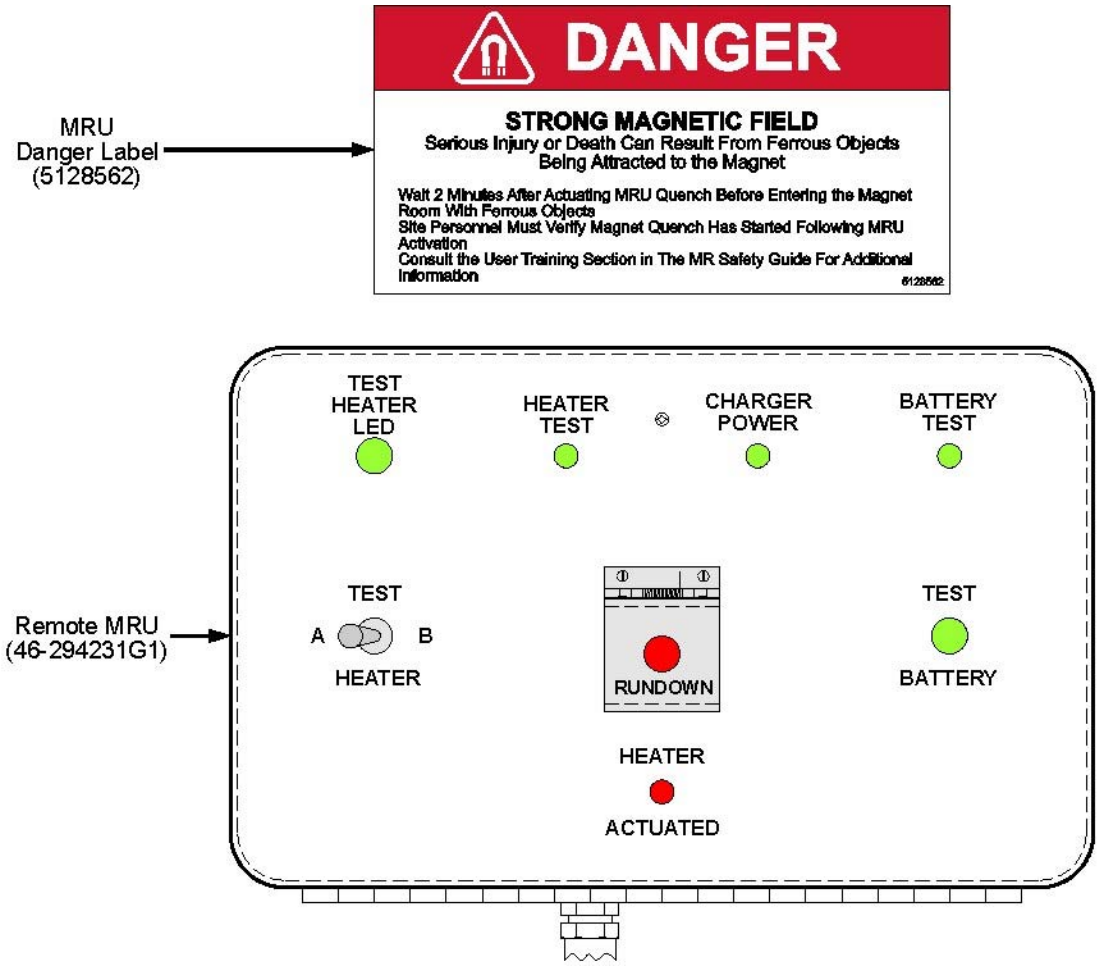
    d. If both a Primary and a Remote MRU are installed:

    - Connect the 5-pin Switchcraft connector (P3) end of Cable 2128699 (Run 606) to 'J3 MRU Primary' on Remote MRU Connector Box 5128151 at the magnet.
    - Connect the 5-pin Switchcraft connector (P3) end of Cable 2128150 (Run 1265) to 'J3 MRU Remote' on Remote MRU Connector Box 5128151 at the magnet.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

12. Install MRU Danger Label 5128562 centered above the Remote MRU, if one is being installed, as in Illustration 3-23. Make sure to clean the surface to receive the decal using isopropyl alcohol and clean rags before adhering the decal to the surface.

Illustration 3-23: MRU Danger Label 5128562



CAUTION

Loose material produced during drilling could become a health hazard. Make sure to clean up after drilling.

NOTICE

Any loose metal filings produced during drilling could become a source of spike noise. Make sure to clean up after drilling through any metallic material.

13. Clean up using a vacuum cleaner the area where drilling occurred.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.6.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.7 Magnet Monitor Installation

The Magnet Monitor supplied with the magnet monitors the cryogen level inside the magnet and controls the internal helium vessel pressure. Install Magnet Monitor 2219400 in conformance with Direction 2230681, *LCC Magnet Monitor Hardware (SHEM) Installation*. Install Magnet Monitor 2394952 in conformance with the magnet's Service Methods CD.

The Magnet Monitor's connection to magnet is shown in Chapter 6, Section 1.2, Magnet Monitor Interface. Cable schematics are shown in Chapter 6, Section 2.3, Magnet Monitor Cables.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.8 Service Platform Set-Up

1.8.1 HDx Service Platform 5155291 Set-Up

1.8.1.1 Personnel Requirements

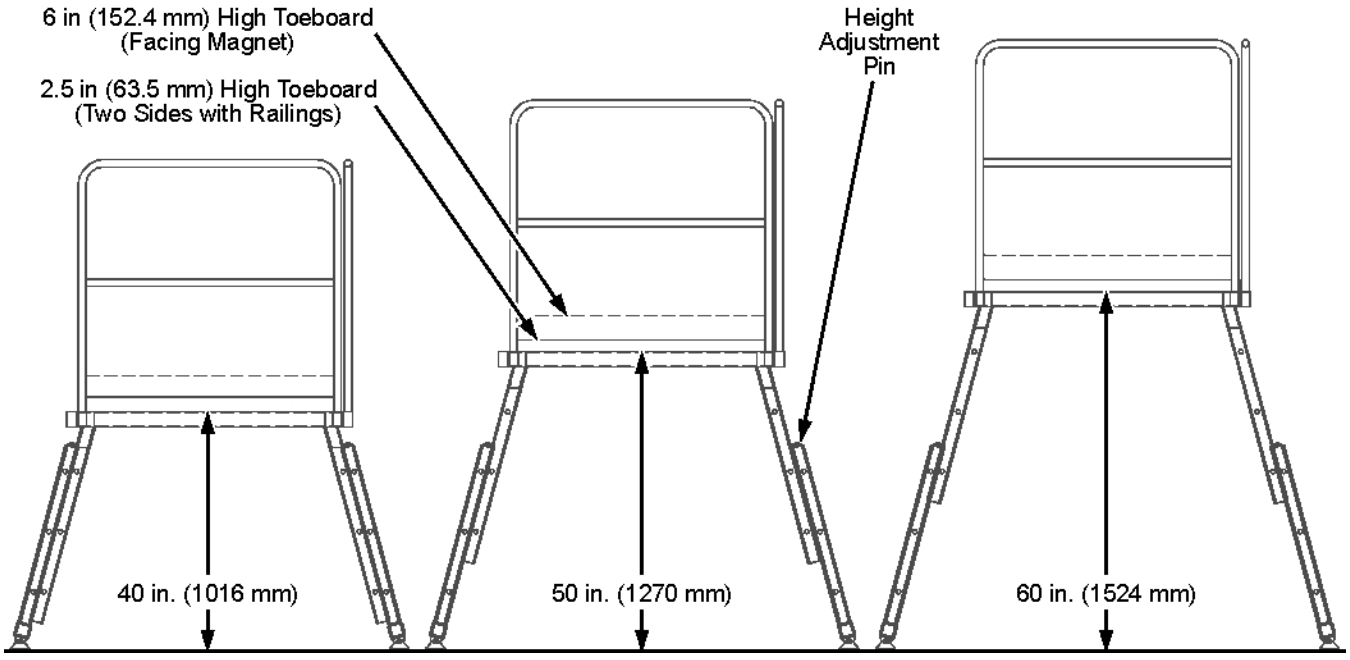
Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	.5 hours	.5 hours

1.8.1.2 Overview

HDx Service Platform 5155291, which is assembled in conformance with this HDx Service Platform 5155291 Set-Up procedure, provides a ~22.5 in. by 44 in. (~570 mm by 1120 mm) work surface that can hold 500 pounds (226 Kg) at platform heights of 40 in., 50 in. or 60 in. (1016 mm, 1270 mm or 1524 mm). See Illustration 3-24. Adjustable outriggers in the ladder's base provide for better stability at higher platform heights. Each safety rail includes a 2.5 in. (63.5 mm) high toeboard, and a 6 in. (152.4 mm) high toeboard is provided for the platform side closest to the magnet.

NOTE: All service procedures must be performed from the floor or from the HDx Service Platform's platform.

Illustration 3-24: HDx Service Platform 5155291



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.8.1.3 Preliminary Requirements

1.8.1.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Leather gloves; one pair per person	1	-	-	-

1.8.1.3.2 Consumables

No consumables required.

1.8.1.3.3 Replacement Parts

No replacement parts required.

1.8.1.3.4 Safety



CAUTION

Potential Scratches/Cuts
HDx Service Platform 5155291 may have edges sharp enough to scratch or cut skin. Wear leather gloves while assembling, adjusting or disassembling HDx Service Platform 5155291 to protect against scratches/cuts and to keep your hands clean.

1.8.1.3.5 Required Conditions

No required conditions.

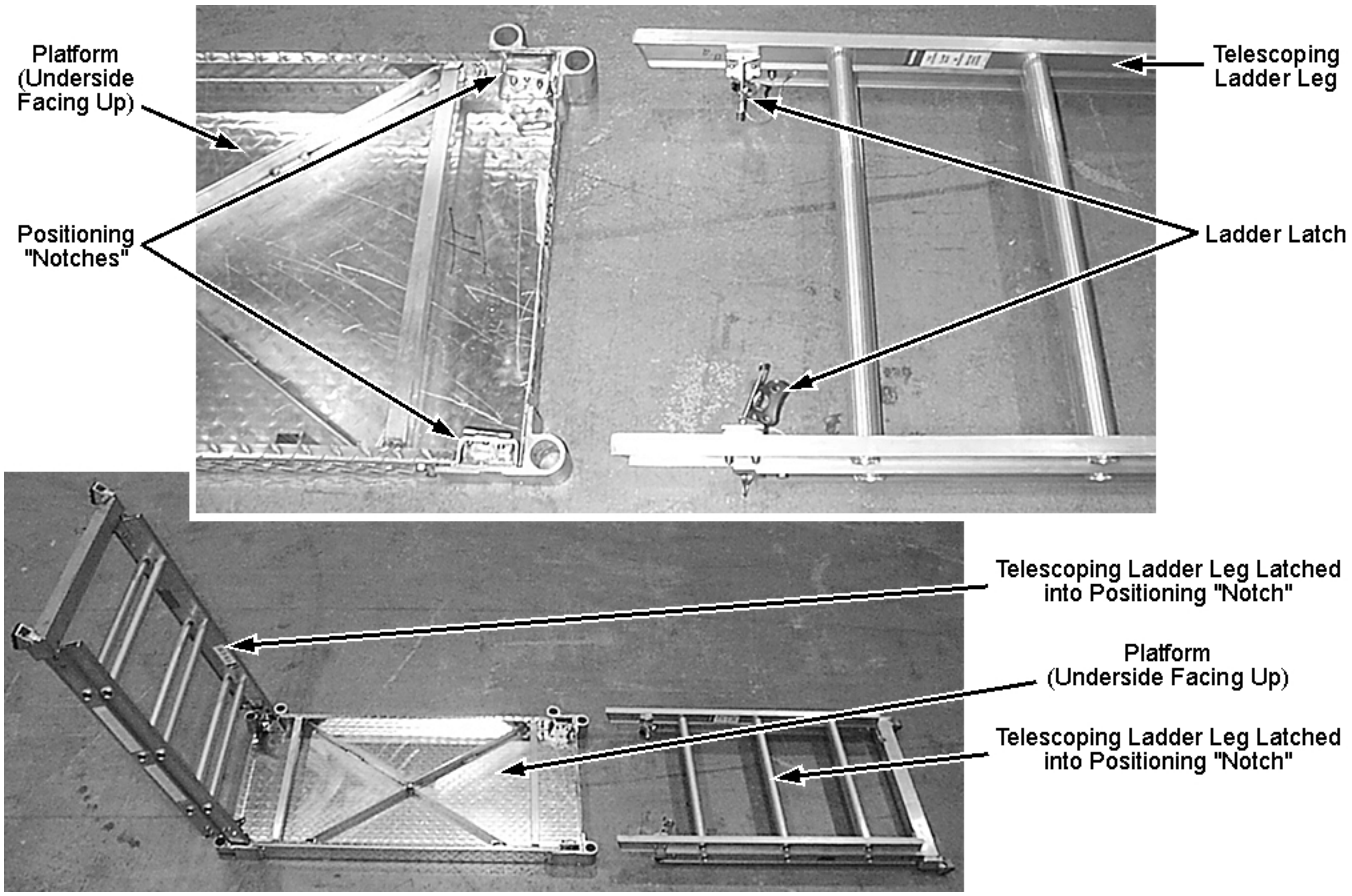
1.8.1.4 Procedure

1. Position the ladder components in an open area away from the magnet about 6 feet (1800 mm) square.

2. Lay the platform section on the floor with its underside facing up as in Illustration 3-25.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-25: Positioning Ladder Leg Sections to Platform Underside

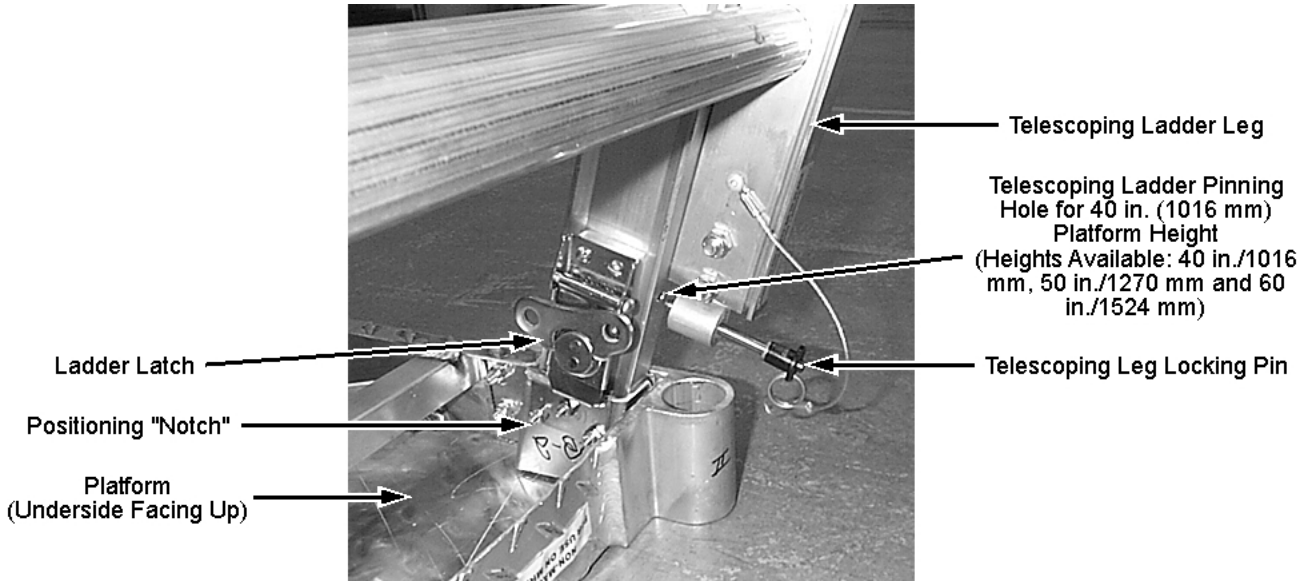


3. Insert each ladder leg in its positioning notch as in Illustration 3-25.

4. Securely latch both ladder latches of each ladder leg to the platform. See Illustration 3-26.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-26: Ladder Leg Section Latches



5. Adjust both telescoping ladder legs to the platform height required. See Illustration 3-26. Pinning holes are available for 40 in., 50 in. and 60 in. (1016 mm, 1270 mm and 1524 mm) platform heights.

   a. Disengage each Telescoping Leg Locking Pin.

   b. Simultaneously slide both sides of each ladder section until the pinning hole for the platform height desired aligns with the Locking Pin.

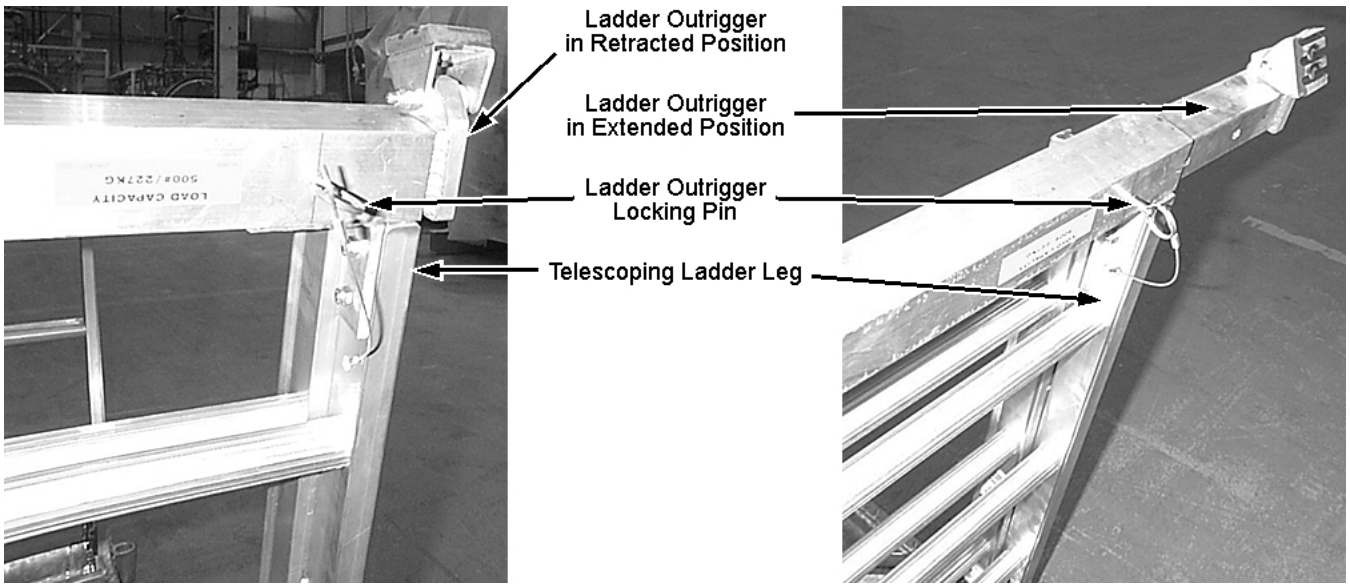
   c. Securely engage all four Locking Pins in pinning holes.

   d. If adjusting the platform to its 60 in. (1524 mm) height, fully extend and securely pin all four Ladder Outriggers. See Illustration 3-27.

NOTE: At the 60 in. (1524 mm) height the ladder can be located to span over the magnet's Rear Pedestal or Patient Table for service operations not readily accessible from beside the magnet.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-27: Extending the Ladder Outriggers



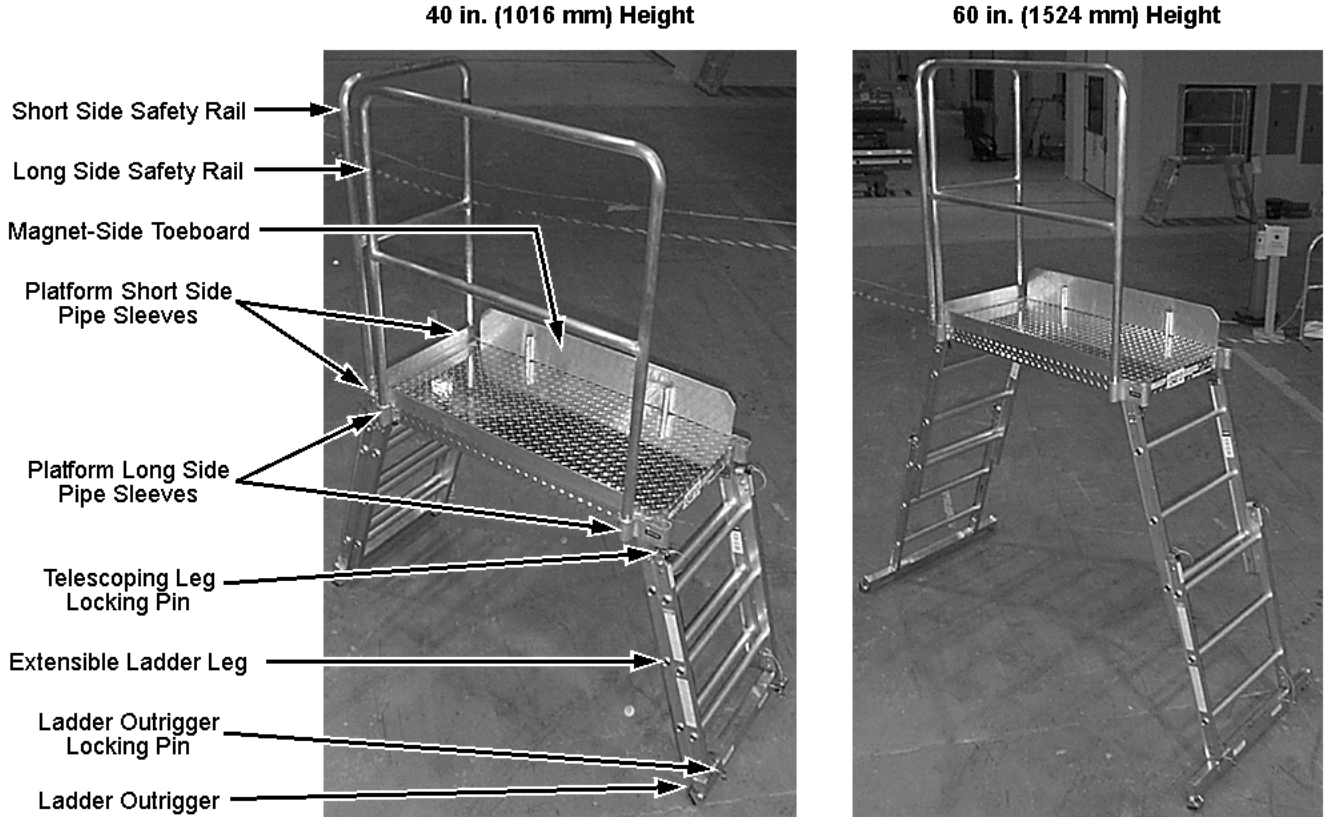
6. Verify that all connections/adjustments are secure, then carefully flip the platform and legs upright.

7. Move the platform and attached legs into the magnet room.

8. Insert the Long Side Safety Rail into two Pipe Sleeves along the long edge of the platform away from the magnet as in Illustration 3-28.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-28: Assembled HDx Service Platform at Lowest and Highest Heights



9. Insert the Short Side Safety Rail into two Pipe Sleeves along a short edge of the platform, typically at the service end of the magnet. See Illustration 3-28.

10. Insert the Magnet Side Toeboard along the magnet side of the platform.

11. Move the assembled HDx Service Platform 5155291 to beside the magnet.

1.8.1.5 Finalization

1. Disassemble HDx Service Platform 5155291 in reverse order to assembling it.

2. Always return HDx Service Platform 5155291 to its designated storage location after usage.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.8.2 Ladder-Platform 2319156 Set-Up

1.8.2.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	.5 hour	Included in 'Procedure'

1.8.2.2 Overview

The Universal Service Ladder-Platform (2319156) is assembled for use at fixed sites according to this Ladder-Platform 2319156 procedure. The ladder-platform provides a 24 inch x 45 inch (610 mm x 1143 mm) working platform that can hold 500 pounds (226 Kg) at platform heights of either 40 inch or 50 inch (1016 mm or 1270 mm).

NOTE: All service procedures must be performed from the floor or from the Universal Service Ladder-Platform's platform.

NOTE: Fixed site magnets shipped through approximately April 1, 2002, included Fixed-Site Service Ladder/Platform 2230707. See Section 1.8.3, Ladder-Platforms 2230707 2230707-2 Set-Up.

1.8.2.3 Preliminary Requirements

1.8.2.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Leather gloves; one pair per person	1	-	-	-
Standard tools; one kit	1	-	-	-

1.8.2.3.2 Consumables

No consumables required.

1.8.2.3.3 Replacement Parts

No replacement parts required.

1.8.2.3.4 Safety



CAUTION

Potential Scratches/Cuts
The Ladder-Platform may have edges sharp enough to scratch or cut skin. Wear leather gloves while assembling, adjusting or disassembling the Ladder-Platform to protect against scratches/cuts and to keep your hands clean.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.8.2.3.5 Required Conditions

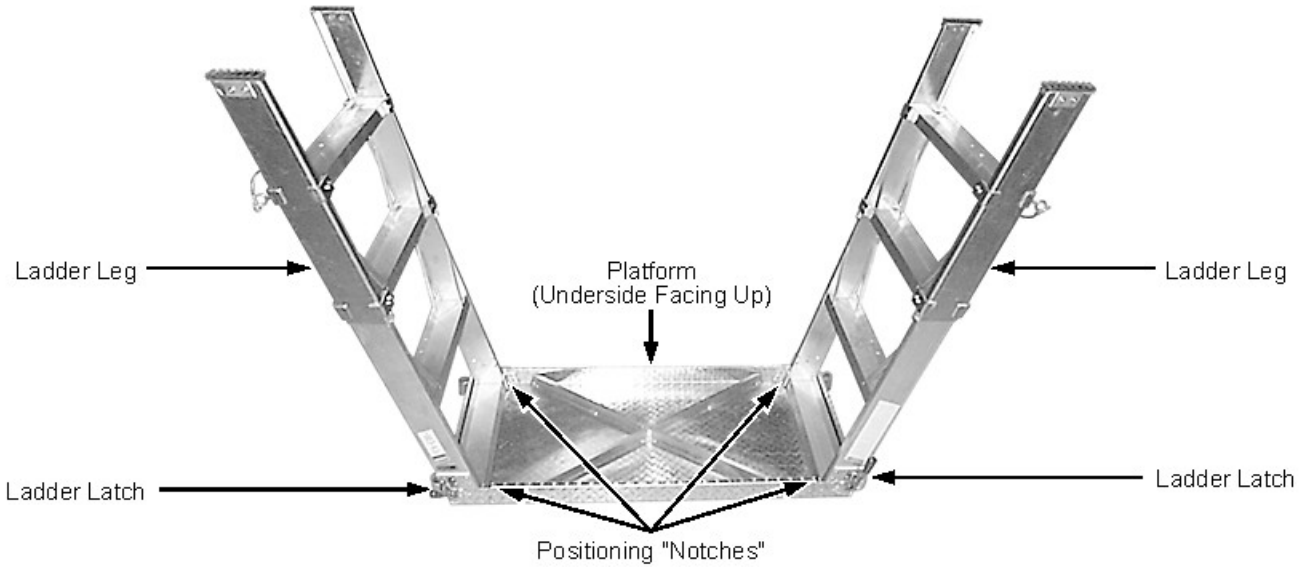
No required conditions.

1.8.2.4 Procedure

1. Position the ladder components in an open area about 6 feet (1800 mm) square.

2. Lay the platform section on the floor with its underside facing up as in Illustration 3-29.

Illustration 3-29: Positioning Ladder Leg Sections to Platform Underside



3. Insert one ladder leg in each positioning notch as in Illustration 3-29.

4. Securely latch both ladder latches of each ladder leg to the platform. See Illustration 3-30.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

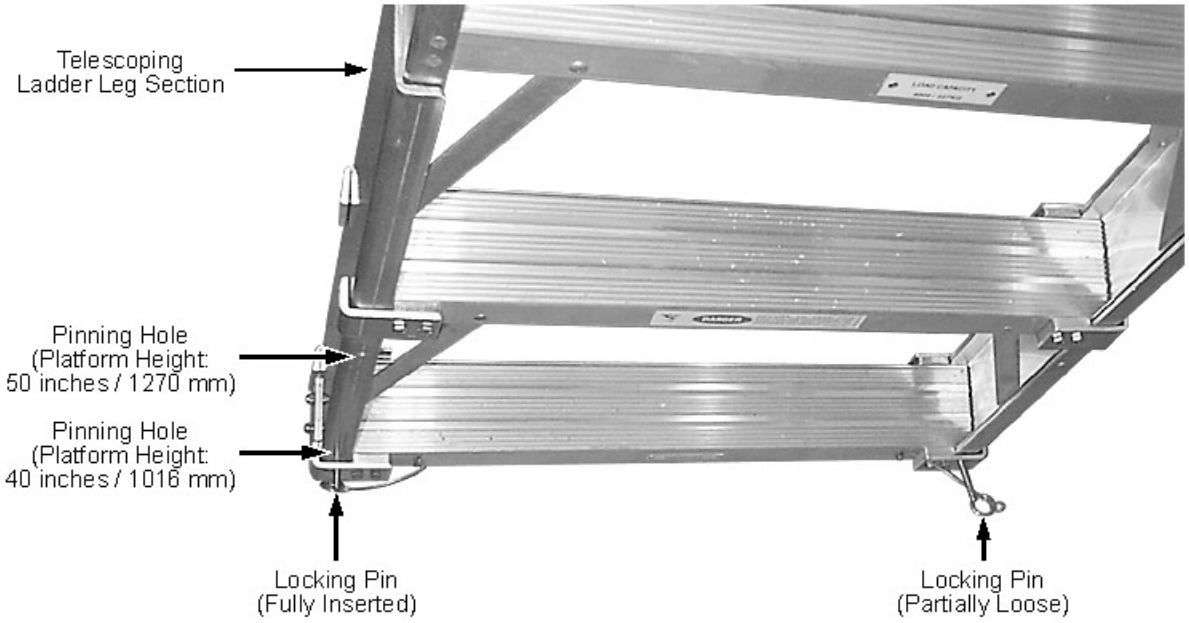
Illustration 3-30: Ladder Leg Section Latches



5. Adjust both telescoping sections of each ladder leg for the platform height required. Pinning the telescoping sections fully retracted yields a 40 inch (1016 mm) platform height, while fully extended yields a 50 inch (1270 mm) platform height. See Illustration 3-30.

NOTE: Although platform height can be set while the ladder-platform is upright or on its side, setting platform height while the platform is face down is easiest. Do not reset the height of an upright platform while weight is on it.

Illustration 3-31: Ladder Leg Telescoping Sections & Locking Pins

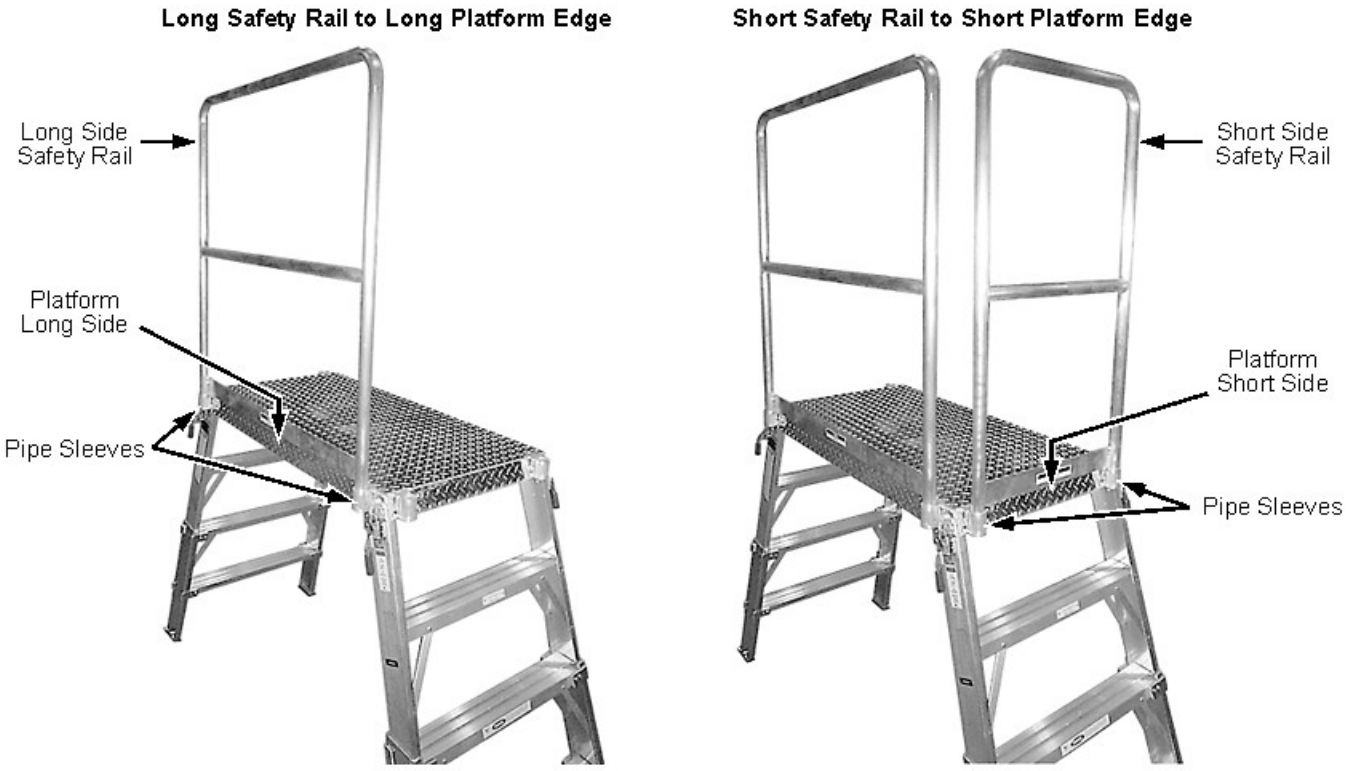


Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6. Carefully flip the assembled platform and ladder legs upright.

7. Insert the long safety rail section in the pipe sleeves on the platform's long edge. See Illustration 3-32.

Illustration 3-32: Installing the Safety Rail



8. Insert the short safety rail section in the pipe sleeves on the platform short edge that will not be needed as a ladder. See Illustration 3-32.

1.8.2.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.8.3 Ladder-Platform 2230707 2230707-2 Set-Up

1.8.3.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	.5 hour	Included in 'Procedure'

1.8.3.2 Overview

The Service Ladder-Platform (fixed site: 2230707; mobile site: 2230707-2) eliminates the need for the Field Engineer to climb on top of the magnet when servicing a Signa MR/i or Signa CV/i fixed-site system. All service procedures must be performed from the floor or from the ladder's platform. This ladder provides the necessary fall protection for working surfaces above 4 feet (1220 mm) required by OSHA. The ladder features:

- Nonferrous construction with bumper guards on the pipe sleeves to prevent enclosure scratches.
- Adjustable outriggers in the ladder's base provide for better stability at higher platform heights.
- Built-in rollers provide mobility when transporting for storage or moving around the magnet.
- Fixed-site ladder-platforms adjustable to three different platform heights above ground.
  - 60 inches (1524 mm)
  - 50 inches (1270 mm)
  - 40 inches (1016 mm)

NOTE: At the 60 inch (1524 mm) height the ladder can be located to span over the magnet's Rear Pedestal for servicing the magnet exhaust plumbing and Recondenser purge tee.

Table 3-6: Service Ladder-Platform Specifications

		Fixed Site Service Ladder-Platform (2230707)	Mobile Site Service Ladder-Platform (2230707-2)
Assembled Configuration	Load Capacity	400 pounds (181 Kg)	400 pounds (181 Kg)
	Platform Width	20.62 in. (524 mm)	20.00 in. (508 mm)
	Platform Height	60.00 in. (1524 mm)*	60.00 in. (1524 mm)*
		50.00 in. (1270 mm)	
		40.00 in. (1016 mm)	
	Maximum Width of Ladder Base	36.88 in. (937 mm)	36.88 in. (937 mm)

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 3-6: Service Ladder-Platform Specifications (cont'd)

		Fixed Site Service Ladder-Platform (2230707)	Mobile Site Service Ladder-Platform (2230707-2)	
Ladder (Storage Configuration)	—	—	Platform Portion	Ladder-Only Portion
	Height	41.88 in. (1064 mm)	62.25 in. (1582 mm)	63.13 in. (1604 mm)
	Width	24.88 in. (632 mm)	24.88 in. (632 mm)	24.88 in. (632 mm)
	Depth	15.06 in. (383 mm)	5.00 in. (127 mm)	2.75 in. (70 mm)
	Weight	66 pounds (30 Kg)	—	—
Safety Rail (Storage Configuration)	Height	45.75 in. (1162 mm)	33.38 in. (848 mm)	
	Width	31.75 in. (806 mm)	31.75 in. (806 mm)	
	Depth	3.31 in. (84 mm)	3.31 in. (84 mm)	
	Weight	18 pounds (8 Kg)	—	
* Able to span the magnet's Rear Pedestal. Use this height to service the magnet exhaust plumbing and the Recondenser purge tee.				

1.8.3.3 Preliminary Requirements

1.8.3.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Leather gloves; one pair per person	1	-	-	-
Standard tools; one kit	1	-	-	-

1.8.3.3.2 Consumables

No consumables required.

1.8.3.3.3 Replacement Parts

No replacement parts required.

1.8.3.3.4 Safety



CAUTION

Potential Scratches/Cuts
The Ladder-Platform may have edges sharp enough to scratch or cut skin. Wear leather gloves while assembling, adjusting or disassembling the Ladder-Platform to protect against scratches/cuts and to keep your hands clean.

1.8.3.3.5 Required Conditions

No required conditions.

1.8.3.4 Procedure

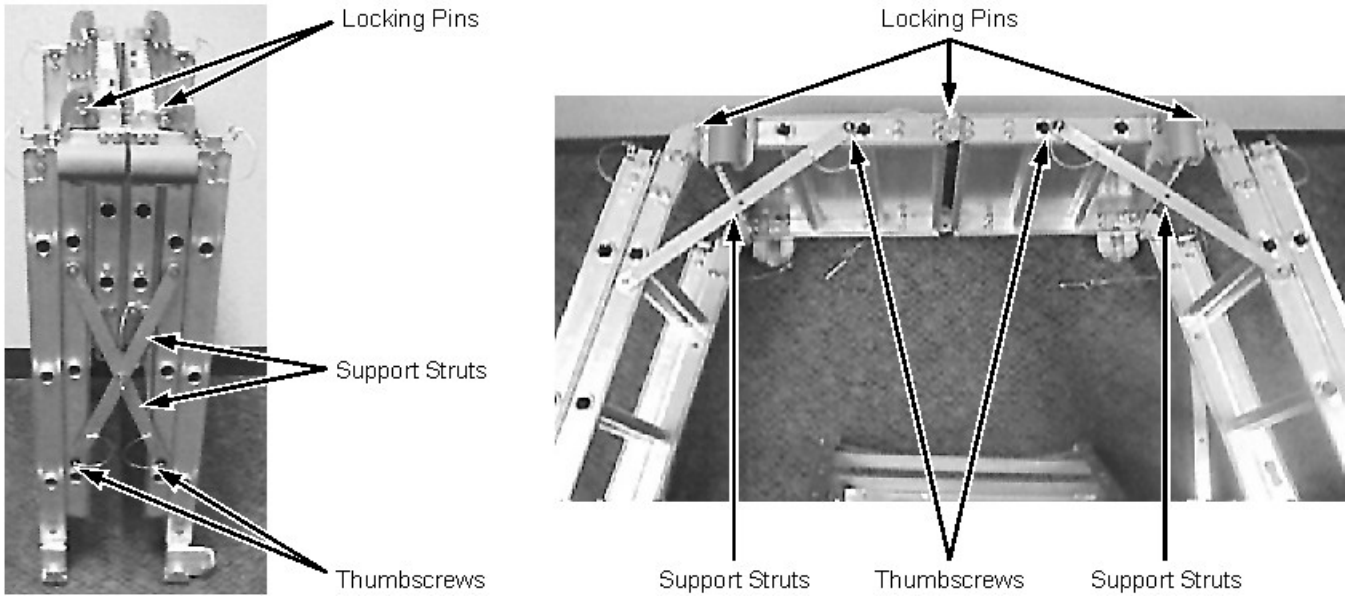
1.8.3.4.1 Fixed-Site Ladder Set-Up

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Position the folded Ladder Assembly in an open area about 5 feet (1500 mm) square.

2. Remove the locking pins from their positions on one side of the ladder, as shown in Illustration 3-33.

Illustration 3-33: Locking Pin and Thumbscrew Locations



3. Unscrew the two thumbscrews and unfold the two support struts.

4. Adjust the folded Ladder Assembly's position so as to access the other side.

5. Repeat Step 2 and Step 3 to remove the locking pins, unscrew the thumbscrews and unfold the support struts for the second side.

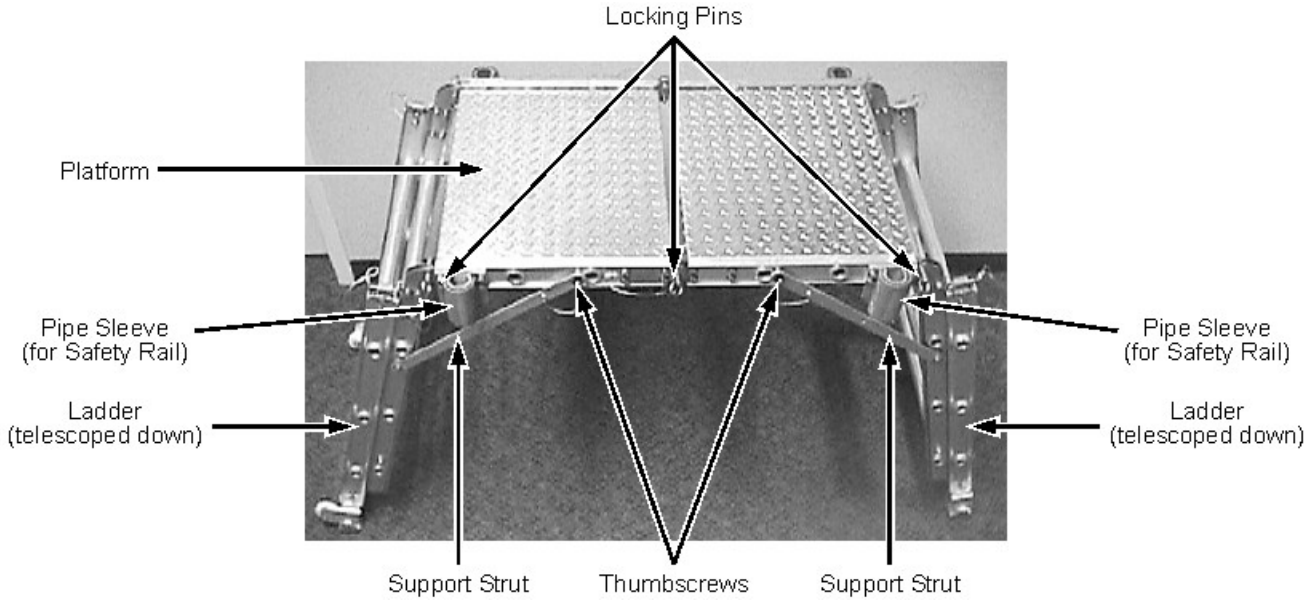
6. Unfold the ladder.

7. Lock the platform into position with the locking pins. See Illustration 3-33.

8. Rotate the two support struts up towards the platform and fasten in place with the thumbscrews. See Illustration 3-34.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-34: Ladder in Upright Position



9. Adjust the folded Ladder Assembly's position so as to access the other side.

10. Repeat Step 7 and Step 8 on the ladder's other side. See Illustration 3-34.

1.8.3.4.2 Mobile-Site Ladder Set-Up

1. Position the portion of the Ladder Assembly with the platform attached in an open area about 5 feet (1500 mm) square.

2. Unfold the platform and lock into position with the locking pins.

3. Attach the remaining ladder portion of the Ladder Assembly to the other end of the platform. Lock into position with the locking pins.

4. Rotate the two support struts up towards the platform and fasten in place with the thumbscrews.

1.8.3.4.3 Safety Rail Installation

1. Install the Safety Rail into the pipe sleeves on a long side of the platform. See Illustration 3-35.

NOTE: It is recommended to install the Safety Rail before changing the height of the platform surface on the Fixed Site Service Ladder-Platform. It is much easier to handle at the lowest height.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-35: Installing the Safety Rail



2. Install the Safety Rail into the pipe sleeve on a short side of the platform. See Illustration 3-35.

NOTE: The Service Ladder-Platform is now completely assembled and ready to use at its normal platform height.

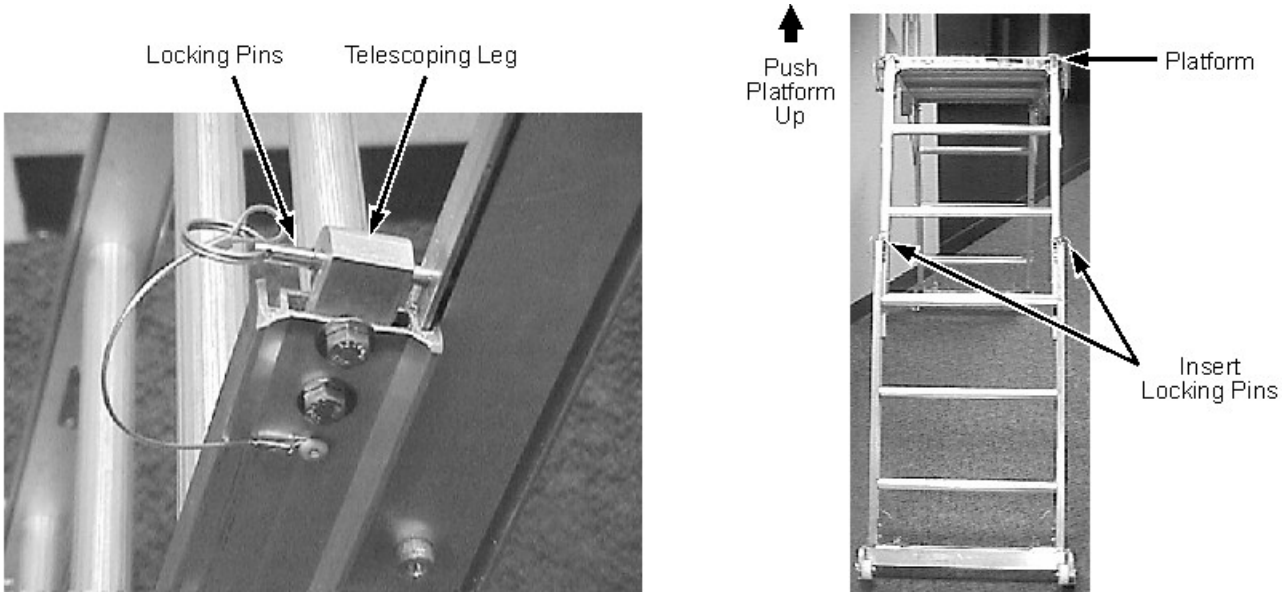
1.8.3.4.4 Changing Platform Heights on the Fixed-Site Service Ladder-Platform

NOTE: The Fixed Site Service Ladder-Platform is adjustable from its normal 40 inches (1016 mm) to either 50 inches (1270 mm) or 60 inches (1524 mm). At the 60 inch (1524 mm) height the ladder can be located to span over the magnet's Rear Pedestal, and therefore is recommended for servicing the magnet exhaust plumbing and Recondenser purge tee.

1. Remove the locking pins securing the telescoping ladder rails. Work with one side at a time. See Illustration 3-36.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-36: Changing Platform Height



2. Push upward on the platform, causing it to tilt. Insert the locking pins at the desired platform height. See Illustration 3-36.

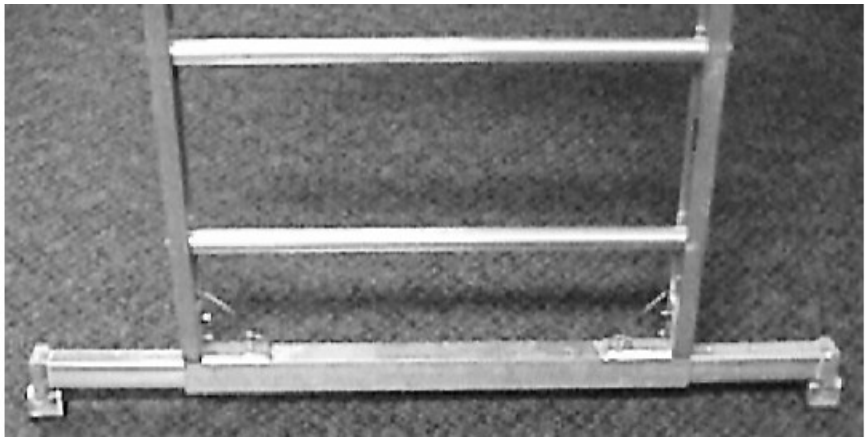
3. Repeat Step 2 on the other platform's side.

NOTE: Extend the ladder outriggers in conformance with Section 1.8.3.4.5 to provide additional stability when using platform heights over 40 inches (1016 mm).

1.8.3.4.5 Extending the Ladder Outrigger Supports

1. Remove the locking pin from the base and extend the outriggers. See Illustration 3-37.

Illustration 3-37: Extending the Ladder Outriggers



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2. Extend the outriggers on the other base rail.

3. Pin each outrigger in place.

NOTE: Make sure the outrigger is securely pinned and not free to slide out.

1.8.3.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2 Magnet Commissioning Checks

2.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	2 hours	Included in 'Procedure'

2.2 Overview

The magnet's electrical circuits must be verified to be in operating condition prior to filling or ramping. The Cryostat's temperature must be determined prior to filling. Magnet Commissioning & Operating Guidelines are stated in Chapter 4, Section 1, Magnet Functional Checks.

2.3 Preliminary Requirements

2.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Digital Voltmeter	1	-	-	-
Resistors as required to total 2.4 MΩ - 2.7 MΩ	Varies	-	-	-
Lakeshore 208 Digital Thermometer Kit 46-301477G2 or Diode Box 46-317543G2	1	-	46-301477G2 or 46-317543G2	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

2.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
9 Volt DC Batteries (if required)	3	-	-	-

2.3.3 Replacement Parts

No replacement parts required.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.3.4 Safety

No general safety information.

2.3.5 Required Conditions

No required conditions.

2.4 Procedure

2.4.1 Magnet Electric Check

The magnet's electrical circuits must be verified to be in operating condition prior to filling or ramping.

1. Make sure Shim Lead is **disengaged** in conformance with Section 5, Shim Lead Engagement and Disengagement.

2. Perform electrical checks called out in Chapter 4, Section 5, Magnet Electrical Checks.

2.4.2 Cryostat Temperature Check

This section describes the procedures and equipment used to establish the temperature inside the Cryostat Helium Vessel. This temperature must be established in order to determine the cooldown and liquid helium filling requirements of the Cryostat in Section 2.4.3, Cryostat Cooling & Cryogen Filling Requirements, prior to the magnet commissioning. LCC magnets are equipped with two temperature sensors requiring a 10 microampere current source with a stability of +0.005 percent. Sensor (Diode) 1 is mounted on top of the patient end of the Magnet Assembly. Sensor (Diode) 2 is mounted on the bottom of the service end of the Magnet Assembly. The Magnet Assembly is inside of the Helium Vessel. (These sensor diodes are identical to those found on the Coldhead Sleeve.)



NOTICE

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. A voltmeter can also be used to troubleshoot the sensor circuit.

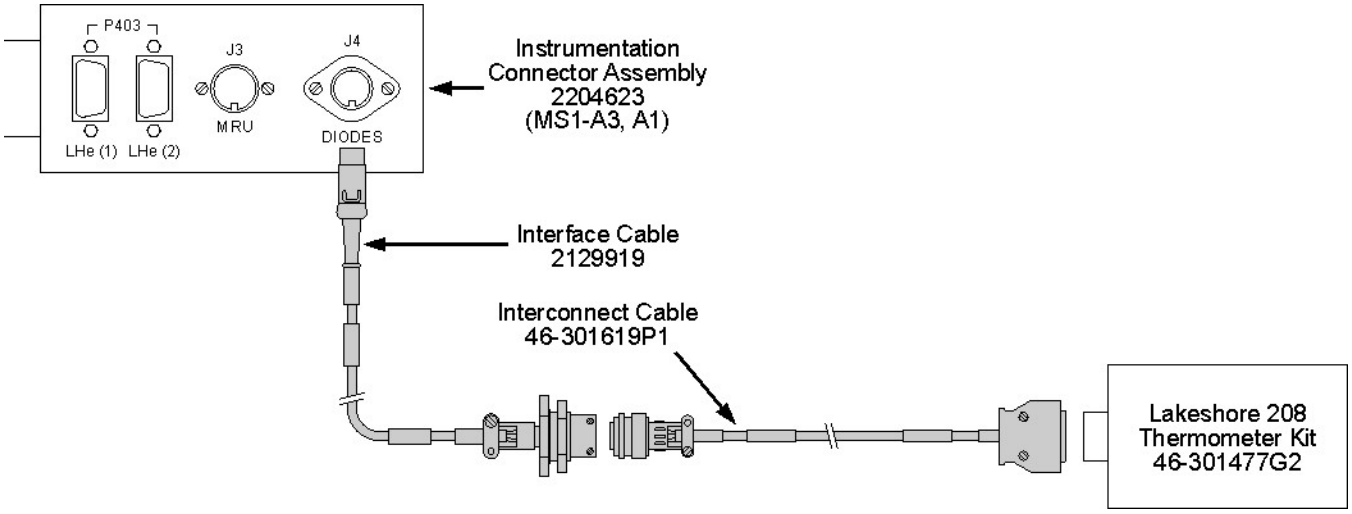
1. Verify that any sensing or troubleshooting equipment used does not exceed 10 microamperes.

2.4.2.1 Using the Lakeshore 208 Thermometer Kit

1. Connect the Lakeshore Model 208 Digital Thermometer to the diode connector on Instrumentation Connector Assembly 2204623 (MS1-A3, A1) in conformance with Illustration 3-38. Select Curve 6 (equivalent to DT 470, Curve 10).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-38: Cryostat Temperature Measurement Set-Up



2. Select the Diode to be monitored as shown in Table 3-7.

Table 3-7: Helium Vessel Temperature Monitor Diodes

Stage	Lakeshore 208 Thermometer Kit
Diode 1	Select Channel #1
Diode 2	Select Channel #2

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 deciding the temperature sensing diode as being defective.

3. Record the Lakeshore 208 readout from the temperature sensing diodes in Chapter 8, Section 1, Magnet Commissioning Log.

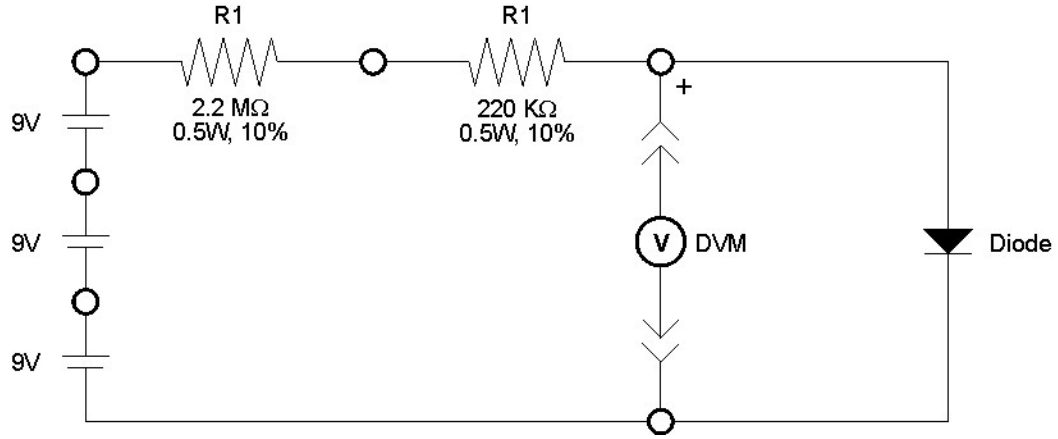
2.4.2.2 Using a Temperature Sensing Circuit

If the Lakeshore 208 Thermometer Kit or Low Cost Temperature Diode Box are not available, the following temperature sensing circuit can be fabricated from commonly available components for temperature measurements.

1. Assemble three 9 VDC batteries and a series resistance totalling 2.4 MΩ - 2.7 MΩ as shown in Illustration 3-39. Adjust the resistance as required to obtain 10 µA ± 1 µA current.

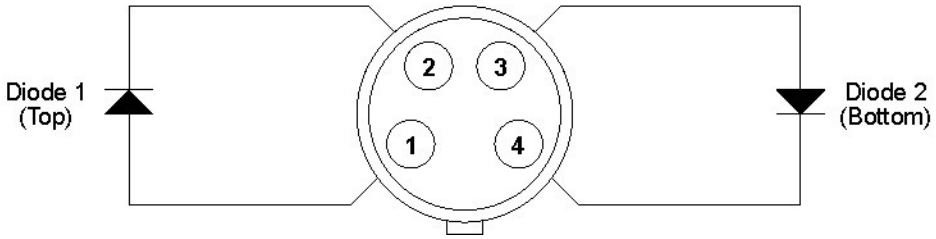
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-39: Temperature Sensing Circuit



2. Connect a Digital Voltmeter (DVM) across the diode with the polarity shown in Illustration 3-39. See Illustration 3-40 for the pin polarities at the J4 Connector.

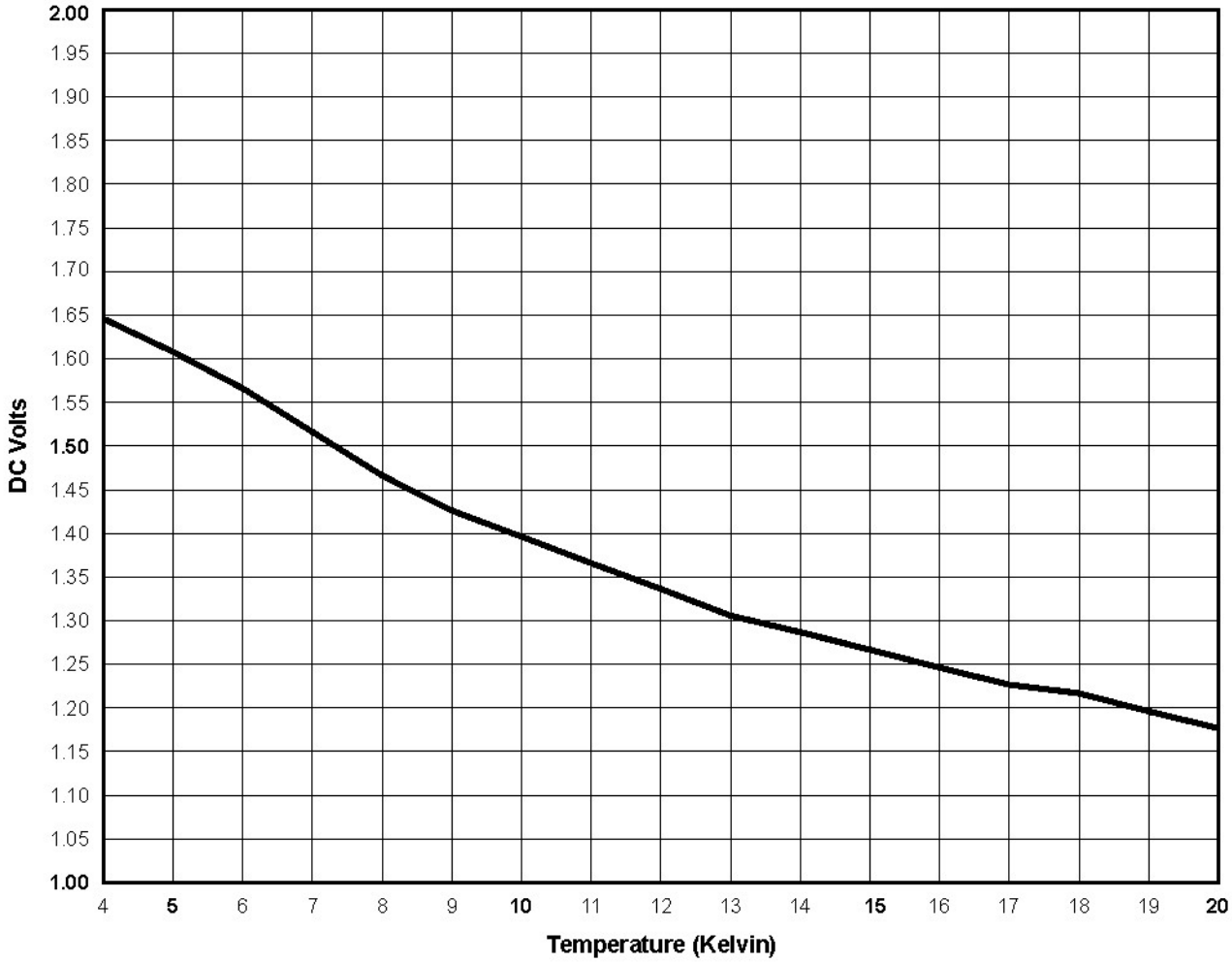
Illustration 3-40: Diode Polarities



3. Record in Chapter 8, Section 1, Magnet Commissioning Log, the voltage reading on the DVM and determine the corresponding temperature reading from Illustration 3-41 and Illustration 3-42.

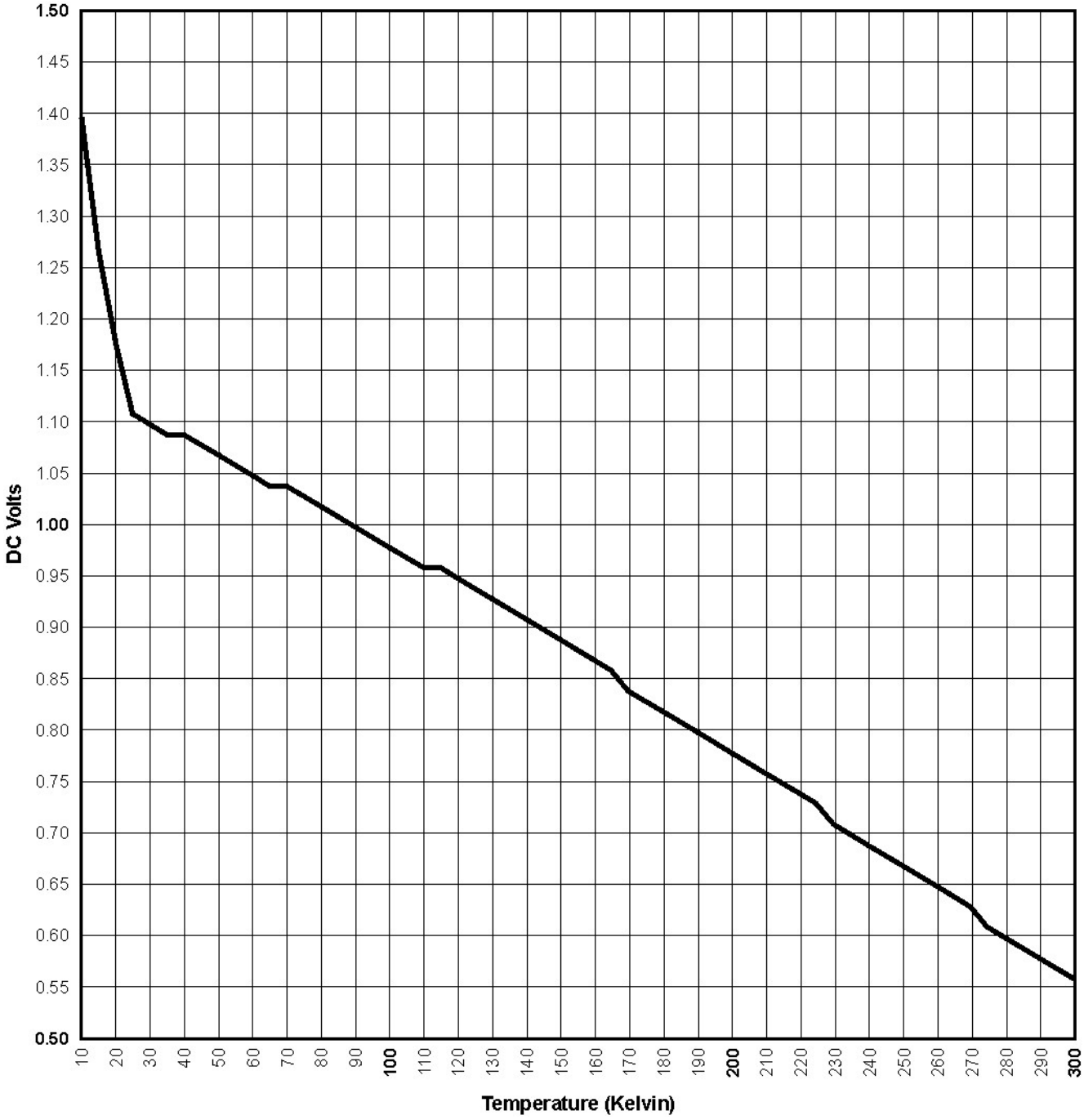
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-41: SI410 Diode Voltage to Temperature Conversion, 4K - 20K



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-42: SI410 Diode Voltage to Temperature Conversion, 10K - 300K



2.4.3 Cryostat Cooling & Cryogen Filling Requirements

1. Measure and record the Diode Temperatures in conformance with Section 2.4.2, Cryostat Temperature Check.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

Do not proceed with Section 3.1, Nitrogen Purge-Precool; Section 3.2 Liquid Helium Fill; or Section 4, Preparations for Field Measurement — or initiate magnet ramping — prior to establishing the Cryostat cooling and cryogen filling requirements in conformance with this section.

2. Use Table 3-8, the temperature readout obtained in Section 2.4.2, Cryostat Temperature Check, and the reading from the Magnet Monitor installed in Section 1.7, Magnet Monitor Installation, to determine the Cryostat cooling & cryogen filling procedures required.

Table 3-8: Determination of Cooling/Filling Procedure by Diode Temperature

Diode Temperature	Helium Level	Required Cryostat Cooling/Cryogen Filling Procedures			
		Section 3.1, Nitrogen Purge-Precool			Section 3.2, Liquid Helium Fill
		Gaseous Nitrogen Purge	Liquid Nitrogen Precool	Helium Purge	
> 220K	Empty	Yes	Yes	Yes	Yes
100K - 220K		—	Yes	Yes	Yes
< 100K		—	—	—	Yes
	> 90%	No Action			

2.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3 Precool & Fill

3.1 Nitrogen Purge-Precool

3.1.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	72 hours	Included in 'Procedure'

3.1.2 Overview

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

NOTE: Precooling a magnet is not normally required since all magnets ship from the factory with the cryostat full of liquid helium.

- If precooling is deemed necessary, make sure the temperature check in Section 2, Magnet Commissioning Checks, is above 100K before proceeding with this section.
- A cryostat with temperatures > 220K will require Gaseous Nitrogen Purge (Section 3.1.4.1) before a liquid nitrogen precool to prevent any latent moisture in the cryostat from freezing.
- If the cryostat temperature is 100K or less, proceed with Section 3.2, Liquid Helium Fill.

3.1.3 Preliminary Requirements

3.1.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Universal Fill Line Kit	1	-	46-294705G1	-
Liquid Helium Transfer Line Kit	1	-	46-294513G1	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Helium Regulator and Hose Kit	1	-	46-306734G1	-
Nonmagnetic Helium Cylinder Cart	1	-	46-258150P1	-
Lakeshore 208 Digital Thermometer Kit (or equivalent temperature sensing device)	1	-	46-301477G2	-
Nonmagnetic Tool Kit, Inch/Metric (46-320273G4) (magnets with magnetic fields ≤ 1.5T only); one kit	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

3.1.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Gaseous Helium, 235 SCF Nonferrous Cylinder	2	-	-	-
Liquid Nitrogen, 250 Liter Dewars (pressure-building preferred)	22 - 24	-	-	-
Large, lightweight, thin-walled tieable trash bags	1	-	-	-

3.1.3.3 Replacement Parts

No replacement parts required.

3.1.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING NITROGEN PURGE-PRECOOL.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR NITROGEN PURGE/PRECOOL IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING NITROGEN PURGE-PRECOOL.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING NITROGEN PURGE-PRECOOL.



DANGER

FATAL EXPLOSIVE HAZARD!
GAS CYLINDER RUPTURE/DAMAGE OR OPENING CYLINDER VALVE FAST WILL RELEASE 2400 PSI GAS FROM CYLINDER.
MAKE SURE GAS CYLINDERS ARE SECURE FROM FALLS AND AWAY FROM MOVING OBJECTS BEFORE USING. ALWAYS OPEN CYLINDER VALVE SLOWLY.



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING NITROGEN PURGE-PRECOOL.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN PERFORMING GASEOUS NITROGEN PURGE.

3.1.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting the Nitrogen Purge/Precool procedure.	Chapter 1, Section 2	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Condition	Reference	Effectivity
The removal of some magnet enclosure components may be required to complete the Nitrogen Purge/Precool procedure. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, before continuing with the Nitrogen Purge/Precool procedure if cover removal is required.	Chapter 5, Section 5	-
(continued)	Appendix A, Section 1.1	-

3.1.4 Procedure

3.1.4.1 Gaseous Nitrogen Purge



WARNING

POTENTIAL INJURY
MAKE SURE TO REVIEW, UNDERSTAND AND FOLLOW THE SAFETY MEASURES CONTAINED IN CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS.



WARNING

ASPHYXIATION HAZARD!
NITROGEN PURGE/PRECOOL PROCEDURES RELEASE LARGE QUANTITIES OF NITROGEN GAS, WHICH WILL DISPLACE OXYGEN IN THE AIR AND POTENTIALLY CAUSE ASPHYXIATION.
MAKE SURE SUFFICIENT VENTILATION EXISTS IN THE MAGNET ROOM TO DISPEL LARGE QUANTITIES OF NITROGEN GAS.



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING GASEOUS NITROGEN PURGE.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN PERFORMING GASEOUS NITROGEN PURGE.



NOTICE

Maintain internal Cryostat pressure < 5 psig at all times while precooling/filling with cryogens to prevent the pressure relief valve from activating, thereby reducing transfer efficiency. See Illustration 3-45.

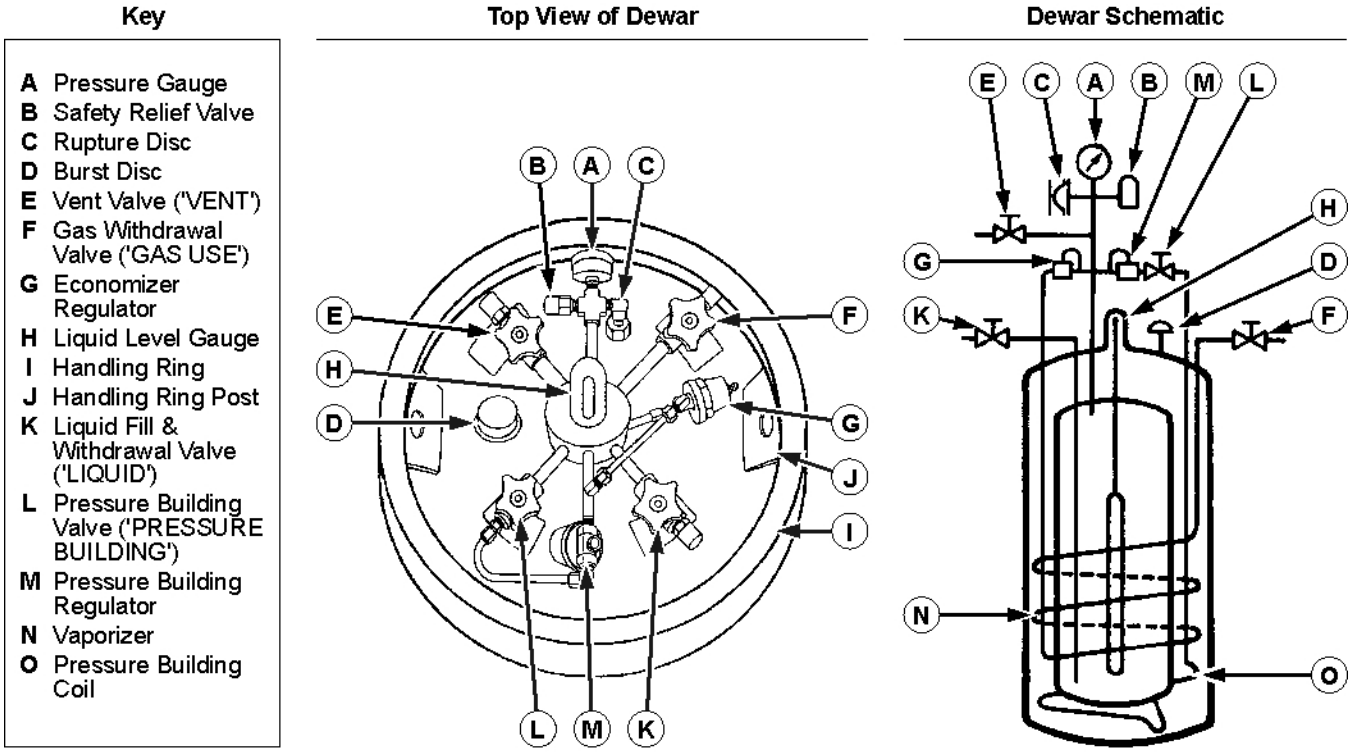
1. Obtain a full liquid nitrogen Dewar. Verify that all valves are in the closed position.

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

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2. Open the Dewar's “Pressure Building" Valve; verify that the pressure gauge reading does not exceed 20 psig. See Illustration 3-43.

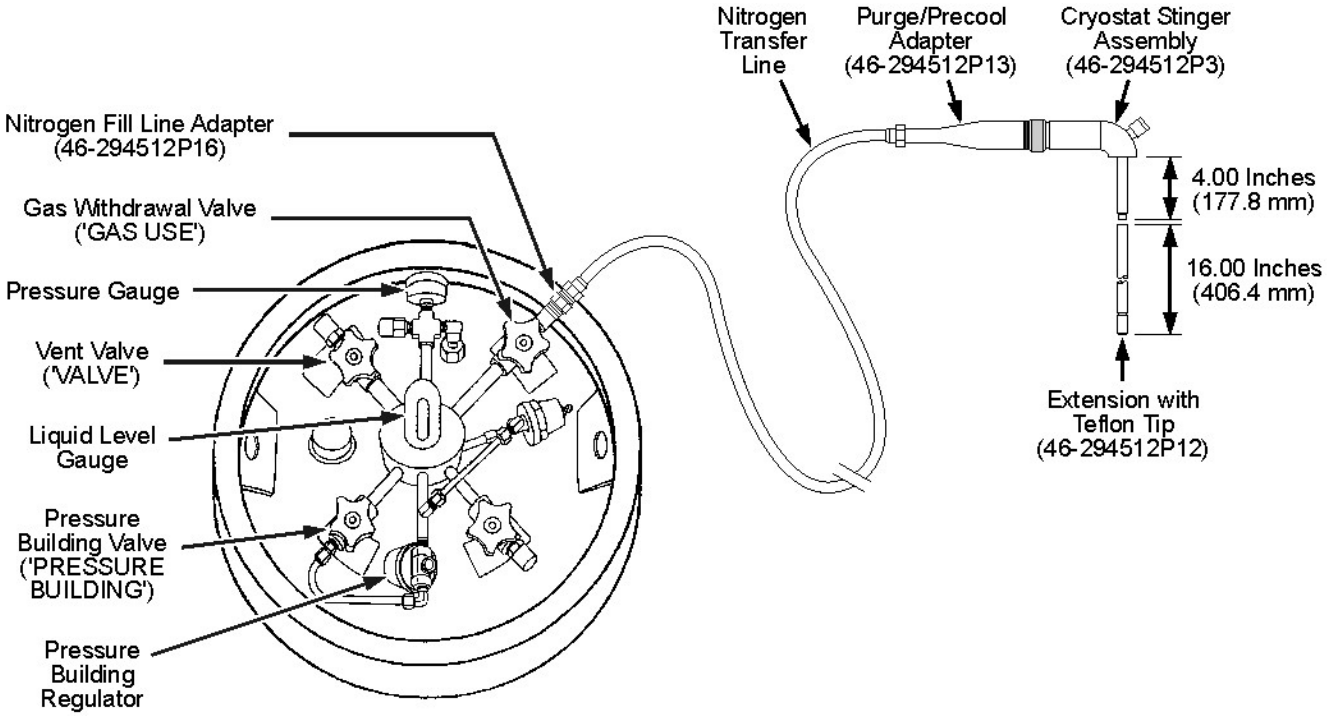
Illustration 3-43: Nitrogen Gas/Liquid Dewar



3. Connect the Nitrogen Transfer Line to the Dewar's “Gas Use" valve using a Nitrogen Fill Line Adapter. See Illustration 3-44.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-44: Nitrogen Purge/Precool Adapter



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

NOTICE

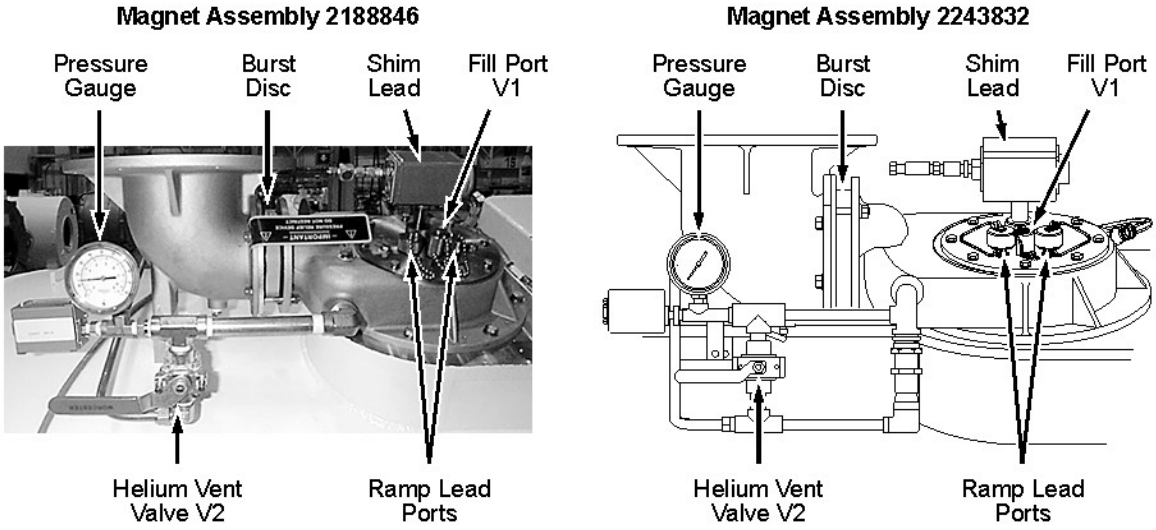
Make sure the 16 inch (406 mm) Cryostat Stinger Extension and Teflon Tip are firmly secured during installation to prevent them from loosening and falling into magnet.

5. Screw the 16 inch (406 mm) Cryostat Stinger Extension onto the Cryostat Stinger Assembly. Make sure the Teflon Tip is firmly attached to end of the extension tube.

6. Observe the 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 3-45.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-45: Helium Vent Plumbing



7. Uncap Fill Port V1. Remove the Fill Port Plug.

8. Purge the Nitrogen Transfer Line Assembly by partially opening the Dewar's “Gas Use" valve. Purge the line for a minimum of 10 seconds, then connect the Purge/Precool Adapter to the Cryostat Stinger Assembly.

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

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

10. Open Helium Vent Valve V2.

11. Fully open the Dewar's “Gas Use" valve.

NOTICE

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 Step 12 and Step 13 is necessary to adequately purge the Helium Vessel.

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

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

14. Close the Dewar's “Gas Use” valve.

15. Close Helium Vent Valve V2.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

16. Continue with Section 3.1.4.2, Liquid Nitrogen Precool.

3.1.4.2 Liquid Nitrogen Precool



WARNING

POTENTIAL INJURY
MAKE SURE TO REVIEW, UNDERSTAND AND FOLLOW THE SAFETY MEASURES CONTAINED IN CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS.



WARNING

ASPHYXIATION HAZARD!
NITROGEN PURGE-PRECOOL PROCEDURES RELEASE LARGE QUANTITIES OF NITROGEN GAS, WHICH WILL DISPLACE OXYGEN IN THE AIR AND POTENTIALLY CAUSE ASPHYXIATION.
MAKE SURE SUFFICIENT VENTILATION EXISTS IN THE MAGNET ROOM TO DISPEL LARGE QUANTITIES OF NITROGEN GAS.



WARNING

ASPHYXIATION HAZARD!
NITROGEN PRECOOL PROCEDURE GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR.
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE STARTING A LIQUID NITROGEN PRECOOL.



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING LIQUID NITROGEN PRECOOL.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN PERFORMING LIQUID NITROGEN PRECOOL.



WARNING

EXPLOSION HAZARD!
LIQUID CRYOGENS CAN LIQUEFY ATMOSPHERIC OXYGEN, PRODUCING A HIGHLY COMBUSTIBLE OXYGEN LIQUID.
NO SMOKING IN MAGNET AND CRYOGEN STORAGE ROOMS!

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

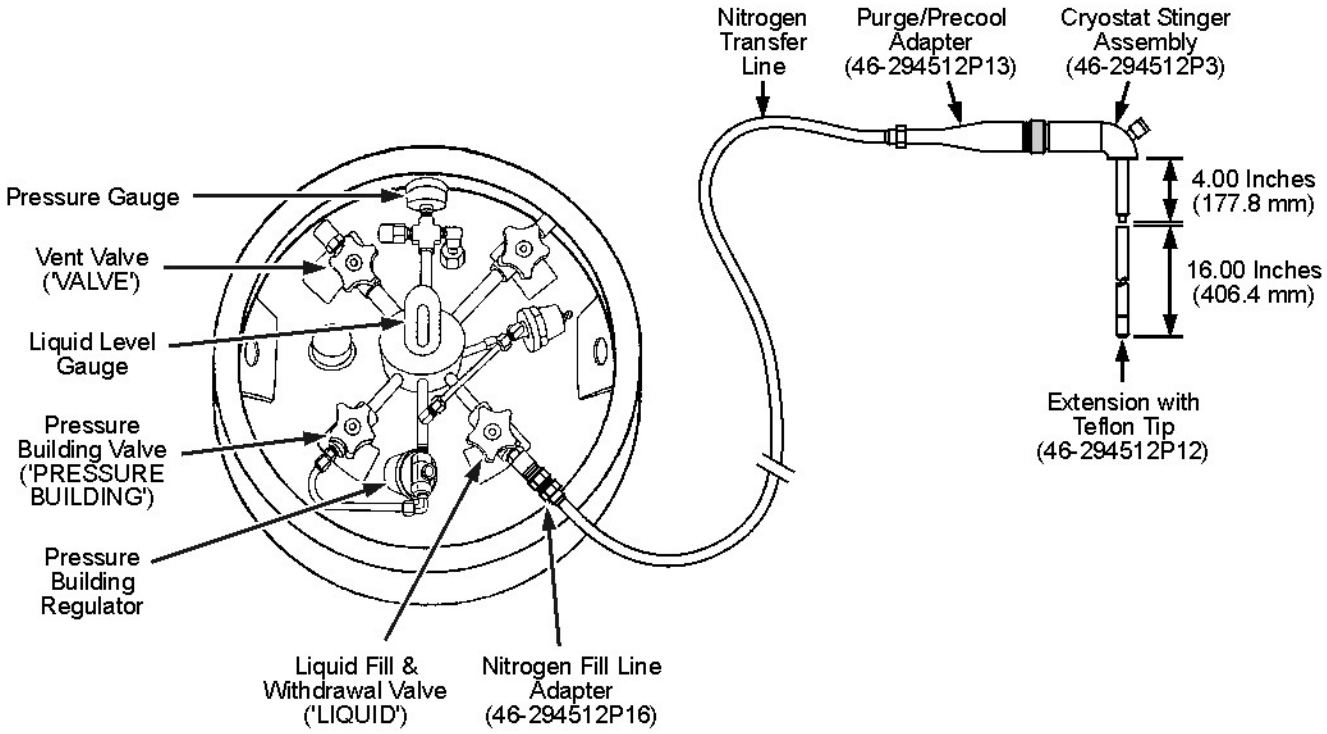
NOTE: Other sources of gaseous and liquid nitrogen may be used with appropriate setup apparatus.

2. Open the Dewar's “Pressure Building" valve. Verify that the pressure gauge reading does not exceed 20 psig. See Illustration 3-43.

3. Connect the Nitrogen Transfer Line to the “Liquid” valve on the Dewar. Remove the special Nitrogen Fill Line Adapter, if attached to the Transfer Line, before connecting. See Illustration 3-46.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-46: Nitrogen Precool Set-Up



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

NOTICE

Make sure the 16 inch (406 mm) Cryostat Stinger Extension and Teflon Tip are firmly secured during installation to prevent them from loosening and falling into magnet.

5. Screw the 16 inch (406 mm) Cryostat Stinger Extension onto the Cryostat Stinger Assembly. Make sure the Teflon Tip is firmly attached to end of the extension tube.

6. Observe the cryostat pressure gauge. If pressure exceeds 1.0 psig, temporarily open Helium Vent Valve V2, allowing pressure to decrease to 1.0 psig. See Illustration 3-45.

7. Uncap Fill Port V1.

8. Purge the Nitrogen Transfer Line Assembly by partially opening the Dewar's “Liquid" valve.

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

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

10. Open Helium Vent Valve V2.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

11. Close the Dewar's “Liquid" valve, then immediately connect the Purge/Precool Adapter to the Cryostat Stinger Assembly.

NOTICE

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.

12. Open the “Liquid" valve and monitor the Cryostat Pressure Gauge. Adjust the valve as required to maintain 3 psig - 4 psig as displayed on the Cryostat Pressure Gauge.

13. Connect a Lakeshore 208 Thermometer (or equivalent) to the Diode Connector on the Magnet Connector Assembly (MSI-A3, A1) in conformance with Section 2, Magnet Commissioning Checks.

14. During magnet precool:

    - Record temperature readings at 1 hour intervals.
    - Observe the ΔT between magnet diodes. If ΔT exceeds the values shown in Table 3-9, temporarily suspend liquid nitrogen flow to allow diode temperatures to reach equilibrium.

Table 3-9: Approximate Cooldown Rates

From	To	K/hr	Diode* ΔT
300K	200K	5	< 75K
200K	100K	3 - 4	< 50K
* Top and bottom diode temperatures.			

NOTICE

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

A sudden drop in temperature to 77K - 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 3.1.4.1, until a temperature of 95K is indicated on both diodes.

15. Continue until a 95K reading is reached on either of the magnet diodes. When a nitrogen Dewar is empty:

    a. Close all Dewar valves (Illustration 3-46).

    b. Close V2.

    c. Disconnect the Purge/Precool Adapter from the Cryostat Stinger Assembly and immediately install a Brass Blanking Cap onto the Cryostat Stinger Assembly.

    d. Remove the Nitrogen Transfer Line Assembly.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

e. Repeat Step 1 through Step 15 for each consecutive Dewar.

NOTE: It may take up to 48 hours and 12 Dewars to 15 Dewars to precool the cryostat from room temperature (300K) to 95K.

16. When a 95K reading is reached on either of the magnet diodes:

    1. Close all Dewar valves,
    2. Close V2,
    3. Disconnect the Purge/Precool Adapter from the Cryostat Stinger Assembly and immediately install a Brass Blanking Cap onto the Cryostat Stinger Assembly and
    4. Remove the Nitrogen Transfer Line Assembly and Dewar from magnet room.

17. Proceed to Section 3.1.4.3, Helium Purge.

3.1.4.3 Helium Purge



WARNING

POTENTIAL INJURY
MAKE SURE TO REVIEW, UNDERSTAND AND FOLLOW THE SAFETY MEASURES CONTAINED IN CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS.



WARNING

ASPHYXIATION HAZARD!
THE HELIUM PURGE PROCEDURE RELEASES LARGE QUANTITES OF HELIUM GAS, WHICH WILL DISPLACE OXYGEN IN THE AIR AND POTENTIALLY CAUSE ASPHYXIATION.
MAKE SURE SUFFICIENT VENTILATION EXISTS IN THE MAGNET ROOM TO DISPEL LARGE QUANTITIES OF HELIUM GAS.



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING HELIUM PURGE.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN PERFORMING HELIUM PURGE.

1. Obtain two large (235 SCF), full, aluminum cylinders of gaseous helium (GHe).



WARNING

POTENTIAL HIGH PRESSURE GAS RELEASE
IF A GAS CYLINDER FALLS, THE VALVE OUTLET COULD SHEAR, RELEASING HAZARDOUS HIGH PRESSURE GAS.
SECURE THE GAS CYLINDER BEFORE REMOVING THE PROTECTIVE VALVE CAP.

2. Connect a standard high pressure GHe regulator and hose assembly to the valve outlet (CGA 580) on the GHe cylinder. See Illustration 3-47 and Illustration 3-48.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-47: Recondenser Purge Set-Up, LCC Magnet Assembly 2188846

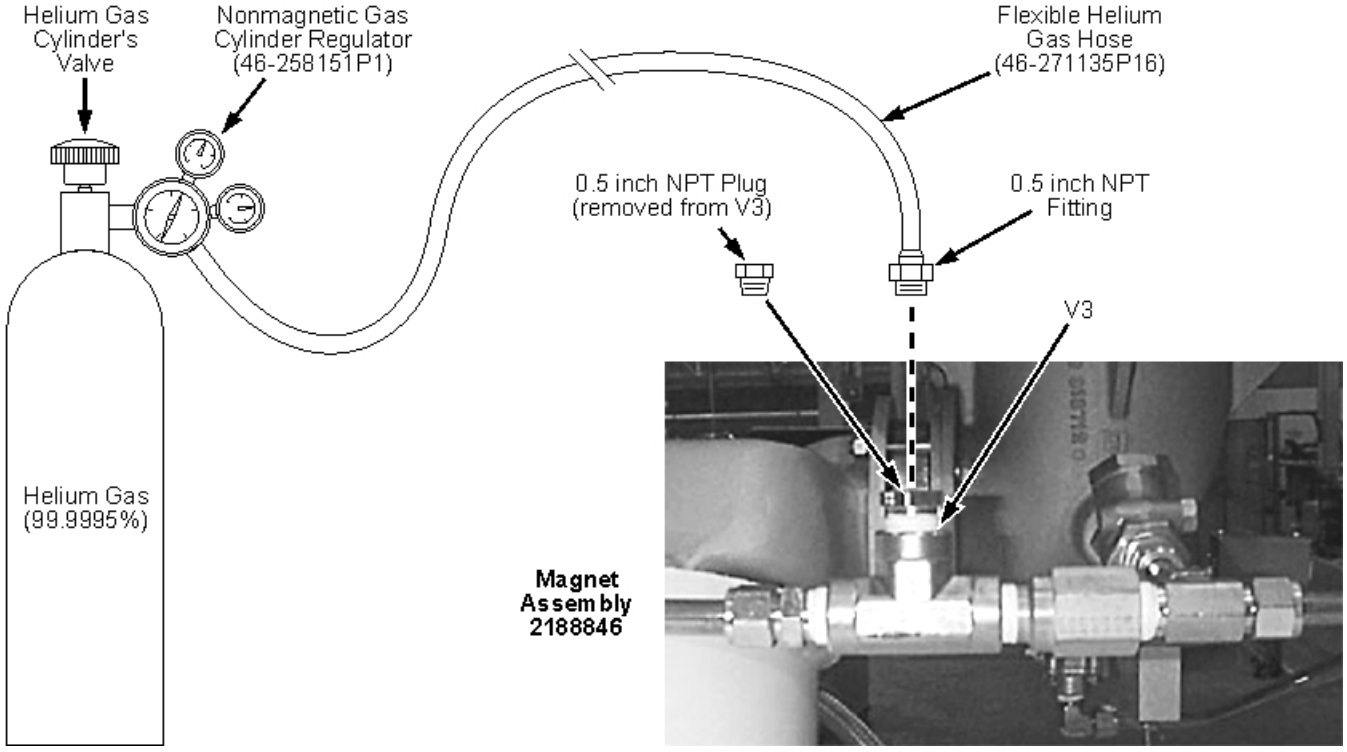
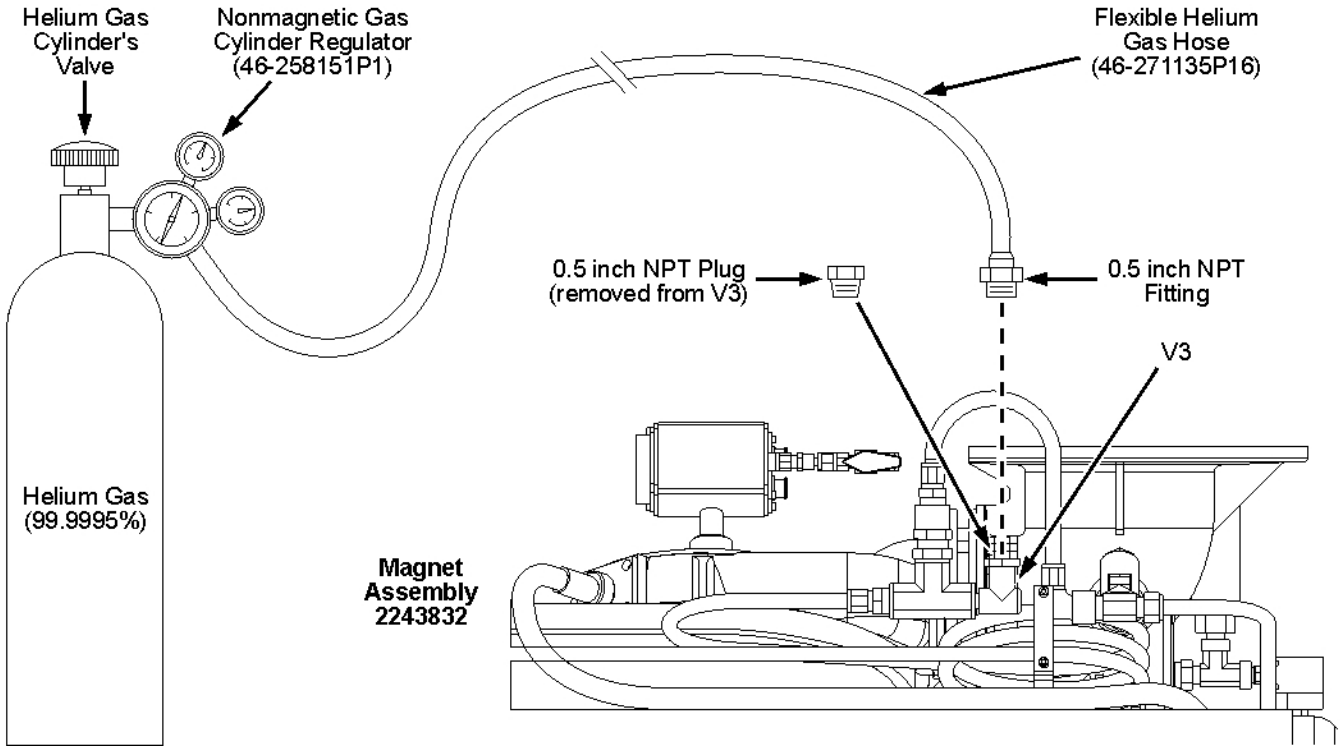


Illustration 3-48: Recondenser Purge Set-Up, LCC Magnet Assembly 2243832



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. Connect the gas cylinder and regulator to the flexible gas hose. See Illustration 3-47 and Illustration 3-48.



DANGER

FATAL EXPLOSIVE HAZARD!
GAS CYLINDER RUPTURE/DAMAGE OR OPENING CYLINDER VALVE FAST WILL RELEASE 2400 PSI GAS FROM CYLINDER.
MAKE SURE GAS CYLINDERS ARE SECURE FROM FALLS AND AWAY FROM MOVING OBJECTS BEFORE USING. ALWAYS OPEN CYLINDER VALVE SLOWLY.



NOTICE

Make sure the 16 inch (406 mm) Cryostat Stinger Extension and Teflon Tip are firmly secured during installation to prevent them from loosening and falling into magnet.

4. Screw the 16 inch (406 mm) Cryostat Stinger Extension onto the Cryostat Stinger Assembly. Make sure the Teflon Tip is firmly attached to end of the extension tube.

5. Observe the Cryostat Pressure Gauge. If pressure exceeds 5.0 psig, temporarily open Helium Vent Valve V2, allowing pressure to decrease to 0.5 psig. See Illustration 3-45.

6. Uncap Fill Port V1. Remove the Fill Port Plug.

NOTE: If ceiling height prevents insertion of the Cryostat Stinger in Step 7, remove the Extension Tip from the Cryostat Stinger and partially insert the Stinger into Fill Port V1 before attaching it to the Cryostat Stinger. Grip the Extension firmly when inserting to prevent it from falling into the magnet.

7. Fully insert the Cryostat Stinger Assembly with Extension Tip into Fill Port V1. Make sure the Extension Tip is firmly seated, then tighten the Fill Port Compression Fitting.

8. Loosely tie a large, lightweight, thin-wall trash bag over the Stinger outlet so that bag inflation and float will indicate helium collection and flow.

9. Make sure the regulator handle is backed out (CCW) to avoid regulator damage, then open the gas cylinder slowly. The high pressure gauge should indicate 2,100 psig - 2,400 psig (150 kg/cm^2 - 170 kg/cm^2) if the cylinder is full.

NOTE: Two full gas cylinders are required for this Nitrogen Purge/Precool procedure.

10. Open the cylinder valve and set a low pressure gas flow at 1 psig. Purge the apparatus for one minute.

11. Remove the 1/2 inch NPT plug from the relief valve tee and screw the gas hose onto the tee via the hose's 1/2 inch NPT male fitting. See Illustration 3-47 and Illustration 3-48.

12. Increase the pressure of the helium gas flow to 4 psig. Listen for gas flowing in the stinger vent line to make sure the flow continues to be present during the purge.



NOTICE

Do not allow cryostat pressure to exceed 5 psig in Step 13 to prevent any possible damage to the Burst Disc and Cryostat Pressure Gauge.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

13. When the first cylinder's pressure decreases to 1,000 psig, open V2 for one minute to purge the penetration volume.

14. Monitor cryostat pressure during the purge to make sure the cryostat does not depressurize below 0.3 psig.

15. Observe the regulator high pressure gauge while purging with the second cylinder of gaseous helium. When pressure decreases to 250 psig, close cylinder valve and fully back out the regulator's adjusting handle. Plug the stinger outlet while changing cylinders.

NOTE: By this time a successful purge should be evident by the inflation/flotation of the trash bag on the stinger tube.

16. When the purge is complete, check to see that V2 was closed. Remove the trash bag from the stinger, remove the stinger itself and cap the fill port. Remove the gas line from the tee and immediately place the plug back into the tee.

17. Continue with Section 3.2, Liquid Helium Fill.

3.1.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.2 Liquid Helium Fill

3.2.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	2 hours	Included in 'Procedure'

3.2.2 Overview

Liquid helium is used to cool the magnet when cryostat temperatures are below 100K. Initiate Liquid Helium Fill when cryogen levels, based upon Cryogen Monitor percentage (%) readings, approach the **minimum** values for stated functions listed in Table 3-10 for the stated function. Starting levels take into account expected helium loss to maintain the required level during the operation. Refer to Chapter 8, Section 4, Volumetric Conversion of Helium Level.

Table 3-10: Minimum Cryogen Levels (Percent Displayed on Cryogen Monitor)

Magnet	Ramp	Shim	Emergency Fill	Fill (250 Liter Dewars)*		
				1 Dewar	2 Dewars	3 Dewars
1.0T LCC	90%	90%	50%	90%	78% - 90%	60% - 78%
1.5T LCC						
* At 90% fill efficiency.						

NOTE: Do not operate magnet below 40% fill level to avoid possible damage from a magnet quench.

NOTE: “Target levels" are established for magnets with a normal or “in-spec" boil-off rate. Magnets with an “out-of-spec" boil-off rate may require emergency fills at Helium levels higher than defined in Table 3-10. Contact your MAC Team Leader or the Magnet Support Team at the Online Center for assistance in determining whether an emergency transfill is required.

3.2.3 Preliminary Requirements

3.2.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Heat Gun	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Liquid Helium Transfer Line Kit	1	-	46-294513G1	-
Liquid Helium Transfer Line, 20 Ft. (6.1 M): Mobile Sites	1	-	2166440	-
Helium Regulator and Hose Kit	1	-	46-306734G1	-
Nonmagnetic Helium Cylinder Cart	1	-	46-258150P1	-
Extended Coupling Nut	1	-	46-318619P1	-
Retaining Ring	1	-	46-260272P1	-
O-Ring	1	-	46-260342P9	-
Nonmagnetic Tool Kit, Inch/Metric (46-320273G4) (magnets with magnetic fields ≤ 1.5T only); one kit	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

3.2.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Liquid Helium Dewars (250 or 500 Liter)	1 - 4	-	-	-
Full Aluminum 135 SCF Helium Gas Cylinders (1 GHe per 500 liters LHe)	1 - 2	-	-	-

3.2.3.3 Replacement Parts

No replacement parts required.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.2.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE FILLING THE MAGNET.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR LIQUID HELIUM FILL IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE FILLING THE MAGNET.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE FILLING THE MAGNET.



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING LIQUID HELIUM FILL.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLE WHEN FILLING THE MAGNET.



WARNING

ASPHYXIATION HAZARD!
THE LIQUID HELIUM FILL PROCEDURE GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR.
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE FILLING THE MAGNET.



WARNING

EXPLOSION HAZARD!
LIQUID CRYOGENS CAN LIQUEFY ATMOSPHERIC OXYGEN, PRODUCING A HIGHLY COMBUSTIBLE OXYGEN LIQUID.
NO SMOKING IN MAGNET AND CRYOGEN STORAGE ROOMS!

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL PROJECTILE HAZARD
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.
NEVER BRING HELIUM DEWARS — OR GAS CYLINDERS THAT ARE MADE FROM FERROMAGNETIC MATERIAL — INTO THE MAGNET ROOM. MAKE SURE ALL EQUIPMENT AND TOOLS USED IN THE MAGNET ROOM ARE NON-FERROMAGNETIC.



WARNING

POTENTIAL HIGH PRESSURE GAS RELEASE
IF A GAS CYLINDER FALLS, THE VALVE OUTLET COULD SHEAR, RELEASING HAZARDOUS HIGH PRESSURE GAS.
SECURE THE GAS CYLINDER BEFORE REMOVING THE PROTECTIVE VALVE CAP.

3.2.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting the Liquid Helium Fill procedure.	Chapter 1, Section 2	-
Make sure the magnet room exhaust fan is on and operational before starting Liquid Helium Fill.	-	-
The removal of some magnet enclosure components may be required to complete the Liquid Helium Fill procedure. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, before continuing with the Liquid Helium Fill procedure if cover removal is required.	Chapter 5, Section 5	-
(continued)	Appendix A, Section 1.1	-

3.2.4 Procedure

3.2.4.1 Helium Fill Equipment

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

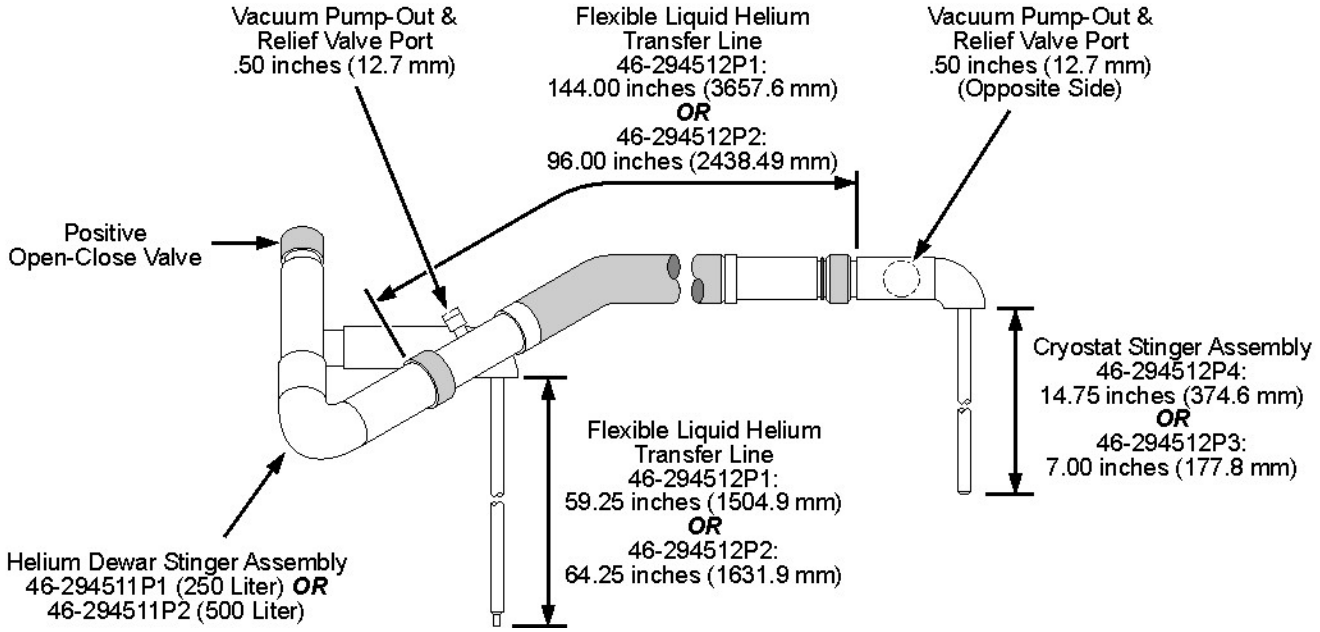
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTE: Select the proper cryostat and Dewar stinger lengths to be used during a fill. Refer to Illustration 3-49 (top fill) and Illustration 3-50 (bottom fill) for the appropriate stinger configuration.

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

1. **Top Fill:** Top Fill is the preferred fill method and should be used if any liquid helium exists in the magnet. See Illustration 3-49.

Illustration 3-49: Vacuum Jacketed Helium Transfer Line and Dewar/Cryostat Stinger Assemblies, Top Fill Configuration



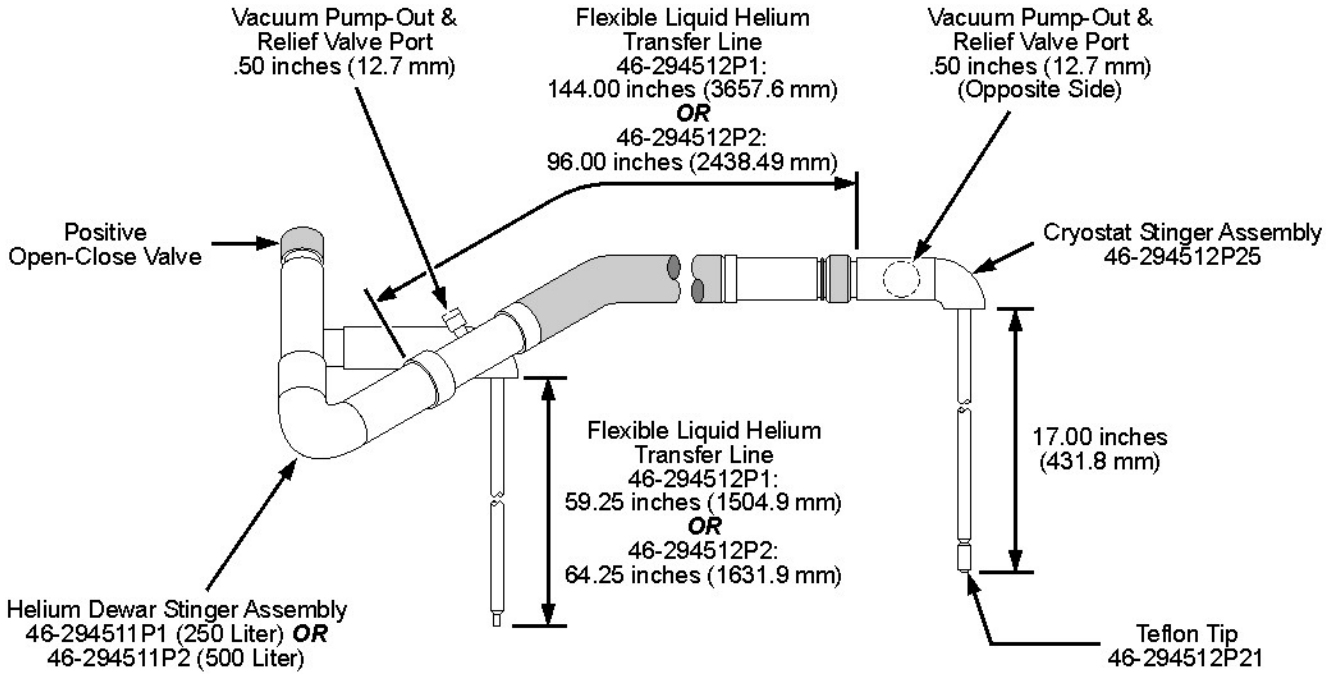
NOTICE

If bottom filling, make sure the 16 inch (406 mm) Cryostat Stinger Extension and Teflon Tip are firmly secured during installation to prevent them from loosening and falling into magnet.

2. **Bottom Fill:** A Bottom Fill is performed only when there is no liquid helium in the magnet such as after a quench. See Illustration 3-50.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

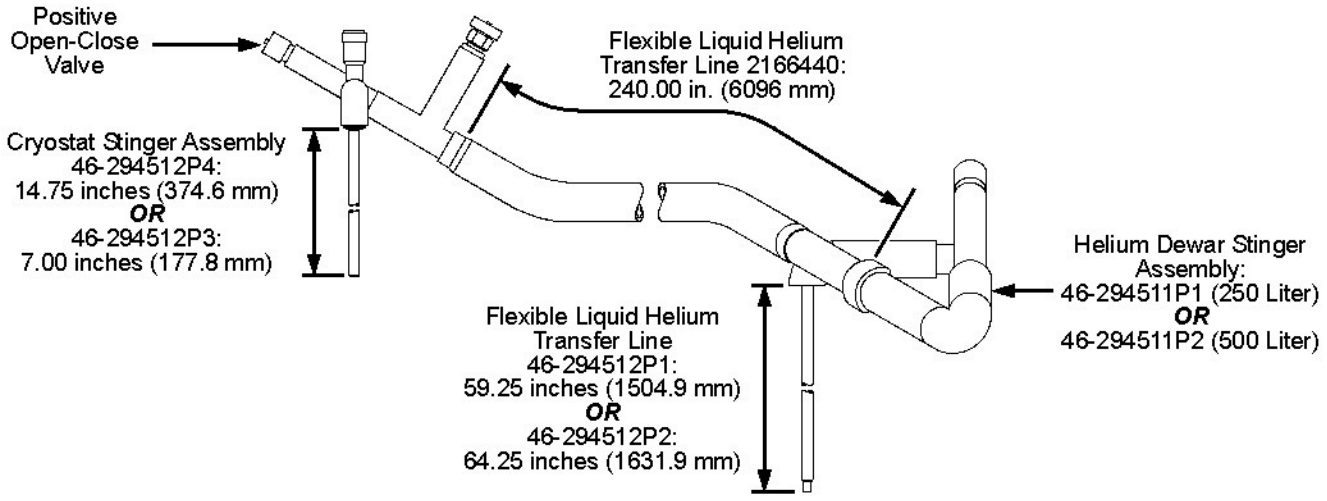
Illustration 3-50: Vacuum Jacketed Helium Transfer Line and Dewar/Cryostat Stinger Assemblies, Bottom Fill Configuration



3. At mobile sites use the arrangement shown in Illustration 3-51.

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

Illustration 3-51: Vacuum Jacketed Helium Transfer Line and Dewar/Cryostat Stinger Assemblies, Mobile Sites



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.2.4.2 Preparation

NOTE: Refer to Chapter 8, Section 4, Volumetric Conversion of Helium Level, to determine the 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 the magnet, go to Step 4.

2. If there isn't helium in the magnet, refer to Section 2, Magnet Commissioning Checks, to check shield temperatures.

3. If temperature is > 100K, refer to Section 2, Magnet Commissioning Checks, for cryostat cooling/filling requirements.

NOTICE

Make sure the Cryogen Level Meter has been calibrated in conformance with the Magnet Monitor Manual. A calibrated Cryogen Level Meter is required to accurately determine helium fill level and efficiency.

4. Check Magnet Monitor calibration. Read and record the liquid helium level in Chapter 8, Section 3, Helium Fill Data. Make sure the Magnet Monitor sample rate is set to 11. Refer to the vendor's manual for Magnet Monitor calibration.

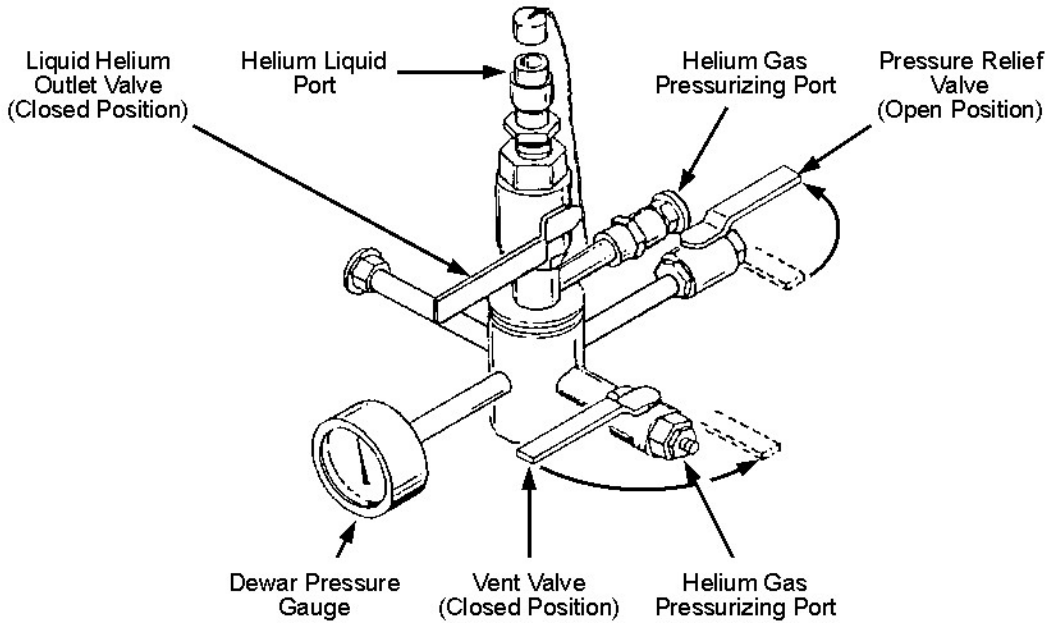
5. Obtain a full LHe Dewar. Check the Dewar's pressure gauge. If pressure is above 1 psig, slowly open Dewar's Vent Valve and reduce Dewar pressure to 1 psig. See Illustration 3-52.

NOTE:

- If Dewar pressure does not vent down to 1 psig, verify that the Dewar pressure relief valve is left in the open position. Contact the cryogen supplier immediately.
- The Pressure Relief Valve is normally open during shipping and storage to prevent excessive build up of pressure in the Dewar. Therefore, always reopen the Pressure Relief Valve after using a Dewar.
- If 99.999% Helium Gas is used (five nines certified gas), the purity of the gas remaining in the cylinder will degrade as a result of this process (i.e., the purity of the remaining gas will be something less than 99.999%).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-52: Dewar Connections



6. Obtain one full aluminum 135 SCF cylinder of helium gas for every two 250 liter LHe Dewars required.



DANGER

FATAL EXPLOSIVE HAZARD!
GAS CYLINDER RUPTURE/DAMAGE OR OPENING CYLINDER VALVE FAST WILL RELEASE 2400 PSI GAS FROM CYLINDER.
MAKE SURE GAS CYLINDERS ARE SECURE FROM FALLS AND AWAY FROM MOVING OBJECTS BEFORE USING. ALWAYS OPEN CYLINDER VALVE SLOWLY.



WARNING

POTENTIAL HIGH PRESSURE GAS RELEASE
IF A GAS CYLINDER FALLS, THE VALVE OUTLET COULD SHEAR, RELEASING HAZARDOUS HIGH PRESSURE GAS.
SECURE THE GAS CYLINDER BEFORE REMOVING THE PROTECTIVE VALVE CAP.

7. Connect a Helium Regulator and Hose Assembly (46-306734G1) to the Valve Outlet (CGA 580) on the GHe cylinder.

8. Make sure the Regulator's adjusting handle is fully backed out, then slowly open the GHe cylinder's valve.

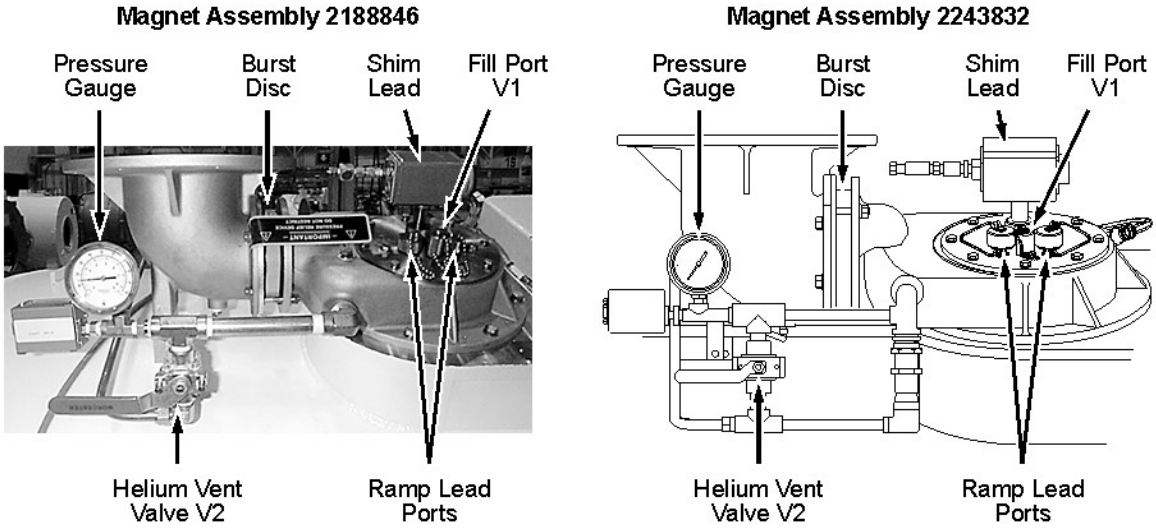
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

9. Observe the Regulator's high pressure gauge. Make sure the indicated pressure is approximately 2000 psig, indicating a full cylinder.

10. Record the Cryostat Pressure Gauge reading in Chapter 8, Section 1, Magnet Commissioning Log.

11. Vent the magnet by temporarily opening Helium Vent Valve V2 (Illustration 3-53) as required to obtain 1.0 psig - 1.5 psig pressure. Read and record the final pressure in the Cryostat Performance Log.

Illustration 3-53: Helium Vent Plumbing

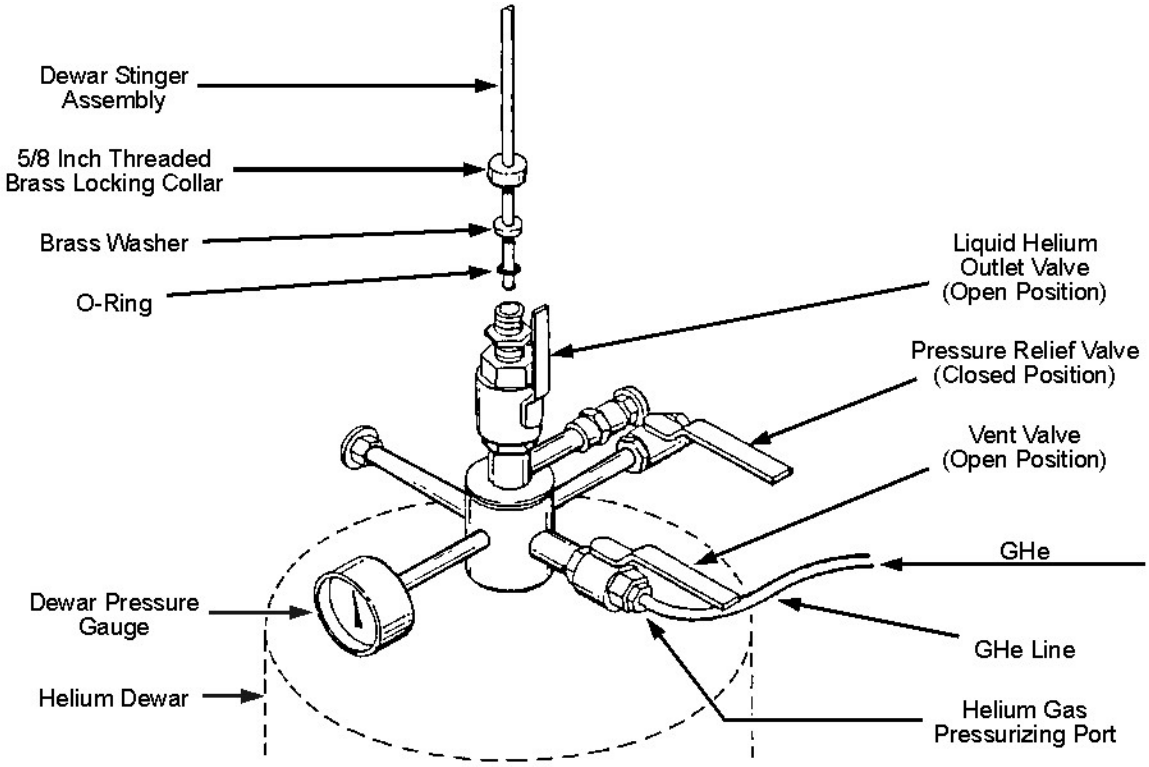


3.2.4.3 Liquid Helium Fill

1. Verify that the Dewar's Liquid Helium Outlet Valve is in the closed position. See Illustration 3-54.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-54: Helium Dewar Transfer Line Extension Connection



2. Remove the 1/2 inch cap and adapters, exposing the 5/8 inch locking collar.

3. Loosen the 5/8 inch threaded brass locking collar.

4. Verify that the Pressure Relief Valve is in the open position. See Illustration 3-54.

5. Make sure the Dewar Stinger Assembly's Valve is closed. See Illustration 3-49 (top fills), Illustration 3-50 (bottom fills) or Illustration 3-51 (mobile sites).

6. Insert the Dewar Stinger Assembly through the 5/8 inch locking collar until the Stinger Tip contacts the Helium Outlet Valve. See Illustration 3-54.

7. Open the Helium Outlet Valve.

8. Slowly insert the Dewar Stinger Assembly into the Dewar until the Stinger Tip contacts liquid helium. Contact is indicated by a pressure increase on the Dewar's pressure gauge and by expulsion of gas from the Pressure Relief Valve Port.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

9. Continue to insert the Dewar Stinger Assembly at a rate that maintains a maximum 5 psig reading on the Dewar's pressure gauge.

10. When the Dewar Stinger Assembly contacts the bottom of the Dewar, raise the Stinger Assembly 1 inch (25 mm) and securely tighten the 5/8 inch locking collar.

NOTE: If magnet room ceiling height prohibits insertion of the Dewar Stinger Assembly into the Dewar, the Dewar must be moved to an area with a higher ceiling height, the Stinger Assembly inserted there and then transported back into the magnet room.

11. When Dewar pressure stabilizes ≤ 5 psig, close the Pressure Relief Valve.

12. Attach the selected Cryostat Stinger Assembly (46-294511P1 for 250 liter helium Dewars; 46-294511P2 for 500 liter helium Dewars) to the Helium Transfer Line.

13. Install the threaded coupling nut 46-318619P1, retainer ring 46-260272P1, and o-ring 46-260342P9 onto the Cryostat Stinger.

14. Attach the opposite end of the Helium Transfer Line onto the Dewar Stinger Assembly.



WARNING

POTENTIAL IMPACT INJURIES
THE UNATTACHED END OF THE GAS LINE MAY EXHIBIT WHIPPING MOTION AND COLLIDE INTO OBJECTS AND PERSONNEL DURING GAS LINE PURGE.
FIRMLY HOLD THE UNATTACHED END DURING GAS LINE PURGE.

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

15. Purge Helium Regulator and Hose Kit 46-306734G1 by alternately turning the regulator handle fully in and out 3 times. Upon completion of the purge, back the regulator out until a minimal flow is felt exiting the hose.

16. Open the helium Dewar's Vent Valve to allow a small amount of gas flow.

17. Attach the purged Helium Regulator and Hose Kit to the helium Dewar's GHe Pressurizing Port. See Illustration 3-54.

18. Back out the regulator handle all the way.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

19. Open Helium Vent Valve V2 (Illustration 3-53) on the magnet. Turn the Magnet Monitor key switch to the "Fill" (horizontal) position. Vent the magnet cryostat pressure to < 1.0 psig.

⚠ CAUTION

Potential Magnet Quench
The helium fill line may become damaged and/or a magnet at field may quench if a Cryostat Stinger Pump-Out Port contacts the Shim Lead Connector Housing during helium fill.
Do not allow a Cryostat Stinger Pump-Out Port to contact the Shim Lead Connector Housing during helium fill.

20. Partially open the Dewar Stinger Assembly's valve, allowing liquid helium to purge and precool the Transfer Line Assembly until a liquid plume is observed exiting the assembly. Allow Dewar pressure to decrease no more than 3 psig before continuing.

NOTICE

If Bottom Filling and ceiling height prevents Cryostat Stinger insertion in Step 21:

1. **Install a Brass Blanking Cap on the Cryostat Stinger Assembly,**
2. **Remove the Extension from the Cryostat Stinger,**
3. **Place a brass alligator clip near the top end of the Cryostat Stinger,**
4. **Partially insert the Extension into Fill Port V1, and then**
5. **Reattach the Extension.**

21. With the plume present, uncap Fill Port V1 (Illustration 3-53) and fully insert the Cryostat Stinger Assembly. Then securely tighten Fill Port V1's compression fitting.

22. Fully open the Dewar Stinger Assembly Valve.

NOTE: If gas is observed escaping from the compression fitting on Fill Port V1 or on the helium Dewar, use a heat gun to warm the compression fitting and recheck the compression fitting tightness.

23. Open the Vent Valve at the Dewar's GHe Pressurizing Port.

NOTE: Maximum transfer efficiency occurs when Dewar pressure is near 2 psig.

24. Verify that the GHe cylinder valve is fully open, and then adjust the 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.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

Normal cryostat pressure during helium fill is approximately 1 psig. Cryostat pressure will rise to just above 1 psig at the beginning of the fill, and then slowly drop back to around 1 psig. Make sure cryostat pressure never exceeds 1.5 psig during fill. If the cryostat pressure gauge reads > 2.0 psig, stop the fill immediately and check fill equipment for loss of vacuum, high Dewar pressure, etc.

NOTICE

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

NOTE: Helium Vent Port V2 should frost up, indicating there is no restriction in the venting circuit.

25. Check the Magnet Monitor for an increase in the helium level. During the fill process monitor cryogen level readings once every minute for the first 5 minutes of the fill and once every 3 minutes thereafter.

WARNING

POTENTIAL MAGNET QUENCH
BLOWING WARM HELIUM GAS INTO A MAGNET AT FIELD MAY CAUSE THE MAGNET TO QUENCH.
DO NOT ALLOW AN EMPTY DEWAR TO BLOW WARM HELIUM GAS INTO A RAMPED MAGNET.

NOTICE

If the Magnet Monitor's helium level reading is not increasing, check the magnet and fill equipment for frosting or blockage. If the Magnet Monitor reading is decreasing:

1. **Stop the fill immediately,**
2. **Remove the Stinger from the magnet and**
3. **Contact service.**

26. Monitor the Dewar transfer for one or more of the following to prevent blowing helium gas into the helium vessel:

- 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.
- 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).
- Monitor the percent change on the Magnet Monitor. Stop the transfill when there is no positive (increasing) change in the meter reading.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

- 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.

NOTE: Multiple Dewars may be required to achieve a 100% fill of the magnet cryostat.

27. Record information for each Dewar in Chapter 8, Section 3, Helium Fill Data, or Chapter 8, Section 2, Liquid Helium Refill Log.

28. When the cryostat is full (a Magnet Monitor reading of 100%), or when changing helium Dewars:

    a. Close the valve on the Dewar Stinger Assembly,

    b. Close the GHe cylinder valve,

    c. Close the Dewar's Vent Valve, and then

    d. Open the Dewar's Pressure Relief Valve.

29. Remove the Cryostat Stinger from Fill Port V1 and immediately replace the Fill Port Cap.

30. If additional Dewars are required, change helium Dewars in conformance with Section 3.2.4.4, Changing Helium Dewars, before continuing with the Liquid Helium Fill procedure.

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

31. Tighten Fill Port V1's compression fitting to prevent a leak from occurring.

32. Disconnect the Helium Transfer Line Assembly from the Helium Dewar Stinger Assembly.

33. Make sure the helium Dewar is under 1 psig, then remove the Helium Dewar Stinger Assembly from the helium Dewar.

34. Close the GHe cylinder valve.

35. Disconnect the Helium Gas Line from the Dewar's Helium Gas Pressurizing Port.

36. Back off the GHe cylinder Pressure Regulator's adjusting handle (CCW) until no resistance is felt.

37. Verify following Dewar configuration:

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

- Liquid Helium Outlet Valve: **closed**
- Helium Vent Valve: **closed**
- Pressure Relief Valve: **open**
- Replace all adapters on Liquid Helium Valve Outlet

38. Remove the GHe cylinder Regulator from the helium gas cylinder and install the protective valve cap on the cylinder.

39. Turn the Magnet Monitor key switch to the normal (vertical) position.

40. Check and record the Magnet Monitor and cryostat pressure readings. Make sure the vessel pressure is increasing at a rate of 0.11 psig/hour.

3.2.4.4 Changing Helium Dewars



CAUTION

Potential Magnet Quench
Helium gas from the helium transfer line can enter the magnet while Dewars are being changed if the Cryostat Stinger is left in the Fill Port. This can cause a ramped magnet to quench.
Always remove the Cryostat Stinger from the Fill Port and start the Fill Procedure over again when changing helium Dewars while filling a ramped magnet.

1. Close Helium Vent Valve V2 (Illustration 3-53) on the magnet.

2. Remove the Stinger and cap the Fill Port V1.

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

3. Obtain a full liquid helium Dewar. Check the Dewar pressure gauge. If the pressure is > 1 psig, slowly open the Dewar Vent Valve and reduce Dewar pressure to 1 psig. See Illustration 3-54.

NOTE:

- If Dewar pressure does not vent down to 1 psig, verify that the Dewar pressure relief valve is left in the open position. Contact the cryogen supplier immediately.
- The Pressure Relief Valve is normally open during shipping and storage to prevent excessive build up of pressure in the Dewar. Therefore, always reopen the Pressure Relief Valve after using a Dewar.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4. Observe the high pressure gauge on the GHe cylinder Regulator. Make sure the indicated pressure is > 1000 psig, indicating sufficient gas volume for transferring a full 250 liter helium Dewar.



WARNING

POTENTIAL HIGH PRESSURE GAS RELEASE
IF A GAS CYLINDER FALLS, THE VALVE OUTLET COULD SHEAR, RELEASING HAZARDOUS HIGH PRESSURE GAS.
SECURE THE GAS CYLINDER BEFORE REMOVING THE PROTECTIVE VALVE CAP.

5. If a new GHe aluminum cylinder is required in Step 4, connect a Helium Regulator and Hose Assembly (46-306734G1) to GHe cylinder's Valve Outlet (CGA 580).

6. Make sure the Regulator's adjusting handle is fully backed out, then slowly open GHe cylinder valve.

7. Refer to Section 3.2.4.1 for appropriate Helium Fill equipment.

8. Observe the cryostat pressure gauge. Temporarily open Vent Valve V2 as required to obtain a pressure ≤ 0.5 psig.

9. Verify that the Helium Outlet Valve is closed on the full Dewar.

10. Loosen the 5/8 inch locking collar on the full Dewar.

11. Remove the 1/2 inch cap and adapters, exposing the 5/8 inch brass locking collar.

12. Verify that the Pressure Relief Valve is in the open position.

13. Verify that the Dewar Stinger Assembly Valve is in the closed position, and then disconnect the Helium Transfer Line from the Dewar Stinger Assembly.

14. Remove the Dewar Stinger Assembly from the empty Dewar.

15. Wipe off frost or moisture on the Dewar Stinger and insert the Dewar Stinger Assembly through the 5/8 inch locking collar until the Stinger Tip contacts the Helium Outlet Valve in the full Dewar. See Illustration 3-54.

16. Open the Helium Outlet Valve.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

17. Slowly insert the Dewar Stinger Assembly into the Dewar until the Stinger Tip contacts liquid helium. Contact is indicated by a pressure increase on the Dewar pressure gauge and by expulsion of gas from the Pressure Relief Valve Port.

18. Continue to insert the Dewar Stinger Assembly at a rate that maintains a maximum 5 psig reading on the Dewar pressure gauge.

19. When the Dewar Stinger Assembly contacts bottom of the Dewar, raise the Stinger Assembly 1 inch (25 mm) and securely the tighten threaded 5/8 inch locking collar.

NOTE: If magnet room ceiling height prohibits insertion of the Dewar Stinger Assembly into the Dewar, the Dewar must be moved to an area with a higher ceiling height, the Stinger Assembly inserted there and then transported back into the magnet room.

20. When Dewar pressure stabilizes at 5 psig, close the Pressure Relief Valve.

21. Attach the Helium Transfer Line onto the Dewar Stinger Assembly.



WARNING

POTENTIAL IMPACT INJURIES
THE UNATTACHED END OF THE GAS LINE MAY EXHIBIT WHIPPING MOTION AND COLLIDE INTO OBJECTS AND PERSONNEL DURING GAS LINE PURGE.
FIRMLY HOLD THE UNATTACHED END DURING GAS LINE PURGE.

22. Disconnect the Helium Gas Line from the empty Dewar. Purge the GHe cylinder Regulator and Hose Assembly by alternately turning the Regulator's handle fully in and out 3 times. Upon completion of the purge, back the Regulator out until a minimal flow is felt exiting the hose.

23. Slightly open the GHe Vent Valve to allow helium gas to flow from the Dewar.

24. Attach the purged Gas Line Assembly to the Dewar's Helium Gas Pressurizing Port. Fully back out the Regulator's adjusting handle.

25. Attach the Cryostat Stinger to the Transfer Line.

26. Prepare the empty Dewar as follows:

    - Liquid Helium Outlet Valve: **closed**
    - Helium Vent Valve: **closed**
    - Pressure Relief Valve: **open**
    - Replace all adapters on Liquid Helium Valve Outlet

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

27. Proceed with Section 3.2.4.3, Step 19.

3.2.4.5 Changing Helium Gas Bottles



DANGER

FATAL EXPLOSIVE HAZARD!
GAS CYLINDER RUPTURE/DAMAGE OR OPENING CYLINDER VALVE FAST WILL RELEASE 2400 PSI GAS FROM CYLINDER.
MAKE SURE GAS CYLINDERS ARE SECURE FROM FALLS AND AWAY FROM MOVING OBJECTS BEFORE USING. ALWAYS OPEN CYLINDER VALVE SLOWLY.



WARNING

POTENTIAL PROJECTILE HAZARD
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.
HELIUM GAS CYLINDER (BOTTLE) CAPS ARE FERROUS AND MUST BE REMOVED BEFORE BRINGING THE CYLINDER INTO THE MAGNET ROOM OF A RAMPED MAGNET.

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 the Dewar vent valve and remove the gas hose.

2. Close the main valve and regulator on the helium gas bottle.

3. Bring a full helium gas bottle into the magnet room and reconnect the regulator and hoses.

4. Purge the hose before reconnecting to the Dewar.

3.2.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4 Preparations for Field Measurement

4.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	4 hours	Included in 'Procedure'

4.2 Overview

A Teslameter connected to a single Teslameter Probe is used whenever the strength of the magnet's magnetic field must be measured, monitored or mapped. A single Teslameter Probe accurately positioned at the magnet's iso-center may be used whenever only a single measurement of the magnet's overall magnetic field strength is required. Whenever a detailed map of the magnet's magnetic field strength at a large number of angles within a spherical volume is required the Teslameter Probe must be mounted to Universal Field Mapping Fixture 46-294060G4. Use this section to set up a Teslameter, a single Teslameter Probe (used both with and without Universal Field Mapping Fixture 46-294060G4, as appropriate) and Universal Field Mapping Fixture 46-294060G4.

NOTE: Included in this section are:

- Section 4.4.1, Preparation for Field Monitoring, to set up for single-point field measuring/monitoring of overall magnetic field strength;
- Section 4.4.2, Preparation for Field Mapping, to assemble and install Universal Field Mapping Fixture 46-294060G4 when a detailed magnetic field mapping is required; and
- Section 4.4.3, Teslameter Adjustment and Resynchronization, to set-up and resynchronize the Teslameter and Teslameter Probe whenever they are used.

4.3 Preliminary Requirements

4.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Digital Voltmeter (DVM), Volt-Ohm Meter (VOM) or non-contact voltage tester	1	-	-	-
Oscilloscope (optional)	1	-	-	-
Cardboard box or nonferromagnetic frame (for field monitoring)	1	-	-	-
Tape Measure (nonmagnetic if magnet is at field)	1	-	-	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
MetroLab Teslameter Kit	1	-	46-251865G4	-
#5 MetroLab Probe (included in MetroLab Teslameter Kit 46-251865G4)	1	-	46-255839P104	-
Universal Field Mapping Fixture	1	-	46-294060G4	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-

4.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Permatex (1 oz. tube: 2119594) or Bostik (4 oz. can: 46-294151P8) anti-seize lubricant	1	-	-	-
NOALOX Compound Lubricant (46-252065P65) or mechanical grease	1	-	-	-

4.3.3 Replacement Parts

No replacement parts required.

4.3.4 Safety



WARNING

POTENTIAL PROJECTILE HAZARD
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.
NEVER BRING FERROMAGNETIC MATERIAL INTO THE MAGNET ROOM. MAKE SURE ALL EQUIPMENT AND TOOLS USED IN THE MAGNET ROOM ARE NON-FERROMAGNETIC.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED TESLAMETER CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE TESLAMETER IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE TESLAMETER. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.

4.3.5 Required Conditions

Condition	Reference	Effectivity
The removal of some magnet enclosure components may be required to complete the Preparations for Field Measurement procedure. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with the Preparations for Field Measurement procedure if cover removal is required.	Chapter 5, Section 5	-
(continued)	Appendix A, Section 1.1	-
The Magnet Bore should be clear for mounting and operating the Field Mapping Fixture.	-	-

4.4 Procedure

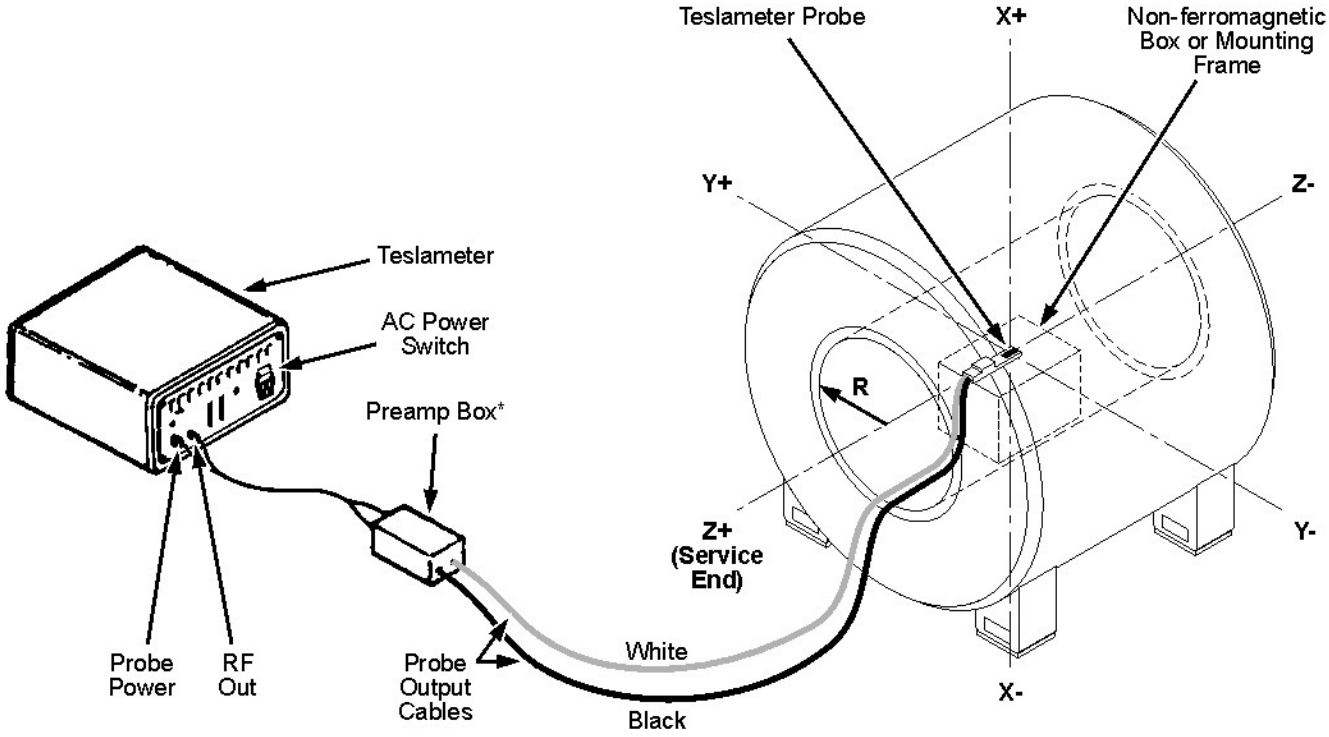
4.4.1 Preparation for Field Monitoring

When a measurement of overall magnetic field strength is required, only a single probe accurately placed at the magnet's center is necessary. If field mapping will be performed soon after field monitoring, set up for field mapping in conformance with Section 4.4.2.

1. Mount a #5 MetroLab Probe (46-255839P104) on a cardboard box or nonferromagnetic frame. See Illustration 3-55.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-55: Teslameter Probe Set-Up for Field Monitoring



* Connect Teslameter Probes with built-in preamplifiers directly to the probe 'Power' and 'RF Out' connectors on the Teslameter and not to the Preamp Box.

2. Position the box or frame along the magnet's Z-Axis half way between the bore's patient and service ends.

3. Verify using measurements that the Probe is centered on the magnet's X, Y and Z Axes.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED TESLAMETER CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE TESLAMETER IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE TESLAMETER.

4. Make sure input power to the Teslameter is disconnected. Lockout/tagout Teslameter input power. Verify that no voltage is present by using a DVM or equivalent measuring device.

5. Connect the probe to the Teslameter and set-up the Teslameter in conformance with Section 4.4.3, Teslameter Adjustment and Resynchronization.

6. Remove lockout/tagout and connect input power to the Teslameter.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.4.2 Preparation for Field Mapping

The Universal Field Mapping Fixture (46-294060G4) provides three-axis probe positioning (radial, angular and axial) of the Teslameter Probe at specific points within the magnet bore. The probe readings taken at those points map the homogeneity of the magnet's field for diagnostic purposes. This section covers mapping fixture assembly and mounting, probe positioning and setting-up and using the Teslameter for a 45cm DSV.

4.4.2.1 Mapping Fixture 46-294060G4 Set-Up



WARNING

POTENTIAL PROJECTILE HAZARD
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.
NEVER BRING FERROMAGNETIC MATERIAL INTO THE MAGNET ROOM. MAKE SURE ALL EQUIPMENT AND TOOLS USED IN THE MAGNET ROOM ARE NON-FERROMAGNETIC.



NOTICE

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

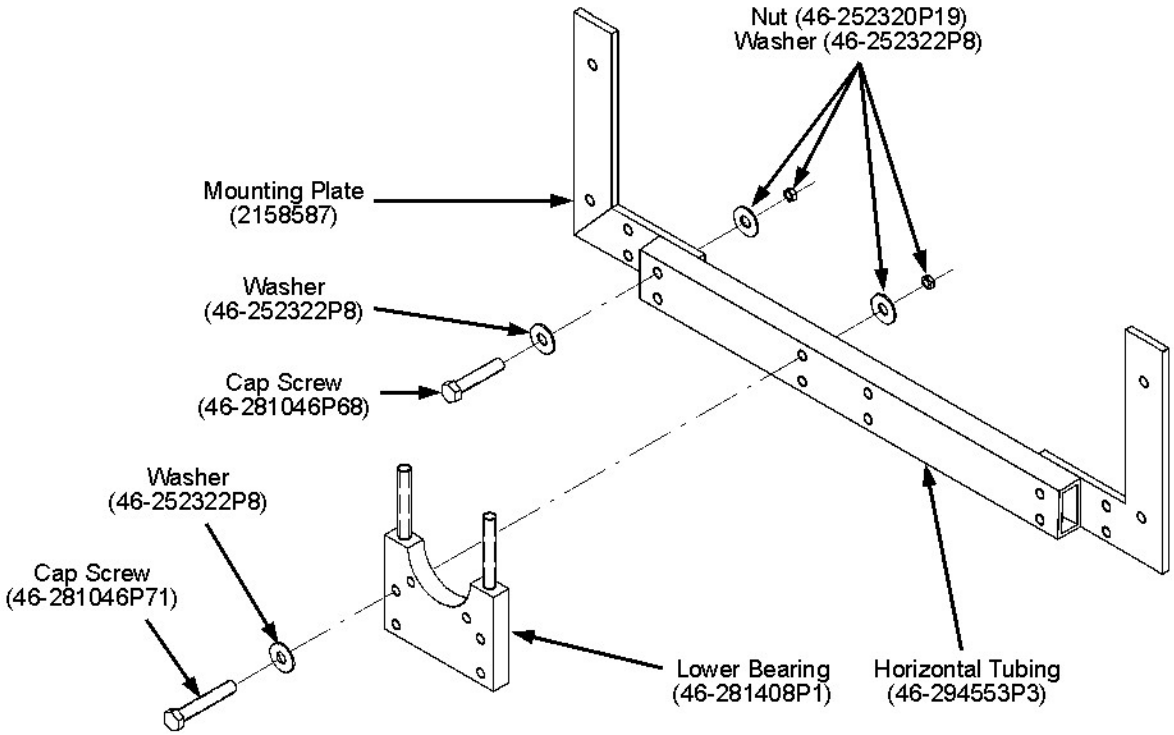
NOTE:

- Removal of some magnet cover components may be required to complete the Preparations for Field Measurement procedure. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with the Preparations for Field Measurement procedure if cover removal is required.
- The Magnet Bore should be clear for mounting and operating the Field Mapping Fixture.
- Field mapping is performed from the table (patient) end of the magnet.

1. Assemble each Support Frame using 3/8-16 x 3.00 inch brass cap screws (46-281046P68), washers (46-252322P8), and nuts (46-252320P19). Install the horizontal member of the Support Frame as shown in Illustration 3-56.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-56: Assembling the Support Frame Assembly and Lower Bearing

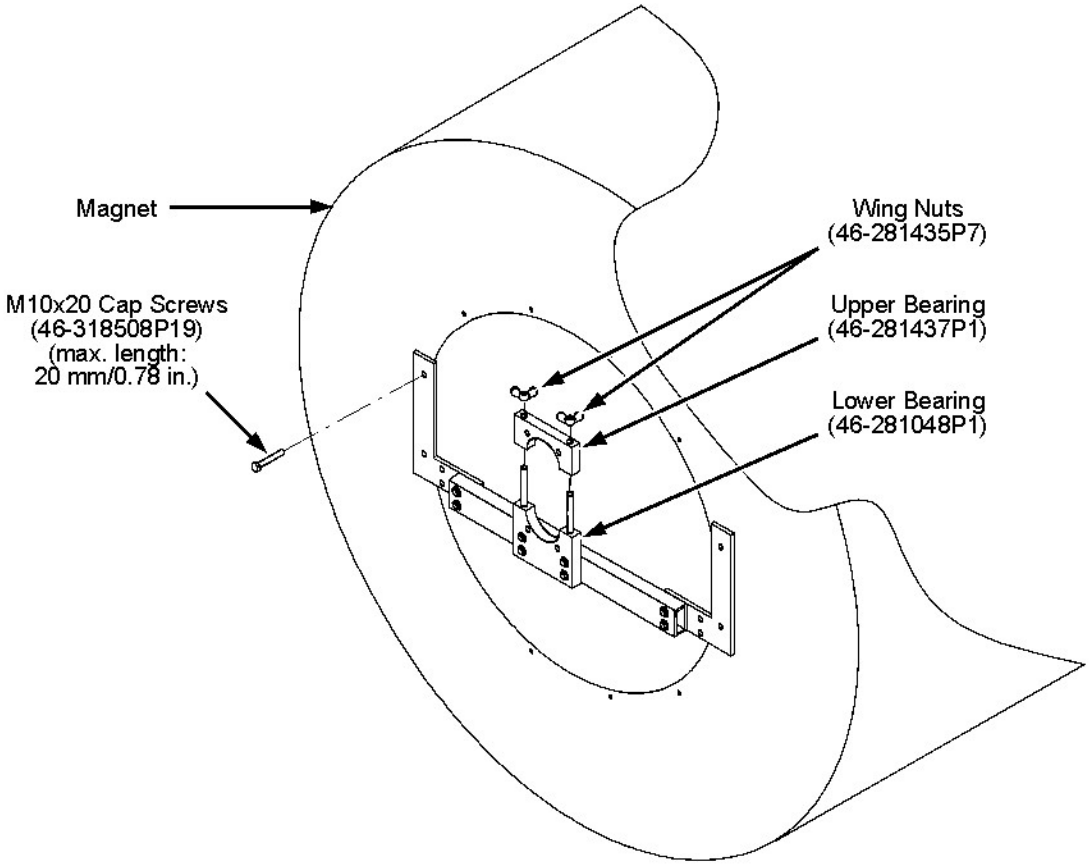


2. Attach the Lower Bearings (46-281408P1) to the Support Frame's horizontal tubing using 3.5 inch (90 mm) long cap screws (46-281046P71), washers (46-252322P8), and nuts (46-252320P19). See Illustration 3-56.

3. Attach one of the Support Frames to the back end of the magnet with four M10 x 20 mm cap screws (46-318508P19), at the required positions. See Illustration 3-57. The use of Permatex (1 oz. tube: 2119594) or Bostik (4 oz. can: 46-294151P8) anti-seize lubricant is recommended.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-57: Support Frame Mounting and Upper Bearing Attachment



NOTICE

Do not use mounting bolts any longer than the M10 x 20 mm (0.78 inch) cap screws (46-318508P19) specified. Damage to the magnet's end flange can occur. See Illustration 3-57.

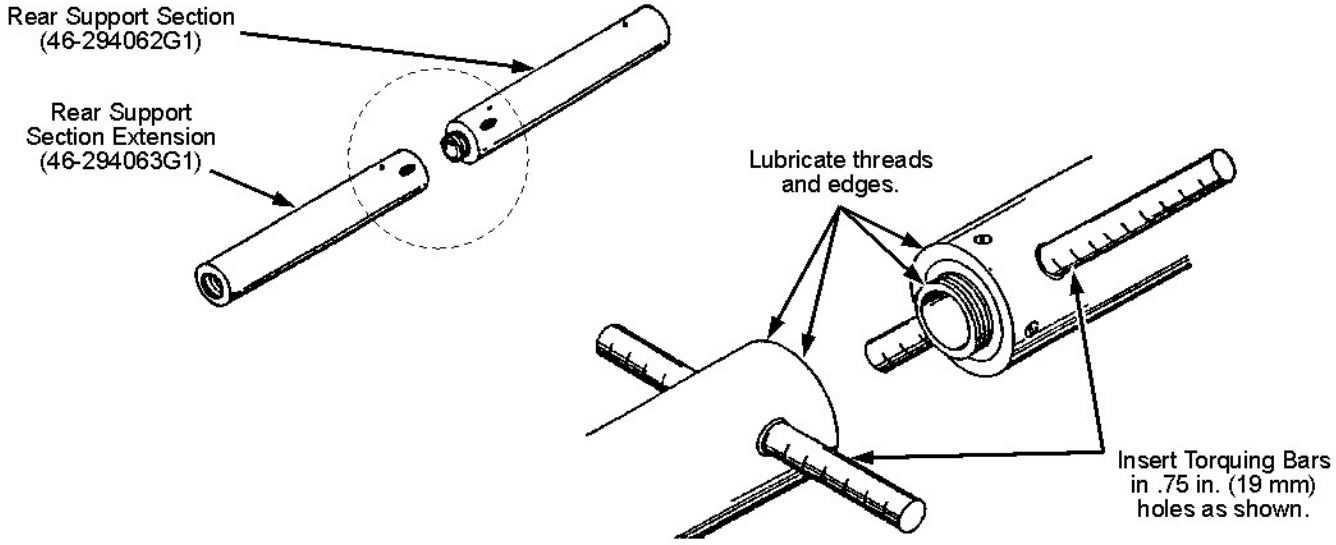
4. Loosely attach an Upper Bearing (46-281437P1) to the Lower Bearing on each Support Frame. Use the wing nuts to support the Upper Bearing. See Illustration 3-57.

5. Thread the Rear Support Section Extension into the Rear Support Section. See Illustration 3-58.

NOTE: Lubricate the threads and aluminum tube edges with NOALOX Compound Lubricant (46-252065P65) or mechanical grease to prevent galling during assembly. See Illustration 3-58 for lubricant placement.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-58: Attaching the Rear Support Section Extension to the Rear Support Section





CAUTION

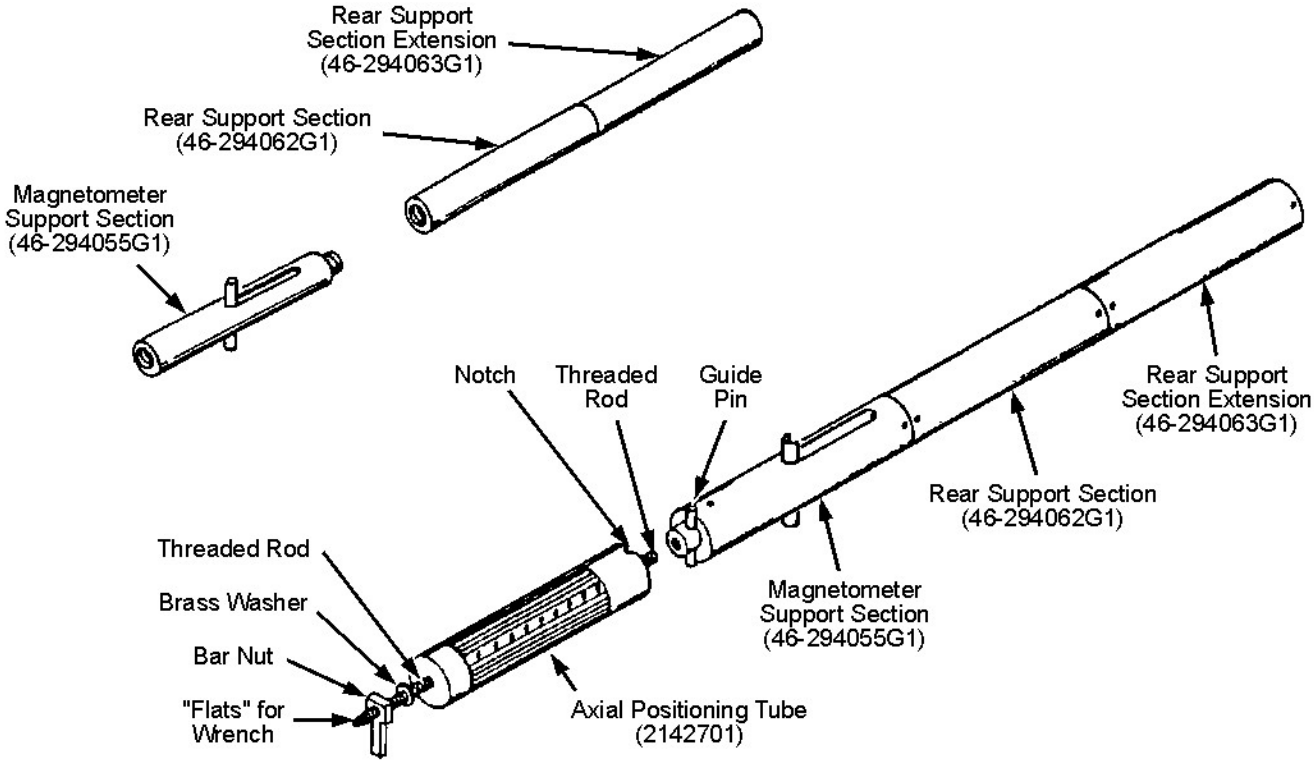
Ferromagnetic Tool
The stainless steel Torquing Bar will be slightly attracted to a ramped magnet when used close to the magnet.
Maintain a secure grip on the Torquing Bar while the tool is within 24 inches (600 mm) of a ramped magnet.

6. Use Torquing Bar 46-294019P1 mounted through the .75 inch (19 mm) holes near each to tighten the joint. See Illustration 3-58.

7. Thread the Axial Tube Magnetometer Support Section into the Rear Support Section as in Illustration 3-59. Lubricate and tighten the joint in same fashion as Step 5 and Step 6.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-59: Attaching the Axial Tube Magnetometer Support Section and the Axial Positioning Tube



8. Join the Axial Positioning Tube (2142701), shown in Illustration 3-59, to the other assembled tubes as described below:

   a. Line up the notch in the Axial Positioning Tube with the guide pin in the front of the Magnetometer Support Section and slide the tubes together.

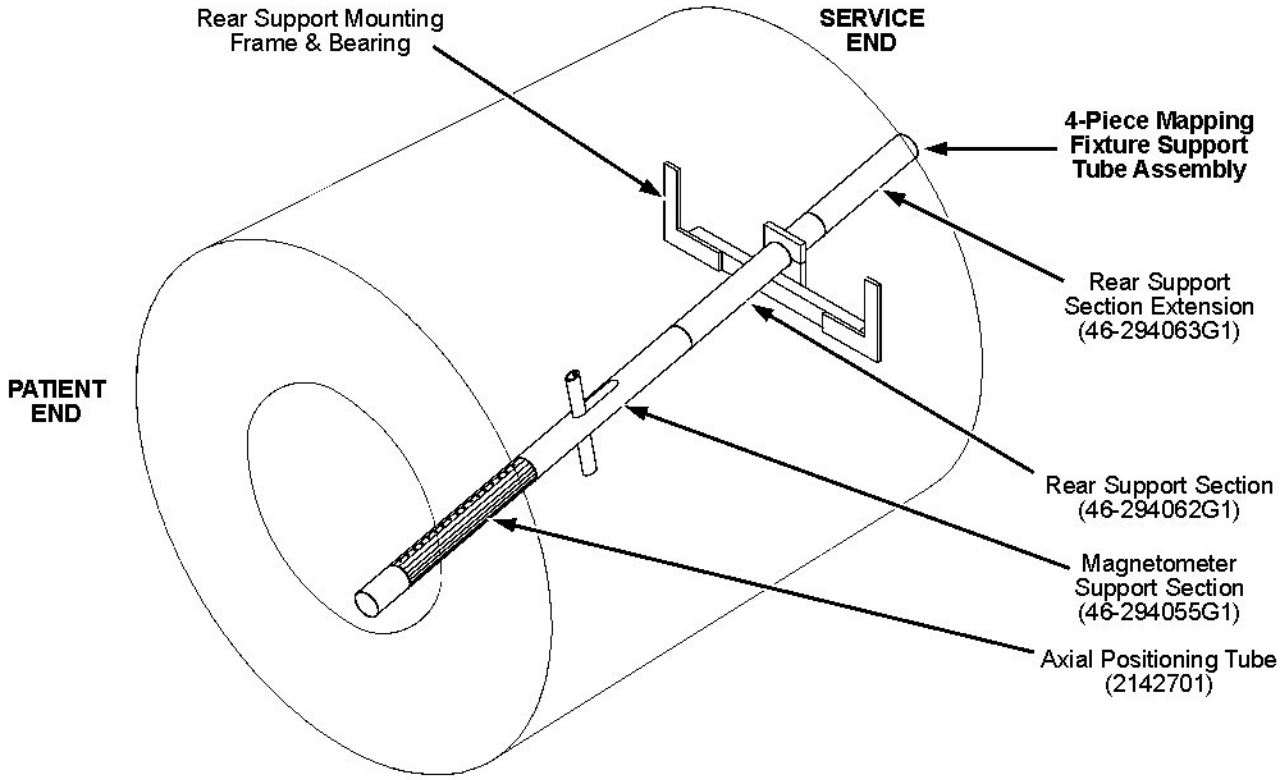
   b. Using a 9/16 inch wrench on the “Flats" of the threaded brass rod, turn the rod until it engages the Magnetometer Support Section (at least 4 turns).

   c. Turn the Bar Nut (46-294072P1) to snug the two tubes firmly against each other.

9. Place the four-piece Mapping Fixture Support Tube Assembly into the bore of the magnet, entering from the table (patient) end of the magnet with the Rear Support Section. See Illustration 3-60.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-60: Inserting the Support Tube Assembly



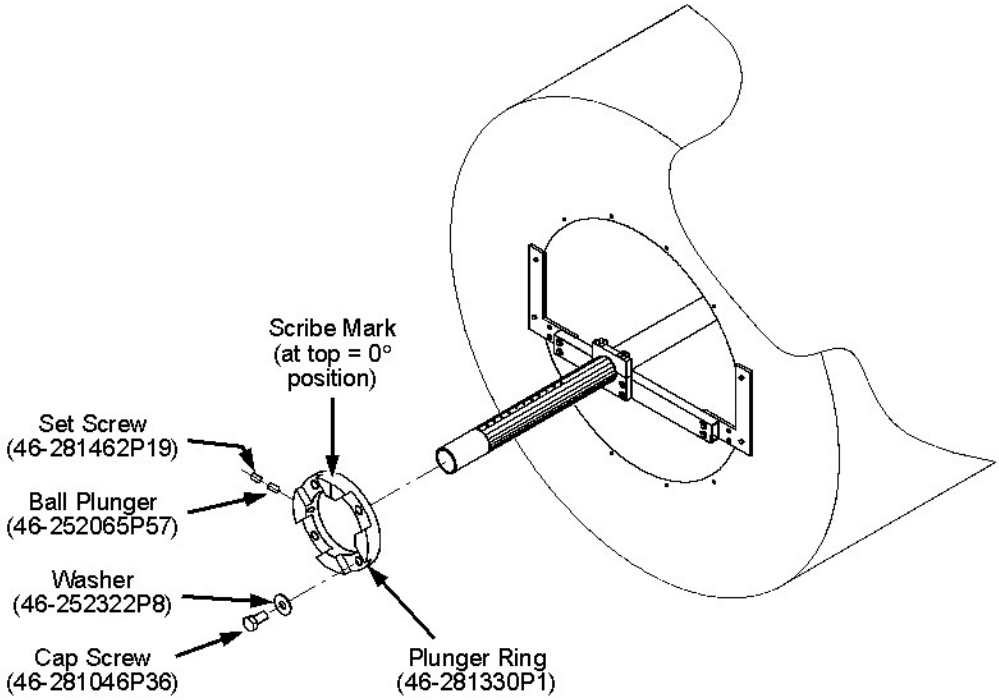
10. Insert the Rear Support Section into the open bearing at the rear end of the magnet and slide the tube assembly through until the tube assembly at the table end is even with the front of the magnet. See Illustration 3-60.

11. Attach the remaining Support Frame to the table end of the magnet.

12. Lift and pull the Mapping Fixture Support Tube Assembly through the table end bearing hole until the tube assembly is supported by both Support Frames. See Illustration 3-61.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-61: Attaching the Plunger Ring



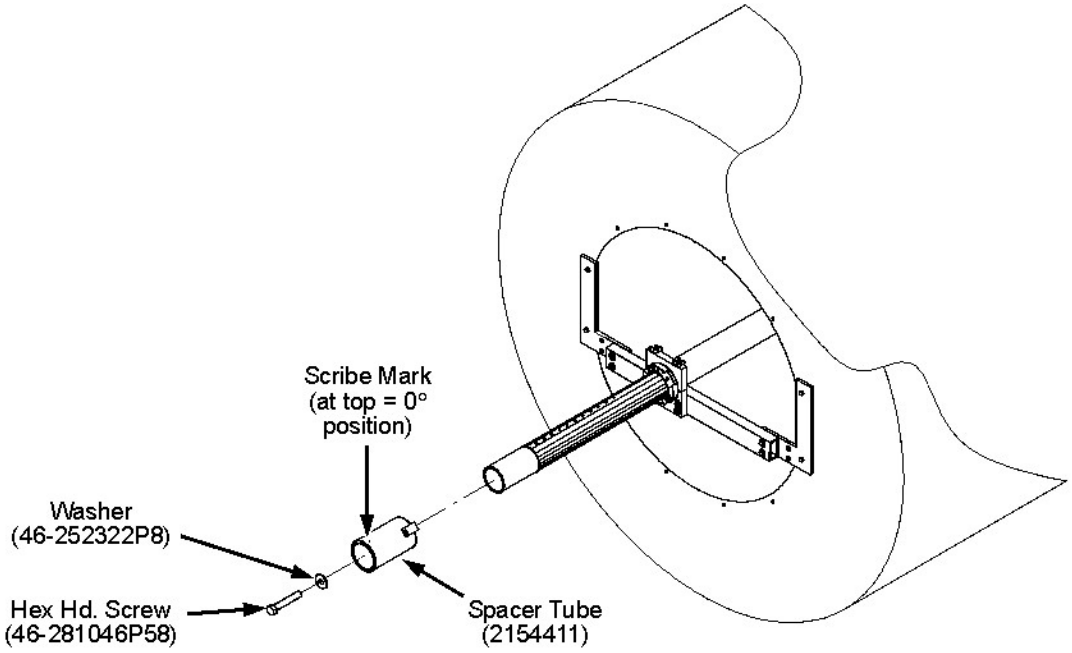
13. Tighten the wing nuts on both Lower Bearings hand tight.

14. Slide the Plunger Ring onto the Axial Positioning Tube and secure it to the bearing with four 3/8-16 x 1.5 inch (38 mm) cap screws (46-281046P36). Back out the Set Screw and Ball Plunger if they interfere with this process. See Illustration 3-61.

15. Slide the Spacer Tube 2154411 onto the Axial Positioning Tube and secure it to the Plunger Ring with 3/8-16 x 3 inch (76 mm) hex head screw 46-281046P68 and washer 46-252322P8. See Illustration 3-62.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-62: Attaching the Spacer Tube



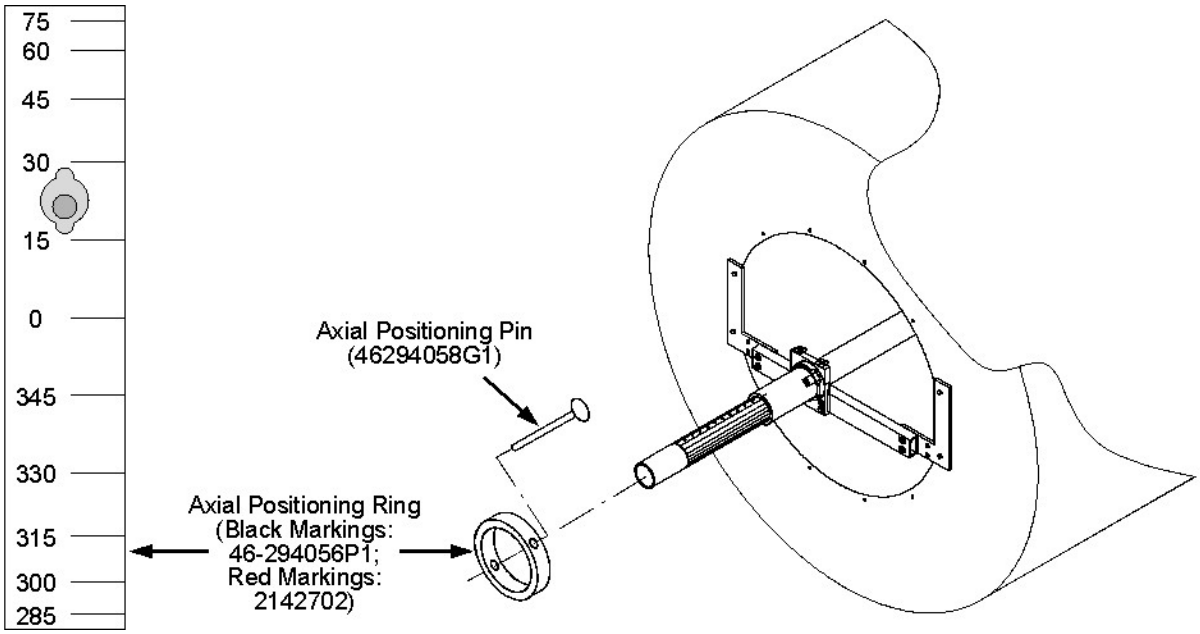
NOTICE

The 45cm DSV Axial Positioning Ring (2142702) is different from the C6 Axial Positioning Ring. On the 45cm DSV Axial Positioning ring the index marks are red and the pin hole is offset 305° from the C6 Axial Positioning Ring's pin hole location. See Illustration 3-63.

16. Slide Axial Positioning Ring 2142702 onto the Axial Positioning Tube. Pin the ring at a convenient axial position. Make sure the Axial Positioning Ring is oriented with the degree numbers advancing in a clockwise direction. See Illustration 3-63.

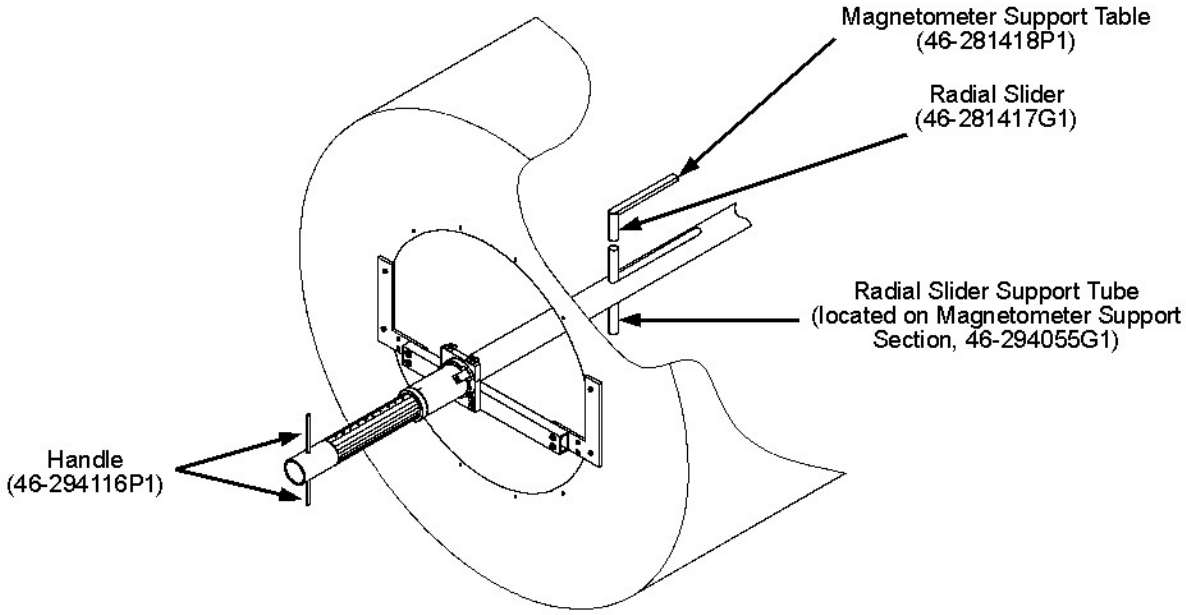
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-63: Attaching the Axial Positioning Ring



17. Attach the Handles to the Axial Positioning Tube. See Illustration 3-64.

Illustration 3-64: Radial Slider Insertion & Handle Attachment



NOTICE

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

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

18. Adjust the Ball Plunger in the Plunger Ring. See Illustration 3-61. Move the fixture circumferentially to establish sufficient Plunger pressure to “click" in the detente without binding. Adjust the Ball Plunger's Set Screw to maintain the Plunger at the proper pressure.

19. Attach the 45cm DSV Radial Slider Tube to the Magnetometer Support Table. See Illustration 3-64.

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

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

4.4.2.2 Probe Reference Position Adjustments

During the magnetic field mapping process the probe must be repositioned radially, angularly and axially.

1. Radial Positioning

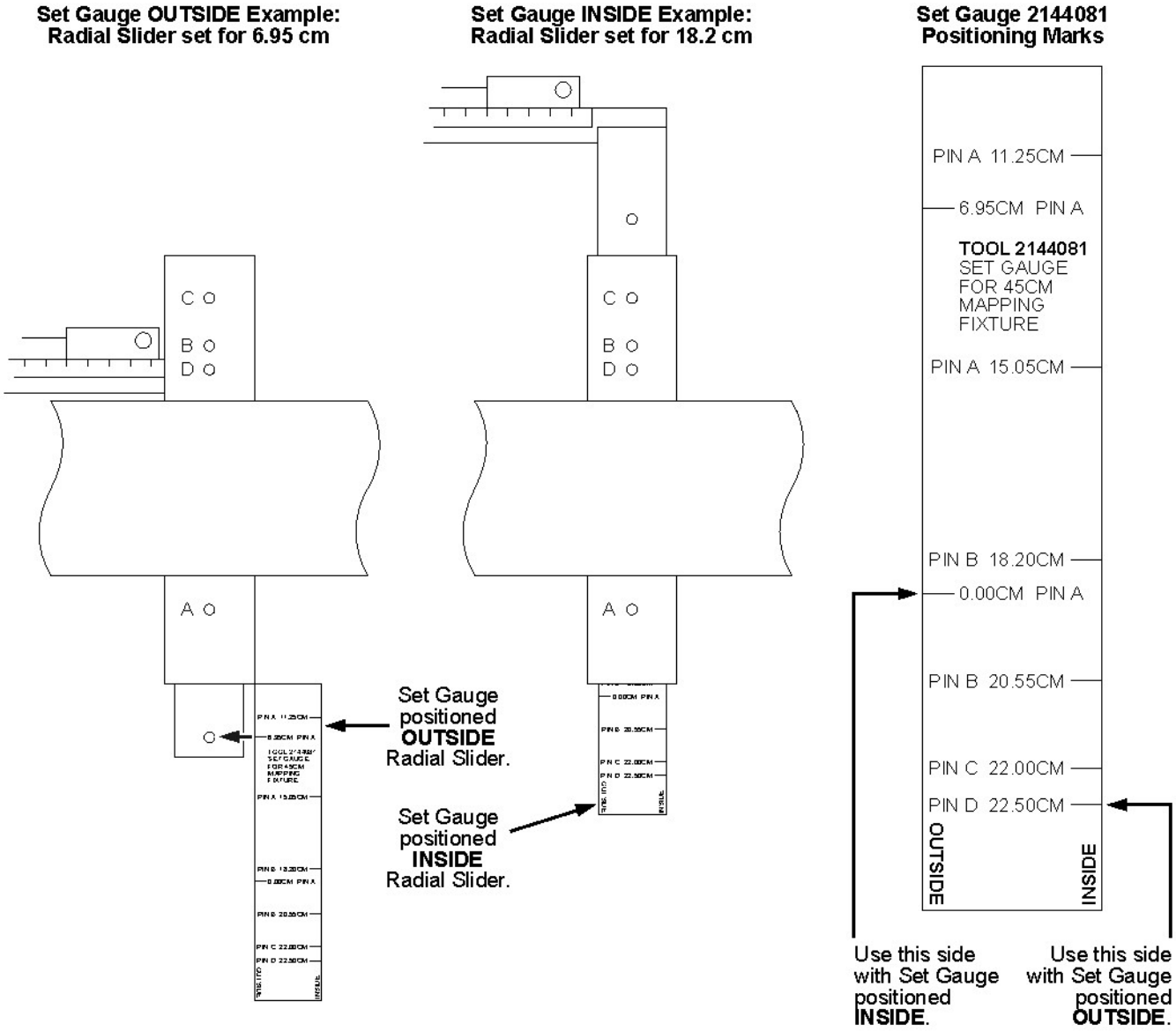
   a. Relocate the Radial Support Tube until the Set Gauge (2144081) reads the required radial position. See Illustration 3-65 and Table 3-11.

Table 3-11: Radial Arm Pinning Locations

Radius	0.00 cm	6.95 cm	11.25 cm	15.05 cm	18.05 cm	20.55 cm	22.00 cm	22.50 cm
Set Gauge Location	Outside	Outside	Inside	Inside	Inside	Inside	Inside	Inside
Pin Location	A	A	A	A	A	B	C	D
Use this table in conjunction with Illustration 3-65 and Illustration 3-66.								

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

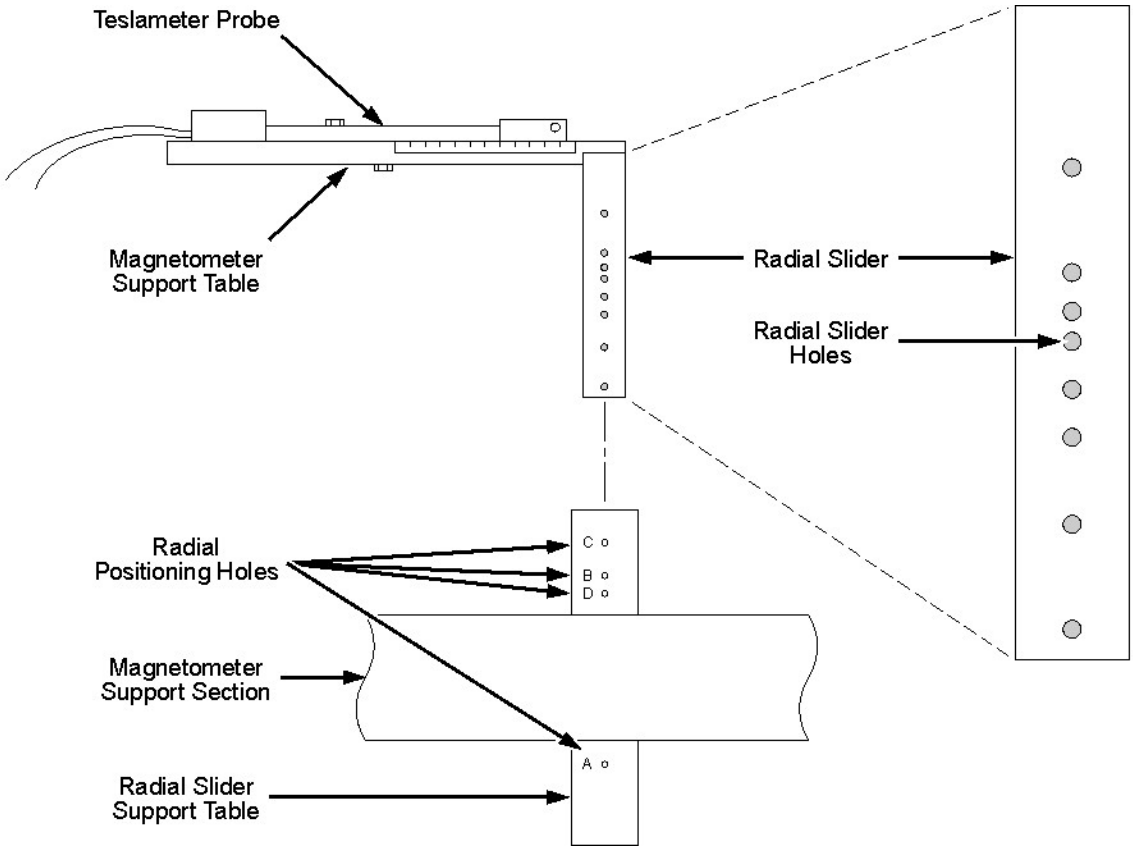
Illustration 3-65: Radial Arm Pinning Locations



b. Pin through the appropriate A, B, C or D hole to hold the Radial Slider Tube in position. See Illustration 3-66 and Table 3-11.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-66: Radial Positioning Holes

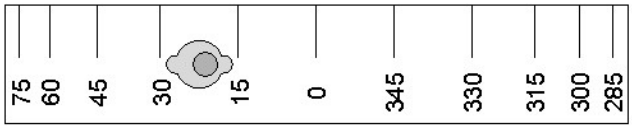


2. Angular Positioning

   a. Angular positions are obtained by rotating the Axial Positioning Tube through the specific 15 degree detente positions, shown on the tube.

   b. 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 3-67.

Illustration 3-67: Angular Positioning



Axial Positioning Ring
(Black Markings: 46-294056P1; Red Markings: 2142702)

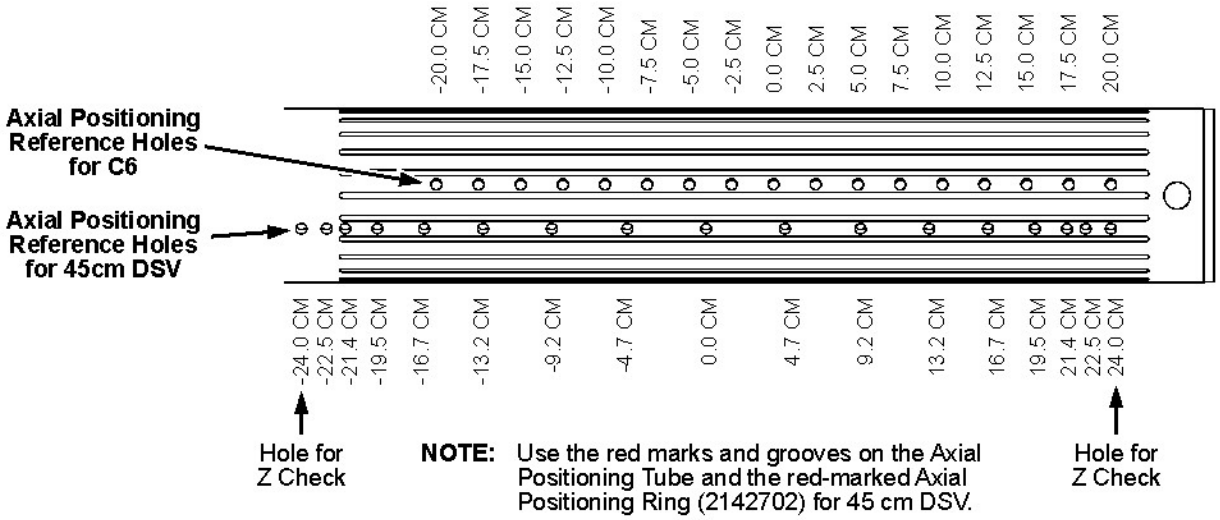
3. Axial Positioning

   a. Slide the Axial Positioning Tube along the bore of the magnet.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

b. Insert the Locating Pin through the desired Axial Position Reference Hole. See Illustration 3-68.

Illustration 3-68: Axial Positioning



4.4.2.3 Teslameter Probe Mechanical Centering

Precise magnetic field measurements are made with the Teslameter and Probe when properly set up and positioned in the Magnet Bore. The only method for Transverse Probe Centering is mechanical.



WARNING

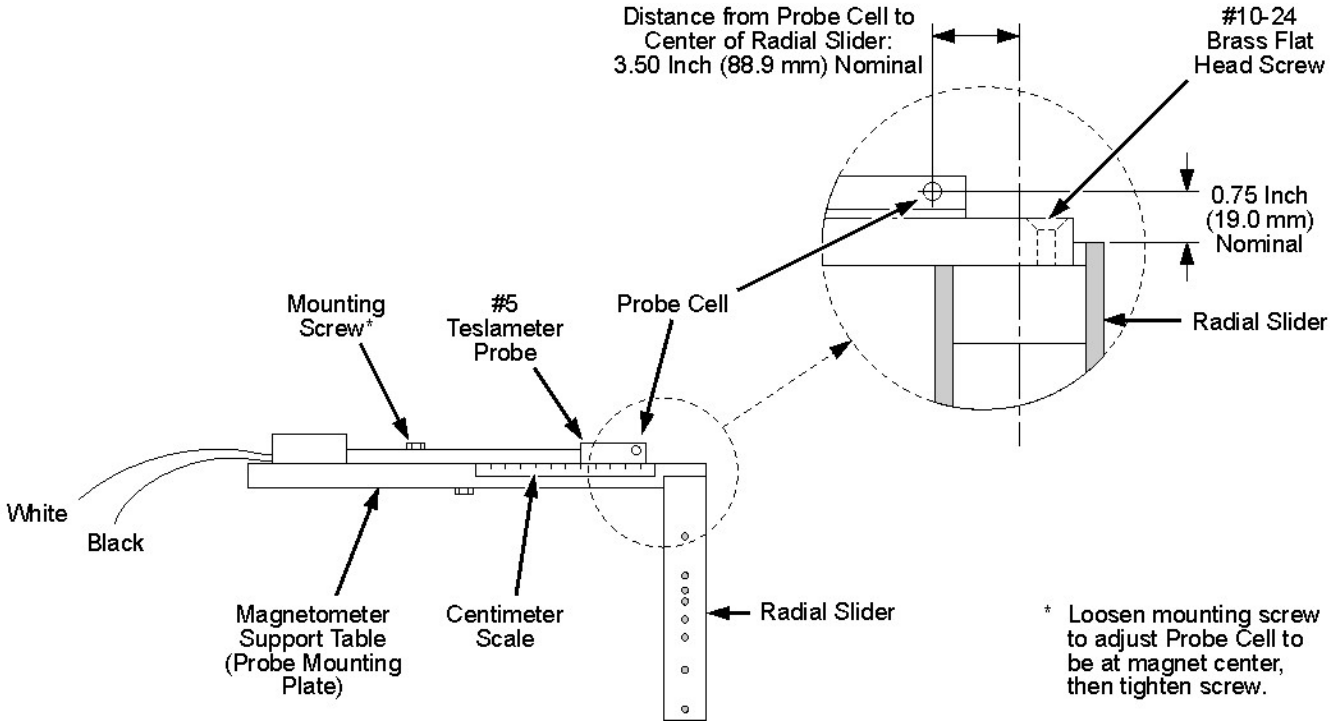
ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED TESLAMETER CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE TESLAMETER IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE TESLAMETER.

1. Make sure input power to the Teslameter is disconnected. Lockout/tagout Teslameter input power. Verify that no voltage is present by using a DVM or equivalent measuring device.

2. Attach a #5 Teslameter Probe (46-255839P104) to the Magnetometer Support Table (Probe Mounting Plate) with brass machine screws as shown in Illustration 3-69.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-69: Mechanical Axial Centering of the Teslameter Probe



3. Install Shims, if necessary, to bring Probe height to 0.75 inches (19.0 mm), measured from the center of the Probe Cell to the top of the Radial Slider. See Illustration 3-69.

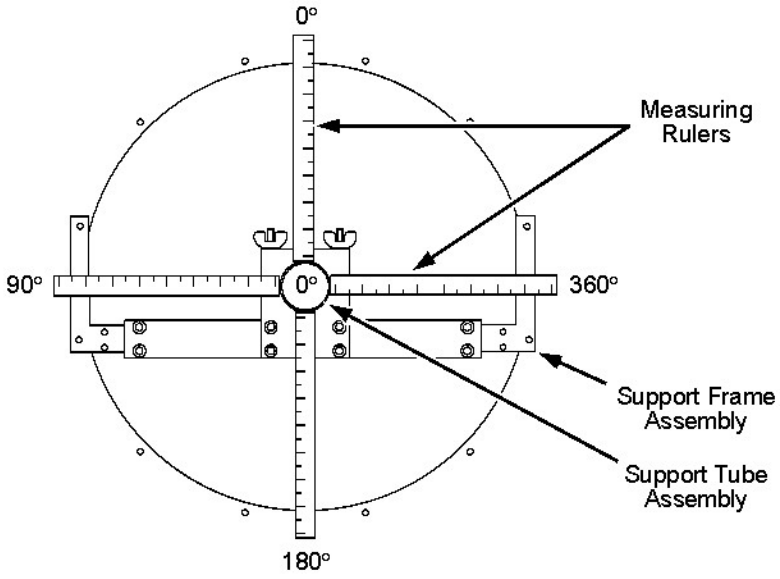
NOTE: To get proper radial spacing of the probe — 0.75 inches (19.0 mm) from the top of the Radial Slider — Nylon Spacers (46-294059P1/P2) are included with Mapping Fixture 46-294060G4. These Shims should only be needed with the MetroLab Teslameter Probe. The total distance from the Radial Slider and the center of the Probe Cell should be 0.75 inches (19.0 mm) as shown in Illustration 3-69.

4. Loosen Probe Mounting Screw and set the Probe Cell 3.50 inches (88.9 mm) from the center of the Radial Slider. See Illustration 3-69.

5. 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 1 mm (0.04 in.). See Illustration 3-70.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-70: Mechanical Transverse Centering of the Mapping Fixture



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

7. Loosen the four Support Frame Mounting Bolts on the appropriate Support Frame slightly and adjust the Support Frame in the appropriate direction to bring the distances within the ± 1 mm (0.04 in.) tolerance.

8. Repeat Step 5 through Step 7 for both sides of the Mapping Fixture.

9. Remove lockout/tagout and connect input power to the Teslameter.

4.4.3 Teslameter Adjustment and Resynchronization

4.4.3.1 Teslameter Set-Up



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED TESLAMETER CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE TESLAMETER IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE TESLAMETER.

1. Make sure input power to the Teslameter is disconnected. Lockout/tagout Teslameter input power. Verify that no voltage is present by using a DVM or equivalent measuring device.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

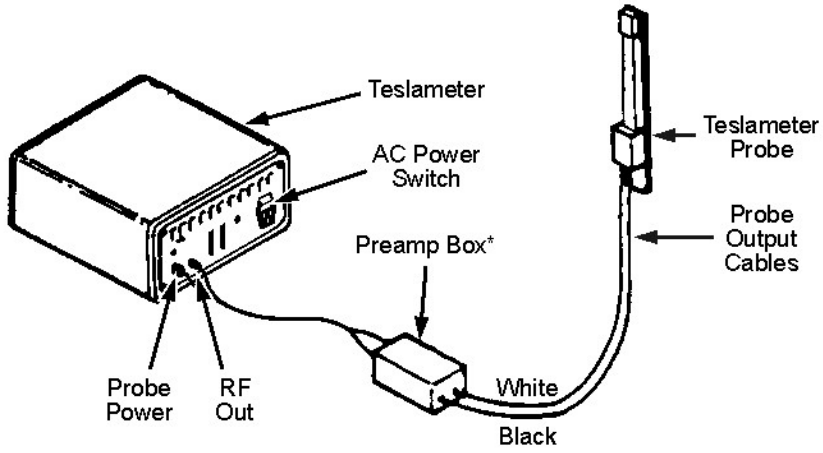
POTENTIAL PROJECTILE HAZARD
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.
NEVER BRING FERROMAGNETIC MATERIAL INTO THE MAGNET ROOM. MAKE SURE ALL EQUIPMENT AND TOOLS USED IN THE MAGNET ROOM ARE NON-FERROMAGNETIC.

2. Mount and center a #5 Teslameter Probe (46-255839P104) in the magnet's bore.

   - If a detailed map of the magnet's magnetic field is required, assemble Universal Field Mapping Fixture (46-294060G4) and mount the Probe in conformance with Section 4.4.2, Preparations For Field Mapping.
   - If a single overall magnetic field strength reading at the magnet's center is required instead of a detailed magnetic field map, mount the Probe in conformance with Section 4.4.1, Preparations for Field Monitoring.

3. Connect the white wire from the Preamp Box to the Teslameter Probe's left input jack and the black wire from the Preamp Box to the right, lacing connector end of the Probe. See Illustration 3-71.

Illustration 3-71: Teslameter Interconnections



* Connect Teslameter Probes with built-in preamplifiers directly to the probe 'Power' and 'RF Out' connectors on the Teslameter and not to the Preamp Box.

4. Connect the Preamp Box to the two-probe connection input plug on the Teslameter.

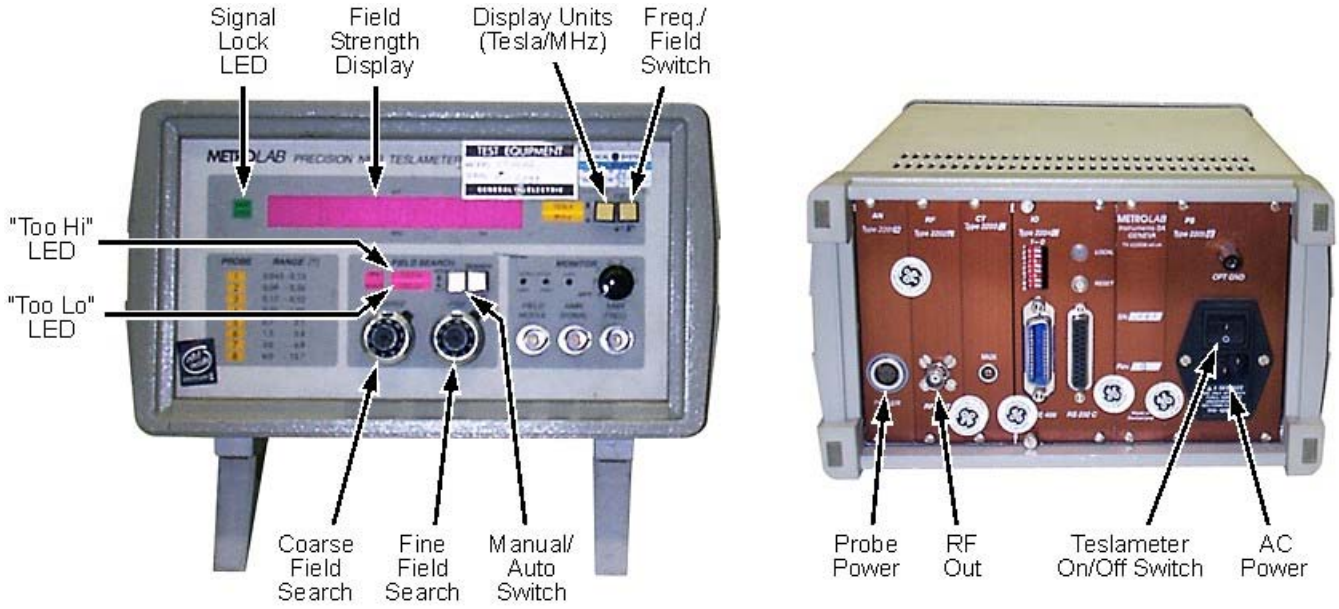
5. Verify using measurements that the Teslameter Probe is at the physical center of the magnet bore (R = 0 and Z = 0).

6. Remove lockout/tagout and connect input power to the Teslameter.

7. Turn on AC power to the Teslameter. See Illustration 3-72.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-72: Teslameter Front and Back Views



NOTICE

If the Manual/Auto Switch is not in its "Manual" position when magnetic field search begins during ramping, its sweep will be in the ± 1 Tesla range and the system could lock on to the mechanical oscillation harmonic of the Shield Cooler Coldhead, resulting in an erroneous reading.

8. Place the Manual/Auto Switch in the "Manual" position.
9. Set the Coarse and Fine Field Search controls fully counterclockwise (CCW).
10. Set the Freq./Field Switch to the "Field" position.

NOTE:
- The Teslameter is now set up and prepared to start monitoring magnetic field strength.
- The Teslameter will not lock in on the probe's signal until the magnetic field is ~ 0.3 - 0.7 Tesla, depending on the probe being used and the magnet's magnetic field strength.

4.4.3.2 Teslameter Adjustment for Ramp Up

1. Once ramping has started, monitor the Power Supply's Current Meter until an indication of ~ 350 amps is approached, then start monitoring the Teslameter.
2. As the developing magnetic field approaches the lower limit of the Teslameter probe (~ 0.7 Tesla), the "Strobe Lock" LED will start blinking. When this LED goes out, reposition the Manual/Auto Switch to the "Lock" position. See Illustration 3-72.

NOTE: If the signal does not lock in, reposition of the Probe Modulation Switch.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. As the magnetic field continues to increase, the "HI" LED above the Coarse Field Search control will light. Turn the Coarse Field Search control clockwise (CW) until the LED is extinguished.

4. As the magnetic field increases, the resonant frequency of the probe sample will increase above the Teslameter's range setting. Periodically increase the setting of the Coarse Field Search control to keep the Teslameter locked on the probe sample.

NOTE: The Fine Field Search control does not function when the Manual/Auto Switch is in the “Locked” position.

4.4.3.3 Teslameter Adjustment for Rampdown

1. Increase the Coarse Field Search control setting until a magnetic field reading of ~ 1.5 Tesla (~ 1.0 Tesla on a 1.0 Tesla magnet) is obtained. This should occur near but slightly below the actual magnetic field.

2. Slowly start increasing the Fine Field Search control. When the “Strobe Lock” LED stops blinking and remains out, reposition the Manual/Auto Switch to the “Locked" position.

NOTE: If the signal will not lock on, reposition of the Probe Modulation Switch.

3. Once the Teslameter is locked onto the magnetic field, either the “LO" or “HI" LED will be lit. Turn the Coarse Field Search control counterclockwise (CCW) if the “LO” LED lit or clockwise (CW) if the “HI” LED is lit. Slowly the lit LED will go out and stay out.

4. As the magnetic field decreases, the resonant frequency of the probe sample will decrease below Teslameter's range setting. Periodically decrease the Coarse Field Search control to keep the Teslameter locked on the probe sample.

NOTE: The Fine Field Search control does not function when the Manual/Auto Switch is in the “Locked” position.

4.4.3.4 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.

1. Manual Resynchronization

   a. Reposition the Manual/Auto Switch to “Manual".

NOTE: The “Strobe Lock” LED will be on and both the “LO" and “HI" LEDs will be oscillating, indicating a search mode.

   b. Read the Main Power Supply's Current Meter. Multiply the meter's present current reading by 20 gauss (since there's ~ 20 gauss/amp). Reset the Current Meter this calculated value.

   c. Slowly start increasing (if ramping up) the Coarse and/or Fine Field Search control while monitoring the “Strobe Lock” LED.

   d. Once the “Strobe Lock” LED light extinguishes, quickly place the Manual/Auto Switch to the “Locked" position. The meter will now be synchronized.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTE: If the “HI" LED is lit, the Coarse Field Search control will have to be turned clockwise (CW) until the LED goes out. Repeat this adjustment as required until the parking field Is reached.

2. Manual Resynchronization Using an Oscilloscope

NOTE: An oscilloscope can be set up near the Teslameter to display and trigger on the Field Modulation signal from a jack on the Teslameter's front panel. Adjust the time base to display one or two ramp waveforms. On the second channel, display the “NMR Signal" from the Teslameter's front panel.

a. Leave the Teslameter's Manual/Auto Switch in the “Locked" position.

b. Slowly turn the Coarse Field Search control in the direction the magnetic field is going (i.e., if the magnetic field is increasing, turn the control towards the higher numbers; if the magnetic field is decreasing, turn the control towards the lower numbers).

NOTE: As the meter is approaching the actual magnetic field, the baseline of the "FID" display will start to wander. Once the meter is in range of the magnetic field, the "FID" will appear on the scope trace as the meter locks on.

c. When locked on, the “Strobe Lock” LED will be out. Slightly readjust the Coarse Field Search control counterclockwise (if the “LO” LED lit) or clockwise (if the “HI” LED is lit) until the lit LED goes out.

d. Maintain tracking through end of ramp sequence.

4.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5 Shim Lead Engagement and Disengagement

5.1 Personnel Requirements

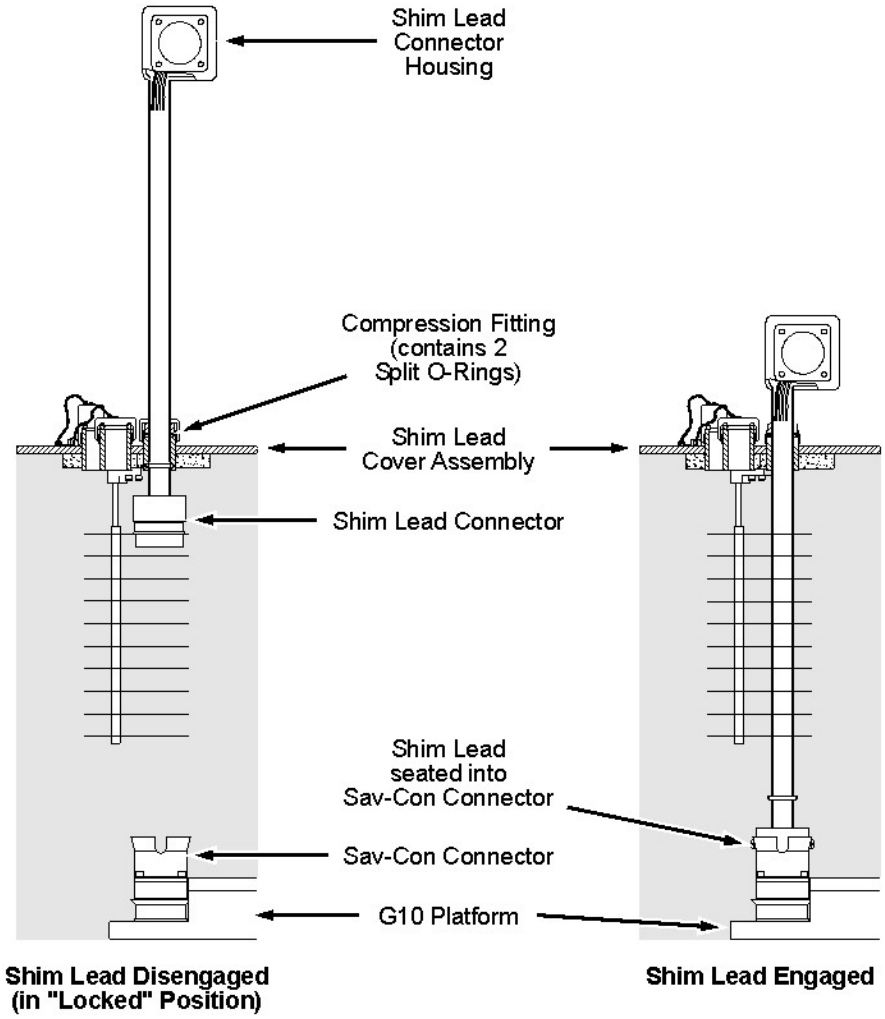
Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	.5 hour	Included in 'Procedure'

5.2 Overview

During normal operation the Shim Lead Assembly will be in the “disengaged" position. See Illustration 3-73. To ramp or shim the magnet, engage the Shim Lead according to the “four position method" described below. See Illustration 3-75.

NOTE: These procedures are for use with both the Retractable Shim Lead Assembly (2173354) and the Reduced Height Retractable Shim Lead Assembly (2285073).

Illustration 3-73: Shim Lead in Disengaged and Engaged Positions



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5.3 Preliminary Requirements

5.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Heat Gun	1	-	-	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

5.3.2 Consumables

No consumables required.

5.3.3 Replacement Parts

No replacement parts required.

5.3.4 Safety

No general safety information.

5.3.5 Required Conditions

Condition	Reference	Effectivity
The removal of some magnet enclosure components may be required to complete the Shim Lead Engagement and Disengagement procedures. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with the Shim Lead Engagement and Disengagement procedures if cover removal is required.	Chapter 5, Section 5	-
(continued)	Appendix A, Section 1.1	-

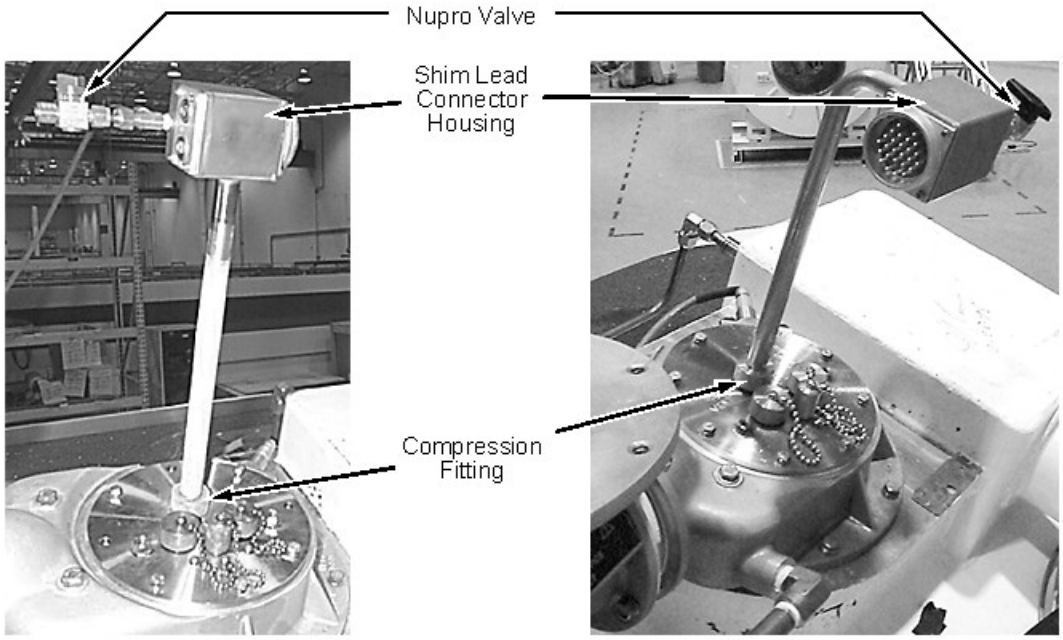
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5.4 Procedure

5.4.1 Shim Lead Engagement

1. Loosen the Shim Lead compression fitting. Make sure the Shim Lead is held locked in the up position. See Illustration 3-74.

Illustration 3-74: Disengaged & Locked Shim Leads



Disengaged/Locked Retractable Shim Lead Assembly 2173354

Disengaged/Locked Reduced Height Retractable Shim Lead Assembly 2285073



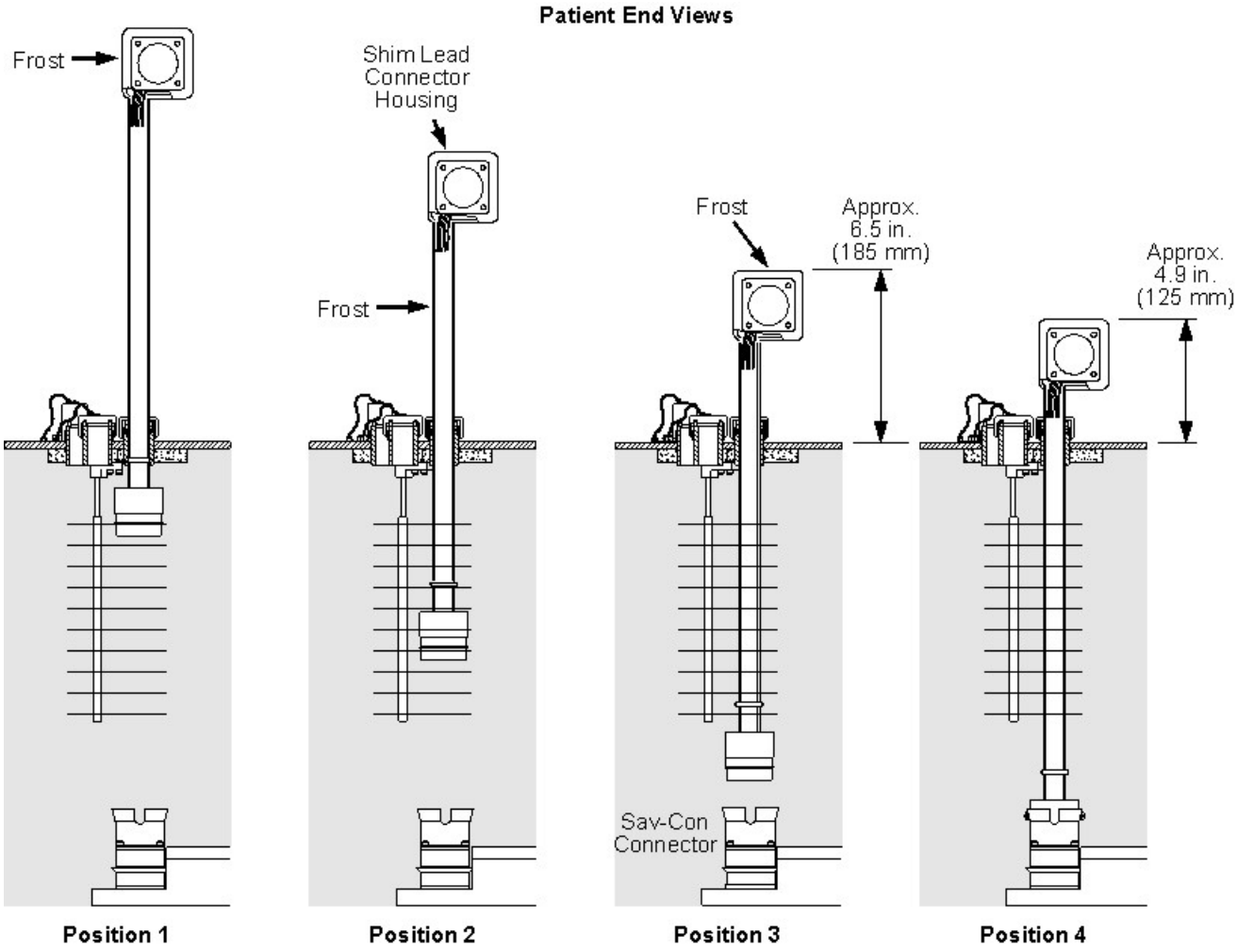
⚠ CAUTION

Potential Asphyxiation Hazard
A closed Nupro Valve during Shim Lead engagement can cause a magnet quench. Make sure the Nupro Valve is fully open and the valve is frosted before engaging the Shim Lead. Do not remove the Shim Lead's Orifice Cap that controls helium gas flow.

2. Fully open the NuPro valve to the Connector Housing on top of the Shim Lead and wait until the housing begins to frost. See Illustration 3-74. The Shim Lead should be in Position 1 shown in Illustration 3-75.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-75: Shim Lead Engage Sequence



3. Pull up slightly on the Shim Lead Connector Housing and rotate clockwise to “unlock" the assembly.

NOTE: If using the 2.5 meter (98 inch) ceiling height Shim Lead Assembly (2285073), rotate the Shim Lead Assembly 180° after “unlocking" so that the Connector Housing is at its lowest orientation, as shown in Illustration 3-74.

⚠ CAUTION

Potential Asphyxiation Hazard
Inserting Shim Lead faster than it cools to magnet temperature can cause a magnet quench.
Use the “four positions" when inserting Shim Lead, proceeding slowly between positions when pushing down on the Shim Lead Assembly.

4. Carefully push down on the Shim Lead Connector Housing until the assembly is at Position 2 in Illustration 3-75.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5. Leave the Shim Lead in Position 2 for approximately 2 minutes until the shaft begins to frost.

6. Warm the compression fitting with a heat gun to thaw its o-ring. See Illustration 3-74

7. Carefully push down on the Shim Lead Connector Housing until the assembly is at Position 3 in Illustration 3-75.

8. Leave the Shim Lead in Position 3 for approximately 2 minutes until the Shim Lead Box begins to frost.

9. Warm the compression fitting with a heat gun to thaw its o-ring.

10. Carefully push down on the Shim Lead Connector Housing until the Shim Lead contacts the Sav-Con Connector as shown in Position 4 in Illustration 3-75.

NOTE: The Shim Lead Connector and the mating G10 Sav-Con Connector are keyed and can only be mated in one position.

11. Seat the Shim Lead fully, after contact is felt, by continuing to push on the Shim Lead Connector Housing with moderate pressure. To fully engage, the Shim Lead should move downwards approximately .25 inch (6 mm), after contact is felt.

12. Tighten the Shim Lead compression fitting.

13. Close the NuPro valve.

14. After seating the Shim Lead, do electrical checks per Chapter 4, Section 5, Magnet Electrical Checks.

5.4.2 Shim Lead Disengagement

1. Remove ice around the Shim Lead Assembly and Shim Lead compression fitting with a heat gun, if required. See Illustration 3-74

2. Loosen the Shim Lead compression fitting.

3. Pull up firmly from the underside of the Shim Lead Connector Housing until the Shim Lead Assembly unseats. See Illustration 3-73 and Illustration 3-74.

4. Hand tighten the Shim Lead compression fitting.

5. Check for leaks.

5.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6 Connections for Ramping and Shimming

6.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	1 hour	Included in 'Procedure'

6.2 Overview

This section covers electrical connections required to be made before performing the ramping or rampdown procedures (beginning in Section 7.1, Ramping Overview, or Chapter 5, Section 6, Magnet Rampdown to Zero Field, respectively) or Section 8, Shim Current Adjustment).

- The Main and Superconducting Shim Power Supply input/output connections have the same P and J designations, used in the Connections for Ramping and Shimming procedure, for the Service Power Supply units.
- Make sure the Power Supply Cabinets are installed and checked in conformance with the supplier's manual, supplied with the unit, before making any power supply connections to the magnet. See Chapter 2, Section 3, Vendor Manual Matrix, for supplier manual numbers.
- Chapter 6, Section 1.1, Magnet System Interconnects, shows the cable numbers, run numbers and interconnect pattern covered in this section.

NOTE: If Ramp and Shim Cables were not ordered with the magnet, a Ramp Cable Kit (750 Amp: 2135435; 1000 Amp: 2353394) will be needed to ramp the magnet and Field Shim Cable Kit 2135558 will be needed to shim the magnet. If Ramp and Shim Cables will remain on site, order the appropriate R-Cat numbers as explained in Service Note 63034.

6.3 Preliminary Requirements

6.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Gloves (electrically insulating); one pair per person	1	-	-	-
Safety Glasses; one pair per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Digital Voltmeter (DVM)	1	-	-	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
750 Amp TCR 7.5T750 Main Power Supply 46-260776G3 or 1000 Amp ESS 7.5-1000-2-D-1236 Main Power Supply 46-260776G4	1	-	46-260776G3 or 46-260776G4	-
Superconducting Shim Coil Power Supply	1	-	46-260777G3	-
Fixed Main Lead Extension 46-294204G1 or Flexible Main Lead Extension 2287029 (for low ceiling height sites)	1	-	46-294204G1 or 2287029	-
Hold-Down Tool 2193922 or Hold-Down Tool, Short 2276755 (for low ceiling height sites)	1	-	2193922 or 2276755	-
Retractable Shim Lead Assembly 2173354 or Retractable Shim Lead Assembly, Short 2285073 (for low ceiling height sites)	1	-	2173354 or 2285073	-
750 Amp Ramp Cable Kit 2135435 or 1000 Amp Ramp Cable Kit w/ Ground 2353394	1	-	2135435 or 2353394	-
Field Shim Cable Kit (if not already ordered with the magnet)	1	-	2135558	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

6.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Cable Ty-Wraps	6	-	-	-
Bronze Wool; package	1	-	46-318068P1	-
ScotchBrite© Pads (or equivalent)	1	-	-	-

6.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
Main Lead Extension Contact Band (included in Magnet Ramping Equipment Kit 46-260703G5)	2	-	46-281256P1	-

6.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THIS CONNECTIONS FOR RAMPING AND SHIMMING PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS TO MAKE RAMPING AND SHIMMING CONNECTIONS IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING THIS CONNECTIONS FOR RAMPING AND SHIMMING PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THIS CONNECTIONS FOR RAMPING AND SHIMMING PROCEDURE.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING AN ENERGIZED POWER SUPPLY TO CAN CAUSE ELECTRICAL SHOCK.
ALWAYS WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE) — ELECTRICALLY INSULATED GLOVES, NONFERROUS SAFETY SHOES AND SAFETY GLASSES/GOGGLES — WHILE PERFORMING THIS CONNECTIONS FOR RAMPING AND SHIMMING PROCEDURE.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO A MAIN POWER SUPPLY OR A SHIM POWER SUPPLY. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.



NOTICE

Read, understand and apply all safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, applicable to this Connections for Ramping and Shimming procedure both before and while performing this Connections for Ramping and Shimming procedure.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting this Connections for Ramping and Shimming procedure.	Chapter 1, Section 2	-
Perform the Shim Lead Connector and Vertical Penetration Deicing subsection of Chapter 5, Section 9.2, Ice Removal, to make sure the Shim Lead connector plug (P100) is functional prior to making power supply connections. Remove ice as required.	Chapter 5, Section 9.2	-
The removal of some magnet enclosure components may be required to complete the Connections for Ramping and Shimming procedure. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with the Connections for Ramping and Shimming procedure if cover removal is required.	Chapter 5, Section 5	-
(continued)	Appendix A, Section 1.1	-

6.4 Procedure

6.4.1 Superconducting Shim Coil Power Supply Connections to Magnet



NOTICE

- **Do not connect input power to the Superconducting Shim Coil Power Supply until it is verified that ALL current controls are set to zero (turned fully counterclockwise) and the supply is turned off.**
- **Connecting the Superconducting Shim Coil Harness to the magnet when the Superconducting Shim Coil Power Supply is turned on may cause irreparable damage to the vapor-cooled shim leads.**

1. Engage the Shim Leads in conformance with Section 5, Shim Lead Engagement and Disengagement.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

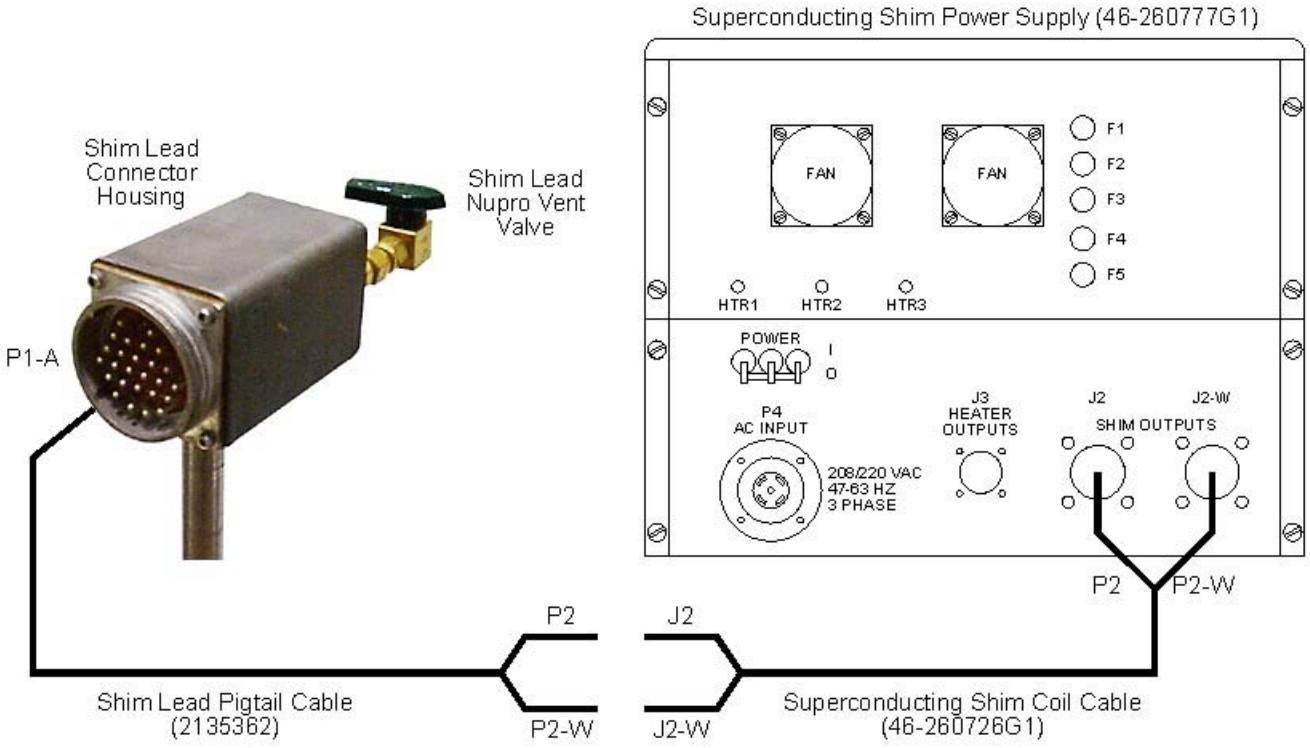
WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO THE SHIM POWER SUPPLY.

2. Disconnect and lockout/tagout input power to the Shim Coil Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

3. Connect electrical cabling to the Superconducting Shim Coil Power Supply as shown in Illustration 3-76.

Illustration 3-76: Shim Power Supply Connections



6.4.2 Main Power Supply Connections to Magnet

WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO THE MAIN POWER SUPPLY.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL COLD BURN OR ASPHYXIATION HAZARD
INTERNAL CRYOSTAT PRESSURE BUILD-UP TO > 5.25 PSIG WILL OPEN 5.25 PSIG RELIEF VALVE.
BEFORE REMOVING EITHER RAMP OR FILL PORT CAPS OR LOOSENING ANY COMPONENT RESULTING IN THE RELEASE OF CRYOGEN PRESSURE:

1. **OBSERVE THE INTERNAL CRYOSTAT PRESSURE GAUGE READING,**
2. **SET MAGNET MONITOR PRESSURE TO 0.5 PSIG AND**
3. **VENT CRYOSTAT DOWN TO 0.2 PSIG THROUGH VENT VALVE V2.**

NOTE: If the site has Magnet Monitor proprietary software, connect to Magnet Monitor and turn off the alarm for vessel pressure. Then turn the vessel pressure control to a high value of .5 psig and a low value of .4 psig.

1. Disconnect and lockout/tagout input power to the Main Coil Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

2. Connect electrical cabling to the Main Coil Power Supply as shown in Illustration 3-77 or Illustration 3-78.

NOTE: Clean all connections on the Main Leads and Main Lead Extensions to prevent high resistance contacts and minimize voltage drops. Brass wool or scouring pads can be used to clean connections.

NOTE: Make sure all nuts are tightened sufficiently to prevent a high resistance contact. Connect red cables to the positive (+) buss bar and black cables to the negative (-) buss bar. Two red and two black cables are connected in parallel to the buss bars for a 750 amp power supply, and three red and three black cables for a 1,000 amp power supply. Make sure the cable lugs and/or exposed wire from the Ramp Cables are not touching the case of the Main Coil Power Supply.

NOTE: Either heater connector J5-1 or J5-2 can be used to turn on the heater(s). See Illustration 3-77 or Illustration 3-78. Do not connect two heater cables at the same time.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-77: Magnet Power Supply Connections, 750 Amp Power Supply

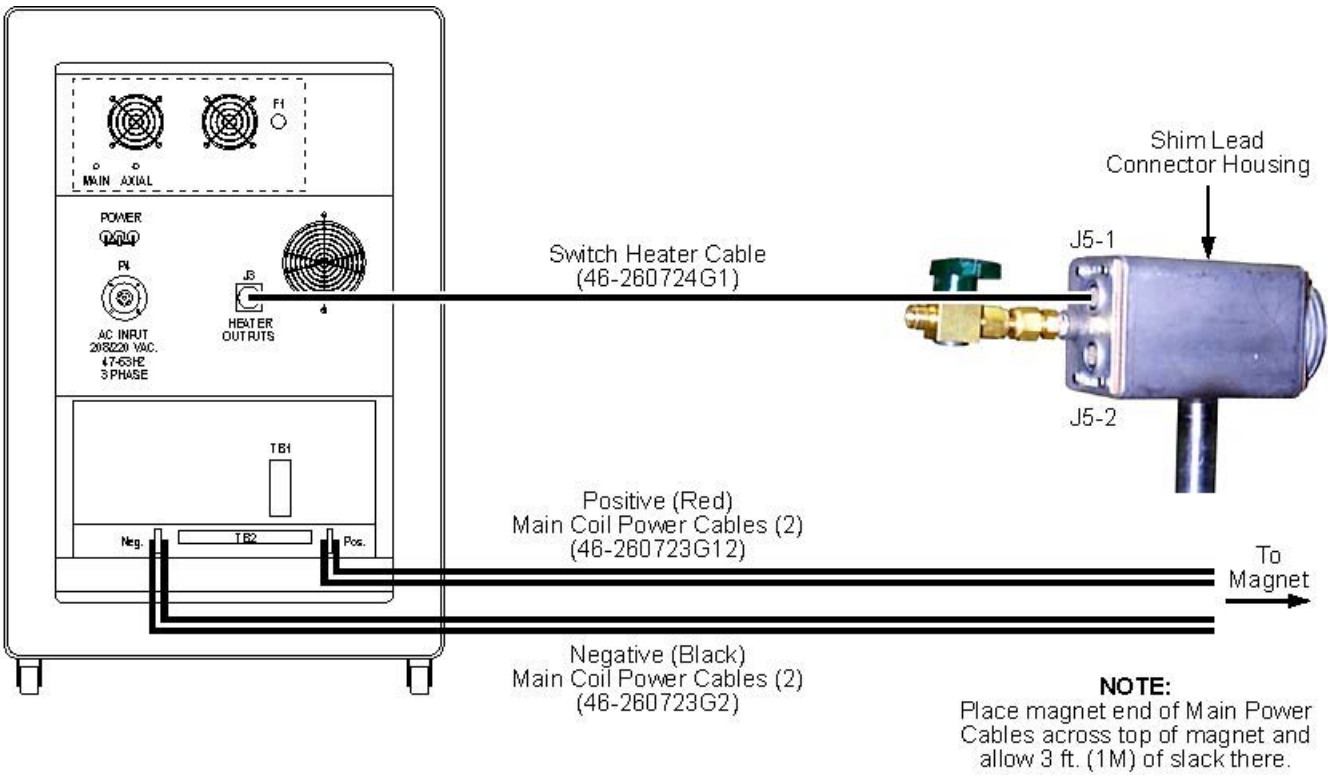
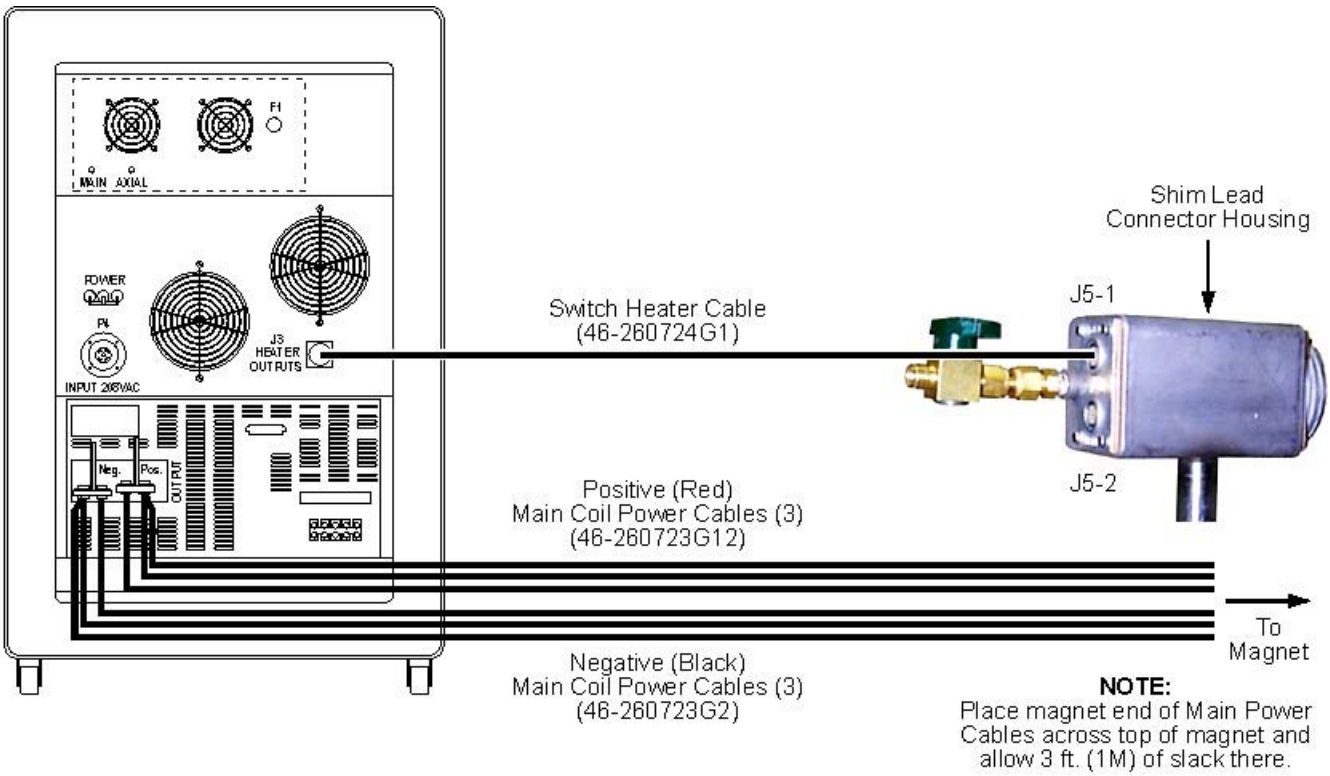


Illustration 3-78: Magnet Power Supply Connections, 1,000 Amp Power Supply



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

The Main Lead Extensions used for the LCC magnet are the same as those used for other active shield magnets (SIV, SV and SX) but different than those used for non-active shield magnets (SII, SIII and Max). The LCC Main Lead Extensions have a helium flow hole seen from the Contact Band end of each Extension and are shorter than SIII Ramp Leads.

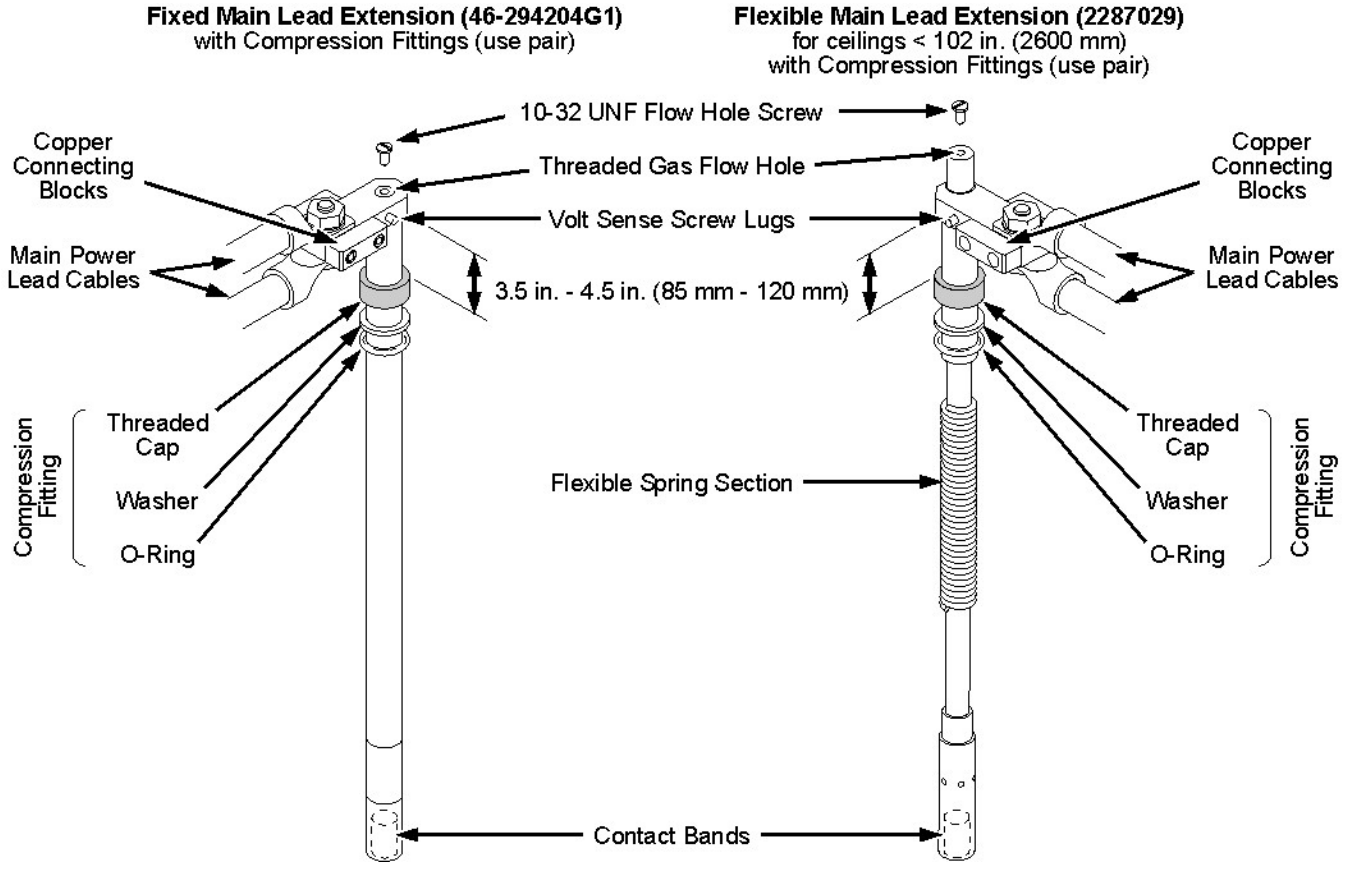
NOTICE

Make sure Main Lead Extensions 46-294204G1 are used for the Connections for Ramping and Shimming procedure when the ceiling height is > 103 inches (2616 mm). Use Flexible Main Lead Extensions 2287029 and the Ramp Lead Hold-Down Tool (2276755) in low ceiling height conditions. See Illustration 3-79.

3. Replace the Contact Bands on the Main Lead Extensions in conformance with Chapter 5, Section 4, Main Lead Extension Contact Band Replacement, before starting the ramp procedure. Make sure the gas flow holes are not blocked.

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

Illustration 3-79: Main Lead Extensions



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE PERFORMING THE FOLLOWING STEP.



WARNING

ASPHYXIATION HAZARD!
PROCEDURE GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR.
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE PERFORMING THE FOLLOWING STEP.



WARNING

POTENTIAL MAGNET QUENCH!
IMPROPER ENGAGEMENT/DISENGAGEMENT OF THE MAIN LEAD EXTENSIONS WITH THE MAIN LEAD PINS CAN CAUSE A RAMPED MAGNET TO QUENCH.
INSERT MAIN LEAD EXTENSIONS ONE AT A TIME AND, IF THE MAGNET IS AT FIELD, ALLOW THEM TO COOL SUFFICIENTLY (A FOG OR WATER VAPOR FORMS AROUND THE LEAD EXTENSIONS) BEFORE THEY CONTACT THE MAIN LEAD PINS.



WARNING

ELECTRICAL SHOCK HAZARD!
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT.
DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



WARNING

ELECTRICAL SHOCK HAZARD!
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.



WARNING

POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THIS CONNECTIONS FOR RAMPING AND SHIMMING PROCEDURE.
WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL MAGNET QUENCH!
MISWIRING CAN RESULT IN A MAGNET QUENCH.
TO PREVENT THE POSSIBILITY OF MISWIRING AND A RESULTANT QUENCH DURING FUTURE RAMPING OF THE MAGNET, RECORD CONNECTION POLARITIES IN CHAPTER 8, SECTION 5, MAGNET RAMPING AND PARKING CURRENT LOG.



CAUTION

Potential Magnet Quench
Contact between the brass bolts securing the power cables to the Main Lead Extensions 46-294204G1 and the Fill Port (V1) Cap can quench the magnet. Make sure the brass bolts are installed correctly.

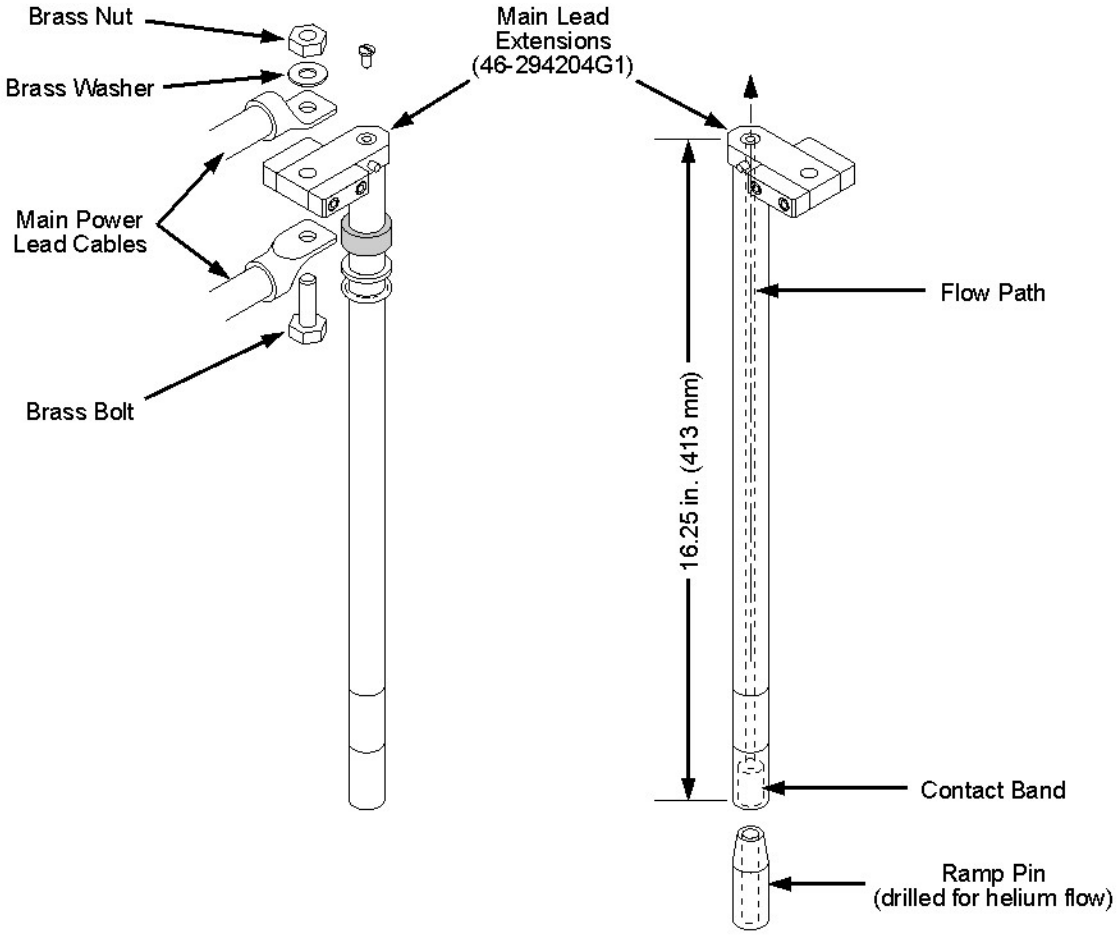
4. When using Fixed Main Lead Extensions 46-294204G1 (only), connect the other end of the Main Power Cables to the Main Lead Extensions with the 1 inch (25.4 mm) brass bolts as shown in Illustration 3-80. Secure the bolts with the brass nuts and brass washers provided. Tighten the connections sufficiently to provide a good electrical connection.

NOTE: Only use brass washers when connecting Main Leads to the Main Lead Extensions to keep voltage drop to a minimum.

NOTE: Main Lead connections for Flexible Main Lead Extensions 2287029 are made after lead insertion in Step 12.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-80: Hardware Mounting on Fixed Main Lead Extensions 46-294204G1

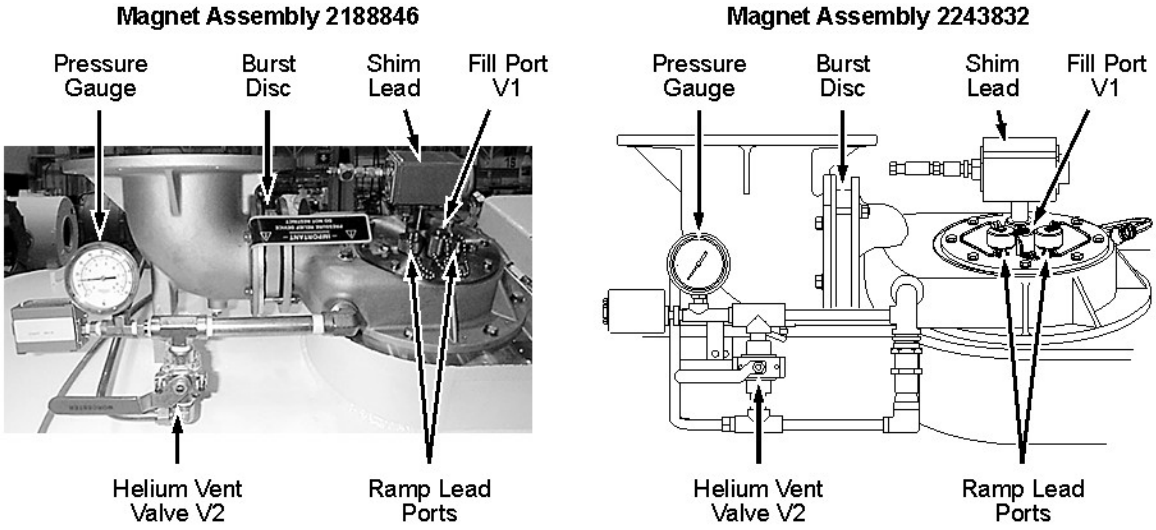


5. Install the 10-32UNF gas flow hole screws into the gas flow holes on each Main Lead Extension. See Illustration 3-80.

6. Open the vent valve V2 (Illustration 3-81); turn off the “C0BO" (Controlled Zero Boil-Off) heater on the Magnet Monitor, if in the “ON" position; and vent to < 0.5 psig. Then close vent valve V2.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-81: Helium Vent Plumbing

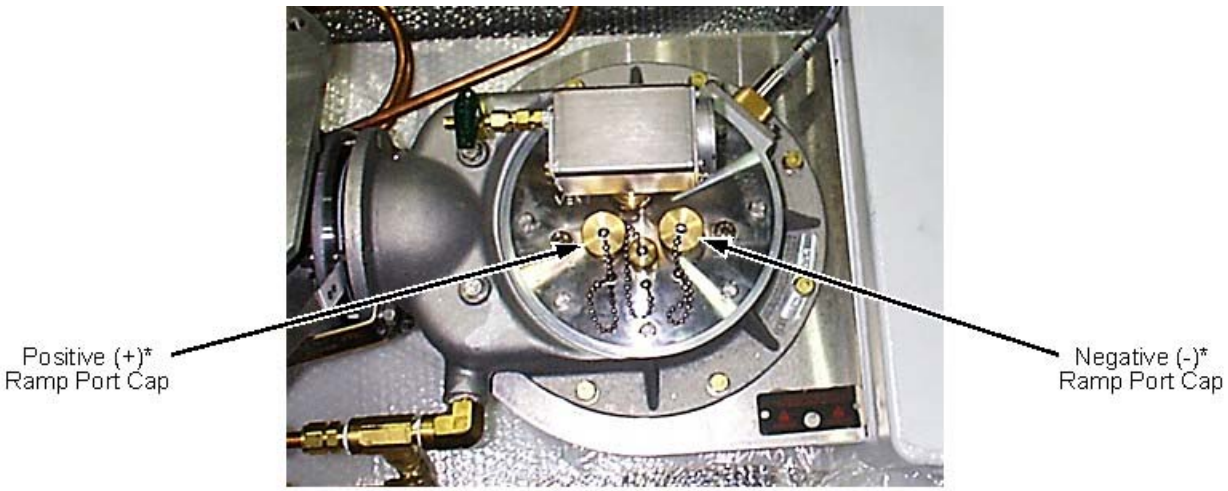


NOTICE

"Normal" ramp polarity has positive ("+") on the left and negative ("-") on the right as viewed from the Coldhead side of the magnet. "Reversed" ramp polarity has "+" on the right and "-" on the left as viewed from the Coldhead side of the magnet. If using Polarity Plate 2111737, make sure the plate properly indicates which polarity the magnet is to be ramped. Also make sure the chosen ramp polarity is recorded in Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

7. Remove the Positive (+) Ramp Port Cap located on the magnet's vertical stack. See Illustration 3-82. Make sure the gasket inside the cap does not get lost.

Illustration 3-82: Ramp Lead Port Polarities



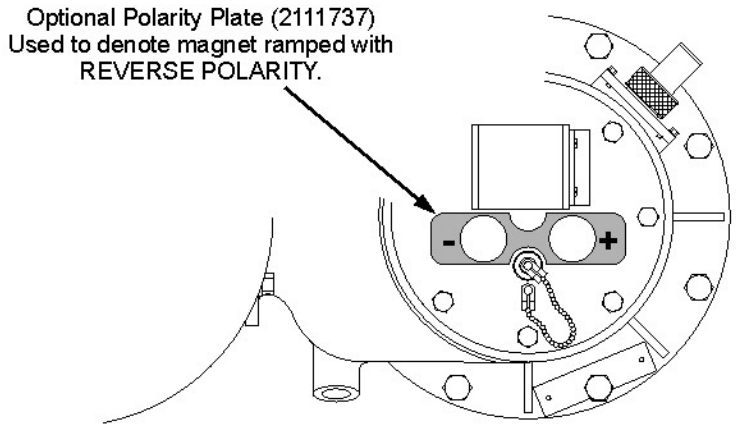
* Normal polarity shown.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTE: The optional Polarity Plate (2111737), shown in Illustration 3-83, is normally used only to indicate a reverse-ramped magnet. The plate can be ordered if desired.

Polarity Plate position is changed by 1) venting the magnet to 0.2 psig, 2) removing both Ramp Port Caps (shown in Illustration 3-82), 3) pulling the Polarity Plate up over the Ramp Ports, 4) reinstalling the plate to indicate the chosen polarity and 5) immediately replacing the Ramp Port Caps.

Illustration 3-83: Polarity Plate 2111737



NOTE: For a reverse-ramped magnet, reverse the connections in Step 8: Insert the Positive (red cables attached) Main Lead Extension into the "-" (Negative) Ramp Lead Port, and insert the Negative (black cables attached) into the "+" (Positive) Ramp Lead Port.

NOTICE

If using Flexible Main Lead Extensions 2287029, bend the lead extension to a 45° angle in order to clear the ceiling when inserting the lead in Step 8. Allow the flexible lead to straighten out and pre-cool before full insertion. The lead must be in its staight position to prevent cooling exhaust helium from escaping the coils.

8. Quickly insert the Positive (red cables attached) Main Lead Extension **less than halfway** into the open receptacle.

9. **Quickly** screw the Main Lead Extension compression nut onto the ramp port to prevent icing of the threads.

10. Loosely screw the compression nut onto the Ramp Lead Port. See Illustration 3-82 or Illustration 3-83 for correct connection polarities.

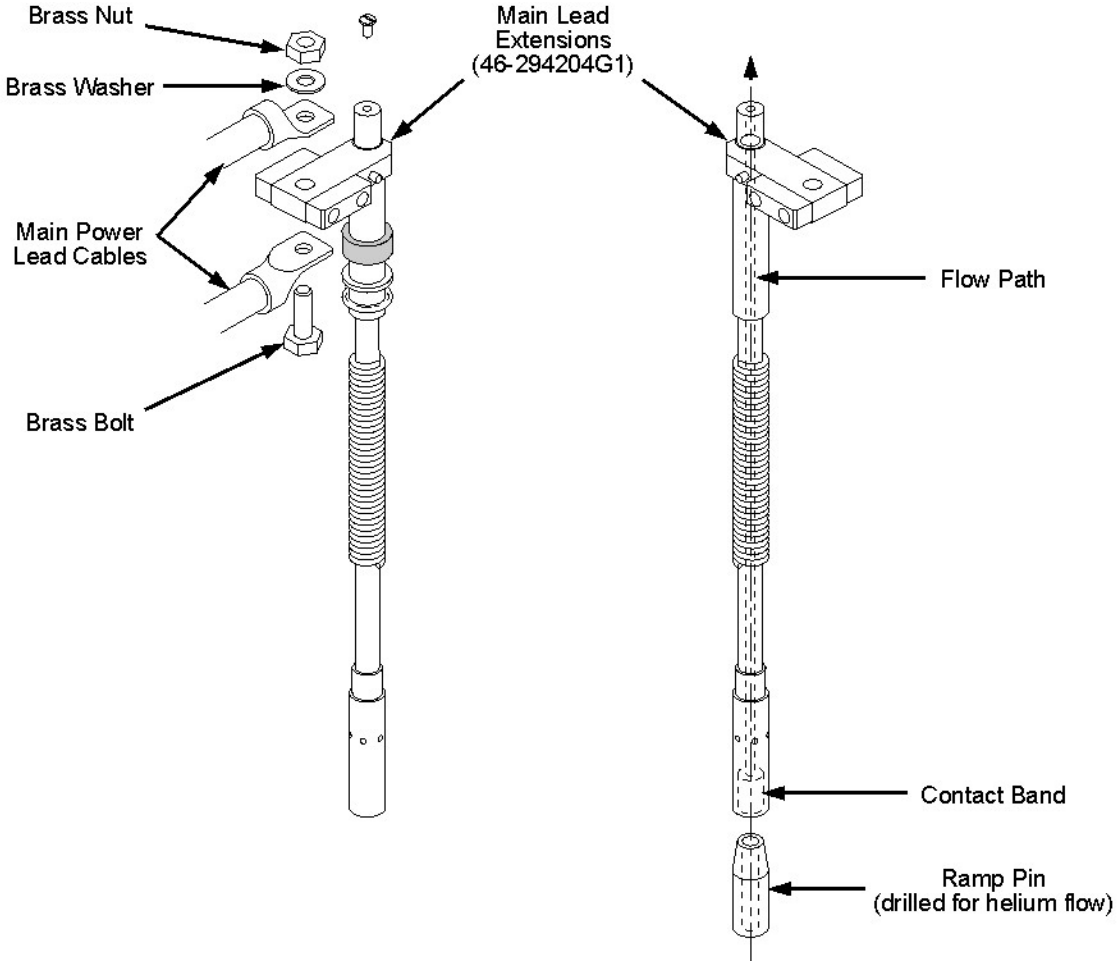
11. Repeat Step 7 through Step 10 for the other Main Lead Extension.

12. When using Flexible Main Lead Extensions 2287029 (only), connect the other end of the Main Power Cables to the Main Lead Extensions with the 1 inch (25.4 mm) brass bolts as shown in Illustration 3-84. Secure the bolts with the brass nuts and brass washers provided. Tighten the connections sufficiently to provide a good electrical connection.

NOTE: Only use brass washers when connecting Main Leads to the Main Lead Extensions to keep voltage drop to a minimum.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-84: Hardware Mounting on Flexible Main Lead Extensions 2287029



13. Connect the Voltage Sense Leads (shown in Illustration 3-79) to the outside edges of the Main Lead Extensions to allow for correct placement of the Ramp Lead Hold-Down Tool. Terminate the other end of the Voltage Sense Leads to a DVM or VOM placed near the Main Coil Power Supply.

14. Remove the flow hole screws. See Illustration 3-79.

WARNING

POTENTIAL MAGNET QUENCH!
IMPROPER ENGAGEMENT/DISENGAGEMENT OF THE MAIN LEAD EXTENSIONS WITH THE MAIN LEAD PINS CAN CAUSE A RAMPED MAGNET TO QUENCH. IF THE MAGNET IS AT FIELD, ALLOW THE MAIN LEAD EXTENSIONS TO COOL SUFFICIENTLY (A FOG OR WATER VAPOR FORMS AROUND THE LEAD EXTENSIONS) BEFORE THEY CONTACT THE MAIN LEAD PINS.

NOTICE

Make sure gas flow holes in the Main Lead Extension are not blocked and that helium gas is exiting the holes.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

15. When the Main Lead Extensions are sufficiently cooled, loosen the compression fittings and fully engage the Main Lead Extensions. Loosely screw the compression nut onto the Ramp Lead Ports.

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



⚠ CAUTION

Potential Magnet Quench
Excess power cable motion during ramping may disrupt contact between the Main Lead Extensions and the Main Lead Contact Pins. This can cause the magnet to quench.
Secure the Main Power Cables using Ty-Wraps and the Main Lead Extensions using a Ramp Lead Hold-Down Tool.



NOTICE

After installing the Main Leads, take the following steps to prevent power cable motion disrupting Main Lead Extension contact.

16. After installing the Main Leads, secure the Main Power Cables using Ty-Wraps (a field-supplied item). The cables should be secured to each other and to convenient fixed points, such as the shroud rails, to prevent their movement.

NOTE: Using a Ramp Lead Hold-Down Tool is required to minimize motion of the Main Leads and aid in getting good contact resistance.

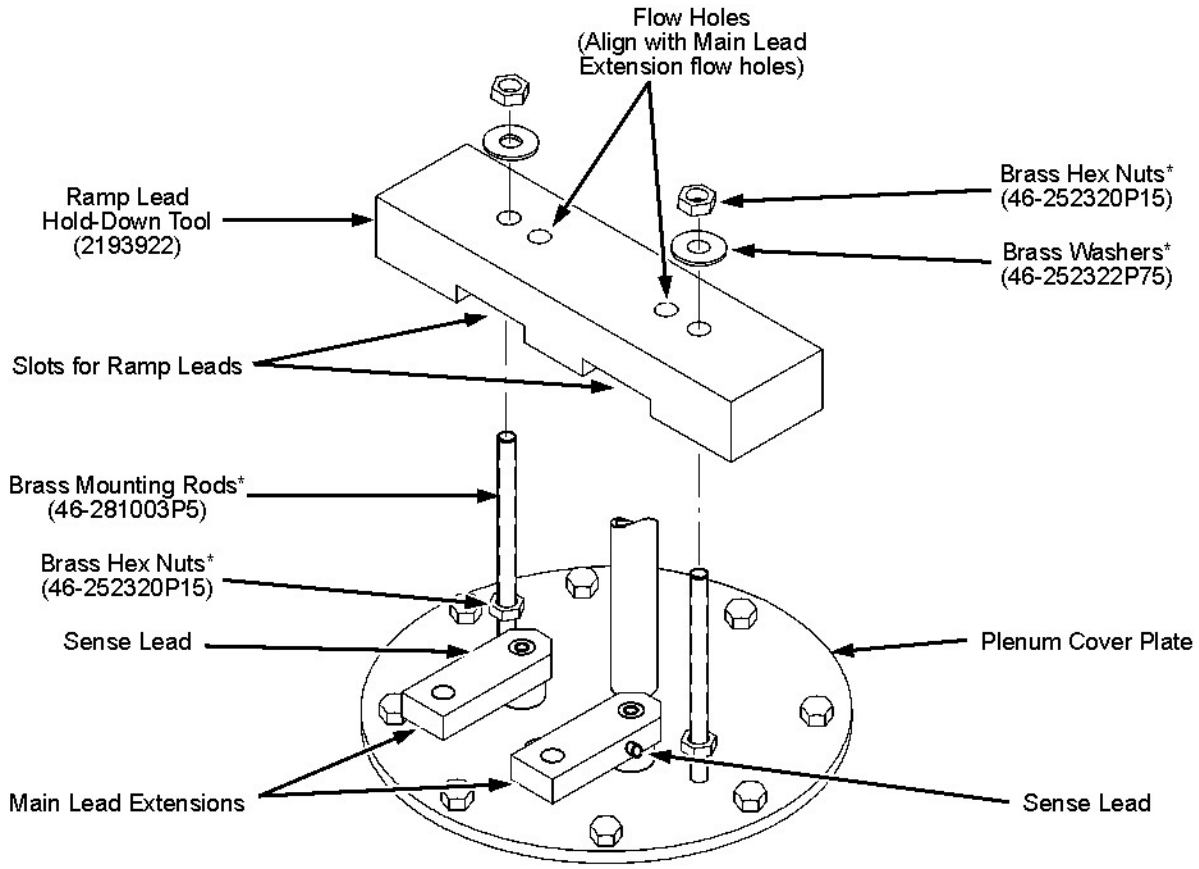
17. Install a Ramp Lead Hold-Down Tool (2193922 with Fixed Main Lead Extensions or 2276755 with Flexible Main Lead Extensions):

    a. Make sure the heads of the Main Lead Extensions are oriented to match the grooves for them in the under side of the hold-down tool being used.

    b. Screw the mounting studs of the Hold-Down Tool into the mounting holes welded onto the Main Lead Base Plate. See Illustration 3-85.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-85: Hold-Down Tool Installation



* Hold-Down Tool Hardware Kit 2236233 is available. It includes threaded rods, nuts and washers.

c. Install the Hold-Down Tool onto the mounting bolts. Make sure that the Main Leads fit into the slots on the plate. See Illustration 3-85.

d. Tighten the Nuts on top of the Hold-Down Tool to lock the tool firmly in place and prevent Main Lead motion. While tightening the nuts, adjust the leveling screw to keep the tool level. See Illustration 3-85.

⚠ CAUTION

Potential Magnet Quench
Blocked Main Lead Extension vent holes can allow the voltage between the Main Lead Extensions and the Main Lead Contact Pins to drop. This can cause the magnet to quench.
Make sure the vent holes in the Main Lead Extensions are not blocked.

e. Verify that the vent holes in the Main Lead Extensions are not blocked.

6.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7 Ramping Magnet to Field

7.1 Ramping Overview

During the ramping process the magnet is energized to the magnetic field strength stated in the Acceptance Test Report (ATR) as the magnet's “Recommended Site Parking Field”.



NOTICE

The 1.0T LCC magnet must be parked to ± 0.5 Gauss of the “Recommended Site Parking Field” provided in the magnet's ATR (Acceptance Test Report).

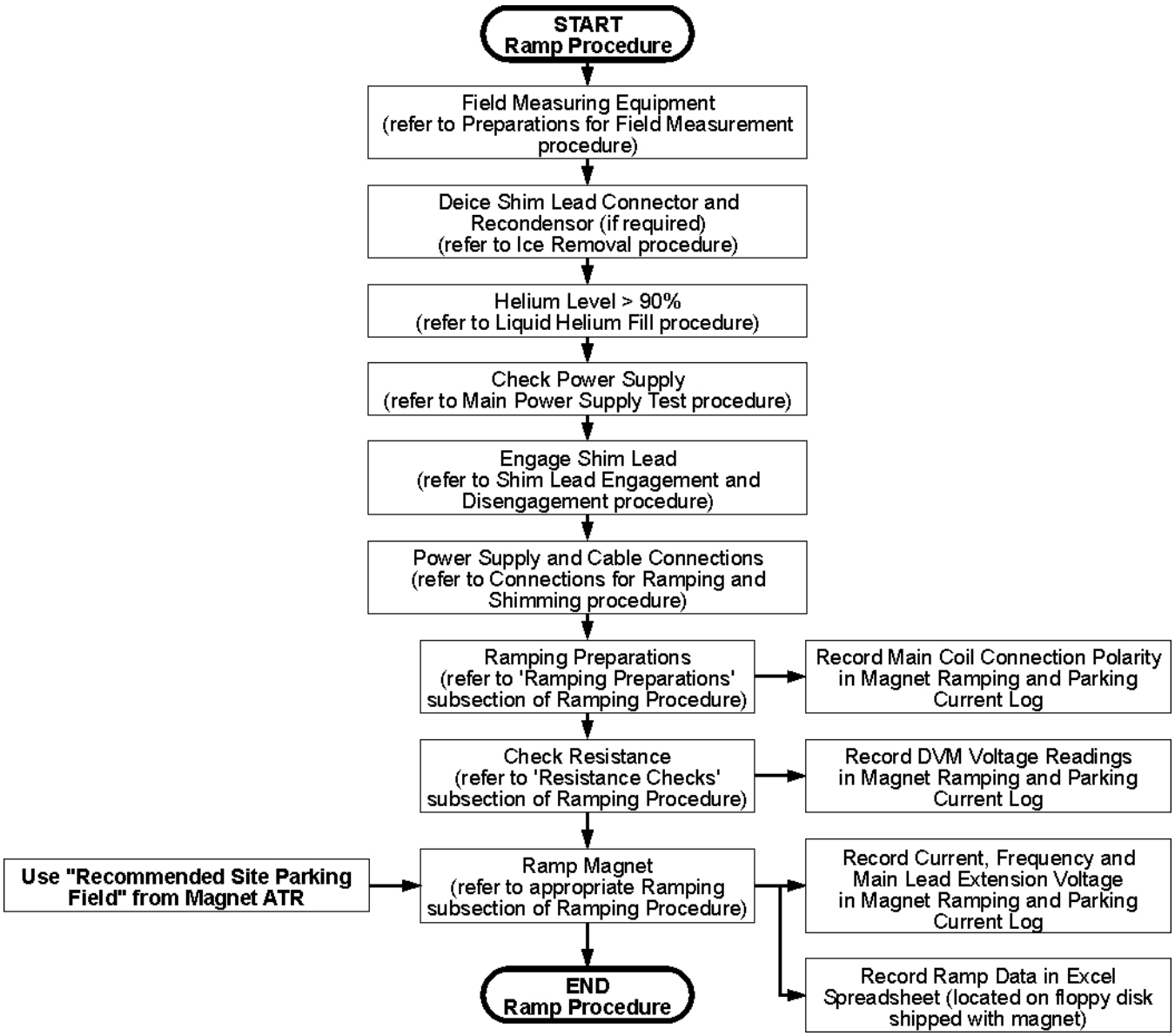
LCC magnets are ramped using voltage control to a nominal current of 736 amps for 1.0T LCC's or 740 amps for 1.5T LCC's. Parking the magnet ± 0.5 Gauss of the “Recommended Site Parking Field” provided in the ATR (Acceptance Test Report) will result in a post-shimming (“Operational”) magnetic field strength as stated in Chapter 4, Section 1, Magnet Functional Checks.

A 750 Amp Ramp Cart/Cable Kit (2135435) or a 1000 Amp Ramp Cart/Cable Kit w/ Ground (2353394) plus a Field Shim Case & Cable Kit (2135558) are required to ramp and shim the magnet. Additionally, a MetroLab Teslameter Kit (46-251865G4) is required, although Universal Field Mapping Fixture 46-294060G4 is not required for ramping since only the overall magnetic field strength is monitored during ramping.

A flowchart of the ramping process is shown in Illustration 3-86.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-86: Ramp Flowchart



List of Procedures & Data Sheets Referenced	
Located in the Current Chapter	**Located in Other Chapters**
Section 4, Preparations for Field Measurement	Chapter 5, Section 9.2, Ice Removal
Section 3.2, Liquid Helium Fill	Chapter 4, Section 8.1, Main Power Supply Test
Section 5, Shim Lead Engagement and Disengagement	Chapter 8, Section 5, Magnet Ramping and Parking Current Log
Section 6, Connections for Ramping and Shimming	
'Ramping Preparations' subsection of Section 7.2, Ramping Procedure	
'Resistance Checks' subsection of Section 7.2, Ramping Procedure	
Use 'Ramping Procedure Selection' subsection of Section 7.2, Ramping Procedure, to determine subprocedure to use.	

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7.2 Ramping Procedure

7.2.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	6 hours	Included in 'Procedure'

7.2.2 Preliminary Requirements

7.2.2.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Digital Voltmeter (DVM)	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
750 Amp TCR 7.5T750 Main Power Supply 46-260776G3 or 1000 Amp ESS 7.5-1000-2-D-1236 Main Power Supply 46-260776G4	1	-	46-260776G3 or 46-260776G4	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
750 Amp Ramp Cable Kit 2135435 or 1000 Amp Ramp Cable Kit w/ Ground 2353394	1	-	2135435 or 2353394	-
Superconducting Shim Coil Power Supply (mobile sites only)	1	-	46-260777G3	-
Field Shim Cable Kit (if not already ordered with the magnet)	1	-	2135558	-
Fixed Main Lead Extension 46-294204G1 or Flexible Main Lead Extension 2287029 (for low ceiling height sites)	1	-	46-294204G1 or 2287029	-
Hold-Down Tool 2193922 or Hold-Down Tool, Short 2276755 (for low ceiling height sites)	1	-	2193922 or 2276755	-
Retractable Shim Lead Assembly 2173354 or Retractable Shim Lead Assembly, Short 2285073 (for low ceiling height sites)	1	-	2173354 or 2285073	-
MetroLab Teslameter Kit	1	-	46-251865G4	-
#5 MetroLab Probe (included in MetroLab Teslameter Kit 46-251865G4)	1	-	46-255839P104	-
Portable Leak Detector (optional)	1	-	2270571	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7.2.2.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Leak detection fluid (e.g., Snoop, Bird Dog Quart Spray (p/n DOG-1Q), Big Blue (p/n Rt100S or Rt100G) or Leak-Tec)	1	-	-	-

7.2.2.3 Replacement Parts

No replacement parts required.

7.2.2.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE RAMPING PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR RAMPING IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING THE RAMPING PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE RAMPING PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL PROJECTILE HAZARD
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.

- **REMOVE ALL LOOSE FERROMAGNETIC MATERIAL FROM THE MAGNET ROOM. MAKE SURE ALL EQUIPMENT AND TOOLS USED IN THE MAGNET ROOM ARE NON-FERROMAGNETIC.**
- **LOCATE POWER SUPPLIES AS FAR AWAY FROM THE MAGNET AS THE CABLES AND ROOM GEOMETRY ALLOWS.**
- **DO NOT ALLOW ANYONE CARRYING FERROMAGNETIC MATERIALS — INCLUDING CARDIAC PACEMAKERS, NEUROSTIMULATORS OR STEEL PLATES — INSIDE THE 5 GAUSS ZONE.**



WARNING

HIGH MAGNETIC FIELD
CARDIAC PACEMAKERS, NEUROSTIMULATORS (OR OTHER BIOSTIMULATORS), STEEL PLATES AND FERROMAGNETIC MATERIAL, EQUIPMENT AND TOOLS WILL BE ADVERSELY EFFECTED BY THE STRONG MAGNETIC FIELD.

- **NOTIFY SITE ADMINISTRATION BEFORE RAMPING THE MAGNET THAT ALL MAGNETIC SAFETY PRECAUTIONS MUST BE TAKEN.**
- **POST WARNING SIGNS OUTSIDE THE 5 GAUSS ZONE TO ALERT PERSONNEL WITH CARDIAC PACEMAKERS, NEUROSTIMULATORS OR OTHER BIOSTIMULATORS 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 CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS.**
- **POST “RAMPED MAGNET” AND “AUTHORIZED PERSONNEL ONLY” WARNING SIGNS AT THE MAGNET ROOM ENTRANCE AND AT THE MR SUITE ENTRANCE, RESPECTIVELY, PRIOR TO RAMPING THE MAGNET. WARNINGS ARE TO ALERT PERSONNEL THAT NO FERROMAGNETIC MATERIAL OR INDIVIDUALS WITH CARDIAC PACEMAKERS, NEUROSTIMULATORS OR STEEL PLATES ARE ALLOWED IN THE MAGNET ROOM WHEN THE MAGNET IS RAMPED.**



WARNING

ASPHYXIATION HAZARD!
THE RAMPING PROCEDURE GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR.
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE STARTING THE RAMPING PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

EXPLOSION HAZARD!
LIQUID CRYOGENS CAN LIQUIFY ATMOSPHERIC OXYGEN, PRODUCING A HIGHLY COMBUSTIBLE OXYGEN LIQUID.
NO SMOKING IN MAGNET AND CRYOGEN STORAGE ROOMS!



WARNING

HIGH MAGNETIC FIELD
BE PREPARED FOR EMERGENCIES
MAKE SURE THE MAGNET RUNDOWN UNIT (MRU) IS INSTALLED AND OPERATIONAL TO ENABLE THE MAGNETIC FIELD TO BE QUICKLY DISCHARGED IN CASE OF AN EMERGENCY. SEE SECTION 1.6.



WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH, RAPIDLY RELEASING CRYOGENIC GASES, IF ITS LIQUID HELIUM LEVEL DROPS TOO LOW DURING THE RAMPING PROCEDURE.
MAKE SURE THE MAGNET ≥ 90% FULL OF LIQUID HELIUM BEFORE STARTING THE RAMPING PROCEDURE.



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE RAMPING PROCEDURE.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN PERFORMING THE RAMPING PROCEDURE.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7.2.2.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting the Ramping Procedure.	Chapter 1, Section 2	-
The removal of some magnet enclosure components may be required to complete the Ramping Procedure. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with the Ramping Procedure if cover removal is required.	Chapter 5, Section 5	-
(continued)	Appendix A, Section 1.1	-
The Shim Lead Connector must be free of ice. Perform Shim Lead Connector checks in conformance with Chapter 4, Section 5, Magnet Electrical Checks. If an ice blockage is found, deice in conformance with the Shim Lead Connector and Vertical Penetration Deicing subsection of Chapter 5, Section 9.2, Ice Removal.	Chapter 4, Section 5	-
(continued)	Chapter 5, Section 9.2	-
Purge the Recondenser with helium gas in conformance with the Level Three Deicing subsection of Chapter 5, Section 9.2, Ice Removal.	Chapter 5, Section 9.2	-
Make sure the liquid helium level is ≥ 90% before starting the Ramping procedure.	Section 3.2	-
Make sure the magnet room exhaust fan is on and operational before starting the Ramping procedure.	-	-
Make sure the magnet room door is propped open — or the hatch is opened if a mobile van — before starting the Ramping procedure.	-	-

7.2.3 Procedure

7.2.3.1 Ramping Preparations

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Make sure Magnet Monitor's Level 1 and Level 2 helium level readings are approximately equal. If problems are found, troubleshoot before ramping.

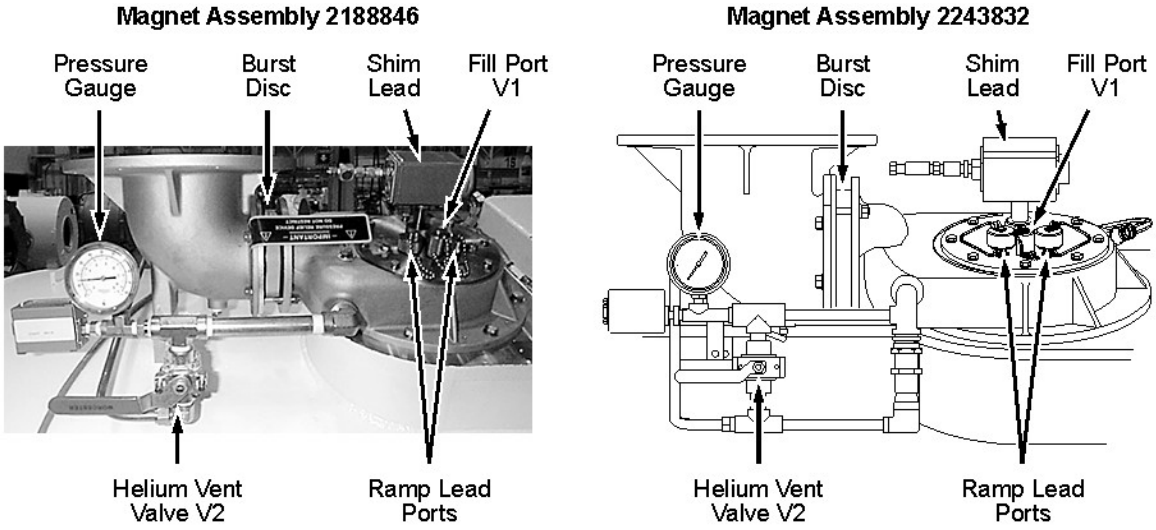
NOTE: Refer to Direction 2230681, GEMS Magnet Monitoring Hardware (SHEM) Installation, if Magnet Monitor calibration is required.

2. Set up the MetroLab Teslameter (46-255839P2) and a #5 Teslameter Probe (46-255839P104), for general magnetic field strength monitoring in conformance with Section 4, Preparations for Field Measurement.

3. Check for ice on the Shim Lead Connector and the Recondensor. Deice in conformance with the Shim Lead Connector and Vertical Penetration Deicing subsection of Chapter 5, Section 9.2, Ice Removal, before ramping the magnet.

4. Make sure the magnet is > 90% full of helium and Vent Valve V2 (Illustration 3-87) is closed before ramping the magnet. If necessary, fill the magnet in conformance with Section 3.2, Liquid Helium Fill.

Illustration 3-87: Helium Vent Plumbing



CAUTION

Potential Magnet Quench
The magnet may quench if the Main Power Supply experiences large output fluctuations and/or excessive ripple.
Make sure the Main Power Supply is routinely calibrated at an approved facility.

5. Make sure that the Main Power Supply is installed, checked and adjusted in conformance with the vendor manual supplied with the unit and either Chapter 4, Section 8.2, TCR 7.5T750 Main Power Supply Tests, for 750 amp power supplies or Chapter 4, Section

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8.3, ESS7.5-1000-2-D-1236 Main Power Supply Tests, for 1000 amp power supplies, as appropriate.

6. Make sure the Shim Lead Assembly is “Engaged" in conformance with Section 5, Shim Lead Engagement and Disengagement.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

7. Disconnect and lockout/tagout input power to the Main Power Supply (as well as the Shim Power Supply used at mobile sites). Verify that no voltage is present by using a DVM or equivalent measuring device.



⚠ WARNING

POTENTIAL MAGNET QUENCH!
IMPROPER ENGAGEMENT/DISENGAGEMENT OF THE MAIN LEAD EXTENSIONS WITH THE MAIN LEAD PINS CAN CAUSE A RAMPED MAGNET TO QUENCH. INSERT MAIN LEAD EXTENSIONS ONE AT A TIME AND ALLOW THEM TO COOL SUFFICIENTLY (A FOG OR WATER VAPOR FORMS AROUND THE LEAD EXTENSIONS) BEFORE THEY CONTACT THE MAIN LEAD PINS.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT. DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



⚠ WARNING

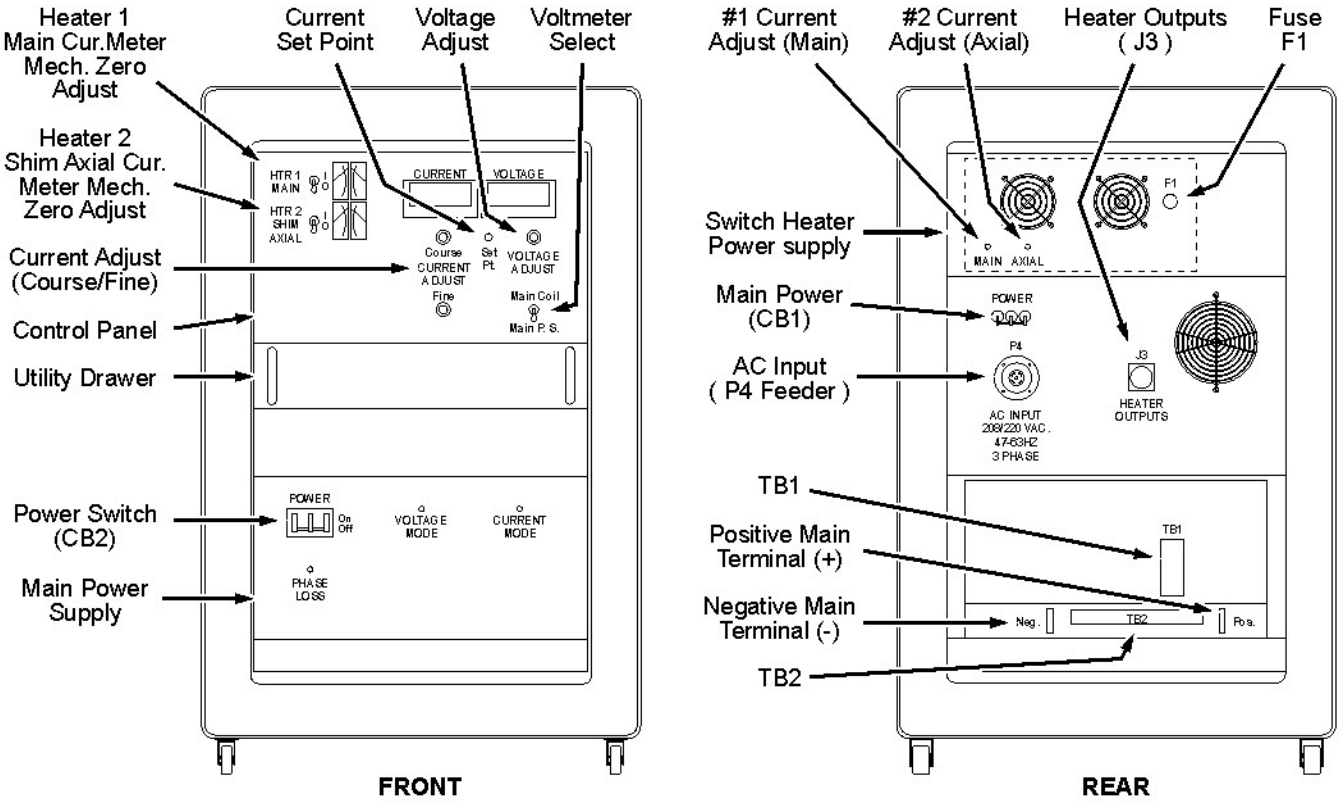
POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE RAMPING PROCEDURE.
WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.

8. Connect the Main Power Supply — as well as the Shim Power Supply at mobile sites — to the magnet by making all cable connections in conformance with Section 6, Connections for Ramping and Shimming.

9. Record the Main Coil connection polarity in Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

10. Set all heater switches on the power supply (Illustration 3-88: 750 amp Main Power Supply; Illustration 3-89: 1000 amp Main Power Supply; Illustration 3-90: Shim Power Supply (used at mobile sites only)) to the “OFF" position. Set the Current Adjust and Voltage controls to zero (full CCW).

Illustration 3-88: 750 Amp TCR 7.5T750 Superconducting Main Coil Service Power Supply Cabinet (46-260776G3)



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-89: ESS7.5-1000-2-D-1236 Superconducting Main Coil Service Power Supply Cabinet (46-260776G4)

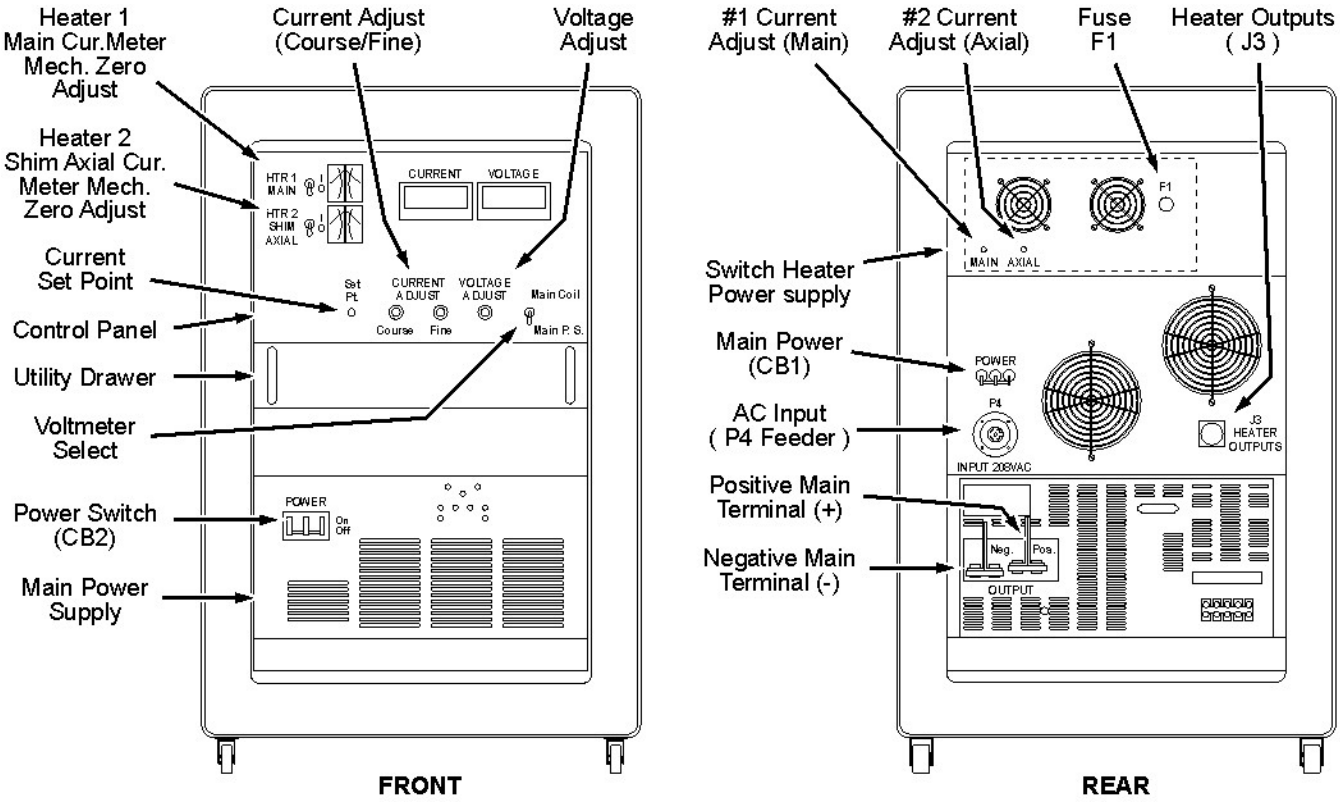
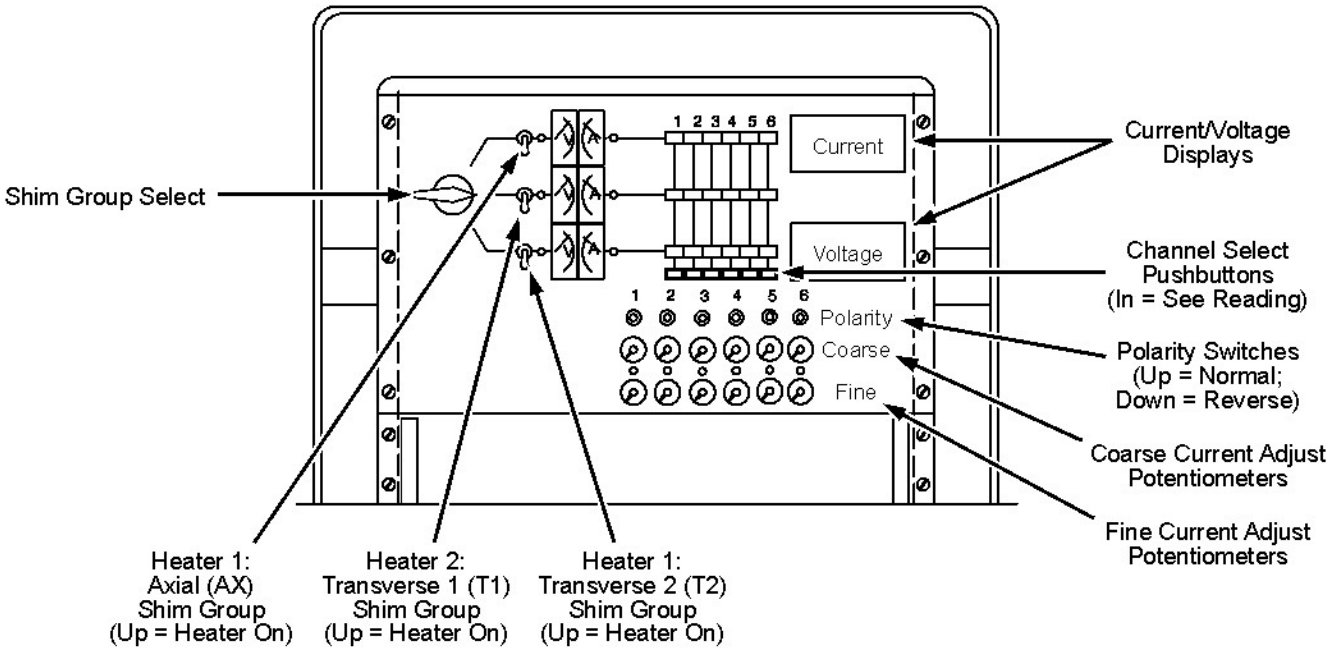


Illustration 3-90: Shim Power Supply Controls (Front Panel)



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

11. Remove lockout/tagout and connect input power to the Main Power Supply (and to the Shim Power Supply at mobile sites).

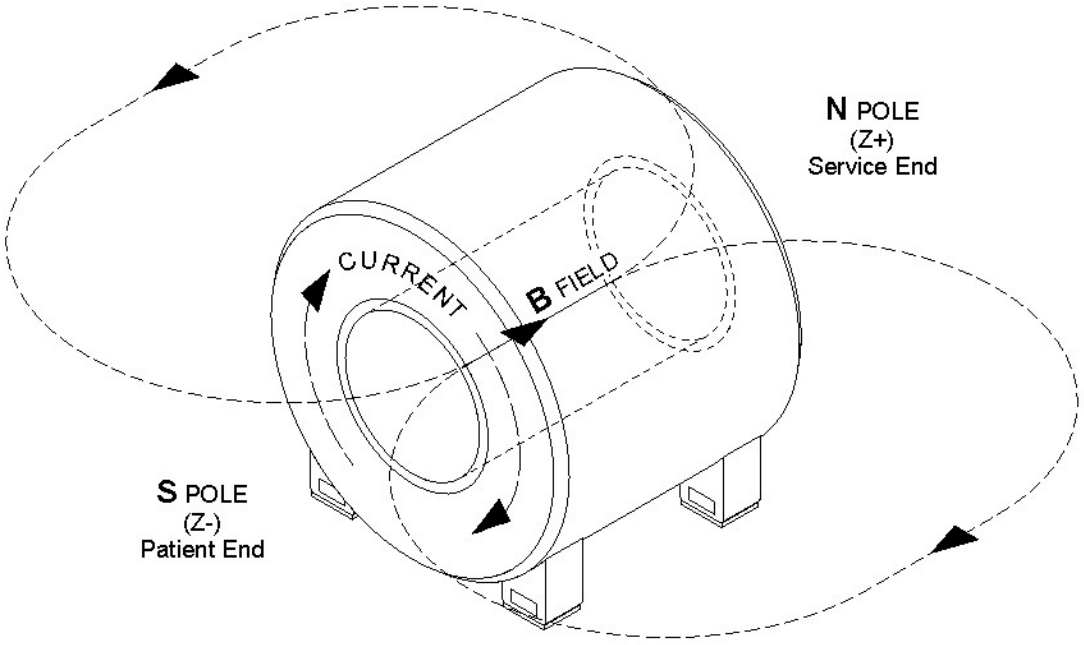
7.2.3.2 Resistance Checks

1. If the magnet is not at field, check Switch Heater and Shim Coil resistances in conformance with Chapter 4, Section 5, Magnet Electrical Checks.

2. Make sure the Current Adjust and Voltage Adjust controls on the Main Power Supply are “OFF" (full CCW).

NOTE: All main coil driving voltages provided in this Magnet Rampdown to Zero Field procedure are the same in overall magnitude regardless of the magnet having normal or reverse polarity. Normal polarity is shown in Illustration 3-91.

Illustration 3-91: Magnet Polarity Ramped Normal



3. Set the Main Power Supply's Main Power and Power On switches to “ON."

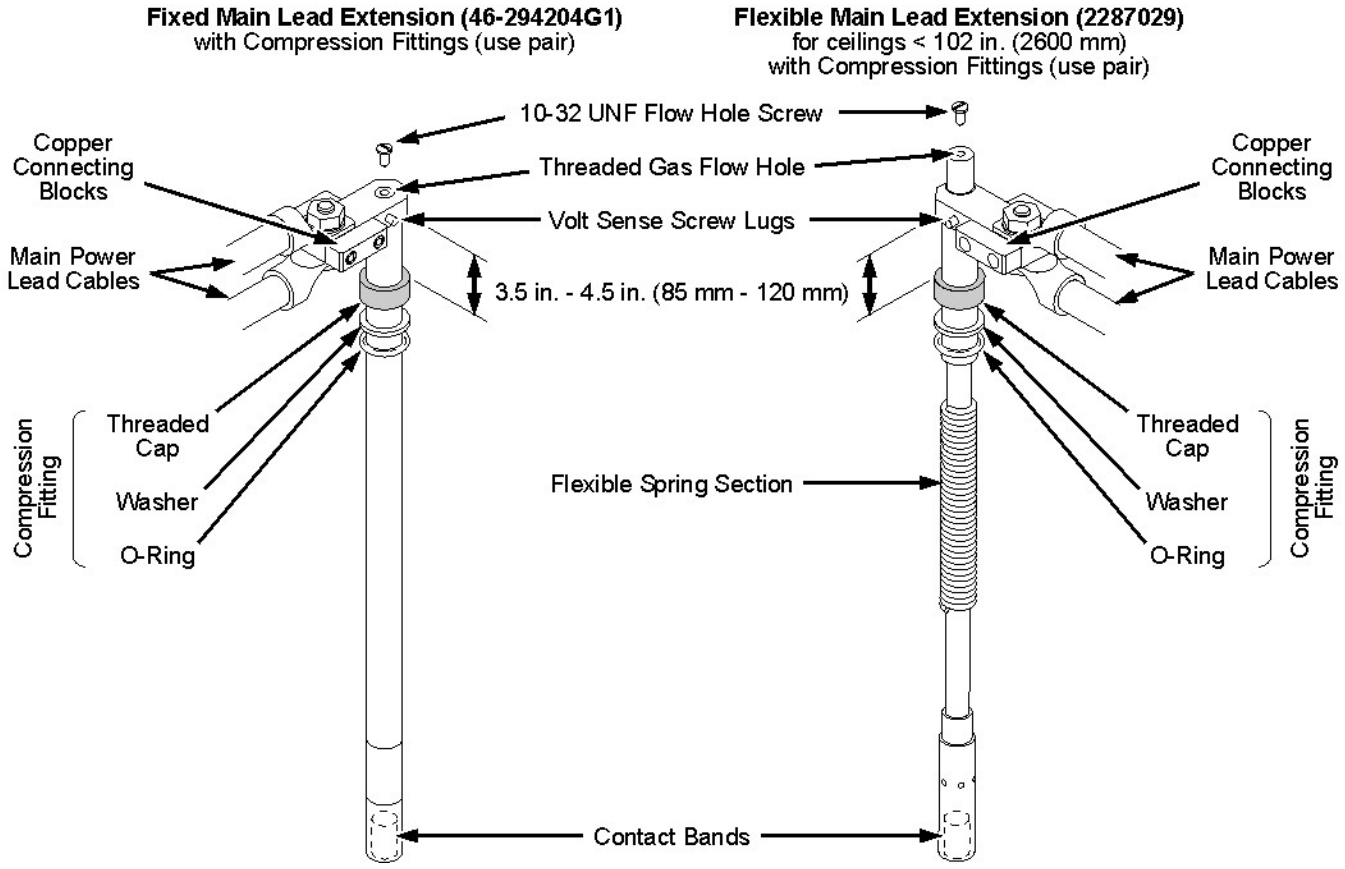
NOTE: There are duplicate Main Power and Power On switches on the front and back of the Main Power Supply.

4. Make sure the Main Heater Switch is off, then set the Heater 2 Shim Axial Switch to “I" (on) and observe the current rise in the Main Power Supply Ammeter (800 mA - 820 mA) to verify circuit continuity.

5. Connect a Digital Voltmeter (DVM) to the end of the Voltage Sense Leads. See Illustration 3-92.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-92: Main Lead Extensions



6. Set the Current Adjust Coarse Control on the power supply to maximum (full CW). See Illustration 3-88 for the 750 amp power supply and Illustration 3-89 for the 1000 amp power supply.

7. Observe the Main Power Supply Ammeter and slowly turn the Voltage Adjust Control clockwise to set a 750 amp current through the Main Leads, Main Lead Extensions and persistent Main Switch.

8. Record the voltage reading on the DVM in the Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

⚠ CAUTION

Potential Magnet Quench
Voltage readings > 150 millivolts at 750 amps indicate unacceptable internal contact resistance at the Main Lead Extensions. Higher resistances will add more heat to the magnet, increasing boiloff and possibly causing a quench during ramping. Make sure the voltage readings are ≤ 150 mV at 750 amps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

9. If the DVM voltage is > 150 millivolts, perform one or more of the following to reduce contact resistance:

   a. Wait approximately 1 minute with current running, readings may drop as the Main Lead Extensions cool.

   b. Tighten the nuts (one flat at a time) on top of the Hold-Down Tool while measuring DVM readings.

   c. If the reading still exceeds 150 mV:

      i. Turn the Voltage and Current Adjust Controls to zero (full CCW).



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

      ii. Turn off the Main Power Supply input power. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

      iii. Check and tighten the bolts securing the Ramp Cables to the Power Supply and Main Leads Extensions.

      iv. Remove lockout/tagout and reconnect input power to the power supply.

   d. Repeatedly failing the contact resistance check may indicate one of the following:

      - The Main Lead Extension Contact Bands replaced as directed Section 6, Connections for Ramping and Shimming, in are not performing correctly and need replacing in conformance with Chapter 5, Section 4, Main Lead Extension Contact Band Replacement.
      - The Main Leads are damaged and need replacing.

   e. If changes are made in Step 9, repeat Step 6 through Step 9.

NOTE: Do not continue to Step 10 until after the DVM voltage is < 150 mV.

10. Set the power supply's Voltmeter Select Switch to the “MAIN POWER SUPPLY” position. This will display the output at the output lugs of the power supply monitored. A voltage < 2.2 V at 750 A indicates acceptable system resistance. If the voltage exceeds 2.2 V during the test, follow the procedures in Step 9 for decreasing contact resistance.

11. Gradually increase the Voltage Adjust Control to pass 750 A through the Main Power Leads, Lead Extensions and persistent Main Switch while observing the power supply's Voltmeter. If the voltage exceeds 2.2 V, then retighten the bolts securing the Ramp Cables to the Power Supply and Main Lead Extensions.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

12. Turn the Current Adjust and Voltage controls off (full CCW).

7.2.3.3 Ramping

7.2.3.3.1 Ramping Procedure Selection

Each magnet **MUST** be ramped in conformance with the subprocedure specific to that magnet.



WARNING

POTENTIAL QUENCH HAZARD
RAMPING A LCC MAGNET USING AN INCORRECT RAMPING PROFILE MAY CAUSE A MAGNET QUENCH.
MAKE SURE THE CORRECT RAMPING PROFILE FOR THE MAGNET MODEL AND SITE APPLICATION FROM THE TABLE BELOW IS FOLLOWED.

1. For 1.0T LCC magnet ramping:

   - Use Section 7.2.3.3.2, 1.0T Fixed Site Ramping, to ramp fixed site Q Series 1.0T LCC magnets (magnet model 2226333).
   - Use Section 7.2.3.3.4, 1.0T QR Series Ramping, to ramp QR Series 1.0T LCC magnets (magnet model 2243334).
   - Use Section 7.2.3.3.5, 1.0T Mobile Site Ramping, to ramp mobile site Q Series 1.0T LCC magnets (magnet model 2226334).
   - Use Section 7.2.3.3.7, 1.0T YQ Series Ramping, to ramp YQ Series 1.0T LCC magnets (Fixed Site: magnet model 2226333-2; Mobile Site: magnet model 2226334-2).

2. For 1.5T LCC magnet ramping:

   - Use Section 7.2.3.3.3, 1.5T Fixed Site Ramping, to ramp fixed site R and RA Series 1.5T LCC magnets (magnet model 2226300).
   - Use Section 7.2.3.3.6, 1.5T Mobile Site Ramping, to ramp mobile site R and RA Series 1.5T LCC magnets (magnet model 2226322).
   - Use Section 7.2.3.3.8, 1.5T YR Series Ramping, to ramp YR Series 1.5T LCC magnets (Fixed Site: magnet model 2226300-2; Mobile Site: magnet model 2226322-2).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7.2.3.3.2 1.0T Fixed Site Ramping



⚠ WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH AND THE COILS BECOME DAMAGED IF THE AXIAL SWITCH HEATERS ARE NOT "ON" DURING RAMPING.
MAKE SURE THE AXIAL SHIM SWITCH HEATERS ARE "ON" DURING RAMPING TO PREVENT COIL DAMAGE AND A MAGNET QUENCH. (GE POWER SUPPLIES HAVE PROTECTIVE CIRCUITRY TO PREVENT RAMPING VOLTAGE WITH THE AXIAL HEATER SWITCH IN THE "OFF" POSITION.)



⚠ CAUTION

Potential Magnet Quench
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.
If a quench occurs during ramping, immediately:

1. **Turn the Main Power Supply Voltage and Current Controls to zero (fully CCW),**
2. **Turn off the Power Supply,**
3. **Leave the room and**
4. **Turn off the Cryocooler Compressor outside the magnet room. Do not reenter the magnet room until the quench is over.**

NOTE: Ice will form around the flow holes in the Ramp Lead Hold-Down Tool during ramping. Remove ice as needed to maintain helium gas flow.

1. Make sure the power supply controls are set as follows:
   - Voltage Adjust Control: **zero (full CCW)**
   - Current Adjust Control: **maximum (full CW)**
   - Main Power Switches on the Main Power Supply: **"ON"**
   - Heater 2 Shim Axial Switch on the Main Power Supply: **"I" (ON)**
   - Voltmeter Select Switch on the power supply: **"Main Coil" position**

NOTE: Power supply controls are shown in Illustration 3-88 and Illustration 3-89.

2. Set the Heater 1 Main Switch to "I" (on). Wait 3 minutes.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. Use a Range 5 Teslameter Probe (46-255839P104) to monitor magnetic field strength. The probe will lock on when magnet current rises to approximately 515 amps. This usually occurs between 0.6 Tesla and 0.7 Tesla (25.545900 MHz - 29.803550 MHz).

4. Ramp the magnet in conformance with Table 3-12 as follows:

   a. Slowly turn the power supply's Voltage Control to obtain the Main Coil (Ramp) Voltage value shown in the table, starting with 5.00 volts.

   b. Allow the voltage to decay over the current interval shown in the table.

   c. Monitor the power supply's Current Meter. When the limit of the current range for the voltage setting is reached, slowly turn the Voltage Control to obtain the Main Coil Voltage for the next current range.

Table 3-12: 1.0T Fixed Site Ramping Profile

"Stage"	Main Coil (Ramp) Voltage	Main Coil (Ramp) Current Range	Magnetic Field Strength Reached
1	5.00 Volts	0 Amps - 100 Amps	—
2	4.60 Volts	100 Amps - 200 Amps	
3	4.20 Volts	200 Amps - 300 Amps	
4	3.80 Volts	300 Amps - 400 Amps	
5	3.30 Volts	400 Amps - 500 Amps	
6	2.50 Volts	500 Amps - 550 Amps	
7	2.00 Volts	550 Amps - 600 Amps	
8	1.50 Volts	600 Amps - 625 Amps	
9	1.00 Volts	625 Amps - 650 Amps	
10	0.75 Volts	650 Amps - 675 Amps	
11	0.60 Volts	675 Amps - 700 Amps	
12	0.50 Volts	700 Amps - 720 Amps	
13	0.30 Volts	720 Amps - 730 Amps	
14	Slowly lower from 0.30 Volts to 0.10 Volts	730 Amps	
15	0.10 Volts	—	0.999 Tesla
16	Set voltage as required to maintain constant field	**Use "Recommended Site Parking Field" frequency stated in ATR**	

5. When the Main Coil (Ramp) Current reaches 200 amps, estimate the system inductance by measuring current change over a 10 second ramping interval:

$$L_{Inductance} = 10 \times Voltage / Current\ Change$$

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

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6. If inductance (L) is outside the range of 4.8 henries - 5.2 henries, discontinue ramping, measure main coil resistance in conformance with Chapter 4, Section 5, Magnet Electrical Checks, and contact your regional MAC Team representative.



WARNING

POTENTIAL MAGNET QUENCH!
1.0T LCC MAGNETS CAN BE QUENCHED IF LARGE CURRENT OR VOLTAGE CHANGES OCCUR NEAR PARKING.
ADJUST THE VOLTAGE CONTROL IN A SLOW, CONTINUOUS MOTION IN THE FOLLOWING STEPS.

7. When the magnet current reaches 730 amps, slowly lower the Voltage Adjust Control from 0.3 V to 0.1 V Main Coil Voltage.

8. When magnetic field strength reaches 0.999 Tesla, slowly adjust the Voltage Adjust Control to a 0.1 V Main Coil Voltage.

NOTE: The magnet's ATR gives the optimum magnet on-site parking field beside “Recommended Site Parking Field.” The parking field is generally 25 Gauss above the final magnetic field strength of 1.0T to compensate for correction coil currents.

9. Check the Teslameter reading and **slowly** adjust the Voltage Adjust Controls as required to bring the magnetic field to frequency shown on the ATR as the “Recommended Site Parking Field." The total current will be approximately 745 amps. Allow the magnetic field to stabilize. The last two digits on the Teslameter should be the only digits changing.

10. Maintain the magnetic field at Step 9's setting for 5 minutes before proceeding to Step 11.

NOTE: Observe the Power Supply Voltmeter reading with the Voltmeter Select Switch in “Main Coil” position. When the switch goes 'persistent' the voltage across the magnet terminals will stabilize at 0.00 V.

11. Turn off the Main Switch Heater. Wait a minimum of 15 minutes for the switch to fully cool and go 'persistent.'

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



⚠ WARNING

POTENTIAL MAGNET QUENCH!
INCORRECT MAIN COIL CONNECTION POLARITY AND RAMPING CURRENT SETTINGS AT A LATER DATE CAN RESULT IN A MAGNET QUENCH WHEN THE MAIN POWER SUPPLY SWITCH IS TURNED ON.
WHEN CHANGING MAGNETIC FIELD IN THE FUTURE, THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS. UPON COMPLETION OF EACH RAMP RECORD MAIN COIL CONNECTION POLARITIES AND FINAL RAMPING CURRENTS IN CHAPTER 8, SECTION 5, MAGNET RAMPING AND PARKING CURRENT LOG.

12. Record current, frequency and lead extension voltage values at which the switch went 'persistent' in the Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

13. When the switch goes 'persistent,' **slowly** turn the power supply's Voltage Adjust Control to zero (full CCW) over a two minute period.

NOTE: Check that the Teslameter does not decrease as the Voltage Adjust Control is turned to zero. Only the last two digits on the Teslameter should change. If magnetic field strength decreases as the Voltage Adjust Control is turned, the Main Coil Switch is not persistent; slowly adjust the Voltage Control to return to parking field. The magnetic field will drop approximately 1 KHz when the power supply is being dialed down to zero amps.

14. Gradually turn the Current Adjust Control to zero (over a one minute period).

15. Set the Heater 2 Shim Axial Switch to “O” (off).

16. Set the Main Power and Power On switches on the Main Power Supply to “OFF“.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

17. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

18. Remove the Ramp Lead Hold-Down Tool.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT. DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



WARNING

ELECTRICAL SHOCK HAZARD
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.



WARNING

POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE RAMPING PROCEDURE.
WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.



NOTICE

Step 19 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.

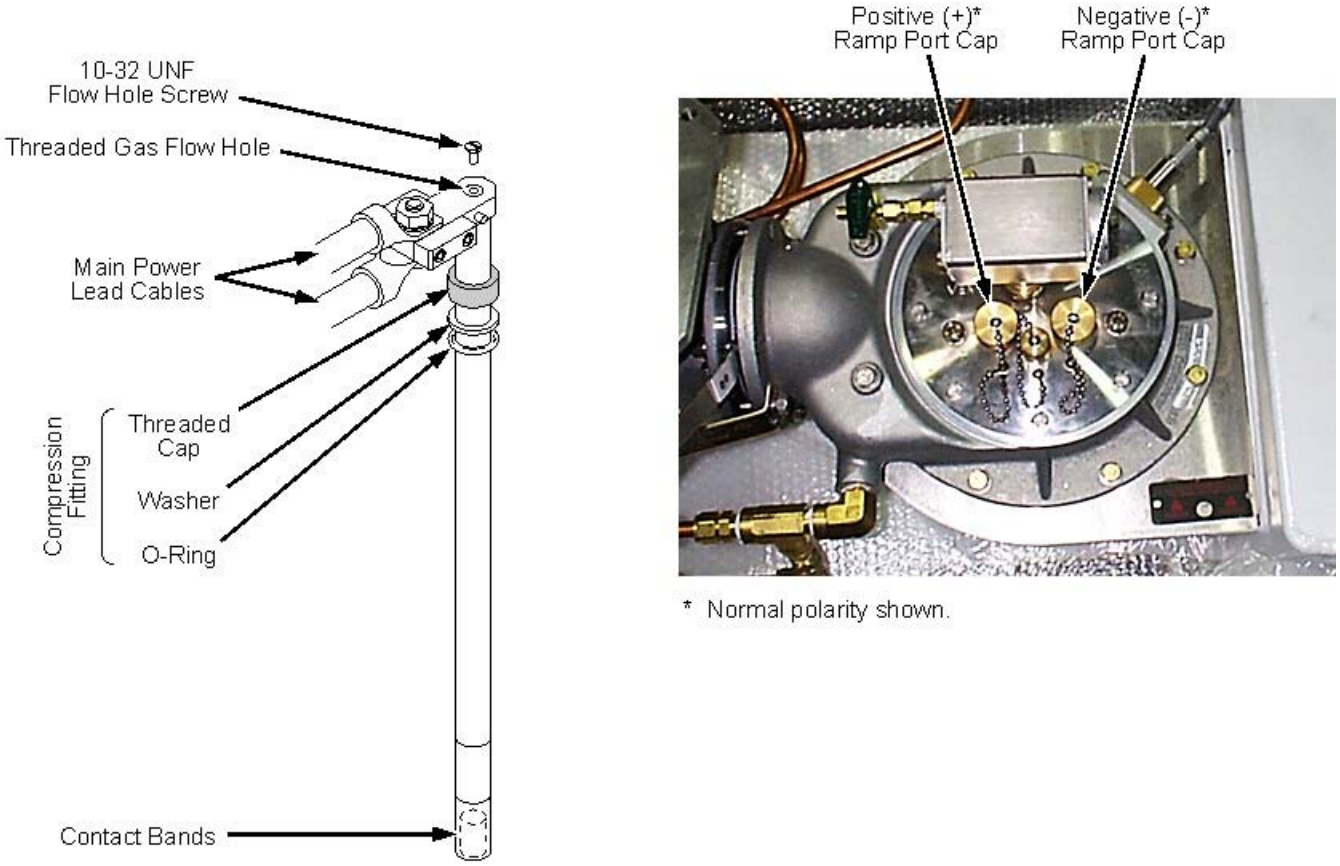
19. After parking the magnet and disconnecting the Main Power Supply, plug and **remove one Main Extension at a time** in the following sequence:

    a. Open Valve V2. Bleed vessel pressure down below 1.0 psig. Do not allow pressure to go below 0.5 psig as read on the magnet pressure gauge or Magnet Monitor. Close V2.

    b. Remove all ice around the ramp lead port compression fitting on the Main Lead Extension that is being removed first. See Illustration 3-93.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-93: Main Lead Extension and Ramp Ports



⚠ WARNING

POTENTIAL MAGNET QUENCH!
PLUGGING THE FLOW HOLE OF AN ENGAGED MAIN LEAD EXTENSIONS WILL CAUSE THE MAGNET TO QUENCH.
DO NOT INSERT FLOW HOLE SCREWS INTO MAIN LEAD EXTENSIONS UNTIL AFTER EXTENSIONS ARE REMOVED.

c. Unscrew the ramp lead port compression fitting and remove the first Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

d. Remove all ice around the ramp lead port compression fitting on the other Main Lead Extension.

e. Unscrew the ramp lead port compression fitting and remove the second Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

f. Install the flow hole screws in the flow hole of both Main Lead Extensions **after** both leads have been removed.

g. Check the Main Leads and fill port cap for leaks.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

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. Plug in the heater on the Magnet Monitor with a setpoint of 4.0 psig. Allow the magnetic field to settle.

NOTE: If a shorter pressure rise time is needed, turn on the Axial Heater on the Main Power Supply.

NOTICE

Make sure any currents induced in the Transverse Coils during ramping are removed in conformance with the 'Magnet Stability Check' subsection of Section 8, Shim Current Adjustment, before centering the Teslameter Probe and shimming the magnet.

21. Continue with Section 8, Shim Current Adjustment.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7.2.3.3.3 1.5T Fixed Site Ramping



⚠ WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH AND THE COILS BECOME DAMAGED IF THE AXIAL SWITCH HEATERS ARE NOT "ON" DURING RAMPING.
MAKE SURE THE AXIAL SHIM SWITCH HEATERS ARE "ON" DURING RAMPING TO PREVENT COIL DAMAGE AND A MAGNET QUENCH. (GE POWER SUPPLIES HAVE PROTECTIVE CIRCUITRY TO PREVENT RAMPING VOLTAGE WITH THE AXIAL HEATER SWITCH IN THE "OFF" POSITION.)



⚠ CAUTION

Potential Magnet Quench
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.
If a quench occurs during ramping, immediately:

1. **Turn the Main Power Supply Voltage and Current Controls to zero (fully CCW),**
2. **Turn off the Power Supply,**
3. **Leave the room and**
4. **Turn off the Cryocooler Compressor outside the magnet room. Do not reenter the magnet room until the quench is over.**

NOTE: Ice will form around the flow holes in the Ramp Lead Hold-Down Tool during ramping. Remove ice as needed to maintain helium gas flow.

1. Make sure the power supply controls are set as follows:
   - Voltage Adjust Control: **zero (full CCW)**
   - Current Adjust Control: **maximum (full CW)**
   - Main Power Switches on the Main Power Supply: **"ON"**
   - Heater 2 Shim Axial Switch on the Main Power Supply: **"I" (ON)**
   - Voltmeter Select Switch on the power supply: **"Main Coil" position**

NOTE: Power supply controls are shown in Illustration 3-88 and Illustration 3-89.

2. Set the Heater 1 Main Switch to "I" (on). Wait 3 minutes.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. Use a Range 5 Teslameter Probe (46-255839P104) to monitor magnetic field strength. The probe will lock on when magnet current rises to approximately 325 amps. This usually occurs between 0.6 Tesla and 0.7 Tesla (25.545900 MHz - 29.803550 MHz).

4. Ramp the magnet in conformance with Table 3-13 as follows:

   a. Slowly turn the power supply's Voltage Control to obtain the Main Coil (Ramp) Voltage value shown in the table, starting with 6.00 volts.

   b. Allow the voltage to decay over the current interval shown in the table.

   c. Monitor the power supply's Current Meter. When the limit of the current range for the voltage setting is reached, slowly turn the Voltage Control to obtain the Main Coil Voltage for the next current range.

Table 3-13: 1.5T Fixed Site Ramping Profile

"Stage"	Main Coil (Ramp) Voltage	Main Coil (Ramp) Current Range	Magnetic Field Strength Reached
1	6.00 Volts	0 Amps - 100 Amps	—
2	5.60 Volts	100 Amps - 200 Amps	
3	5.20 Volts	200 Amps - 300 Amps	
4	4.70 Volts	300 Amps - 400 Amps	
5	4.30 Volts	400 Amps - 500 Amps	
6	3.50 Volts	500 Amps - 550 Amps	
7	3.00 Volts	550 Amps - 600 Amps	
8	2.35 Volts	600 Amps - 625 Amps	
9	2.00 Volts	625 Amps - 650 Amps	
10	1.00 Volts	650 Amps - 675 Amps	
11	0.75 Volts	675 Amps - 700 Amps	
12	0.50 Volts	700 Amps - 720 Amps	
13	0.30 Volts	720 Amps -730 Amps	
14	Slowly lower from 0.30 Volts to 0.10 Volts	730 Amps	
15	0.10 Volts	—	1.499 Tesla
16	Set voltage as required to maintain constant field	**Use "Recommended Site Parking Field" frequency stated in ATR**	

5. When the Main Coil (Ramp) Current reaches 200 amps, estimate the system inductance by measuring current change over a 10 second ramping interval:

$$L_{Inductance} = 10 \times Voltage / Current\ Change$$

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

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6. If inductance (L) is outside the range of 10.9 henries - 11.3 henries, discontinue ramping, measure main coil resistance in conformance with Chapter 4, Section 5, Magnet Electrical Checks, and contact your regional MAC Team representative.



WARNING

POTENTIAL MAGNET QUENCH!
1.5T LCC MAGNETS CAN BE QUENCHED IF LARGE CURRENT OR VOLTAGE CHANGES OCCUR NEAR PARKING.
ADJUST THE VOLTAGE CONTROL IN A SLOW, CONTINUOUS MOTION IN THE FOLLOWING STEPS.

7. When the magnet current reaches 730 amps, slowly lower the Voltage Adjust Control from 0.3 V to 0.1 V Main Coil Voltage.

8. When magnetic field strength reaches 1.499 Tesla, slowly adjust the Voltage Adjust Control to a 0.1 V Main Coil Voltage.

NOTE: The magnet's ATR gives the optimum magnet on-site parking field beside “Recommended Site Parking Field.” The parking field is generally 25 Gauss above the final magnetic field strength of 1.5T to compensate for correction coil currents.

9. Check the Teslameter reading and **slowly** adjust the Voltage Adjust Controls as required to bring the magnetic field to the frequency shown on the ATR as the “Recommended Site Parking Field." The total current will be approximately 742 amps. Allow the magnetic field to stabilize. The last two digits on the Teslameter should be the only digits changing.

10. Maintain magnetic field at Step 9's setting for 5 minutes before proceeding to Step 11.

NOTE: Observe the Power Supply Voltmeter reading with the Voltmeter Select Switch in “Main Coil” position. When the switch goes 'persistent' the voltage across the magnet terminals will stabilize at 0.00 V.

11. Turn off the Main Switch Heater. Wait a minimum of 15 minutes for the switch to fully cool and go 'persistent.'

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



⚠ WARNING

POTENTIAL MAGNET QUENCH!
INCORRECT MAIN COIL CONNECTION POLARITY AND RAMPING CURRENT SETTINGS AT A LATER DATE CAN RESULT IN A MAGNET QUENCH WHEN THE MAIN POWER SUPPLY SWITCH IS TURNED ON.
WHEN CHANGING MAGNETIC FIELD IN THE FUTURE, THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS. UPON COMPLETION OF EACH RAMP RECORD MAIN COIL CONNECTION POLARITIES AND FINAL RAMPING CURRENTS IN CHAPTER 8, SECTION 5, MAGNET RAMPING AND PARKING CURRENT LOG.

12. Record current, frequency and lead extension voltage values at which the switch went 'persistent' in the Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

13. When the switch goes 'persistent,' **slowly** turn the power supply's Voltage Adjust Control to zero (full CCW) over a two minute period.

NOTE: Check that the Teslameter does not decrease as the Voltage Adjust Control is turned to zero. Only the last two digits on the Teslameter should change. If magnetic field strength decreases as the Voltage Adjust Control is turned, the Main Coil Switch is not persistent; slowly adjust the Voltage Control to return to parking field. The magnetic field will drop approximately 1 KHz when the power supply is being dialed down to zero amps.

14. Gradually turn the Current Adjust Control to zero (over a one minute period).

15. Set the Heater 2 Shim Axial Switch to “O” (off).

16. Set the Main Power and Power On switches on the Main Power Supply to “OFF“.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

17. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

18. Remove the Ramp Lead Hold-Down Tool.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT. DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



WARNING

ELECTRICAL SHOCK HAZARD
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.



WARNING

POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE RAMPING PROCEDURE.
WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.



NOTICE

Step 19 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.

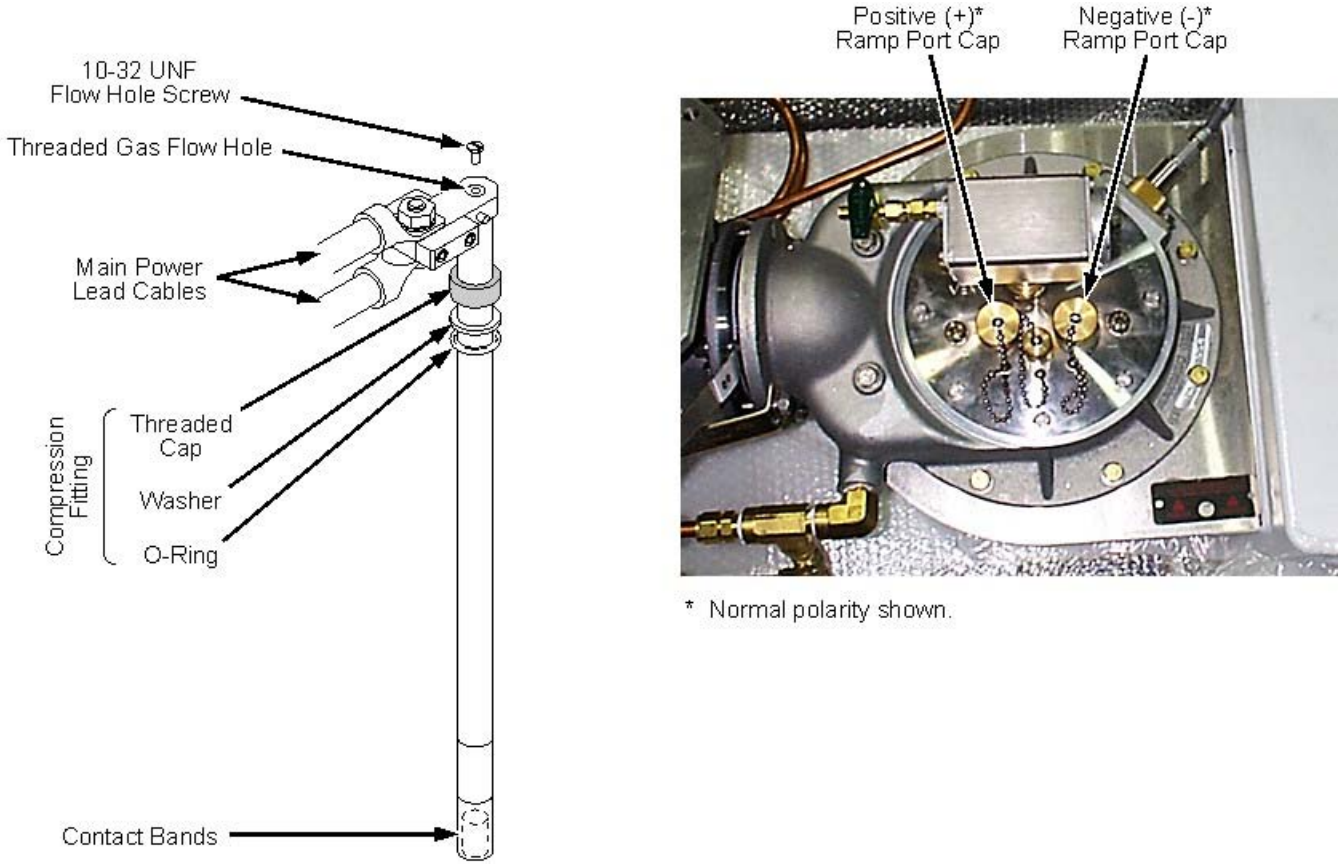
19. After parking the magnet and disconnecting the Main Power Supply, plug and **remove one Main Extension at a time** in the following sequence:

    a. Open Valve V2. Bleed vessel pressure down below 1.0 psig. Do not allow pressure to go below 0.5 psig as read on the magnet pressure gauge or Magnet Monitor. Close V2.

    b. Remove all ice around the ramp lead port compression fitting on the Main Lead Extension that is being removed first. See Illustration 3-94.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-94: Main Lead Extension and Ramp Ports



⚠ WARNING

POTENTIAL MAGNET QUENCH!
PLUGGING THE FLOW HOLE OF AN ENGAGED MAIN LEAD EXTENSIONS WILL CAUSE THE MAGNET TO QUENCH.
DO NOT INSERT FLOW HOLE SCREWS INTO MAIN LEAD EXTENSIONS UNTIL AFTER EXTENSIONS ARE REMOVED.

c. Unscrew the ramp lead port compression fitting and remove the first Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

d. Remove all ice around the ramp lead port compression fitting on the other Main Lead Extension.

e. Unscrew the ramp lead port compression fitting and remove the second Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

f. Install the flow hole screws in the flow hole of both Main Lead Extensions **after** both leads have been removed.

g. Check the Main Leads and fill port cap for leaks.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

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. Plug in the heater on the Magnet Monitor with a setpoint of 4.0 psig. Allow the magnetic field to settle.

NOTE: If a shorter pressure rise time is needed, turn on the Axial Heater on the Main Power Supply.

NOTICE

Make sure any currents induced in the Transverse Coils during ramping are removed in conformance with the 'Magnet Stability Check' subsection of Section 8, Shim Current Adjustment, before centering the Teslameter Probe and shimming the magnet.

21. Continue with Section 8, Shim Current Adjustment.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7.2.3.3.4 1.0T QR Series Ramping



WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH AND THE COILS BECOME DAMAGED IF THE AXIAL SWITCH HEATERS ARE NOT "ON" DURING RAMPING.
MAKE SURE THE AXIAL SHIM SWITCH HEATERS ARE "ON" DURING RAMPING TO PREVENT COIL DAMAGE AND A MAGNET QUENCH. (GE POWER SUPPLIES HAVE PROTECTIVE CIRCUITRY TO PREVENT RAMPING VOLTAGE WITH THE AXIAL HEATER SWITCH IN THE "OFF" POSITION.)



CAUTION

Potential Magnet Quench
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.
If a quench occurs during ramping, immediately:

1. **Turn the Main Power Supply Voltage and Current Controls to zero (fully CCW),**
2. **Turn off the Power Supply,**
3. **Leave the room and**
4. **Turn off the Cryocooler Compressor outside the magnet room. Do not reenter the magnet room until the quench is over.**

NOTE: Ice will form around the flow holes in the Ramp Lead Hold-Down Tool during ramping. Remove ice as needed to maintain helium gas flow.

1. Make sure the power supply controls are set as follows:
   - Voltage Adjust Control: **zero (full CCW)**
   - Current Adjust Control: **maximum (full CW)**
   - Main Power Switches on the Main Power Supply: **"ON"**
   - Heater 2 Shim Axial Switch on the Main Power Supply: **"I" (ON)**
   - Voltmeter Select Switch on the power supply: **"Main Coil" position**

NOTE: Power supply controls are shown in Illustration 3-88 and Illustration 3-89.

2. Set the Heater 1 Main Switch to "I" (on). Wait 3 minutes.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. Use a Range 5 Teslameter Probe (46-255839P104) to monitor magnetic field strength. The probe will lock on when magnet current rises to approximately 300 amps. This usually occurs between 0.6 Tesla and 0.7 Tesla (25.545900 MHz - 29.803550 MHz).

4. Ramp the magnet in conformance with Table 3-14 as follows:

   a. Slowly turn the power supply's Voltage Control to obtain the Main Coil (Ramp) Voltage value shown in the table, starting with 5.00 volts.

   b. Allow the voltage to decay over the current interval shown in the table.

   c. Monitor the power supply's Current Meter. When the limit of the current range for the voltage setting is reached, slowly turn the Voltage Control to obtain the Main Coil Voltage for the next current range.

Table 3-14: 1.0T QR Series Ramping Profile

"Stage"	Main Coil (Ramp) Voltage	Main Coil (Ramp) Current Range	Magnetic Field Strength Reached
1	5.00 Volts	0 Amps - 100 Amps	—
2	4.40 Volts	100 Amps - 200 Amps	
3	3.80 Volts	200 Amps - 300 Amps	
4	3.00 Volts	300 Amps - 400 Amps	
5	2.60 Volts	400 Amps - 425 Amps	
6	2.00 Volts	425 Amps - 450 Amps	
7	1.00 Volts	450 Amps - 475 Amps	
8	0.30 Volts	475 Amps - 497 Amps	
9	Slowly lower from 0.30 Volts to 0.10 Volts	497 Amps	
10	0.10 Volts	—	0.999 Tesla
11	Set voltage as required to maintain constant field	**Use "Recommended Site Parking Field" frequency stated in ATR**	

5. When the Main Coil (Ramp) Current reaches 200 amps, estimate the system inductance by measuring current change over a 10 second ramping interval:

$$L_{Inductance} = 10 \times Voltage / Current\ Change$$

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

6. If inductance (L) is outside the range of 10.9 henries - 11.3 henries, discontinue ramping, measure main coil resistance in conformance with Chapter 4, Section 5, Magnet Electrical Checks, and contact your regional MAC Team representative.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



⚠ WARNING

POTENTIAL MAGNET QUENCH!
1.0T LCC MAGNETS CAN BE QUENCHED IF LARGE CURRENT OR VOLTAGE CHANGES OCCUR NEAR PARKING.
ADJUST THE VOLTAGE CONTROL IN A SLOW, CONTINUOUS MOTION IN THE FOLLOWING STEPS.

7. When the magnet current reaches 497 amps, slowly lower the Voltage Adjust Control from 0.3 V to 0.1 V Main Coil Voltage.

8. When magnetic field strength reaches 0.999 Tesla, slowly adjust the Voltage Adjust Control to a 0.025 V Main Coil Voltage.

NOTE: The magnet's ATR gives the optimum magnet on-site parking field beside “Recommended Site Parking Field.” The parking field is generally 25 Gauss above the final magnetic field strength of 1.0T to compensate for correction coil currents.

9. Check the Teslameter reading and **slowly** adjust the Voltage Adjust Controls as required to bring the magnetic field to frequency shown on the ATR as the “Recommended Site Parking Field." The total current will be approximately 497 amps. Allow the magnetic field to stabilize. The last two digits on the Teslameter should be the only digits changing.

10. Maintain magnetic field at Step 9's setting for 5 minutes before proceeding to Step 11.

NOTE: Observe the Power Supply Voltmeter reading with the Voltmeter Select Switch in “Main Coil” position. When the switch goes 'persistent' the voltage across the magnet terminals will stabilize at 0.00 V.

11. Turn off the Main Switch Heater. Wait a minimum of 15 minutes for the switch to fully cool and go 'persistent.'



⚠ WARNING

POTENTIAL MAGNET QUENCH!
INCORRECT MAIN COIL CONNECTION POLARITY AND RAMPING CURRENT SETTINGS AT A LATER DATE CAN RESULT IN A MAGNET QUENCH WHEN THE MAIN POWER SUPPLY SWITCH IS TURNED ON.
WHEN CHANGING MAGNETIC FIELD IN THE FUTURE, THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS. UPON COMPLETION OF EACH RAMP RECORD MAIN COIL CONNECTION POLARITIES AND FINAL RAMPING CURRENTS IN CHAPTER 8, SECTION 5, MAGNET RAMPING AND PARKING CURRENT LOG.

12. Record current, frequency and lead extension voltage values at which the switch went 'persistent' in the Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

13. When the switch goes 'persistent,' **slowly** turn the power supply's Voltage Adjust Control to zero (full CCW) over a two minute period.

NOTE: Check that the Teslameter does not decrease as the Voltage Adjust Control is turned to zero. Only the last two digits on the Teslameter should change. If magnetic field strength decreases as the Voltage Adjust Control is turned, the Main Coil Switch is not persistent; slowly adjust the Voltage Control to return to parking field. The magnetic field will drop approximately 1 KHz when the power supply is being dialed down to zero amps.

14. Gradually turn the Current Adjust Control to zero (over a one minute period).

15. Set the Heater 2 Shim Axial Switch to “O” (off).

16. Set the Main Power and Power On switches on the Main Power Supply to “OFF“.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

17. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

18. Remove the Ramp Lead Hold-Down Tool.



WARNING

ELECTRICAL SHOCK HAZARD
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT. DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



WARNING

ELECTRICAL SHOCK HAZARD
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE RAMPING PROCEDURE.
WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.



NOTICE

Step 19 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.

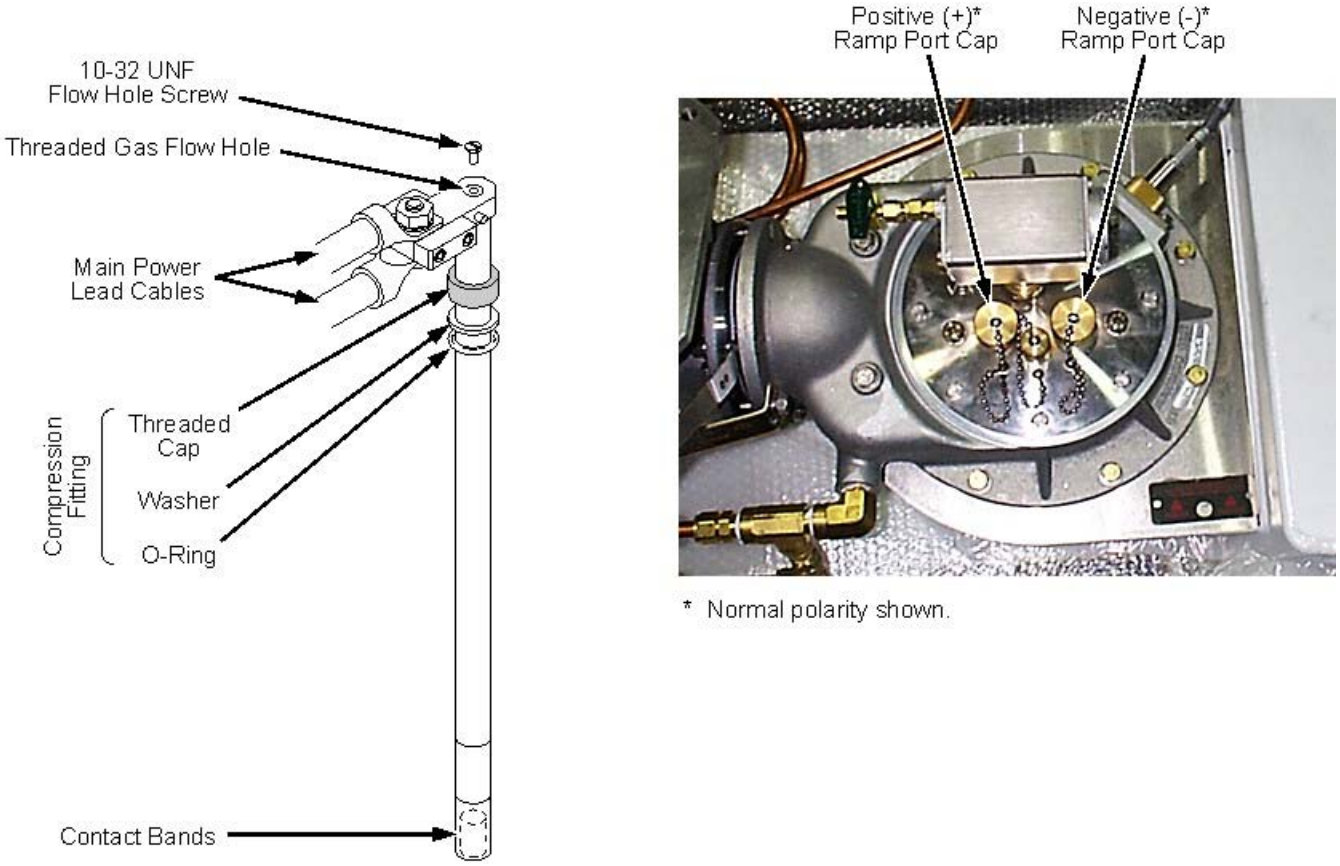
19. After parking the magnet and disconnecting the main power supply, plug and **remove one Main Extension at a time** in the following sequence:

    a. Open Valve V2. Bleed vessel pressure down below 1.0 psig. Do not allow pressure to go below 0.5 psig as read on the magnet pressure gauge or Magnet Monitor. Close V2.

    b. Remove all ice around the ramp lead port compression fitting on the Main Lead Extension that is being removed first. See Illustration 3-95.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-95: Main Lead Extension and Ramp Ports



⚠ WARNING

POTENTIAL MAGNET QUENCH!
PLUGGING THE FLOW HOLE OF AN ENGAGED MAIN LEAD EXTENSIONS WILL CAUSE THE MAGNET TO QUENCH.
DO NOT INSERT FLOW HOLE SCREWS INTO MAIN LEAD EXTENSIONS UNTIL AFTER EXTENSIONS ARE REMOVED.

c. Unscrew the ramp lead port compression fitting and remove the first Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

d. Remove all ice around the ramp lead port compression fitting on the other Main Lead Extension.

e. Unscrew the ramp lead port compression fitting and remove the second Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

f. Install the flow hole screws in the flow hole of both Main Lead Extensions **after** both leads have been removed.

g. Check the Main Leads and fill port cap for leaks.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

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. Plug in the heater on the Magnet Monitor with a setpoint of 4.0 psig. Allow the magnetic field to settle.

NOTE: If a shorter pressure rise time is needed, turn on the Axial Heater on the Main Power Supply.

NOTICE

Make sure any currents induced in the Transverse Coils during ramping are removed in conformance with the 'Magnet Stability Check' subsection of Section 8, Shim Current Adjustment, before centering the Teslameter Probe and shimming the magnet.

21. Continue with Section 8, Shim Current Adjustment.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7.2.3.3.5 1.0T Mobile Site Ramping



⚠ WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH AND THE COILS BECOME DAMAGED IF THE AXIAL SWITCH HEATERS ARE NOT "ON" DURING RAMPING.
MAKE SURE THE AXIAL SHIM SWITCH HEATERS ARE "ON" DURING RAMPING TO PREVENT COIL DAMAGE AND A MAGNET QUENCH. (GE POWER SUPPLIES HAVE PROTECTIVE CIRCUITRY TO PREVENT RAMPING VOLTAGE WITH THE AXIAL HEATER SWITCH IN THE "OFF" POSITION.)



⚠ CAUTION

Potential Magnet Quench
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.
If a quench occurs during ramping, immediately:

1. **Turn the Main Power Supply Voltage and Current Controls to zero (fully CCW),**
2. **Turn off the Main Power Supply,**
3. **Turn the Transverse 1 (T1) and Transverse 2 (T2) Shim Heater Switches on the Shim Power Supply to "O" (OFF),**
4. **Turn off the Shim Power Supply,**
5. **Leave the room and**
6. **Turn off the Cryocooler Compressor outside the magnet room. Do not reenter the magnet room until the quench is over.**

NOTE: When both Main (Ramp) and Shim Power Supplies are used at a mobile site, the shim heater circuits of the two power supplies are connected in parallel. This puts a resistance load across the Main Coil Voltmeter of approximately 30 ohms. The Main Coil Voltmeter display will be approximately 90% of the actual voltage across the Main Coil. The ramp profile used in this subsection compensates for this condition.

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

1. Make sure the power supply controls are set as follows:
   - Voltage Adjust Control: **zero (full CCW)**
   - Current Adjust Control: **maximum (full CW)**
   - Main Power Switches on the Main Power Supply: **"ON"**

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

- Main Power Switches on the Shim Power Supply: **"ON"**
- Heater 2 Shim Axial Switch on the Main Power Supply: **"I" (ON)**
- Transverse 1 (T1) Shim Heater Switch on the Shim Power Supply: **"I" (ON)**
- Transverse 2 (T2) Shim Heater Switch on the Shim Power Supply: **"I" (ON)**
- Voltmeter Select Switch on the power supply: **"Main Coil" position**

NOTE: Power supply controls are shown in Illustration 3-88 - Illustration 3-90.

NOTE: The Axial Switch Heater current is supplied by the Main Power 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.

2. Set the Heater 1 Main Switch to "I" (on). Wait 3 minutes.

3. Use a Range 5 Teslameter Probe (46-255839P104) to monitor magnetic field strength. The probe will lock on when magnet current rises to approximately 515 amps. This usually occurs between 0.6 Tesla and 0.7 Tesla (25.545900 MHz - 29.803550 MHz).

4. Ramp the magnet in conformance with Table 3-15 as follows:

   a. Slowly turn the Main Power Supply's Voltage Control to obtain the Main Coil (Ramp) Voltage value shown in the table, starting with 4.50 volts.

   b. Allow the voltage to decay over the current interval shown in the table.

   c. Monitor the Main Power Supply's Current Meter. When the limit of the current range for the voltage setting is reached, slowly turn the Voltage Control to obtain the Main Coil Voltage for the next current range.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 3-15: 1.0T Mobile Site Ramping Profile

"Stage"	Main Coil (Ramp) Voltage)	Main Coil (Ramp) Current Range	Magnetic Field Strength Reached
1	4.50 Volts	0 Amps - 100 Amps	—
2	4.14 Volts	100 Amps - 200 Amps	
3	3.78 Volts	200 Amps - 300 Amps	
4	3.42 Volts	300 Amps - 400 Amps	
5	2.97 Volts	400 Amps - 500 Amps	
6	2.25 Volts	500 Amps - 550 Amps	
7	1.80 Volts	550 Amps - 600 Amps	
8	1.35 Volts	600 Amps - 625 Amps	
9	0.90 Volts	625 Amps - 650 Amps	
10	0.68 Volts	650 Amps - 675 Amps	
11	0.54 Volts	675 Amps - 700 Amps	
12	0.45 Volts	700 Amps - 720 Amps	
13	0.27 Volts	720 Amps - 730 Amps	
14	Slowly lower from 0.27 Volts to 0.09 Volts	730 Amps	
15	0.09 Volts	—	0.999 Tesla
16	Set voltage as required to maintain constant field	**Use "Recommended Site Parking Field" frequency stated in ATR**	

5. When the Main Coil (Ramp) Current reaches 200 amps, estimate the system inductance by measuring current change over a 10 second ramping interval:

$$L_{Inductance} = 10 \times Voltage / Current\ Change$$

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

6. If inductance (L) is outside the range of 4.8 henries - 5.2 henries, discontinue ramping, measure main coil resistance in conformance with Chapter 4, Section 5, Magnet Electrical Checks, and contact your regional MAC Team representative.



WARNING

POTENTIAL MAGNET QUENCH!
1.0T LCC MAGNETS CAN BE QUENCHED IF LARGE CURRENT OR VOLTAGE CHANGES OCCUR NEAR PARKING.
ADJUST THE VOLTAGE CONTROL IN A SLOW, CONTINUOUS MOTION IN THE FOLLOWING STEPS.

7. When the magnet current reaches 730 amps, slowly lower the Voltage Adjust Control from 0.27 V to 0.09 V Main Coil Voltage.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8. When magnetic field strength reaches 0.999 Tesla, slowly adjust the Voltage Adjust Control to a 0.023 V Main Coil Voltage.

NOTE: The magnet's ATR gives the optimum magnet on-site parking field beside “Recommended Site Parking Field.” The parking field is generally 25 Gauss above the final magnetic field strength of 1.0T to compensate for correction coil currents.

9. Check the Teslameter reading and **slowly** adjust the Voltage Adjust Controls as required to bring the magnetic field to frequency shown on the ATR as the “Recommended Site Parking Field." The total current will be approximately 745 amps. Allow the magnetic field to stabilize. The last two digits on the Teslameter should be the only digits changing.

10. Maintain field at Step 9's setting for 5 minutes before proceeding to Step 11.

NOTE: Observe the Power Supply Voltmeter reading with the Voltmeter Select Switch in “Main Coil” position. When the switch goes 'persistent' the voltage across the magnet terminals will stabilize at 0.00 V.

11. Turn off the Main Switch Heater. Wait a minimum of 15 minutes for the switch to fully cool and go 'persistent.'



WARNING

POTENTIAL MAGNET QUENCH!
INCORRECT MAIN COIL CONNECTION POLARITY AND RAMPING CURRENT SETTINGS AT A LATER DATE CAN RESULT IN A MAGNET QUENCH WHEN THE MAIN POWER SUPPLY SWITCH IS TURNED ON.
WHEN CHANGING MAGNETIC FIELD IN THE FUTURE, THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS. UPON COMPLETION OF EACH RAMP RECORD MAIN COIL CONNECTION POLARITIES AND FINAL RAMPING CURRENTS IN CHAPTER 8, SECTION 5 MAGNET RAMPING AND PARKING CURRENT LOG.

12. Record current, frequency and lead extension voltage values at which the switch went 'persistent' in the Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

13. When the switch goes 'persistent,' **slowly** turn the Main Power Supply's Voltage Adjust Control to zero (full CCW) over a two minute period.

NOTE: Check that the Teslameter does not decrease as the Voltage Adjust Control is turned to zero. Only the last two digits on the Teslameter should change. If magnetic field strength decreases as the Voltage Adjust Control is turned, the Main Coil Switch is not persistent; slowly adjust the Voltage Control to return to parking field. The magnetic field will drop approximately 1 KHz when the power supply is being dialed down to zero amps.

14. Gradually turn the Current Adjust Control to zero (over a one minute period).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

15. Set the Heater 2 Shim Axial Switch to “O” (off).

16. Set the Main Power and Power On switches on the Main Power Supply and Shim Power Supply to “OFF“.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS ANY POWER SUPPLY.

17. Disconnect and lockout/tagout input power to the Main Power Supply and the Shim Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

18. Remove the Ramp Lead Hold-Down Tool.



WARNING

ELECTRICAL SHOCK HAZARD
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT. DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



WARNING

ELECTRICAL SHOCK HAZARD
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.



WARNING

POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE RAMPING PROCEDURE.
WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

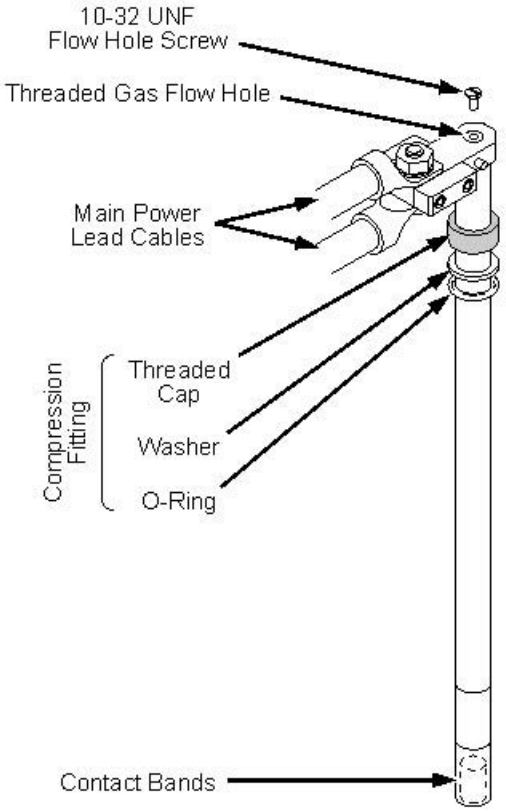
Step 19 must be followed precisely in order to avoid an excessive heat load being applied to the magnet cartridge and a possible quench following a magnet ramp.

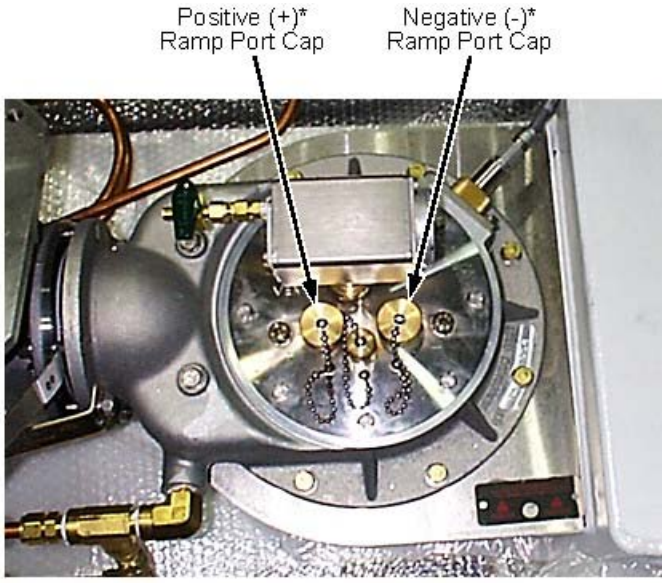
19. After parking the magnet and disconnecting the Main Power Supply and the Shim Power Supply, plug and **remove one Main Extension at a time** in the following sequence:

    a. Open Valve V2. Bleed vessel pressure down below 1.0 psig. Do not allow pressure to go below 0.5 psig as read on the magnet pressure gauge or Magnet Monitor. Close V2.

    b. Remove all ice around the ramp lead port compression fitting on the Main Lead Extension that is being removed first. See Illustration 3-96.

Illustration 3-96: Main Lead Extension and Ramp Ports





* Normal polarity shown.

WARNING

POTENTIAL MAGNET QUENCH!
PLUGGING THE FLOW HOLE OF AN ENGAGED MAIN LEAD EXTENSIONS WILL CAUSE THE MAGNET TO QUENCH.
DO NOT INSERT FLOW HOLE SCREWS INTO MAIN LEAD EXTENSIONS UNTIL AFTER EXTENSIONS ARE REMOVED.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

c. Unscrew the ramp lead port compression fitting and remove the first Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

d. Remove all ice around the ramp lead port compression fitting on the other Main Lead Extension.

e. Unscrew the ramp lead port compression fitting and remove the second Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

f. Install the flow hole screws in the flow hole of both Main Lead Extensions **after** both leads have been removed.

g. Check the Main Leads and fill port cap for leaks.



NOTICE

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. Plug in the heater on the Magnet Monitor with a setpoint of 4.0 psig. Allow the magnetic field to settle.

NOTE: If a shorter pressure rise time is needed, turn on the Axial Heater on the Main Power Supply **OR**, in the case of the Shim Power Supply, turn on both the Axial and the Transverse Heaters. Both the Axial and Transverse Heaters are available on the Shim Power Supply.



NOTICE

Make sure any currents induced in the Transverse Coils during ramping are removed in conformance with the 'Magnet Stability Check' subsection of Section 8, Shim Current Adjustment, before centering the Teslameter Probe and shimming the magnet.

21. Continue with Section 8, Shim Current Adjustment.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7.2.3.3.6 1.5T Mobile Site Ramping



⚠ WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH AND THE COILS BECOME DAMAGED IF THE AXIAL SWITCH HEATERS ARE NOT "ON" DURING RAMPING.
MAKE SURE THE AXIAL SHIM SWITCH HEATERS ARE "ON" DURING RAMPING TO PREVENT COIL DAMAGE AND A MAGNET QUENCH. (GE POWER SUPPLIES HAVE PROTECTIVE CIRCUITRY TO PREVENT RAMPING VOLTAGE WITH THE AXIAL HEATER SWITCH IN THE "OFF" POSITION.)



⚠ CAUTION

Potential Magnet Quench
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.
If a quench occurs during ramping, immediately:

1. **Turn the Main Power Supply Voltage and Current Controls to zero (fully CCW),**
2. **Turn off the Power Supply,**
3. **Turn the Transverse 1 (T1) and Transverse 2 (T2) Shim Heater Switches on the Shim Power Supply to "O" (OFF),**
4. **Turn off the Shim Power Supply,**
5. **Leave the room and**
6. **Turn off the Cryocooler Compressor outside the magnet room. Do not reenter the magnet room until the quench is over.**

NOTE: When both Main (Ramp) and Shim Power Supplies are used at a mobile site, the shim heater circuits of the two power supplies are connected in parallel. This puts a resistance load across the Main Coil Voltmeter of approximately 30 ohms. The Main Coil Voltmeter display will be approximately 90% of the actual voltage across the Main Coil. The ramp profile used in this subsection compensates for this condition.

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

1. Make sure the power supply controls are set as follows:
   - Voltage Adjust Control: **zero (full CCW)**
   - Current Adjust Control: **maximum (full CW)**
   - Main Power Switches on the Main Power Supply: **"ON"**

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

- Main Power Switches on the Shim Power Supply:**"ON"**
- Heater 2 Shim Axial Switch on the Main Power Supply: **"I" (ON)**
- Transverse 1 (T1) Shim Heater Switch on the Shim Power Supply: **"I" (ON)**
- Transverse 2 (T2) Shim Heater Switch on the Shim Power Supply: **"I" (ON)**
- Voltmeter Select Switch on the power supply: **"Main Coil" position**

NOTE: Power supply controls are shown in Illustration 3-88 - Illustration 3-90.

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

2. Set the Heater 1 Main Switch to "I" (on). Wait 3 minutes.

3. Use a Range 5 Teslameter Probe (46-255839P104) to monitor magnetic field strength. The probe will lock on when magnet current rises to approximately 325 amps. This usually occurs between 0.6 Tesla and 0.7 Tesla (25.545900 MHz - 29.803550 MHz).

4. Ramp the magnet in conformance with Table 3-16 as follows:

   a. Slowly turn the Main Power Supply's Voltage Control to obtain the Main Coil (Ramp) Voltage value shown in the table, starting with 5.00 volts.

   b. Allow the voltage to decay over the current interval shown in the table.

   c. Monitor the Main Power Supply's Current Meter. When the limit of the current range for the voltage setting is reached, slowly turn the Voltage Control to obtain the Main Coil Voltage for the next current range.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 3-16: 1.5T Mobile Site Ramping Profile

"Stage"	Main Coil (Ramp) Voltage	Main Coil (Ramp) Current Range	Magnetic Field Strength Reached
1	5.40 Volts	0 Amps - 100 Amps	—
2	5.04 Volts	100 Amps - 200 Amps	
3	4.68 Volts	200 Amps - 300 Amps	
4	4.23 Volts	300 Amps - 400 Amps	
5	3.87 Volts	400 Amps - 500 Amps	
6	3.15 Volts	500 Amps - 550 Amps	
7	2.70 Volts	550 Amps - 600 Amps	
8	2.12 Volts	600 Amps - 625 Amps	
9	1.80 Volts	625 Amps - 650 Amps	
10	0.90 Volts	650 Amps - 675 Amps	
11	0.68 Volts	675 Amps - 700 Amps	
12	0.45 Volts	700 Amps - 720 Amps	
13	0.27 Volts	720 Amps - 730 Amps	
14	Slowly lower from 0.27 Volts to 0.09 Volts	730 Amps	
15	0.09 Volts	—	1.499 Tesla
16	Set voltage as required to maintain constant field	**Use "Recommended Site Parking Field" frequency stated in ATR**	

5. When the Main Coil (Ramp) Current reaches 200 amps, estimate the system inductance by measuring current change over a 10 second ramping interval:

$$L_{Inductance} = 10 \times Voltage / Current\ Change$$

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

6. If inductance (L) is outside the range of 10.9 henries - 11.3 henries, discontinue ramping, measure main coil resistance in conformance with Chapter 4, Section 5, Magnet Electrical Checks, and contact your regional MAC Team representative.



WARNING

POTENTIAL MAGNET QUENCH!
1.5T LCC MAGNETS CAN BE QUENCHED IF LARGE CURRENT OR VOLTAGE CHANGES OCCUR NEAR PARKING.
ADJUST THE VOLTAGE CONTROL IN A SLOW, CONTINUOUS MOTION IN THE FOLLOWING STEPS.

7. When the magnet current reaches 730 amps, slowly lower the Voltage Adjust Control from 0.27 V to 0.09 V Main Coil Voltage.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8. When magnetic field strength reaches 1.499 Tesla, slowly adjust the Voltage Adjust Control to a 0.023 V Main Coil Voltage.

NOTE: The magnet's ATR gives the optimum magnet on-site parking field beside “Recommended Site Parking Field.” The parking field is generally 25 Gauss above the final magnetic field strength of 1.5T to compensate for correction coil currents.

9. Check the Teslameter reading and **slowly** adjust the Voltage Adjust Controls as required to bring the magnetic field to frequency shown on the ATR as the “Recommended Site Parking Field." The total current will be approximately 745 amps. Allow the magnetic field to stabilize. The last two digits on the Teslameter should be the only digits changing.

10. Maintain field at Step 9's setting for 5 minutes before proceeding to Step 11.

NOTE: Observe the Power Supply Voltmeter reading with the Voltmeter Select Switch in “Main Coil” position. When the switch goes 'persistent' the voltage across the magnet terminals will stabilize at 0.00 V.

11. Turn off the Main Switch Heater. Wait a minimum of 15 minutes for the switch to fully cool and go 'persistent.'



⚠ WARNING

POTENTIAL MAGNET QUENCH!
INCORRECT MAIN COIL CONNECTION POLARITY AND RAMPING CURRENT SETTINGS AT A LATER DATE CAN RESULT IN A MAGNET QUENCH WHEN THE MAIN POWER SUPPLY SWITCH IS TURNED ON.
WHEN CHANGING MAGNETIC FIELD IN THE FUTURE, THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS. UPON COMPLETION OF EACH RAMP RECORD MAIN COIL CONNECTION POLARITIES AND FINAL RAMPING CURRENTS IN CHAPTER 8, SECTION 5 MAGNET RAMPING AND PARKING CURRENT LOG.

12. Record current, frequency and lead extension voltage values at which the switch went 'persistent' in the Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

13. When the switch goes 'persistent,' **slowly** turn the Main Power Supply's Voltage Adjust Control to zero (full CCW) over a two minute period.

NOTE: Check that the Teslameter does not decrease as the Voltage Adjust Control is turned to zero. Only the last two digits on the Teslameter should change. If magnetic field strength decreases as the Voltage Adjust Control is turned, the Main Coil Switch is not persistent; slowly adjust the Voltage Control to return to parking field. The magnetic field will drop approximately 1 KHz when the power supply is being dialed down to zero amps.

14. Gradually turn the Current Adjust Control to zero (over a one minute period).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

15. Set the Heater 2 Shim Axial Switch to “O” (off).

16. Set the Main Power and Power On switches on the Main Power Supply and Shim Power Supply to “OFF“.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

17. Disconnect and lockout/tagout input power to the Main Power Supply and Shim Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

18. Remove the Ramp Lead Hold-Down Tool.



WARNING

ELECTRICAL SHOCK HAZARD
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT. DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



WARNING

ELECTRICAL SHOCK HAZARD
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.



WARNING

POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE RAMPING PROCEDURE.
WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

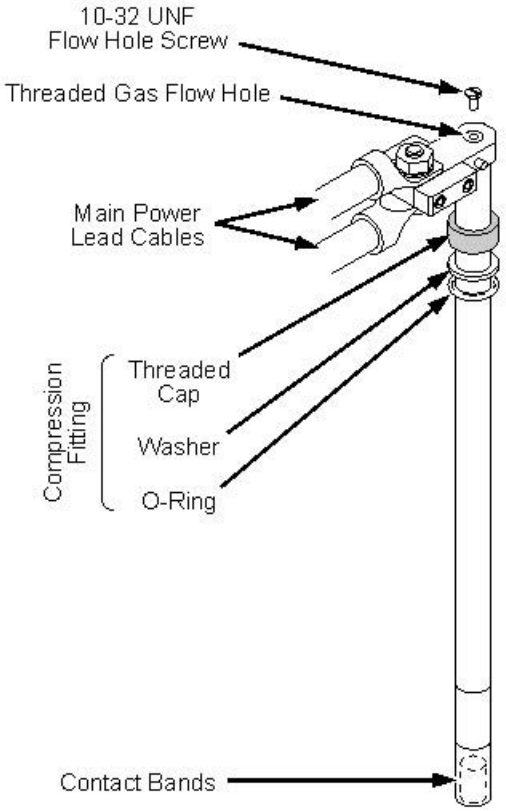
Step 19 must be followed precisely in order to avoid an excessive heat load being applied to the magnet cartridge and a possible quench following a magnet ramp.

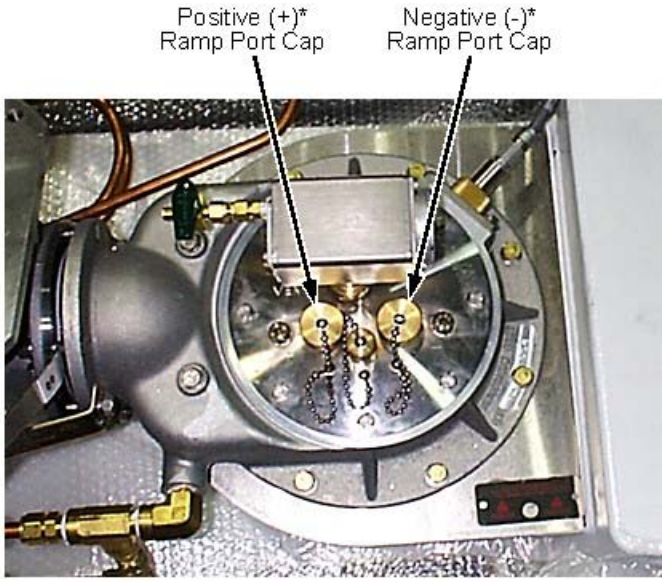
19. After parking the magnet and disconnecting the Main Power Supply and Shim Power Supply, plug and **remove one Main Extension at a time** in the following sequence:

    a. Open Valve V2. Bleed vessel pressure down below 1.0 psig. Do not allow pressure to go below 0.5 psig as read on the magnet pressure gauge or Magnet Monitor. Close V2.

    b. Remove all ice around the ramp lead port compression fitting on the Main Lead Extension that is being removed first. See Illustration 3-97.

Illustration 3-97: Main Lead Extension and Ramp Port





* Normal polarity shown.

WARNING

POTENTIAL MAGNET QUENCH!
PLUGGING THE FLOW HOLE OF AN ENGAGED MAIN LEAD EXTENSIONS WILL CAUSE THE MAGNET TO QUENCH.
DO NOT INSERT FLOW HOLE SCREWS INTO MAIN LEAD EXTENSIONS UNTIL AFTER EXTENSIONS ARE REMOVED.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

c. Unscrew the ramp lead port compression fitting and remove the first Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

d. Remove all ice around the ramp lead port compression fitting on the other Main Lead Extension.

e. Unscrew the ramp lead port compression fitting and remove the second Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

f. Install the flow hole screws in the flow hole of both Main Lead Extensions **after** both leads have been removed.

g. Check the Main Leads and fill port cap for leaks.



NOTICE

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. Plug in the heater on the Magnet Monitor with a setpoint of 4.0 psig. Allow the magnetic field to settle.

NOTE: If a shorter pressure rise time is needed, turn on the Axial Heater on the Main Power Supply **OR**, in the case of the Shim Power Supply, turn on both the Axial and the Transverse Heaters. Both the Axial and Transverse Heaters are available on the Shim Power Supply.



NOTICE

Make sure any currents induced in the Transverse Coils during ramping are removed in conformance with the 'Magnet Stability Check' subsection of Section 8, Shim Current Adjustment, before centering the Teslameter Probe and shimming the magnet.

21. Continue with Section 8, Shim Current Adjustment.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7.2.3.3.7 1.0T YQ Series Ramping



⚠ WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH AND THE COILS BECOME DAMAGED IF THE AXIAL SWITCH HEATERS ARE NOT "ON" DURING RAMPING.
MAKE SURE THE AXIAL SHIM SWITCH HEATERS ARE "ON" DURING RAMPING TO PREVENT COIL DAMAGE AND A MAGNET QUENCH. (GE POWER SUPPLIES HAVE PROTECTIVE CIRCUITRY TO PREVENT RAMPING VOLTAGE WITH THE AXIAL HEATER SWITCH IN THE "OFF" POSITION.)



⚠ CAUTION

Potential Magnet Quench
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.
If a quench occurs during ramping, immediately:

1. **Turn the Main Coil Power Supply Voltage and Current Controls to zero (fully CCW),**
2. **Turn off the Power Supply,**
3. **Leave the room and**
4. **Turn off the Cryocooler Compressor outside the magnet room. Do not reenter the magnet room until the quench is over.**

NOTE: Ice will form around the flow holes in the Ramp Lead Hold-Down Tool during ramping. Remove ice as needed to maintain helium gas flow.

1. Make sure the power supply controls are set as follows:
   - Voltage Adjust Control: **zero (full CCW)**
   - Current Adjust Control: **maximum (full CW)**
   - Main Power Switches on the Main Power Supply: **"ON"**
   - Heater 2 Shim Axial Switch on the Main Power Supply: **"I" (ON)**
   - Voltmeter Select Switch on the Main Power Supply: **"Main Coil" position**

NOTE: Power supply controls are shown in Illustration 3-88 and Illustration 3-89.

2. Set the Heater 1 Main Switch to "I" (on). Wait 3 minutes.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. Use a Range 5 Teslameter Probe (46-255839P104) to monitor magnetic field strength. The probe will lock on when magnet current rises to approximately 515 amps. This usually occurs between 0.6 Tesla and 0.7 Tesla (25.545900 MHz - 29.803550 MHz).

4. Ramp the magnet in conformance with Table 3-17 as follows:

   a. Slowly turn the power supply's Voltage Control to obtain the Main Coil (Ramp) Voltage value shown in the table, starting with 2.50 volts.

   b. Allow the voltage to decay over the current interval shown in the table.

   c. Monitor the power supply's Current Meter. When the limit of the current range for the voltage setting is reached, slowly turn the Voltage Control to obtain the Main Coil Voltage for the next current range.

Table 3-17: 1.0T YQ Series Ramping Profile

"Stage"	Main Coil (Ramp) Voltage	Main Coil (Ramp) Current Range	Magnetic Field Strength Reached
1	2.50 Volts	0 Amps - 100 Amps	—
2	2.30 Volts	100 Amps - 200 Amps	
3	2.10 Volts	200 Amps - 300 Amps	
4	1.90 Volts	300 Amps - 400 Amps	
5	1.65 Volts	400 Amps - 500 Amps	
6	1.25 Volts	500 Amps - 550 Amps	
7	1.00 Volts	550 Amps - 600 Amps	
8	0.75 Volts	600 Amps - 625 Amps	
9	0.50 Volts	625 Amps - 650 Amps	
10	0.40 Volts	650 Amps - 675 Amps	
11	0.30 Volts	675 Amps - 720 Amps	
12	Slowly lower to 0.3 Volts	720 Amps	
13	0.30 Volts	—	0.999 Tesla
14	Set voltage as required to maintain constant field	**Use "Recommended Site Parking Field" frequency stated in ATR**	

5. When the Main Coil (Ramp) Current reaches 200 amps, estimate the system inductance by measuring current change over a 10 second ramping interval:

$$L_{Inductance} = 10 \times Voltage / Current\ Change$$

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

6. If inductance (L) is outside the range of 4.8 henries - 5.2 henries, discontinue ramping, measure main coil resistance in conformance with Chapter 4, Section 5, Magnet Electrical Checks, and contact your regional MAC Team representative.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



⚠ WARNING

POTENTIAL MAGNET QUENCH!
1.0T LCC MAGNETS CAN BE QUENCHED IF LARGE CURRENT OR VOLTAGE CHANGES OCCUR NEAR PARKING.
ADJUST THE VOLTAGE CONTROL IN A SLOW, CONTINUOUS MOTION IN THE FOLLOWING STEPS.

7. When the magnet current reaches 720 amps, slowly lower the Voltage Adjust Control from 0.3 V Main Coil Voltage.

8. When magnetic field strength reaches 0.999 Tesla, slowly adjust the Voltage Adjust Control to a 0.1 V Main Coil Voltage.

NOTE: The magnet's ATR gives the optimum magnet on-site parking field beside “Recommended Site Parking Field.” The parking field is generally 25 Gauss above the final magnetic field strength of 1.0T to compensate for correction coil currents.

9. Check the Teslameter reading and **slowly** adjust the Voltage Adjust Controls as required to bring the magnetic field to frequency shown on the ATR as the “Recommended Site Parking Field." The total current will be approximately 745 amps. Allow the magnetic field to stabilize. The last two digits on the Teslameter should be the only digits changing.

10. Maintain magnetic field at Step 9's setting for 5 minutes before proceeding to Step 11.

NOTE: Observe the Power Supply Voltmeter reading with the Voltmeter Select Switch in “Main Coil” position. When the switch goes 'persistent' the voltage across the magnet terminals will stabilize at 0.00 V.

11. Turn off the Main Switch Heater. Wait a minimum of 15 minutes for the switch to fully cool and go 'persistent.'



⚠ WARNING

POTENTIAL MAGNET QUENCH!
INCORRECT MAIN COIL CONNECTION POLARITY AND RAMPING CURRENT SETTINGS AT A LATER DATE CAN RESULT IN A MAGNET QUENCH WHEN THE MAIN POWER SUPPLY SWITCH IS TURNED ON.
WHEN CHANGING MAGNETIC FIELD IN THE FUTURE, THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS. UPON COMPLETION OF EACH RAMP RECORD MAIN COIL CONNECTION POLARITIES AND FINAL RAMPING CURRENTS IN CHAPTER 8, SECTION 5, MAGNET RAMPING AND PARKING CURRENT LOG.

12. Record current, frequency and lead extension voltage values at which the switch went 'persistent' in the Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

13. When the switch goes 'persistent,' **slowly** turn the power supply's Voltage Adjust Control to zero (full CCW) over a two minute period.

NOTE: Check that the Teslameter does not decrease as the Voltage Adjust Control is turned to zero. Only the last two digits on the Teslameter should change. If magnetic field strength decreases as the Voltage Adjust Control is turned, the Main Coil Switch is not persistent; slowly adjust the Voltage Control to return to parking field. The magnetic field will drop approximately 1 KHz when the power supply is being dialed down to zero amps.

14. Gradually turn the Current Adjust Control to zero (over a one minute period).

15. Set the Heater 2 Shim Axial Switch to “O” (off).

16. Set the Main Power and Power On switches on the Main Power Supply to “OFF“.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

17. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

18. Remove the Ramp Lead Hold-Down Tool.



WARNING

ELECTRICAL SHOCK HAZARD
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT. DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



WARNING

ELECTRICAL SHOCK HAZARD
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE RAMPING PROCEDURE.
WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.



NOTICE

Step 19 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.

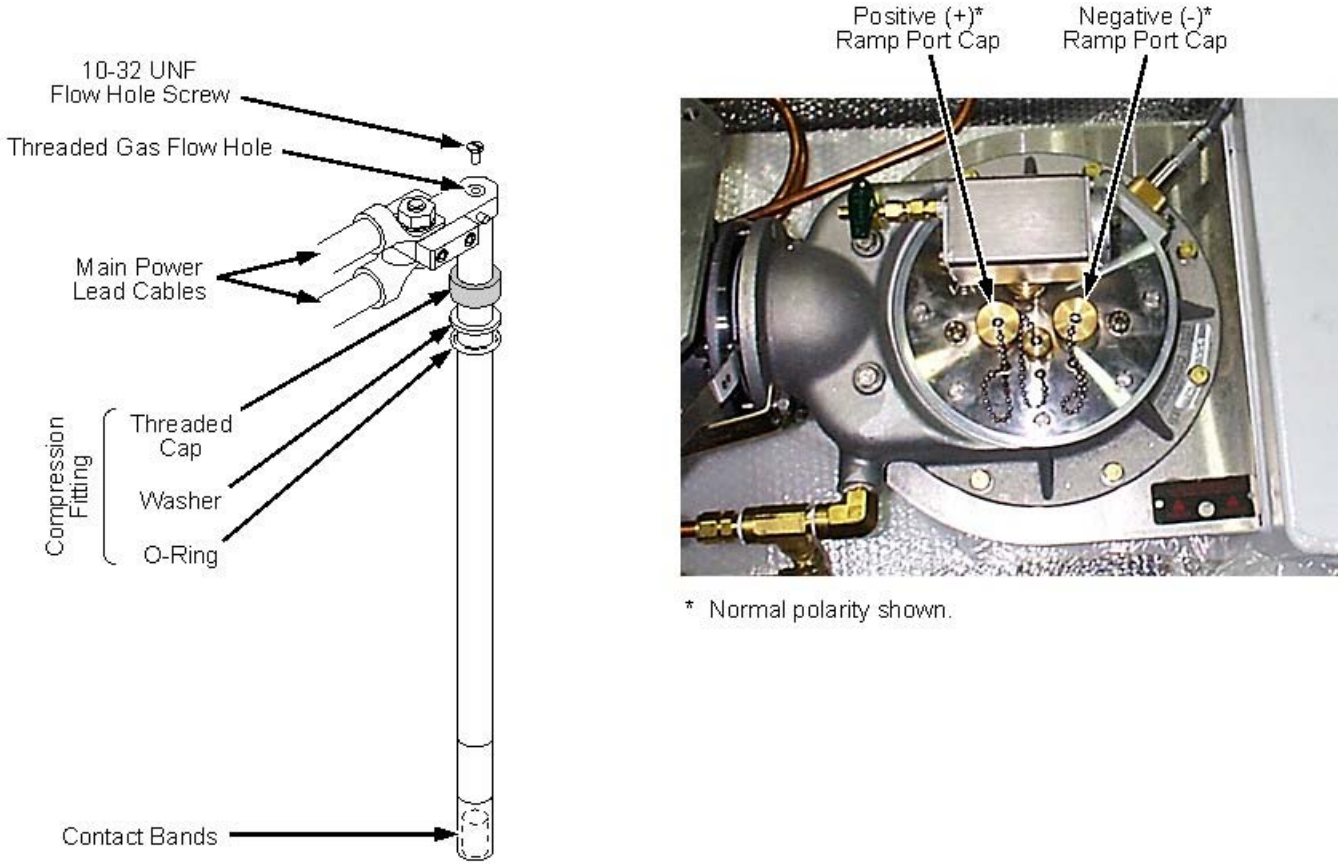
19. After parking the magnet and disconnecting the Main Power Supply, plug and **remove one Main Extension at a time** in the following sequence:

    a. Open Valve V2. Bleed vessel pressure down below 1.0 psig. Do not allow pressure to go below 0.5 psig as read on the magnet pressure gauge or Magnet Monitor. Close V2.

    b. Remove all ice around the ramp lead port compression fitting on the Main Lead Extension that is being removed first. See Illustration 3-98.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-98: Main Lead Extension and Ramp Ports



⚠ WARNING

POTENTIAL MAGNET QUENCH!
PLUGGING THE FLOW HOLE OF AN ENGAGED MAIN LEAD EXTENSIONS WILL CAUSE THE MAGNET TO QUENCH.
DO NOT INSERT FLOW HOLE SCREWS INTO MAIN LEAD EXTENSIONS UNTIL AFTER EXTENSIONS ARE REMOVED.

c. Unscrew the ramp lead port compression fitting and remove the first Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

d. Remove all ice around the ramp lead port compression fitting on the other Main Lead Extension.

e. Unscrew the ramp lead port compression fitting and remove the second Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

f. Install the flow hole screws in the flow hole of both Main Lead Extensions **after** both leads have been removed.

g. Check the Main Leads and fill port cap for leaks.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

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. Plug in the heater on the Magnet Monitor with a setpoint of 4.0 psig. Allow the magnetic field to settle.

NOTE: If a shorter pressure rise time is needed, turn on the Axial Heater on the Main Power Supply.

NOTICE

Make sure any currents induced in the Transverse Coils during ramping are removed in conformance with the 'Magnet Stability Check' subsection of Section 8, Shim Current Adjustment, before centering the Teslameter Probe and shimming the magnet.

21. Continue with Section 8, Shim Current Adjustment.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7.2.3.3.8 1.5T YR Series Ramping



⚠ WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH AND THE COILS BECOME DAMAGED IF THE AXIAL SWITCH HEATERS ARE NOT "ON" DURING RAMPING.
MAKE SURE THE AXIAL SHIM SWITCH HEATERS ARE "ON" DURING RAMPING TO PREVENT COIL DAMAGE AND A MAGNET QUENCH. (GE POWER SUPPLIES HAVE PROTECTIVE CIRCUITRY TO PREVENT RAMPING VOLTAGE WITH THE AXIAL HEATER SWITCH IN THE "OFF" POSITION.)



⚠ CAUTION

Potential Magnet Quench
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.
If a quench occurs during ramping, immediately:

1. **Turn the Main Power Supply Voltage and Current Controls to zero (fully CCW),**
2. **Turn off the Power Supply,**
3. **Leave the room and**
4. **Turn off the Cryocooler Compressor outside the magnet room. Do not reenter the magnet room until the quench is over.**

NOTE: Ice will form around the flow holes in the Ramp Lead Hold-Down Tool during ramping. Remove ice as needed to maintain helium gas flow.

1. Make sure the power supply controls are set as follows:
   - Voltage Adjust Control: **zero (full CCW)**
   - Current Adjust Control: **maximum (full CW)**
   - Main Power Switches on the Main Power Supply: **"ON"**
   - Heater 2 Shim Axial Switch on the Main Power Supply: **"I" (ON)**
   - Voltmeter Select Switch on the Main Power Supply: **"Main Coil" position**

NOTE: Power supply controls are shown in Illustration 3-88 and Illustration 3-89.

2. Set the Heater 1 Main Switch to "I" (on). Wait 3 minutes.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. Use a Range 5 Teslameter Probe (46-255839P104) to monitor magnetic field strength. The probe will lock on when magnet current rises to approximately 325 amps. This usually occurs between 0.6 Tesla and 0.7 Tesla (25.545900 MHz - 29.803550 MHz).

4. Ramp the magnet in conformance with Table 3-18 as follows:

   a. Slowly turn the power supply's Voltage Control to obtain the Main Coil (Ramp) Voltage value shown in the table, starting with 3.00 volts.

   b. Allow the voltage to decay over the current interval shown in the table.

   c. Monitor the power supply's Current Meter. When the limit of the current range for the voltage setting is reached, slowly turn the Voltage Control to obtain the Main Coil Voltage for the next current range.

Table 3-18: 1.5T YR Series Ramping Profile

"Stage"	Main Coil (Ramp) Voltage	Main Coil (Ramp) Current Range	Magnetic Field Strength Reached
1	3.00 Volts	0 Amps - 100 Amps	—
2	2.80 Volts	100 Amps - 200 Amps	
3	2.60 Volts	200 Amps - 300 Amps	
4	2.35 Volts	300 Amps - 400 Amps	
5	2.15 Volts	400 Amps - 500 Amps	
6	1.75 Volts	500 Amps - 550 Amps	
7	1.50 Volts	550 Amps - 600 Amps	
8	1.20 Volts	600 Amps - 625 Amps	
9	1.00 Volts	625 Amps - 650 Amps	
10	0.50 Volts	650 Amps - 675 Amps	
11	0.35 Volts	675 Amps - 720 Amps	
12	Slowly lower from 0.35 Volts to 0.30 Volts	730 Amps	
13	0.30 Volts	—	1.499 Tesla
14	Set voltage as required to maintain constant field	**Use "Recommended Site Parking Field" frequency stated in ATR**	

5. When the Main Coil (Ramp) Current reaches 200 amps, estimate the system inductance by measuring current change over a 10 second ramping interval:

$$L_{Inductance} = 10 \times \text{Voltage} / \text{Current Change}$$

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

6. If inductance (L) is outside the range of 10.9 henries - 11.3 henries, discontinue ramping, measure main coil resistance in conformance with Chapter 4, Section 5, Magnet Electrical Checks, and contact your regional MAC Team representative.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



⚠ WARNING

POTENTIAL MAGNET QUENCH!
1.5T LCC MAGNETS CAN BE QUENCHED IF LARGE CURRENT OR VOLTAGE CHANGES OCCUR NEAR PARKING.
ADJUST THE VOLTAGE CONTROL IN A SLOW, CONTINUOUS MOTION IN THE FOLLOWING STEPS.

7. When the magnet current reaches 730 amps, slowly lower the Voltage Adjust Control from 0.3 V to 0.1 V Main Coil Voltage.

8. When magnetic field strength reaches 1.499 Tesla, slowly adjust the Voltage Adjust Control to a 0.1 V Main Coil Voltage.

NOTE: The magnet's ATR gives the optimum magnet on-site parking field beside “Recommended Site Parking Field.” The parking field is generally 25 Gauss above the final magnetic field strength of 1.5T to compensate for correction coil currents.

9. Check the Teslameter reading and **slowly** adjust the Voltage Adjust Controls as required to bring the magnetic field to frequency shown on the ATR as the “Recommended Site Parking Field." The total current will be approximately 742 amps. Allow the magnetic field to stabilize. The last two digits on the Teslameter should be the only digits changing.

10. Maintain magnetic field at Step 9's setting for 5 minutes before proceeding to Step 11.

NOTE: Observe the Power Supply Voltmeter reading with the Voltmeter Select Switch in “Main Coil” position. When the switch goes 'persistent' the voltage across the magnet terminals will stabilize at 0.00 V.

11. Turn off the Main Switch Heater. Wait a minimum of 15 minutes for the switch to fully cool and go 'persistent.'



⚠ WARNING

POTENTIAL MAGNET QUENCH!
INCORRECT MAIN COIL CONNECTION POLARITY AND RAMPING CURRENT SETTINGS AT A LATER DATE CAN RESULT IN A MAGNET QUENCH WHEN THE MAIN POWER SUPPLY SWITCH IS TURNED ON.
WHEN CHANGING MAGNETIC FIELD IN THE FUTURE, THE MAIN POWER SUPPLY MUST BE SET TO THE SAME CURRENT AND POLARITY IN THE MAIN COILS. UPON COMPLETION OF EACH RAMP RECORD MAIN COIL CONNECTION POLARITIES AND FINAL RAMPING CURRENTS IN CHAPTER 8, SECTION 5, MAGNET RAMPING AND PARKING CURRENT LOG.

12. Record current, frequency and lead extension voltage values at which the switch went 'persistent' in the Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

13. When the switch goes 'persistent,' **slowly** turn the power supply's Voltage Adjust Control to zero (full CCW) over a two minute period.

NOTE: Check that the Teslameter does not decrease as the Voltage Adjust Control is turned to zero. Only the last two digits on the Teslameter should change. If magnetic field strength decreases as the Voltage Adjust Control is turned, the Main Coil Switch is not persistent; slowly adjust the Voltage Control to return to parking field. The magnetic field will drop approximately 1 KHz when the power supply is being dialed down to zero amps.

14. Gradually turn the Current Adjust Control to zero (over a one minute period).

15. Set the Heater 2 Shim Axial Switch to “O” (off).

16. Set the Main Power and Power On switches on the Main Power Supply to “OFF“.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

17. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

18. Remove the Ramp Lead Hold-Down Tool.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT. DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE RAMPING PROCEDURE.
WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.



NOTICE

Step 19 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.

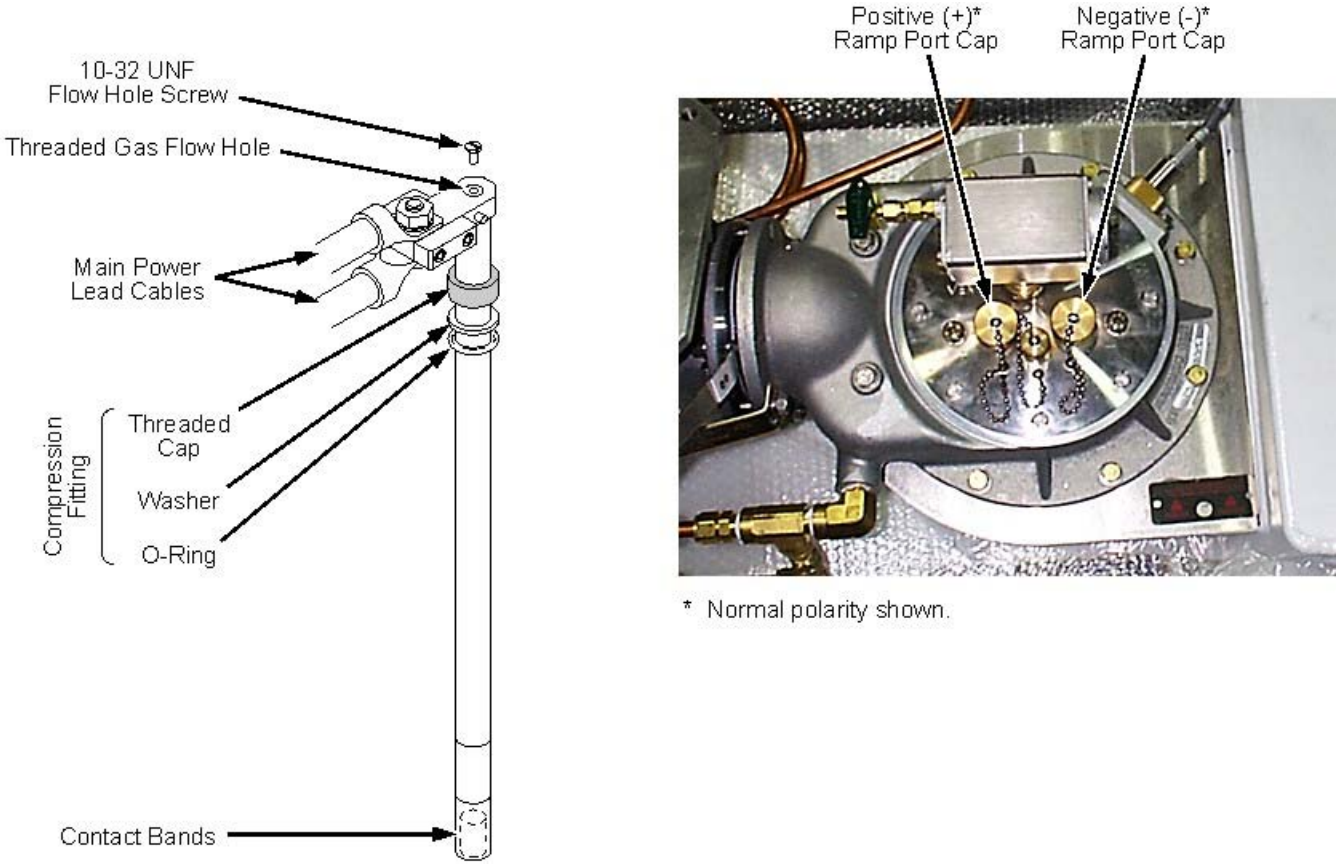
19. After parking the magnet and disconnecting the Main Power Supply, plug and **remove one Main Extension at a time** in the following sequence:

    a. Open Valve V2. Bleed vessel pressure down below 1.0 psig. Do not allow pressure to go below 0.5 psig as read on the magnet pressure gauge or Magnet Monitor. Close V2.

    b. Remove all ice around the ramp lead port compression fitting on the Main Lead Extension that is being removed first. See Illustration 3-99.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-99: Main Lead Extension and Ramp Ports



⚠ WARNING

POTENTIAL MAGNET QUENCH!
PLUGGING THE FLOW HOLE OF AN ENGAGED MAIN LEAD EXTENSIONS WILL CAUSE THE MAGNET TO QUENCH.
DO NOT INSERT FLOW HOLE SCREWS INTO MAIN LEAD EXTENSIONS UNTIL AFTER EXTENSIONS ARE REMOVED.

c. Unscrew the ramp lead port compression fitting and remove the first Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

d. Remove all ice around the ramp lead port compression fitting on the other Main Lead Extension.

e. Unscrew the ramp lead port compression fitting and remove the second Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

f. Install the flow hole screws in the flow hole of both Main Lead Extensions **after** both leads have been removed.

g. Check the Main Leads and fill port cap for leaks.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

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. Plug in the heater on the Magnet Monitor with a setpoint of 4.0 psig. Allow the magnetic field to settle.

NOTE: If a shorter pressure rise time is needed, turn on the Axial Heater on the Main Power Supply.

NOTICE

Make sure any currents induced in the Transverse Coils during ramping are removed in conformance with the 'Magnet Stability Check' subsection of Section 8, Shim Current Adjustment, before centering the Teslameter Probe and shimming the magnet.

21. Continue with Section 8, Shim Current Adjustment.

7.2.4 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8 Shim Current Adjustment

8.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	4 hours - 6 hours	Included in 'Procedure'

8.2 Overview

"Shimming" is the process of measuring the change in the magnetic field over a fixed volume and using the acquired data to improve the field homogeneity. This improvement is accomplished through changes to the shim currents as directed by shimming programs, selected from the Magnet Maintenance Menu. The magnet is shimmed at the factory on a 45 cm DSV. On site shimming is performed after the magnet has been energized to its nominal magnetic field strength and stabilized in conformance with Section 7.2, Ramping Magnet to Field, or when environmental changes significantly reduce the homogeneity of the magnet. 'Shim Current Adjustment' gives the procedure for changing the shim currents in the 1.5T & 1.0T LCC Active Shield Magnets, and was formerly called 'Shimming'.

NOTE: The LV Shim program — included on the current Signa Service Methods CD-ROM (available through your GE Field Service representative), along with instructions for its use — is used along with this Shim Current Adjustment procedure to shim the magnet with factory currents, found in the Acceptance Test Report (ATR), put into the S/C Shim Coils.

NOTE: Allow the magnet to stabilize to < 0.1 ppm/hr (6.3 Hz/hr for 1.5T; 4.2 Hz/hr for 1.0T) main field drift before a full shim of the magnet. This will take from 4 to 12 hours. Other commissioning functions can be performed during this time. The minimum helium level to start shimming is 75%.

8.3 Preliminary Requirements

8.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
Shim Power Supply	1	-	46-260777G3	-
750 Amp Ramp Cable Kit 2135435 or 1000 Amp Ramp Cable Kit w/ Ground 2353394	1	-	2135435 or 2353394	-
Shim Cable Kit (if not already ordered with the magnet)	1	-	2135558	-
MetroLab Teslameter Kit	1	-	46-251865G4	-
#5 MetroLab Probe (included in MetroLab Teslameter Kit 46-251865G4)	1	-	46-255839P104	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

8.3.2 Consumables

No consumables required.

8.3.3 Replacement Parts

No replacement parts required.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE SHIMMING THE MAGNET.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR SHIMMING IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE SHIMMING THE MAGNET.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE SHIMMING THE MAGNET.



WARNING

ASPHYXIATION HAZARD!
THE SHIM CURRENT ADJUSTMENT PROCEDURE GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR.
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE SHIMMING THE MAGNET.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO A MAIN POWER SUPPLY OR A SHIM POWER SUPPLY. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.



NOTICE

Make sure the “C0BO” (Controlled Zero Boil-Off) heater on Magnet Monitor is turned on.



NOTICE

Moving articles or equipment in the Exam Room may affect readings of the magnet's magnetic field strength.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

ONLY use titanium tools when working in the Magnet Room.

8.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting to shim the magnet.	Chapter 1, Section 2	-
The removal of some magnet enclosure components may be required to shim the magnet. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing to shim the magnet if cover removal is required.	Chapter 5, Section 5	-
(continued)	Appendix A, Section 1.1	-
Verify that Magnet Monitor is on and operational. If using proprietary Magnet Monitor software, verify that Magnet Monitor Pressure Control is enabled and operational.	-	-
Verify that the magnet helium level is ≥ 75%. Fill the magnet in conformance with Section 3.2, Liquid Helium Fill, to make sure the helium level is ≥ 75% before continuing the Shim Current Adjustment procedure.	Section 3.2	-
Make sure the magnet room exhaust fan is on and operational before starting to shim the magnet.	-	-
Make sure the magnet room door is propped open — or the hatch is opened if a mobile van — before starting the Shimming procedure.	-	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8.4 Procedure

8.4.1 Preparations for Shim Current Adjustment

8.4.1.1 Initial Preparations

NOTE: Section 8.4.1, Preparations for Shim Current Adjustment, must be completed before adjusting the magnet's shim currents.

1. Prepare for field monitoring using a single #5 MetroLab Probe (46-255839P104) in conformance with Section 4, Preparations for Field Measurement, before shimming, if not already done.

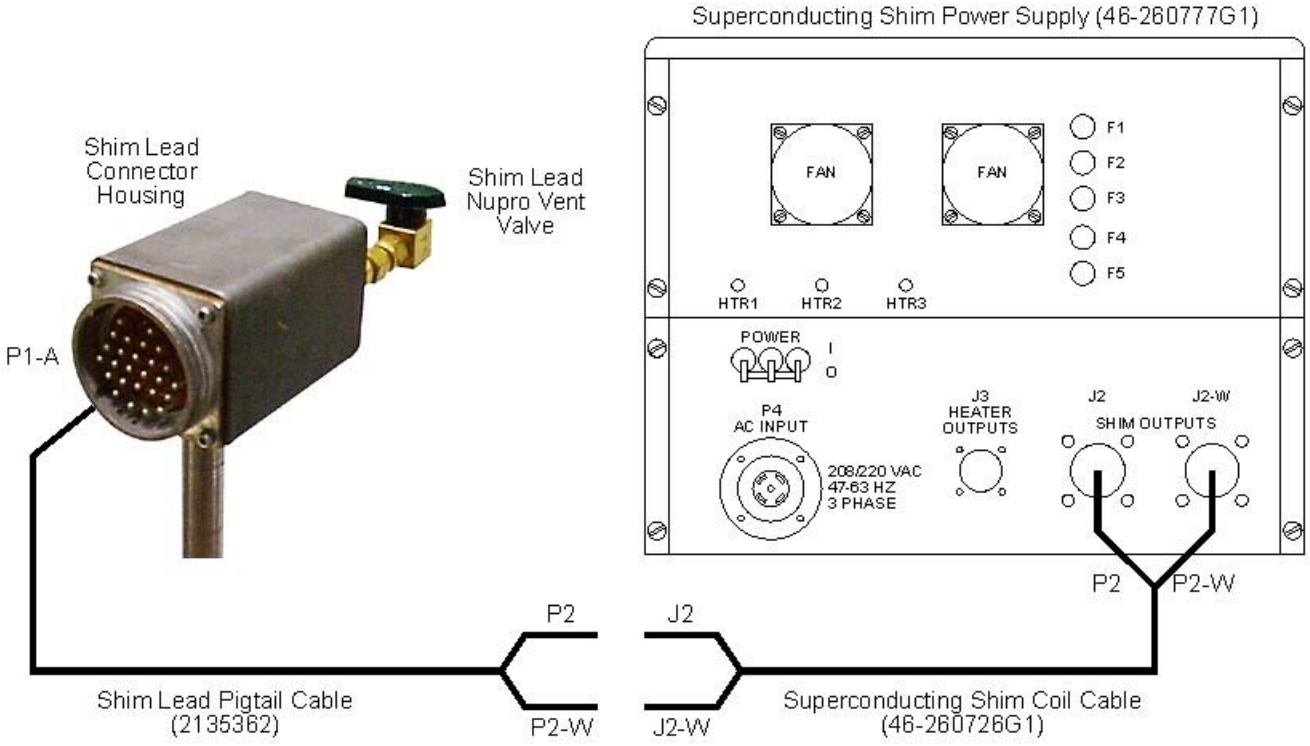
2. Allow the magnet to stabilize to < 0.1 ppm/hr (6.3 Hz/hr for 1.5T; 4.2 Hz/hr for 1.0T) main magnetic field drift before shimming. This will take 4 hours - 12 hours. Other commissioning functions can be performed during this time.

3. Verify that the magnet helium level is ≥ 75%. Fill the magnet in conformance with Section 3.2, Liquid Helium Fill, to make sure the helium level is ≥ 75% before continuing.

8.4.1.2 Shim Coil Power Supply Connections

1. Verify that the Shim Lead Pigtail Cable (2135362) is connected to P1-A on the Shim Lead Assembly in conformance with the 'Superconducting Shim Coil Power Supply Connections to Magnet' subsection of Section 6, Connections for Ramping and Shimming. See Illustration 3-100.

Illustration 3-100: Shim Power Supply Connections to P1-A



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2. Make sure the Shim Lead Assembly is engaged in conformance with Section 5, Shim Lead Engagement and Disengagement.

3. Open the Shim Lead Vent Valve to increase the Shim Leads' ability to carrying current.

NOTICE

Do not connect input power to the Superconducting Shim Coil Power Supply until it is verified that ALL current controls are set to zero (turned fully counterclockwise) and the supply is turned off.

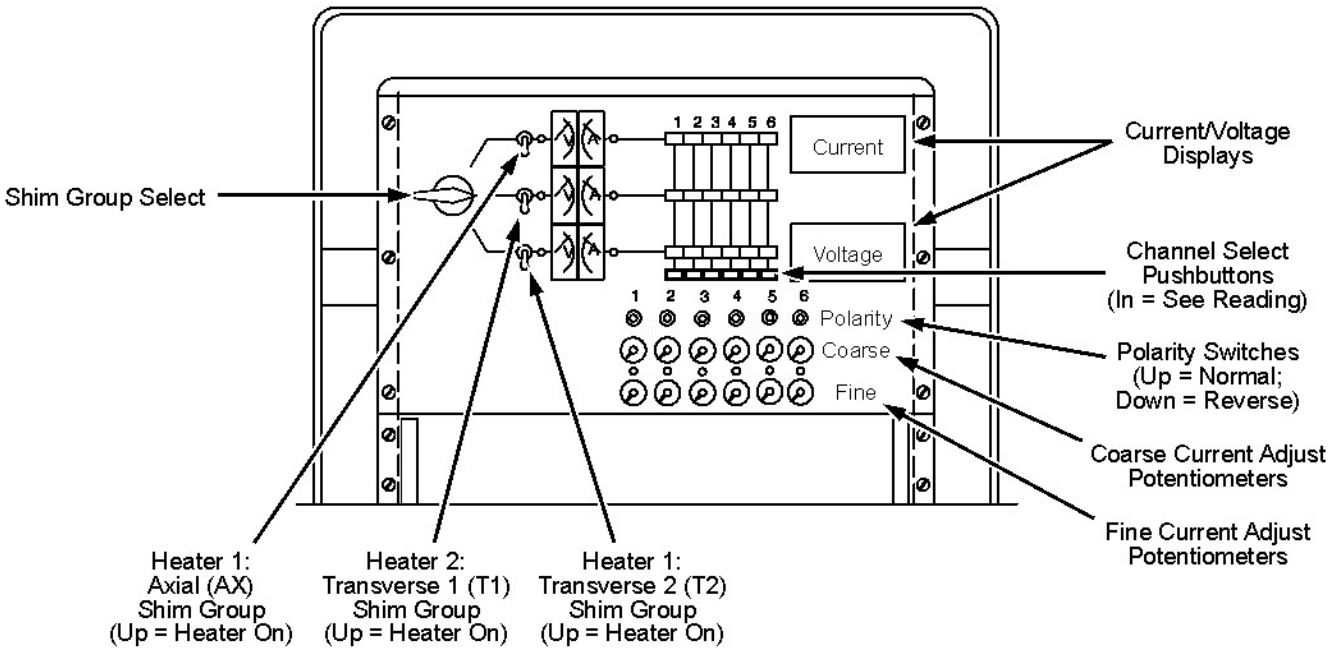
Connecting the Superconducting Shim Coil Harness to the magnet when the Superconducting Shim Coil Power Supply is turned on may cause irreparable damage to the vapor-cooled shim leads.

4. Remove lockout/tagout and connect power to the Superconducting Shim Coil Power Supply and set the Heater Currents: T1 = 610 mA,T2 = 610 mA and Axial = 710 mA. See Section 4 of the vendor's service manual for details.

NOTE: Always check the ATR for any possible magnet-specific current settings.

5. After sufficient cooling of the Shim Lead Assembly, verify that all six shim power supply channels operate at both positive and negative polarities for the Axial, Transverse 1 and Transverse 2 shim groups. See Illustration 3-101.

Illustration 3-101: Shim Power Supply Controls (Front Panel)



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO THE SHIM POWER SUPPLY.

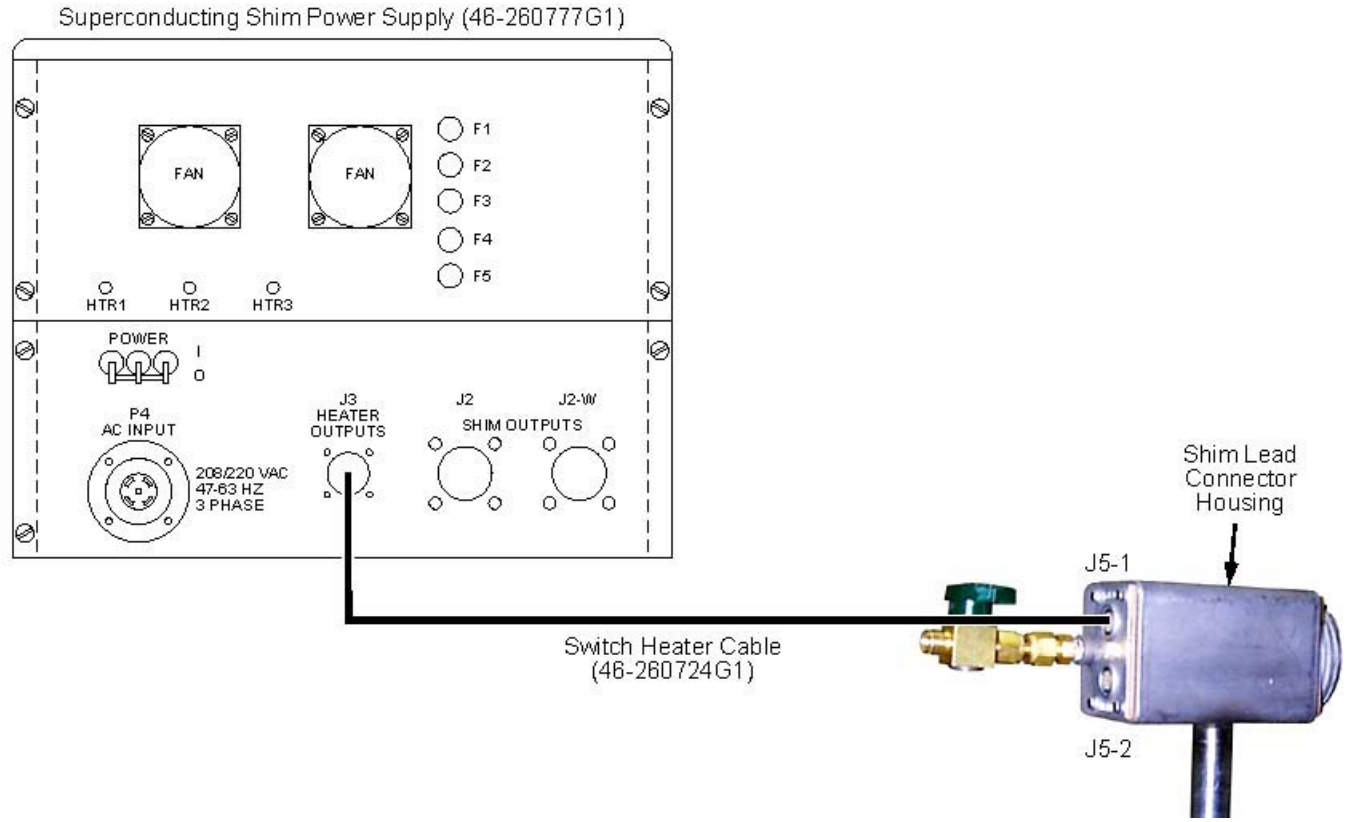
6. Disconnect and lockout/tagout input power to the Shim Coil Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

7. Verify that connectors P2 and P2W on Superconducting Shim Coil Cable 46-260726G1 (run 603) are connected to the J2 and J2-W “Shim Output” connectors on the back of the Power Supply Cabinet (MS7-A1). See Illustration 3-100.

8. Verify that connectors J2 and J2-W on the other end of Superconducting Shim Coil Cable 46-260726G1 are connected to the Shim Lead Pigtail Cable (2135362). See Illustration 3-100.

9. Connect P703 on Switch Heater Cable 46-260724G1 (run 604) to connector J3 on the back of the Superconducting Shim Coil Power Supply Cabinet (MS7-A1). See Illustration 3-102.

Illustration 3-102: Shim Power Supply Connections to J5-1



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

Connect only one Heater Wire Harness to the Shim Lead Assembly.

10. Verify that connector P5 on the Switch Heater Cable (run 604) is connected to connector J5-1 or J5-2 on the Shim Lead Assembly. See Illustration 3-102.

8.4.1.3 Field Stability Check

This check requires at least 2 hours between the first measurement and the second.

NOTICE

Make sure the Teslameter Probe is not moved between readings of the magnet's magnetic field strength.

1. Make sure a #5 Teslameter Probe (46-255839P104) is at the magnet's physical center (R=0, Z=0) and set-up a MetroLab Teslameter (46-251865G4) in conformance with Section 4, Preparations for Field Measurement.

NOTE: If the Teslameter has been turned off, turn it on and wait one hour for stabilization before continuing with this section.

NOTICE

Before turning on the Superconducting Shim Coil Power Supply, make sure all current controls are set to zero (full counterclockwise).

2. Remove lockout/tagout and connect input power to the S/C Shim Coil Power Supply.
3. Turn on (“I”) all Shim Coil Switch Heaters for five minutes to dump any residual Shim Currents. See Illustration 3-101.
4. Turn off (“O”) the Switch Heaters. Allow 3 to 5 minutes for the switch heaters to go persistent before continuing with Step 5.
5. Disconnect the heater cable (P703) from the Shim Coil Power Supply. See Illustration 3-102.
6. Turn off the Shim Coil Power Supply.

WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO THE SHIM POWER SUPPLY.

7. Disconnect and lockout/tagout input power to the Shim Coil Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8. Measure and record the magnetic field (center frequency). This is “Frequency 1”.

NOTE: The “Frequency 1" measurement should be taken as soon after ramping as possible.

NOTICE

Do not move the probe between the first and second measurements.

Do not move or rearrange any articles or equipment in or near the exam room during the test.

9. After at least 2 hours repeat Step 2 - Step 8. Measure and record this as “Frequency 2”.

10. Verify that the magnet has stabilized (0.1 ppm/hr maximum drift) by using this formula:

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

$$\text{Drift Rate (Hz/hr)} = \frac{(\text{Freq 1} - \text{Freq 2})}{N}$$

Where:
Freq 1 = Initial Reading (Hz)
Freq 2 = Reading (Hz) after N Hours
N = Number Hours between Readings

8.4.1.4 Magnet Monitor

NOTICE

Shimming is affected by magnet pressure. Make sure the Magnet Monitor Pressure Controller is functioning properly and that magnet pressure is steady at 3.9 psig - 4.1 psig before starting to shim the magnet.

1. Check magnet pressure. Make sure it is maintained with the 3.9 psig - 4.1 psig range when taking maps of the magnetic field.

2. Verify that the magnet helium level is ≥ 75%. Fill the magnet in conformance with Section 3.2, Liquid Helium Fill, to make sure the helium level is ≥ 75% before continuing.

8.4.1.5 Quench Supercon Shield

1. In order to quench the Supercon Shield around the Coldhead, turn the Cryocooler off for 10 minutes.

NOTE: This only needs to be done before initial shim current adjustment and not between each subsequent iteration of shim current adjustment.

2. —

8.4.2 Shim Coil Power Supply Current Adjustments

The “RECOMMENDED TOTAL CURRENT” values calculated by the shim program must be entered into the S/C Correction Coils before performing subsequent magnetic field mapping. The Correction Coils are organized in groups, each connected to 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 (AX2) coil, the complete

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Axial Set (1 through 6) would have to be dumped and the appropriate currents adjusted for each. The coil groups are:

- **Transverse 1 (T1)**: Transverse Coils T1-1 through T1-6
- **Transverse 2 (T2)**: Transverse Coils T2-1 through T2-6
- **Axial (AX)**: Axial Coils AX1 through AX6



⚠ CAUTION

Potential Magnet Quench
The magnet may quench if the Nupro Valve on the Shim Lead is closed or the Shim Lead is not cold.
Make sure the Nupro Valve is fully open and the valve is frosted before slowly engaging the Shim Lead. Do not remove the Shim Lead's Orifice Cap that controls helium gas flow. Always engage/disengage the Shim Lead in conformance with Section 5, Shim Lead Engagement and Disengagement.



NOTICE

Before turning on the Shim Coil Power Supply and applying shim currents, make sure the following conditions exist to prevent irreparable damage to the vapor-cooled Shim Leads:

- **The orifice on the Shim Lead vent is in place,**
- **The Shim Lead is frosted and**
- **The power supply current controls are set to zero (full CCW).**

NOTE: Shim Lead engagement and disengagement must be done in conformance with Section 5, Shim Lead Engagement and Disengagement.

1. Make sure vapor is escaping the Shim Lead before proceeding to add currents.
2. Input shim currents for one group at a time in conformance with Step 3. The suggested order is:
   - Transverse 1 (T1)
   - Transverse 2 (T2)
   - Axial Coils (Axial)
3. Repeat the following steps for each Shim Coil Group in sequence:
   a. Set the Shim Group Select Switch to the appropriate group (T1, T2 and then Axial). See Illustration 3-101.
   b. Set the existing current in the Shim Coils with the knobs on the Shim Power Supply as follows:
      i. FIRST ITERATION (no currents in the Shim Coils): Set the power supply knobs to zero (0) amps (full CCW).
      ii. SUBSEQUENT ITERATIONS:

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Set the polarity toggle switches as required for positive or negative current.
2. Set the power supply “Coarse" and “Fine" control knobs to match the current level existing in the coils.

NOTE: The polarity relays will not change polarity if there is any current flowing through their respective channels. The current must be reduced to zero before the relays will change to the position indicated by the external switches on the power supply.



NOTICE

When the Switch Heaters are turned on, any existing currents 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.

c. Turn on the appropriate Switch Heater. Verify that the heater current is 810 mA ± 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.

d. Adjust the appropriate Shim Power Supplies to the “RECOMMENDED TOTAL CURRENT” values listed by the shim program. (See also Chapter 8, Section 8, Calculated Shim Coil Correction Currents.)

e. 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 the shim program call for the same change in current in a shim coil, indicating the Shim Switch not going resistive, then one of the two following actions may help drive the Shim Switch resistive:

- Make sure the Heater current is set properly *or*
- Set 20 amps in the coil, then lower current to the required value.

NOTE: Adjust slightly, as required. 1 mA high is better than 1 mA 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).

NOTE: In some cases, the Teslameter frequency in Step 3.f (below) could vary as much as 100 Hz. Shutting off the Coldhead Compressor during acquisition/mapping of shim data may help reduce the frequency change.

f. Check the frequency reading on the Teslameter to make sure the Correction Coils are stable (i.e., change in total magnetic field during two minutes is < 20 Hz). If the current in a coil (especially an axial coil) is changed by a large amount, the necessary time for the current to reach the full value and stabilize could take as long as 15 - 18 minutes. It is extremely important that a Teslameter be used to determine when the correction magnetic field of the Shim Coil has reached a stable condition.

g. Once the magnetic field is stable (see Step 3.f), turn OFF the last Switch Heater turned on and allow the Heater to cool for 5 minutes.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

h. Slowly turn all the Shim Power Supplies back down to zero amperes (full CCW).

i. Repeat Step 1 - Step 3.h for the remaining coil groups.



NOTICE

Make sure the Shim Switch is in the Transfer 1 or Transfer 2 position before turning off the Shim Power Supply to prevent any random quench of the axial shim currents when the Shim Power Supply is turned off.

4. When all currents are set:

a. Turn off the Power Supply.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO THE SHIM POWER SUPPLY.

b. Disconnect and lockout/tagout input power to the Shim Coil Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

c. Disconnect all leads between the magnet and the Shim Coil Power Supply (P2, P2-W, Heater Cable).

5. Close the Shim Lead's Nupro Vent Valve.



NOTICE

Make sure the cap is replaced and does not leak and result in gaseous helium loss or frosting.

6. Retract the Shim Lead in conformance with Section 5, Shim Lead Engagement and Disengagement, tighten the brass cap and check for leaks.

8.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

9 Polarity and Functional Checks

9.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	As Required	Included in 'Procedure'

9.2 Overview

Follow the procedures below if problems are encountered in shimming the magnet with the Superconducting Shim Coils. These procedures will help to identify a Shim Cable wiring error, a Shim Coil switch malfunction, a Switch Heater malfunction or a defective/misaligned Shim Coil. If problems are encountered, refer to Chapter 6, Section 2.1, Magnet System Wiring; Chapter 6, Section 2.2, RuO Circuits and Pinouts; and Chapter 4, Section 5, Magnet Electrical Checks, for troubleshooting assistance.

NOTE: The procedures in this section require Universal Field Mapping Fixture 46-294060G4. See Section 4, Preparations for Field Measurement. Use the black ring and markings on the Mapping Fixture's tube when performing checks in this section.

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

9.3 Preliminary Requirements

9.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Shoes; one pair per person	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
MetroLab Teslameter Kit	1	-	46-251865G4	-
#5 MetroLab Probe (included in MetroLab Teslameter Kit 46-251865G4)	1	-	46-255839P104	-
Universal Field Mapping Fixture	1	-	46-294060G4	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Shim Power Supply	1	-	46-260777G3	-
Field Shim Cable Kit (if not already ordered with the magnet)	1	-	2135558	-

9.3.2 Consumables

No consumables required.

9.3.3 Replacement Parts

No replacement parts required.

9.3.4 Safety

No general safety information.

9.3.5 Required Conditions

Condition	Reference	Effectivity
The removal of some magnet enclosure components may be required to complete this procedure. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with this procedure if cover removal is required.	Chapter 5, Section 5	-
(continued)	Appendix A, Section 1.1	-

9.4 Procedure

9.4.1 Axial Correction Coil Checks

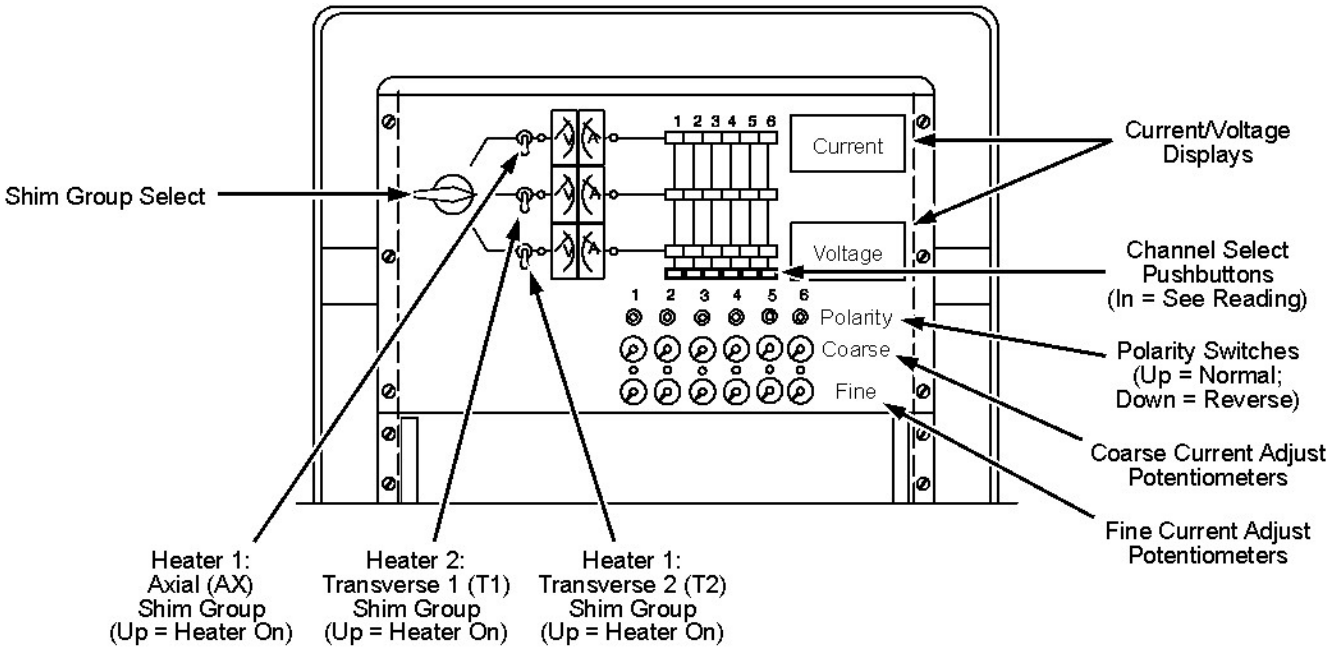
1. Connect the Superconducting Shim Power Supply and cable in conformance with the 'Preparations for Shim Current Adjustment' subsection of Section 8, Shim Current Adjustment.

2. Install and align the Universal Field Mapping Fixture 46-294060G4, Teslameter and Teslameter Probe in conformance with Section 4, Preparations for Field Measurement.

3. Turn on all Switch Heaters for 5 minutes, then turn the heaters off to produce a virgin magnetic field. See Illustration 3-103.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-103: Shim Power Supply Controls (Front Panel)



4. Verify that the #5 Teslameter Probe is at the physical center of the magnet (radius = 0 cm, axial = 0 cm and 0 degree rotation). Adjust Probe position radially, angularly and axially as needed in conformance with Section 4, Preparations for Field Measurement.

5. Record the virgin magnetic field at the magnet center (Z = 0 cm) in Table 3-19.

Table 3-19: Axial Coil Data

S/C Coil	Gauss Reading (15,XXX.X)		
	Z = -20 cm (Table End)	Z = 0 cm (Center)	Z = +20 cm (Service End)
Virgin Map			
Axial 1			
Axial 2			
Axial 3			
Axial 4			
Axial 5			
Axial 6			

6. Move the Probe along the Z-axis and record the virgin magnetic field at Z = -20 cm and at Z = +20 cm.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

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

7. Turn on the Axial and Transverse Switch Heaters. Allow the heaters to warm up for 5 minutes.

8. Set the Axial 1 Shim Coil Power Supply to 10 amps, thereby applying 10 amps to the Axial 1 Coil.

9. Turn off the Axial and Transverse S/C Switch Heaters and allow the heaters to cool for 5 minutes.

10. Ramp the Axial 1 Shim Coil Power Supply down to 0 amps.

11. Position the Probe at Z = -20 cm, Z = 0 cm and Z = +20 cm, recording the measured gauss value at each location in Table 3-19.

12. Subtract each value found in Step 11 from the corresponding point in the virgin map measured in Step 5 and Step 6. Compare these “Gauss Differences” with the coil maps in:

    - Illustration 3-104 for R-, Q-, Yr-, YQ, and QR-series LCC magnets and
    - Illustration 3-107 for RA-series LCC magnets.

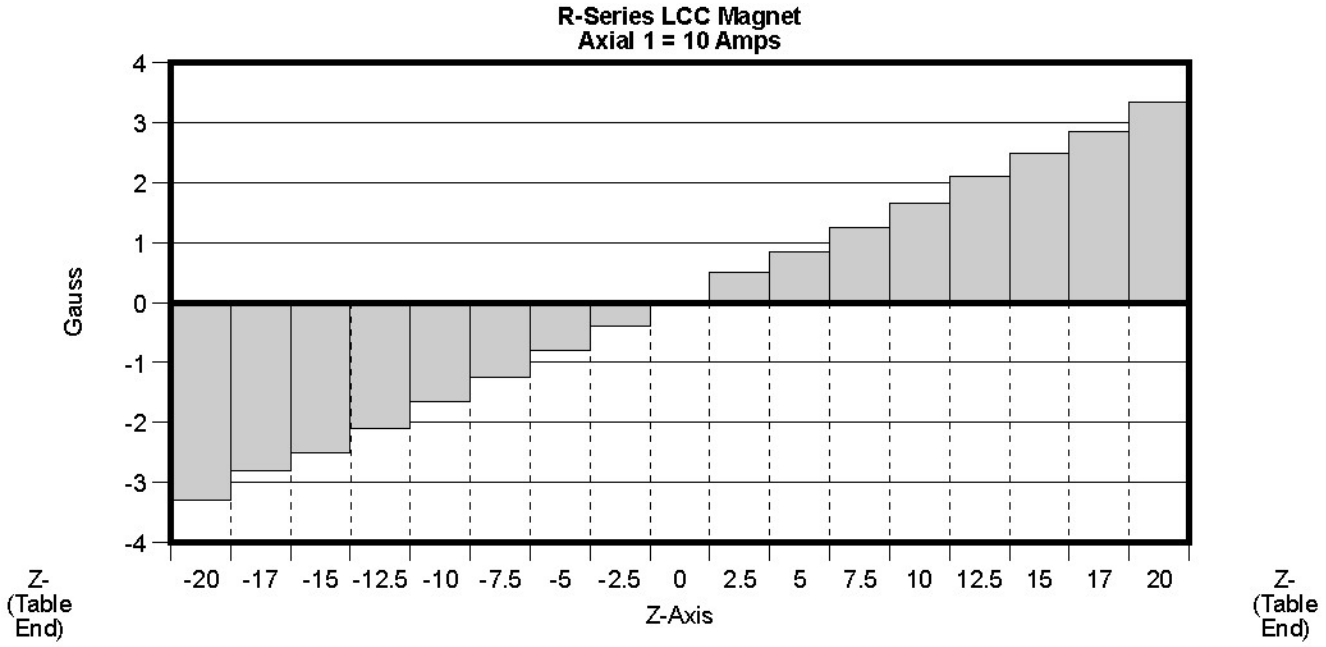
NOTE: If the polarity is correct for the Axial 1 Coil, the gauss value at the Table End (Z = -20 cm) will be approximately 4 gauss less than the -20 cm virgin map value. However, the gauss value at the Service end (Z = +20 cm) will be approximately 4 gauss greater than the +20 cm virgin value.

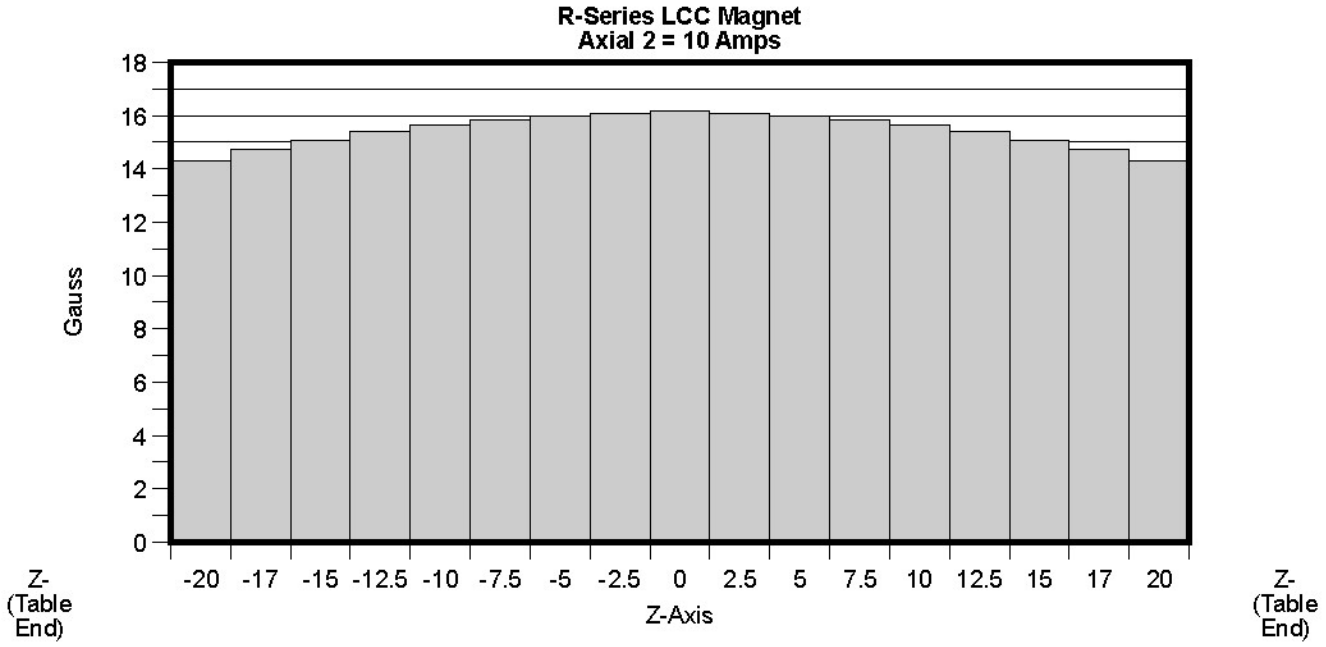
13. Repeat Step 7 through Step 12 for each of the other Axial S/C Coils (Axial 2 through Axial 6).

    - For R-, Q-, Yr-, YQ, and QR-series LCC magnets compare the gauss differences for:
        - Axial 1 and 2 with the plots in Illustration 3-104,
        - Axial 3 and 4 with Illustration 3-105 and
        - Axial 5 and 6 with Illustration 3-106.
    - For RA-series LCC magnets compare the gauss differences for :
        - Axial 1 and 2 with the plots in Illustration 3-107,
        - Axial 3 and 4 with Illustration 3-108 and
        - Axial 5 and 6 with Illustration 3-109.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

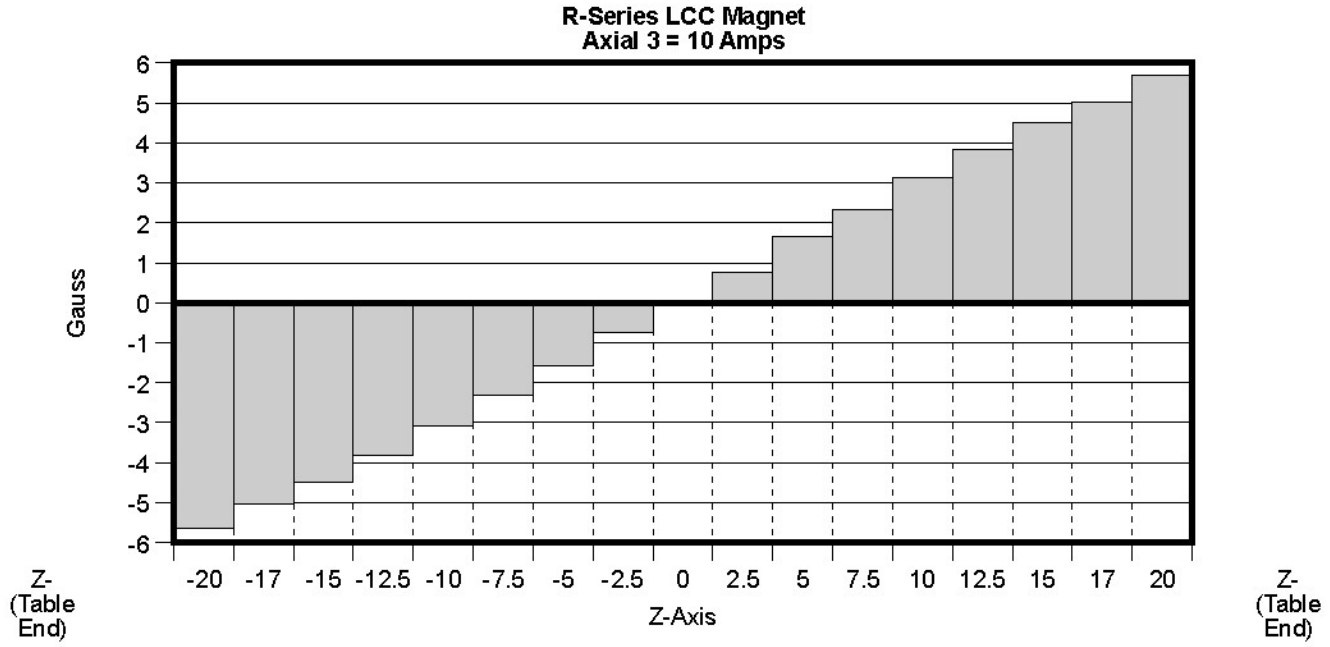
Illustration 3-104: R-, Q-, Yr-, YQ, and QR-Series LCC Magnet Axial 1 and Axial 2 Correction Coil Plots (Normal Polarity & Positive Shim Currents)

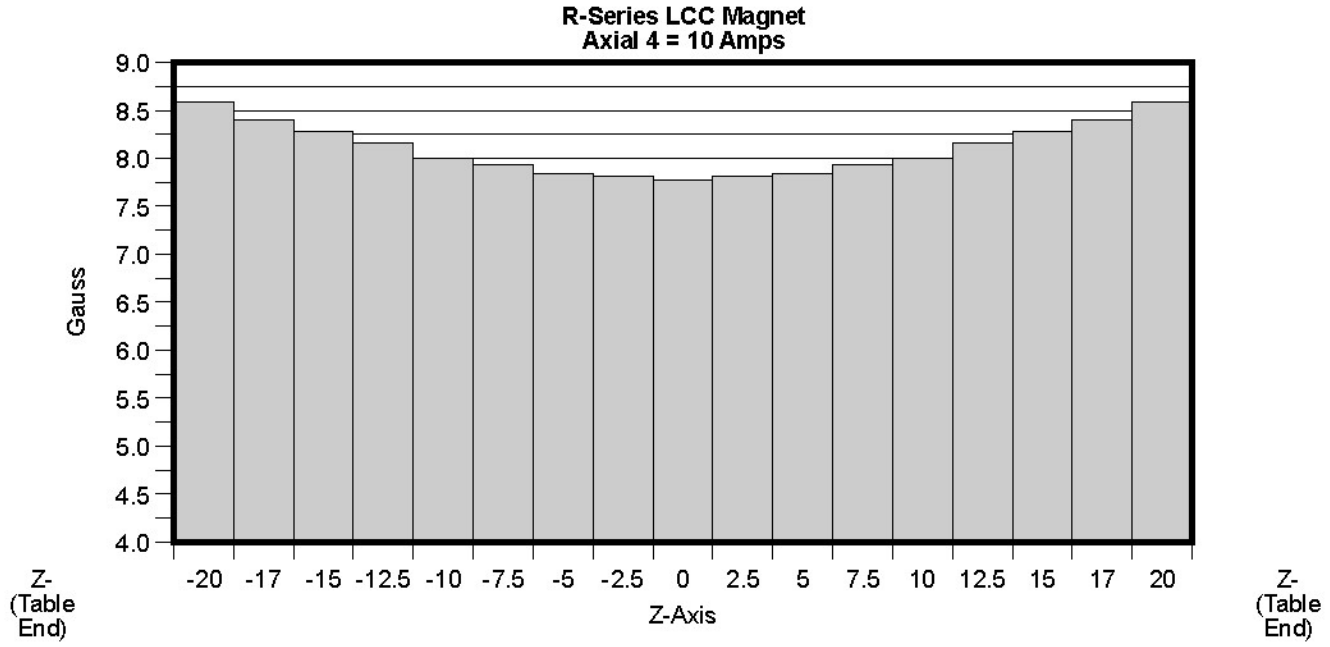




Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

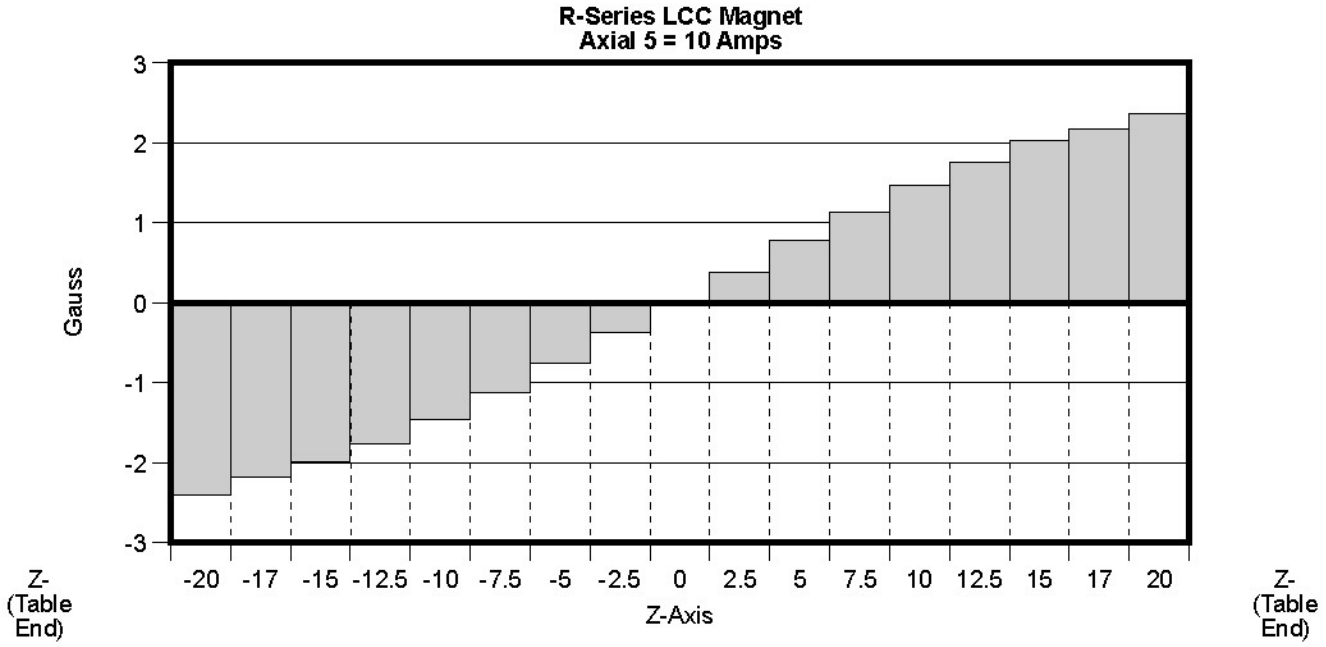
Illustration 3-105: R-, Q-, Yr-, YQ, and QR-Series LCC Magnet Axial 3 and Axial 4 Correction Coil Plots (Normal Polarity & Positive Shim Currents)

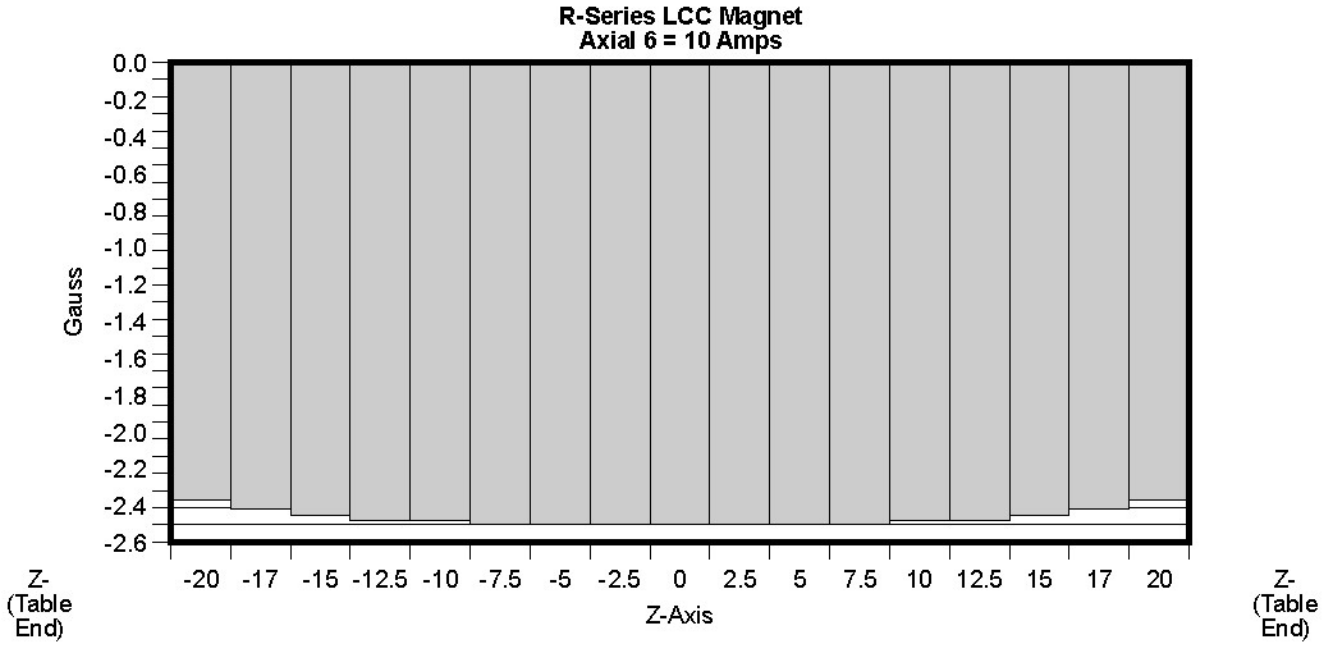




Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

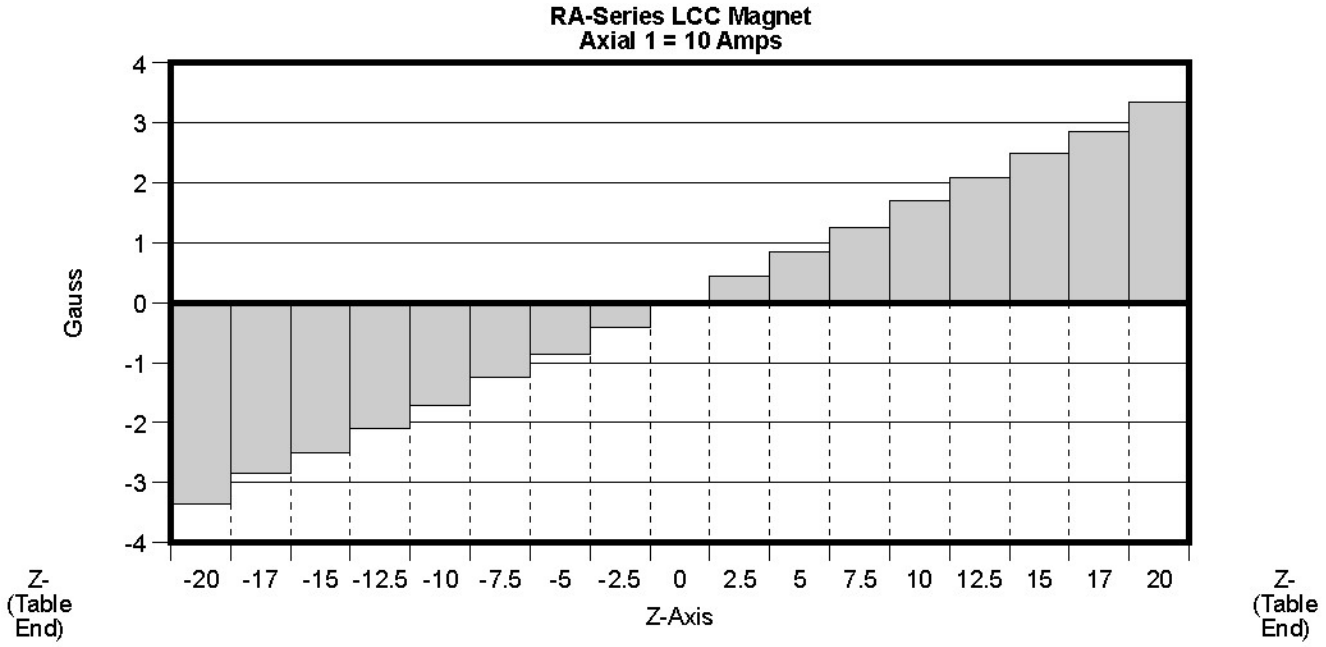
Illustration 3-106: R-, Q-, Yr-, YQ, and QR-Series LCC Magnet Axial 5 and Axial 6 Correction Coil Plots (Normal Polarity & Positive Shim Currents)

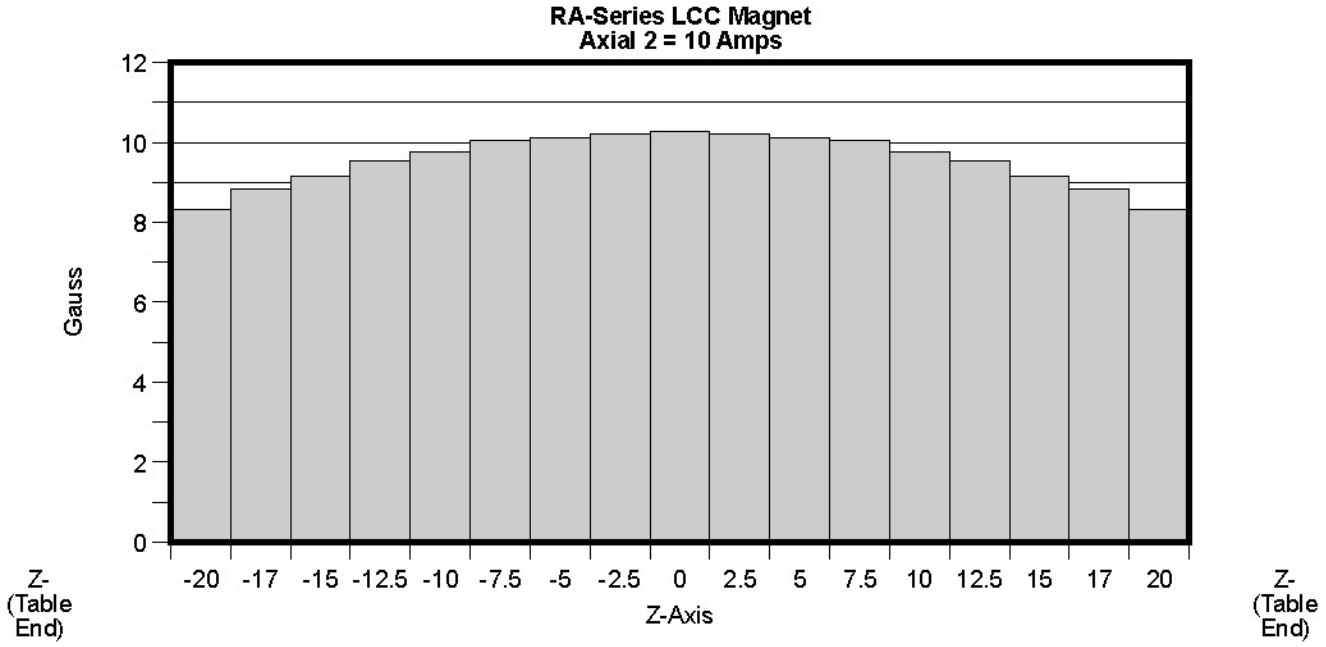




Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

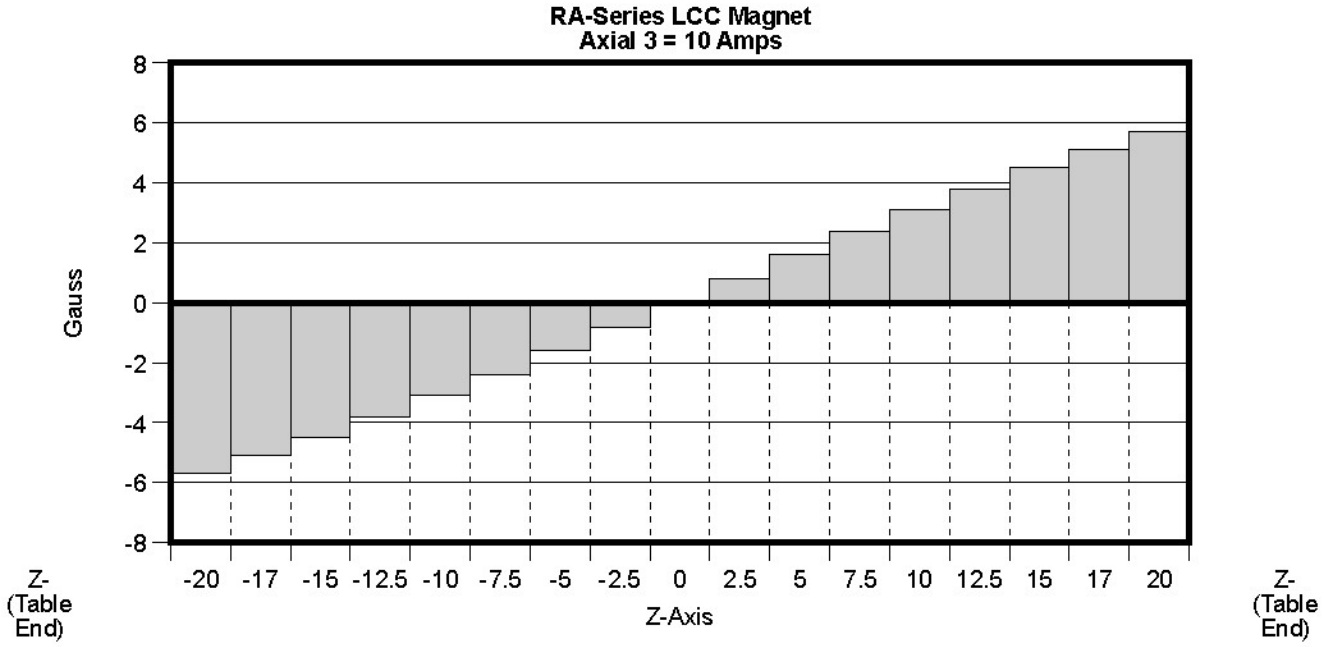
Illustration 3-107: RA-Series LCC Magnet Axial 1 and Axial 2 Correction Coil Plots (Normal Polarity & Positive Shim Currents)

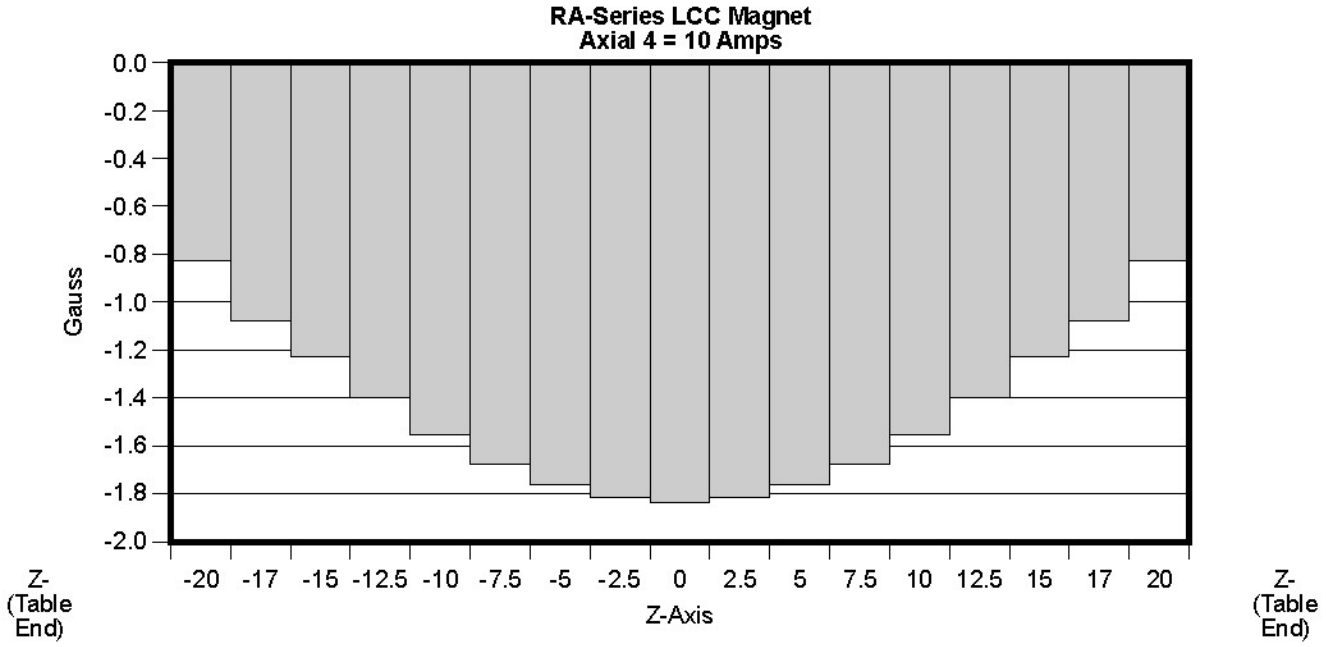




Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

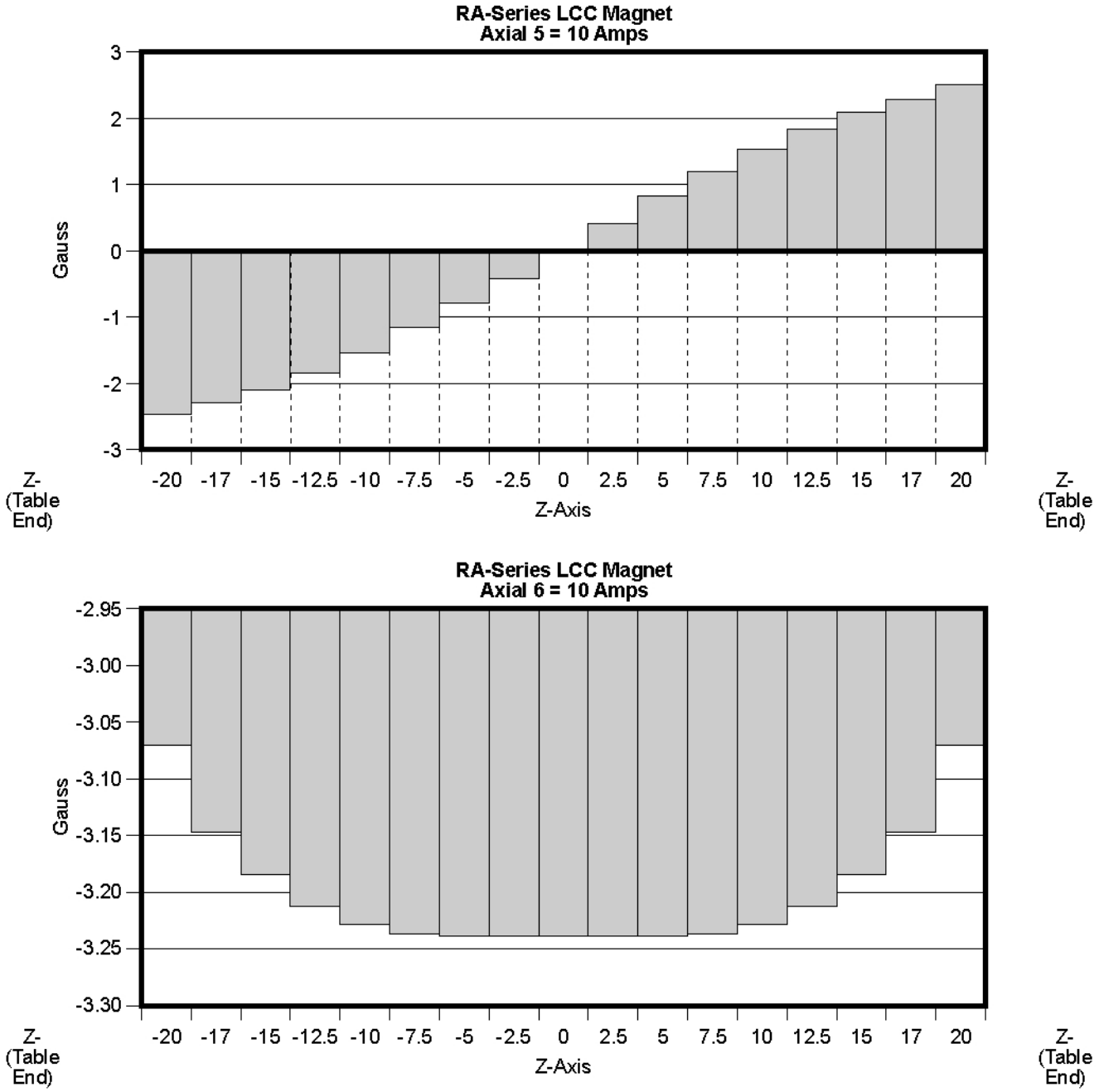
Illustration 3-108: RA-Series LCC Magnet Axial 3 and Axial 4 Correction Coil Plots (Normal Polarity & Positive Shim Currents)





Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-109: RA-Series LCC Magnet Axial 5 and Axial 6 Correction Coil Plots (Normal Polarity & Positive Shim Currents)



9.4.2 Transverse Correction Coil Checks

1. After completing Section 9.4.1, Axial Correction Coil Checks, dump any remaining current in the Correction Coils by turning on both the Axial and Transverse Switch Heaters for one minute. See Illustration 3-103.

2. Set the Mapping Fixture's Radial Slider in conformance with Section 4, Preparations for Field Measurement, to position the Teslameter Probe at the 15 cm radius position.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. Measure and record in Table 3-20 a new “Virgin (0 Amps)” magnetic field map as follows:

   a. Position the Probe axially at Z = -20 cm.

   b. Rotate the Probe to 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315° angular positions, recording in Table 3-20 the “Virgin (0 Amps)” magnetic field reading at each angular position.

   c. Repeat Step 3.a and Step 3.b with the Probe repositioned first to Z = 0 cm and then repositioned to Z = +20 cm.

Table 3-20: Transverse Coil Data

Correction Coil Configuration		Z-Axis	Gauss Reading (XX,XXX.X) with Probe at 15 cm Radius							
Map	Power Supply Current Input(s)		0°	45°	90°	135°	180°	225°	270°	315°
VIRGIN	Virgin (0 Amps)	+20 cm								
		0 cm								
		-20 cm								
C11	T1-2 (C11+) = 10 Amps T1-4 (C11-) = 5 Amps	+20 cm								
		0 cm								
		-20 cm								
S11	T2-2 (S11+) = 10 Amps T2-4 (S11-) = 5 Amps	+20 cm								
		0 cm								
		-20 cm								
C22	T1-3 (C22+) = 10 Amps T1-5 (C22-) = 5 Amps	+20 cm								
		0 cm								
		-20 cm								
S22	T2-3 (S22+) = 10 Amps T2-5 (S22-) = 5 Amps	+20 cm								
		0 cm								
		-20 cm								
C31	T1-1 = 10 Amps	+20 cm								
		0 cm								
		-20 cm								
S31	T2-1 = 10 Amps	+20 cm								
		0 cm								
		-20 cm								
C33	T1-6 = 10 Amps	+20 cm								
		0 cm								
		-20 cm								
S33	T2-6 = 10 Amps	+20 cm								
		0 cm								
		-20 cm								

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4. Turn on the Transverse and Axial Switch Heaters. Allow the heaters to warm for 2 minutes.

5. Measure and record in Table 3-20 maps for C11, S11, C22, S22, C31, S31, C33 and S33 “Correction Coil Configurations” as follows:

    a. Ramp the correct power supply(s) to the current specified in Table 3-20 for the map.

NOTE: For instance, the “C11" map requires T1-2 (C11+) to be ramped to 10 amps and T1-4 (C11-) to be ramped to 5 amps.

    b. Turn off the Axial and Transverse Odd and Even Switch Heaters. Allow the heaters to cool 2 minutes.

    c. Ramp down each power supply mentioned for the map to 0 amps.

    d. Position the Probe axially at Z = -20 cm.

    e. Rotate the Probe to 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315° angular positions, recording in Table 3-20 the map's magnetic field reading at each angular position.

    f. Repeat Step 5.d and Step 5.e with the Probe repositioned first to Z = 0 cm and then repositioned to Z = +20 cm.

    g. Subtract the corresponding “Virgin (0 Amps)” magnetic field value from each data point. Compare these “Gauss Differences” with Illustration 3-110 - Illustration 3-115.

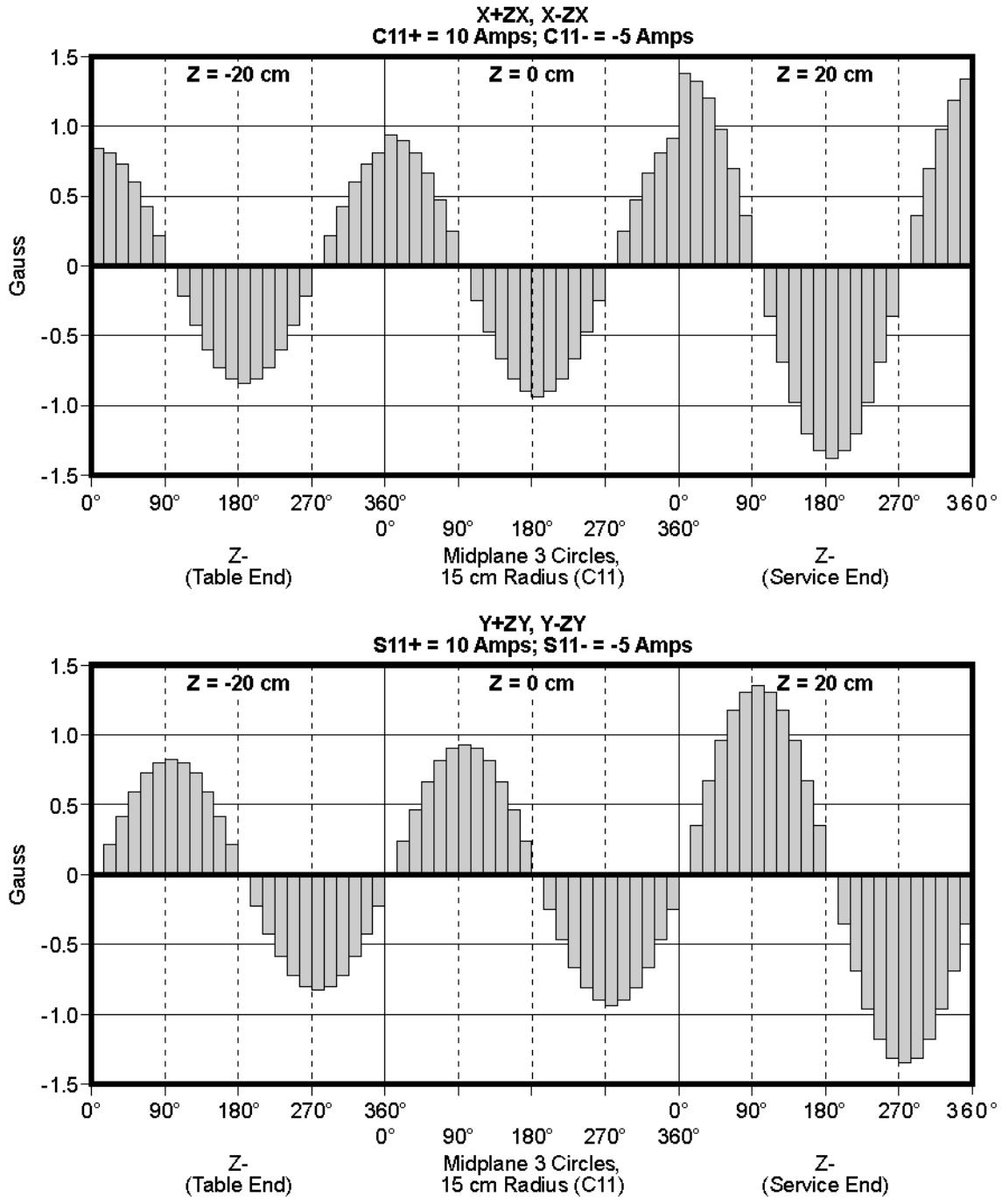
NOTE: The lead connections for any individual coil could be reversed or interchanged (mirrored) with another coil. See Illustration 3-116 and Illustration 3-117 for determining where wiring problems could occur.

    h. Turn on both the Axial and Transverse Switch Heaters. Allow the heaters to warm up for 5 minutes.

    i. Repeat Step 5.a - Step 5.h for the next “Correction Coil Configuration.”

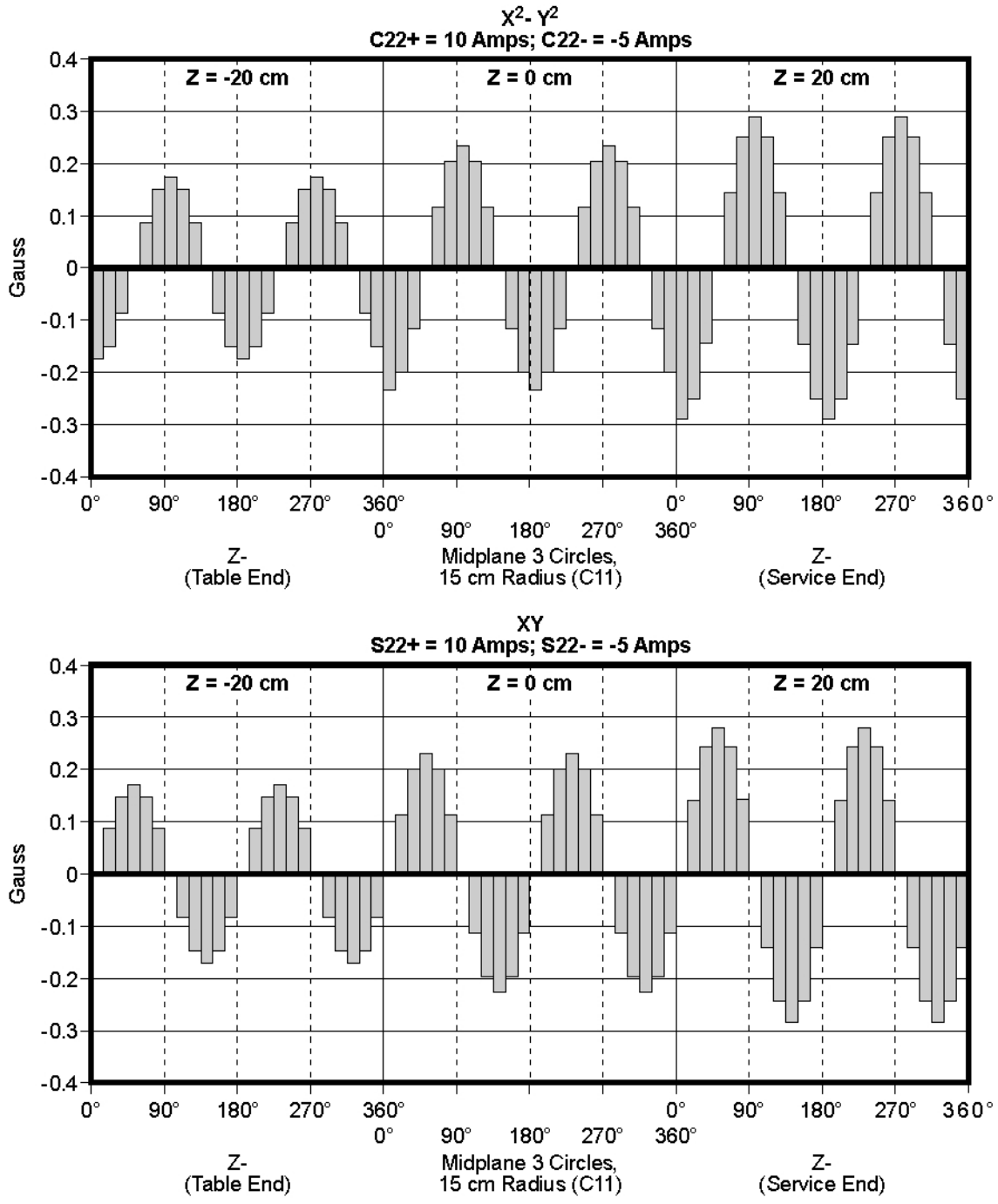
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-110: Transverse Correction Coil Plots, C11 and S11 (Normal Polarity & Positive Shim Currents)



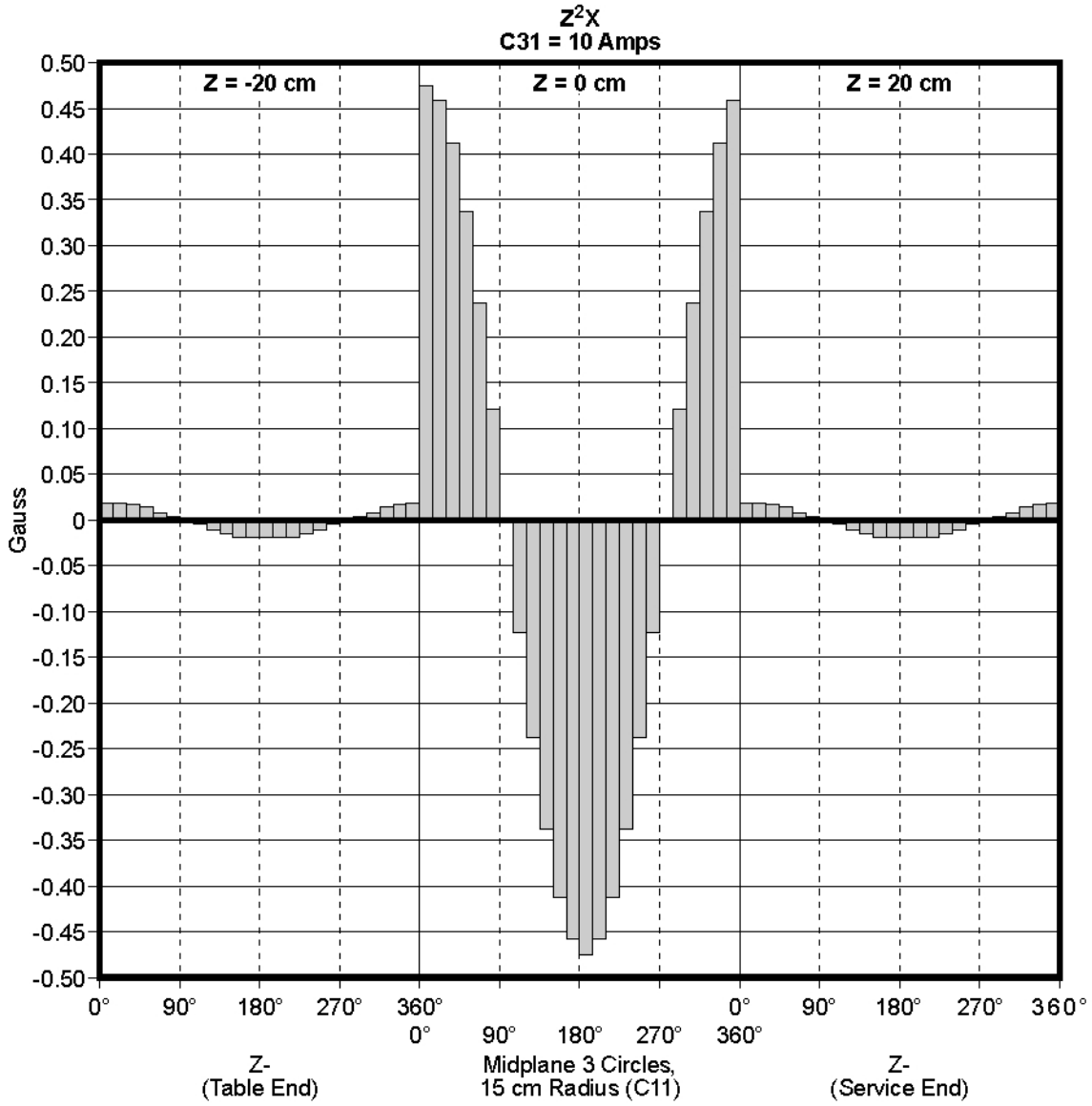
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-111: Transverse Correction Coil Plots, C22 and S22 (Normal Polarity & Positive Shim Currents)



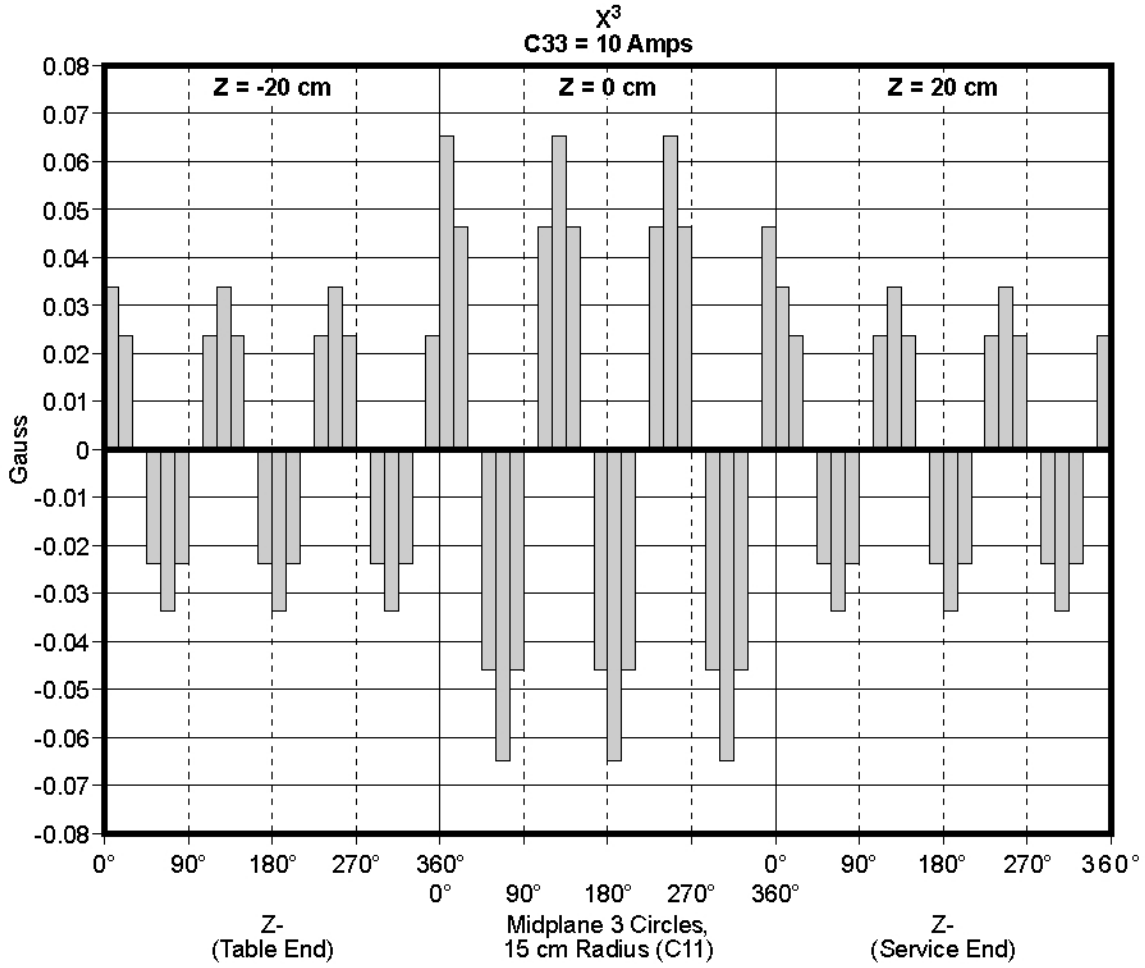
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-112: Transverse Correction Coil Plots, C31 (Normal Polarity & Positive Shim Currents)



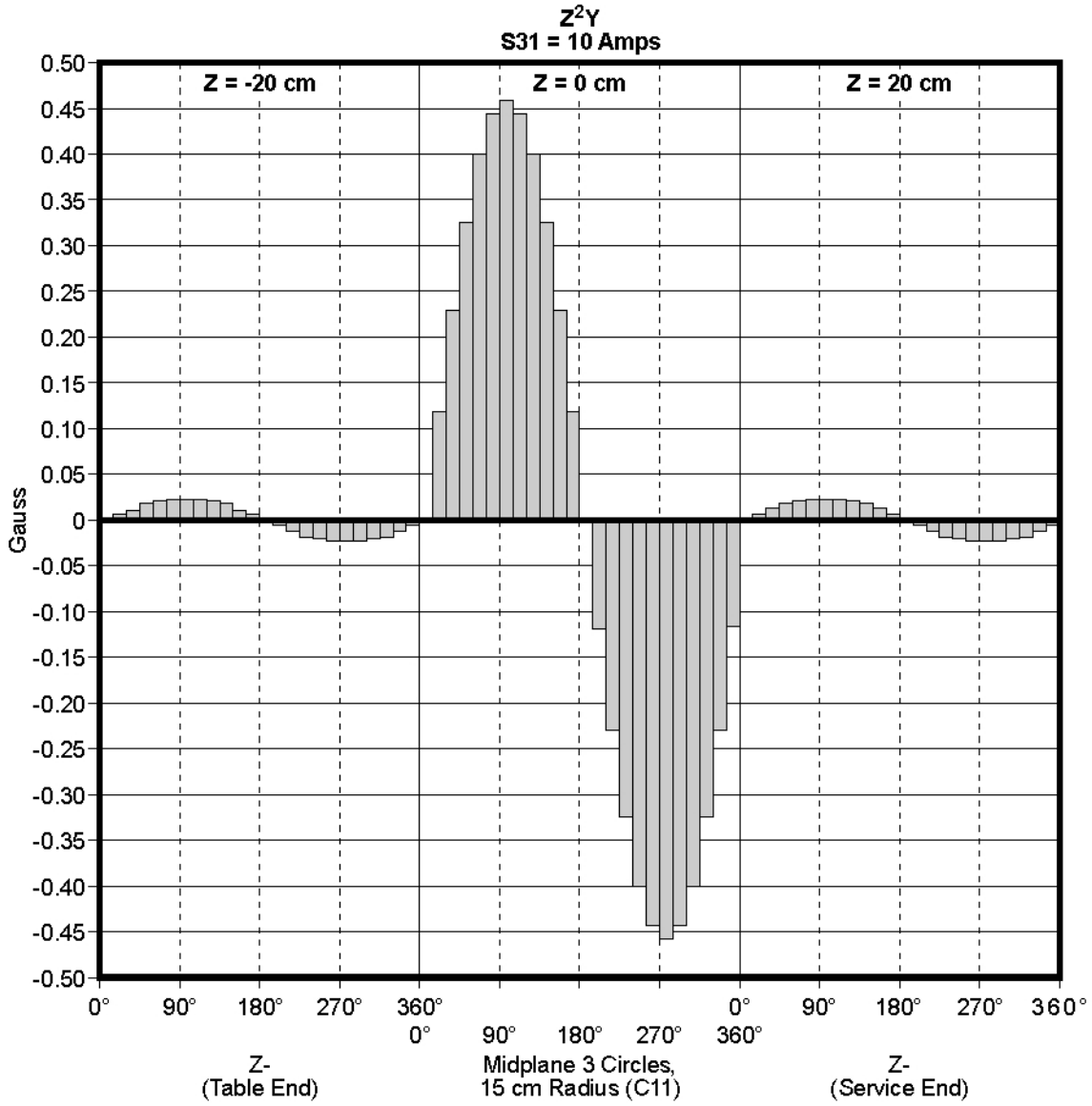
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-113: Transverse Correction Coil Plots, C33 (Normal Polarity & Positive Shim Currents)



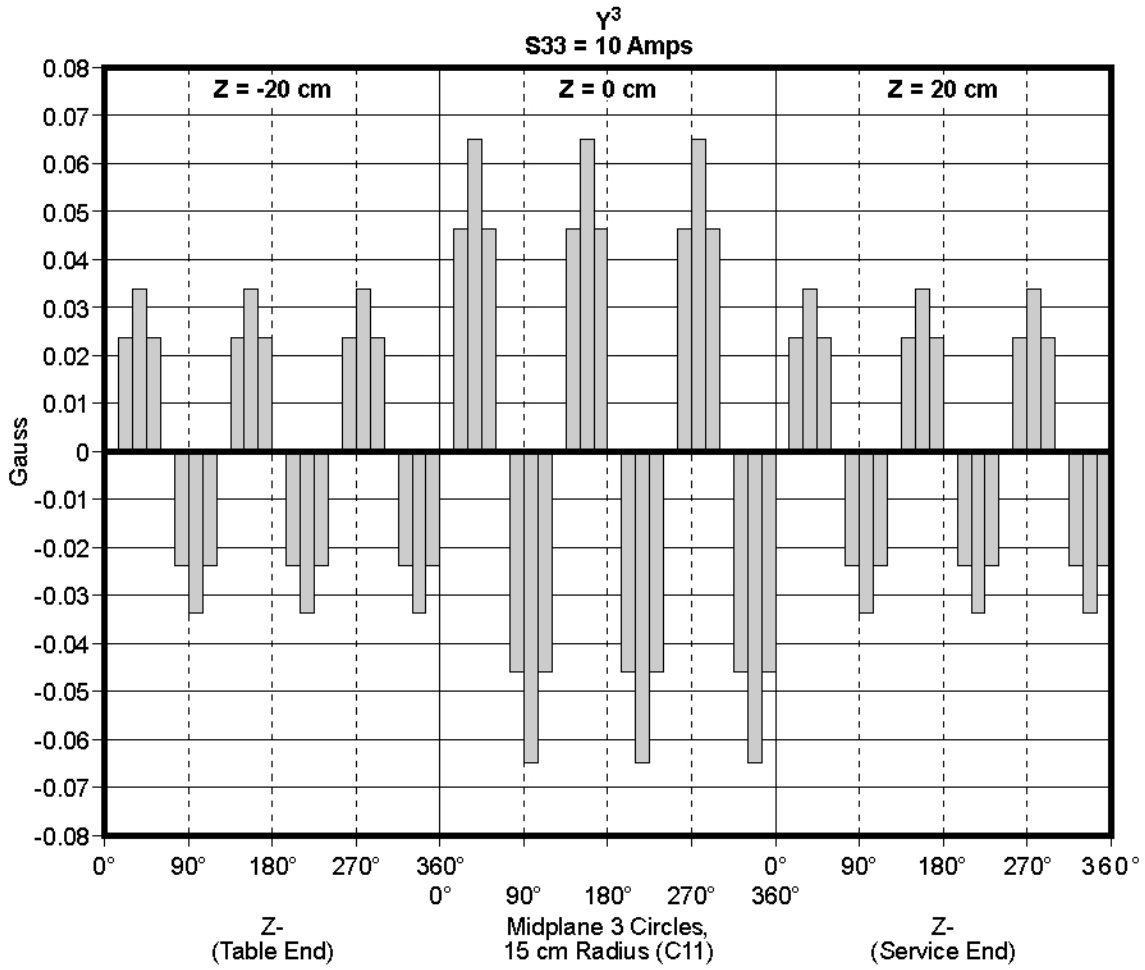
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-114: Transverse Correction Coil Plots, S31 (Normal Polarity & Positive Shim Currents)



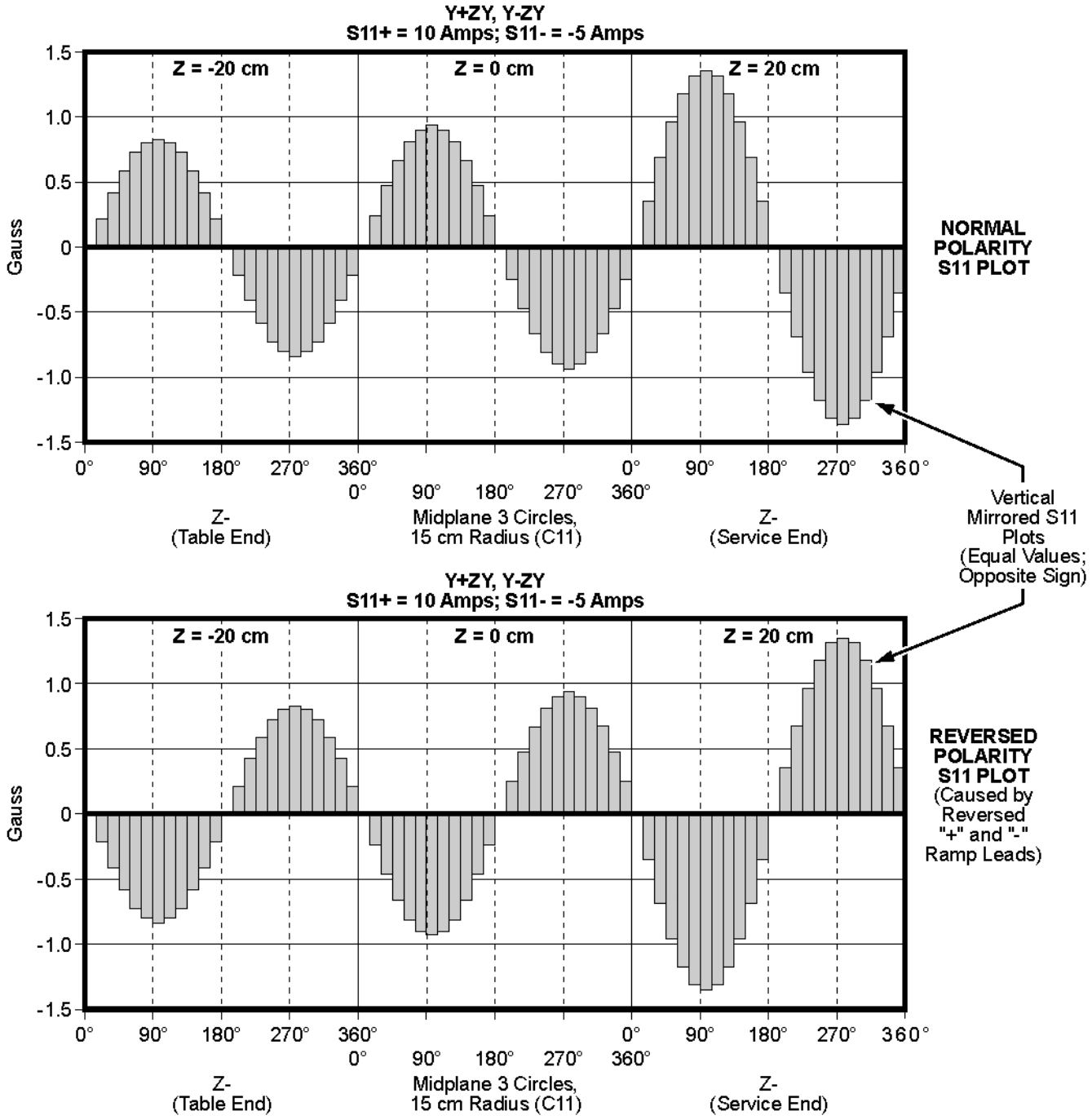
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-115: Transverse Correction Coil Plots, S33 (Normal Polarity & Positive Shim Currents)



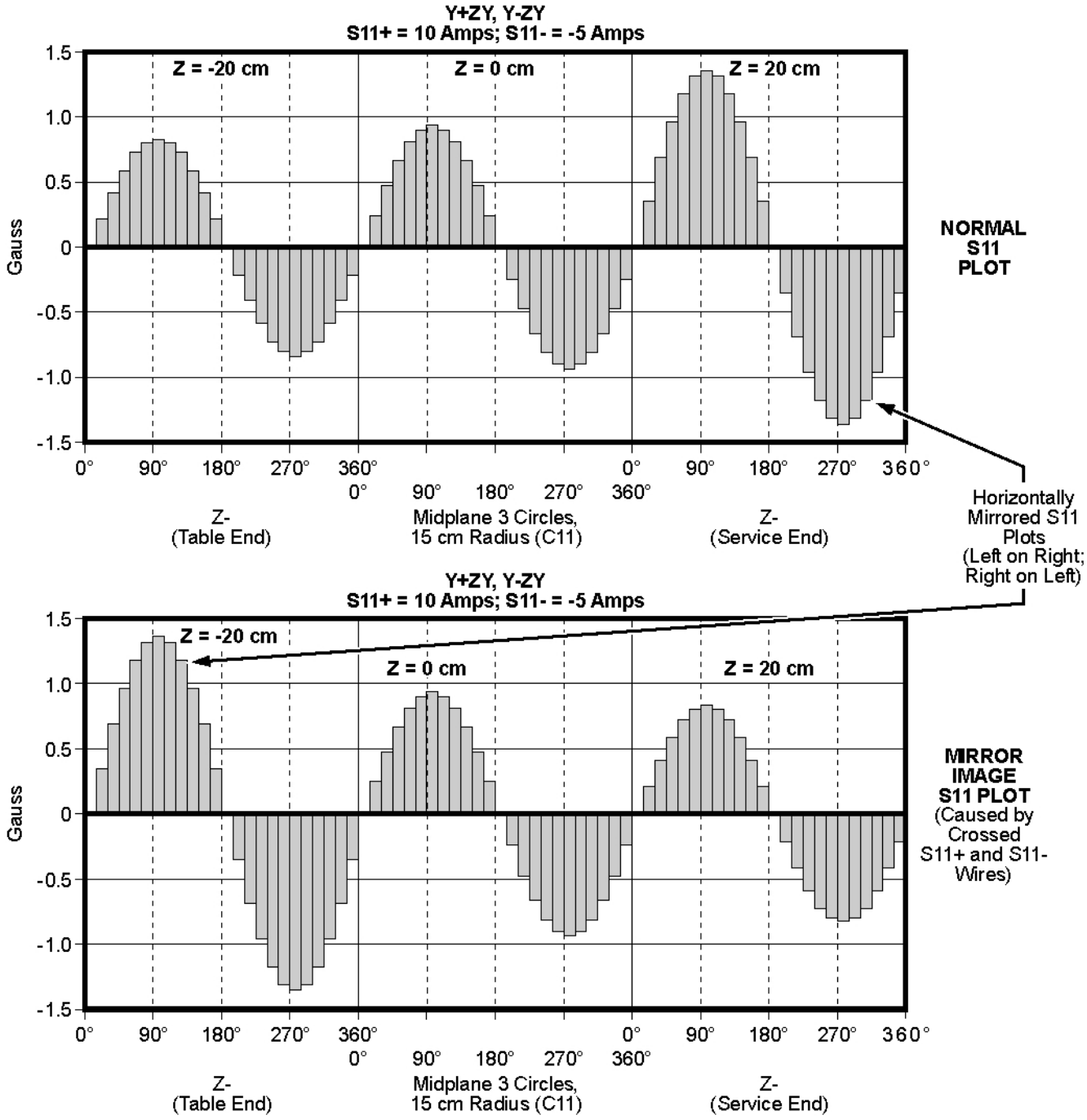
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-116: Correction Coil Wiring Problems: Polarity



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-117: Correction Coil Wiring Problems: Crossed Wires



9.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

10 Field Adjustment after Shimming

10.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	4 hours	Included in 'Procedure'

10.2 Overview

The final magnetic field strength for a 1.0T LCC Magnet is 10,000 Gauss ± 5.0 Gauss (42.576 MHz ± 21.288 KHz). For a 1.5T LCC Magnet it is 15,000 Gauss ± 7.5 Gauss (63.864 MHz ± 31.932 KHz). If the magnetic field is out of range after performing LVshim, the following magnetic field adjustment is required.

NOTE: If the Shim Supply can be powered simultaneously with the Main Power Supply, then the axial shim currents can be dialed in and held constant throughout the magnetic field adjustment procedure.

Refer to the power supply vendor manuals for control locations and descriptions.

10.3 Preliminary Requirements

10.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Digital Voltmeter (DVM)	1	-	-	-
Ammeter	1	-	-	-
Cardboard box or nonferromagnetic frame	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
750 Amp TCR 7.5T750 Main Power Supply 46-260776G3 OR 1000 Amp ESS 7.5-1000-2-D-1236 Main Power Supply 46-260776G4		-	46-260776G3 or 46-260776G4	-
Shim Power Supply	1	-	46-260777G3	-
750 Amp Ramp Cable Kit 2135435 or 1000 Amp Ramp Cable Kit w/ Ground 2353394	1	-	2135435 or 2353394	-
Shim Cable Kit (if not already ordered with the magnet)	1	-	2135558	-
MetroLab Teslameter Kit	1	-	46-251865G4	-
#5 MetroLab Probe (included in MetroLab Teslameter Kit 46-251865G4)	1	-	46-255839P104	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

10.3.2 Consumables

No consumables required.

10.3.3 Replacement Parts

No replacement parts required.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

10.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE FIELD ADJUSTMENT AFTER SHIMMING PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THE FIELD ADJUSTMENT AFTER SHIMMING PROCEDURE IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING THE FIELD ADJUSTMENT AFTER SHIMMING PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE FIELD ADJUSTMENT AFTER SHIMMING PROCEDURE.



WARNING

ASPHYXIATION HAZARD!
THE FIELD ADJUSTMENT AFTER SHIMMING PROCEDURE GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR. MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE STARTING THE FIELD ADJUSTMENT AFTER SHIMMING PROCEDURE.



WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH, RAPIDLY RELEASING CRYOGENIC GASES, IF ITS LIQUID HELIUM LEVEL DROPS TOO LOW DURING THE FIELD ADJUSTMENT AFTER SHIMMING PROCEDURE.
MAKE SURE THE MAGNET ≥ 90% FULL OF LIQUID HELIUM BEFORE STARTING THE FIELD ADJUSTMENT AFTER SHIMMING PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL MAGNET QUENCH!
APPLYING POWER THROUGH THE SHIM LEAD BEFORE THE SHIM LEAD IS SUFFICIENTLY COOLED OR WHILE THE SHIM LEAD'S VENT VALVE IS CLOSED MAY RESULT IN A MAGNET QUENCH.
MAKE SURE THE SHIM LEAD'S NUPRO VENT VALVE IS OPEN AND FROSTING IS VISIBLE ON THE SHIM LEAD HOUSING BEFORE TURNING ON THE SHIM COIL POWER SUPPLY.



WARNING

ELECTRICAL SHOCK HAZARD!
CONNECTING THE MAIN LEAD EXTENSIONS WHILE THE MAIN POWER SUPPLY IS ON WILL CREATE A RAPID ELECTRICAL DISCHARGE OF 100 VOLTS OR MORE.
MAKE SURE INPUT POWER TO THE MAIN POWER SUPPLY IS DISCONNECTED WHEN CONNECTING THE MAIN LEAD EXTENSIONS.



WARNING

ELECTRICAL SHOCK HAZARD!
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT.
DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE FIELD ADJUSTMENT AFTER SHIMMING PROCEDURE.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN PERFORMING THE FIELD ADJUSTMENT AFTER SHIMMING PROCEDURE.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO A MAIN POWER SUPPLY OR A SHIM POWER SUPPLY. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

10.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting the Field Adjustment after Shimming procedure.	Chapter 1, Section 2	-
The removal of some magnet enclosure components may be required to complete the Field Adjustment after Shimming procedure. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with the Field Adjustment after Shimming procedure if cover removal is required.	Chapter 5, Section 5	-
(continued)	Appendix A, Section 1.1	-
Make sure the Shim Power Supply has been calibrated in conformance with the vendor manual (46-294439P7) and that the heater currents are set to Transverse 1 = 610 mA ± 5 mA, Transverse 2 = 610 mA ± 5 mA and Axial = 710 mA ± 10 mA.	-	-
Make sure the liquid helium level is ≥ 90% before starting the Field Adjustment after Shimming procedure.	Section 3.2	-
The Shim Lead must be engaged, pre-cooled and frosted in conformance with Section 5, Shim Lead Engagement and Disengagement, before entering shim currents.	Section 5	-
Make sure the magnet room exhaust fan is on and operational before starting the Field Adjustment after Shimming procedure.	-	-
Make sure the magnet room door is propped open — or the hatch is opened if a mobile van — before starting the Field Adjustment after Shimming procedure.	-	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

10.4 Procedure

10.4.1 Removing Transverse and Axial Shim Currents

1. "Top" fill the magnet to > 90% helium level in conformance with Section 3.2, Liquid Helium Fill, before continuing with the Field Adjustment after Shimming procedure.

2. Replace the Main Lead Extension's Contact Bands in conformance with Chapter 5, Section 4, Main Lead Extension Contact Band Replacement.



⚠ CAUTION

Potential Magnet Quench
The magnet may quench if the Nupro Valve on the Shim Lead is closed or the Shim Lead is not cold.
Make sure the Nupro Valve is fully open and the valve is frosted before slowly engaging the Shim Lead. Do not remove the Shim Lead's Orifice Cap that controls helium gas flow. Always engage/disengage the Shim Lead in conformance with the Shim Lead Engagement and Disengagement procedure. See Section 5.

3. Make sure the Shim Lead Assembly is engaged in conformance with Section 5, Shim Lead Engagement and Disengagement.

4. Set up a Teslameter and #5 Probe for single point magnetic field measurement in conformance with Section 4, Preparations for Field Measurement, making sure the probe is at the physical center (R = 0, Z = 0) of the magnet.

5. Make sure the Magnet and Shim Power Supplies are checked and adjusted in conformance with the vendor manuals supplied with each unit.

NOTE: Refer to the vendor manuals for power supply control locations and descriptions.

6. Make sure the Shim Lead Vent Valve is open and that there is frost on the Shim Lead Connector Housing before removing shim currents.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO A MAIN POWER SUPPLY OR A SHIM POWER SUPPLY.

7. Disconnect and lockout/tagout input power to both the Main and Shim Coil Power Supplies. Verify that no voltage is present by using a DVM or equivalent measuring device.

8. Measure the present Base Frequency of the magnet's magnetic field; from this subtract the desired Center Frequency to calculate the "Delta Frequency."

Base Freqency - Center Frequency = Delta Frequency

Delta Frequency = _____ Hz

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

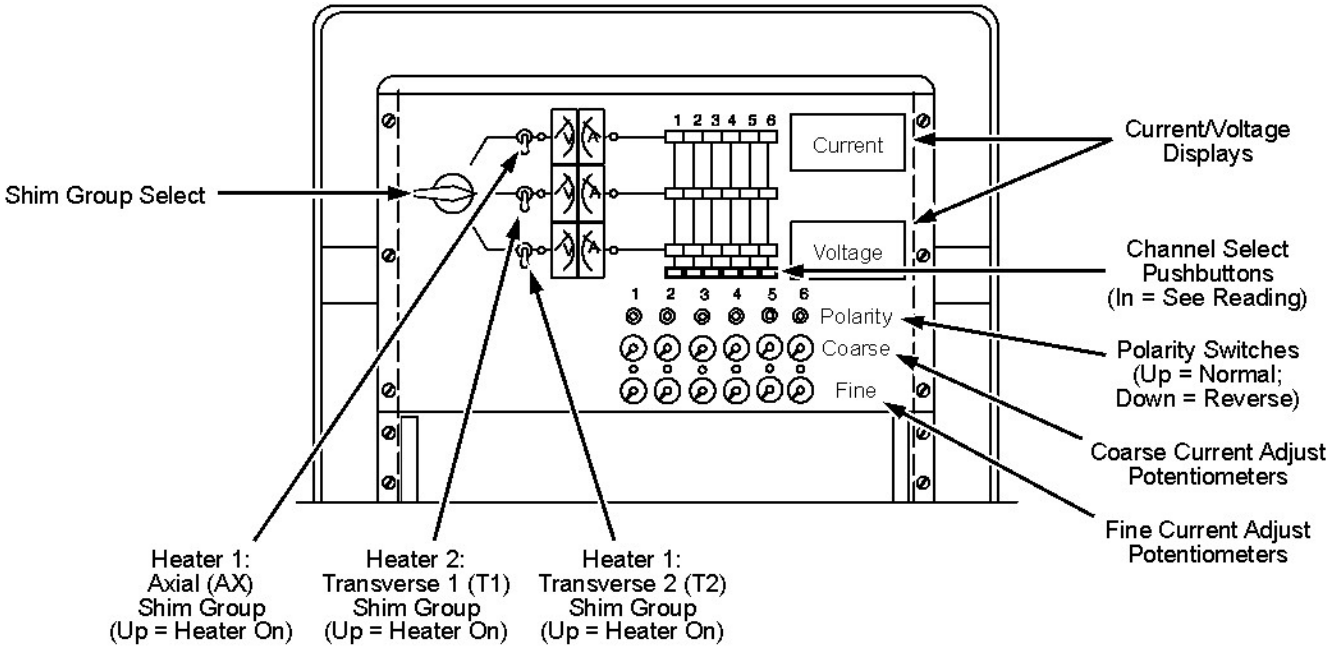
9. Connect the Shim Power Supply to the magnet in conformance to the Preparations for Shim Current Adjustment subsection of Section 8, Shim Current Adjustment.

10. Remove lockout/tagout and connect the input power cable to the Shim Power Supply.

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

12. Set the Shim Group Select Switch to the appropriate group (T1, T2 and then Axial). See Illustration 3-118. It is recommended that the Transverse Coils be ramped down first, then finally the Axial Coils.

Illustration 3-118: Shim Power Supply Controls (Front Panel)



13. Dial into the Shim Power Supply all last recorded Shim Currents, from Chapter 8, Section 8, Calculated Shim Coil Correction Currents. Make sure the shim current polarities are correct.

14. Turn on appropriate Switch Heater (T1, T2 or Axial) on the Shim Power Supply. Verify that the heater currents are set to Transverse 1 = 610 mA ± 5 mA, Transverse 2 = 610 mA ± 5 mA and Axial = 710 mA ± 10 mA. If any current level is not correct, adjust the adjustment screw on the rear of the Shim Power Supply.

15. Allow 5 minutes for the Switch Heater to drive the switches resistive.

16. Slowly adjust the Current Controls for the appropriate shim group (T1, T2 or Axial) to zero.

17. Turn off the appropriate Switch Heater (T1, T2 or Axial).

18. Repeat Step 12 through Step 17 for the Transverse 2 Coils and then for the Axial Coils.

19. Turn off main power to the Shim Power Supply.

20. Disconnect the heater cable from Shim Power Supply.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO THE SHIM POWER SUPPLY.

21. Disconnect and lockout/tagout input power to the Shim Coil Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

10.4.2 Resistance Checks



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO THE MAIN POWER SUPPLY.

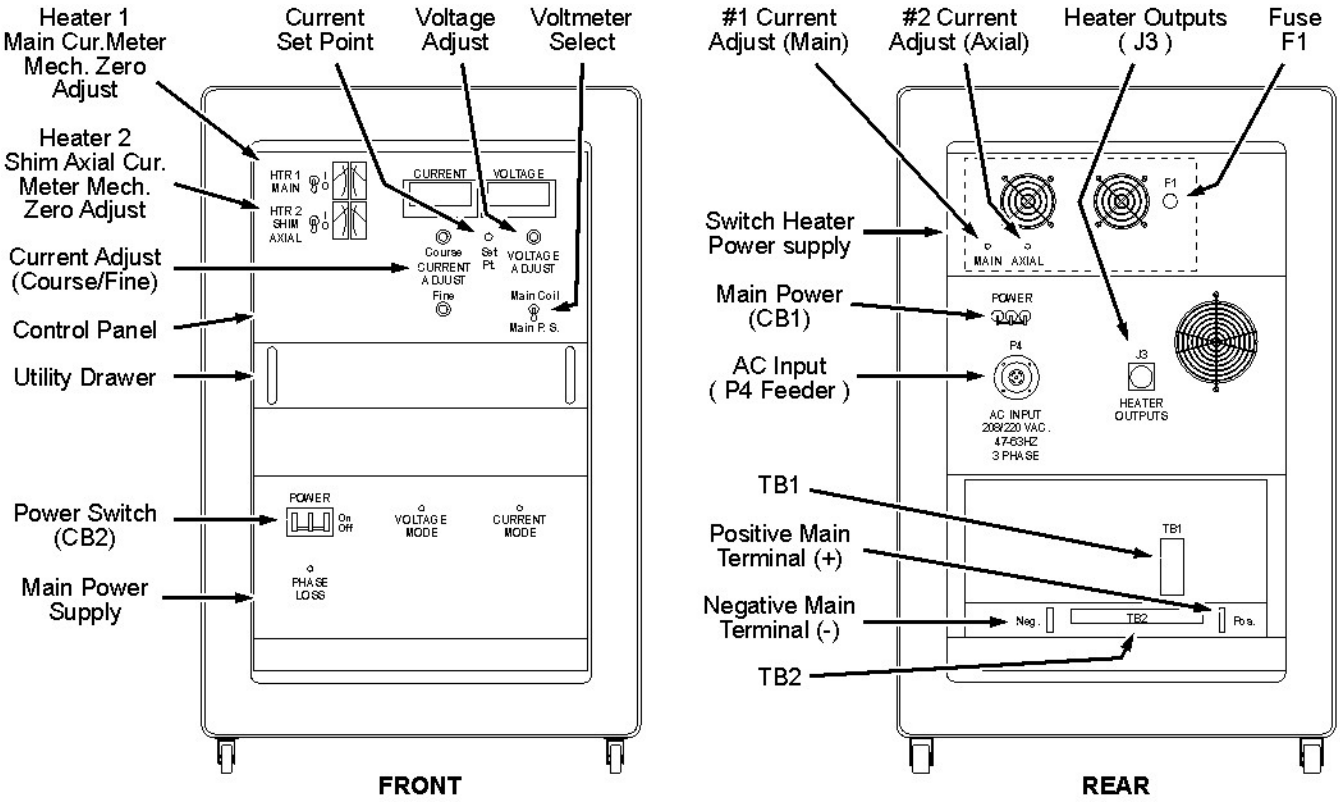
1. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

2. If resistance checks were not previously performed on the ramping circuit, connect the Main Power Supply and Main Lead Extensions to the magnet in conformance with Section 6, Connections for Ramping and Shimming.

3. Make sure all power supply Heater Switches are set to “O” (off). See Illustration 3-119 or Illustration 3-120.

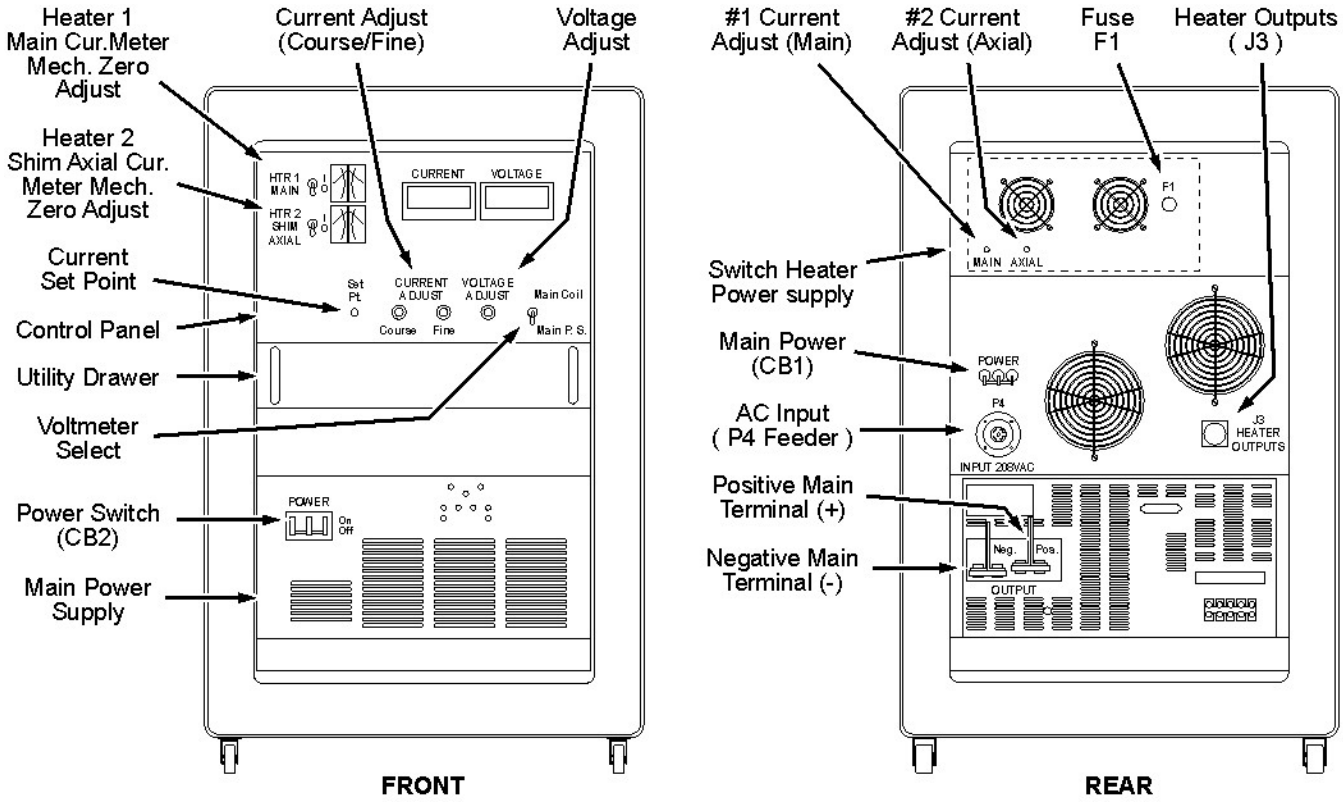
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-119: 750 Amp TCR 7.5T750 Superconducting Main Coil Service Power Supply Cabinet (46-260776G3)



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-120: ESS7.5-1000-2-D-1236 Superconducting Main Coil Service Power Supply Cabinet (46-260776G4)



4. Set the Current Adjust and Voltage Adjust controls on the Main Power Supply to zero (full CCW).

5. Remove lockout/tagout and connect input power to the Main Power Supply.

WARNING

POTENTIAL MAGNET QUENCH!
TURNING ON THE MAIN HEATER SWITCH WHILE PERFORMING THESE RESISTANCE CHECKS WILL CAUSE A MAGNET QUENCH.
MAKE SURE THE MAIN HEATER SWITCH STAYS OFF DURING RESISTANCE CHECKS.

6. Turn on the Main Power Supply's Input Power Switches.

NOTE: There are duplicate Main Power and Power On switches on the front and back of the Main Power Supply.

7. Make sure the Main Heater Switch is off, then turn on the Axial Shim Heaters and observe the current rise in the Main Power Supply Ammeter (810 mA ± 10 mA) to verify circuit continuity. If the heater current is not correct, adjust it with the Current Adjust control on the rear of the power supply.

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

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

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

10. Set the Current Adjust Coarse Control on the power supply to maximum (full CW).

11. Observe the Main Power Supply's Ammeter and slowly turn the Voltage Adjust Control clockwise to set a 750 amp current through the Main Leads, Main Lead Extensions and persistent Main Switch.

12. Record the voltage reading on the DVM in Chapter 8, Section 5, Magnet Ramping and Parking Current Log.



⚠ CAUTION

Potential Magnet Quench
Voltage readings > 150 millivolts at 750 amps indicate unacceptable internal contact resistance at the Main Lead Extensions. Higher resistances will add more heat to the magnet, increasing boiloff and possibly causing a quench during ramping. Make sure the voltage readings are ≤ 150 mV at 750 amps.

13. If the DVM voltage is > 150 millivolts, perform one or more of the following to reduce contact resistance:

    a. Wait approximately 1 minute with current running, readings may drop as the Main Lead Extensions cool.

    b. Tighten the nuts (one flat at a time) on top of the Hold-Down Tool while measuring DVM readings.

    c. If the reading still exceeds 150 mV:

        i. Turn the Voltage and Current Adjust controls to zero (full CCW).



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO THE MAIN POWER SUPPLY.

        ii. Turn off the Magnet Power Supply input power. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

        iii. Check and tighten the bolts securing the Ramp Cables to the Power Supply and Main Leads Extensions.

        iv. Lift and reseat the Main Leads.

        v. Remove lockout/tagout and reconnect input power to the power supply.

    d. Repeatedly failing the contact resistance check may indicate one of the following:

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

- The Main Lead Extension Contact Bands replaced as directed Section 6, Connections for Ramping and Shimming, in are not performing correctly and need replacing in conformance with Chapter 5, Section 4, Main Lead Extension Contact Band Replacement.
- The Main Leads are damaged and need replacing.

e. If changes are made in Step 13, repeat Step 9 through Step 13.

NOTE: Do not continue to Step 14 until after the DVM voltage is < 150 mV.

14. Set the power supply's Voltmeter Select Switch to the “MAIN POWER SUPPLY” position so that the voltmeter will display the power supply output to the output lugs. If the voltage exceeds 2.2 V at 750 Amps during the test, repeat Step 13.

NOTE: A voltage less than 2.2V at 750 Amps indicates acceptable system resistance.

15. Turn the Current Adjust Controls and the Voltage Adjust Control to zero (full CCW) and continue with Section 10.4.3.

10.4.3 Main Field Adjustment



WARNING

POTENTIAL MAGNET QUENCH!
INCORRECT CONNECTION POLARITY AND POWER SUPPLY CURRENT SETTINGS CAN CAUSE THE MAGNET'S MAIN COILS TO QUENCH AND CAN BURN UP THE POWER SUPPLY WHEN TURNING ON THE MAIN SWITCH.
MAKE SURE THE CONNECTION POLARITY AND POWER SUPPLY CURRENT SETTINGS ARE THE SAME AS LAST RECORDED IN CHAPTER 8, SECTION 5, MAGNET RAMPING AND PARKING CURRENT LOG.



WARNING

POTENTIAL MAGNET QUENCH!
IF THE AXIAL SHIM HEATER SWITCH IS NOT “ON” DURING THE ENTIRE MAIN FIELD ADJUSTMENT PROCESS, A MAGNET QUENCH CAN OCCUR AND IRREPARABLE DAMAGE SHIM COIL DAMAGE CAN BE DONE. THE POWER SUPPLY WILL NOT PASS CURRENT TO THE MAIN LEAD EXTENSIONS WITH THE AXIAL SHIM HEATER OFF.
MAKE SURE THE AXIAL SHIM HEATER SWITCH REMAINS “ON” DURING THIS ENTIRE PROCEDURE.



WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH IF THE MAIN POWER SUPPLY EXPERIENCES LARGE OUTPUT FLUCTUATIONS AND/OR EXCESSIVE RIPPLE.
MAKE SURE THE MAIN POWER SUPPLY IS ROUTINELY CALIBRATED AT AN APPROVED FACILITY.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

If a Quench occurs during change of magnetic field, immediately turn the Voltage Adjust and Current Adjust controls to zero.

NOTICE

Make sure the polarity recorded Chapter 8, Section 5, Magnet Ramping and Parking Current Log, matches the configuration of the Ramp Polarity Plate (Illustration 3-122). The "Normal" ramp polarity is "+" (positive) on the left and "-" (negative) on the right as viewed from the Coldhead side of the magnet. "Reversed" ramp polarity has "+" on the right and "-" on the left as viewed from the Coldhead side of the magnet. Call the National Support Center if the two do not match.

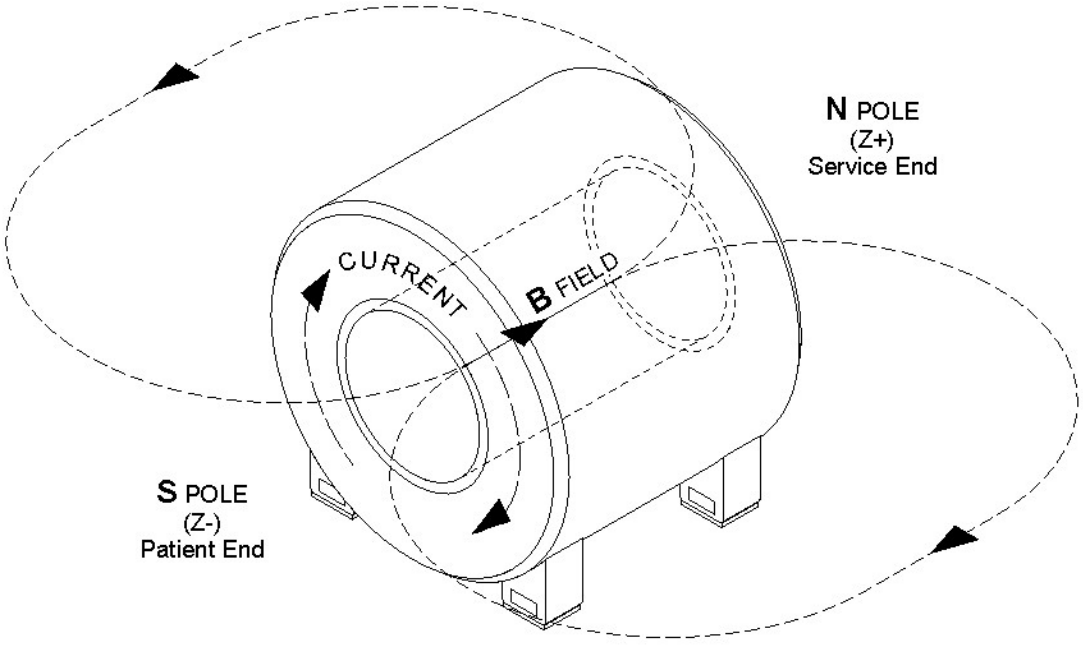
NOTE: All main coil driving voltages provided in the Field Adjustment after Shimming procedure will be equal in magnitude but opposite in polarity for "reverse ramped" magnets. Normal polarity is shown in Illustration 3-121.

1. Retrieve the last recorded Main Coil Connection Polarity from Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

NOTE: The Center Frequency will change by about 86 KHz per Amp of change in Main Coil current.

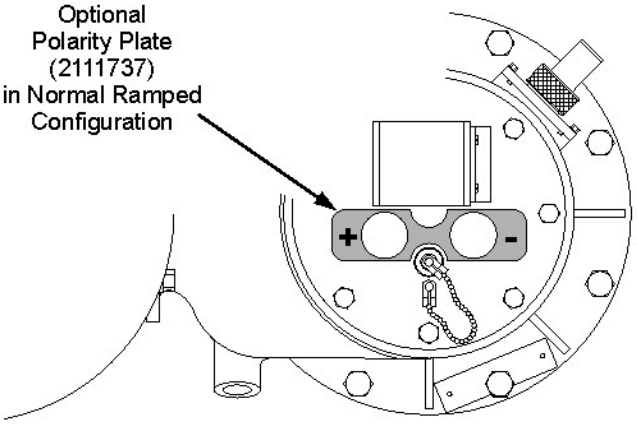
The main magnetic field will have either increased or decreased by the amount recorded in Section 10.4.1, Step 8. For example, a Delta Frequency of +21.288 KHz indicates the main magnetic field is too high and will have to be decreased by this amount.

Illustration 3-121: Magnet Polarity Ramped Normal



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-122: Polarity Plate 2111737



2. Make sure the Axial Shim Heater is on and the Main Leads are connected with the polarity retrieved in Step 1.

3. Set the power supply's Voltmeter Select Switch to the “MAIN COIL” position. See Illustration 3-119 or Illustration 3-120.

4. Set the power supply's Current Adjust Controls to maximum (full CW).

5. Adjust the power supply's Voltage Adjust Control to the Parking Current value retrieved in Step 1.

6. Turn on the Main Switch Heater.

7. Make sure the Axial Shim Switch Heater power supply is on and left on throughout the Main Field Adjustment procedure.

8. Allow approximately 3 minutes for the Main Switch to go resistive.

9. When the Main Switch is resistive, **slowly** adjust the Voltage Adjust Control until the measured main magnetic field Base Frequency matches the desired Center Frequency. This will counter the Delta Frequency calculated in Section 10.4.1, Step 8.

NOTE: For example, where the Delta Frequency calculated in Section 10.4.1, Step 8, is +21.288 KHz, the main magnetic field Base Frequency needs a -21.288 KHz adjustment to match the desired Center Frequency.

10. Allow 6 minutes for magnetic field to stabilize, then turn off the Main Switch Heater.

11. Wait a minimum of 15 minutes for the switch to fully cool and go “persistent,” then record current value at which the switch went “persistent” in Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

12. When the switch goes “persistent,” **slowly** turn the power supply's Voltage Adjust Control to zero (full CCW) over a 2 minute period.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTE: Only the last two digits of the Teslameter reading should change while Voltage Adjust Control is turned to zero. Any larger decrease in Teslameter reading indicates the Main Coil Switch is NOT “persistant,” and the Voltage Adjust Control must be slowly returned to the magnet's parking field.

13. Turn off the Axial Shim Heater.

14. Gradually turn the Current Adjust Controls to zero (full CCW) over a one minute period.

15. Turn the Main Power Supply off.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO THE MAIN POWER SUPPLY.

16. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.



WARNING

POTENTIAL MAGNET QUENCH!
IMPROPER ENGAGEMENT/DISENGAGEMENT OF THE MAIN LEAD EXTENSIONS WITH THE MAIN LEAD PINS CAN CAUSE A RAMPED MAGNET TO QUENCH. INSERT MAIN LEAD EXTENSIONS ONE AT A TIME AND ALLOW THEM TO COOL SUFFICIENTLY (A FOG OR WATER VAPOR FORMS AROUND THE LEAD EXTENSIONS) BEFORE THEY CONTACT THE MAIN LEAD PINS.



WARNING

ELECTRICAL SHOCK HAZARD!
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT. DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



WARNING

ELECTRICAL SHOCK HAZARD!
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE FIELD ADJUSTMENT AFTER SHIMMING PROCEDURE.
WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.



NOTICE

Follow Step 17precisely to avoid an excessive heat load being applied to the magnet cartridge and a possible quench following a magnet ramp.

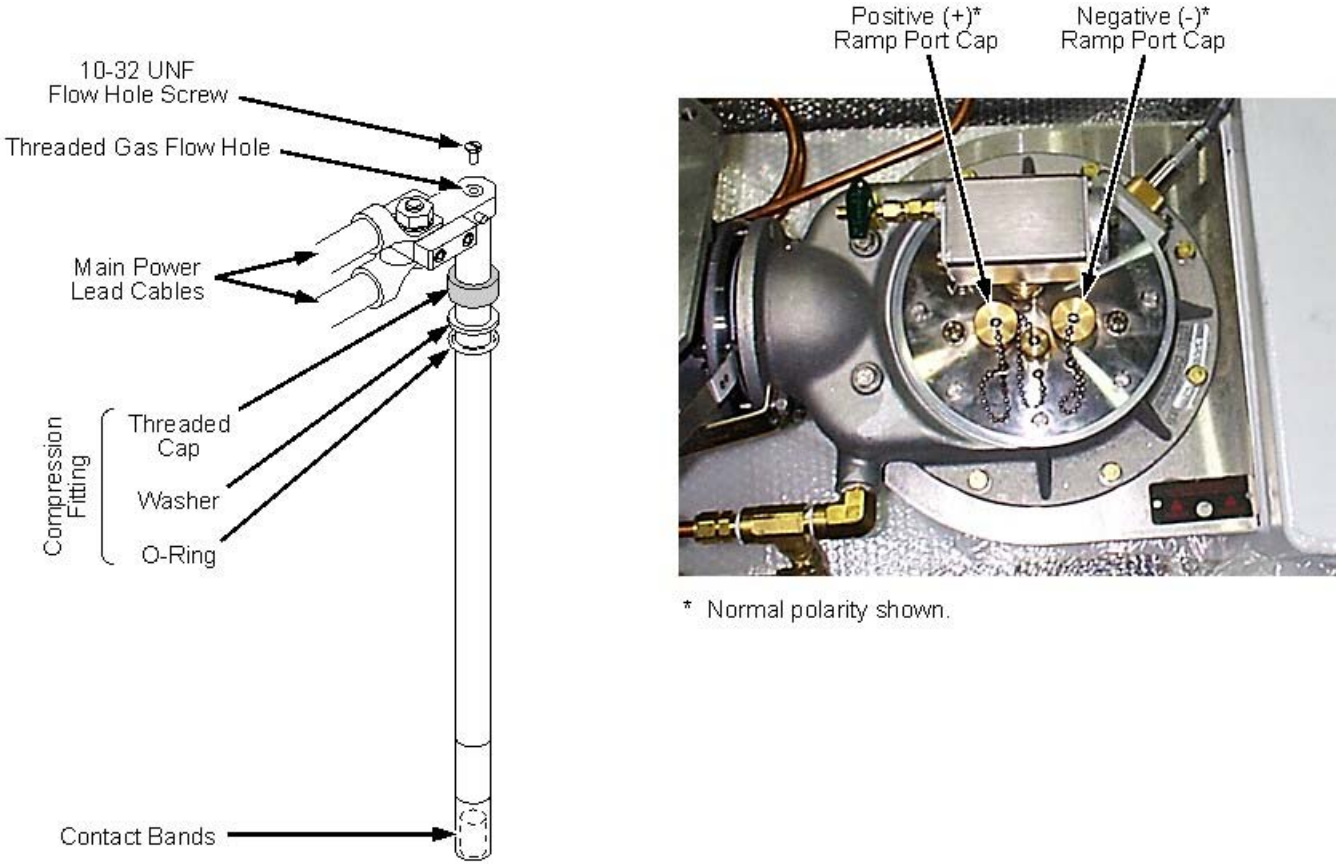
17. After parking the magnet, disconnecting and locking-out/tagging-out input power to the Main Power Supply and verifying that no voltage is present by using a DVM or equivalent measuring device, plug and **remove one Main Extension at a time** in the following sequence:

    a. Open Valve V2. Bleed vessel pressure down below 1.0 psig. Do not allow pressure to go below 0.5 psig as read on the magnet pressure gauge or Magnet Monitor. Close V2.

    b. Remove all ice around the ramp lead port compression fitting on the Main Lead Extension that is being removed first. See Illustration 3-123.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 3-123: Main Lead Extension and Ramp Ports



⚠ WARNING

POTENTIAL MAGNET QUENCH!
PLUGGING THE FLOW HOLE OF AN ENGAGED MAIN LEAD EXTENSION WILL CAUSE THE MAGNET TO QUENCH.
DO NOT INSERT FLOW HOLE SCREWS INTO MAIN LEAD EXTENSIONS UNTIL AFTER EXTENSIONS ARE REMOVED.

c. Unscrew the ramp lead port compression fitting and remove the first Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

d. Remove all ice around the ramp lead port compression fitting on the other Main Lead Extension.

e. Unscrew the ramp lead port compression fitting and remove the second Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

f. Install the flow hole screws in the flow hole of both Main Lead Extensions **after** both leads have been removed.

g. Check the Main Leads and fill port cap for leaks.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

10.4.4 Input Shim Currents

CAUTION

Potential Magnet Quench
The magnet may quench if the Nupro Valve on the Shim Lead is closed or the Shim Lead is not cold.
Make sure the Nupro Valve is fully open and the valve is frosted before slowly engaging the Shim Lead. Do not remove the Shim Lead's Orifice Cap that controls helium gas flow. Always engage/disengage the Shim Lead in conformance with Section 5, Shim Lead Engagement and Disengagement.

NOTICE

Before turning on the Shim Coil Power Supply and applying shim currents, make sure the following conditions exist to prevent irreparable damage to the vapor-cooled Shim Leads:

- **The orifice on the Shim Lead vent is in place,**
- **The Shim Lead is frosted and**
- **The power supply current controls are set to zero (full CCW).**

1. Make sure the Shim Lead Assembly is engaged in conformance with Section 5, Shim Lead Engagement and Disengagement.

NOTE: To frost the Shim Lead, open the Shim Lead Vent Valve. Do not remove the Shim Lead's calibrated orifice.

2. Remove lockout/tagout and reconnect the Shim Power Supply to the magnet in conformance to Section 6, Connections for Ramping and Shimming. Verify that the Shim Lead Vent Valve is open and the lead is sufficiently cooled.

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

4. Input shim currents for one group at a time in the following order:

   - **Transverse 1 (T1)** (Transverse Coils T1-1 through T1-6 as a group)
   - **Transverse 2 (T2)** (Transverse Coils T2-1 through T2-6 as a group)
   - **Axial (AX)** (Axial Coils AX1 through AX6 as a group)

5. Repeat the following steps for each group in sequence:

   a. Set the Shim Group Select Switch to the appropriate group (T1, T2 or Axial). See Illustration 3-118.

NOTICE

When the Switch Heaters are turned on, any existing currents 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.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

b. Dial into the power supply the last recorded shim currents and polarities from Chapter 8, Section 8, Calculated Shim Coil Correction Currents. Make sure the shim current polarities are correct.

c. Make sure the Shim Lead Extension is frosted, then turn on the appropriate Switch Heater.

d. Verify that the T1, T2 and Axial heater currents are within range (T1: 610 mA ± 5 mA; T2: 610 mA ± 5 mA; Axial: 710 mA ± 10 mA). Use the adjustment screw on the rear of the Shim Power Supply to make sure the current is within range.

e. Allow 5 minutes for the heater to drive the switches resistive.

f. 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.

g. Check the Teslameter's frequency reading 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).

h. Once the magnetic field is stable (Step 5.g), turn off the Switch Heater and allow the heater to cool for 15 minutes.

i. Turn the Shim Power Supply back down to zero amps (full CCW).

j. Repeat the Step 5.a - Step 5.i for the Transverse 2 and then for the Axial Shim Coil groups.

10.5 Finalization

1. Disconnect all cables between the magnet and shim power supply.



NOTICE

Make sure the Shim Lead Vent Valve and Ramp Lead Port Caps are closed, sealed and do not leak in order to prevent gaseous helium loss and/or frost and ice formation in the Vertical Penetration.

2. Close the Shim Lead's NuPro Vent Valve.

3. Turn off input power to the Shim Power Supply. Disconnect and lockout/tagout all power supply cables. Verify that no voltage is present by using a DVM or equivalent measuring device.

4. Check the magnet's helium level, and add liquid helium in conformance with Section 3.2, Liquid Helium Fill, if the level is < 75%.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

This page left intentionally blank.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Chapter 4 Functional Checks

1 Magnet Functional Checks

Commissioning and operating guidelines for the magnet system are provided in Table 4-1, Magnet Commissioning & Operating Guidelines. Checking and maintaining the guideline conditions will make sure optimum commissioning and operation of the Magnet will be achieved.

Table 4-1: Magnet Commissioning & Operating Guidelines

Element	Guideline	Check/Setting Requirements
Main Field, 1.5T LCC Magnet	Operation (after Shimming): 15,000 Gauss ± 7.5 Gauss (63,864,382 Hz± 31,932 Hz)	After ramping & shimming or when out of gradient amplifier bandwidth.
	Parking: ATR's “Recommended Site Parking Field" ± 0.5 Gauss	After ramping
Main Field, 1.0T LCC Magnet	Operation (after Shimming): 10,000 Gauss ± 5.0 Gauss (42,576,255 Hz ± 21,288 Hz)	After ramping & shimming or when out of gradient amplifier bandwidth.
	Parking: ATR's “Recommended Site Parking Field" ± 0.5 Gauss	After ramping
Main Coil Inductance	—	At start of ramp
Uncompensated Drift	6.3 Hz/Hr for 1.5T (12 Hrs after Ramp)	Before shimming
	4.2 Hz/Hr for 1.0T (12 Hrs after Ramp)	
Homogeneity	10 PPM @ 40 cm DSV	After shimming, environment changes or image degradation.
Main Power Supply	810 ± 10 mA Main Heater	Before ramping up/down
	Passes Power Supply Checks in Section 8.2, TCR 7.5T750 Main Power Supply Tests, when using a 750 A power supply or Section 8.3, ESS7.5-1000-2-D-1236 Main Power Supply Tests, when using a 1000 A power supply	
Ramping Circuit Voltage	< 2.1 V Total @750 A	Before ramping up/down
	< 150 mV Ramp Leads @ 750 A	
Main Heater Resistance	20.5 Ohms - 25.0 Ohms	At start of commissioning
Ramp Lead Preparation	New Contact Bands	Before ramping up/down
	Gas Flow Out Top Holes	
Stabilized Cryostat Pressure	3.9 psig - 4.1 psig	After installation, venting, Coldhead changeouts, ramping and shimming
Coldhead Second Stage	$\Delta T \leq 0.2K$	At installation and Coldhead changeouts
Coldhead Temperatures	First Stage ≤ 45K	At installation and Coldhead changeouts
	Stage Stage ≤ 4.4K	

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 4-1: Magnet Commissioning & Operating Guidelines (cont'd)

Element	Guideline	Check/Setting Requirements
Helium Level (LHe)	95% - 100% Maximum	For top-off
	90% Minimum	For ramp up/down
	90% Minimum	For customer turnover
	75% Minimum	Shimming
	60% Minimum	Before fill
Fill Conditions	Cryostat Pressure = 1.0 psig	Helium (LHe) fill/refill
	Dewar < 2 psig	
	V2 Open	
Shim Heater Currents	Transverse 1 = 610 mA ± 10 mA	Before shimming
	Transverse 2 = 610 mA ± 10 mA	
	Axial = 710 mA ± 10 mA	

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2 Temp. Pressure and Leak Troubleshooting

2.1 Overview

Helium loss on a “Zero Boil-Off" magnet should be insignificant (i.e., not measurable) over a period of weeks or months. If significant helium loss is suspected, the following is required to define and quantify the suspected loss:

- The magnet must be in a normal operating mode and have stabilized after a ramp or fill.
- Two sets of data must be taken over time (2 days to 2 weeks, depending on size of leak), with known and calibrated instrumentation and at the same vessel pressure, to establish extent of the problem.

If high pressure or helium loss is established, use this section's troubleshooting guides to determine the root cause(s) of the problem and to resolve the issue(s).

2.2 Preliminary Requirements

2.2.1 Tools and Test Equipment

Item	Part Number	Spare Part
Portable Liquid Helium Level Meter	2270571	Yes
Leybold Leak Detector	—	—
Portable RuO Temperature Monitor (included in Chapter 7, Section 4.2.2, RuO Temperature Monitor Kit 2183710)	2171219	Yes
Plexiglas Heat Exchanger Cover Plate	2174214	Yes
Helium Gas Tubing	—	—
Coldhead Maintenance Kit	46-281088G3	Yes
Field Vacuum Pump Kit	46-294047G1	Yes
Magnet Monitor Pin Tester	2356202	Yes
M10 Allen Wrench	46-320470P10	Yes
Plus those items required by the procedure(s) needed to fix the problem.		

2.2.2 Consumables

Item	Part Number	Spare Part
Portable Leak Detector *or* Leak detector fluid, such as Bird Dog Quart Spray (p/n DOG-1Q), Big Blue (p/n Rt100S or Rt100G) or Snoop	2270571 —	Yes —
Small Balloon	—	—
Plus those items required by the procedure(s) needed to fix the problem.		

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.2.3 Replacement Parts

Item	Part Number	Spare Part
O-Rings included in Field Spare Parts Kit	46-294744G5	—
Transition Flange O-Ring	46-281247P1	Yes
Plus those items required by the procedure(s) needed to fix the problem.		

2.2.4 Safety

No general safety information.

2.2.5 Required Conditions

No required conditions.

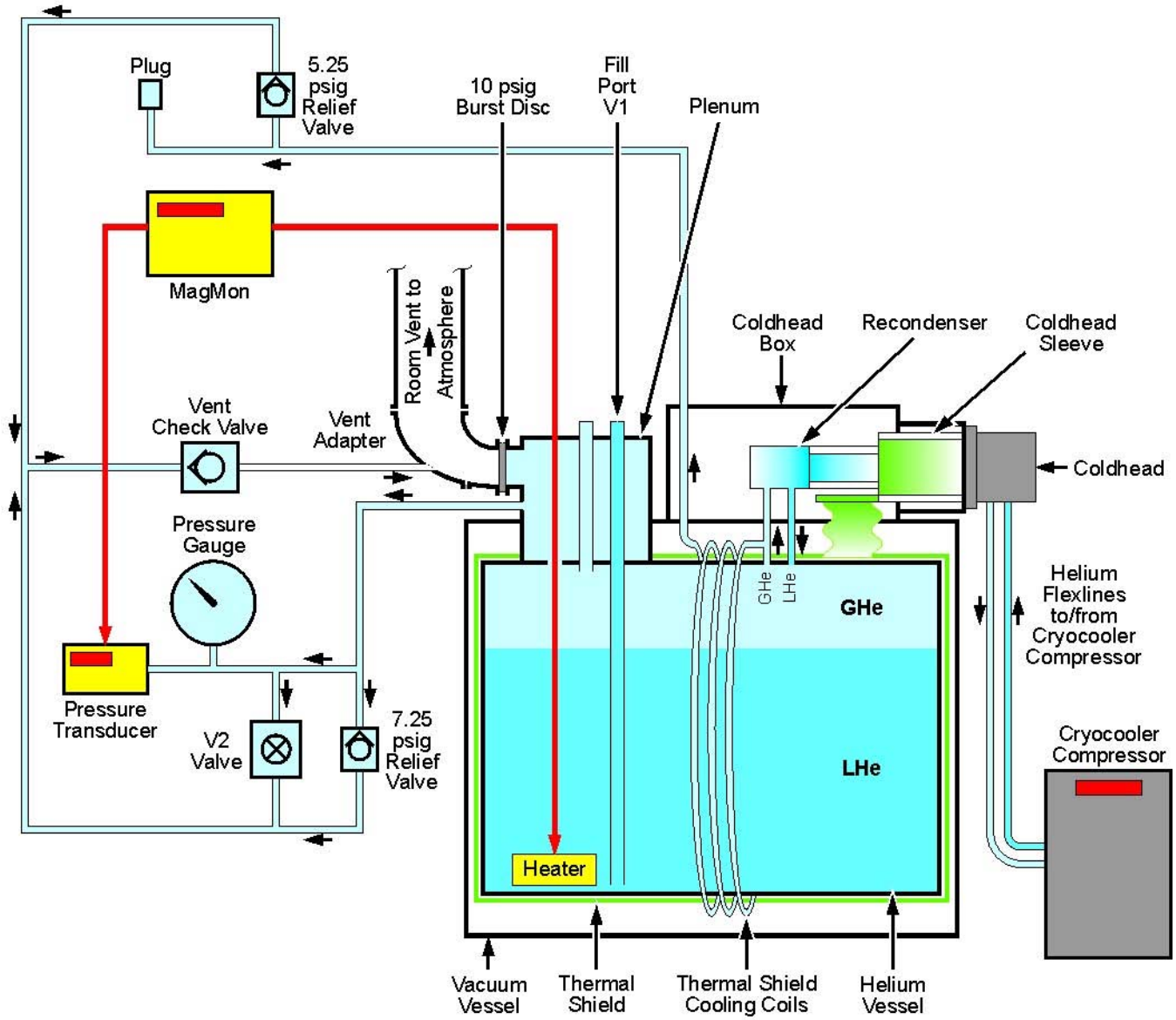
2.3 Procedure

2.3.1 Troubleshooting Guide

NOTE: Illustration 4-1 shows a thermal system schematic of an installed magnet, including the path of liquid helium (LHe) and gaseous helium (GHe) through the helium vessel and plumbing.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 4-1: Magnet Thermal System Schematic



NOTICE

Follow the temperature and pressure troubleshooting procedures in sequence to minimize unnecessary Coldhead removal/replacement. Repair all problems as discovered, then proceed with additional troubleshooting, as required.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 4-2: Initial Troubleshooting

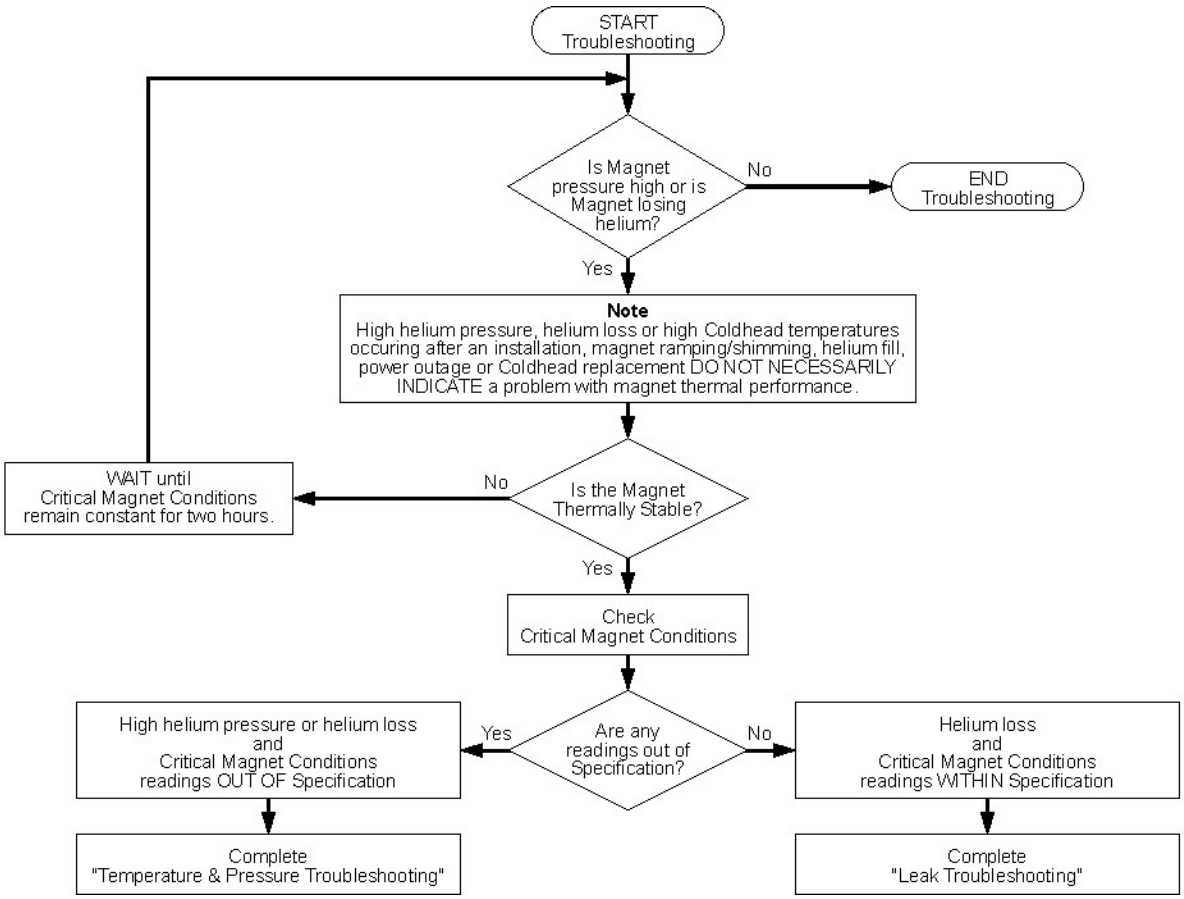


Table 4-2: Critical Magnet Conditions

Condition	Measure Using	Specification
Second Stage Coldhead Temperature	Portable RuO Monitor 2171219	< 4.4K
First Stage Coldhead Temperature	Magnet Monitor	< 45K
Recondenser Temperature	Portable RuO Monitor 2171219	> 4.2K but < 4.5K
ΔT = (Recondenser Temperature) - (Second Stage Coldhead Temperature)	Portable RuO Monitor 2171219	> 0.0K but < 0.2K
Magnet Helium Pressure	Magnet Monitor	4.0 psig ± 0.2 psig

NOTICE

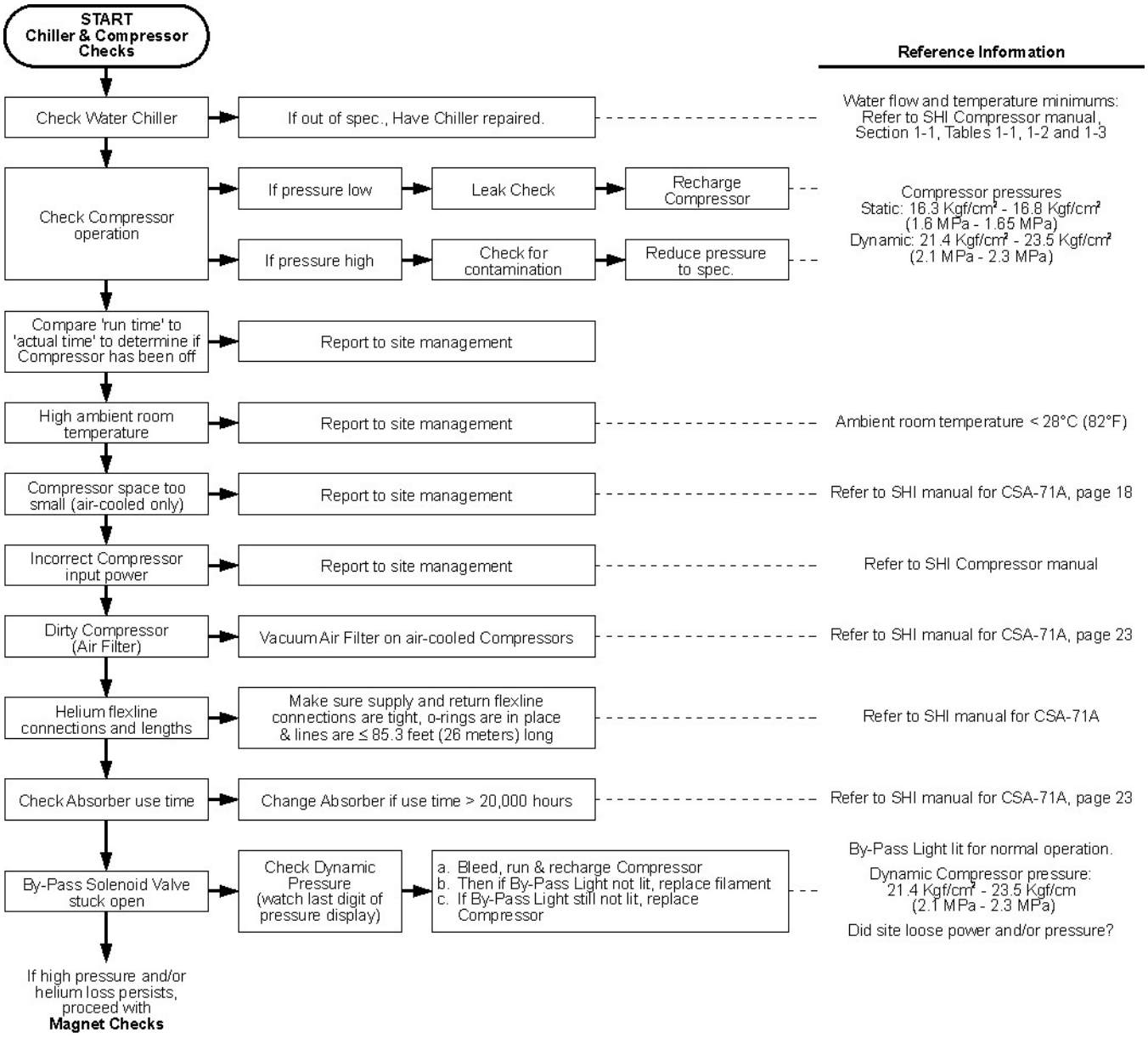
Second Stage Coldhead and Recondenser readings MUST be taken using the Portable RuO Temperature Monitor (2171219) connected directly to the RuO outputs on the Coldhead and Sleeve.

NOTE: The Portable RuO Temperature Monitor (2171219) readings of the Second-Stage Coldhead may show a small oscillation (0.1K - 0.25K) resulting from Displacer motion inside the Coldhead Sleeve and the monitor's sampling rate. Record the average temperature reading: $(T_{min} + T_{max}) / 2$.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.3.1.1 Chiller and Compressor Checks

Illustration 4-3: High Pressure/Temperature Troubleshooting Flowchart: Site Problems and Chiller/Compressor Checks



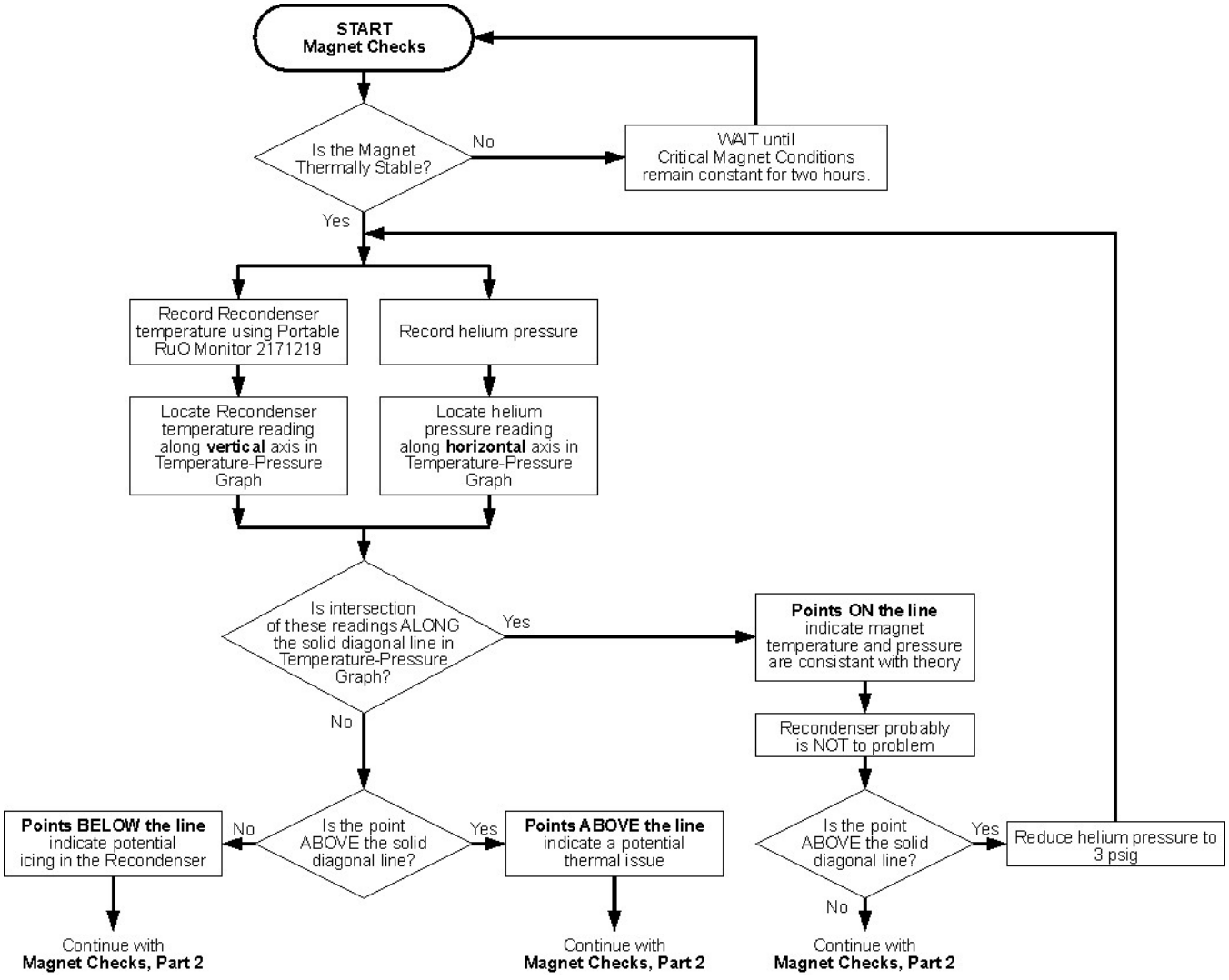
Manual	Vendor Part Number	GE Part Number
SHI SRDK Cryocooler Service Manual	CD32ZZ-055D	2262271
CSA-71A Compressor Unit Manual	CD32ZZ-060H	included in 2262271

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.3.1.2 Magnet Checks

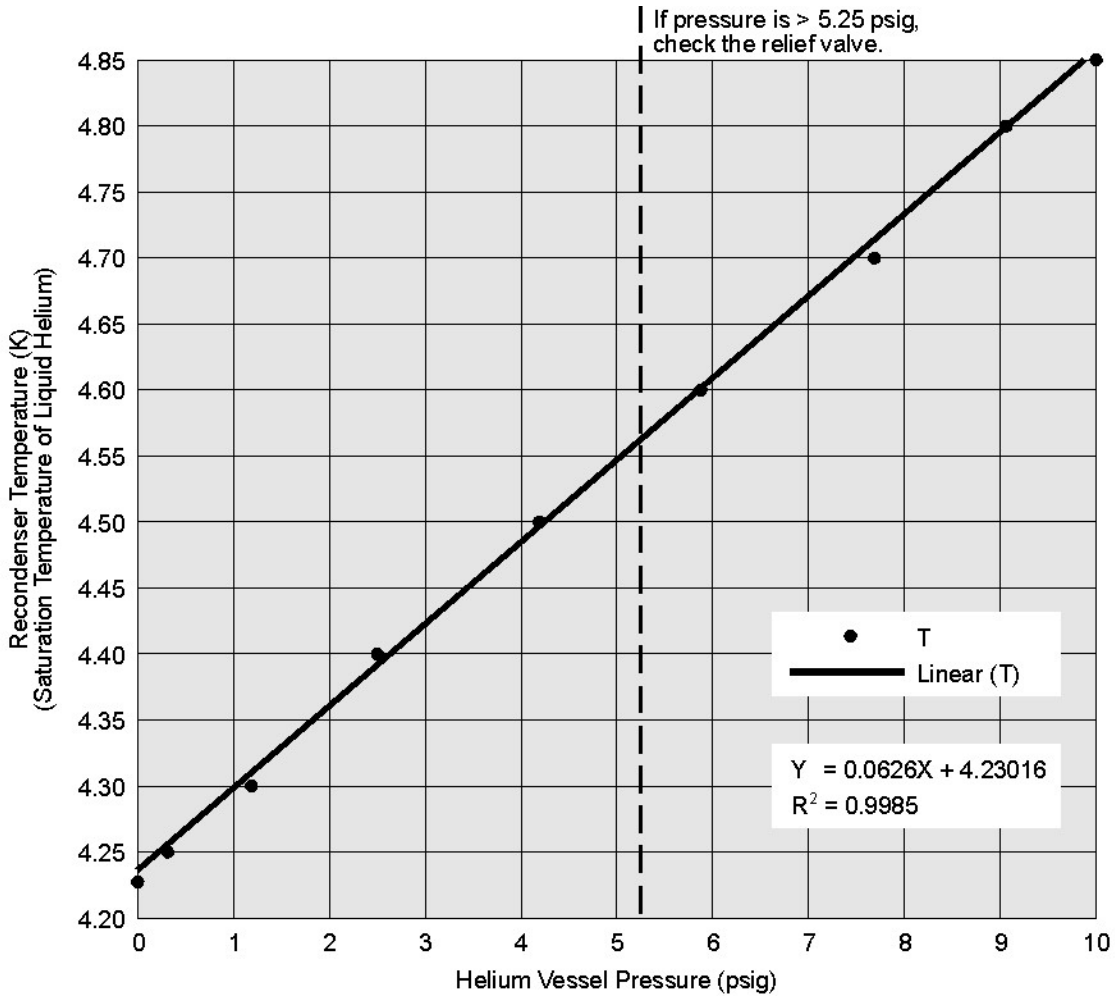
NOTE: Use the flowchart in Illustration 4-4 in conjunction with the temperature-pressure graph in Illustration 4-5 to determine if vapor pressure is consistent with RuO readings.

Illustration 4-4: High Pressure/Temperature Troubleshooting Flowchart: Magnet and Coldhead Interface Checks (Part 1)



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 4-5: Temperature-Pressure Graph: Liquid Helium (LHe) Saturation Temperature (Approximate Recondenser Temperature vs. Helium Vessel Pressure)





⚠ WARNING

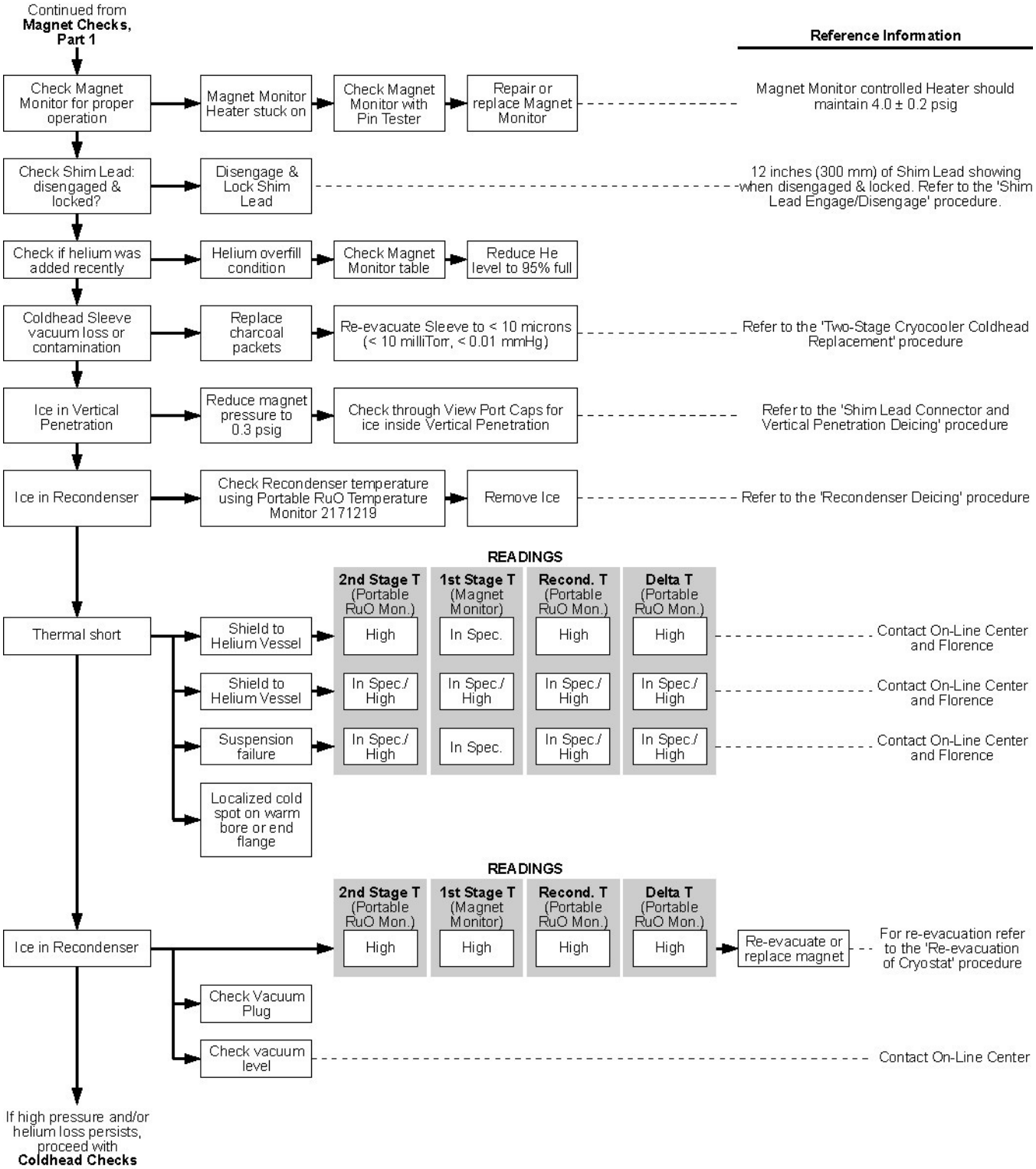
POTENTIAL COLD BURN OR ASPHYXIATION HAZARD
INTERNAL CRYOSTAT PRESSURE BUILD-UP TO > 5.25 PSIG WILL OPEN 5.25 PSIG RELIEF VALVE.
BEFORE REMOVING EITHER RAMP OR FILL PORT CAPS OR LOOSENING ANY COMPONENT RESULTING IN THE RELEASE OF CRYOGEN PRESSURE:

1. **OBSERVE THE INTERNAL CRYOSTAT PRESSURE GAUGE READING,**
2. **SET MAGNET MONITOR PRESSURE TO 0.5 PSIG AND**
3. **VENT CRYOSTAT DOWN TO 0.2 PSIG THROUGH VENT VALVE V2.**

NOTE: If the site has Magnet Monitor proprietary software, connect to Magnet Monitor and turn off the alarm for vessel pressure. Then turn the vessel pressure control to a high value of .5 psig and a low value of .4 psig.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 4-6: High Pressure/Temperature Troubleshooting Flowchart: Magnet and Coldhead Interface Checks (Part 2)



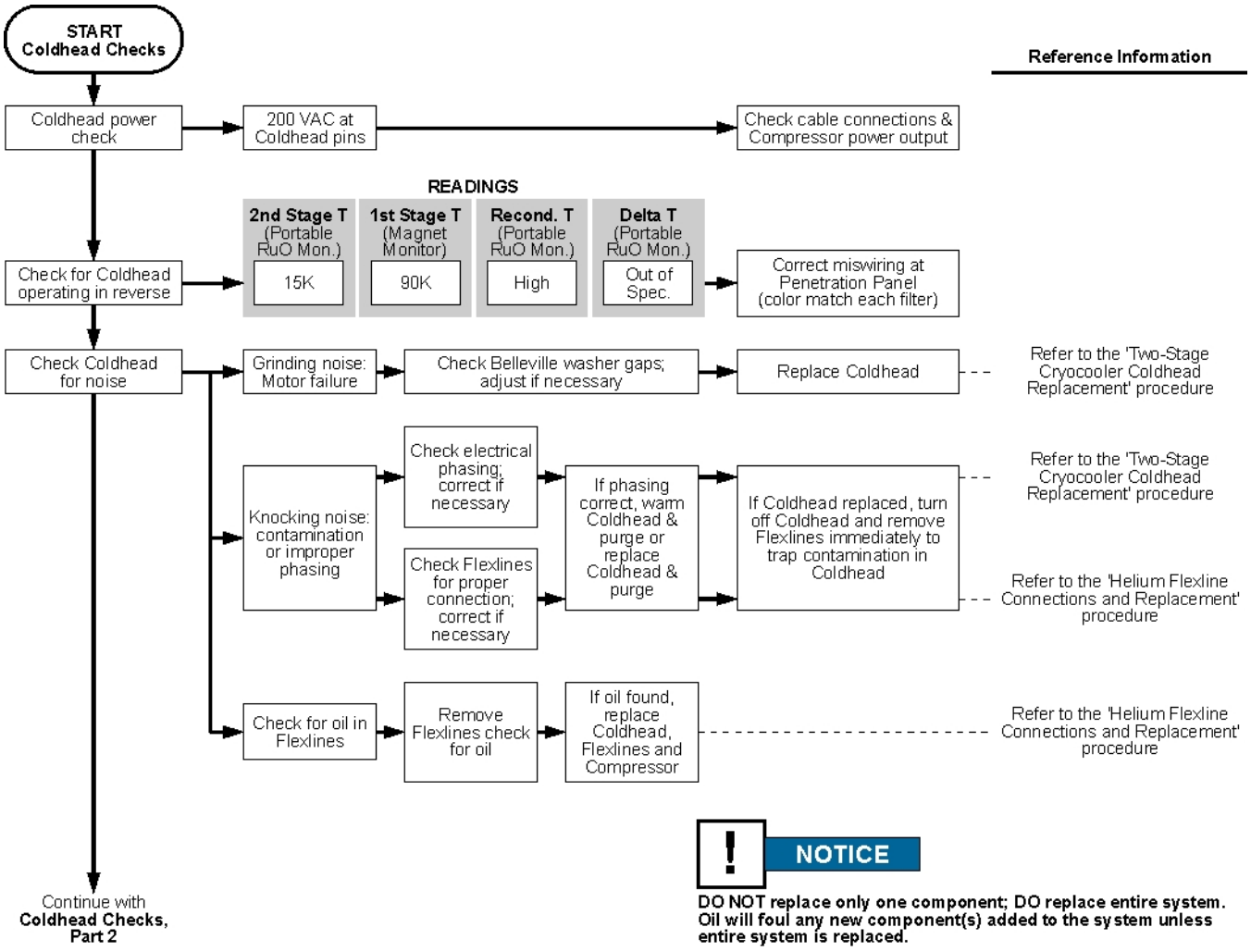
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Procedures referenced
Chapter 3, Section 5, Shim Lead Engagement and Disengagement
Chapter 5, Section 10, Two-Stage Cryocooler Coldhead Replacement
Chapter 5, Section 9.2, Ice Removal, 'Shim Lead Connector and Vertical Penetration Deicing' subsection
Chapter 5, Section 9.2, Ice Removal, 'Recondenser Deicing' subsection
Chapter 5, Section 8, Re-Evacuation of Cryostat

2.3.1.3 Coldhead Checks

NOTE: Only perform Coldhead Checks after completion of Chiller and Compressor Checks.

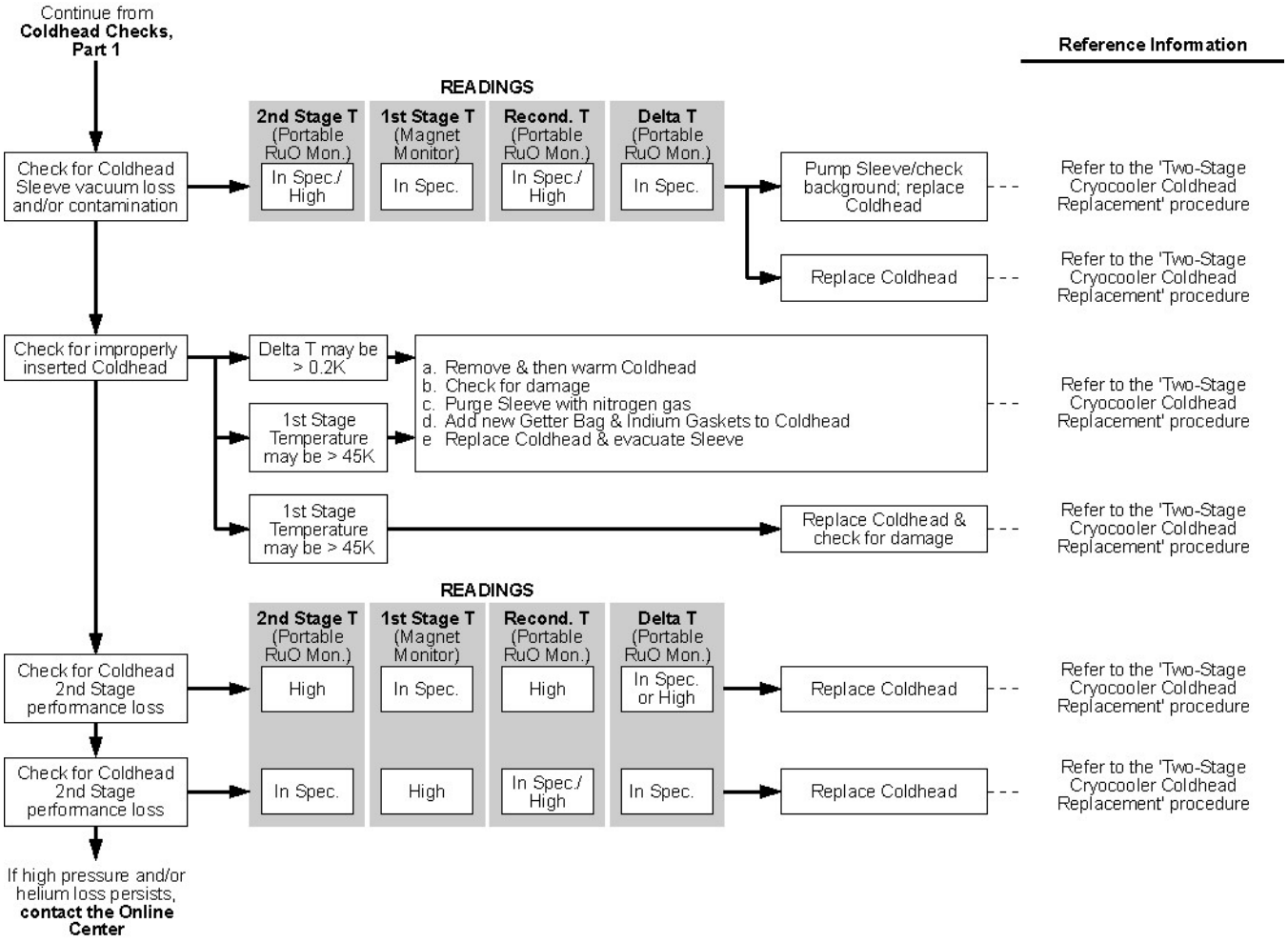
Illustration 4-7: High Pressure/Temperature Troubleshooting Flowchart: Coldhead Checks (Part 1)



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Procedures referenced
Chapter 5, Section 10, Two-Stage Cryocooler Coldhead Replacement
Chapter 5, Section 3, Helium Flexline Connections and Replacement

Illustration 4-8: High Pressure/Temperature Troubleshooting Flowchart: Coldhead Checks (Part 2)



Procedures referenced
Chapter 5, Section 10, Two-Stage Cryocooler Coldhead Replacement

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.3.2 Leak Troubleshooting

2.3.2.1 Introduction

Operation of the magnet in the “C0BO" (Controlled Zero Boil-Off) mode with internal helium pressure > 4.1 psig increases the potential of helium leaks. A number of small helium leaks will have a significant effect on boil-off and result in the measurable loss of helium over time.

Ice or condensation on plenum plumbing indicates a leak in the helium plumbing.

Major helium leaks will depressurize the helium vessel and can result in cryopumping and icing inside the vessel.

NOTE: Observe Magnet Monitor helium level data over a month or more. A slow helium level decrease is evidence of leaking helium.



WARNING

POTENTIAL ASPHYXIATION HAZARD
ODORLESS, COLORLESS HELIUM GAS IS RELEASED DURING LEAK TROUBLESHOOTING. HELIUM GAS WILL DISPLACE OXYGEN.
MAKE SURE THE MAGNET ROOM VENT EXHAUST FAN IS TURNED ON — OR THE HATCH IS OPEN IF A MOBILE VAN — BEFORE STARTING LEAK TROUBLESHOOTING.



WARNING

POTENTIAL COLD BURN HAZARD
SKIN CONTACT WITH A COLD VENT SYSTEM CAN CAUSE COLD BURNS.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN REPLACING THE BURST DISC ON A COLD VENT SYSTEM.

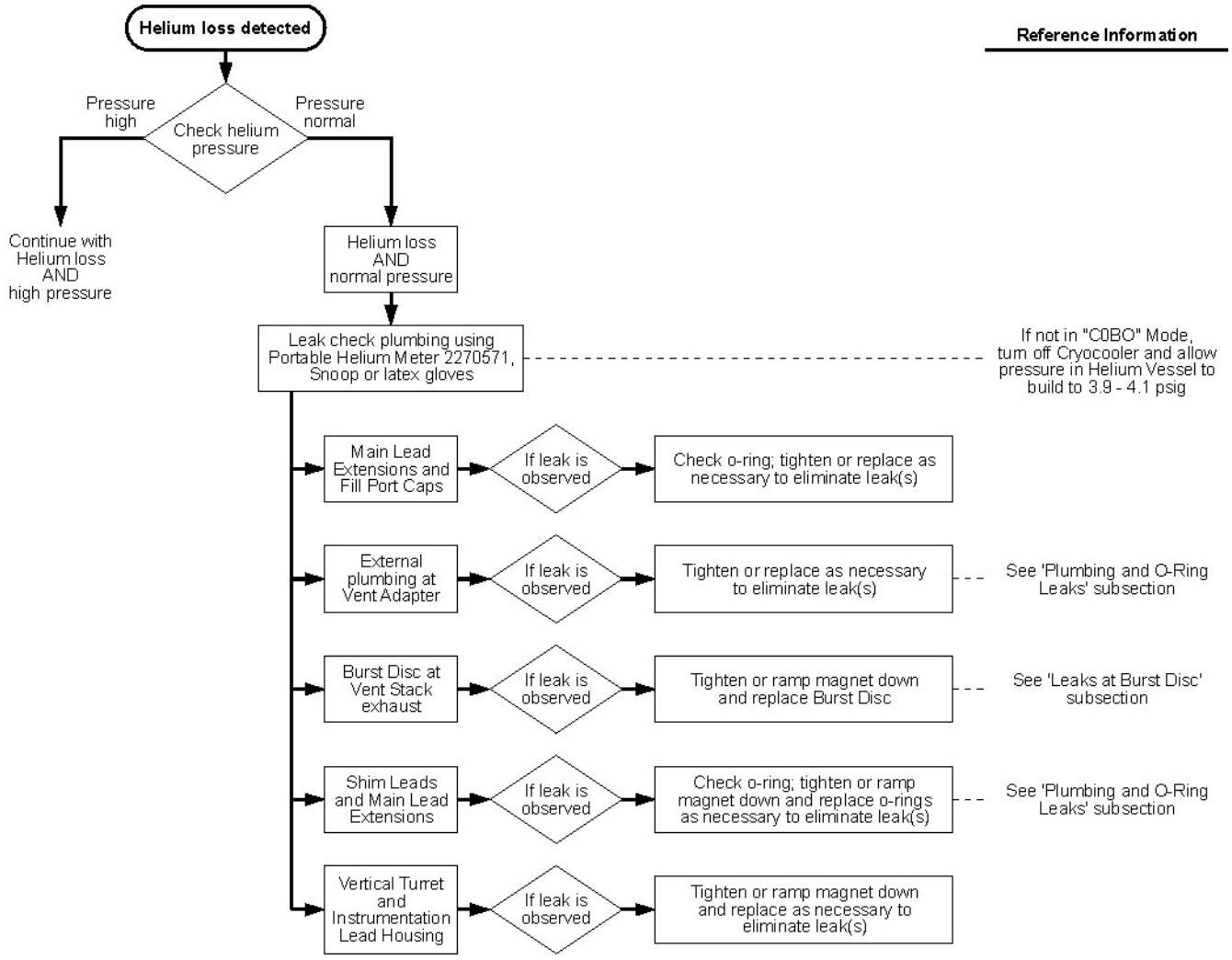


NOTICE

Review and follow the safety measures contained in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

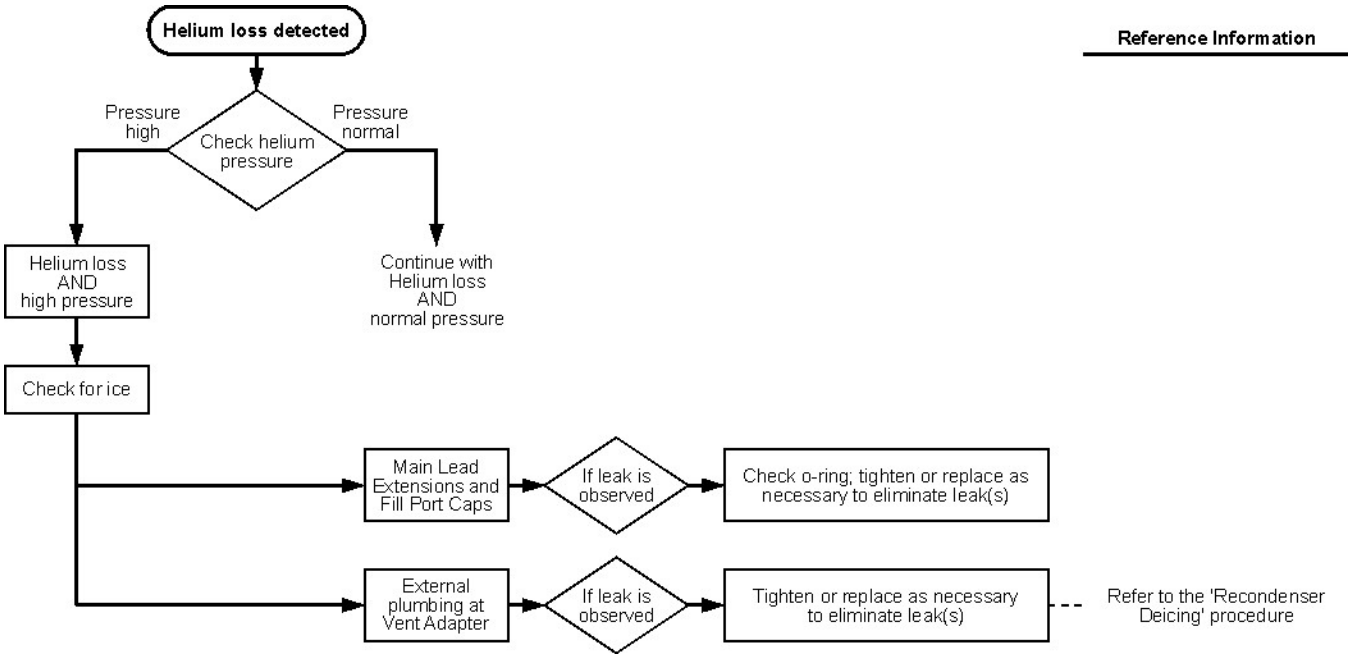
Illustration 4-9: Leak Troubleshooting Flowchart, Helium Loss and Normal Pressure



Subsections of Temp., Pressure and Leak Troubleshooting referenced
Section 2.3.2.4, Plumbing and O-Ring Leaks
Section 2.3.2.5, Leaks at Burst Disc

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 4-10: Leak Troubleshooting Flowchart, Helium Loss and High Pressure



Procedures referenced
Chapter 5, Section 9.2, Ice Removal, 'Recondenser Deicing' subsection

2.3.2.2 Pressure

Check Magnet Monitor operation if pressure is < 3.9 psig.

NOTE: Helium pressure < 3.9 psig indicates a leak.

2.3.2.3 Leak Detection

Commercial leak detector fluids or instruments available in the HVAC industry can be used to determine small leaks in the helium plumbing and venting. Some examples available through HVAC distributors are:

- Bird Dog Quart Spray (p/n DOG-1Q)
- Big Blue (p/n Rt100S or p/n Rt100G)
- Snoop
- Portable Leak Detector

1. When the pressure is < 3.9 psig, check the following areas for leaks with a leak detector fluid or instrument.
   - All external plumbing joints
   - Vertical Turret, Instrumentation Lead Cover and the feed-through pins
   - Main Lead and fill port caps
   - Shim Lead collar/cap
   - Pressure Gauge

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

- Shim Lead Pins

2. Repair any leaks found and then test the repairs.

2.3.2.4 Plumbing and O-Ring Leaks

NOTE: Replacement o-rings and a Burst Disc are contained in the Field Spare Parts Kit 46-294744G5. See Chapter 7, Section 3.10, Field Spares Kit 46-294744G5.

1. Remove the outlet plumbing (Vent Adapter side) for the 5.25 psig relief valve and the 7.25 psig bypass valve.
2. Remove the cap from the Nupro valve at the top of the Shim Lead.

NOTE: Suitable alternative leak checking equiment can be used in the following steps.

3. Attach a small balloon tightly to the exhaust side of the 5.25 psig relief valve, 7.25 psig bypass valve and the Nupro valve.
4. Observe any expansion of the balloon from leaking helium gas.
5. Replace any valve that has suspected leaks and retest the new valve for leaks. Valve part numbers are shown in Chapter 7, Section 2.1, LCC Magnet Assemblies.

2.3.2.5 Leaks at Burst Disc



NOTICE

Small (micro) bubbles may appear between the gasket and flange. This is normal for this gasket material. Make sure the Belleville washers are flattened and that no major leaks (continuous bubbles over 0.08 inch or 2 mm in diameter) are present. Foam-like bubbles may be present.

1. Ramp the magnet down to zero field in conformance with Chapter 5, Section 6, Magnet Rampdown to Zero Field.
2. Remove the Vent Adapter.
3. Check the Burst Disc for cracks or significant leaks around the gasket. Replace any cracked or leaking Burst Disc in conformance with Chapter 5, Section 11.1, Burst Disc (2349529) Replacement (or Chapter 5, Section 11.2, Burst Disc (2194545-7) Replacement, where appropriate).

2.3.3 Assistance for Florence-Manufactured Magnets

When the furthest right digit on the Magnet Monitor pressure gauge decreases by a few units over 1 - 2 hours there is a 90% probability that high pressure/helium loss issue(s) are resolved. Magnet pressure usually returns to and stabilizes at ~ 4 psig in less than one week.

If the root cause of an issue is not found after completing Section 2.3.1, Troubleshooting Guide, and Section 2.3.2, Leak Troubleshooting, collect the information in Table 4-3 and call the online center for assistance.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 4-3: Magnet Information (Collect before Calling for Assistance)

Item		Information
System ID		
Magnet Number		
Magnet Installation Date		
MAC Team Leader		
Two-Stage Cryocooler Compressor	Serial Number	
	Install Date	
	Run Time	
	Static Pressure	
	Dynamic Pressure	
	Inlet Water Flow	
	Water Temperature at Inlet	
Two-Stage Cryocooler Coldhead	Serial Number	
	Second Stage Temperature (Hand-Held RuO)	
	Recondenser Temperatur (Hand-Held RuO)	
	Delta T	
	First Stage Temperature	
	Sleeve Vacuum	
	Number of Getter Bags	
	Date Getter Bags Last Changed	
	Noise	
Magnet Pressure		
Helium Level, Cylindrical		
Frost of Plumbing		
Magnet Monitor Heater Operation Verification		
Comments		

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3 Temperature Sensor Checks

3.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	1 hour	Included in 'Procedure'

3.2 Preliminary Requirements

3.2.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Digital Voltmeter (DVM). Must be able to supply 10 microamps or less current.	1	-	-	-
Portable RuO Temperature Monitor (included in RuO Temperature Monitor Kit 2183710)	1	-	2171219	-
Lakeshore 208 Digital Thermometer Kit 46-301477G2 or Diode Box 46-317543G2	1	-	46-301477G2 or 46-317543G2	-
Cable	1	-	46-301619P1	-
SI-410 Diode Temperature Readout Cable	1	-	2300866	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

3.2.2 Consumables

No consumables required.

3.2.3 Replacement Parts

No replacement parts required.

3.2.4 Safety

No general safety information.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.2.5 Required Conditions

Condition	Reference	Effectivity
The removal of some magnet enclosure components may be required to complete Temperature Sensor Checks. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with Temperature Sensor Checks if cover removal is required.	Chapter 5, Section 5	-
(continued)	Appendix A, Section 1.1	-

3.3 Procedure

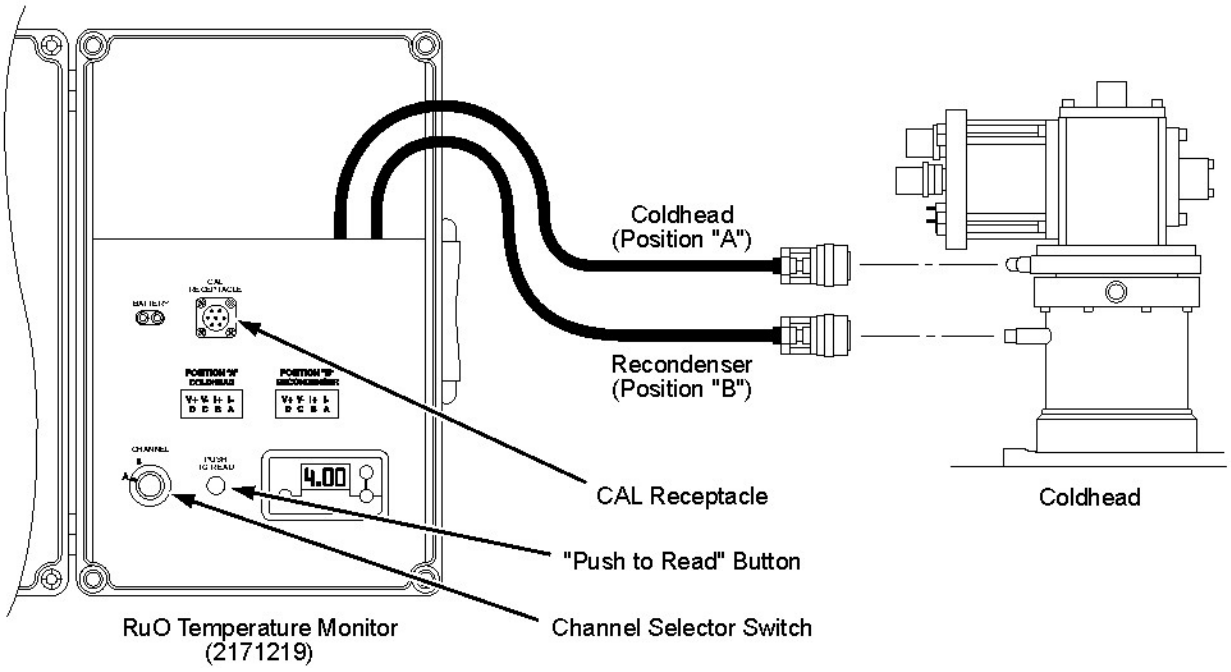
3.3.1 Using Portable RuO Temperature Monitor 2171219

NOTICE

RuO Temperature Monitor readings will increase slightly if the meter is cold. For best results the meter should be at or near room temperature.

1. Attach either cable of Portable RuO Temperature Monitor 2171219 to the CAL receptacle located in the upper left side of the monitor. See Illustration 4-11.

Illustration 4-11: RuO Temperature Monitor (2171219) Connections



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2. Press the “Push To Read" button. The reading for the first cable should be 3.95K to 4.05K.

3. Attach Portable RuO Temperature Monitor's other cable to the CAL receptacle.

4. Press the “Push To Read" button. The reading for the second cable should be 3.95K to 4.05K.



WARNING

STRONG MAGNETIC FIELD
FERROUS MATERIALS CAN BECOME DANGEROUS PROJECTILES IN THE PRESENCE OF THE MAGNETIC FIELD PRODUCED BY THE SIGNA MAGNET. THE RUO TEMPERATURE MONITOR CONTAINS FERROUS MATERIALS. KEEP METER AWAY FROM THE MAGNET BORE.

5. Place the RuO Temperature Monitor on the magnet's left hand (service) side close enough to the Coldhead for the monitor's cables to reach the Coldhead's connection ports.

6. Run the two cables up to the Coldhead box and attach the cables as shown in Illustration 4-11, connecting to the Coldhead and Recondenser Connection Ports shown in Illustration 4-12.

NOTE: Make sure the cables are straight between the monitor and the magnet. Coiled cable can effect accuracy of the readings.

Illustration 4-12: RuO Temperature Monitor 2171219 Connections at Coldhead



7. Read the “Recondenser" temperature:

   a. Rotate the switch on the RuO Temperature Monitor to the “Recondenser" position.

   b. Depress the “Push To Read" button.

   c. Let the readings stabilize for 10 seconds, then record the reading.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8. To read “Recondenser” temperature:

NOTE: Since this reading will vary slightly, record the average of the high and low readings.

a. Rotate the switch in the “Coldhead" position and then depress the “Push To Read" button.

b. Depress the “Push To Read" button.

c. Let the readings stabilize for 10 seconds and record the reading.

d. Wait a few minutes and then depress the “Push To Read” button again.

e. Let the readings stabilize for 10 seconds.

f. Average the first and second “Coldhead” readings.

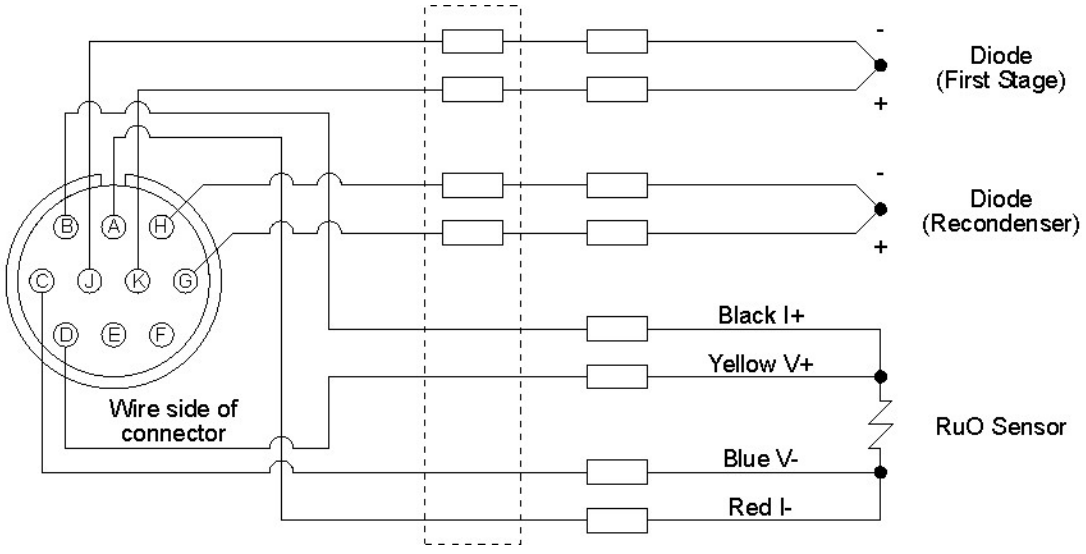
NOTE: If readings are not within the normal range, check battery output by connecting a DVM across the red and black “Battery” terminals on the RuO Temperature Monitor's front panel. Battery output should be above 8 VDC. When sampling, voltage will drop about .7 VDC.

3.3.2 Using a Digital Voltmeter (DVM)

1. Connect a DVM to the appropriate Recondenser contacts shown in Illustration 4-13 and the appropriate Coldhead contacts shown in Illustration 4-14. RuO locations are shown on Illustration 4-15.

NOTE: Use a DVM with 10 microamp or less current supply to minimize $I^2 R$ heating of the RuO.

Illustration 4-13: RuO Circuit & Pinouts, Recondenser Vacuum Sleeve



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 4-14: RuO Circuit & Pinouts, Coldhead Transition Flange

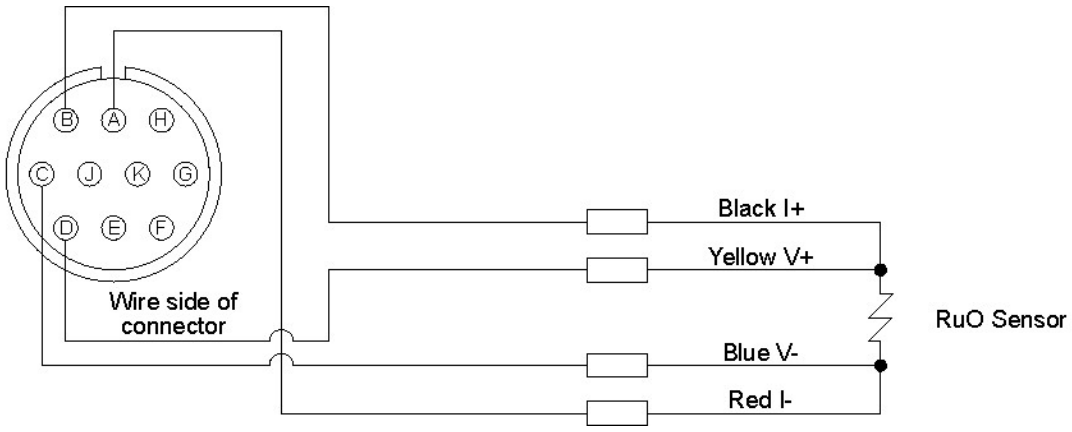
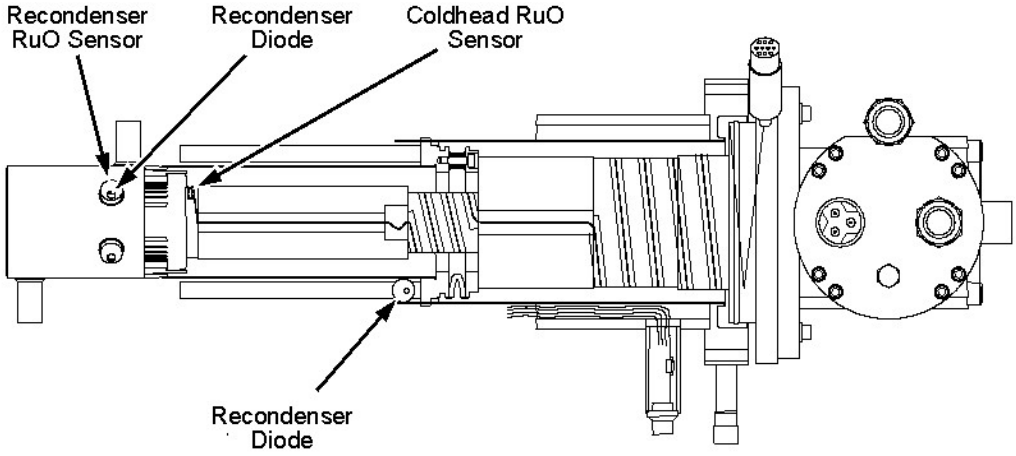


Illustration 4-15: RuO Sensor/Diode Locations



2. Check for isolation of contacts A, B, C and D to the cryostat ground.

3. Check the resistance between contacts A and C (ohms (A,C) = _____) and between contacts B and D (ohms (B,D) = _____). This is the resistance of the phosphor bronze wire loop to the RuO.

NOTE: Phosphor bronze wire has a resistance of 1.08 ohm/foot at 300K and 0.87 ohm/foot at 4.2K. Wire loop resistances are generally in the range of 25 ohms - 75 ohms. Low resistance readings (< 20 ohms) may indicate a short in the wire loop or at the connector. Infinite resistance indicates an open circuit.

4. Check resistance between A and B (ohms (A,B) = _____) and between C and D (ohms (C,D) = _____).

5. Calculate RuO Resistance:

$$\text{RuO Resistance (ohms)} = \frac{\text{ohms(A,B)} + \text{ohms(C,D)}}{2} - \frac{\text{ohms(A,C)} + \text{ohms(B,D)}}{2}$$

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

RuO resistance should be 1,450 ohms - 1,325 ohms when the liquid helium pressure is 3 psig or less.

NOTE: Significant differences between readings in Step 3 or Step 4 or out of the specified range in Step 5 indicate a resistance short or open problem. A fully open sensor will read “000K," a fully shorted sensor will read “300K" on the portable temperature monitor.

3.4 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4 Field Stability Check

4.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	.25 hours + .25 hours	.25 hours

4.2 Overview

The following check is made to determine the “uncompensated" main field drift of the magnet. Compensated drift is also performed in the factory and requires a very tightly controlled environment. Contact the factory through the GE Magnet and Cryogens (MAC) field specialist if compensated drift information is required.

4.3 Preliminary Requirements

4.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Digital Voltmeter (DVM)	1	-	-	-
Warning Sign: “Authorized Personnel Only”	1	-	2289812	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
MetroLab Teslameter Kit (or equivalent magnetic field measuring device)	1	-	46-251865G4	-
#5 Teslameter Probe	1	-	46-255839P104	-

4.3.2 Consumables

No consumables required.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.3.3 Replacement Parts

No replacement parts required.

4.3.4 Safety



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO A SHIM POWER SUPPLY OR A TESLAMETER. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.

4.3.5 Required Conditions

Condition	Reference	Effectivity
The removal of some magnet enclosure components may be required to complete Field Stability Check. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with Field Stability Check if cover removal is required.	Chapter 5, Section 5	-
(continued)	Appendix A, Section 1.1	-

4.4 Procedure



NOTICE

Moving equipment may effect magnetic field readings.

1. Post “Authorized Personnel Only” signs (2289812) in conformance with Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, to indicate 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. Set up the MetroLab Teslameter and #5 Probe for single point field measurement in conformance with Chapter 3, Section 4, Preparations for Field Measurement, making sure the probe is at the physical center (R = 0, Z = 0) of the magnet.

3. Set the Teslameter switch to “NMR Frequency (Hz)" and allow the Teslameter to stabilize within a 10 Hz band.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4. Connect the Shim Power Supply to the magnet in conformance with Chapter 3, Section 6, Connections for Ramping and Shimming.

5. Remove all shim currents in conformance with the Preparations for Shim Current Adjustment subsection of Chapter 3, Section 8, Shim Current Adjustment.

6. Set all shim heater switches to “I" (on). After 3 minutes record the frequency as “Frequency 1" in Chapter 8, Section 6, Magnet Uncompensated Drift Log.



NOTICE

Do not move the probe between the first and second measurements.

7. Repeat Step 4 through Step 6 after 24 hours. Record this frequency as “Frequency 2" in Chapter 8, Section 6, Magnet Uncompensated Drift Log, then set all Shim Heater switches to “O” (off).

8. Calculate the 24-hour main field drift rate by using the following formula:

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

$$\text{Drift Rate (Hz/hr)} = \frac{(\text{Freq 1} - \text{Freq 2})}{N}$$

Where:
Freq 1 = Initial Reading (Hz)
Freq 2 = Reading (Hz) after N Hours
N = Number Hours between Readings

9. If the drift rate is greater than 6.3 Hz/hr for 1.5T or 4.2 Hz/hr for 1.0T, the drift rate is outside guidelines; contact the MAC Team Representative or the Regional Service Engineer. High drift rates will require frequent field adjustment and reshimming.

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

4.5 Finalization



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO A SHIM POWER SUPPLY OR A TESLAMETER.

1. Disconnect and lockout/tagout input power to the Shim Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

2. Disconnect the Shim Power Supply from the magnet. Store the Shim Power Supply and cables.

3. Disconnect and lockout/tagout input power to the Teslameter. Verify that no voltage is present by using a DVM or equivalent measuring device.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4. Disconnect the Teslameter from the probe. Store the Teslameter and probe.
5. Remove and store the “Authorized Personnel Only” signs.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5 Magnet Electrical Checks

5.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	1.5 hours	Included in 'Procedure'

5.2 Overview

This section provides “go" / “no go" tests for internal magnet circuitry faults before ramping the magnet.

5.3 Preliminary Requirements

5.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Digital Volt-Ohm Meter (DVM) or Digital Multimeter (DMM)	1	-	-	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

5.3.2 Consumables

No consumables required.

5.3.3 Replacement Parts

No replacement parts required.

5.3.4 Safety



WARNING

POTENTIAL MAGNET QUENCH!
CONTACT WITH CONNECTOR PINS WHILE THE MAGNET IS RAMPED MAY CAUSE A MAGNET COIL QUENCH.
MAKE SURE THE MAIN AND SHIM COILS ARE RAMPED DOWN TO ZERO AMPS BEFORE STARTING THE MAGNET ELECTRICAL CHECKS PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the magnet is at zero field in conformance with Chapter 5, Section 6, Magnet Rampdown to Zero Field, before starting the Magnet Electrical Checks procedure.	Chapter 5, Section 6	-
All superconducting coils measured must be cold (4.2K) for the resistance values shown in Table 4-4, Table 4-5 and Table 4-6 to be accurate.	-	-
The Shim Lead Assembly must be fully “Engaged” in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement, in order to obtain resistance data.	Chapter 3, Section 5	-
The removal of some magnet enclosure components may be required to complete Magnet Electrical Checks. Refer to Chapter 5, Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with Magnet Electrical Checks if cover removal is required.	Chapter 5, Section 5	-
(continued)	Appendix A, Section 1.1	-

5.4 Procedure

1. “Engage" the Shim Lead Assembly in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement.

2. Locate the connector pins using Table 4-4, Table 4-5, Table 4-6 and Illustration 4-16.

NOTE: Wiring is shown in Chapter 6, Section 2.1, Magnet System Wiring.

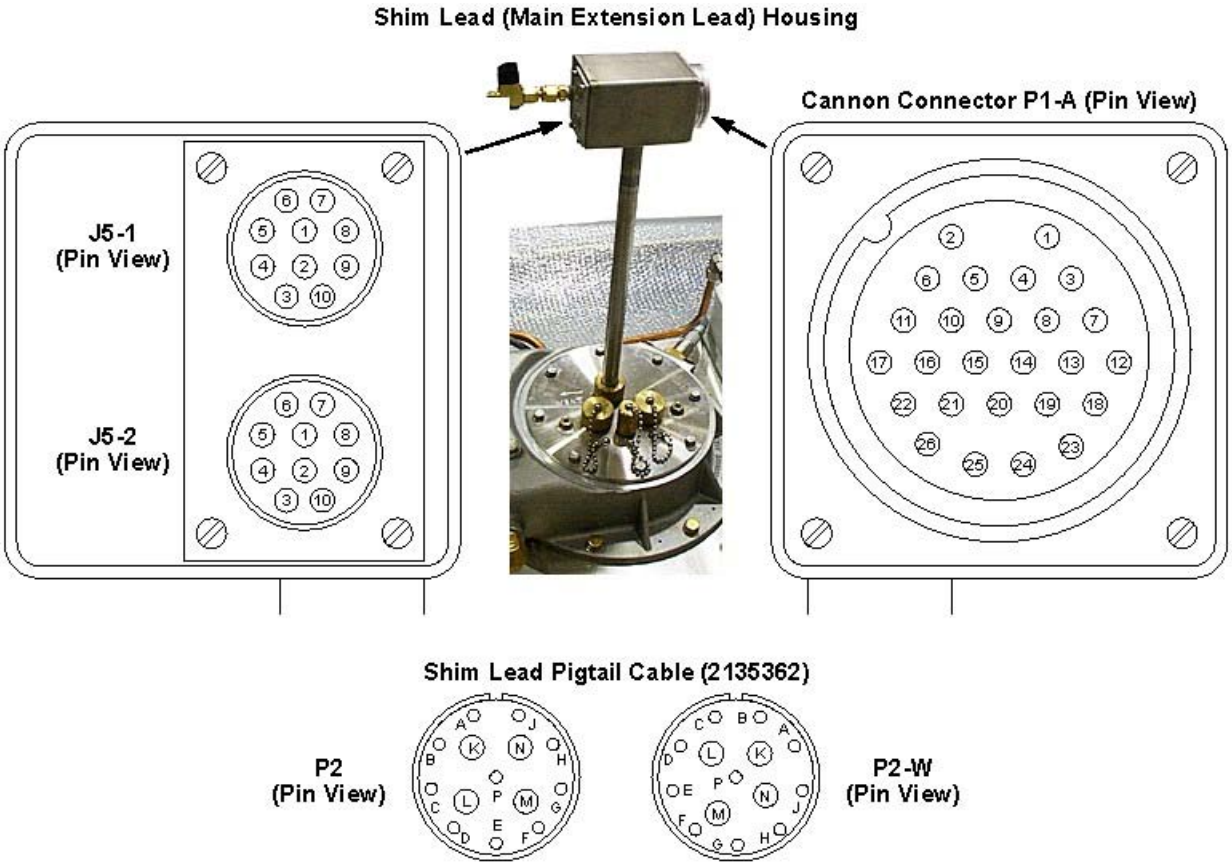
3. Use a digital meter to measure the resistance across the identified connector pins.

4. easure the resistances and record, under “Measured”, Main Coil resistances in Table 4-4, S/C Shim Coil resistances measured on the Shim Lead in Table 4-5 and S/C Shim Coil resistances measured on the Shim Lead Pigtail Cable in Table 4-6.

5. Report all “Measured” readings outside the acceptable range (“Typical” values in Table 4-4, Table 4-5 and Table 4-6) to the Regional Magnet & Cryogens (MAC) Team Leader for further investigation before ramping the magnet.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 4-16: Connector Pinouts



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 4-4: Main Coil Resistance Checks, Cold (4.2K)

Connector	Pins	Resistance (Ohms)	
	+, -	Typical	Measured
Main Coil Power Lugs	+, -	< 6	
J5-1 on Shim Lead	9, 10	< 6	

Table 4-5: Superconducting Shim Coil Resistance Checks, Cold (4.2K), Measured on Shim Lead

Function		Connector	Pins	Resistance (Ohms)	
Shim PS Setting	Shim Coil Circuit		+, -	Typical	Measured
AX1	Z1	P1-A	1, 19	0.3 - 0.5	
AX2	Z2		2, 20		
AX3	Z3		3, 21		
AX4	Z4		4, 22		
AX5	Z5		5, 23		
AX6	Z6		6, 24		
T1-1	C31		13, 23		
T1-2	C11+		16, 19		
T1-3	C22+		14, 21		
T1-4	C11-		17, 20		
T1-5	C22-		15, 22		
T1-6	C33		18, 24		
T2-1	S31		11, 23		
T2-2	S11+		9, 19		
T2-3	S22+		7, 21		
T2-4	S11-		10, 20		
T2-5	S22-		8, 22		
T2-6	S33		12, 24		
S/C Switch Heaters Main Switch		J5-1 or J5-2	1, 2	22 - 27	
Axial Shims			5, 6	27 - 33 *or* 22 - 28*	
Transverse 1			7, 6	8 - 10	
Transverse 2			8, 6		
* New switch configuration incorporated around R216 and Q063.					

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 4-6: Superconducting Shim Coil Resistance Checks, Cold (4.2K), Measured on Shim Lead Pigtail Cable

Function		Connector	Pins	Resistance (Ohms)	
Shim PS Setting	Shim Coil Circuit		+, -	Typical	Measured
AX1	Z1	P2	A*, (K,L)	0.3 - 0.6	
AX2	Z2	P2-W			
AX3	Z3	P2	B, (M,N)		
AX4	Z4	P2-W			
AX5	Z5	P2	C, P		
AX6	Z6	P2-W			
T1-1	C31	P2	D, P		
T1-2	C11+		F, (K,L)		
T1-3	C22+		G, (M,N)		
T1-4	C11-	P2-W	F, (K,L)		
T1-5	C22-		G, (M,N)		
T1-6	C33		D, P		
T2-1	S31	P2	E, P		
T2-2	S11+		H, (K,L)		
T2-3	S22+		J, (M,N)		
T2-4	S11-	P2-W	H, (K,L)		
T2-5	S22-		J, (M,N)		
T2-6	S33		E, P		
* New switch configuration incorporated around R216 and Q063.					

5.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6 Magnet Rundown Unit (MRU) Checks

6.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	Weekly Checks: .5 hour; Yearly Checks: 1 hour	Included in 'Procedure'

6.2 Overview

Check Magnet Rundown Unit (MRU) basic functioning weekly and full functioning yearly. If the MRU fails any of these checks, immediately contact your MAC Team representative.

6.3 Preliminary Requirements

6.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Gloves (electrically insulating); one pair per person	1	-	-	-
Safety Glasses; one pair per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
3.5-Digit Digital Voltmeter — Note: Do not use a Volt-Ohm Meter.	1	-	-	-
20 ohm 5% 20 watt Ceramic Resistor (shipped with MRU or field-supplied equivalent)	1	-	-	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
Magnet Rundown Unit (MRU) Service Manual 46-318393 (vendor manual included in LCC300 Manual Collector 2340870)	1	-	46-318393	-
Magnet Rundown Unit (MRU) Operation Manual 46-318394 (vendor manual included in LCC300 Manual Collector 2340870)	1	-	46-318394	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-

6.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Silicone grease or petroleum jelly; one container	1	-	-	-

6.3.3 Replacement Parts

No replacement parts required.

6.3.4 Safety



WARNING

POTENTIAL MAGNET QUENCH!
INADVERTENTLY PRESSING THE MRU 'RUNDOWN' BUTTON WILL QUENCH THE MAGNET, RESULTING IN THE RAPID EXPULSION OF HELIUM THROUGH THE VERTICAL PENETRATION.
MAKE SURE NO 'RUNDOWN' BUTTON IS PRESSED WHILE PERFORMING MRU FUNCTIONAL CHECKS.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH MRU WIRING WHILE POWER IS SUPPLIED CAN CAUSE ELECTRICAL SHOCK.
DISCONNECT INPUT POWER TO MRU BEING CHECKED AND FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE PERFORMING YEARLY MRU CHECK. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.

6.3.5 Required Conditions

No required conditions.

6.4 Procedure

6.4.1 Weekly MRU Checks



WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH IF THE “RUNDOWN” BUTTON ON ANY MRU INSTALLED IS ACTIVATED < 3 MINUTES AFTER EITHER MRU HAS RECEIVED AC POWER.
DO NOT ACTIVATE THE “RUNDOWN” BUTTON DURING THE MAGNET RUNDOWN UNIT (MRU) CHECKS PROCEDURE.



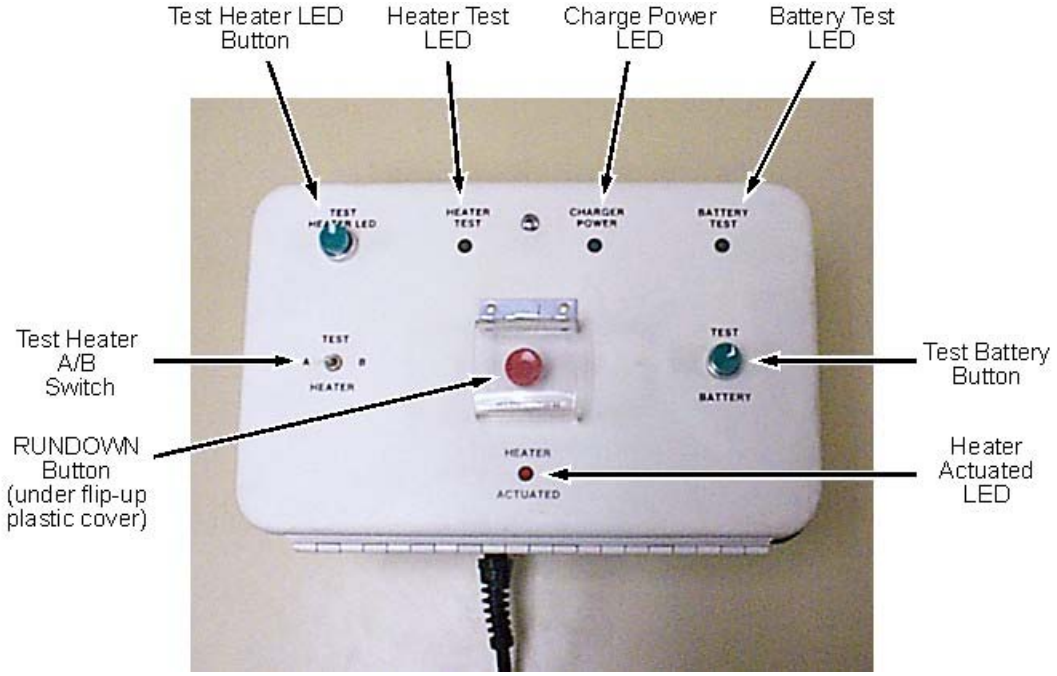
WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH IF 'P2' IS CONNECTED TO 'J2' < 3 MINUTES AFTER ANY MRU BEING INSTALLED HAS RECEIVED AC POWER
DO NOT CONNECT 'P2' TO 'J2' WITHIN 3 MINUTES OF POWERING ON EITHER MRU.

1. Verify that the green “Charger Power" LED is lit. See Illustration 4-17.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 4-17: Magnet Rundown Unit 46-294231G1



2. Depress the “Test Battery" Button. The green “Battery Test" LED should light.
3. Place the “Test Heater" Switch in its “A" position. The green “Heater Test" LED should light.
4. Place the “Test Heater" Switch in its “B" position. The green “Heater Test" LED should light.
5. If the “Heater Test" LED does not light, depress the “Test Heater LED" Button to verify the LED is functioning.

NOTE: See Section 5, Magnet Electrical Checks, for the Main Switch Heaters continuity check.

6.4.2 Yearly MRU Checks

1. Perform weekly checks in conformance with Section 6.4.1, Weekly MRU Checks.



WARNING
ELECTRICAL SHOCK HAZARD
CONTACT WITH MRU WIRING WHILE POWER IS SUPPLIED CAN CAUSE ELECTRICAL SHOCK.
DISCONNECT INPUT POWER TO MRU BEING CHECKED AND FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE PERFORMING YEARLY MRU CHECK.

2. Check each MRU installed:
   a. Disconnect and lockout/tagout input power to the MRU being checked. Verify that no voltage is present by using a DVM or equivalent measuring device.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

b. Disconnect the 4-pin Lemo Connector (P2) end of the cable to the magnet from connector J3 behind the MRU cover.

NOTE: See Chapter 3, Section 1.6, Magnet Rundown Unit (MRU) Installation, for a dual-MRU block diagram and Chapter 6, Section 1.1, Magnet System Interconnects, for wiring diagrams.

c. Remove lockout/tagout and connect input power to the MRU being checked.

d. Perform yearly MRU checks in conformance with the vendor manual

e. Disconnect and lockout/tagout input power to the MRU being checked. Verify that no voltage is present by using a DVM or equivalent measuring device.

f. Reconnect the 4-pin Lemo Connector (P2) end of the cable to the magnet to connector J3 behind the MRU cover.

g. Remove lockout/tagout and connect input power to the MRU being checked.

6.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7 Cryocooler Checks

7.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	1 hour	Included in 'Procedure'

7.2 Overview

The Cryocooler System consists of a Cryocooler Compressor, located in the equipment room, and a Coldhead mechanically attached to the Cryostat Heat Shields. The Cryocooler is designed to maintain a temperature of < 45K on the outside “First Stage" Shield and of < 4.5K on the inside “Second Stage" Recondenser. Both the first and second stage interface points on the Cryocooler Coldhead Mounting Sleeve are equipped with temperature sensing silicon diodes for monitoring and troubleshooting purposes.

NOTE: Perform Cryocooler Checks at installation, when cryostat pressure or boil-off is out of specification and at the yearly Preventative Maintenance (PM) interval if the check was not performed within the year interval.

7.3 Preliminary Requirements

7.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Digital Thermometer	1	-	-	-
2 Gallon (10 Liter) Bucket	1	-	-	-
RuO Temperature Monitor (included in RuO Temperature Monitor Kit 2183710)	1	-	2171219	-
Nonmagnetic Tool Kit, Inch/Metric (46-320273G4) (magnets with magnetic fields ≤ 1.5T only); one kit	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

7.3.2 Consumables

No consumables required.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7.3.3 Replacement Parts

No replacement parts required.

7.3.4 Safety

No general safety information.

7.3.5 Required Conditions

No required conditions.

7.4 Procedure

1. Turn the Cryocooler Compressor off and allow the static gas pressure to equalize on the gauge on the front panel of the unit. See Illustration 4-18.

Illustration 4-18: Cryocooler Compressor Pressure Gauge



2. Read the gauge-equalized pressure and record it in Chapter 8, Section 1, Magnet Commissioning Log. The static pressure should be 16.5 bar - 17.0 bar.

NOTE: If the pressure is outside this range, refer to the vendor's manual for troubleshooting instructions.

3. When the static gas pressure is within the specification range, turn on the Cryocooler Compressor.

4. Verify that the flow rate and temperature of the water supplied to the Cryocooler Compressor are within the specification stated in Table 4-7. If the site doesn't have accurate measurements of flow rate and temperature:

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

a. Disconnect the water supply line from the Cryocooler Compressor and run the water flow into a 2 gallon (10 liter) bucket. If a 2 gallon bucket fills in < 64 seconds or a 10 liter bucket fills in < 89 seconds, the flow rate meets the required 1.85 gallons per minute (gpm) (6.66 liters per minute (lpm)) minimum.

b. Measure the water temperature. The supply water temperature must be between 39.2°F (4°C) and 82.4°F (28°C).

c. Reconnect the water supply line to the Cryocooler Compressor.

d. Check the water supply line for leaks. Repair as necessary.

Table 4-7: Cryocooler Compressor Water Flow Rate & Temperature Specifications

Flow Rate	1.85 gallons per minute (gpm) (6.66 liters per minute (lpm))
Temperature	39.2°F - 82.4°F (4°C - 28°C)

5. Check Cryocooler temperatures. See Chapter 3, Section 1.5, Cryocooler Installation and Checkout, for the correct procedure.

6. Read and record the “First Stage" and “Second Stage" Shield temperatures in Chapter 8, Section 1, Magnet Commissioning Log.

7. Compare these readings to the guidelines given in Table 4-8 and to the initially recorded readings obtained at equilibrium. Refer to Chapter 3, Section 1.5, Cryocooler Installation and Checkout.

Table 4-8: Temperature Guidelines

	Shield Temperature
First Stage	≤ 45K
Second Stage	≥ 4.3K

8. If any Shield temperature is out of range (Table 4-8) or differs drastically from the previous equilibrium temperatures, check the eight mounting bolts of the Cryocooler Coldhead and ensure that they are not loose. See Chapter 5, Section 10, Two-Stage Cryocooler Coldhead Replacement.

9. If gas pressure and water supply are in specification and the mounting bolts are tight when shield temperature is out of range, then Cryocooler Coldhead replacement may be necessary. Contact your MAC Team Representative before replacing the Coldhead.

7.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8 Main Power Supply Tests

8.1 Main Power Supply Introduction

The power supply checkout procedure should always be done before ramp up, ramp down, or readjusting the magnet field after shimming. Heater Current checkout only needs to be performed when the Heater 1 Main or Heater 2 Shim Axial currents are outside the specified range (810 mA ± 10 mA). If any of the checks in this section fail, the Main Power Supply must be repaired before attempting to ramp up, ramp down or readjust the magnet field after shimming.

The 750 amp power supply, model TCR 7.5T750, is normally used. If the magnet Acceptance Test Report (ATR) indicates a ramping current > 750 amps or the site has steel in the floor or ceiling, use the 1000 amp power supply, model ESS 7.5-1000-2-D-1236. Section 8.2 covers the check-out procedures for the TCR 7.5T750, and Section 8.3 covers them for the ESS 7.5-1000-2-D-1236.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8.2 TCR 7.5T750 Main Power Supply Tests

8.2.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	1.5 hours	Included in 'Procedure'

8.2.2 Overview

All TRC 7.5T750 Main Coil Power Supplies (46-260776G3) should be checked in conformance with the TCR 7.5T750 Main Power Supply Tests procedure at least once a year. In addition, use the TCR 7.5T750 Main Power Supply Tests procedure when a TRC 7.5T750 Power Supply is suspected 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."

8.2.3 Preliminary Requirements

8.2.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
4.5-Digit True RMS Digital Voltmeter (Fluke 87 or equivalent)	1	-	-	-
Oscilloscope	1	-	-	-
Nonmetalic tuning tool	1	-	-	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
4/0 Positive Power Cable, red	2	-	46-260723G1	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
4/0 Negative Power Cable, black	2	-	46-260723G2	-
Power Supply Calibration Kit	1	-	2101360	-

8.2.3.2 Consumables

No consumables required.

8.2.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
Potentiometer, 5K 10-Turn (included in Power Supply Calibration Kit 2101360)	1	-	46-281468P12	-
Potentiometer, 100 Ohm 10-Turn (included in Power Supply Calibration Kit 2101360)	1	-	46-281468P26	-

8.2.3.4 Safety



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO A POWER SUPPLY. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.

8.2.3.5 Required Conditions

No required conditions.

8.2.4 Procedure

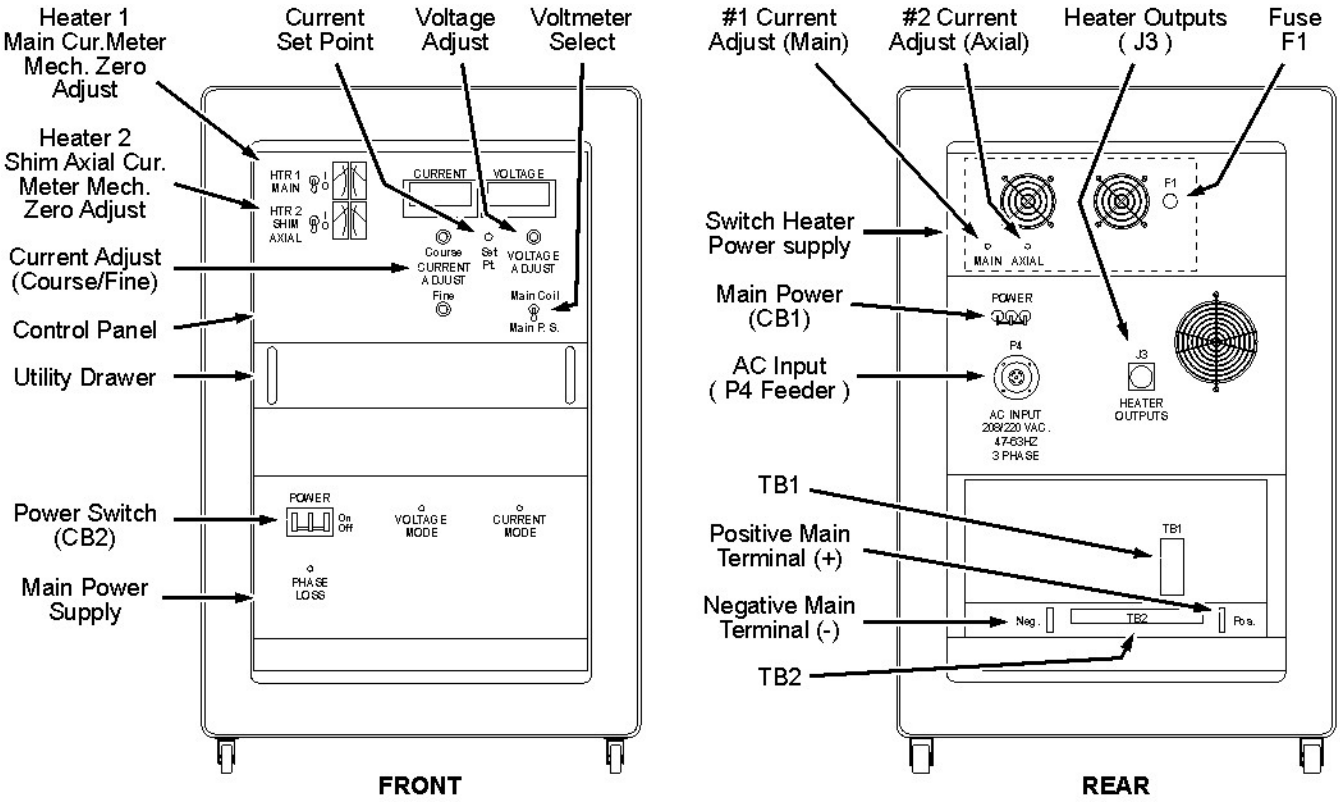
8.2.4.1 Heater Current Meter Zero Calibration

1. Disconnect and lockout/tagout input power to the power supply to be tested. Verify that no voltage is present by using a DVM or equivalent measuring device.

2. Remove the cover plates to access the meter's mechanical Zero Adjustment Screw (located adjacent to each meter). See Illustration 4-19.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 4-19: 750 Amp TCR 7.5T750 Superconducting Main Coil Service Power Supply Cabinet (46-260776G3)



3. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “O" (off).

4. Adjust each meter's mechanical Zero Adjustment Screw as required to position the meter indicator needle at “0" (zero).

5. Replace the cover plates.

8.2.4.2 Heater Calibration

1. Disconnect and lockout/tagout input power to the power supply to be tested. Verify that no voltage is present by using a DVM or equivalent measuring device.

2. Connect the P3 test connector to the heater outputs J3, located on the rear of the power supply. See Illustration 4-19.

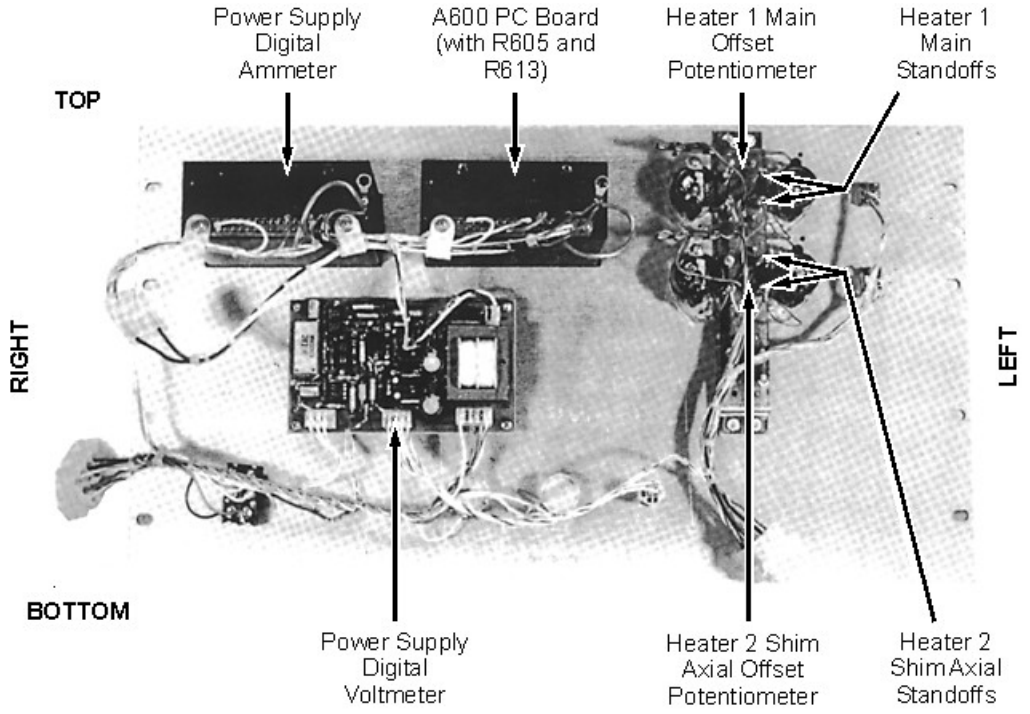
3. Remove the eight mounting screws holding the Control Panel to the power supply.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4. Pull out the Utility Drawer, then place the Control Panel face down on the drawer to expose the component side of the panel.

5. Connect an 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 nearest the heater voltmeter. See Illustration 4-20.

Illustration 4-20: Rear View, Power Supply Control Panel



6. Remove lockout/tagout and connect 208 VAC to the AC input connector.

7. Set the Main Power and Power On Switches to “ON."

8. Set the Heater 1 Main Switch to “I" (on).

9. Adjust the #1 Current Adjustment Potentiometer, located on the rear of the power supply, until the external voltmeter reads 24.3 VDC. See Illustration 4-19.

10. Adjust the Heater 1 Main Meter Offset Potentiometer, located on the component side of the Control Panel (Illustration 4-20), until the Heater 1 Main Current Meter reads 810 mA DC.

11. Set the Heater 2 Shim Axial Switch to “I" (on).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

12. Connect an external DVM (set to “DC Volts") to the Heater 2 Shim Axial standoffs, located on the component side of the Control Panel. See Illustration 4-20

13. Adjust the #2 Current Adjustment Potentiometer, located on the rear of the power supply (Illustration 4-19), until the external voltmeter reads 24.3 VDC.

14. Adjust the Heater 2 Shim Axial Meter Offset Potentiometer, located on the component side of the Control Panel (Illustration 4-20), until the Heater 2 Shim Axial Current Meter reads 810 mA DC.

15. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “I" (off).

16. Set the Main Power and Power On Switches to “OFF."

8.2.4.3 Voltage Calibration

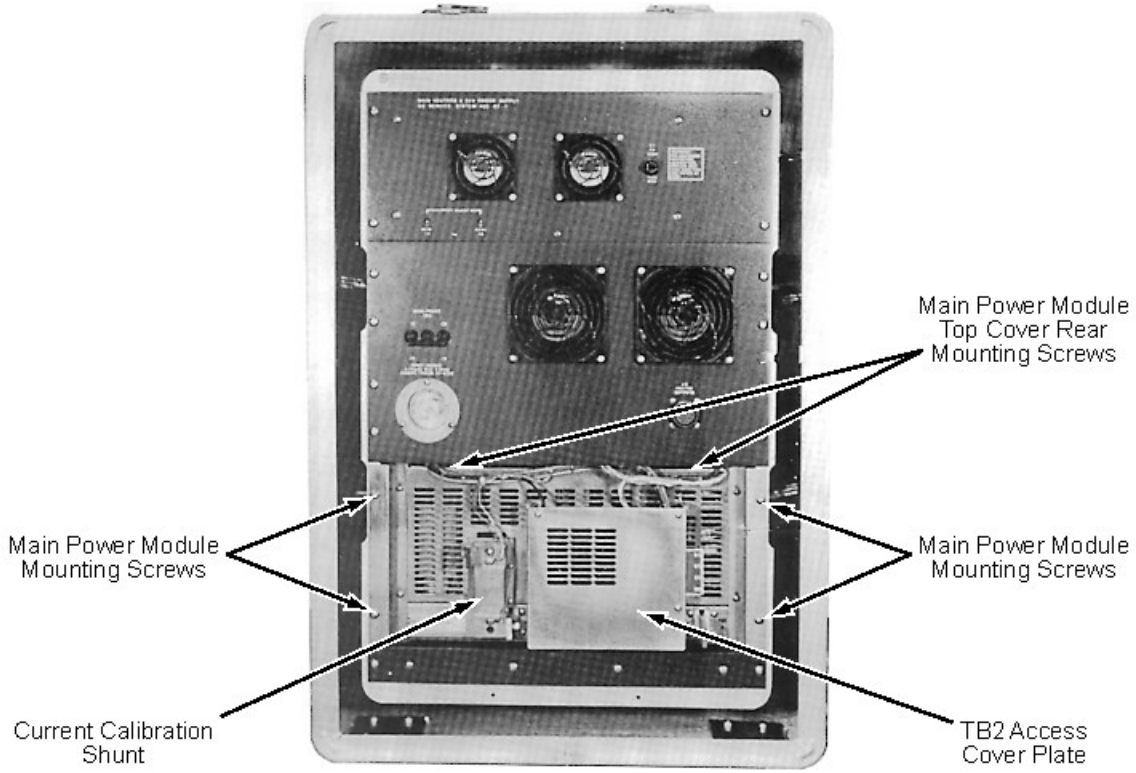
Voltage Calibration is checked under “no load" condition. Make sure the Ramp Leads are disconnected for this test.

1. Turn off the power supply. Then disconnect and lockout/tagout input power to the power supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

2. Remove the TB2 Access Cover Plate. See Illustration 4-21.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 4-21: Main Power Supply Rear View



3. Make sure the P3 test connector is connected to heater outputs J3, located on the rear of the power supply.

4. Set the DVM to the “DC Volt" scale.

5. Connect the DVM's positive lead to TB2 pin 1 and its negative lead to TB2 pin 7.

NOTE: TB2 is numbered from left to right.

6. Adjust the Voltage Adjustment Potentiometer to minimum (full CCW) and both Current Adjustment Potentiometers to maximum (full CW).

DANGER

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

7. Remove lockout/tagout and reconnect input power to the power supply.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8. Set the Main Power and Power On Switches to “ON."

9. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “I" (on).

10. Adjust the Voltage Adjustment Potentiometer to maximum (full CW). The DVM should display within the range of 7.0 VDC - 8.0 VDC.

NOTE: The ideal DVM reading is 7.5 volts. Voltages < 7.5 volts could increase ramp up time. Voltages > 8.0 volts could damage output capacitors. If the voltage < 7.0 VDC or > 8.0 VDC, return the power supply for repair.

11. Adjust the Current Coarse Adjustment Potentiometer to minimum (full CCW).

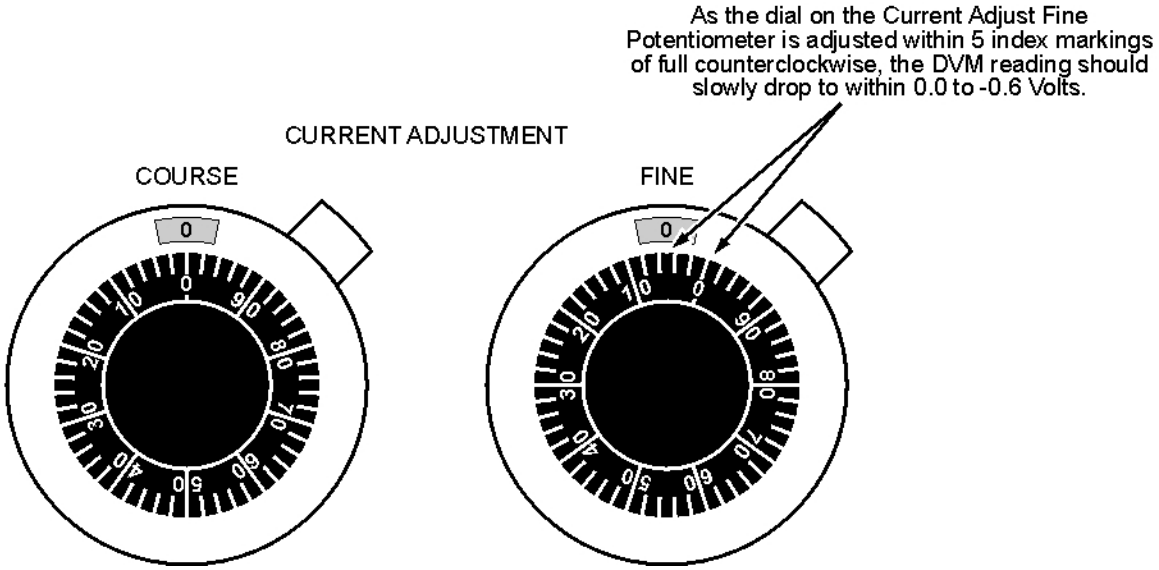
12. Adjust the Current Adjust Fine Potentiometer to minimum (full CCW). As the dial on the Current Adjust Fine Potentiometer is adjusted to within 5 index markings of full counterclockwise, as shown in Illustration 4-22, the DVM reading should drop to within the range of 0.0 VDC and -0.6 VDC. If necessary, adjust the R605 potentiometer, located on the A600 PC board behind the power supply Control Panel (Illustration 4-20), to the point at which the DVM drop occurs.

NOTE: This adjustment 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 Adjustment Potentiometers 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 Adjustment Potentiometers are adjusted, from minimum, until there is a noticeable current output of power supply.

NOTE: It takes approximately 2 minutes for the DVM reading to decay to between 0.0 Volts and -0.6 Volts. A few trials adjusting the Current Adjust Fine Potentiometer must be done to insure the power supply output voltage drops and rises as the Current Adjust Fine Potentiometer is adjusted in and out of the range. See Illustration 4-22.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 4-22: Current Adjust Potentiometers



13. Adjust the Current Adjust Fine Potentiometer in and out of the range stated in Step 12 to insure proper adjustment of R605.

NOTE: The Current Fine Adjustment Potentiometer is very sensitive.

14. Reinstall the Control Panel if previously removed.

NOTE: The Control Panel will have to be removed again later the TCR 7.5T750 Main Power Supply Tests procedure. It is only necessary to replace a couple of the Control Panel mounting screws at this time.

8.2.4.4 Voltage Adjustment Potentiometer Noise Test

The Voltage Adjustment Potentiometer is checked under “no load" condition. Make sure the Ramp Leads are disconnected for this test.

1. Disconnect and lockout/tagout input power to the power supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

2. Verify that the Ramp Leads are disconnected.

3. Measure the resistance, using an ohmmeter, from the Negative Main Terminal 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 a repair facility if the resistance check indicates a shorted or leaky output capacitor.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4. Remove the mounting screws securing the TB2 Access Cover Plate. The plate is located between the main terminals at the bottom rear of the power supply and protects a fan and terminal board TB2. See Illustration 4-21.

5. Connect the X1 Probe to the Oscilloscope.

6. Connect the X1 Probe's ground lead to TB2 pin 7 and its signal lead on TB2 pin 3.

NOTE: TB2 is numbered from left to right.

7. Set the Oscilloscope's “Time Base" Control to 5 msec/div (X1 Probe).

8. Set the Oscilloscope's “VOLT/DIV" Control to 5 mV/div.

9. Set the input coupling to “AC."

10. Plug the Oscilloscope power cable into an AC outlet and turn the Oscilloscope power switch on.

11. Remove lockout/tagout and reconnect input power to the power supply. Turn all power supply breaker switches on.

NOTE: The Oscilloscope beam will move upward and downward as the Voltage Adjustment Control is adjusted.

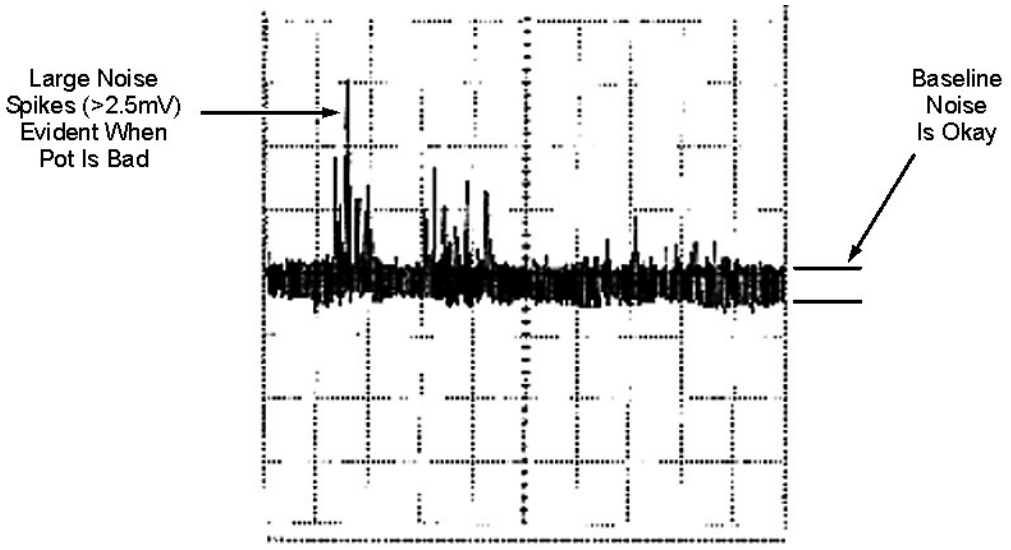
12. Adjust the Voltage Adjustment Potentiometer through its full range of operation while observing the Oscilloscope. The signal should be free from spikes. A bad potentiometer will intermittently display large spikes as the potentiometer is adjusted through its full range. See Illustration 4-23 for an example of a bad pot. Do not confuse spikes or noise seen while the pot is not being adjusted with potentiometer noise.

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 (baseline noise) are caused by switching circuits in the main power module. Do not confuse these spikes as potentiometer noise.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 4-23: Potentiometer Noise



13. If the potentiometer fails this test, turn off and disconnect input power to the power supply and replace the pot. The Voltage Adjustment Potentiometer (46-281468P12) is 5K 10-turn and is included in Power Supply Calibration Kit 2101360.

14. Adjust the Voltage Adjustment Potentiometer to minimum (CCW).

15. Set the power supply Main Power and Power On Switches to “OFF."

8.2.4.5 Current Calibration and Current Potentiometer Noise Check

The external Current Shunt (2101358) should be replaced or calibrated at least once a year. If dropped, it could be forced out of tolerance and should be replaced. The resistance tolerance of the shunt is ± 0.1%. This means that the power supply output could be 750 amps ± 0.75 amps at rated current.

- Use a Fluke 87 4.5-digit Digital Voltmeter or equivalent voltmeter (DVM).
- Current calibration is checked under “no load" condition. Make sure the Ramp Leads are disconnected for this test.

1. Verify that the Ramp Leads are disconnected.

2. Plug the Oscilloscope power cable into an AC outlet and turn the Oscilloscope power switch on.

3. Connect the P3 test connector to heater outputs J3, located on the rear of the power supply (Illustration 4-19).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4. Set the Main Power and Power On Switches to “ON."

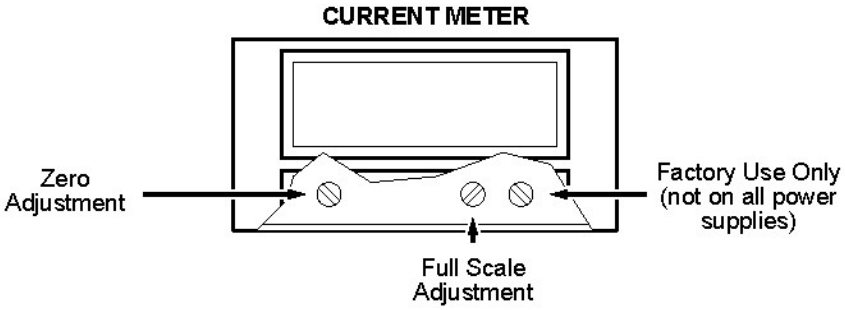
5. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “I" (on).

6. Adjust the Current Adjustment and Voltage Adjustment potentiometers to minimum (full CCW).

7. Remove the snap-on cover plate from the power supply's Current Meter.

8. Adjust the Current Meter Zero “trim pot" on the lower left corner of the meter to 000.0 Amps. This potentiometer is located behind the snap-on cover plate removed in Step 7. See Illustration 4-24.

Illustration 4-24: Power Supply Current Meter Adjustment Potentiometers



9. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “O" (off).

10. Set the Main Power and Power On Switches to “OFF."

11. Connect 2 red 4/0 Positive Ramp Cables (46-260723G1) to the power supply's Positive (+) Main Terminal on the supply's rear (shown in Illustration 4-19) and 2 black 4/0 Negative Ramp Cables (46-260723G2) to its Negative (-) Main Terminal.



⚠ CAUTION

Potential Burn Hazard!
The power supply's high current capacity can cause heat in excess of 60W at the Ramp Cable to 1000A, 100mV Current Shunt junction if the Ramp Cables are not tightly connected to the Current Shunt.
Do not wear rings or other jewelry while performing this portion of the checkout procedure. Make sure the Ramp Cables are tightly connected before performing the following two steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

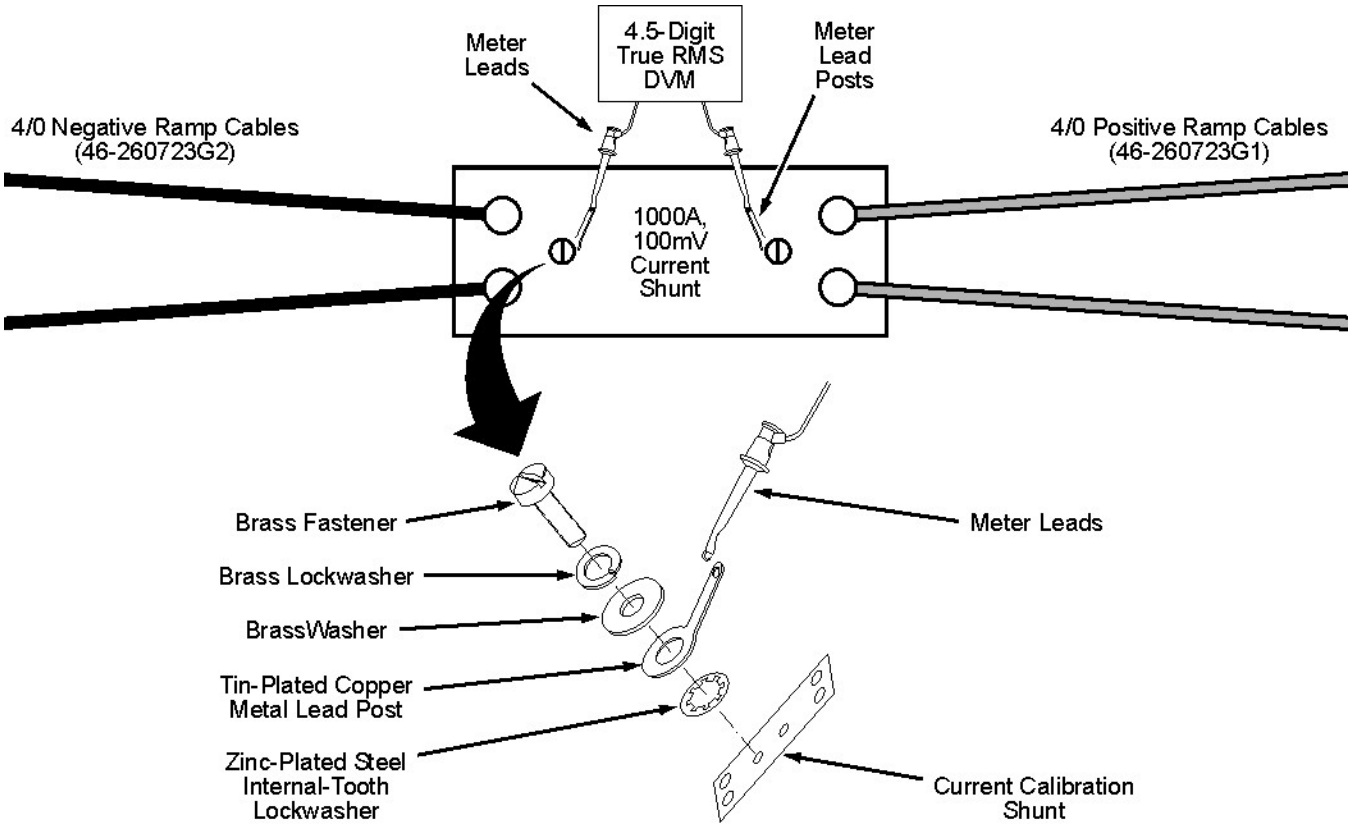
NOTICE

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

12. Tightly bolt the other end of the Positive (+) Ramp Cables to one side of the 1000 amp 100mV Current Shunt. See Illustration 4-25.

13. Tightly bolt the other end of the Negative (-) Ramp Cables to the other side of the 1000 amp 100mV Current Shunt. See Illustration 4-25.

Illustration 4-25: Current Shunt Connections



14. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “O" (off).

15. Adjust the Voltage Control Potentiometer to maximum (full CW). Make sure the Current Adjustment Potentiometers are set to minimum (full CCW).

16. Install the Meter Lead Posts, fasteners and washers to the external Current Shunt as shown in Illustration 4-25. Make sure the Meter Lead Post fasteners are tight.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTE: Erroneous readings will result in Step 25 through Step 27 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 a thermocouple action.

17. Connect a 4.5-digit true RMS Digital Voltmeter (DVM) to the Meter Lead Posts on the Current Shunt. See Illustration 4-25.

18. Set the DVM to read DC millivolts.

19. Connect an Oscilloscope to TB2 pins 9 (+) and 7 (-).

20. Set the Oscilloscope “Time Base" Control to 5 msec/div.

21. Set the Oscilloscope “VOLT/DIV" Control to 5 mV/div.

22. Set the input coupling to AC.

23. Set the power supply Main Power and Power On Switches to “ON."

24. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “I" (on).

25. Adjust the Current Adjust Fine/Coarse Controls to maximum (full CW). The external DVM should indicate a minimum of 75.0 mVDC.

NOTE: Each millivolt increment on the DVM corresponds to 10 amps. Make sure the meter used in the TCR 7.5T750 Main Power Supply Tests procedure is capable of reading to three decimal places.

NOTE: If this voltage is low, maximum rated current (750 amps) will not be achievable, and the power supply should be returned for repair. Include a written description of the problem when returning power supplies.

26. Adjust the Current Adjustment Controls to obtain a reading of 75.0 mVDC on the external DVM. This corresponds to a power supply output of 750 amps.

27. Adjust R613, located on the A600 board, to display a reading of 750 amps on the power supply's digital Current Meter.

    - If a reading of 750 amps cannot be achieved, adjust the power supply's Current Meter's “Full Scale" Trim Potentiometer for 750 amps. See Illustration 4-25.
    - When a reading of 750 amps is achieved, continue with Step 28.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

28. Adjust the Current Adjustment Potentiometers through the full range of operation while observing the Oscilloscope. The signal should be free from spikes. See Illustration 4-23 for an example of a bad pot.

29. If either potentiometer fails this test, turn off and disconnect the power supply input power and replace the potentiometer. The Coarse Current Adjustment Potentiometer is a 5K 10 turn pot (46-281468P12). The Fine Current Adjustment Potentiometer is a 100 ohm 10 turn pot (46-281468P2). Extra potentiometers are included in the Power Supply Checkout Kit (2101360).

30. Adjust all Current and Voltage Adjustment Potentiometers to minimum (full CCW).

31. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “O" (off).

32. Set the Power On and Main Power Switches to “OFF."

33. Reinstall the power supply's Control Panel.

8.2.4.6 Voltage Ripple Check

Typical voltage ripple values, using the TCR 7.5T750 Main Power Supply Tests procedure, are ≤ 30mV RMS. To achieve the lowest voltage ripple reading the power supply being tested must be warmed up for at least 15 minutes before checking and/or adjustment. This test is to be performed using a True RMS Voltmeter.

1. Connect 2 red 4/0 Positive Ramp Cables (46-260723G1) to the power supply's Positive (+) Main Terminal on the supply's rear (shown in Illustration 4-19) and 2 black 4/0 Negative Ramp Cables (46-260723G2) to its Negative (-) Main Terminal.

2. Connect the P3 test connector to heater outputs J3, located on the rear of the power supply.



⚠ WARNING

POTENTIAL BURN HAZARD
DIRECT CONTACT WITH JOINT BETWEEN POSITIVE AND NEGATIVE RAMP CABLES MAY CAUSE SKIN BURNS.
MAKE SURE THE CONNECTION BETWEEN THE POSITIVE AND NEGATIVE RAMP CABLES IS TIGHT TO MINIMIZE RESISTIVE HEAT BUILDUP.

3. Bolt the other ends of the positive and negative ramp cables together. Make sure this connection is tight.

4. Set a True RMS Voltmeter to its AC millivolt scale.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5. Connect the Voltmeter to the power supply's main terminals.

6. Set the Main Power and Power On Switches to “ON."

7. Set the Heater 2 Shim Axial Switches to “I" (on).

8. Adjust the Current Adjustment and Voltage Adjustment Potentiometers to maximum (full CW).

9. Monitor the 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 > 35 millivolts, send the main power supply for repair.

11. Adjust the Voltage Adjustment and Current Adjustment Potentiometers to minimum (CCW).

12. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “I" (off).

13. Set the power supply Main Power and Power On Switches to “OFF."

8.2.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8.3 ESS7.5-1000-2-D-1236 Main Power Supply Tests

8.3.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	1.5 hours	Included in 'Procedure'

8.3.2 Overview

All ESS7.5-1000-2-D-1236 Main Coil Power Supplies (46-260776G4) should be checked in conformance with the ESS7.5-1000-2-D-1236 Main Power Supply Tests procedure at least once a year. In addition, it could be used when a ESS7.5-1000-2-D-1236 Power Supply is suspected 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".

8.3.3 Preliminary Requirements

8.3.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
4.5-Digit True RMS Digital Voltmeter (Fluke 87 or equivalent)	1	-	-	-
Oscilloscope	1	-	-	-
Nonmetallic tuning tool	1	-	-	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
4/0 Positive Power Cable, red	3	-	46-260723G1	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
4/0 Negative Power Cable, black	3	-	46-260723G2	-
Power Supply Calibration Kit	1	-	2101360	-

8.3.3.2 Consumables

No consumables required.

8.3.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
Potentiometer, 5K 10-Turn (included in Power Supply Calibration Kit 2101360)	1	-	46-281468P12	-
Potentiometer, 100 Ohm 10-Turn (included in Power Supply Calibration Kit 2101360)	1	-	46-281468P26	-

8.3.3.4 Safety



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO A POWER SUPPLY. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.

8.3.3.5 Required Conditions

No required conditions.

8.3.4 Procedure

8.3.4.1 Heater Current Meter Zero Calibration



WARNING

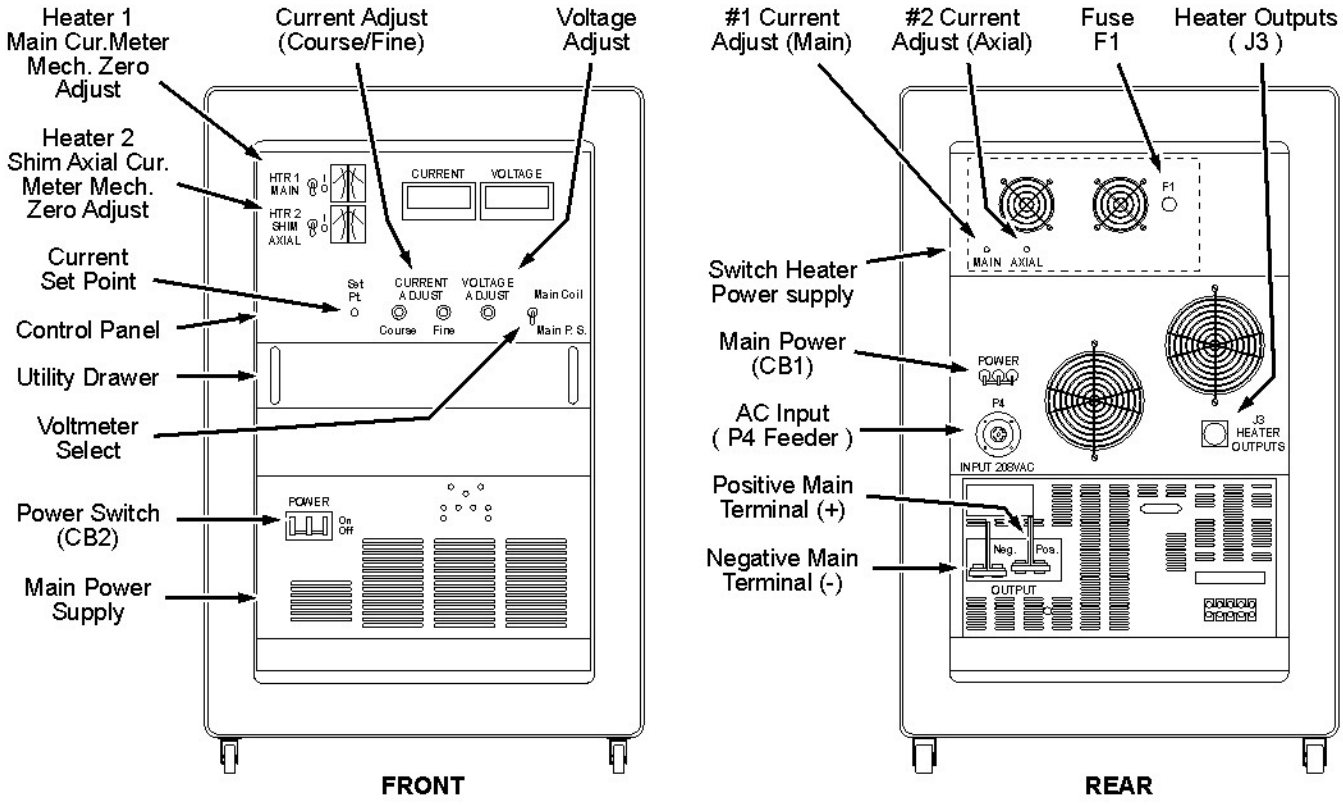
ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO A POWER SUPPLY.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Disconnect and lockout/tagout input power to the power supply to be tested. Verify that no voltage is present by using a DVM or equivalent measuring device.

2. Remove the cover plates to access the meter's mechanical Zero Adjustment Screw (located adjacent to each meter). See Illustration 4-26.

Illustration 4-26: ESS7.5-1000-2-D-1236 Superconducting Main Coil Service Power Supply Cabinet (46-260776G4)



3. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “O" (off).

4. Adjust each meter's mechanical Zero Adjustment Screw as required to position the meter indicator needle at “0" (zero).

5. Replace the cover plates.

8.3.4.2 Heater Calibration

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO A POWER SUPPLY.

1. Disconnect and lockout/tagout input power to the power supply to be tested. Verify that no voltage is present by using a DVM or equivalent measuring device.

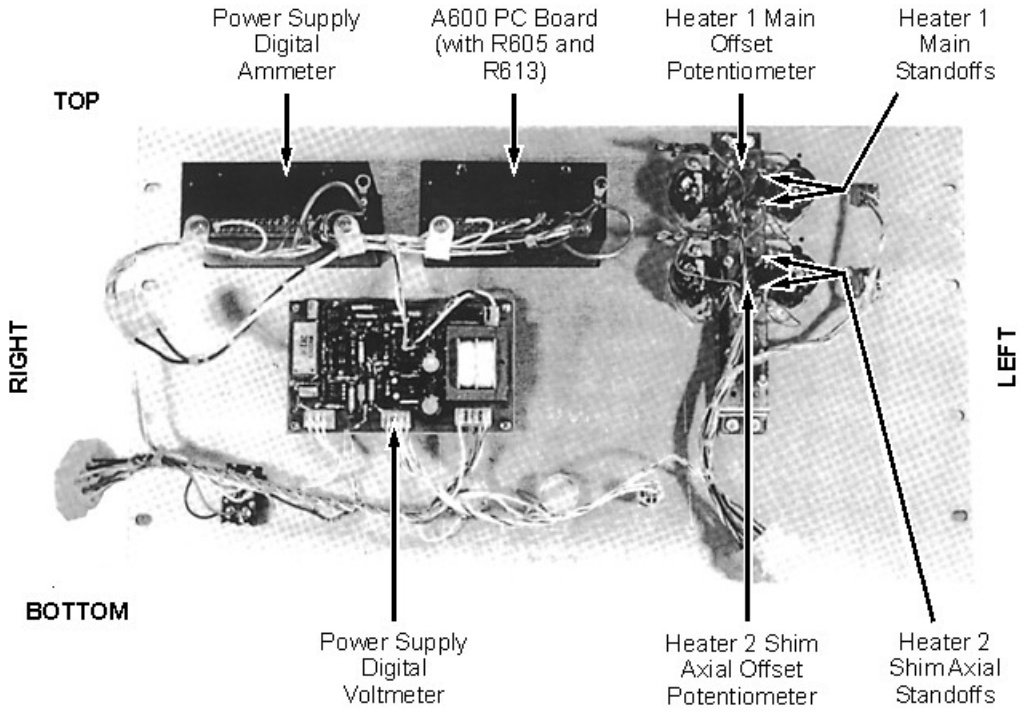
2. Connect the P3 test connector to the heater outputs J3, located on the rear of the power supply. See Illustration 4-26.

3. Remove the eight mounting screws holding the Control Panel to the power supply.

4. Pull out the Utility Drawer, then place the Control Panel face down on the drawer to expose the component side of the panel.

5. Connect an 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 nearest the heater voltmeter. See Illustration 4-27.

Illustration 4-27: Rear View, Power Supply Control Pane



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6. Remove lockout/tagout and connect 208 VAC to the AC input connector.

7. Set the Main Power and Power On Switches to “ON."

8. Set the Heater 1 Main Switch to “I" (on).

9. Adjust the #1 Current Adjustment Potentiometer, located on the rear of the power supply, until the external voltmeter reads 24.3 VDC. See Illustration 4-26.

10. Adjust the Heater 1 Main Meter Offset Potentiometer, located on the component side of the Control Panel (Illustration 4-27), until the Heater 1 Main Current Meter reads 810 mA DC.

11. Set the Heater 2 Shim Axial Switch to “I" (on).

12. Connect an external DVM (set to “DC Volts") to the Heater 2 Shim Axial standoffs, located on the component side of the Control Panel. See Illustration 4-27.

13. Adjust the #2 Current Adjustment Potentiometer, located on the rear of the power supply, until the external voltmeter reads 24.3 VDC.

14. Adjust the Heater 2 Shim Axial Meter Offset Potentiometer, located on the component side of the Control Panel (Illustration 4-27), until the Heater 2 Shim Axial Current Meter reads 810 mA DC.

15. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “I" (off).

16. Set the Main Power and Power On Switches to “OFF."

8.3.4.3 Voltage Calibration

On-site voltage calibration of ESS7.5-1000-2-D-1236 power supplies is not required nor are the voltage calibration components readily accessible.

8.3.4.4 Voltage Adjustment Potentiometer Noise Test

The Voltage Adjustment Potentiometer is checked under “no load" condition. Make sure the Ramp Leads are disconnected and heater output test plug J3 is connected for this test.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO A POWER SUPPLY.

1. Disconnect and lockout/tagout input power to the power supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

2. Verify that the Ramp Leads are disconnected.

3. Verify that the P3 test connector is plugged into heater outputs J3, located on the rear of the power supply. See Illustration 4-26

4. Measure the resistance, using an ohmmeter, from the Negative Main Terminal 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 a repair facility if the resistance check indicates a shorted or leaky output capacitor.

5. Connect the X1 Probe to the Oscilloscope.

6. Connect the X1 Probe's ground lead to the Negative Main Terminal and the signal lead to the Positive Main Terminal.

7. Set the Oscilloscope's “Time Base" Control to 5 msec/div (X1 Probe).

8. Set the Oscilloscope's “VOLT/DIV" Control to 100 mV/div.

9. Set the input coupling to “AC."

10. Connect input power to the Oscilloscope and then turn the Oscilloscope power switch on.

11. Remove lockout/tagout and reconnect input power to the power supply. Turn all power supply breaker switches on.

NOTE: The Oscilloscope beam will move upward and downward as the Voltage Adjustment Control is adjusted.

12. Adjust the Voltage Adjustment Potentiometer through its full range of operation while observing the Oscilloscope. The signal should be free from spikes. A bad potentiometer

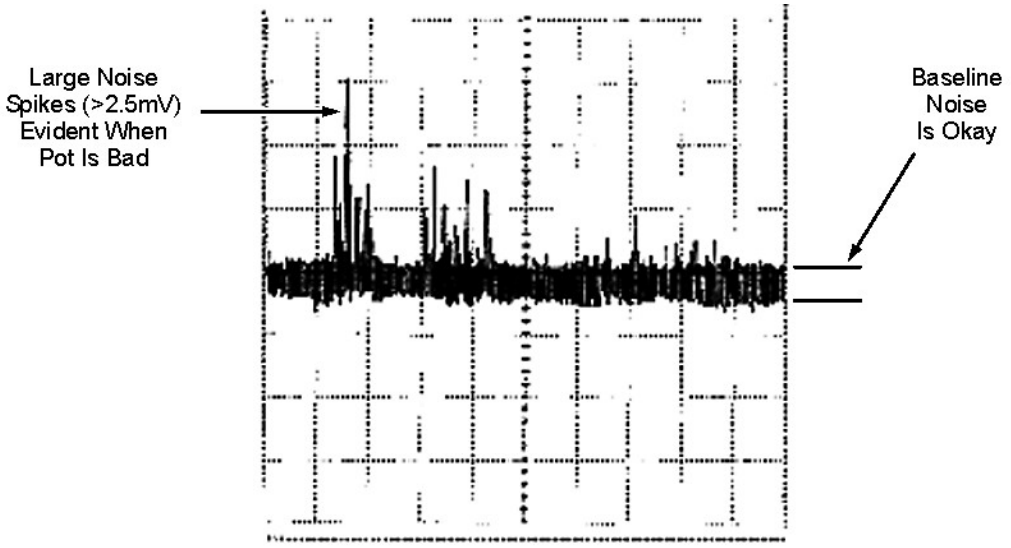
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

will intermittently display large spikes as the potentiometer is adjusted through its full range. See Illustration 4-28 for an example of a bad pot. Do not confuse spikes or noise seen while the pot is not being adjusted with potentiometer noise.

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 (baseline noise) are caused by switching circuits in the main power module. Do not confuse these spikes as potentiometer noise. To isolate spikes of < 1 Volt, make the probe and ground lengths as short as possible.

Illustration 4-28: Potentiometer Noise



13. If the potentiometer fails this test, turn off and disconnect input power to the power supply and replace the pot. The Voltage Adjustment Potentiometer (46-281468P12) is 5K 10-turn and is included in Power Supply Calibration Kit 2101360.

14. Adjust the Voltage Adjustment Potentiometer to minimum (CCW).

15. Set the power supply Main Power and Power On Switches to “OFF."

8.3.4.5 Current Calibration and Current Potentiometer Noise Check

The external Current Shunt (2101358) should be replaced or calibrated at least once a year. If dropped, it could be forced out of tolerance and should be replaced. The resistance tolerance of the shunt is ± 0.1%. This means that the power supply output could be 750 amps ± 0.75 amps at rated current.

- Use a Fluke 87 4.5-digit Digital Voltmeter or equivalent voltmeter (DVM).
- Current calibration is checked under “no load" condition. Make sure the Ramp Leads are disconnected for this test.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Verify that the Ramp Leads are disconnected.

2. Connect input power to the Oscilloscope and then turn the Oscilloscope power switch on.

3. Connect the P3 test connector to heater outputs J3, located on the rear of the power supply. See Illustration 4-26.

4. Set the Main Power and Power On Switches to “ON."

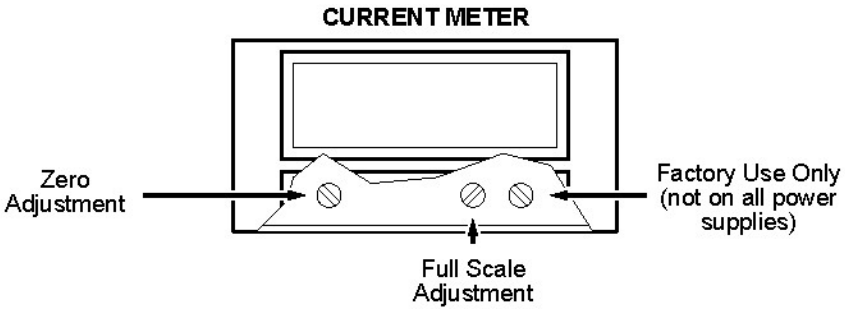
5. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “I" (on).

6. Adjust the Current Adjustment and Voltage Adjustment potentiometers to minimum (full CCW)

7. Remove the snap-on cover plate from the power supply's Current Meter.

8. Adjust the Current Meter Zero “trim pot" on the lower left corner of the meter to 000.0 Amps. This potentiometer is located behind the snap-on cover plate removed in Step 7. See Illustration 4-29.

Illustration 4-29: Power Supply Current Meter Adjustment Potentiometers



9. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “O" (off).

10. Set the Main Power and Power On Switches to “OFF."

11. Connect 3 red 4/0 Positive Ramp Cables (46-260723G1) to the power supply's Positive (+) Main Terminal on the supply's rear (shown in Illustration 4-26) and 3 black 4/0 Negative Ramp Cables (46-260723G2) to its Negative (-) Main Terminal.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

CAUTION

Potential Burn Hazard!
The power supply's high current capacity can cause heat in excess of 60W at the Ramp Cable to 1000A, 100mV Current Shunt junction if the Ramp Cables are not tightly connected to the Current Shunt.
Do not wear rings or other jewelry while performing this portion of the checkout procedure. Make sure the Ramp Cables are tightly connected before performing the following two steps.

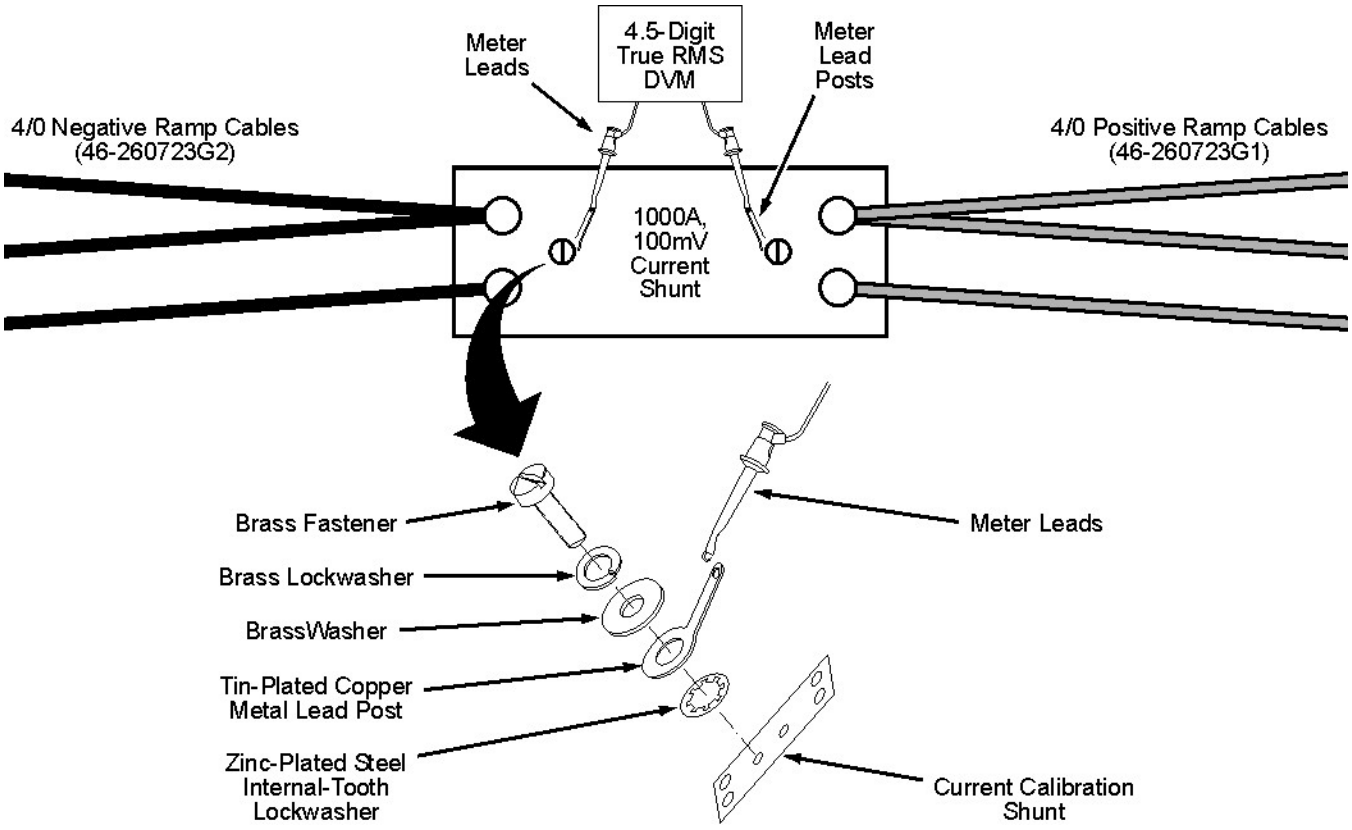
NOTICE

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

12. Tightly bolt the other end of all three Positive (+) Ramp Cables to one side of the 1000 amp 100 mV Current Shunt. See Illustration 4-30.

13. Tightly bolt the other end of all three Negative (-) Ramp Cables to the other side of the 1000 amp 100 mV Current Shunt. See Illustration 4-30.

Illustration 4-30: Current Shunt Connections



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

14. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “O" (off).

15. Adjust the Voltage Control Potentiometer to maximum (full CW). Make sure the Current Adjustment Potentiometers are set to minimum (full CCW).

16. Install the Meter Lead Posts, fasteners and washers to external Current Shunt as shown in Illustration 4-30. Make sure Meter Lead Post fasteners are tight.

NOTE: Erroneous readings will result in Step 25 through Step 27 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 a thermocouple action.

17. Connect a 4.5-digit true RMS Digital Voltmeter (DVM) to the Meter Lead Posts on the Current Shunt. See Illustration 4-30.

18. Set the DVM to read DC millivolts.

19. Connect the X1 Probe to the Oscilloscope, then connect the X1 Probe's ground lead to the Negative Main Terminal and the signal lead to the Positive Main Terminal.

20. Set the Oscilloscope “Time Base" Control to 5 msec/div.

21. Set the Oscilloscope “VOLT/DIV" Control to 100 mV/div.

22. Set the input coupling to AC.

23. Set the power supply Main Power and Power On Switches to “ON."

24. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “I" (on).

25. Adjust the Current Adjust Fine/Coarse Controls to maximum (full CW). The external DVM should indicate a minimum of 75.0 mV DC.

NOTE: Each millivolt increment on the DVM corresponds to 10 amps. Make sure the meter used in the ESS7.5-1000-2-D-1236 Main Power Supply Tests procedure is capable of reading to three decimal places.

NOTE: If this voltage is low, *maximum* rated current (1000 amps) will not be achievable, and the power supply should be returned for repair. Include a written description of the problem when returning power supplies.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

26. Adjust the Current Adjustment Controls to obtain a reading of 75.0 mV DC on the external DVM. This corresponds to a power supply output of 750 amps.

27. Adjust R613, located on the A600 board, to display a reading of 750 amps on the power supply's digital Current Meter.

    a. If a reading of 750 amps cannot be achieved, adjust the power supply's Current Meter's “Full Scale" Trim Potentiometer for 750 amps. See Illustration 4-29.

    b. When a reading of 750 amps is achieved, continue with Step 28.

28. Adjust the Current Adjustment Potentiometers through the full range of operation while observing the Oscilloscope. The signal should be free from spikes. See Illustration 4-28 for an example of a bad pot.

29. If either potentiometer fails this test, turn off and disconnect the power supply input power and replace the potentiometer. The Coarse Current Adjustment Potentiometer is a 5K 10 turn pot (46-281468P12). The Fine Current Adjustment Potentiometer is a 100 ohm 10 turn pot (46-281468P2). Extra potentiometers are included in the Power Supply Checkout Kit (2101360).

30. Adjust all Current and Voltage Adjustment Potentiometers to minimum (full CCW).

31. Set the Heater 1 Main and Heater 2 Shim Axial Switches to “O" (off).

32. Set the Power On and Main Power Switches to “OFF."

33. Reinstall the power supply Control Panel.

8.3.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

9 Magnet Quenches

9.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	.5 hour	1.5 hours	.5 hour

9.2 Overview

Follow the actions below to prevent a magnet quench and to minimize the impact of a quench should one occur.

9.3 Preliminary Requirements

9.3.1 Tools and Test Equipment

No tools or test equipment required.

9.3.2 Consumables

No consumables required.

9.3.3 Replacement Parts

No replacement parts required.

9.3.4 Safety



NOTICE

Review and follow Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements.

9.3.5 Required Conditions

No required conditions.

9.4 Procedure

9.4.1 Quench Prevention

1. Before/during ramping:

   - Verify that the magnet's liquid helium level is > 90%.
   - Make sure the Magnet Monitor is installed and functional before/during ramping.
   - Make sure the power supply has been checked in conformance with Section 8.2, TCR 7.5T750 Main Power Supply Tests, (for 750 amp power supplies) or Section 8.3, ESS7.5-1000-2-D-1236 Main Power Supply Tests (for 1000 amp power suppies).
   - Install new Contact Bands on the Main Lead Extensions in conformance with Chapter 5, Section 4, Main Lead Extension Contact Band Replacement.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

- Make sure the Shim Lead is engaged in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement.
- Make sure gas flow is visible from the Main Lead Extensions' flow holes before starting a ramp.
- Verify that resistance checks are within the specification range, ensuring acceptable contact resistance.
- Ramp the magnet in conformance with Chapter 3, Section 7.1, Ramping Magnet to Field.



WARNING

CRYOGEN BURNS/ELECTRICAL SHOCK
POTENTIAL CONTACT WITH CRYOGENS/ELECTRIC CURRENT WHILE MAIN LEAD EXTENSIONS ARE BEING INSERTED/RETRACTED.
NEVER INSERT/RETRACT A MAIN LEAD EXTENSION WITHOUT WEARING APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE) TO PREVENT POTENTIAL CRYOGEN BURNS OR ELECTRICAL HAZARDS.

2. Ramped magnet:

- Verify that the Magnet Monitor remains completely functional at all times.
- Monitor all critical performance parameters continually during magnet operation.
  - Verify that Cryostat pressure is within specification.
  - Check magnet temperatures and helium usage at each service call.
- Maintain power to the Cryocooler Compressor and associated Chiller at all times. Make sure any emergency back-up power to these components is working.
- Verify that the magnet's liquid helium level is > 60% at 0.5 psig at all times during magnet operation. Refill in conformance with Chapter 3, Section 3.2, Liquid Helium Fill.
- Do not allow a helium Dewar to empty and blow warm gas into the magnet's Fill Port during liquid helium fill/refill.
- Do not insert warm object(s) or blow warm gas into any entry port (Vertical Penetration, Fill Port, etc.) of the magnet.
- Strictly adhere to the rampdown requirements/prerequisites stated in Chapter 5, Section 6, Magnet Rampdown to Zero Field.
- Engage the Shim Lead in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement.
- Insert the Main Lead Extensions in conformance with Chapter 3, Section 6, Connections for Ramping and Shimming.

9.4.2 Quench Recovery



NOTICE

Report ALL quenches by submitting a quench report and by notifying your MAC Team representative. Service a quenched magnet as soon as possible!

NOTE: The first two steps below are essential to maintain positive Cryostat pressure and prevent cryopumping and ice build-up.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Immediately turn off the Cryocooler to prevent cryopumping and icing in the Recondenser.

2. Check and replace the Burst Disc and gaskets in conformance with Chapter 5, Section 11.1, Burst Disc (2349529) Replacement (or Chapter 5, Section 11.2, Burst Disc (2194545-7) Replacement, where appropriate). Make sure debris is cleared. Order a new Burst Disc for the magnet's Field Spares Kit.

3. Purge the Recondenser with 4 bottles of 99.999% (“five nines") helium gas, inputting to the Recondenser shield vent line and exiting through the magnet's helium vent by opening Vent Valve V2. Refer to the Recondenser Deicing subsection of Chapter 5, Section 9.2, Ice Removal.

4. Order and replace liquid helium ASAP.

NOTE: Before performing the next step, make sure positive Cryostat pressure is maintained. If necessary, 99.999% (“five nines") helium gas should be used to pressurize the system.

5. Check for and remove any ice in the Vertical Penetration in conformance with the Shim Lead Connector and Vertical Penetration Deicing subsection of Chapter 5, Section 9.2, Ice Removal.

6. Remove all Baffle Tree debris in the Vertical Penetration. Order and replace the Baffle Tree in conformance with Chapter 5, Section 12, Shim Lead and Baffle Replacement.

7. Connect a DVM between an engaged Main Lead Extension and an unpainted surface on the Cryostat to check for a Main Coil grounding fault. If an open circuit is not indicated, contact your MAC Team representative.

8. Check the Pressure Gauge (2249367) for damage, replacing if required.

9. Refill the magnet in conformance with Chapter 3, Section 3.2, Liquid Helium Fill.

10. Check Cryostat pressure after liquid helium fill and stabilization. Do not adjust Cryostat pressure at this time.

    - If a leak is suspected, check all external plumbing joints, relief valves, the Shim Lead Assembly and the Burst Disc for leaks. Repair as necessary and recheck for leaks.
    - If pressure builds beyond the relief valve's 5 psig threshold, the valve will open. Perform temperature/pressure troubleshooting in conformance with Section 2, Temp., Pressure and Leak Troubleshooting. Continued pressure/flow build-up could indicate Cryostat damage; contact you MAC Team representative.

11. Inspect the entire Vent System, clearing out any Burst Disc/Baffle Tree debris. Notify the site's administration of any Vent System damage found.

12. Ramp the magnet in conformance with Chapter 3, Section 7.1, Ramping Magnet to Field.

13. Shim the magnet in conformance with Chapter 3, Section 8, Shim Current Adjustment.

14. After the system has stabilized maintain Cryostat pressure at 4.0 psig ± 0.1 psig.

15. Complete a magnet quench report and submit it to the On-Line Center.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

9.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

This page left intentionally blank.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Chapter 5 Replacement & Maintenance

1 Periodic Checks and Maintenance

Maintenance procedures should be performed at the intervals specified in Table 5-1. Some procedures require specially trained personnel.

Table 5-1: Maintenance Intervals

Item	Perform Once Every					Trained Service Personnel Required?
	Work Day	Week	Six Months	Year	Two Years	
Check for presence of spare parts kit and service ladder for magnet	—	—	X	—	—	No
Inspect magnet for ice (Section 9.2, Ice Removal)	X	—	—	—	—	Yes
Inspect for damage at vertical stack and plumbing joints	—	—	X	—	—	No
Check helium level on Magnet Monitor	X	—	—	—	—	No
Calculate helium boil-off rate (Chapter 4, Section 2, Temp., Pressure and Leak Troubleshooting)	—	—	X	—	—	No
Check helium vessel operating pressure	X	—	—	—	—	No
Check Magnet Rundown Unit (Chapter 4, Section 6, Magnet Rundown Unit (MRU) Checks)	—	X	—	X	—	No
Check Cryocooler operation (2262271: Sumitomo Heavy Industries, Ltd., SDRK Cryocooler Service Manual CD32ZZ-055B)	—	X	—	—	—	No
Check Cryocooler Compressor operation (Chapter 4, Section 7, Cryocooler Checks)	—	X	—	—	—	No
Measure Cryostat Shield temperature using Magnet Monitor (Chapter 4, Section 3, Temperature Sensor Checks)	—	X	—	—	—	No
Check Compressor cooling water flow rate	—	—	X	—	—	No
Replace Cryocooler Compressor Absorber	—	—	—	—	X	Yes

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2 Cryocooler System Gas Pressure Adjustments

2.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	1.5 hours	Included in 'Procedure'

2.2 Overview

Compressor gas pressure must be in the range stated in the vendor's service manual for proper operation of the Cryocooler. Use the following procedures to check and adjust the pressure to specification, if required.

2.3 Preliminary Requirements

2.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Digital Voltmeter (DVM), Volt-Ohm Meter (VOM) or non-contact voltage tester	1	-	-	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
High Pressure Helium Regulator (included in Coldhead/Compressor Installation & Maintenance Kit 46-281088G3)	1	-	46-2940009P1	-
Helium Line Adapter Hose (included in Coldhead/Compressor Installation & Maintenance Kit 46-281088G3)	1	-	46-294002P1	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Gas Charging Tool	1	-	5102120	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-

2.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
99.999% (“five nines”) Helium Gas, 235 SCF Nonmagnetic Cylinder	1	-	-	-

2.3.3 Replacement Parts

No replacement parts required.

2.3.4 Safety



WARNING

POTENTIAL HIGH PRESSURE GAS RELEASE HAZARD
POTENTIAL EXPLOSIVE RELEASE OF HIGH PRESSURE (~1.62 MPA, 16.5 KGF/CM*CM*G, 235 PSIG) HELIUM GAS IF CRYOCOOLER SYSTEM COMPONENTS ARE HIT WITH SHARP EDGE OR TOUCHED WITH POINTED OBJECT.
HANDLE EQUIPMENT WITH CARE. KEEP SHARP EDGED/POINTED OBJECTS AWAY FROM CRYOCOOLER SYSTEM.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO A CRYOCOOLER COMPRESSOR. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.



NOTICE

Charge Compressor in strict conformance with the Cryocooler System Gas Pressure Adjustments procedure to prevent contamination. Contamination may result in noise at the Coldhead or decreasing cooling capacity.



NOTICE

Cryocooler filling pressure varies with Compressor and Coldhead temperature. Make sure the Cryocooler power is off and gas pressure has stabilized (static pressure) before making pressure adjustments.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.3.5 Required Conditions

No required conditions.

2.4 Procedure

2.4.1 Gas Pressure Check

Check Cryocooler system gas pressure as required for magnet temperature/pressure troubleshooting.

NOTICE

Operating (dynamic high side) pressure checks done while the Cryocooler system is NOT at equilibrium (i.e., the Coldhead is not at ~ 4.2K) will not be accurate.

1. Verify that the Cryocooler system is at equilibrium (i.e., Coldhead at ~ 4.2K) by performing Chapter 4, Section 3, Temperature Sensor Checks.

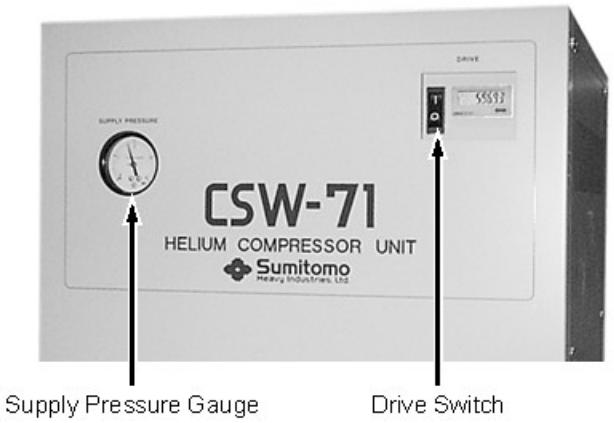
2. Check the operating (dynamic high side) pressure of the Cryocooler system. Compare to the specifications in Table 5-2.

NOTE: The supply pressure gauge (Illustration 5-1) displays static pressure when the compressor is off and high-side dynamic pressure when the compressor is on.

Table 5-2: CSW-71D Compressor Operating Pressures

Connected To	Compressor Operating (Dynamic High Side) Pressure		
	MPa (Approx.)	KgF/cm^{2}G	psig
RDK-408 4K Two-Stage Coldhead	2.10 - 2.30	21.4 - 23.5	319 - 333

Illustration 5-1: Front of CSW-71D Compressor



3. If the dynamic high side pressure is outside the acceptable range:

   a. Turn the Cryocooler system off.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

b. Disconnect and lockout/tagout input power to the Cryocooler Compressor. Verify that no voltage is present by using a DVM or equivalent measuring device.

c. Allow the system to stabilize.

d. Check the static pressure and compare to the specification in Table 5-3.

Table 5-3: Compressor Static Gas Pressures

Connected To	Compressor Static Gas Pressure at 20°C (68°F)		
	MPa (Approx.)	KgF/cm^{2}G	psig
RDK-408 4K Two-Stage Coldhead	1.60 - 1.65	16.3 - 16.8	232 - 239

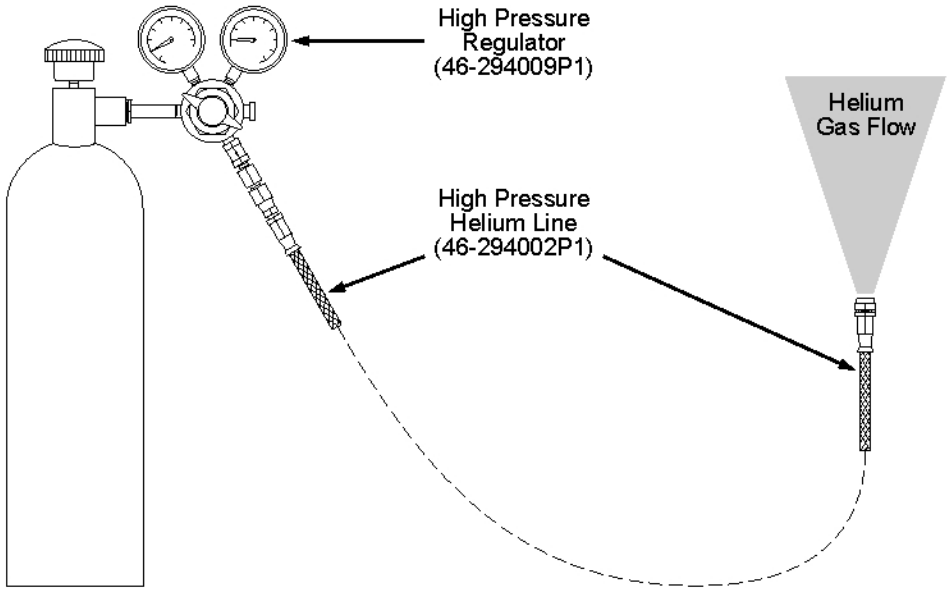
4. If both the dynamic and static pressures are out of range, adjust static pressure in conformance with Section 2.4.2, Gas Pressure Adjustment.

2.4.2 Gas Pressure Adjustment

2.4.2.1 Increasing Gas Pressure

1. Obtain a full cylinder of certified 99.999% helium gas.
2. Attach and tighten the high pressure regulator (46-294009P1) to the gas cylinder.
3. Adjust the regulator handle clockwise (CW) as required to allow gas flow.
4. Attach and tighten the high pressure helium line (46-294002P1) to the regulator. See Illustration 5-2.

Illustration 5-2: Purging the Helium Line



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

DANGER

FATAL EXPLOSIVE HAZARD!
POTENTIAL RELEASE OF HIGH PRESSURE (2400 PSIG) GAS.
TO PREVENT POSSIBLE FATAL EXPLOSIVE RELEASE OF GAS, OPEN THE GAS CYLINDER MAIN VALVE VERY SLOWLY.

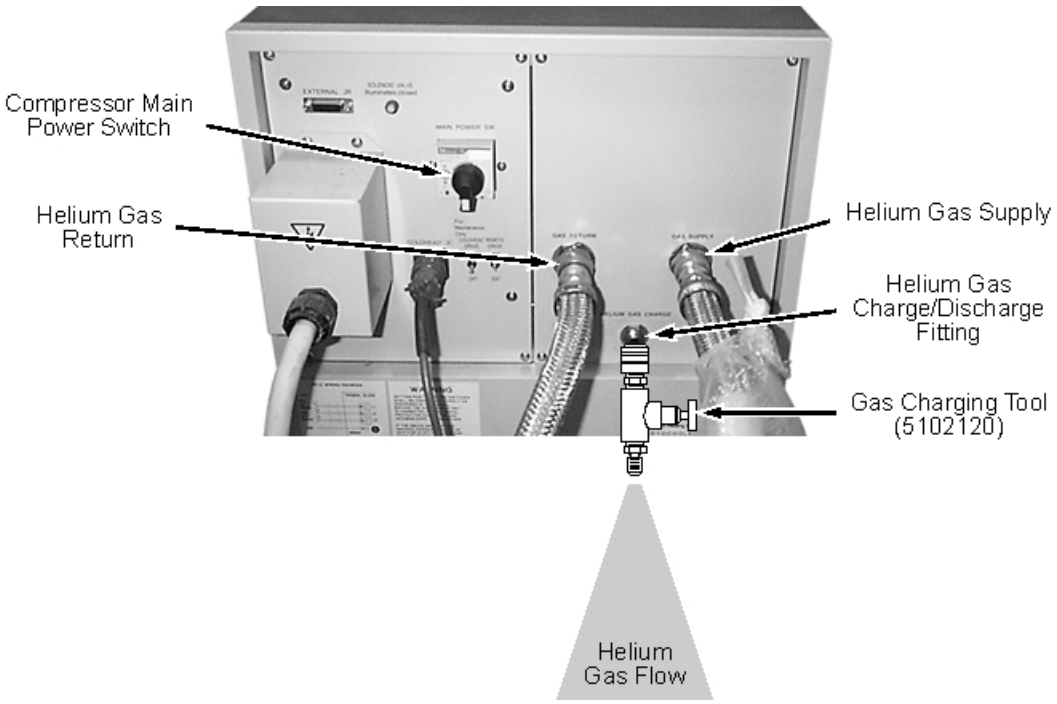
5. Establish gas flow through the regulator and high pressure helium gas line by slowly opening the valve on the gas cylinder counterclockwise (CCW) and adjusting the regulator handle clockwise (CW) to produce an audible gas flow.

6. Purge the regulator and gas line for 30 seconds, then back out the regulator handle (CCW) to limit the gas flow until it is just detectable at the end of the gas line.

7. Verify that the compressor's main power switch is off (Illustration 5-3) and that static pressure is stable (Illustration 5-1).

NOTE: The supply pressure gauge displays static pressure when the compressor is off and high-side dynamic pressure when the compressor is on.

Illustration 5-3: Purging the Gas Charging Tool



8. Verify that the Gas Charging Tool (5102120) valve is fully closed (CW), then slowly open (CCW) the valve one (1) turn to allow gas flow.

9. Remove the protective cap on the #4 male Aeroquip coupling at the compressor's charge/discharge fitting. See Illustration 5-3.

10. Immediately attach and tighten the Gas Charging Tool's #4 female Aeroquip coupling to the compressor's charge/discharge fitting.

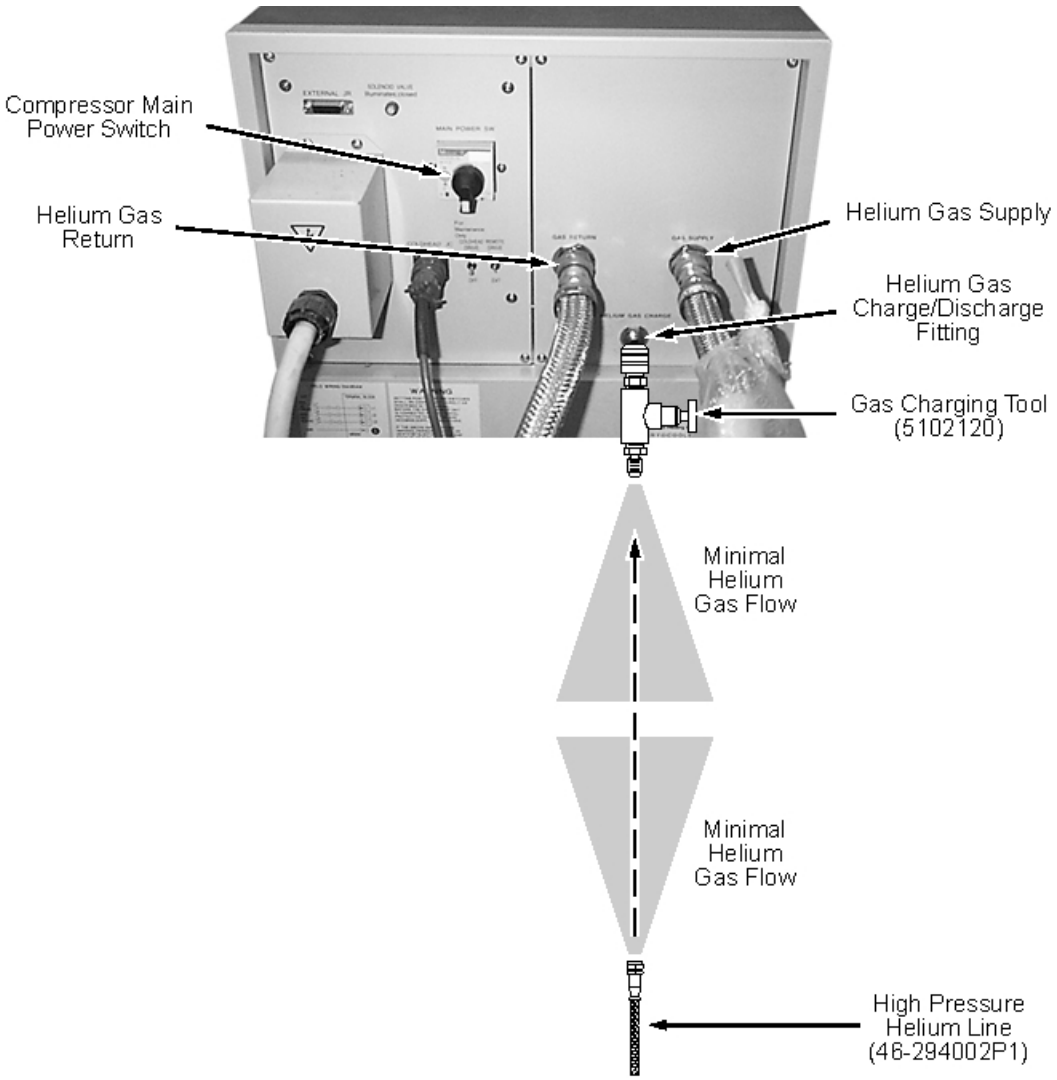
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

11. Adjust the valve on the Gas Charging Tool (CCW) to produce an audible gas flow.

12. Purge the Gas Charging Tool for 5 seconds, then turn the valve (CW) until the flow is just detectable at the end of the Gas Charging Tool.

13. Connect and tighten the .25 inch flare swivel adapter at the end of the high pressure helium gas line to the .25 inch male connector at the end of the Gas Charging Tool while a trickle of helium gas is still flowing from each fitting. See Illustration 5-4.

Illustration 5-4: Connecting Purged Helium Line to Purged Gas Charging Tool



14. Open the Gas Charging Tool's valve and adjust the regulator handle to set the static pressure in the Cryocooler at the middle of the pressure range shown in Table 5-3.

15. When pressure within the middle of the range shown in Table 5-3 is reached, close the Gas Charging Tool's valve (full CW) and then close the gas cylinder's valve (full CW).

16. Disconnect the Gas Charging Tool from the compressor, then gradually unthread the tool from the gas line to bleed pressure from the line.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

17. Disconnect the line and regulator from the Gas Charging Tool and the gas cylinder.

18. Restore power to the compressor and replace the cap on the compressor's charge/discharge fitting.

2.4.2.2 Decreasing Gas Pressure

1. Verify that the compressor's main power switch is off (Illustration 5-3) and that static pressure is stable (Illustration 5-1).

NOTE: The supply pressure gauge (Illustration 5-1) displays static pressure when the compressor is off and high-side dynamic pressure when the compressor is on.

2. Verify that the Gas Charging Tool (5102120) valve is fully closed (CW), then slowly open (CCW) the valve one (1) turn to allow gas flow.

3. Remove the protective cap on the #4 male Aeroquip coupling at the compressor's charge/discharge fitting. See Illustration 5-3.

4. Immediately attach and tighten the Gas Charging Tool's #4 female Aeroquip coupling to the compressor's charge/discharge fitting.

5. Open (CCW) the valve on the Gas Charging Tool as required to decrease gas pressure.

6. When the gas pressure reaches the high end of the pressure range shown in Table 5-3, immediately close (CW) the valve on the Gas Charging Tool.

7. Disconnect the Gas Charging Tool and replace the protective cap on the Compressor's charge/discharge fitting.

2.5 Finalization

1. Check both static and dynamic high side pressures (Section 2.4.1, Gas Pressure Check) after any adjustments.

2. If the pressures are still out of specification, contact the Online Center or your regional MAC Team specialist.

3. When pressures **are** with the specifications stated in Table 5-2 and Table 5-3, return the Cryocooler Compressor to operating condition by removing any lockout/tagout, reconnecting power, and allowing the Cryocooler system to return to equilibrium.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3 Helium Flexline Connections and Casing Replacement

3.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	Connections: .25 hour; Casing: 2 hours - 3 hours	Included in 'Procedure'

3.2 Overview

Follow the procedures in this section to prevent helium loss and damage to the Coldhead and Aeroquip fittings during flexible helium gas line (flexline) replacement. Make sure the gas line insulation is reinstalled on the new gas lines to prevent “spike" noise and image problems.

3.3 Preliminary Requirements

3.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
1 in. Open End Wrench, Leybold #722-81-018 (included in Coldhead/Compressor Installation & Maintenance Kit 46-281088G3)	1	-	46-294150P13	-
1 3/16 in. Open End Wrench, Leybold #722-81-019 (included in Coldhead/Compressor Installation & Maintenance Kit 46-281088G3)	2	-	46-294150P14	-
1 3/8 in. Open End Wrench, Leybold #722-81-020 (included in Coldhead/Compressor Installation & Maintenance Kit 46-281088G3)	1	-	46-294150P15	-
1 5/8 in. Open End Wrench, Leybold #722-81-021 (included in Coldhead/Compressor Installation & Maintenance Kit 46-281088G3)	2	-	46-294150P16	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Clean, lint-free, nonabrasive cloth	4	-	-	-

3.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
Corrugated Plastic Gas Line Raceway Tubing, 50 feet (15.24 M)	2	-	2251611	-

3.3.4 Safety



⚠ WARNING

POTENTIAL INJURY HAZARD!
FLEXLINES WITH BROKEN AEROQUIP FITTINGS MAY DISCONNECT AND MOVE ERRATICALLY.
DO NOT PUT ANY BENDING FORCE ON AEROQUIP FITTINGS WHILE CONNECTING/DISCONNECTING HELIUM FLEXLINES. A BENDING FORCE CAN RESULT IN BENDING OR BREAKAGE OF THE AEROQUIP STEMS.



NOTICE

Do not put any bending force on Aeroquip fittings while connecting/disconnecting helium flexlines. A bending force will create difficulty in the rapid engagement/disengagement required to prevent helium loss and system contamination. Do support the gas lines when connecting/disconnecting to the Coldhead at the top of the magnet or to the Compressor.



NOTICE

Order and technique are important when connecting helium flexlines to prevent inoperative Coldheads and system contamination.

3.3.5 Required Conditions

No required conditions.

3.4 Procedure

3.4.1 Flexline Connection Sequence for Sumitomo Cryocoolers

1. Connect the return line (green mark) and the supply line (yellow mark) to the Compressor.
2. Then connect the return line (green mark) to the Coldhead.
3. Finally connect the supply line (yellow mark) to the Coldhead.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.4.2 Connecting Aeroquip Couplings

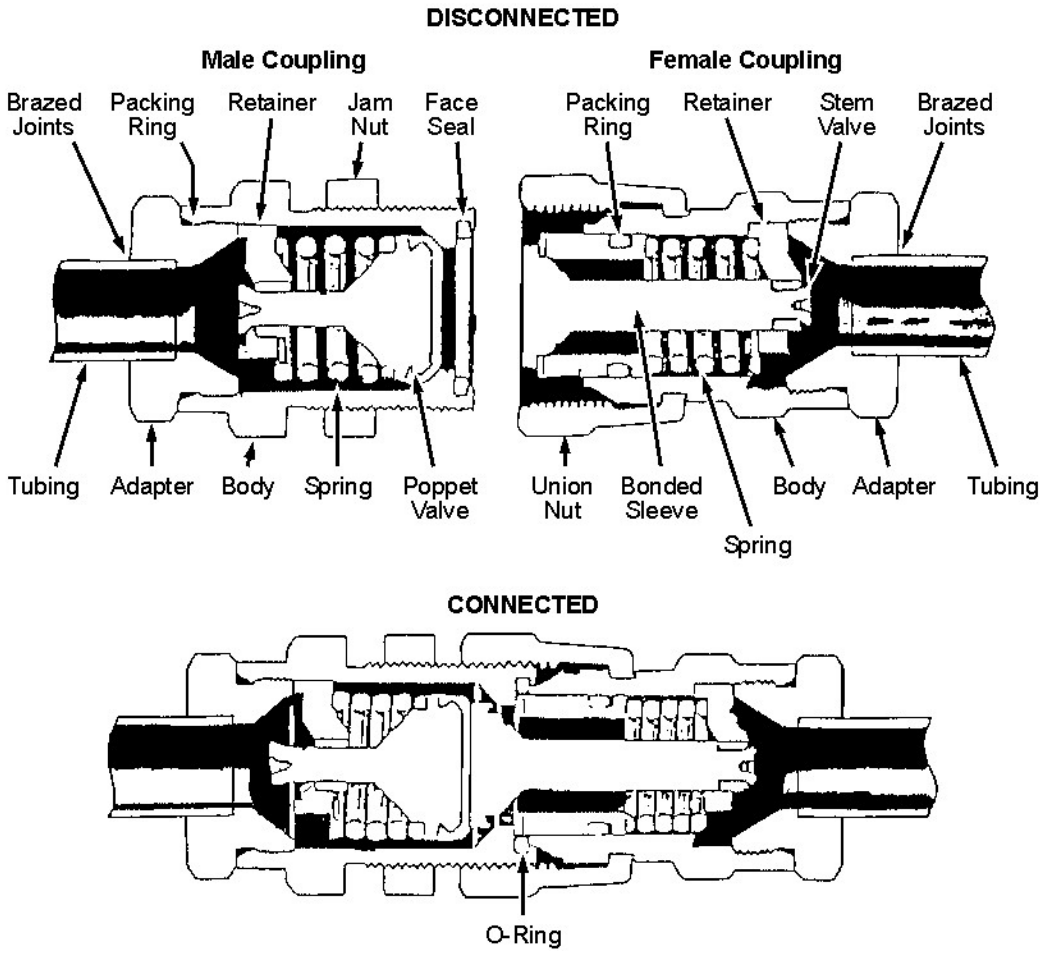
1. Remove the caps and plugs from the system gas connections and thread them together for storage.

NOTE: System gas connections are shipped with caps and plugs to keep the fittings clean and free from damage.

2. Wipe the faces of the couplings with a lint-free cloth to insure they are clean and free of chips and dust.

3. Make sure the face seal is in place on the inside periphery of the male coupling and is not damaged. See Illustration 5-5.

Illustration 5-5: Section through Disconnected and Connected Aeroquip Couplings



4. To make the connection, start the hose-side union nut onto the male connector by hand.

NOTE: Excessive gas will escape if the fittings are not aligned properly during connection or disconnection.

5. Using Aeroquip wrenches, hold the stationary part of the female coupling while turning the union nut with the other wrench. See Illustration 5-6 and Illustration 5-7.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-6: Proper 2-Wrench Connection Technique for Aeroquip Coupling

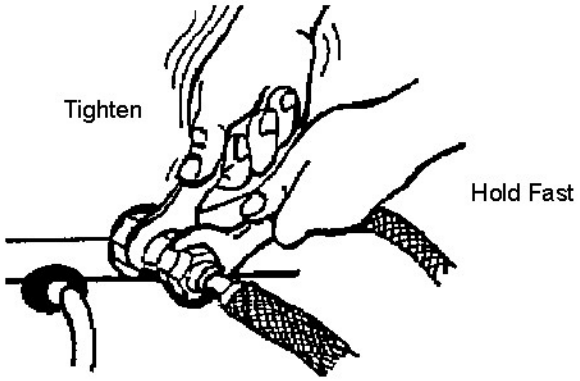
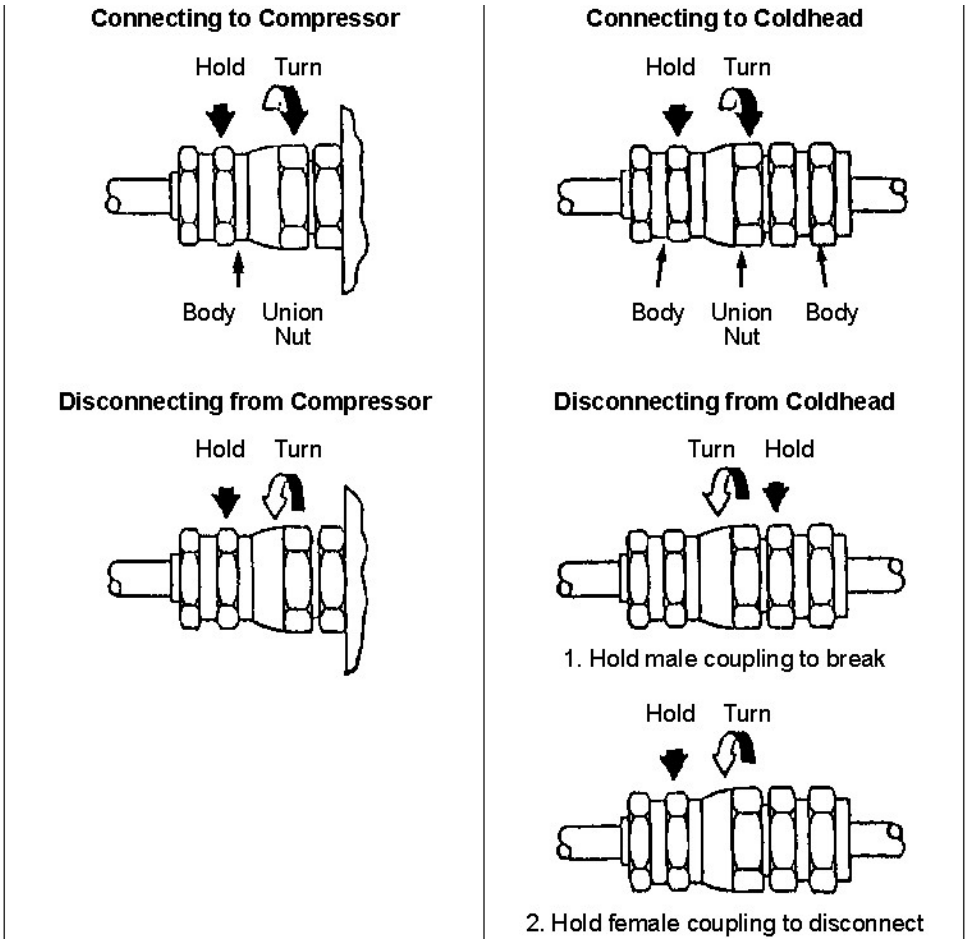


Illustration 5-7: Flexline Connection/Disconnection Technique



6. 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 a 1/2 inch connection
   - 45 ft-lbs (61.0 N-m) for a 3/4 inch connection

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.4.3 Disconnecting Aeroquip Couplings

NOTICE

Make sure the male couplings at the Compressor and Coldhead do not rotate when disconnecting lines. Avoid torsional forces on the flex sections.

1. To disconnect the gas line at the Coldhead:

   a. 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.

   b. Make sure the hose does not rotate to avoid a torsional force on the hose.

   c. Place the second wrench on the stationary part of the female coupling and continue to unthread the union nut. Make sure the male connector does not rotate when disconnecting.

   d. Make sure the bulkhead jam nut is secure and the male coupling does not rotate when removing the gas line.

2. To disconnect the gas line at the Compressor:

   a. 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 bulkheaded to the Compressor front panel with a lock washer, the male coupling should not rotate from its adapter while removing.

   b. When the hoses are disconnected, check each coupling to make sure the face seal is in place.

NOTE: While the hose is venting during disconnection, the face seal is often 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.

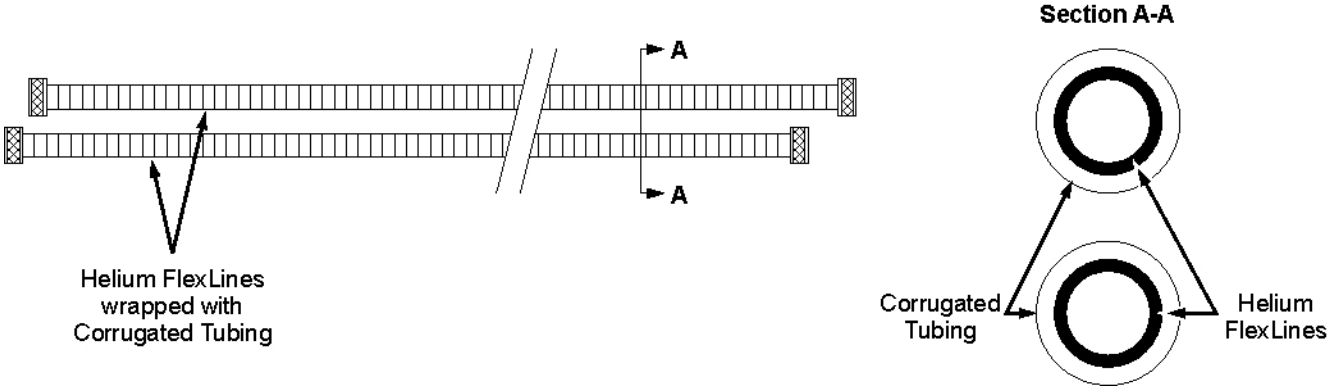
   c. If all seals are in place, replace the dust caps and plugs to the coupling halves.

3.4.4 Replacing Flexline Insulation Casing

1. Slide the old insulated tubing off the gas line. See Illustration 5-8.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-8: Helium Flexline Insulation Casing



NOTICE

Corrugated plastic tubing is used to isolate helium gas lines from each other and from ground to prevent spike noise. If the supplied tubing does not fully cover the helium gas lines, order additional tubing to fully cover the lines.

2. Cover both lines completely with Corrugated Plastic Tubing (2251611) from the Penetration Panel where the lines exit the magnet room to the helium line fittings at the Coldhead. See Illustration 5-8.

NOTE: Corrugated plastic tubing is used to isolate helium gas lines from each other and from ground to prevent spike noise.

3.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4 Main Lead Extension Contact Band Replacement

4.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	.25 hour	Included in 'Procedure'

4.2 Preliminary Requirements

4.2.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Flat Head Screwdriver	1	-	-	-

4.2.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Tricholorethylene degreasing solution (or equivalent); one container	1	-	-	-
Clean, lint-free nonabrasive cloth	2	-	-	-

4.2.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
Main Lead Extension Contact Band (included in Magnet Ramping Equipment Kit 46-260703G5)	2	-	46-281256P1	-

4.2.4 Safety

No general safety information.

4.2.5 Required Conditions

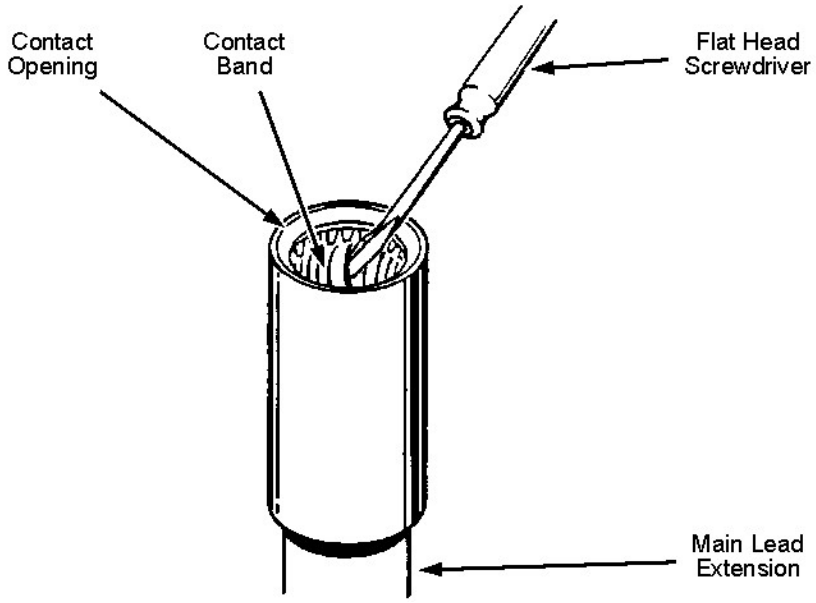
No required conditions.

4.3 Procedure

1. Insert a flat head screwdriver into the .5 inch (12.7 mm) diameter contact opening on the end of the Main Lead Extension. See Illustration 5-9.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-9: Contact Band Removal



2. Engage the Contact Band's louvers with the screwdriver tip and gradually pry the old Contact Band out of the contact opening without scoring the contact opening's wall.

NOTICE

The contact area on which the Contact Band seats is silver plated and must be cleaned with a nonabrasive cloth and cleaning solution before a new Contact Band is inserted.

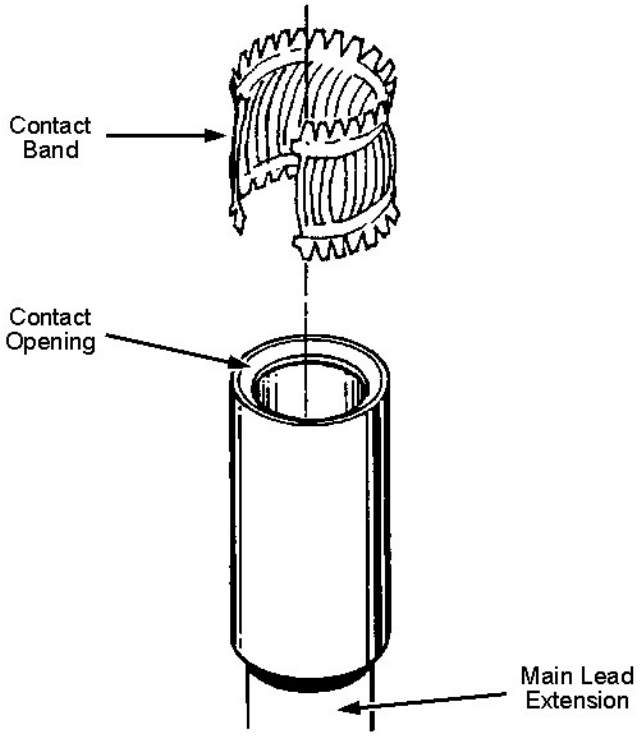
3. Clean the cavity in which the Contact Band seats with a nonabrasive cloth and a degreasing solution such as trichlorethylene.

4. Obtain and inspect a new Contact Band (46-281256P1).

5. Roll the new Contact Band into a uniform cylinder of less than .5 inch (12.7 mm) diameter and fully insert it into the contact opening. See Illustration 5-10.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-10: Contact Band Insertion



6. Make sure the Contact Band has expanded against walls of the contact opening and is fully seated below rim of the opening.

4.4 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5 Upper and Side Enclosure Removal

5.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	1 hour	Included in 'Procedure'

5.2 Overview

All or part of the following procedure may be required to gain access to serviceable and/or replaceable items on top of a LCC magnet with Wide Open enclosures. The initial steps indicated here are necessary before replacing a Coldhead. Other types of service or replacement may require only specific pieces of the magnet enclosure be removed or none at all. Use this Upper and Side Enclosure Removal procedure as a guide when removing any portion of the upper and side enclosures. Follow the steps in order to insure ease of removal and to prevent possible damage to magnet/enclosure components.

NOTE: HDe and HDx LCC enclosure removal and installation procedures are included in this manual in Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures.

5.3 Preliminary Requirements

5.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

5.3.2 Consumables

No consumables required.

5.3.3 Replacement Parts

No replacement parts required.

5.3.4 Safety

No general safety information.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5.3.5 Required Conditions

No required conditions.

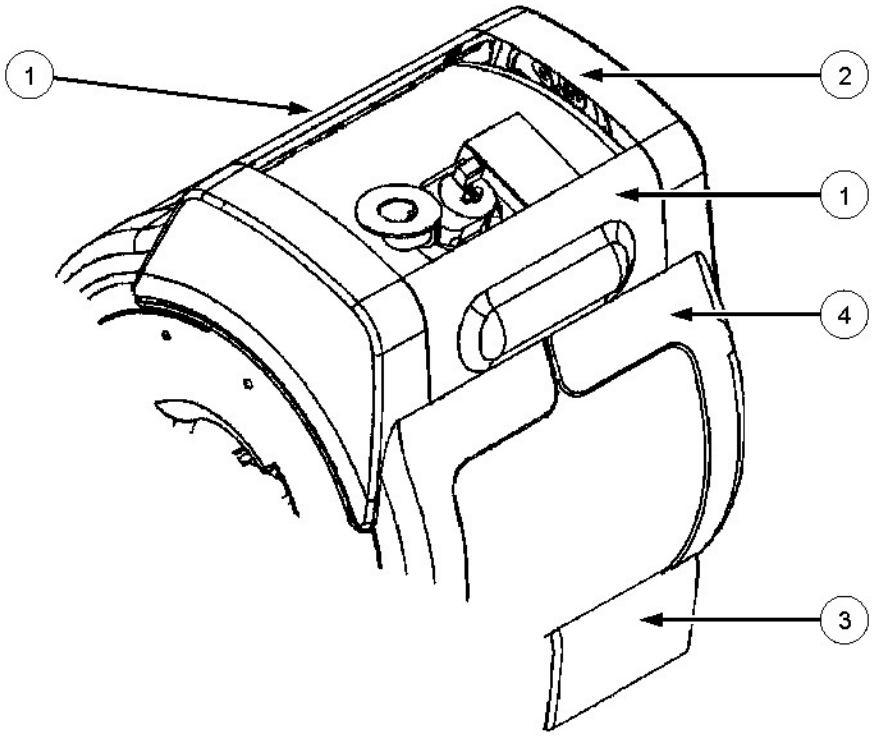
5.4 Procedure

NOTICE

Only use nonmagnetic tools when working in the magnetic field of a ramped magnet.

1. Remove Item 1 of Illustration 5-11 first. There are typically two, each held in place by Velcro.

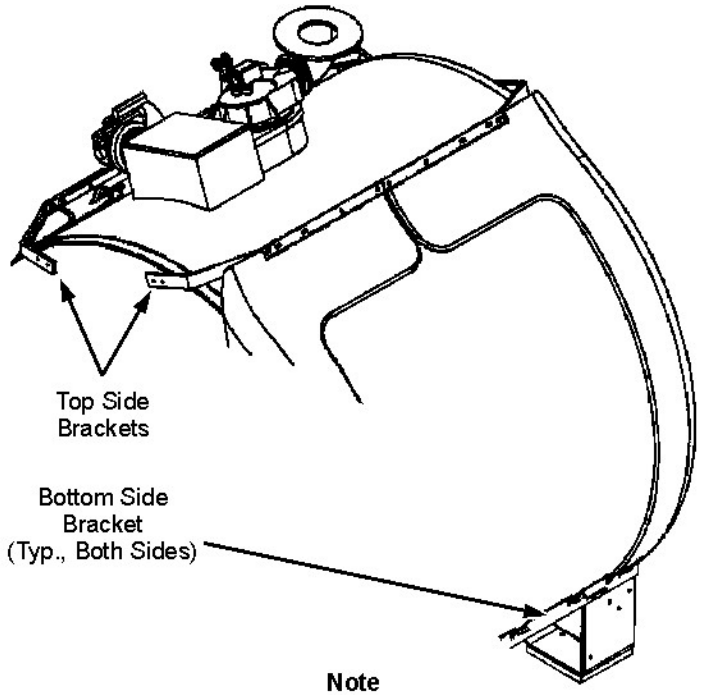
Illustration 5-11: Removal of Upper Cover Items



2. Remove Item 2 of Illustration 5-11. It is held in place by two screws in the Top Side Bracket, one on each side of the magnet enclosure. See Illustration 5-12.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-12: Side Bracket Locations



Note
For clarity, some enclosure pieces are not shown.

3. Remove Item 3 of Illustration 5-11 from lower portion of the magnet. It is supported on hangers inserted into the Bottom Side Bracket, which is shown in Illustration 5-12.

4. Loosen two screws on the Bottom Side Bracket, shown in Illustration 5-12, before attempting to remove Illustration 5-11's Item 4. This will relieve pressure on the lower end of Item 4.

NOTICE

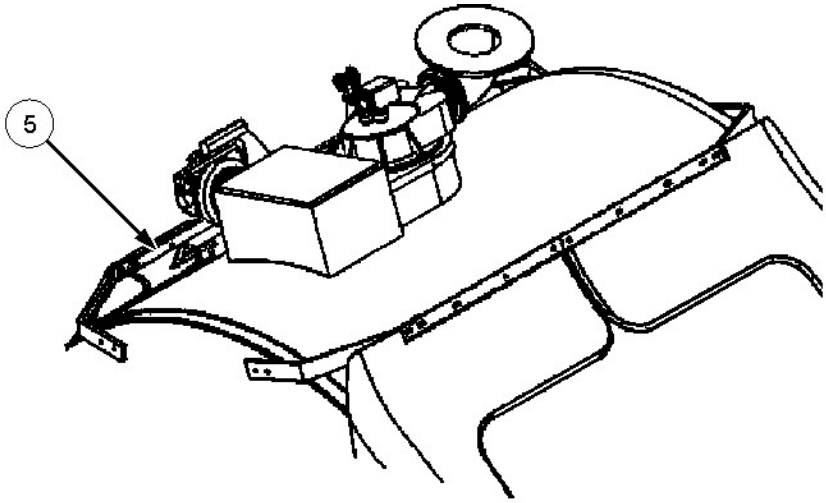
Cables may be attached to the inside of Illustration 5-11's Item 4. Care must be taken not to damage the cables if removal of Item 4 is necessary.

5. Remove Illustration 5-11's Item 4. It is held in place by four bolts along the Top Side Bracket, shown in Illustration 5-12. Rotate the enclosure piece away, pulling up to remove.

6. Remove the frame section (Illustration 1-3's Item 5) just below the Coldhead guard. Two bolts fasten the frame section at either end.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-13: Removal of Frame Section



5.5 Finalization

1. When service or replacement of magnet components is complete, reassemble the side & upper enclosure components in reverse order of removal.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6 Magnet Rampdown to Zero Field

6.1 Personnel Requirements

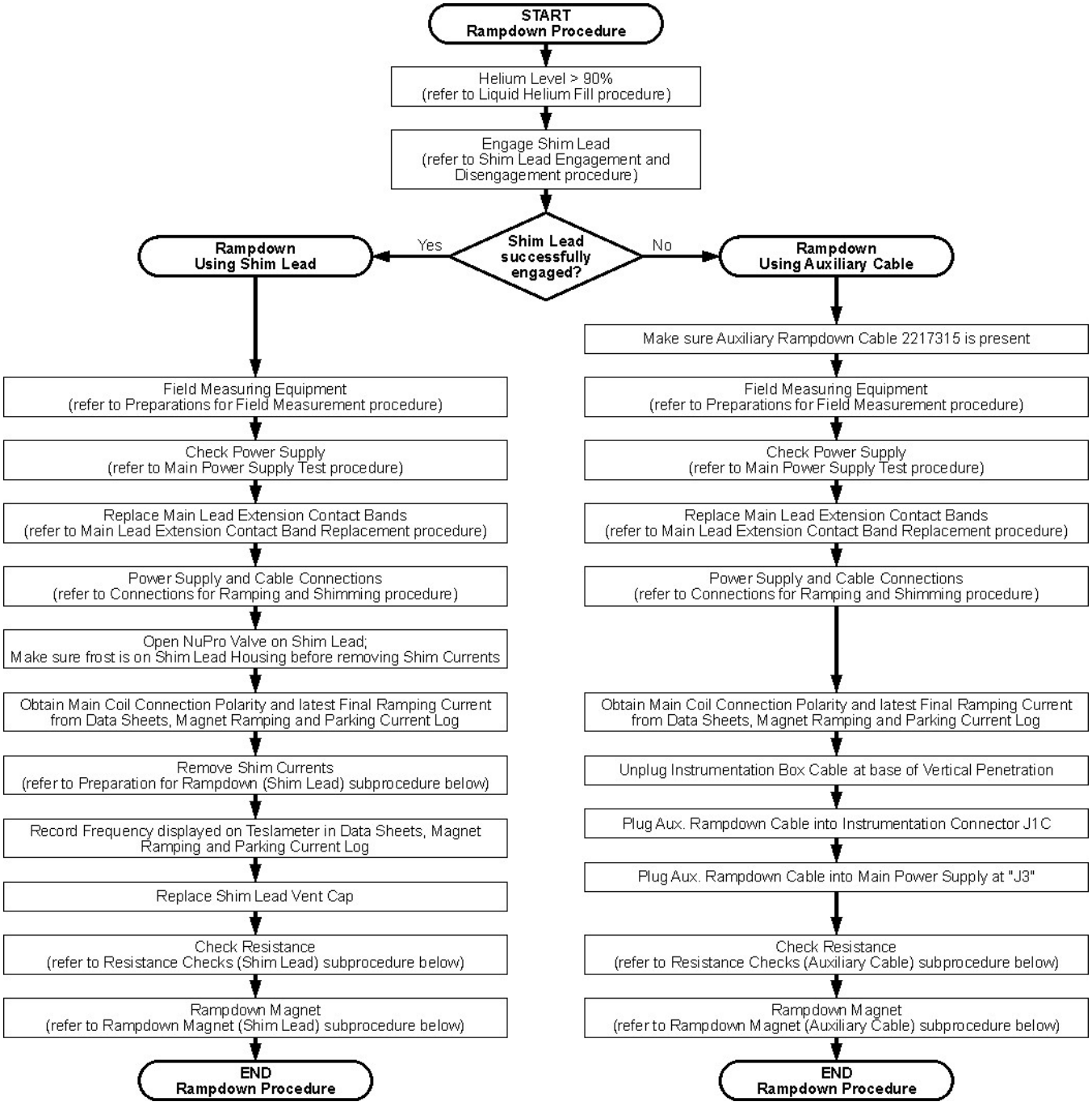
Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	5 hours	Included in 'Procedure'

6.2 Overview

Rampdown is performed using the Shim Lead unless the Shim Lead cannot be engaged into the Shim Lead Connector (P100) in the magnet Vertical Penetration due to ice or damage to the P100's Sav-Con Connector, in which case rampdown is performed using Auxiliary Rampdown Cable 2217315. See Illustration 5-14.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-14: Rampdown Flowchart



Procedures Referenced:	
Rampdown Using Shim Lead	**Rampdown Using Auxiliary Cable**
Chapter 3, Section 3.2, Liquid Helium Fill	Chapter 3, Section 3.2, Liquid Helium Fill
Chapter 3, Section 5, Shim Lead Engagement and Disengagement	Chapter 3, Section 5, Shim Lead Engagement and Disengagement
Chapter 3, Section 4, Preparations for Field Measurement	Chapter 3, Section 4, Preparations for Field Measurement

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Procedures Referenced:	
Rampdown Using Shim Lead	**Rampdown Using Auxiliary Cable**
Main Power Supply Tests: Chapter 4, Section 8.2, TCR 7.5T750 Main Power Supply Tests, for 750 amp power supplies or Chapter 4, Section 8.3, ESS7.5-1000-2-D-1236 Main Power Supply Tests, for 1000 amp power supplies	Main Power Supply Tests: Chapter 4, Section 8.2, TCR 7.5T750 Main Power Supply Tests, for 750 amp power supplies or Chapter 4, Section 8.3, ESS7.5-1000-2-D-1236 Main Power Supply Tests, for 1000 amp power supplies
Section 4, Main Lead Extension Contact Band Replacement	Section 4, Main Lead Extension Contact Band Replacement
Chapter 3, Section 6, Connections for Ramping and Shimming	Chapter 3, Section 6, Connections for Ramping and Shimming
Chapter 8, Section 5, Magnet Ramping and Parking Current Log	Chapter 8, Section 5, Magnet Ramping and Parking Current Log
Section 6.4.1.1, Preparation for Rampdown (Shim Lead)	Section 6.4.2.1, Preparation for Rampdown (Auxiliary Cable)
Section 6.4.1.2, Resistance Checks (Shim Lead Rampdown)	Section 6.4.2.2, Resistance Checks (Auxiliary Cable)
Section 6.4.1.3, Magnet Rampdown (Shim Lead)	Section 6.4.2.3, Magnet Rampdown (Auxiliary Cable)

6.3 Preliminary Requirements

6.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Digital Voltmeter (DVM)	1	-	-	-
Cardboard box or nonferromagnetic frame	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
750 Amp TCR 7.5T750 Main Power Supply 46-260776G3 OR 1000 Amp ESS 7.5-1000-2-D-1236 Main Power Supply 46-260776G4		-	46-260776G3 or 46-260776G4	-
750 Amp Ramp Cable Kit 2135435 or 1000 Amp Ramp Cable Kit w/ Ground 2353394	1	-	2135435 or 2353394	-
Field Shim Cable Kit (if not already ordered with the magnet)	1	-	2135558	-
Fixed Main Lead Extension 46-294204G1 or Flexible Main Lead Extension 2287029 (for low ceiling height sites)	1	-	46-294204G1 or 2287029	-
Hold-Down Tool 2193922 or Hold-Down Tool, Short 2276755 (for low ceiling height sites)	1	-	2193922 or 2276755	-
Retractable Shim Lead Assembly 2173354 or Retractable Shim Lead Assembly, Short 2285073 (for low ceiling height sites)	1	-	2173354 or 2285073	-
Auxiliary Rampdown Cable	1	-	2217315	-
MetroLab Teslameter Kit	1	-	46-251865G4	-
#5 MetroLab Probe (included in MetroLab Teslameter Kit 46-251865G4)	1	-	46-255839P104	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6.3.2 Consumables

No consumables required.

6.3.3 Replacement Parts

No replacement parts required.

6.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING TO RAMP DOWN THE MAGNET.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR MAGNET RAMPDOWN TO ZERO FIELD IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE RAMPING DOWN THE MAGNET.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING TO RAMP DOWN THE MAGNET.



WARNING

ASPHYXIATION HAZARD!
THIS MAGNET RAMPDOWN TO ZERO FIELD PROCEDURE GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR. MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE STARTING TO RAMP DOWN THE MAGNET.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



⚠ WARNING

POTENTIAL PROJECTILE HAZARD
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.

- **REMOVE ALL LOOSE FERROMAGNETIC MATERIAL FROM THE MAGNET ROOM.**
- **MAKE SURE ALL EQUIPMENT AND TOOLS USED IN THE MAGNET ROOM ARE NON-FERROMAGNETIC.**
- **LOCATE POWER SUPPLIES AS FAR AWAY FROM THE MAGNET AS THE CABLES AND ROOM GEOMETRY ALLOWS.**
- **DO NOT ALLOW ANYONE CARRYING FERROMAGNETIC MATERIALS — INCLUDING CARDIAC PACEMAKERS, NEUROSTIMULATORS OR STEEL PLATES — INSIDE THE 5 GAUSS ZONE.**



⚠ WARNING

EXPLOSION HAZARD!
LIQUID CRYOGENS CAN LIQUIFY ATMOSPHERIC OXYGEN, PRODUCING A HIGHLY COMBUSTIBLE OXYGEN LIQUID.
NO SMOKING IN MAGNET AND CRYOGEN STORAGE ROOMS!



⚠ WARNING

POTENTIAL QUENCH HAZARD
THE MAGNET MAY QUENCH, RAPIDLY RELEASING CRYOGENIC GASES, IF ITS LIQUID HELIUM LEVEL DROPS TOO LOW DURING MAGNET RAMPDOWN.
MAKE SURE THE MAGNET ≥ 90% FULL OF LIQUID HELIUM BEFORE STARTING TO RAMP DOWN THE MAGNET.



⚠ WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING MAGNET RAMPDOWN.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN RAMPING DOWN THE MAGNET.



⚠ WARNING

ELECTRICAL SHOCK HAZARD!
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT. DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER. MAKE SURE INPUT POWER TO THE MAIN POWER SUPPLY IS DISCONNECTED WHEN CONNECTING THE MAIN LEAD EXTENSIONS.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.



NOTICE

Locate the Main Power Supply OUTSIDE the Magnet Room.

6.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting magnet rampdown.	Chapter 1, Section 2	-
The removal of some magnet enclosure components may be required to complete this Magnet Rampdown to Zero Field procedure. Refer to Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with magnet rampdown if cover removal is required.	Section 5	-
(continued)	Appendix A, Section 1.1	-
Make sure the helium level in the magnet is ≥ 90% before starting this Magnet Rampdown to Zero Field procedure.	Chapter 3, Section 3.2	-
Locate the Main Power Supply outside the magnet room and remove all loose ferromagnetic materials from the magnet room before starting magnet rampdown.	-	-
Make sure the liquid helium level is ≥ 90% before starting magnet rampdown.	Chapter 3, Section 3.2	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Condition	Reference	Effectivity
Make sure the magnet room exhaust fan is on and operational before starting this Magnet Rampdown to Zero Field procedure.	-	-
Make sure the magnet room door is propped open — or the hatch is opened if a mobile van — before starting this Magnet Rampdown to Zero Field procedure.	-	-

6.4 Procedure

6.4.1 Magnet Rampdown Using Shim Lead

6.4.1.1 Preparation for Rampdown (Shim Lead)

1. “Top Fill" the magnet to ≥ 90% helium level in conformance with Chapter 3, Section 3.2, Liquid Helium Fill, before starting this Magnet Rampdown to Zero Field procedure.

2. Make sure the Shim Lead Assembly is “Engaged" in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement.

NOTE: If the Shim Lead cannot be engaged, ramp down the magnet in conformance with Section 6.4.2.

3. Set up MetroLab Teslameter 46-255839P2 and #5 Teslameter Probe 46-255839P104 for single point magnetic field strength monitoring in conformance with Chapter 3, Section 4, Preparations for Field Measurement.

4. Check the Main Power Supply in conformance with the Main Power Supply Tests section (Chapter 4, Section 8.2, TCR 7.5T750 Main Power Supply Test, for 750 amp power supplies or Chapter 4, Section 8.3, ESS7.5-1000-2-D-1236 Main Power Supply Tests, for 1000 amp power supplies). Verify that the Switch Heater currents are set at 810 mA ± 10 mA.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

5. Disconnect and lockout/tagout input power to both the Main Power Supply and the Shim Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

6. Replace the Main Lead Contact Bands in conformance to Section 4, Main Lead Extension Contact Band Replacement.

7. Connect the Shim Coil Power Supply to the magnet by making all cable connections in conformance with Chapter 3, Section 6, Connections for Ramping and Shimming.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8. Open the Shim Lead's Nupro Vent Valve and allow frost to appear on the Shim Lead Connector Housing before removing shim currents.

NOTICE

Do not connect input power to the Superconducting Shim Coil Power Supply until it is verified that ALL current controls are set to zero (turned fully counterclockwise) and the supply is turned off.

9. Remove lockout/tagout and connect the input power supply cable to the Shim Coil Power Supply.

NOTE: This section allows one to remove all shim currents to find and document the actual main magnetic field strength to use as a target parking frequency when re-ramping the magnet. This will enable parking the magnet at a more accurate frequency.

WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH, RAPIDLY RELEASING CRYOGENIC GASES, IF ITS LIQUID HELIUM LEVEL DROPS TOO LOW DURING MAGNET RAMPDOWN.
MAKE SURE THE MAGNET ≥ 90% FULL OF LIQUID HELIUM BEFORE CONTINUING WITH MAGNET RAMPDOWN.

WARNING

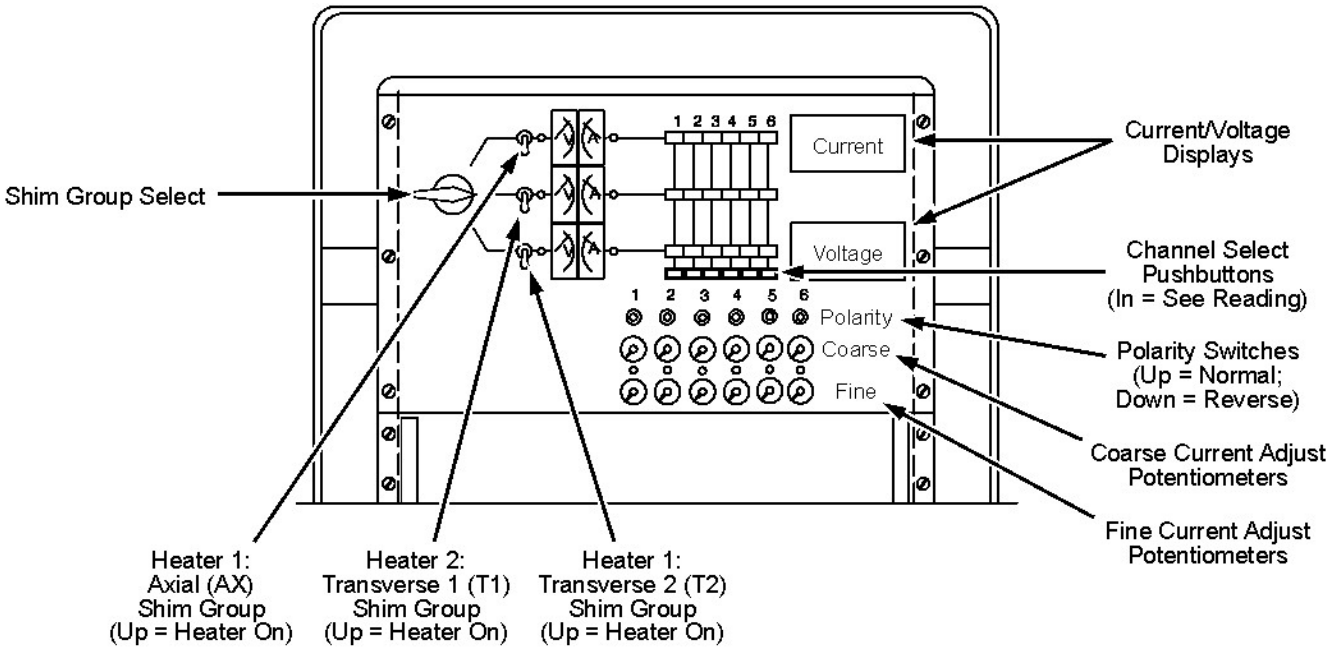
POTENTIAL MAGNET QUENCH!
APPLYING POWER THROUGH THE SHIM LEAD BEFORE THE SHIM LEAD IS SUFFICIENTLY COOLED OR WHILE THE SHIM LEAD'S VENT VALVE IS CLOSED MAY RESULT IN A MAGNET QUENCH.
MAKE SURE THE SHIM LEAD'S NUPRO VENT VALVE IS OPEN AND FROSTING IS VISIBLE ON THE SHIM LEAD HOUSING BEFORE TURNING ON THE SHIM COIL POWER SUPPLY.

10. Set the Main Power Switch on the Shim Coil Power Supply to the “ON” position.

11. Set the Shim Coil Power Supply (Illustration 5-15) to all last recorded Transverse 1 Currents from Chapter 8, Section 5, Magnet Ramping and Parking Current Log. Make sure the current polarities are correct.

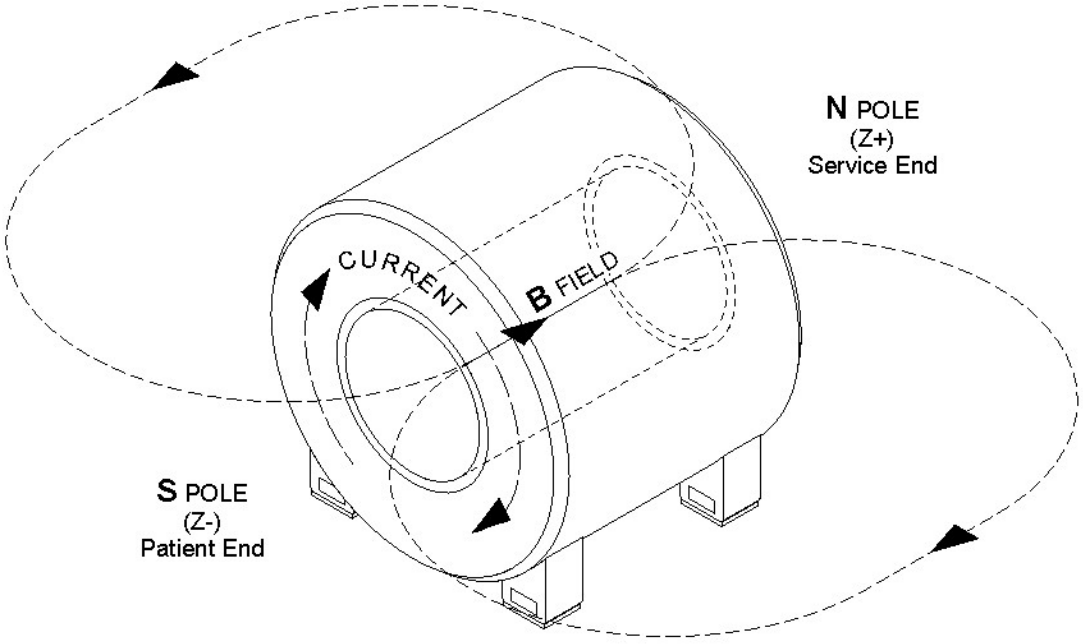
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-15: Shim Coil Power Supply Controls (Front Panel)



NOTE: All main coil driving voltages provided in this Magnet Rampdown to Zero Field procedure are the same in overall magnitude regardless of the magnet having normal or reverse polarity. Normal polarity is shown in Illustration 5-16.

Illustration 5-16: Magnet Polarity Ramped Normal



12. Set the Transverse 1 Heater Switch on the Shim Power Supply to “I" (on).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

13. Verify that the heater currents are set to Transverse 1 = 610 mA ± 5 mA, Transverse 2 = 610 mA ± 5 mA and Axial = 710 mA ± 10 mA. If any current level is not correct, adjust the adjustment screw on the rear of the Shim Power Supply. Allow a few minutes for the heater to drive the switches resistive.

14. Slowly adjust all Shim “Current" controls to zero.

NOTE: The magnetic 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, wait an additional 2 minutes before continuing to decrease currents.

15. Set the Heater Switch to “O” (off).

16. Repeat Step 11 through Step 15 for Transverse 2 and then the Axial Shim Coils.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

17. Set the Main Power Switch on the Shim Power Supply to “OFF”. Disconnect all cables; lockout/tagout input power. Verify that no voltage is present by using a DVM or equivalent measuring device.

NOTE: The frequency displayed on the Teslameter after the shim currents are removed is the target frequency for when the magnet is re-ramped.

18. Record the frequency displayed on the Teslameter in Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

19. Close the Shim Lead's Nupro Vent Valve.

6.4.1.2 Resistance Checks (Shim Lead Rampdown)



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

1. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL MAGNET QUENCH!
IMPROPER ENGAGEMENT/DISENGAGEMENT OF THE MAIN LEAD EXTENSIONS WITH THE MAIN LEAD PINS CAN CAUSE A RAMPED MAGNET TO QUENCH. INSERT MAIN LEAD EXTENSIONS ONE AT A TIME AND, IF THE MAGNET IS AT FIELD, ALLOW THEM TO COOL SUFFICIENTLY (A FOG OR WATER VAPOR FORMS AROUND THE LEAD EXTENSIONS) BEFORE THEY CONTACT THE MAIN LEAD PINS.



WARNING

ELECTRICAL SHOCK HAZARD!
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT. DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



WARNING

ELECTRICAL SHOCK HAZARD!
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.



WARNING

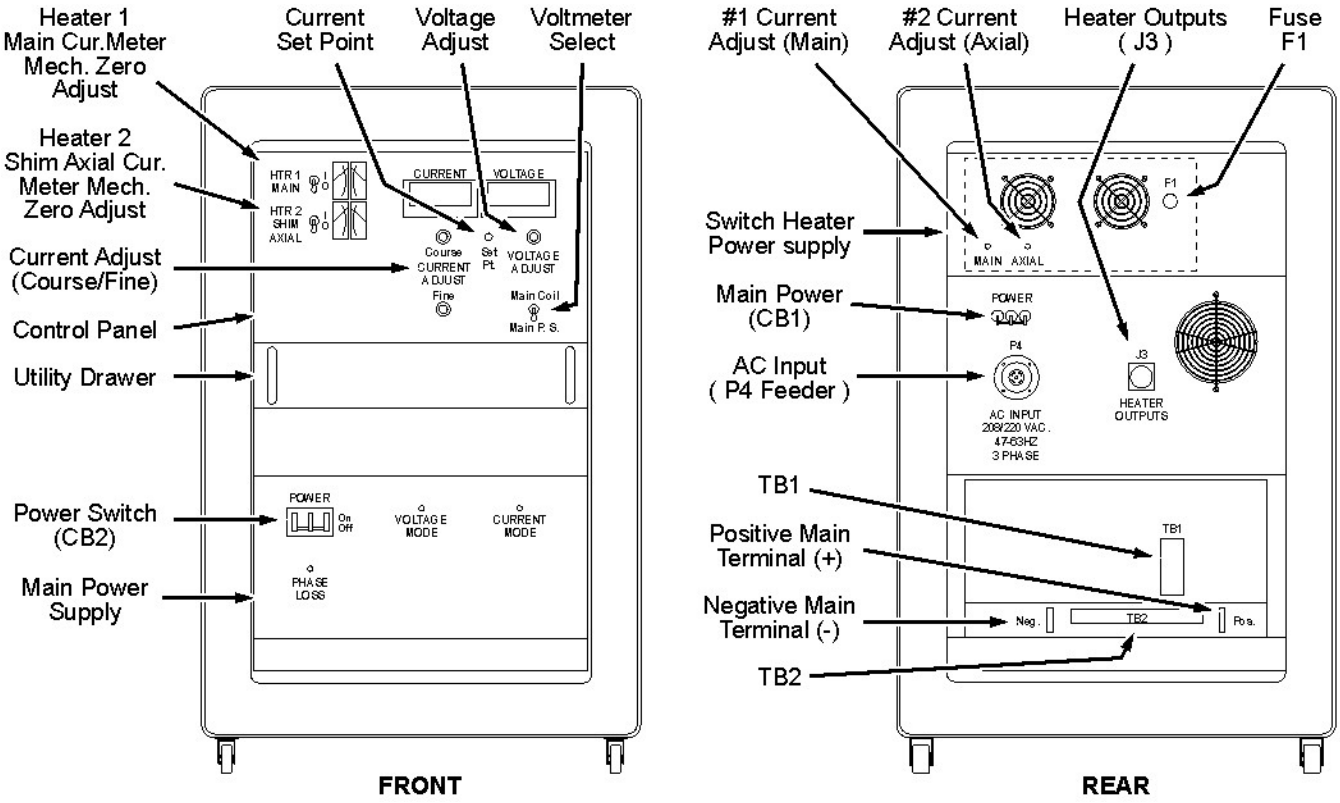
POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING MAGNET RAMPDOWN. WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.

2. Connect the Main Power Supply and Main Lead Extensions to the magnet by making all cable connections in conformance with Chapter 3, Section 6, Connections for Ramping and Shimming.

3. Set the Heater 1 Main and Heater 2 Shim Axial switches to the “O” (off) position. See Illustration 5-17 (750 amp Main Power Supply) or Illustration 5-18 (1000 amp Main Power Supply).

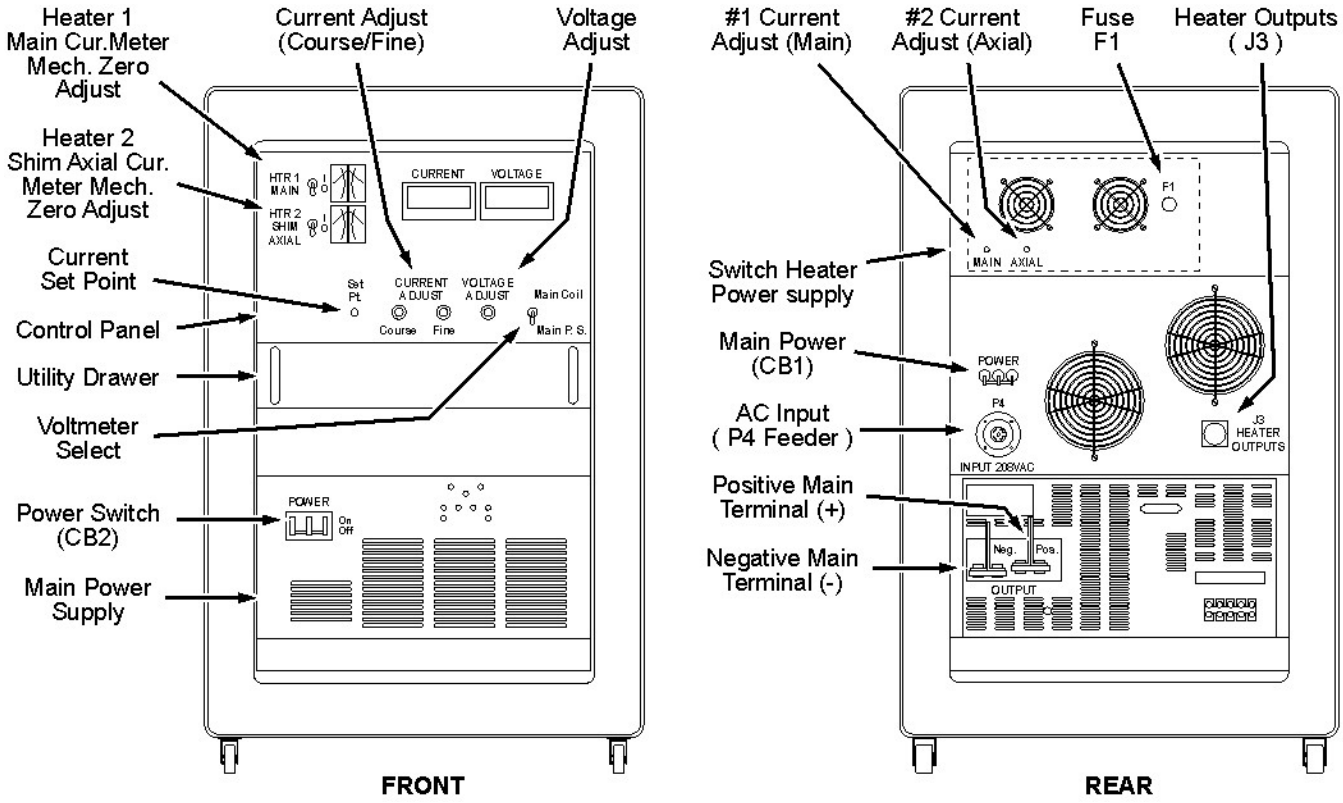
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-17: 750 Amp TCR 7.5T750 Superconducting Main Coil Service Power Supply Cabinet (46-260776G3)



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-18: ESS7.5-1000-2-D-1236 Superconducting Main Coil Service Power Supply Cabinet (46-260776G4)



4. Set the Current Adjust and Voltage Adjust controls to “O” (full CCW).

5. Remove lockout/tagout and connect the input power cable for the Main Power Supply.

⚠ WARNING

POTENTIAL MAGNET QUENCH
TURNING ON THE MAIN HEATER SWITCH WHILE PERFORMING THESE RESISTANCE CHECKS WILL CAUSE A MAGNET QUENCH.
MAKE SURE THE MAIN HEATER SWITCH STAYS OFF DURING RESISTANCE CHECKS.

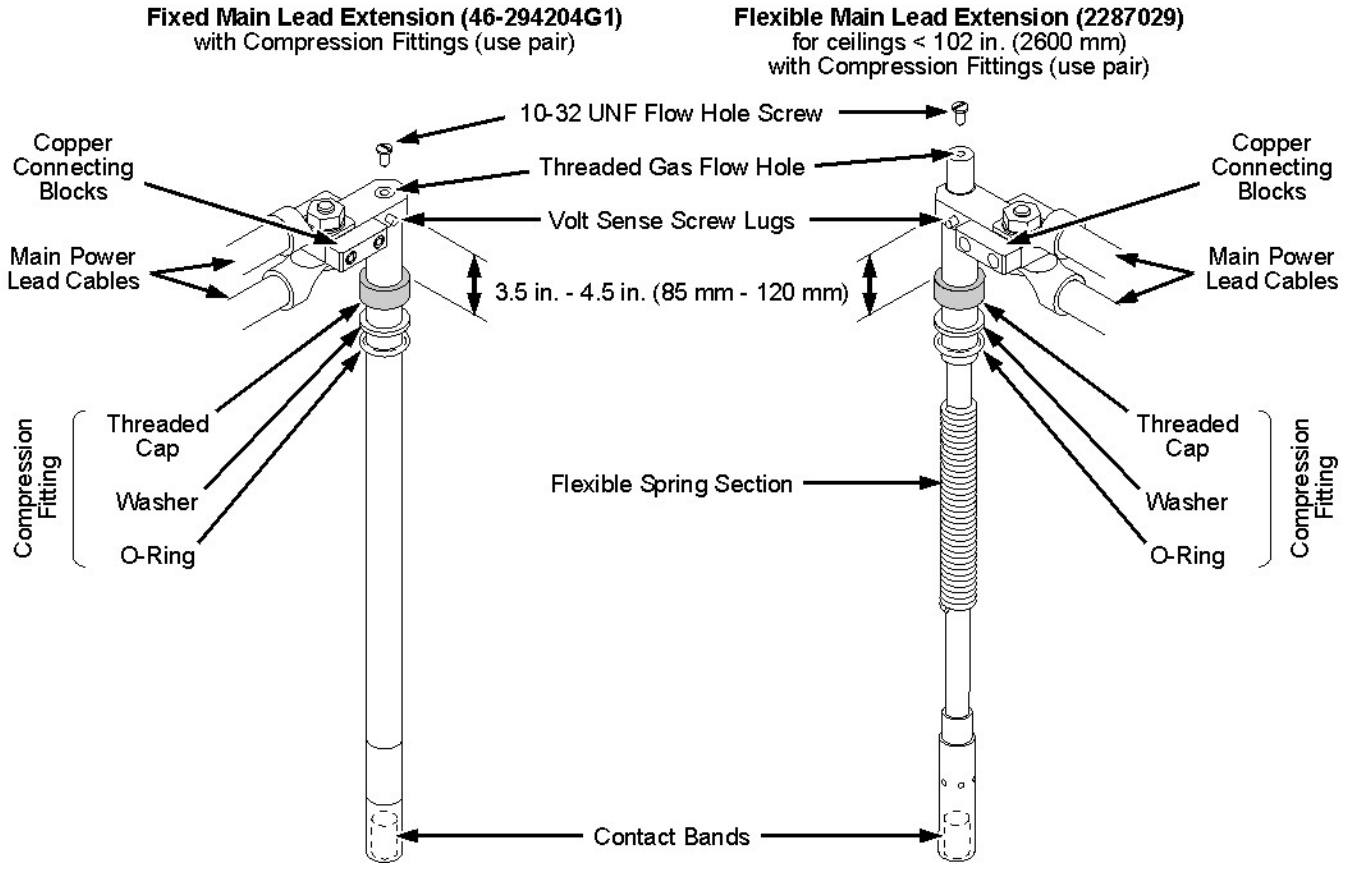
6. Set the Main Power and Power On switches to “ON.”

7. Set the Heater 2 Shim Axial Switch to “I” (on) and observe current rise in an analog ammeter (810 mA± 10 mA) to verify circuit continuity. Make sure the Main Heater Switch is off.

8. Connect a digital voltmeter (DVM) to the end of the Voltage Sense Leads (identified in Illustration 5-19).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-19: Main Lead Extensions



9. Set the Current Adjust Controls on the Main Power Supply to maximum (full CW).

10. Observe the Digital Current Meter and slowly turn the Voltage Control (CW) to set a 750 amp current through the Main Leads, Main Lead Extensions and the persistent Main Switch.

11. Record the voltage reading on the DVM in Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

⚠ CAUTION

Potential Magnet Quench
Voltage readings > 150 millivolts at 750 amps indicate unacceptable internal contact resistance at the Main Lead Extensions. Higher resistances will add more heat to the magnet, increasing boil-off and possibly causing a quench during ramping. Make sure the voltage readings are ≤ 150 mV at 750 amps.

12. If the DVM reads > 150mV, perform one or more of the following steps to reduce the contact resistance.

    a. Wait approximately 1 minute with current running, readings may drop as the Main Lead Extensions cool.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

b. Tighten the nuts (one flat at a time) on top of the Hold-Down Tool while measuring DVM readings.

c. If the reading still exceeds 150 mV:

i. Turn the Voltage and Current Adjust Controls to zero (full CCW).



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO THE SHIM POWER SUPPLY.

ii. Turn off the Main Power Supply input power. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

iii. Check and tighten the bolts securing the Ramp Cables to the Power Supply and Main Leads Extensions.

iv. Lift and reseat the Main Leads.

v. Remove lockout/tagout and reconnect input power to the power supply.

d. Repeatedly failing the contact resistance check may indicate one of the following:

- The Main Lead Extension Contact Bands replaced as directed in Chapter 3, Section 6, Connections for Ramping and Shimming, are not performing correctly and need replacing in conformance with Section 4, Main Lead Extension Contact Band Replacement.
- The Main Leads are damaged and need replacing.

e. If changes are made in Step 12, repeat Step 1 through Step 12.

NOTE: Do not continue to Step 13 until after the DVM voltage is < 150 mV.

13. Gradually increase the Voltage Adjust Control to pass 750 amps through the Main Leads, Main Lead Extensions and the persistent Main Switch while observing the power supply's Voltmeter. If the voltage exceeds 2.2 V, discontinue the test and perform Step 12 above.

14. Set the power supply's Voltmeter Select Switch to the “MAIN POWER SUPPLY” position. (This will display the output at the output lugs of the power supply monitored.) A voltage < 2.2 V at 750 amps indicates acceptable system resistance. If the voltage exceeds 2.2 V during the test, perform Step 12 to adjust contact resistance.

15. Turn the Current Adjust and Voltage Adjust controls off (full CCW) and continue with Section 6.4.1.3.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6.4.1.3 Magnet Rampdown (Shim Lead)



WARNING

POTENTIAL MAGNET QUENCH!
INCORRECT CONNECTION POLARITY AND POWER SUPPLY CURRENT SETTINGS CAN CAUSE THE MAGNET'S MAIN COILS TO QUENCH AND CAN BURN UP THE POWER SUPPLY WHEN TURNING ON THE MAIN SWITCH.
MAKE SURE THE CONNECTION POLARITY AND POWER SUPPLY CURRENT SETTINGS ARE THE SAME AS LAST RECORDED IN CHAPTER 8, SECTION 5, MAGNET RAMPING AND PARKING CURRENT LOG.



WARNING

POTENTIAL MAGNET QUENCH!
IF THE AXIAL SHIM HEATER SWITCH IS NOT "ON" DURING THE ENTIRE MAGNET RAMPDOWN PROCESS, A MAGNET QUENCH CAN OCCUR AND IRREPARABLE DAMAGE SHIM COIL DAMAGE CAN BE DONE. THE POWER SUPPLY WILL NOT PASS CURRENT TO THE MAIN LEAD EXTENSIONS WITH THE AXIAL SHIM HEATER OFF.
MAKE SURE THE AXIAL SHIM HEATER SWITCH REMAINS "ON" DURING THIS ENTIRE MAGNET RAMPDOWN PROCEDURE.



WARNING

POTENTIAL MAGNET QUENCH!
THE MAGNET MAY QUENCH IF THE MAIN POWER SUPPLY EXPERIENCES LARGE OUTPUT FLUCTUATIONS AND/OR EXCESSIVE RIPPLE.
MAKE SURE THE MAIN POWER SUPPLY IS ROUTINELY CALIBRATED AT AN APPROVED FACILITY.



NOTICE

If a Quench occurs during change of magnetic field, immediately turn the Voltage Adjust and Current Adjust controls to zero, turn off the power supply and leave the room until the quench is over.



NOTICE

Make sure the polarity recorded Chapter 8, Section 5, Magnet Ramping and Parking Current Log, matches the configuration of the Ramp Polarity Plate (Illustration 5-20). The "Normal" ramp polarity is "+" (positive) on the left and "-" (negative) on the right as viewed from the Coldhead side of the magnet. "Reversed" ramp polarity has "+" on the right and "-" on the left as viewed from the Coldhead side of the magnet. Call the National Support Center if the two do not match.

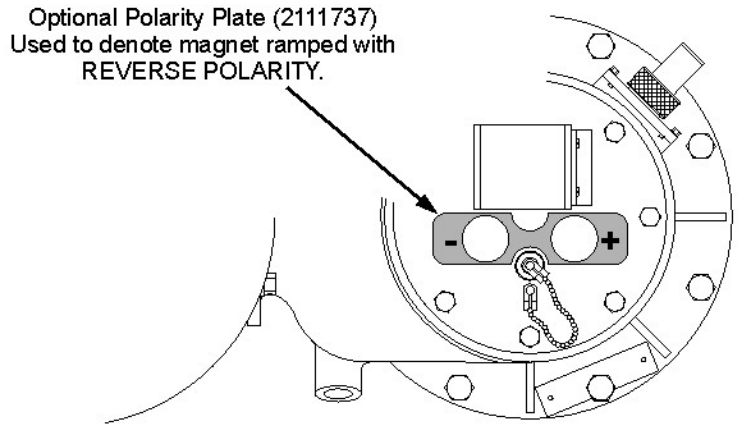
NOTE: All main coil driving voltages provided in this Magnet Rampdown to Zero Field procedure will be equal in magnitude but opposite in polarity for "reverse ramped" magnets. Normal polarity is shown in Illustration 5-16.

NOTE: Ice will build up around the Ramp Lead Hold-Down Tool flow holes during the rampdown procedure. Remove ice as needed to maintain helium gas flow through the flow holes.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Retrieve the Main Coil connection polarity and latest final parking current from Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

Illustration 5-20: Polarity Plate 2111737



2. Make sure the Axial Shim Heater (Shim Power Supply: Illustration 5-15) is on and the Main Leads are connected with the polarity indicated in Step 1.

NOTE: The Axial Shim Heater must remain on throughout the rampdown procedure.

3. Set the Main Power Supply's Voltmeter Select Switch to “MAIN COIL" position.

4. Set the Main Power Supply's Current Adjust Controls to:

   - for 750 amp power supply 46-260776G3: maximum (full CW).
   - for 1,000 amp power supply 46-260776G4: 10 amps more than the parking current retrieved in Step 1.

NOTE: Main Power Supply controls are shown in Illustration 5-17 (750 amp Main Power Supply) and Illustration 5-18 (1000 amp Main Power Supply).

5. Set the Voltage Control to adjust the Main Power Supply's output current to the parking current value retrieved in Step 1 above.

6. Set the Heater 1 Main Switch to “I" (on).

7. Allow approximately 1 minute for the Main Switch to go normal.

8. When the Main Switch is normal, **slowly** decrease the Voltage Control (CCW) until -0.3 V is observed across the power supply voltmeter (“Main Coil” position).

9. Continue to adjust power supply voltage using the Voltage Control during rampdown in conformance with the voltages and main coil current ranges shown in Table 5-4.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 5-4: Rampdown (Using Shim Lead) Profile

Main Coil Voltage	Main Coil Current Range
-0.30 Volts	Start - 720 Amps
-0.50 Volts	720 Amps - 700 Amps
-0.60 Volts	700 Amps - 675 Amps
-0.75 Volts	675 Amps - 650 Amps
-1.00 Volts	650 Amps - 625 Amps
-1.50 Volts*	625 Amps - 500 Amps
Gradually turn the Voltage Control to zero (full CCW) then turn the Current Controls to zero (full CCW)	500 Amps - 0 Amps
* -1.50 volts is the approximate maximum voltage obtainable during rampdown.	

10. Observe the voltmeter reading with the power supply Voltmeter Select Switch in the “MAIN COIL" position. A zero reading on the power supply digital voltage and current meters indicates that the magnet is fully discharged.

11. When the magnet is full discharged, set the Heater 1 Main and the Heater 2 Shim Axial switches to “O” (off).

12. Set the Main Power and Power On switches to “OFF.”



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

13. Disconnect and lockout/tagout input power cables from the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

NOTE: The Pressure Controller will maintain helium vessel pressure.



WARNING

POTENTIAL ASPHYXIATION AND COLD BURN HAZARD!
IMPROPER ENGAGEMENT/DISENGAGEMENT OF THE MAIN LEAD EXTENSIONS WITH THE MAIN LEAD PINS CAN CAUSE A RAMPED MAGNET TO QUENCH.
INSERT MAIN LEAD EXTENSIONS ONE AT A TIME AND, IF THE MAGNET IS AT FIELD, ALLOW THEM TO COOL SUFFICIENTLY (A FOG OR WATER VAPOR FORMS AROUND THE LEAD EXTENSIONS) BEFORE THEY CONTACT THE MAIN LEAD PINS.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD!
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT. DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



WARNING

ELECTRICAL SHOCK HAZARD!
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.



WARNING

POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING MAGNET RAMPDOWN. WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.



NOTICE

Replace the Ramp Port Caps immediately after removing Main Lead Extensions to prevent ice build-up inside the Vertical Penetration.

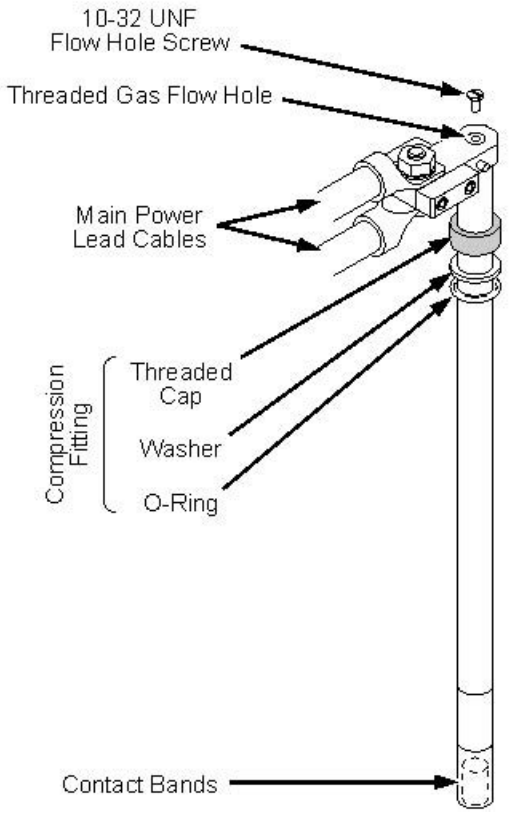
14. **AFTER** ramping down the magnet and disconnecting the main power supply, plug and **remove one Main Extension at a time** in the following sequence:

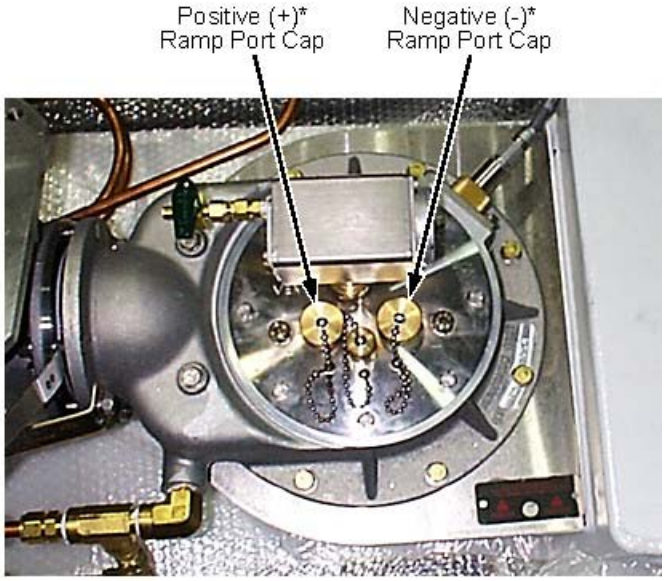
    a. Open Valve V2. Bleed vessel pressure down below 1.0 psig. Do not allow pressure to go below 0.5 psig as read on the magnet pressure gauge or Magnet Monitor. Close V2.

    b. Remove all ice around the ramp lead port compression fitting on the Main Lead Extension that is being removed first. See Illustration 5-21.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-21: Main Lead Extension and Ramp Ports





* Normal polarity shown.

⚠ WARNING

POTENTIAL MAGNET QUENCH!
PLUGGING THE FLOW HOLE OF AN ENGAGED MAIN LEAD EXTENSIONS WILL CAUSE THE MAGNET TO QUENCH.
DO NOT INSERT FLOW HOLE SCREWS INTO MAIN LEAD EXTENSIONS UNTIL AFTER EXTENSIONS ARE REMOVED.

c. Unscrew the ramp lead port compression fitting and remove the first Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

d. Remove all ice around the ramp lead port compression fitting on the other Main Lead Extension.

e. Unscrew the ramp lead port compression fitting and remove the second Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

f. Install the flow hole screws in the flow hole of both Main Lead Extensions **after** both leads have been removed.

g. Check the Main Leads and fill port cap for leaks.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6.4.2 Magnet Rampdown Using Auxiliary Cable

The Auxiliary Rampdown Cable (2217315) is used to rampdown a magnet when the Shim Lead cannot be engaged into the Shim Lead Connector (P100) in the magnet Vertical Penetration due to ice or damage to the P100's Sav-Con Connector. This cable connects the Main Coil Heater via the J1C connector on the magnet penetration and J3 on the Main Power Supply. Main Coil voltage will not be accessible with this wiring configuration. Use a digital voltmeter (DVM) with the Voltage Sense Leads connected to the Main Lead Extensions to approximate the Main Coil voltage.

6.4.2.1 Preparation for Rampdown (Auxiliary Cable)

NOTICE

Use Auxiliary Rampdown Cable 2217315 and procedure below ONLY when the Shim Leads cannot be engaged into the P100 connector.

NOTICE

DO NOT contact the Shim Lead Connector (P100) or the Main Lead Pins with metallic or conductive tools or materials since the Auxiliary Rampdown Cable may leave current in the Superconductive Shim Coils. This current can transfer to the Main Coils.

1. “Top Fill" the magnet to ≥ 90% helium level in conformance with Chapter 3, Section 3.2, Liquid Helium Fill, before continuing with this Magnet Rampdown to Zero Field procedure.

2. Set up MetroLab Teslameter 46-255839P2 and #5 Teslameter Probe 46-255839P104 for single point magnetic field strength monitoring in conformance with Chapter 3, Section 4, Preparations for Field Measurement.

3. Perform power supply checks in conformance with the Main Power Supply Tests section (Chapter 4, Section 8.2, TCR 7.5T750 Main Power Supply Tests, for 750 amp power supplies or Chapter 4, Section 8.3, ESS7.5-1000-2-D-1236 Main Power Supply Tests, for 1000 amp power supplies). Verify that the Shim Supply Heater currents are set at 810 mA ± 10 mA.

WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

4. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

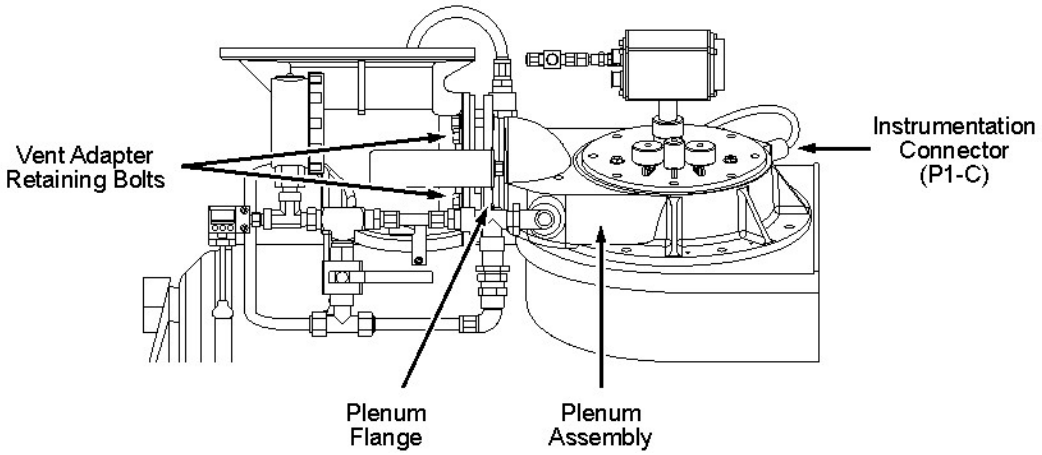
5. Replace the Main Lead Contact Bands in conformance to Section 4, Main Lead Extension Contact Band Replacement.

6. Disconnect the Instrumentation Connector (P1C) from connector J1C on the Plenum (Illustration 5-22). Connect Auxiliary Rampdown Cable 2217315 between connector J3 on the power supply (750 amp Main Power Supply: Illustration 5-17; 1000 amp Main

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Power Supply: Illustration 5-18) and connector J1C. See Chapter 6, Section 2.1, Magnet System Wiring.

Illustration 5-22: Instrumentation Connector (P1C) Location



6.4.2.2 Resistance Checks (Auxiliary Cable)



WARNING

POTENTIAL QUENCH HAZARD
THE MAGNET MAY QUENCH, RAPIDLY RELEASING CRYOGENIC GASES, IF ITS LIQUID HELIUM LEVEL DROPS TOO LOW DURING MAGNET RAMPDOWN.
MAKE SURE THE MAGNET ≥ 90% FULL OF LIQUID HELIUM BEFORE STARTING THIS MAGNET RAMPDOWN TO ZERO FIELD PROCEDURE.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

1. Make sure the input power cable for the Magnet Power Supply is disconnected and locked-out/tagged-out. Verify that no voltage is present by using a DVM or equivalent measuring device.

2. Connect the Main Power Supply and Main Lead Extensions to the magnet by making all cable connections in conformance with Chapter 3, Section 6, Connections for Ramping and Shimming, but using the Auxiliary Rampdown Cable instead of the Switch Heater Cable.

3. Set the Heater 1 Main and Heater 2 Shim Axial Switches to the “O” (off) position. See Illustration 5-17 (750 amp Main Power Supply) or Illustration 5-18 (1000 amp Main Power Supply).

NOTE: Main Power Supply controls are shown in Illustration 5-17 (750 amp Main Power Supply) and Illustration 5-18 (1000 amp Main Power Supply).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4. Set the Current Adjust and Voltage Controls to “O" (full CCW).

5. Remove lockout/tagout and connect the input power to the Main Power Supply.



WARNING

POTENTIAL MAGNET QUENCH
TURNING ON THE MAIN HEATER SWITCH WHILE PERFORMING THESE RESISTANCE CHECKS WILL CAUSE A MAGNET QUENCH.
MAKE SURE THE MAIN HEATER SWITCH STAYS OFF DURING RESISTANCE CHECKS.

6. Set the Main Power and Power On Switches to “ON."

7. Connect a digital voltmeter (DVM) to the end of the Voltage Sense Leads.

8. Set the Current Adjust Controls on the Magnet Power Supply to maximum (full CW).

9. Observe the Digital Current Meter and slowly turn the Voltage Control (CW) to set a 500 A current through the Main Leads, Main Lead Extensions and the persistent Main Switch.

10. Record the voltage reading on the DVM in Chapter 8, Section 5, Magnet Ramping and Parking Current Log.



CAUTION

Potential Magnet Quench
Voltage readings > 150 millivolts at 750 amps indicate unacceptable internal contact resistance at the Main Lead Extensions. Higher resistances will add more heat to the magnet, increasing boiloff and possibly causing a quench during ramping. Make sure the voltage readings are ≤ 150 mV at 750 amps.

11. If the DVM reads > 150 mV, perform one or more of the following steps to reduce the contact resistance.

    a. Wait approximately 1 minute with current running, readings may drop as the Main Lead Extensions cool.

    b. Make sure the Hold-Down Tool is properly mounted and tightened.

    c. If the reading still exceeds 150 mV:

        i. Turn the Voltage and Current Adjust controls to zero (full CCW).



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

ii. Turn off the Main Power Supply input power. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

iii. Tighten the bolts securing the Ramp Cables to the power supply and Main Leads Extensions.

iv. Lift and reseat the Main Leads.

v. Remove lockout/tagout and reconnect input power to the power supply.

d. Repeatedly failing the contact resistance check may indicate one of the following:

- The Main Lead Extension Contact Bands replaced as directed in Chapter 3, Section 6, Connections for Ramping and Shimming, are not performing correctly and need replacing in conformance with Section 4, Main Lead Extension Contact Band Replacement.
- The Main Leads are damaged and need replacing.

e. If changes are made in Step 11, repeat Step 1 through Step 11.

NOTE: Do not continue to Step 12 until after the DVM voltage is ≤ 150 mV.

12. Set the Voltmeter Select Switch to the “MAIN POWER SUPPLY" position and increase the current to 750 amps. If the voltage reading at 750 amps is > 2.2 volts:

a. Reduce the voltage/current to zero.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

b. Turn off the Main Power Supply input power. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

c. Remove, clean and tighten the ramp cable contacts at both the power supply and the Main Lead Extensions. Make sure the proper hardware is used to connect the ramp cables.

d. Remove lockout/tagout and reconnect input power to the power supply.

e. Repeat the resistance check in Step 11.

13. When the resistance check voltage reading in Step 12 is < 2.2 volts, turn the Voltage and Current Controls to zero and turn off the power supply.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6.4.2.3 Magnet Rampdown (Auxiliary Cable)



WARNING

POTENTIAL QUENCH HAZARD
INCORRECT CONNECTION POLARITY AND POWER SUPPLY CURRENT SETTINGS CAN CAUSE THE MAGNET'S MAIN COILS TO QUENCH AND CAN BURN UP THE POWER SUPPLY WHEN TURNING ON THE MAIN SWITCH.
MAKE SURE THE CONNECTION POLARITY AND POWER SUPPLY CURRENT SETTINGS ARE THE SAME AS LAST RECORDED IN CHAPTER 8, SECTION 5, MAGNET RAMPING AND PARKING CURRENT LOG.



WARNING

POTENTIAL QUENCH HAZARD
IF THE AXIAL SHIM HEATER SWITCH IS NOT “ON” DURING THE ENTIRE MAGNET RAMPDOWN PROCESS, A MAGNET QUENCH CAN OCCUR AND IRREPARABLE DAMAGE SHIM COIL DAMAGE CAN BE DONE. THE POWER SUPPLY WILL NOT PASS CURRENT TO THE MAIN LEAD EXTENSIONS WITH THE AXIAL SHIM HEATER OFF.
MAKE SURE THE AXIAL SHIM HEATER SWITCH REMAINS “ON” DURING THIS ENTIRE MAGNET RAMPDOWN PROCEDURE.



WARNING

POTENTIAL QUENCH HAZARD
THE MAGNET MAY QUENCH IF THE MAIN POWER SUPPLY EXPERIENCES LARGE OUTPUT FLUCTUATIONS AND/OR EXCESSIVE RIPPLE.
MAKE SURE THE MAIN POWER SUPPLY IS ROUTINELY CALIBRATED AT AN APPROVED FACILITY.



NOTICE

Make sure the polarity recorded Chapter 8, Section 5, Magnet Ramping and Parking Current Log, matches the configuration of the Ramp Polarity Plate (Illustration 5-20). The "Normal" ramp polarity is “+” (positive) on the left and “-” (negative) on the right as viewed from the Coldhead side of the magnet. “Reversed” ramp polarity has “+” on the right and “-” on the left as viewed from the Coldhead side of the magnet. Call the National Support Center if the two do not match.



NOTICE

If a Quench occurs during change of magnetic field, immediately turn the Voltage Adjust and Current Adjust controls to zero.

NOTE: All main coil driving voltages provided in this Magnet Rampdown to Zero Field procedure are the same in overall magnitude regardless of the magnet having normal or reverse polarity. Normal polarity is shown in Illustration 5-16.

NOTE: Ice will build up around the Ramp Lead Hold-Down Tool flow holes during the rampdown procedure. Remove ice as needed to maintain helium gas flow through the flow holes.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Retrieve the Main Coil connection polarity and latest final parking current in the Chapter 8, Section 5, Magnet Ramping and Parking Current Log.

2. Make sure the Main Leads are connected with the polarity indicated in Step 1.

NOTE: Main Coil voltage is not directly accessible with the Shim Lead connector disengaged. Use digital voltmeter (DVM) readings with the Voltage Sense Leads connected to the Main Lead Extensions for the steps below. This voltage approximates the Main Coil voltage and will prevent the rampdown voltage from exceeding the recommended value.

3. Make sure the DVM is connected to the Voltage Sense Leads (Illustration 5-21) from the Main Lead Extensions.

4. Set the Current Adjust Controls on power supply to:

   - for 750 amp power supply 46-260776G3: maximum (full CW).
   - for 1,000 amp power supply 46-260776G4: 10 amps more than the parking current retrieved in Step 1.

NOTE: Power supply controls are shown in Illustration 5-17 (750 amp Main Power Supply) and Illustration 5-18 (1000 amp Main Power Supply).

5. Set the Voltage Control to adjust the power supply output current to the parking current value retrieved in Step 1 above.

6. Set the Heater 1 Main Switch to “I" (on).

7. Allow approximately 1 minute for the Main Switch to go normal.

8. When the Main Switch is normal, **slowly** decrease the Voltage Control (CCW) until -0.3 V is observed on the DVM.

9. Continue to adjust the power supply voltage using the Voltage Control during rampdown in conformance with the voltages read on the DVM and Main Coil current ranges shown in Table 5-5.

Table 5-5: Rampdown (Using Auxiliary Cable) Profile

Main Coil Voltage	Main Coil Current Range
-0.10 Volts	Start - 720 Amps
-0.30 Volts	720 Amps - 700 Amps
-0.40 Volts	700 Amps - 675 Amps
-0.50 Volts	675 Amps - 650 Amps
-0.80 Volts	650 Amps - 625 Amps
-1.40 Volts	625 Amps - 500 Amps
Gradually turn the Voltage Control to zero (full CCW) then turn the Current Controls to zero (full CCW)	500 Amps - 0 Amps

10. Observe the voltmeter reading with the power supply's Voltmeter Select Switch in the “MAIN COIL" position. A zero reading on the power supply's digital Voltage and Current Meters indicates that the magnet is fully discharged.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

11. When the magnet is fully discharged, set the Heater 1 Main Switch to “O” (off).

12. Set the Main Power and Power On switches to “OFF.”



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED POWER SUPPLY CAN CAUSE ELECTRICAL SHOCK.
FOLLOW LOCKOUT/TAGOUT PROCEDURES WHILE MAKING ELECTRICAL CONNECTIONS TO ANY POWER SUPPLY.

13. Disconnect and lockout/tagout input power to the Main Power Supply. Verify that no voltage is present by using a DVM or equivalent measuring device.

NOTE: The Pressure Controller will maintain helium vessel pressure.



⚠ WARNING

POTENTIAL ASPHYXIATION AND COLD BURN HAZARD!
IMPROPER ENGAGEMENT/DISENGAGEMENT OF THE MAIN LEAD EXTENSIONS WITH THE MAIN LEAD PINS CAN CAUSE A RAMPED MAGNET TO QUENCH.
INSERT MAIN LEAD EXTENSIONS ONE AT A TIME AND, IF THE MAGNET IS AT FIELD, ALLOW THEM TO COOL SUFFICIENTLY (A FOG OR WATER VAPOR FORMS AROUND THE LEAD EXTENSIONS) BEFORE THEY CONTACT THE MAIN LEAD PINS.



⚠ WARNING

ELECTRICAL SHOCK HAZARD!
TOUCHING BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME OR ALLOWING THEM TO CONTACT EACH OTHER WHILE THE MAGNET IS AT FIELD WILL RESULT IN A RAPID DISCHARGE THROUGH THEIR CONTACT POINTS IF THE SWITCH HEATER IS ACTIVATED OR CIRCUIT RESISTANCE DEVELOPS AT THAT MOMENT.
DO NOT TOUCH BOTH MAIN LEAD EXTENSIONS AT THE SAME TIME. DO NOT ALLOW THE MAIN LEAD EXTENSIONS TO CONTACT EACH OTHER.



⚠ WARNING

ELECTRICAL SHOCK HAZARD!
DO NOT ALLOW EXPOSED BODY AREAS TO COME IN CONTACT WITH THE CRYOSTAT OR PLUMBING WHILE INSERTING OR EXTRACTING THE MAIN LEAD EXTENSIONS.



⚠ WARNING

POTENTIAL COLD BURN HAZARD
CONTACT WITH COLD OBJECTS IS POSSIBLE DURING MAGNET RAMPDOWN.
WEAR NONABSORBENT LEATHER GLOVES WITH NO HOLES OR TEARS DURING INSERTION OR EXTRACTION OF THE MAIN LEAD EXTENSIONS.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

Replace the Ramp Port Caps immediately after removing Main Lead Extensions to prevent ice build-up inside the Vertical Penetration.

14. **AFTER** ramping down the magnet and disconnecting the main power supply, plug and **remove one Main Extension at a time** in the following sequence:

    a. Open Valve V2. Bleed vessel pressure down below 1.0 psig. Do not allow pressure to go below 0.5 psig as read on the magnet pressure gauge or Magnet Monitor. Close V2.

    b. Remove all ice around the ramp lead port compression fitting on the Main Lead Extension that is being removed first. See Illustration 5-21.

WARNING

POTENTIAL MAGNET QUENCH!
PLUGGING THE FLOW HOLE OF AN ENGAGED MAIN LEAD EXTENSIONS WILL CAUSE THE MAGNET TO QUENCH.
DO NOT INSERT FLOW HOLE SCREWS INTO MAIN LEAD EXTENSIONS UNTIL AFTER EXTENSIONS ARE REMOVED.

    c. Unscrew the ramp lead port compression fitting and remove the first Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

    d. Remove all ice around the ramp lead port compression fitting on the other Main Lead Extension.

    e. Unscrew the ramp lead port compression fitting and remove the second Main Lead Extension from the magnet. Immediately replace the cap onto the Ramp Lead Port.

    f. Install the flow hole screws in the flow hole of both Main Lead Extensions **after** both leads have been removed.

    g. Check the Main Leads and fill port cap for leaks.

6.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7 Cryostat Warm-Up

7.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	10 hours	Included in 'Procedure'

7.2 Overview

In a few situations the magnet Cryostat may need to be warmed to room temperature by the removal of cryogens after the magnet is at zero magnetic field strength. Example situations are when removing an internal ice blockage or repairing a vacuum leak that requires re-evacuation. If a magnet warm-up is required, contact the Regional Field Service Engineer before proceeding with this Cryostat Warm-Up procedure.

NOTE: The Cryostat is designed to allow for the recovery of liquid helium (LHe); however, because of the nature of the failure modes requiring warm-up, the liquid helium is most likely boiled off. If the unit is less than 50% full of liquid helium, warm up the magnet without liquid helium recovery. If recovery of liquid helium is to be done, a prepared Dewar (cold and containing helium gas) is recommended for liquid helium recovery. A warm Dewar evaporates a significant quantity of liquid helium in the cooldown process.

7.3 Preliminary Requirements

7.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Heat Gun	1	-	-	-
Copper Tubing, approximately 6 ft. (2 M) long	1	-	-	-
Digital Voltmeter (DVM), Volt-Ohm Meter (VOM) or non-contact voltage tester	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit	1 kit per person	-	46-271137G1	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
Universal Fill Line Kit	1	-	46-294705G1	-
Liquid Helium Transfer Line Kit	1	-	46-294513G1	-
Helium Regulator and Hose Kit	1	-	46-306734G1	-
Nonmagnetic Helium Cylinder Cart	1	-	46-258150P1	-
Flexible Helium Hose, 40 foot (12.2 M)	1 or 2	-	46-271135P1	-
Lakeshore Cryotronics 208 Digital Thermometer (46-301477G2), Lakeshore Cryotronics DRC-80 (46-265269G1), Low-Cost Shield Temperature Diode Box (46-317543G1) or equivalent temperature sensing device	1	-	46-301477G2, 46-265269G1 or 46-317543G1	-
Universal Service Ladder/Platform	1	-	2319156	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Gaseous Helium, 235 SCF Nonferrous Cylinder	8	-	-	-
Liquid Nitrogen Dewars (pressure-building preferred)	12	-	-	-
250 SCF or 500 SCF Helium Dewars (prepared: cold and containing helium gas)	4 @ 250 SCF or 2 @ 500 SCF	-	-	-

7.3.3 Replacement Parts

No replacement parts required.

7.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING TO WARM-UP THE CRYOSTAT.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR CRYOSTAT WARM-UP IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE WARMING UP THE CRYOSTAT.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE BUDDY SYSTEM REQUIREMENTS & CERTIFICATION SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING TO WARM-UP THE CRYOSTAT.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



DANGER

FATAL EXPLOSIVE HAZARD!
GAS CYLINDER RUPTURE/DAMAGE OR OPENING CYLINDER VALVE FAST WILL RELEASE 2400 PSI GAS FROM CYLINDER.
MAKE SURE GAS CYLINDERS ARE SECURE FROM FALLS AND AWAY FROM MOVING OBJECTS BEFORE USING. ALWAYS OPEN CYLINDER VALVE SLOWLY.



WARNING

POTENTIAL MAGNET QUENCH!
A MAGNET QUENCH DURING CRYOSTAT WARM-UP COULD RESULT IN RAPID EXPULSION OF LIQUID HELIUM THROUGH THE VERTICAL PENETRATION.
MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE STARTING TO WARM-UP THE CRYOSTAT.



WARNING

ASPHYXIATION HAZARD!
ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR IS GENERATED DURING CRYOSTAT WARM-UP.
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — AND THAT THE MAGNET ROOM DOORS ARE SECURED IN THE OPEN POSITION BEFORE WARMING UP THE CRYOSTAT.



WARNING

POTENTIAL COLD BURN OR ASPHYXIATION HAZARD
INTERNAL CRYOSTAT PRESSURE BUILD-UP TO > 5.25 PSIG WILL OPEN 5.25 PSIG RELIEF VALVE.
BEFORE REMOVING EITHER RAMP OR FILL PORT CAPS OR LOOSENING ANY COMPONENT RESULTING IN THE RELEASE OF CRYOGEN PRESSURE:

1. **OBSERVE THE INTERNAL CRYOSTAT PRESSURE GAUGE READING,**
2. **SET MAGNET MONITOR PRESSURE TO 0.5 PSIG AND**
3. **VENT CRYOSTAT DOWN TO 0.2 PSIG THROUGH VENT VALVE V2.**



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING CRYOSTAT WARM-UP.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN WARMING UP THE CRYOSTAT.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
DISCONNECT THE POWER CABLE AND FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR WHILE WARMING UP THE CRYOSTAT. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.



NOTICE

- **Do not warm up the magnet if it is to be shipped from the site!**
- **Make sure the MAC Team Leader is present and has determined that magnet warm-up is required before proceeding.**
- **Make sure all required equipment is on site. Enough prepared Dewars to handle liquid helium recovery must be available if liquid helium (LHe) is to be recovered.**

NOTE: If the site has Magnet Monitor proprietary software, connect to Magnet Monitor and turn off the alarm for vessel pressure. Then turn the vessel pressure control to a high value of .5 psig and a low value of .4 psig.

7.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting Cryostat Warm-Up.	Chapter 1, Section 2	-
The removal of some magnet enclosure components may be required to complete this Cryostat Warm-Up procedure. Refer to Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with this Cryostat Warm-Up procedure if cover removal is required.	Section 5	-
(continued)	Appendix A, Section 1.1	-
The magnet must be at zero field (Section 6, Magnet Rampdown to Zero Field) before starting this Cryostat Warm-Up procedure.	Section 6	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Condition	Reference	Effectivity
Make sure the magnet room exhaust fan is on and operational before starting Cryostat Warm-Up.	-	-
Make sure the magnet room door is propped open before starting Cryostat Warm-Up.	-	-

7.4 Procedure

7.4.1 Cryostat Warm-Up without Liquid Helium Recovery

NOTE: The following procedure must be used when the magnet's liquid helium level is < 50%.

1. Verify that the magnet is at zero magnetic field strength.
2. Check the magnet's liquid helium level. If the level is > 50%, use the warm-up procedure in Section 7.4.2, Cryostat Warm-Up with Liquid Helium Recovery.

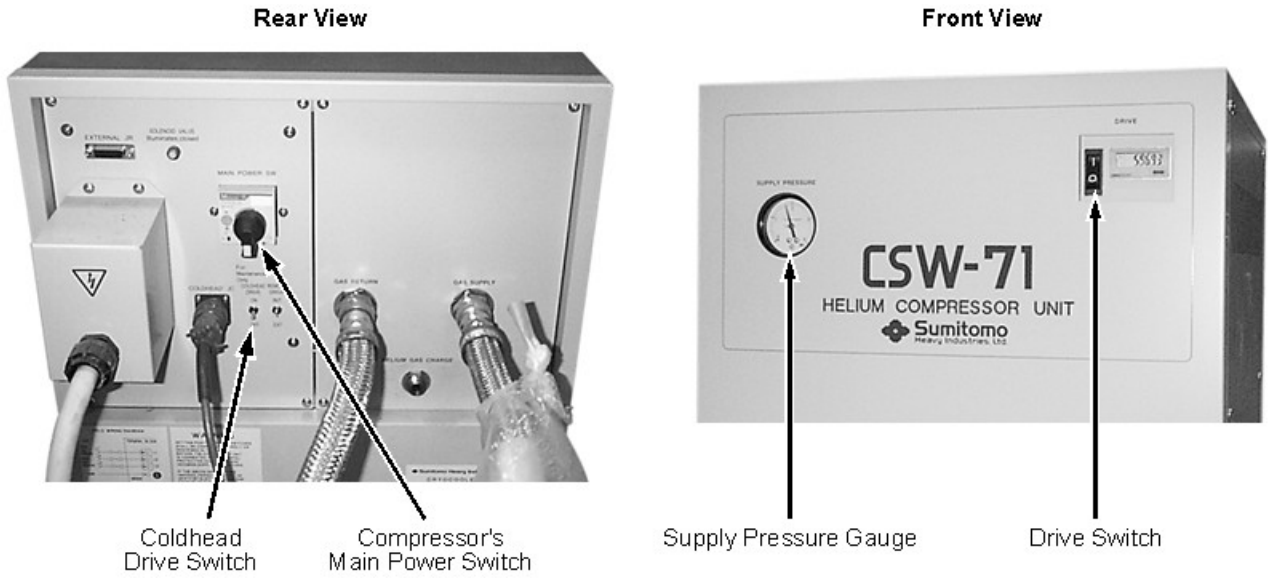


⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
DISCONNECT THE POWER CABLE AND FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR.

3. Turn the Cryocooler Compressor off. Disconnect and lockout/tagout input power to the Cryocooler Compressor (Illustration 5-23). Verify that no voltage is present by using a DVM or equivalent measuring device.

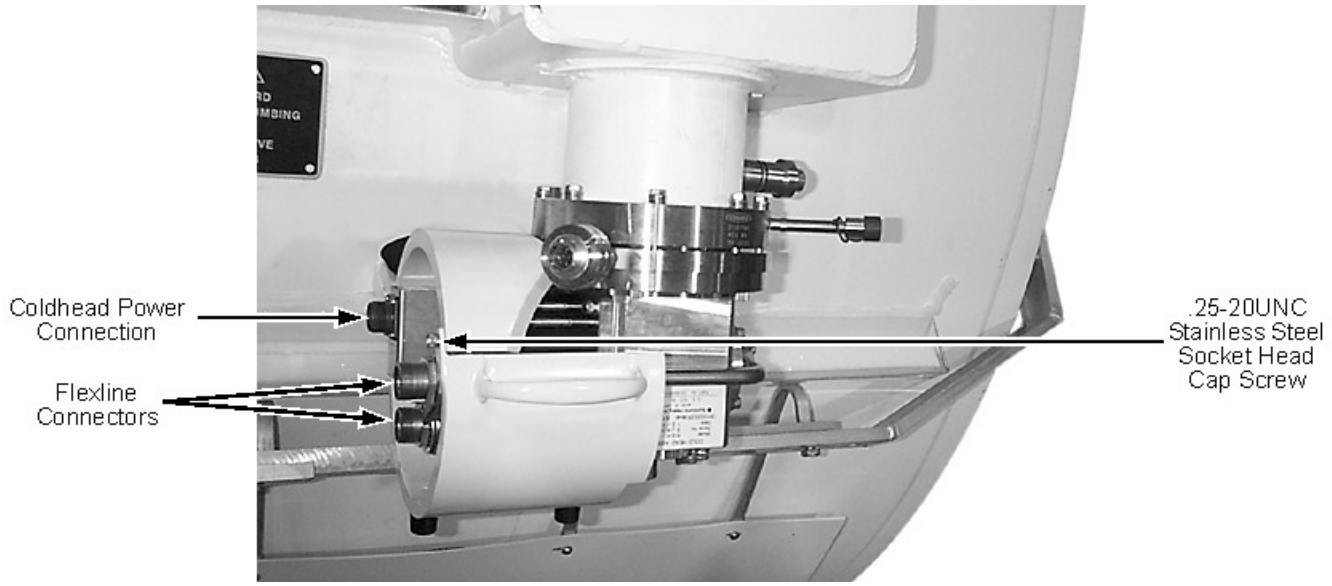
Illustration 5-23: Views of the CSW-71D Compressor



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

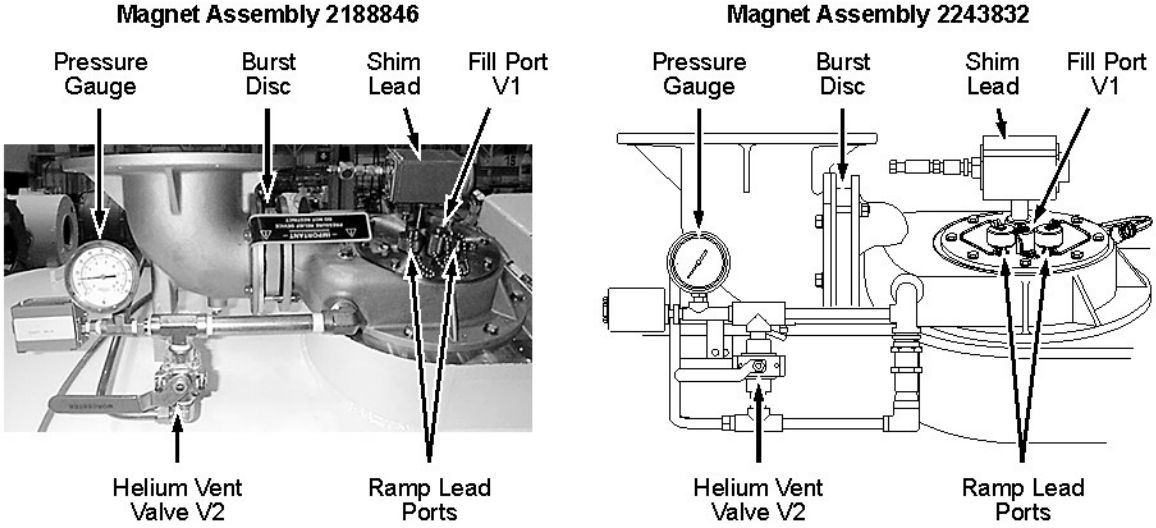
4. Disconnect the supply and return gas lines at the Coldhead (Illustration 5-24).

Illustration 5-24: Coldhead Flexline and Power Connection Locations



5. Open helium Vent Valve V2. See Illustration 5-25.

Illustration 5-25: Helium Vent Plumbing



6. Remove the Burst Disc in conformance with Section 11.1, Burst Disc (2349529) Replacement (or Section 11.2, Burst Disc (2194545-7) Replacement, where appropriate), and then reconnect the Vent Adapter.

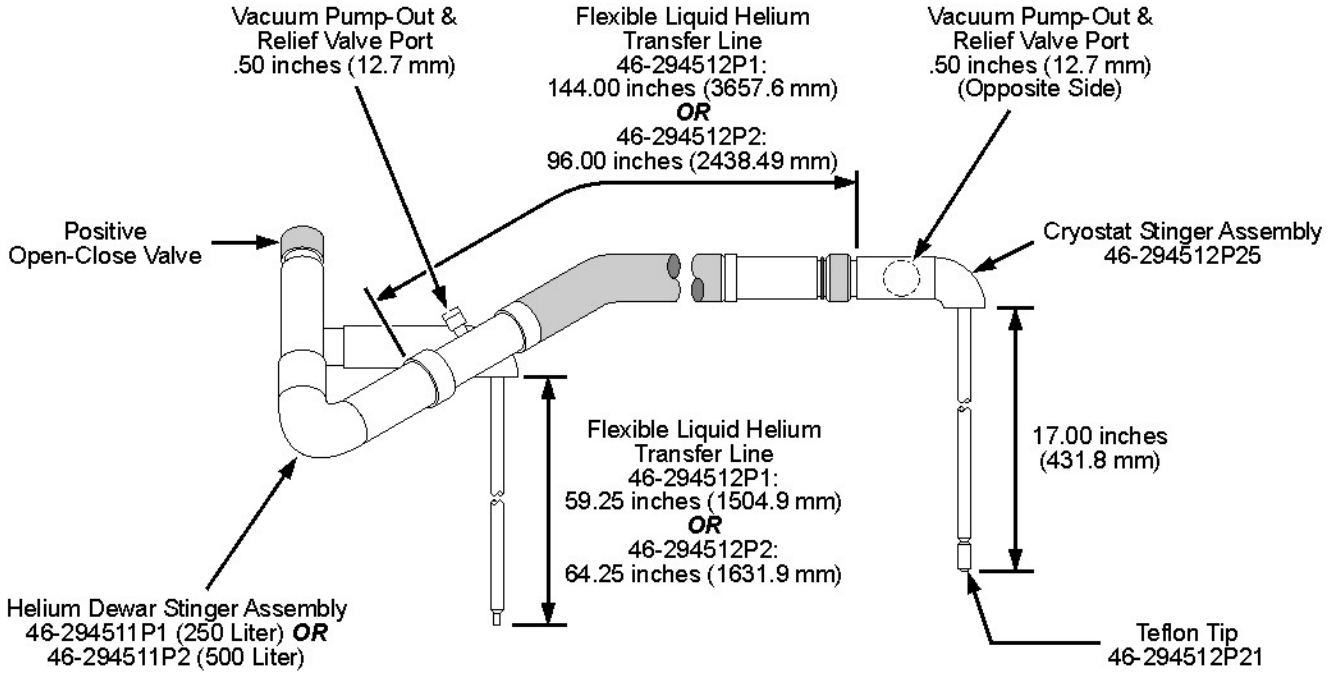
7. Connect the Lakeshore Cryotonics DRC-80 46-265269G1), the Lakeshore Cryotonics Model 208 Thermometer Kit (46-301477G1) or the Low-Cost Shield Temperature Diode Box (46-317543G1) to monitor silicon diode temperature in conformance with Chapter 3, Section 2, Magnet Commissioning Checks.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8. Connect a helium gas (99.995%) and regulator set-up to the Helium Fill Port at Valve V1 (Illustration 5-25).

9. Insert a 7 inch (178 mm) Cryostat Stinger (46-294512P3) with a 16 inch (406 mm) Cryostat Stinger Extension (46-294512P12) into the Fill Port, and then tighten the compression fitting. See Illustration 5-26.

Illustration 5-26: Helium 'Bottom Fill' Equipment

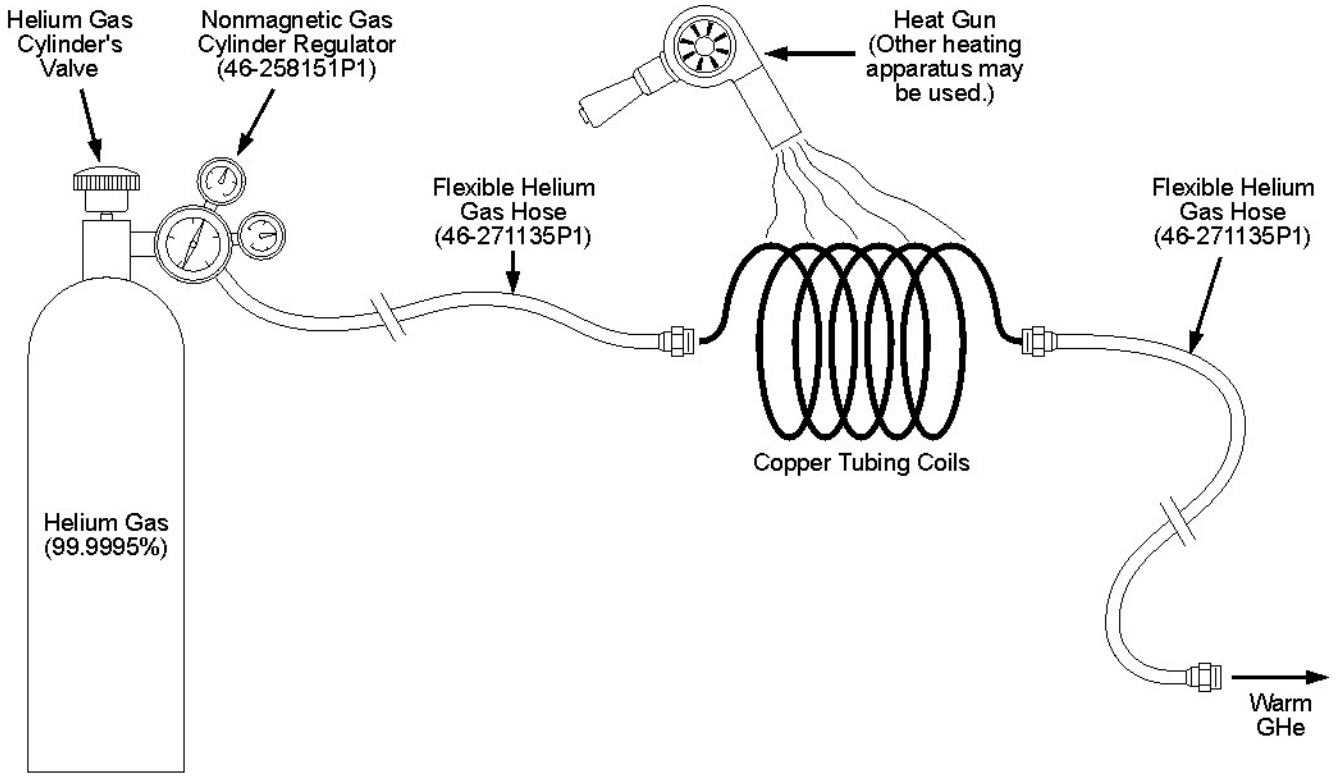


10. Blow warm helium gas regulated at 4 psig - 6 psig through the Cryostat until the silicon diode temperature readout exceeds 90K.

NOTE: The gas may be warmed through the heat exchange coil heated with a heat gun, as in Illustration 5-27.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-27: Helium Gas Warm-Up Set-Up (Optional)

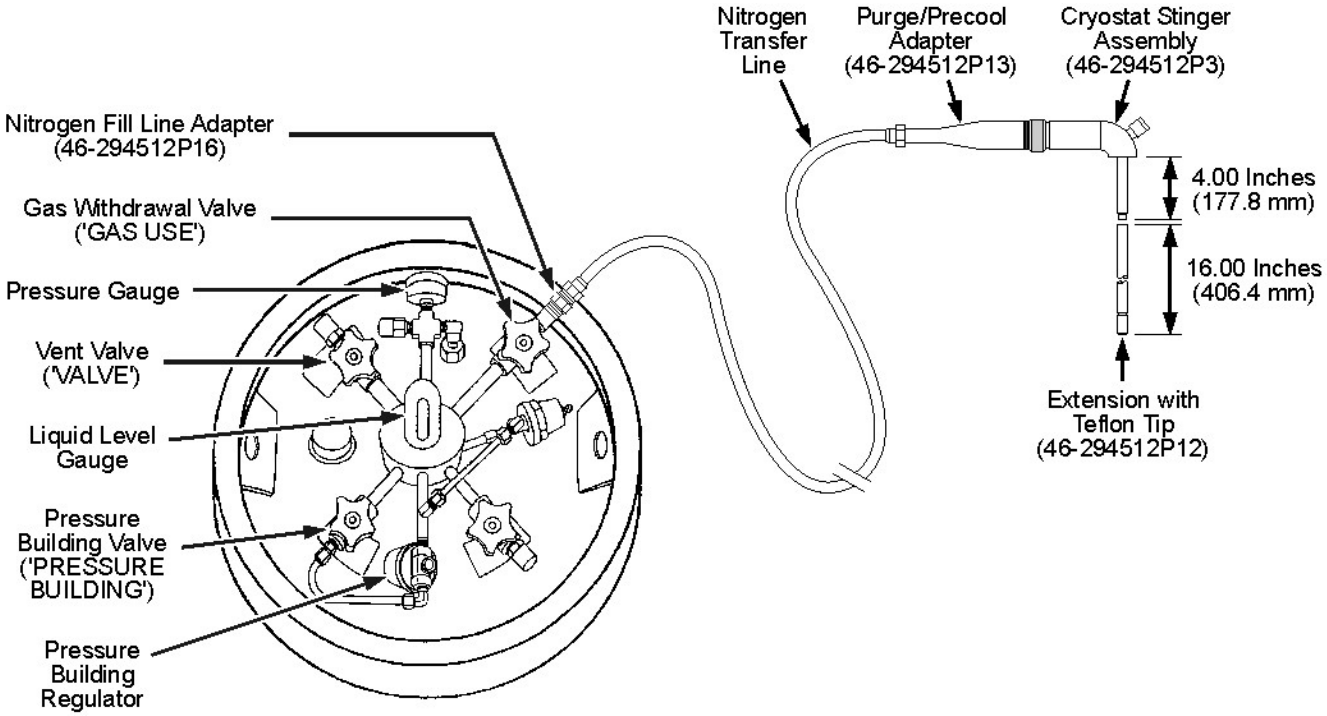


11. Shut off the helium gas flow using the Positive On/Off Valve. See Illustration 5-26.

12. Remove the helium gas cylinder & regulator set-up and connect the nitrogen gas set-up (Illustration 5-28) in its place.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-28: Nitrogen Gas Set-Up



13. Open the Positive On/Off Valve.
14. Start a nitrogen gas flow regulated at 4 psig - 6 psig and continue until the silicon diode temperature readout exceeds 290K.
15. Discontinue the nitrogen gas flow, remove the Stinger and cap Helium Fill Port V1. Close V2.

7.4.2 Cryostat Warm-Up with Liquid Helium Recovery

NOTICE

Do not use this Cryostat Warm-Up procedure if the magnet's liquid helium level is < 50%.

1. Verify that the magnet is at zero magnetic field strength.
2. Check the magnet's liquid helium level. If the level is < 50%, use the warm-up procedure in Section 7.4.1, Cryostat Warm-Up without Liquid Helium Recovery.

WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
DISCONNECT THE POWER CABLE AND FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. Turn the Cryocooler Compressor off. Disconnect and lockout/tagout input power to the Cryocooler Compressor (Illustration 5-23). Verify that no voltage is present by using a DVM or equivalent measuring device.

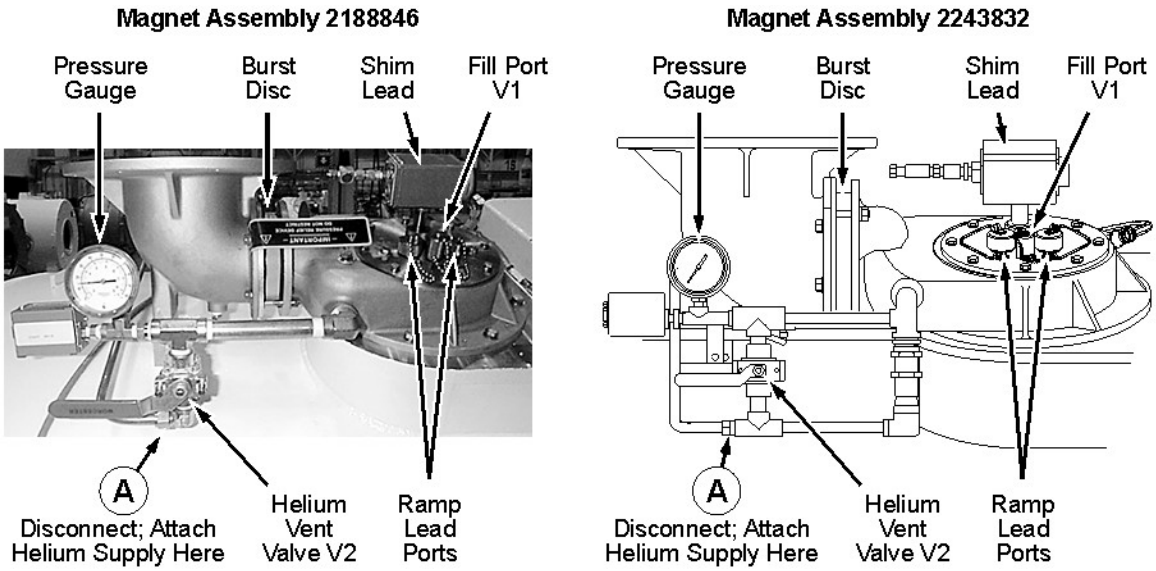
4. Disconnect the supply and return gas lines at the Coldhead (Illustration 5-24).

5. Connect the Lakeshore Cryotonics DRC-80 46-265269G1), the Lakeshore Cryotonics Model 208 Thermometer Kit (46-301477G1) or the Low-Cost Shield Temperature Diode Box (46-317543G1) to monitor silicon diode temperature in conformance with Chapter 3, Section 2, Magnet Commissioning Checks.

6. Open Vent Valve V2 momentarily to purge the vent plumbing and reduce internal pressure to < 0.2 psig. Close V2. See Illustration 5-25.

7. Disconnect the helium vent plumbing at “A” in Illustration 5-29 and connect the helium gas (99.995%) and regulator set-up at that point.

Illustration 5-29: Location for Helium Gas Connection



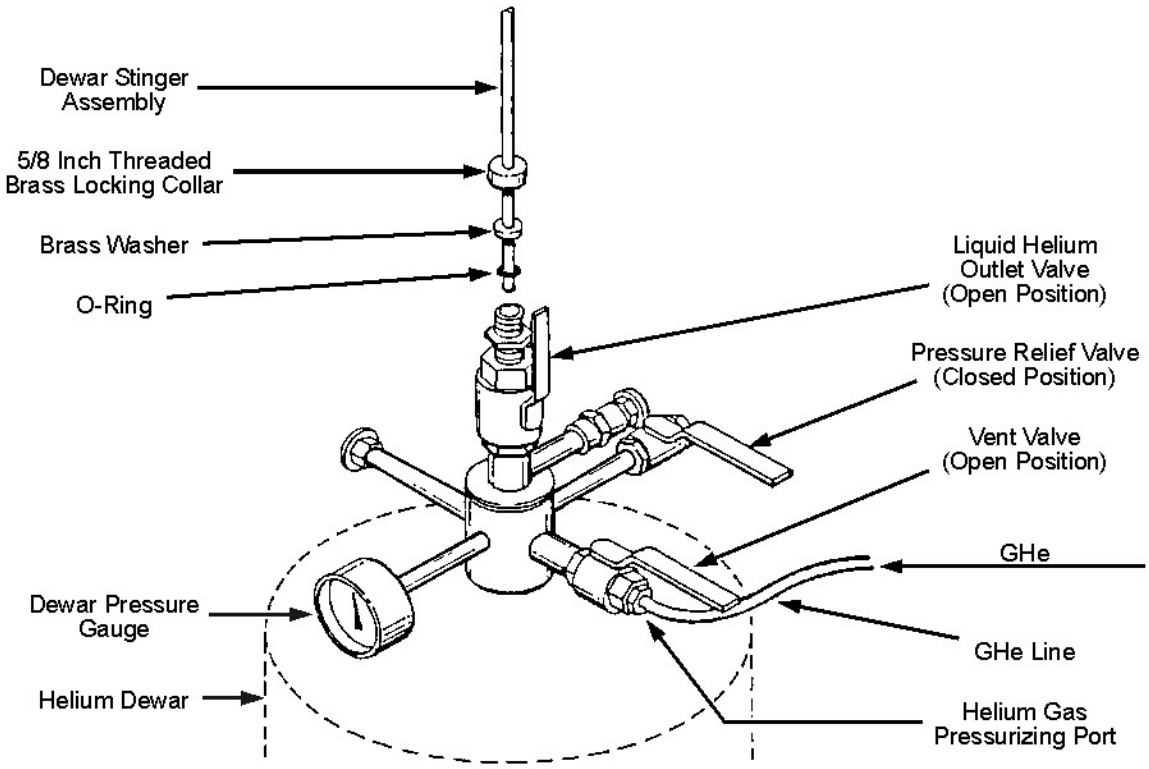
8. Loosen and remove the cap from Helium Fill Port V1 (Illustration 5-29).

9. Insert a 7 inch (178 mm) Cryostat Stinger (46-294512P3) with a 16 inch (406 mm) Cryostat Stinger Extension (46-294512P12) into the Fill Port, and then tighten the compression fitting. See Illustration 5-26.

10. Place the locking collar, washer and o-ring from a prepared helium Dewar onto the other end of the transfer line. See Illustration 5-30.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-30: Helium Transfer Line Extension Connection



11. Open Valve V2.

12. Blow helium gas regulated at 4 psig - 6 psig through the setup and into the Cryostat.

13. Set the valves on the Dewar (Illustration 5-30) to:

    - Helium Outlet Valve - Closed
    - Pressure Relief Valve - Closed
    - Helium Vent Valve - Open

14. Wait for a bluish plume to start expelling from the transfer line, then:

    a. Open the Helium Outlet Valve.

    b. Fully insert the transfer line into the Dewar.

    c. Back off the transfer line approximately 1 inch (25 mm) from the bottom of the Dewar.

    d. Engage and lock the locking collar, washer and o-ring, securing the Transfer Line onto the Dewar.

NOTE: If a warm Dewar is used, insert and lock the transfer line onto the Dewar immediately for maximum cooling and flushing impact.

15. Monitor the cryogen level, gas pressure and Vent Valve to establish when the Dewar has filled and when the Cryostat is empty of liquid helium.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

16. When the Dewar is full or the Cryostat is empty, turn off the gas flow to the Cryostat and close Valve V2.

17. Close the Positive On/Off Valve on the transfer tube.

18. Loosen the Dewar's compression fitting and withdraw the transfer line from the Dewar.

19. Set and wire the valves on the Dewar in the following positions:

    - Helium Outlet Valve - Closed
    - Pressure Relief Valve - Open
    - Helium Vent Valve - Closed

20. For continued liquid helium recovery with another prepared Dewar, repeat Step 11 through Step 19.

7.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8 Re-Evacuation of Cryostat

8.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	8 hours	Included in 'Procedure'

8.2 Overview

Re-evacuation of the Cryostat is required when the magnet temperature has exceeded 100K. During the warm-up, gas is released into the vacuum chamber. The cryopumped gas, redeposited on the magnet's internal surfaces, can result in increased heat leakage if not removed. Internal temperatures must be > 273K to ensure adequate pumping of water vapor.

8.3 Preliminary Requirements

8.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Lakeshore 208 Digital Thermometer (included in Lakeshore 208 Thermometer Kit 46-301477G2)	1	-	46-301478P1	-
3 Inch (76.2 mm) Valve Port Operator	1	-	46-252210P1	-

8.3.2 Consumables

No consumables required.

8.3.3 Replacement Parts

No replacement parts required.

8.3.4 Safety

No general safety information.

8.3.5 Required Conditions

No required conditions.

8.4 Procedure

1. Determine the temperature of the Magnet Cartridge using a Lakeshore 208 Thermometer (46-301478P1; Kit: 46-301477G2) or equivalent.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2. If re-evacuation of the Cryostat is required, contact the GE Regional Service Engineer (MAC Team).

NOTE: A Vacuum Pump Cart has been developed to re-evacuate the Cryostat. Connection, monitoring and pumping procedures are included with the cart. A 3 inch Valve Port Operator (46-252210P1) is required to connect the vacuum pumping equipment to the magnet's Pump-Out Port.

8.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

9 Ice Removal

9.1 Ice Removal Overview

Ice can form in the Shim Lead Assembly, Shim Lead Connector, Instrumentation Connector and the Vent Plumbing because of the cryopumping of air entering through a ruptured Burst Disc, open Fill, Vent or Ramp Lead Ports, or leaks at relief valves, plumbing joints and fittings.

Ice tends to form on the cold walls and platform of the Vertical Penetration and at the entry of the shield exhaust plumbing. Icing of the Recondenser can also result from the migration of ice and moisture into the colder areas of the cryostat.

Ice in the Vertical Penetration may result in a minor thermal short, causing an increase in Cryocooler temperature and magnet pressure and/or the inability to install the Ramp Leads or Fill Stinger. Ice plugs in the plumbing will restrict or prevent venting through cryostat Vent Valve V2 or the Shield Coil Vent Valve V3. An ice plug in the Recondenser will interfere with the recondensing cycle and result in a temperature drop at the Cryocooler and Recondenser and a simultaneous pressure increase in the cryostat.



NOTICE

Check the flow through Vent Valve V2. If the flow from V2 is restricted, DO NOT open any other ports. Check the vessel pressure reading on the mechanical gauge and on Magnet Monitor. Turn off the Coldhead and see if pressure builds over time. If there is no flow from V2 and no increase in vessel pressure with the Coldhead off, immediately contact your MAC Team Representative before continuing.

Maintaining a positive pressure inside the cryostat and making routine leak checks will minimize cryopumping and ice formation. See Chapter 4, Section 2, Temp., Pressure and Leak Troubleshooting.

When resistance measurements of the magnet's electrical circuits are performed in conformance with Chapter 4, Section 5, Magnet Electrical Checks, and the resistance readings are open or intermittent, it is usually due to icing in the P100 Shim Lead Connector.

Use the troubleshooting guide in Chapter 4, Section 2, Temp., Pressure and Leak Troubleshooting, to determine the location and extent of the suspected ice before starting any Ice Removal procedure.



NOTICE

Make sure all DANGERS, WARNINGS and CAUTIONS are complied with before starting any Ice Removal procedure.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

9.2 Ice Removal Procedures

9.2.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Included in 'Procedure'	up to 120 hours or 160 hours	Included in 'Procedure'

9.2.2 Overview

Make sure to read Section 9.1, Ice Removal Overview, before starting any Ice Removal procedure.

9.2.3 Preliminary Requirements

9.2.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbant protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Digital Voltmeter (DVM), Volt-Ohm Meter (VOM) or non-contact voltage tester	1	-	-	-
Tygon Tubing, 20 feet (6.1 M)	1	-	-	-
Coil Copper Tubing, 6 feet (2 M)	1	-	-	-
Flashlight	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
Helium Regulator and Hose Kit	1	-	46-306734G1	-
Flexible Helium Hose, 40 foot (12.2 M)	1 or 2	-	46-271135P1	-
Nonmagnetic Gas Cylinder Cart	1	-	46-306717G1	-
Nonmagnetic Helium Cylinder Cart	1	-	46-258150P1	-
RuO Temperature Monitor 2171219 (included RuO Temperature Monitor Kit 2183710) OR Lakeshore 208 Digital Thermometer Kit 46-301477G2	1	-	2171219 or 46-301477G2	-
Deicing Tool Kit (includes Lexan Penetration Cover Plate 46-294765G1 and Deicing Purge Tube 2347725)	1	-	2374573	-
Universal Coldhead Replacement Tool Kit	1	-	2300306-2	-
Plexiglas Cover Plate & Heater Assembly (included in Universal Coldhead Replacement Tool Kit 2300306-2)	1	-	2303715	-
Coldhead Insertion and Purge Cover Tool Kit 2232674 (for fixed sites) or LCC Mobile Site Coldhead Insertion and Purge Cover Tool Kit 2275779 (for mobile sites)	1	-	2232674 or 2275779	-
Sav-Con and Instrumentation Lead Installation/Removal Kit (includes Connector Insertion/Removal Tool 46-281934P1)	1	-	46-294872G2	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
50 Ft. (15.24 M) Auxiliary Rampdown Cable	1	-	2217315	-
Heat Gun	1	-	46-306830G3	-
Portable Leak Detector (optional)	1	-	2270571	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

9.2.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Gaseous Helium, 235 SCF Nonferrous Cylinder (with Regulator)	4	-	-	-
Leak detection fluid (e.g., Snoop, Bird Dog Quart Spray (p/n DOG-1Q), Big Blue (p/n Rt100S or Rt100G) or Leak-Tec)	1	-	-	-

9.2.3.3 Replacement Parts

No replacement parts required.

9.2.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING ICE REMOVAL.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR ICE REMOVAL IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING ICE REMOVAL.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING ICE REMOVAL.



DANGER

FATAL EXPLOSIVE HAZARD!
GAS CYLINDER RUPTURE/DAMAGE OR OPENING CYLINDER VALVE FAST WILL RELEASE 2400 PSI GAS FROM CYLINDER.
MAKE SURE GAS CYLINDERS ARE SECURE FROM FALLS AND AWAY FROM MOVING OBJECTS BEFORE USING. ALWAYS OPEN CYLINDER VALVE SLOWLY.



WARNING

POTENTIAL MAGNET QUENCH!!
A MAGNET QUENCH DURING ICE REMOVAL COULD RESULT IN RAPID EXPULSION OF LIQUID HELIUM THROUGH THE VERTICAL PENETRATION.
MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE STARTING PORTIONS OF THE ICE REMOVAL PROCEDURE.



WARNING

ASPHYXIATION HAZARD!
ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR IS GENERATED DURING ICE REMOVAL.
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE STARTING ICE REMOVAL.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



⚠ WARNING

POTENTIAL COLD BURN OR ASPHYXIATION HAZARD
INTERNAL CRYOSTAT PRESSURE BUILD-UP TO > 5.25 PSIG WILL OPEN 5.25 PSIG RELIEF VALVE.
BEFORE REMOVING EITHER RAMP OR FILL PORT CAPS OR LOOSENING ANY COMPONENT RESULTING IN THE RELEASE OF CRYOGEN PRESSURE:

1. **OBSERVE THE INTERNAL CRYOSTAT PRESSURE GAUGE READING,**
2. **SET MAGNET MONITOR PRESSURE TO 0.5 PSIG AND**
3. **VENT CRYOSTAT DOWN TO 0.2 PSIG THROUGH VENT VALVE V2.**



⚠ WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING ICE REMOVAL.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN PERFORMING ICE REMOVAL.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.



NOTICE

- **Maintain a positive pressure inside the Cryostat and keep all valves closed in strict conformance with the Ice Removal procedure to minimize cryopumping of air.**
- **Turn off the Cryocooler before depressurizing and opening the cryostat to prevent the migration of ice and moisture into the Recondenser.**
- **Do not allow the Vertical Penetration to remain open during deicing procedures to prevent air & moisture from entering and cryopumping the walls. Cover the open vertical stack immediately with the Cover Plate.**

NOTE: If the site has Magnet Monitor proprietary software, connect to Magnet Monitor and turn off the alarm for vessel pressure. Then turn the vessel pressure control to a high value of .5 psig and a low value of .4 psig.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

9.2.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting any Ice Removal procedure.	Chapter 1, Section 2	-
The removal of some magnet enclosure components may be required to complete Ice Removal. Refer to Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with Ice Removal if cover removal is required.	Section 5	-
(continued)	Appendix A, Section 1.1	-
Make sure the magnet room exhaust fan is on and operational before starting Ice Removal.	-	-
Make sure the magnet room door is propped open — or the hatch is opened if a mobile van — before starting Ice Removal.	-	-

9.2.4 Procedure

9.2.4.1 Shim Lead Connector and Vertical Penetration Deicing



NOTICE

Make sure the Vertical Penetration is clear of any obstructions before inserting/extracting any tools/apparatus to prevent possible magnet damage.



NOTICE

When removing ice in the Vertical Penetration, be careful not to contact the Instrumentation Lead Connector with ice-clearing tools. Contact could damage the lead or connector.

1. Either turn Magnet Monitor power off or disable the Magnet Monitor's Master Alarm and Vessel Pressure Control. This will prevent false alarms and long-term heater operation.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2. Make sure the Shim Lead is disengaged, then engage the Shim Lead in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement.

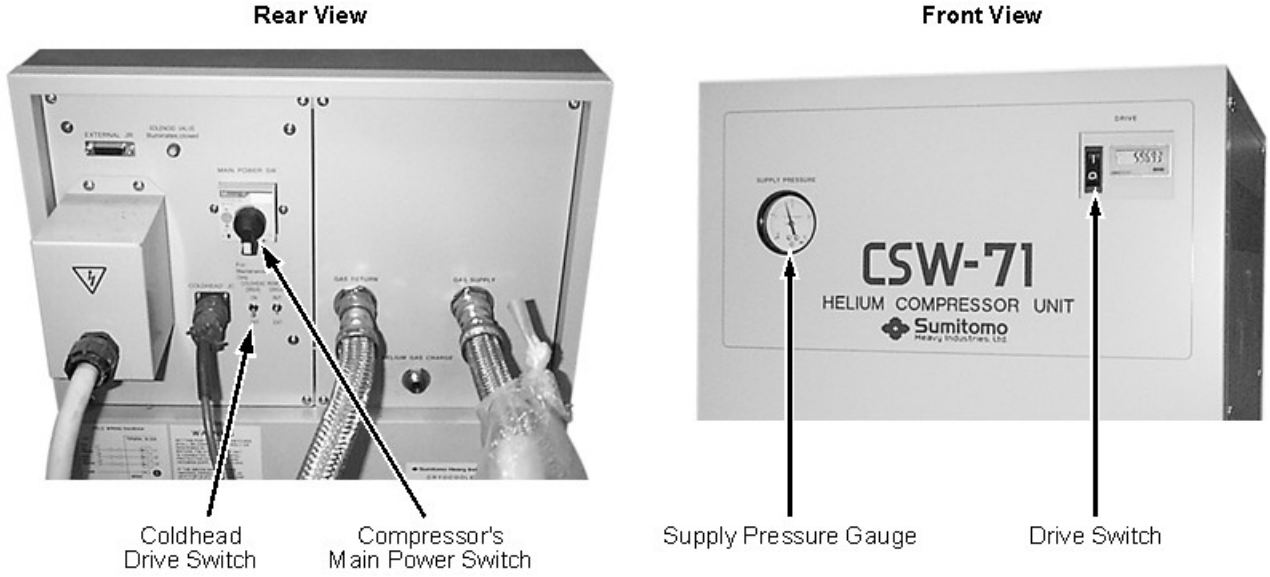
3. Perform Shim Coil resistance checks per Chapter 4, Section 5, Magnet Electrical Checks.
   - If the checks are successful, deicing is not required.
   - If the checks are not successful or the Shim Lead cannot be engaged, go to Step 4.

4. Ramp down the magnet (if at field) in conformance with Section 6, Magnet Rampdown to Zero Field, using the 50 Ft. (15.24 M) Auxiliary Rampdown Cable (2217315).

5. Turn off the Cryocooler to prevent ice migration into the Recondenser:

   a. Turn 'ON' (upwards) the Coldhead Drive Switch on the Compressor's back panel. See Illustration 5-31.

Illustration 5-31: Views of CSW-71D Compressor



   b. Place the Drive Switch on the Compressor's front panel in the 'O' (off) position. See Illustration 5-31.

   c. Run the Coldhead for 10 seconds (only) with the Compressor turned off to prevent pressure build-up in the Coldhead, then turn 'OFF' the Coldhead Drive Switch and the Compressor's Main Power Switch. See Illustration 5-31.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

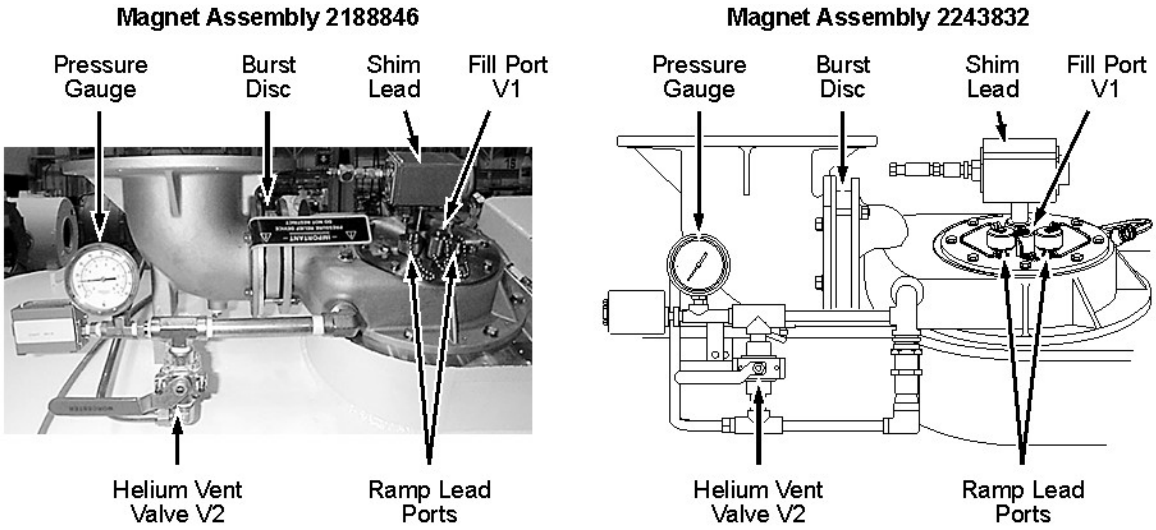
WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR.

d. Disconnect and lockout/tagout input power to the Compressor. Verify that no voltage is present by using a DVM or equivalent measuring device.

6. Vent the magnet down to 0.2 psig by opening/closing Vent Valve V2. See Illustration 5-32.

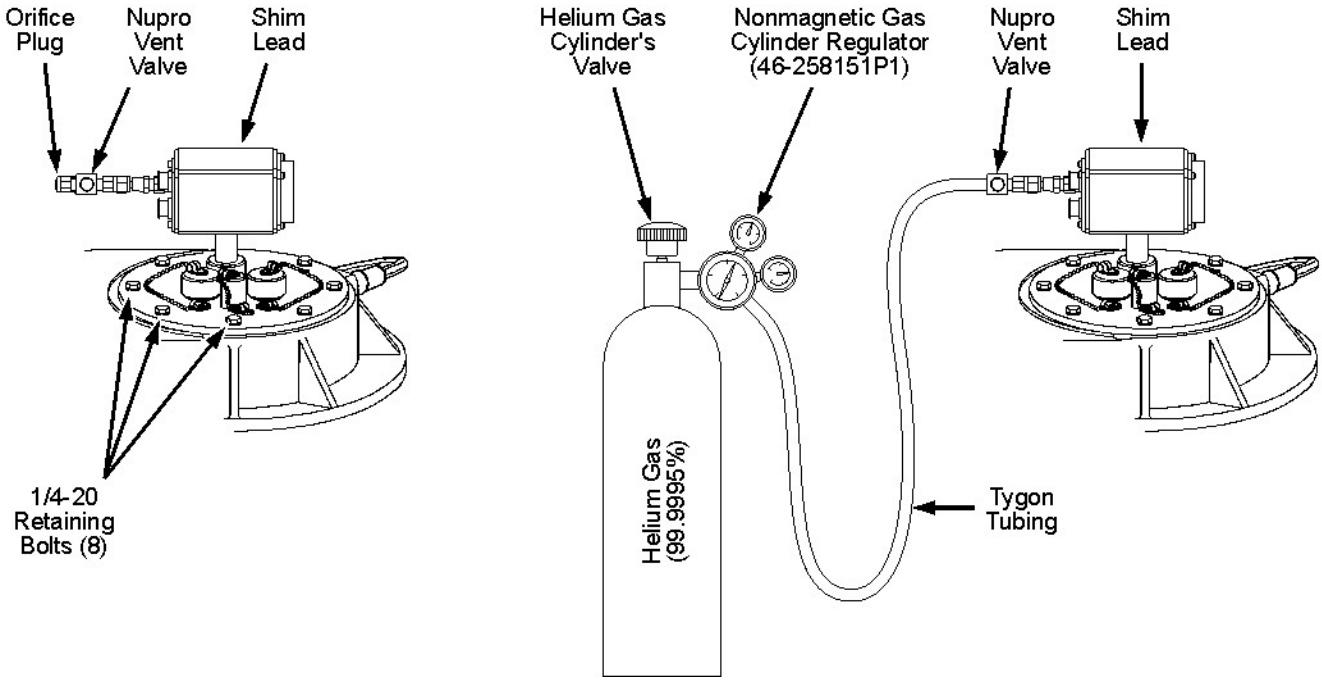
Illustration 5-32: Helium Vent Plumbing



7. Assemble the regulator and tygon tubing to a helium cylinder. Remove the orifice plug and nut at the end of the Shim Lead Nupro Vent Valve and assemble the other end of the tygon tube over the exhaust stem. See Illustration 5-33.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-33: Warming Shim Lead



8. Partially open Vent Valve V2 and immediately open the NuPro Vent Valve. Blow warm helium gas through the Shim Lead at 4 psig for 5 minutes with the Shim Lead engaged/partially engaged.

9. Attempt to engage the Shim Lead Connector. If successful:

   a. Close the Nupro Vent Valve and Vent Valve V2

   b. Perform Shim Coil resistance checks per Chapter 4, Section 5, Magnet Electrical Checks.

   c. Remove the tygon tubing and replace the orifice plug and nut.

      - If the checks are successful, deicing is not required.
      - If the checks are not successful or the Shim Lead cannot be engaged, go to Step 10.

10. Disengage the Shim Lead and lock it in the “up" position in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement.

11. Make sure magnet pressure is 0.2 psig, venting the magnet as required.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

Perform Step 12 - Step 13 rapidly to prevent cryopumping of air into the Vertical Stack. Make sure Lexan Cover Plate 46-294765G1 is on the Service Platform and the holes are plugged before removing the Shim Lead Assembly.

12. Loosen and remove the eight 1/4-20 retaining bolts (identified in Illustration 5-33) and remove the Shim Lead Assembly.

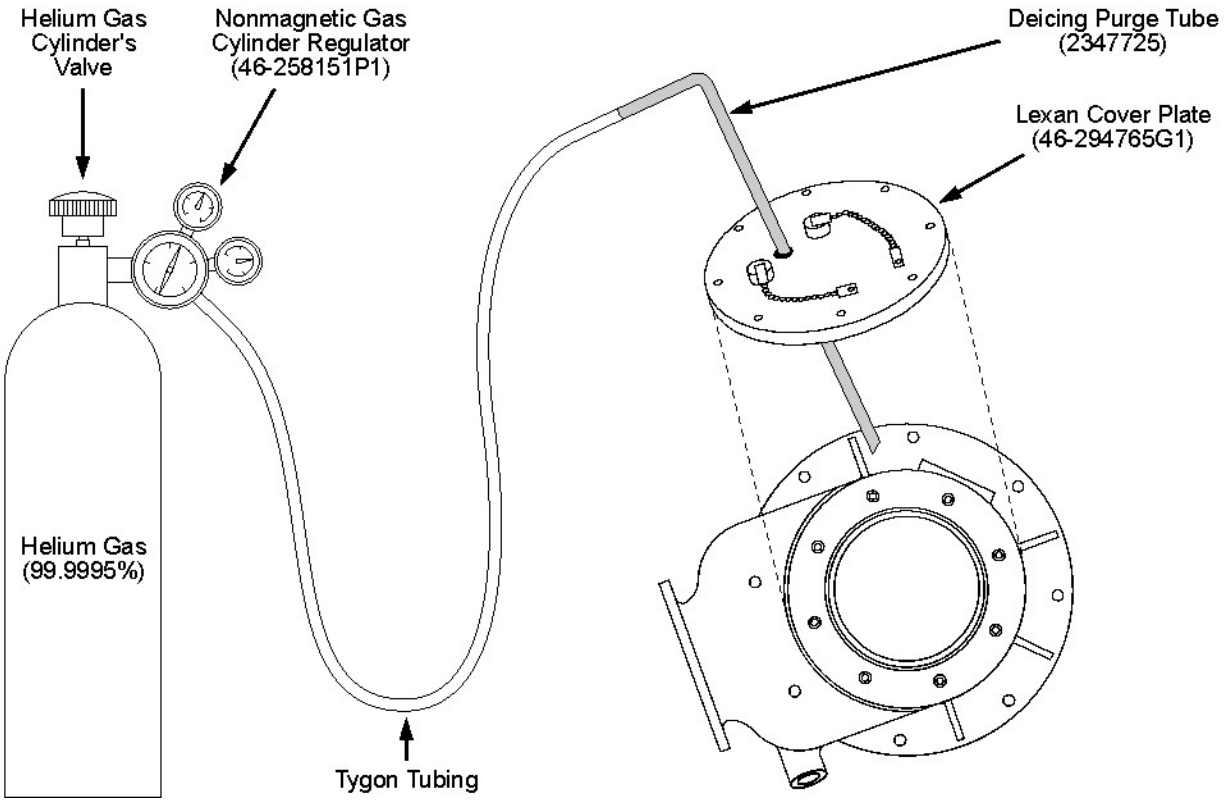
13. Immediately cover the Vertical Penetration with Lexan Penetration Cover Plate 46-294765G1. Align the scribe mark toward the Vent Adaptor.

14. Secure the Lexan Penetration Cover Plate onto the Vertical Penetration with the eight 1/4-20 retaining bolts removed in Step 12.

15. Attach Deicing Purge Tube 2347725 to the end of the tygon tubing. Purge the tube at 4 psig.

16. Remove the plugs on the Cover Plate and insert the Deicing Purge Tube through the hole closest to the Shim Lead Connector. See Illustration 5-34.

Illustration 5-34: Purge Tube Insertion



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

17. Remove ice by directing an 8 psig - 10 psig flow of warm helium gas onto the Shim Lead connector inside the Vertical Penetration and other affected areas while Vent Valve V2 is partially open.

18. Shine the flashlight through the Lexan Penetration Cover Plate; verify that all ice is removed inside.

19. Remove any remaining ice on the inside of the Vertical Penetration. Some bending of the Deicing Purge Tube may be required.

20. Shine the flashlight through the Lexan Penetration Cover Plate. When all ice is removed, close V2 and remove the Lexan Cover Plate.

21. Temporarily disconnect the Instrumentation Lead Connector using the Connector Insertion/Removal Tool (46-281934P1).

22. Direct a 8 psig - 10 psig flow of warm helium gas at the connector until all ice is removed, then reconnect the Instrumentation Lead Connector.

23. Replace the Shim Lead Assembly in conformance with Section 12, Shim Lead and Baffle Replacement.

24. Perform Shim Coil resistance checks per Chapter 4, Section 5, Magnet Electrical Checks. If the checks are not successful, replace the Shim Lead Sav-Con connector in conformance with Section 13, Sav-Con Connector Replacement.



NOTICE

Perform all MRU checks in Chapter 4, Section 6, Magnet Rundown Unit (MRU) Checks, upon completion of Vertical Penetration ice removal to make sure no Instrumentation Lead Connector damage has occurred. Correct any damage found by reconnecting the Instrumentation Lead Connector or replacing the Instrumentation Lead Assembly.

25. Check the Instrumentation Lead Connector by performing the MRU checks in Chapter 4, Section 6, Magnet Rundown Unit (MRU) Checks.

26. After completing Step 25, remove lockout/tagout and connect input power to the Compressor, then turn on the Cryocooler.

27. Leak check the magnet in conformance with Leak check the magnet in conformance with Chapter 4, Section 2, Temp., Pressure and Leak Troubleshooting. Repair any leaks found. Repair any leaks found.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

28. Return the Magnet Monitor to normal operation by re-enabling the Magnet Monitor's Master Alarm and Vessel Pressure Control or by turning Magnet Monitor power on.

9.2.4.2 Recondenser Deicing

Section 9.2.4.2, Recondenser Deicing, contains four procedures — Section 9.2.4.2.2, Level One Deicing; Section 9.2.4.2.3, Level Two Deicing; Section 9.2.4.2.4, Level Three Deicing; and Section 9.2.4.2.5, Level Four Deicing — for clearing ice from the Recondenser. Each procedure involves greater cost and more down time than the one before. The first two procedures do not require a magnet ramp down, while the third and fourth do. The fourth procedure also requires a magnet warm-up and a dry nitrogen purge. **Always evaluate the magnet, start with the first procedure and progress through no more procedures than required to clear the ice.**

9.2.4.2.1 Initial Magnet Evaluation



NOTICE

Check the flow through Vent Valve V2. If the flow from V2 is restricted, slightly open the Fill Port. If there is no flow from V2 or the Fill Port, immediately contact your MAC Team Representative before continuing.

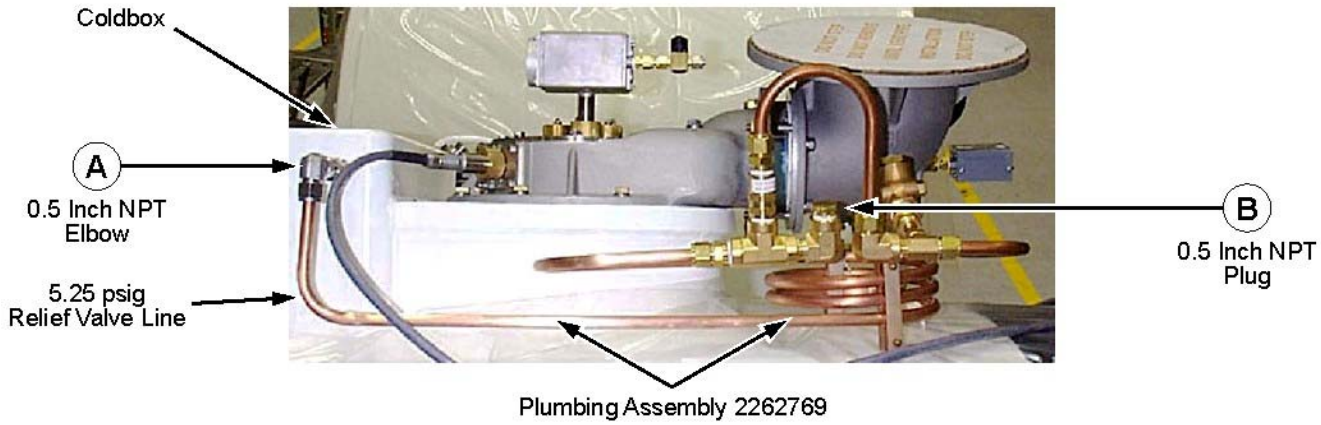
1. Evaluate the magnet's condition before taking **any** action involving changes to the magnet operating condition. Confirm that the magnet is not operating in "C0BO" (Controlled Zero Boil-Off) condition — where the heater maintains the magnet pressure at 4 psig ± 0.1 psig — before continuing.

2. Verify that the Magnet Monitor functions properly for “C0BO" operation. Correct any problems found and recheck for “C0BO" operation as per Step 1.

3. Verify flow through the shield vent line either by frost on the 5.25 psig relief valve line at point “A" in Illustration 5-35 or by momentarily cracking the 1/2 inch NPT plug at point “B" in Illustration 5-35.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-35: 5 psig Relief Valve Plumbing



4. Determine if the second stage Coldhead temperature is ≤ 4.0K.

5. If the shield vent line is blocked, remove and inspect the 5.25 psig relief valve, remove any blockage and reinstall the valve.

6. If the shield vent line is still blocked and/or the coldhead temperature is ≤ 4.0K, continue with Section 9.2.4.2.2, Level One Deicing.

9.2.4.2.2 Level One Deicing

NOTICE

Make sure the Coldhead is off during Level One Deicing to prevent any re-icing of purged contaminants in the Recondenser.

NOTE: The Level One Deicing procedure simply shuts down the Coldhead, denies cooling flow to the Recondenser and expands shield-trapped gas back through the Recondenser. No special tools are required.

1. Verify that the helium level is < 90% with ≥ 4.0 psig or < 85% at 1 psig - 2 psig.

NOTE: LHe levels greater than those specified in Step 1 could result in an overfill condition and block the Recondenser cycle.

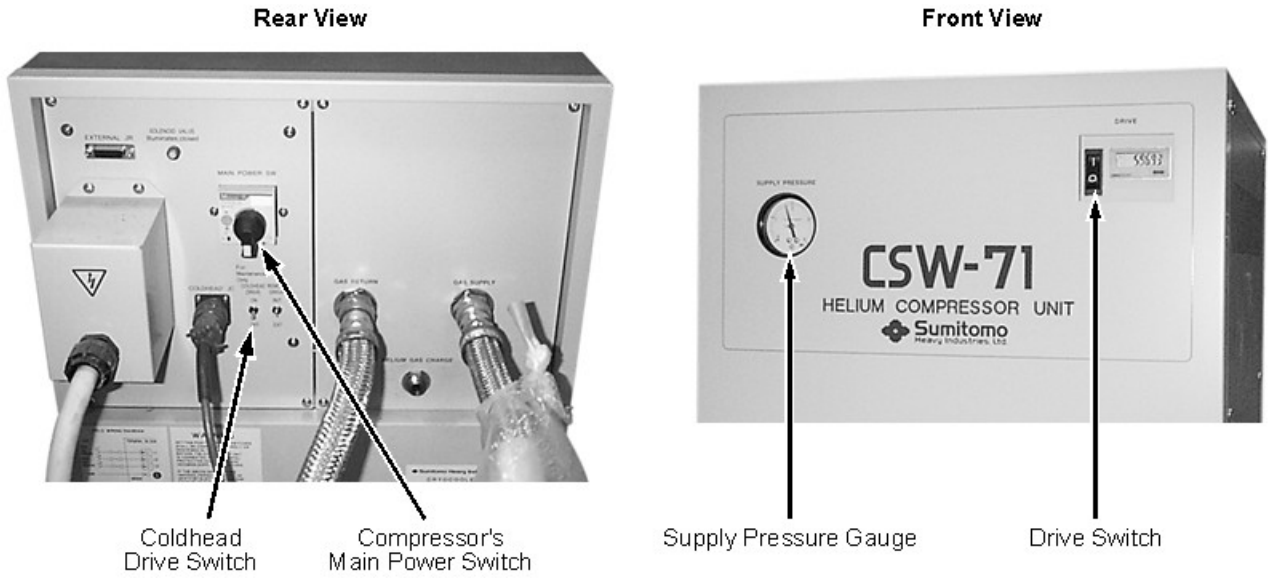
2. If the pressure is ≥ 4.0 psig, partially open Vent Valve V2 (shown in Illustration 5-32) and vent down to 4 psig so that the 5.25 psig relief valve closes. No venting should occur through the 5.25 psig relief valve line during Level One Deicing.

3. Shut down the compressor as follows to prevent pressure build-up in the Coldhead:

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

a. Turn 'ON' (upwards) the Coldhead Drive Switch on the Compressor's back panel. See Illustration 5-36.

Illustration 5-36: Views of CSW-71D Compressor



b. Place the Drive Switch on the Compressor's front panel in the 'O' (off) position. See Illustration 5-36.

c. Run the Coldhead for 10 seconds (only) with the Compressor turned off to prevent pressure build-up in the Coldhead, then turn 'OFF' the Coldhead Drive Switch and the Compressor's Main Power Switch. See Illustration 5-36.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR.

d. Disconnect and lockout/tagout input power to the Compressor. Verify that no voltage is present by using a DVM or equivalent measuring device.

4. Monitor the Coldhead temperature. When it stabilizes at an elevated temperature (> 80K), check for helium gas flow through the 5.25 psig relief valve, indicating the blockage has cleared.

NOTE: Frost on the cooling line and a hissing sound at the 5.25 psig relief valve mean helium gas is flowing.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5. After 4 hours, remove lockout/tagout, reconnect input power to the Compressor, turn the Coldhead on again and reset the Magnet Monitor for “C0BO" operation (4.0 psig ± 0.1 psig).

6. Monitor the Recondenser - Coldhead temperature difference (ΔT) as well as Coldhead performance to verify ΔT is < 0.2K and that the second stage Coldhead temperature is ≤ 4.3K.

   - If the Recondenser resumes normal operation, but the Coldhead does not, allow the Coldhead several days to clean up internal contaminants before proceeding with further corrective action.
   - If the Recondenser does not return to normal operation, continue with Section 9.2.4.2.3, Level Two Deicing.
   - If the Coldhead operation does not return to the operating specifications found in Chapter 4, Section 1, Magnet Functional Checks, within a few days, then replace the Coldhead.

9.2.4.2.3 Level Two Deicing

NOTICE

Make sure the Coldhead is off during Level Two Deicing to prevent any re-icing of purged contaminants in the Recondenser.

NOTE: The Level Two Deicing procedure uses the same ice removal strategy as Section 9.2.4.2.2, Level One Deicing, but also removes the Coldhead to improve warming. Try Level One Deicing before progressing to Level Two.

1. Make sure all “Tools and Test Equipment,” “Consumables” and “Replacement Parts” required for a complete Coldhead changeout in conformance with Section 10, Two-Stage Cryocooler Coldhead Replacement, are in the site area before proceeding.

2. Verify that the helium level is < 90% with ≥ 4.0 psig or < 85% at 1 psig - 2 psig.

3. Either turn Magnet Monitor power off or disable the Magnet Monitor's Master Alarm and Vessel Pressure Control. This will prevent false alarms and long-term heater operation.

4. If the pressure is ≥ 4.0 psig, vent the magnet down through Vent Valve V2 (shown in Illustration 5-32) to 4 psig. Monitor pressure throughout the Level Two Deicing procedure and vent through V2 as required to keep cryostat pressure at 4 psig.

NOTE: No venting should occur through the 5.25 psig relief valve line during this level Two Deicing procedure.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

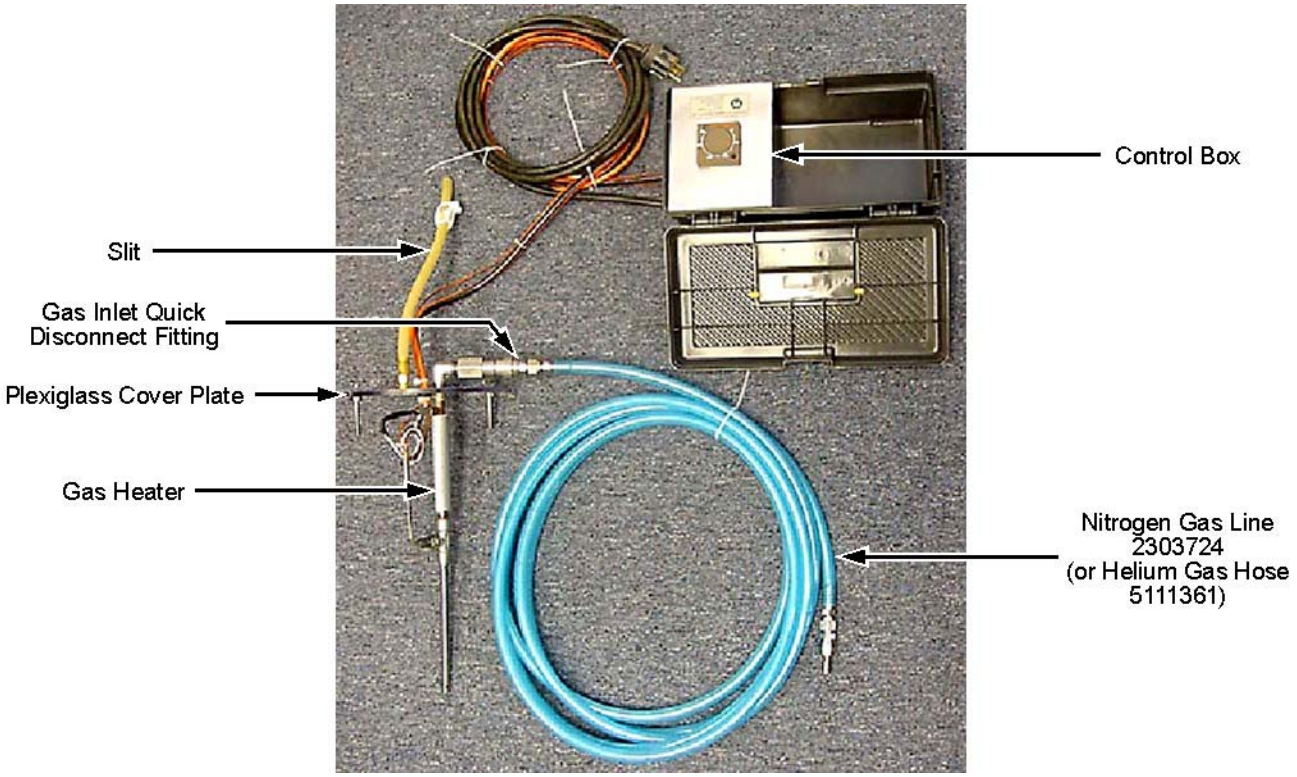
5. Prepare for Coldhead removal in conformance with the Removal Preparation subsection of Section 10, Two-Stage Cryocooler Coldhead Replacement. While doing so, listen as the Coldhead relief valve opens and makes hissing sounds as the Coldhead warms. Popping sounds indicate trapped contaminants.

6. Remove the Coldhead in conformance with the appropriate (fixed/mobile) Coldhead Extraction subsection of Section 10, Two-Stage Cryocooler Coldhead Replacement.

NOTE: Open Vent Valve V2 as required during Step 7 - Step 9 to maintain cryostat pressure at 4 psig.

7. Install the Plexiglass Cover Plate & Heater Assembly (2303715) in conformance with the Sleeve Warm-Up subsection of Section 10, Two-Stage Cryocooler Coldhead Replacement. See Illustration 5-37.

Illustration 5-37: Plexiglas Cover Plate & Heater Assembly 2303715



⚠ WARNING

POTENTIAL MAGNET QUENCH!
HEATING THE COLDHEAD SLEEVE TO > 275K MAY DAMAGE INSTRUMENTATION WIRING INSIDE THE MAGNET OR LEAD TO A MAGNET QUENCH.
DO NOT HEAT THE COLDHEAD SLEEVE TO > 275K.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8. Heat the Coldhead Sleeve to 275K as indicated on the SI-410 Diode read by the Magnet Monitor or Lakeshore 208 Digital Thermometer.

9. Keep the Coldhead Sleeve at 275K and check for helium gas flow through the 5.25 psig relief valve, indicating the blockage has cleared.

NOTE: Frost on the cooling line and a hissing sound at the 5.25 psig relief valve mean helium gas is flowing.

10. After heating for 4 hours, reinstall the Coldhead in conformance with the Coldhead Replacement and the Coldhead Interface Adjustment subsections of Section 10, Two-Stage Cryocooler Coldhead Replacement.

11. Return the magnet to “C0BO" operation and observe cryostat performance.

NOTE: The pressure may stay high for up to two days because the shields have warmed. The Recondenser should recover in one day. “C0BO" operation will resume when the shield temperature is < 45K.

12. Monitor the Recondenser - Coldhead second stage temperature difference (ΔT) as well as Coldhead performance to verify ΔT is < 0.2K and that the second stage Coldhead temperature is ≤ 4.3K.

    - If the Recondenser does not return to normal operation, continue with Section 9.2.4.2.4, Level Three Deicing.
    - If the Coldhead operation does not return to the operating specifications found in Chapter 4, Section 1, Magnet Functional Checks, within a few days, then replace the Coldhead.

9.2.4.2.4 Level Three Deicing



WARNING

POTENTIAL MAGNET QUENCH!
A MAGNET QUENCH DURING LEVEL THREE DEICING COULD RESULT IN RAPID EXPULSION OF LIQUID HELIUM THROUGH THE VERTICAL PENETRATION.
MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE STARTING LEVEL THREE DEICING.



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING LEVEL THREE DEICING.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN PERFORMING LEVEL THREE DEICING.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



NOTICE

- **Make sure the Coldhead is off during Level Three Deicing to prevent any re-icing of purged contaminants in the Recondenser.**
- **Make sure ALL Dangers, Warnings, Cautions and Notices are complied with before and during Level Three Deicing.**
- **Make sure all "Tools and Test Equipment," "Consumables" and "Replacement Parts" required for a complete Coldhead changeout in conformance with Section 10, Two-Stage Cryocooler Coldhead Replacement, are in the site area before proceeding.**

NOTE: The Level Three Deicing procedure uses the same ice removal strategy as Section 9.2.4.2.3, Level Two Deicing, but also forces warmed helium purge gas through the 40K shield cooling shield. Try Level Two Deicing before progressing to Level Three.

Section 9.2.4.2.3, Level Two Deicing, is performed while performing Section 9.2.4.2.4, Level Three Deicing.

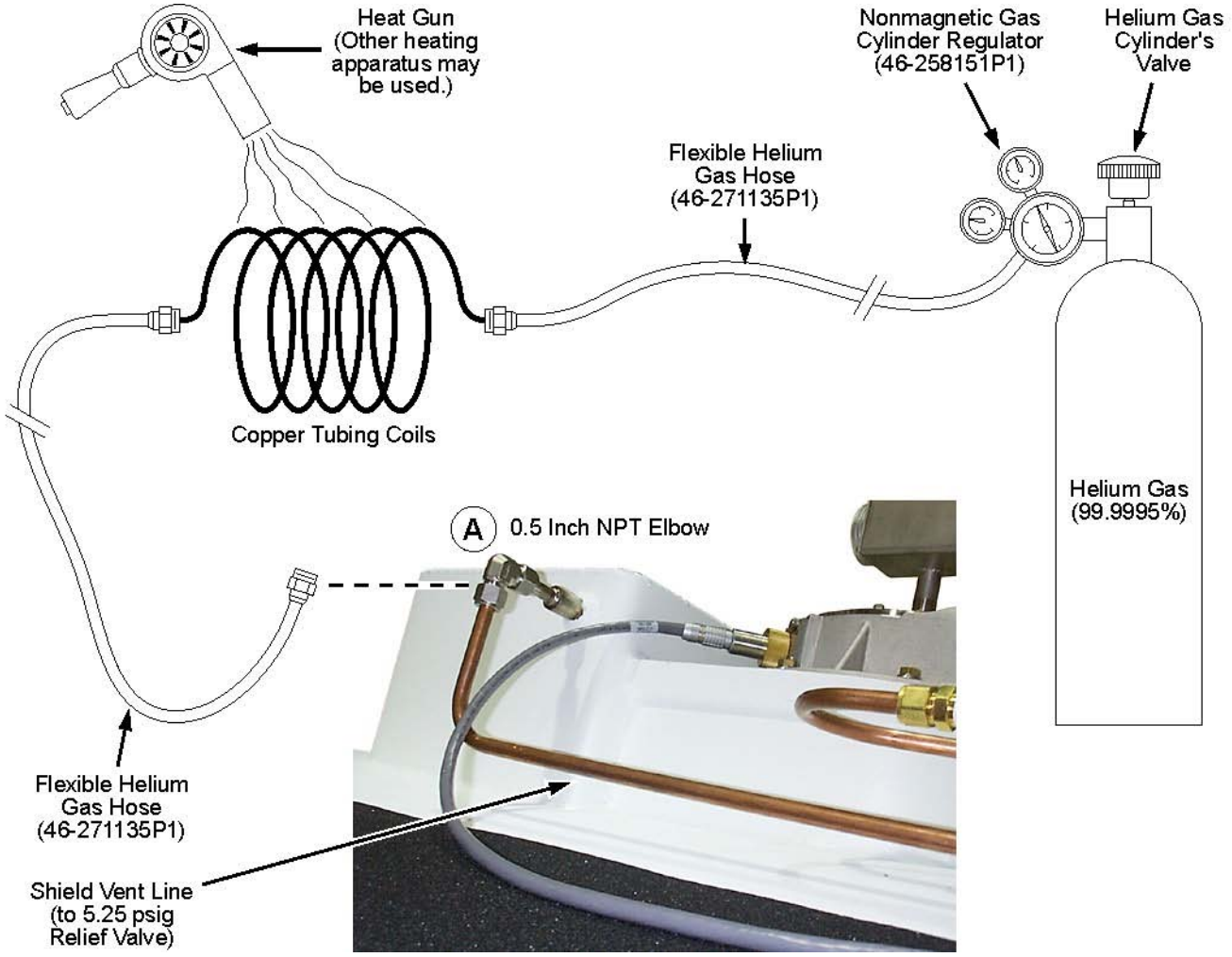
1. Perform Section 9.2.4.2.3, Step 2 - Section 9.2.4.2.3, Step 8.

2. Ramp the magnet down to zero field in conformance with Section 6, Magnet Rampdown to Zero Field.

3. Connect a helium gas cylinder (235 SCF, 99.9995% pure) with regulator to a flexible gas hose. Connect the gas hose to the copper coil heating apparatus using a 1/2 inch NPT fitting connected on the hose's exhaust end. Connect another flexible gas hose with 1/2 inch NPT fittings at each end to the heating apparatus. See Illustration 5-38.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-38: Recondenser Purge Set-Up



DANGER

FATAL EXPLOSIVE HAZARD!
GAS CYLINDER RUPTURE/DAMAGE OR OPENING CYLINDER VALVE FAST WILL RELEASE 2400 PSI GAS FROM CYLINDER.
MAKE SURE GAS CYLINDERS ARE SECURE FROM FALLS AND AWAY FROM MOVING OBJECTS BEFORE USING. ALWAYS OPEN CYLINDER VALVE SLOWLY.

4. Make sure the regulator handle is backed out (CCW) to avoid regulator damage, then open the gas cylinder slowly. The high pressure gauge should indicate 2,100 psig - 2,400 psig (150 kg/cm^2 - 170 kg/cm^2) if the cylinder is full.

NOTE: Four full helium gas cylinders are required for Level Three Deicing.

5. Open the cylinder valve and set a low pressure gas flow at 1 psig. Purge the apparatus for one minute.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6. Disconnect the shield vent line at the Coldbox elbow at point “A" in Illustration 5-35 and screw the gas hose's 1/2 inch MNPT fitting into the elbow.

7. Open Vent Valve V2, then increase purge gas pressure to 0.5 psig. Listen for gas flow in the V2 lines to make sure gas continues flowing during the purge process.

8. Monitor cryostat pressure during the purge to make sure it is ≤ 0.3 psig. Use V2 to regulate pressure.

NOTICE

Do not allow the gas temperature to exceed 315K (180^{O}F, 85^{O}C) in Step 9.

9. Heat the helium purge gas with the heating apparatus set up in Step 3 and shown in Illustration 5-38.

10. After a trickle flow of purge gas for 5 minutes, slowly increase the purge gas regulator pressure to 4 psig.

NOTE: If gas flow is not present, the Recondenser may have an ice plug. Temporarily increase gas pressure to 10 psig to blow out any ice plug, then return to the 4 psig setting. If an ice plug is still present, allow the level two deicing procedure (Section 9.2.4.2.3) to warm the Recondenser at 275K for one hour and then temporarily raise the gas pressure to 10 psig again.

11. Monitor Recondenser RuO temperature using the RuO Temperature Monitor or the Lakeshore 208 Digital Thermometer. Make sure the Recondenser temperature increases to at least 120K during the purge cycle. This increase is due to warm helium purge gas and Coldhead warming.

12. When the purge is complete, close valve V2, remove the gas line from the Coldbox elbow and immediately reconnect the 1/2 inch shield vent line.

13. Remove the level two deicing apparatus.

14. Reinstall the Coldhead in conformance with the Coldhead Replacement and the Coldhead Interface Adjustment subsections of Section 10, Two-Stage Cryocooler Coldhead Replacement.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

15. Monitor the Recondenser - Coldhead second stage temperature difference (ΔT) as well as Coldhead performance to verify ΔT is < 0.2K and that the second stage Coldhead temperature is ≤ 4.3K.

    - If the Coldhead operation does not return to the operating specifications found in Magnet Functional Checks, within a few days, then replace the Coldhead.
    - If the Recondenser does not return to normal operation, continue with Section 9.2.4.2.5, Level Four Deicing.

9.2.4.2.5 Level Four Deicing



NOTICE

Make sure the Coldhead is off during Level Four Deicing to prevent any re-icing of purged contaminants in the Recondenser.

NOTE: The fourth and most extreme Recondenser deicing procedure is a complete magnet warm up and dry purge in conformance with Section 7, Cryostat Warm-Up. Try Level Three Deicing before progressing to Level Four.

1. If Section 9.2.4.2.4, Level Three Deicing, has failed to deice the magnet, rampdown the magnet in conformance with Section 6, Magnet Rampdown to Zero Field.

2. Warm and dry purge the magnet in conformance with Section 7, Cryostat Warm-Up.

9.2.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

10 Two-Stage Cryocooler Coldhead Replacement

10.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	4 hours	Included in 'Procedure'

10.2 Overview

Maintenance of cryocooler temperatures within specification is essential for proper operation of a zero boil-off magnet. Coldhead replacement is required when elevated thermal station (first or second stage) temperature problems have been isolated to the Coldhead or the complete cryocooler system or from catastrophic failure of the Coldhead. (See Chapter 4, Section 2, Temp., Pressure and Leak Troubleshooting, for fault isolation of Coldhead problems.)

- It is important to change out Coldheads as soon as defects are uncovered.
- Complete Coldhead replacement will take two trained and qualified people approximately four hours.
- Make sure a new Coldhead and all required tools and equipment are on-site before starting the procedure.
- Perform the change-out rapidly to minimize temperature rise in the magnet.

10.3 Preliminary Requirements

10.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Insulated leather gloves (for opening/closing the Motor Shield and handling the removed Coldhead); one set per person	1	-	-	-
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Digital Voltmeter (DVM), Volt-Ohm Meter (VOM) or non-contact voltage tester	1	-	-	-
Flashlight	1	-	-	-
Tweezers (long)	1	-	-	-
Heat Gun	1	-	-	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Shop Vacuum with >20 feet (>6 meters) nonmagnetic ~1 in. (~25 mm) dia. extension hose	1	-	-	-
Cardboard box (or proven nonmagnetic equivalent) for transporting the 50 pounds (22.7 kg) Coldhead and Carriage Bracket to/from the magnet at fixed sites	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
FIXED SITES: Coldhead Insertion and Purge Cover Tool Kit 2380981 (includes: Fixed Site Coldhead Insertion Fixture 2379886, Lexan Purge Cover Plate Assembly 2232560) — Note: Older Coldhead insertion fixtures will not work with High Efficiency Two-Stage Cryocooler Coldhead Assembly 2218465-3.	1	**Fixed Sites**	2380981	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
MOBILE SITES: LCC Mobile Coldhead Insertion/Removal Tool Kit 2380985 (includes: LCC Mobile Site Coldhead Insertion Fixture 2379888, Mobile Site Coldhead Lifting Tool 2258802, Purge Cover Plate Assembly 2275776) — Note: Older Coldhead insertion fixtures will not work with High Efficiency Two-Stage Cryocooler Coldhead Assembly 2218465-3.	1	**Mobile Sites**	2380985	-
Coldhead Gas/Vacuum Service Adapter (included in Universal Coldhead Replacement Tool Kit 2300306-2)	1	-	2287707	-
Coldhead Sleeve Pump-Out Line (included in Universal Coldhead Replacement Tool Kit 2300306-2)	1	-	2267197	-
Digital Vacuum Meter (included in Universal Coldhead Replacement Tool Kit 2300306-2)	1	-	2287716	-
Seal-Off Valve Operator (included in Universal Coldhead Replacement Tool Kit 2300306-2)	1	-	46-260267P3	-
Plexiglas Cover Plate & Heater Assembly (included in Universal Coldhead Replacement Tool Kit 2300306-2)	1	-	2303715	-
Lexan Cover Plate (included in Universal Coldhead Replacement Tool Kit 2300306-2)	1	-	2303728	-
KF16 (QF16) Flexline Coupling, 15 Inch (380mm) (included in Universal Coldhead Replacement Tool Kit 2300306-2)	1	-	2321289	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
KF16 (QF16) Centering Ring (included in Universal Coldhead Replacement Tool Kit 2300306-2)	2	-	46-294030G1	-
KF16 (QF16) Clamp (included in Universal Coldhead Replacement Tool Kit 2300306-2)	2	-	46-294026P1	-
Nitrogen Gas Line, 20 Foot (6.1 Meter) (included in Universal Coldhead Replacement Tool Kit 2300306-2)	1	-	2303724	-
Backfill Air Hose, 25 Foot (7.6 Meter) (included in Universal Coldhead Replacement Tool Kit 2300306-2) — Note: Use only when helium gas is used.	1	-	5111335	-
Helium Vent Hose, 5 Foot (1.5 Meter) (included in Universal Coldhead Replacement Tool Kit 2300306-2) — Note: Use only when helium gas is used.	1	-	5111361	-
Indium Removal Tool (included in Universal Coldhead Replacement Tool Kit 2300306-2)	1	-	2365037	-
Vacuum Pump, 10 millitorr (10 microns; .0004 millibar)	1	-	2305056	-
Coldhead Stand (Holding Tool)	1	-	2214919	-
Portable RuO Temperature Monitor (included in RuO Temperature Monitor Kit 2183710)	1	-	2171219	-
Lakeshore 208 Digital Thermometer Kit; (optional)	1	-	46-301477G2	-
Gas Regulator and Hose Kit	1	-	46-306734G1	-
Nonmagnetic Gas Cylinder Cart	1	-	46-306717G1	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Nonmagnetic Coldhead Wrenches Kit	1	-	46-294804G1	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

10.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Transition Flange O-Ring (included in Coldhead Replacement Gasket Kit 2171620)	1	-	46-281247P1	-
Coldhead Flange O-Ring (included in Coldhead Replacement Gasket Kit 2171620)	1	-	2191112-6	-
Indium Gasket (included in Coldhead Replacement Gasket Kit 2171620)	1	-	46-281241P1	-
Indium Gasket Kit (included in Coldhead Replacement Gasket Kit 2171620)	1	-	2171621	-
Disposable In-Line Dessicant Filter (included in Coldhead Replacement Gasket Kit 2171620) — Note: Use only when helium gas is used.	1	-	2391747	-
Charcoal Packet Kit, pack of 3 Getter Bags (1 per Coldhead change) (included in Coldhead Replacement Gasket Kit 2171620)	1	-	2290272	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Pump-Out Port Dual O-Ring Plug (included in Universal Coldhead Replacement Tool Kit 2300306-2)	1	-	2236606	-
Full, nonmagnetic cylinder(s) of nitrogen gas (if available)	1	-	-	-
Aluminum Tape, .5 Inch (12.6 mm) wide (46-260802P1), roll	1	-	-	-
Aluminum Tape, .125 Inch (3 mm) wide (46-260802P6), roll	1	-	-	-
Permacel Tape, .006 x .5 Inch (.15 x 12.6 mm), roll	1	-	-	-
Vacuum Grease (included in Universal Coldhead Replacement Tool Kit 2300306-2)	1	-	46-252065P24	-
Scotch Brite™ Pads, pack	1	-	-	-

10.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
High Efficiency Sumitomo Two-Stage Cryocooler Coldhead Assembly — Note: New/reconditioned high efficiency Coldhead must have been inspected and be free of defects before bringing to the site.	1	-	2218465-3	-

10.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THIS COLDHEAD REPLACEMENT PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR COLDHEAD REPLACEMENT IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING THIS COLDHEAD REPLACEMENT PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THIS COLDHEAD REPLACEMENT PROCEDURE.



WARNING

POTENTIAL INJURY HAZARD!
DO NOT PERFORM COLDHEAD REPLACEMENT WITHOUT THE ASSISTANCE OF A QUALIFIED/CERTIFIED “WORK ASSISTANT.”



WARNING

POTENTIAL INJURY HAZARD
INJURIES CAN RESULT FROM FAILURE TO USE THE COLDHEAD INSERTION/EXTRACTION TOOL AND/OR FROM NOT HAVING THAT TOOL SECURELY INSTALLED BEFORE REMOVING THE COLDHEAD.
ONLY REPLACE COLDHEADS USING THE COLDHEAD INSERTION/EXTRACTION TOOL.



WARNING

POTENTIAL PROJECTILE HAZARD
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.

- **REMOVE ALL LOOSE FERROMAGNETIC MATERIAL FROM THE MAGNET ROOM.**
- **MAKE SURE ALL EQUIPMENT, TOOLS, CARTS AND GAS CYLINDERS USED IN THE MAGNET ROOM ARE NON-FERROMAGNETIC.**
- **DO NOT ALLOW ANYONE CARRYING OR WEARING FERROMAGNETIC MATERIALS — INCLUDING CARDIAC PACEMAKERS, NEUROSTIMULATORS OR STEEL PLATES — INSIDE THE 5 GAUSS ZONE.**

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

HIGH MAGNETIC FIELD
BE PREPARED FOR EMERGENCIES.
MAKE SURE THE MAGNET RUNDOWN UNIT (MRU) IS INSTALLED AND OPERATIONAL TO ENABLE THE MAGNETIC FIELD TO BE QUICKLY DISCHARGED IN CASE OF AN EMERGENCY. SEE CHAPTER 3, SECTION 1.6.



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING COLDHEAD REPLACEMENT.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN PERFORMING THIS COLDHEAD REPLACEMENT PROCEDURE.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
DISCONNECT THE POWER CABLE AND FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR WHILE PERFORMING THIS COLDHEAD REPLACEMENT PROCEDURE. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.



NOTICE

Monitor cryostat pressure throughout the Coldhead replacement procedure. If magnet pressure is above 4 psig, vent the magnet down to 4 psig through Vent Valve V2 (Illustration 5-39). Pressure may require venting multiple times to prevent cold helium gas from cooling the shield and first stage heat station in the Coldhead Sleeve during Coldhead replacement. Cold helium exhaust flows through the shield exhaust plumbing, cooling the shield and first stage heat station.

10.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting this Coldhead Replacement procedure.	Chapter 1, Section 2	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Condition	Reference	Effectivity
The removal of some magnet enclosure components may be required to complete this Coldhead Replacement procedure. Refer to Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with Coldhead Replacement if cover removal is required.	Section 5	-
(continued)	Appendix A, Section 1.1	-

10.4 Procedure

10.4.1 Coldhead Removal

10.4.1.1 Removal Preparation

1. Either turn Magnet Monitor power off or disable the Magnet Monitor's Master Alarm and Vessel Pressure Control. This will prevent false alarms and long-term heater operation.

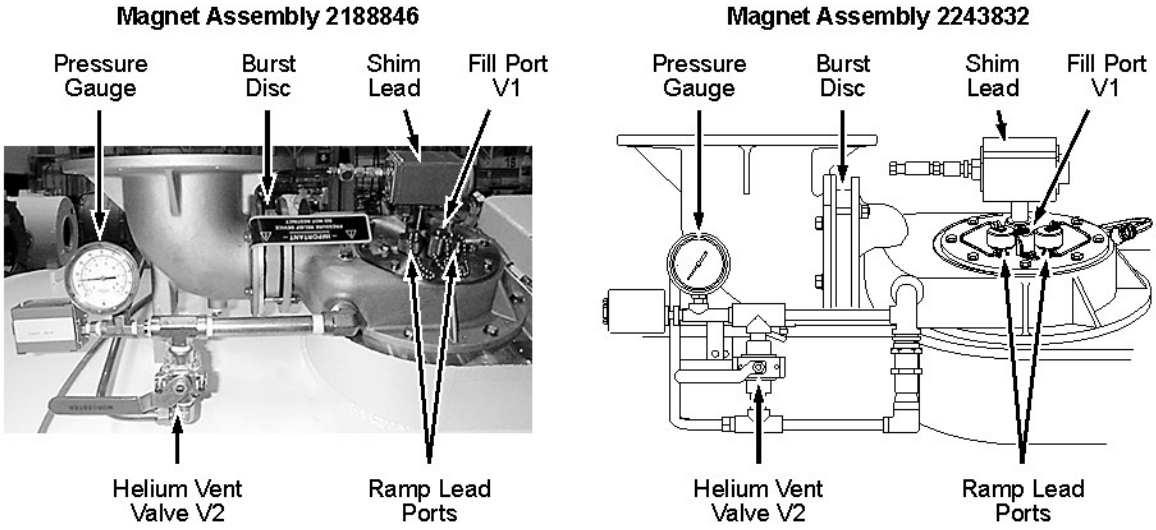
2. Set-up the HDx Service Platform (5155291) in conformance with Chapter 3, Section 1.8.1, HDx Service Platform 5155291 Set-Up. Position the platform approximately centered between the magnet's patient and service end flanges.

NOTE: If service space to the left of the magnet is ≥ 30 inches (762 mm), then the Universal Service Ladder/Platform (2319156) or the Service Ladder/Platform (2230707/2230707-2) can be used when set-up in conformance with Chapter 3, Section 1.8.2, Ladder-Platform 2319156 Set-Up, or Chapter 3, Section 1.8.3, Ladder-Platform 2230707 & 2230707-2 Set-Up, respectively.

3. If magnet pressure is > 4 psig, vent the magnet down through Vent Valve V2 to 4 psig. Monitor pressure throughout the Coldhead replacement procedure and vent through V2 as required to keep cryostat pressure at 4 psig. See Illustration 5-39.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-39: Helium Vent Plumbing



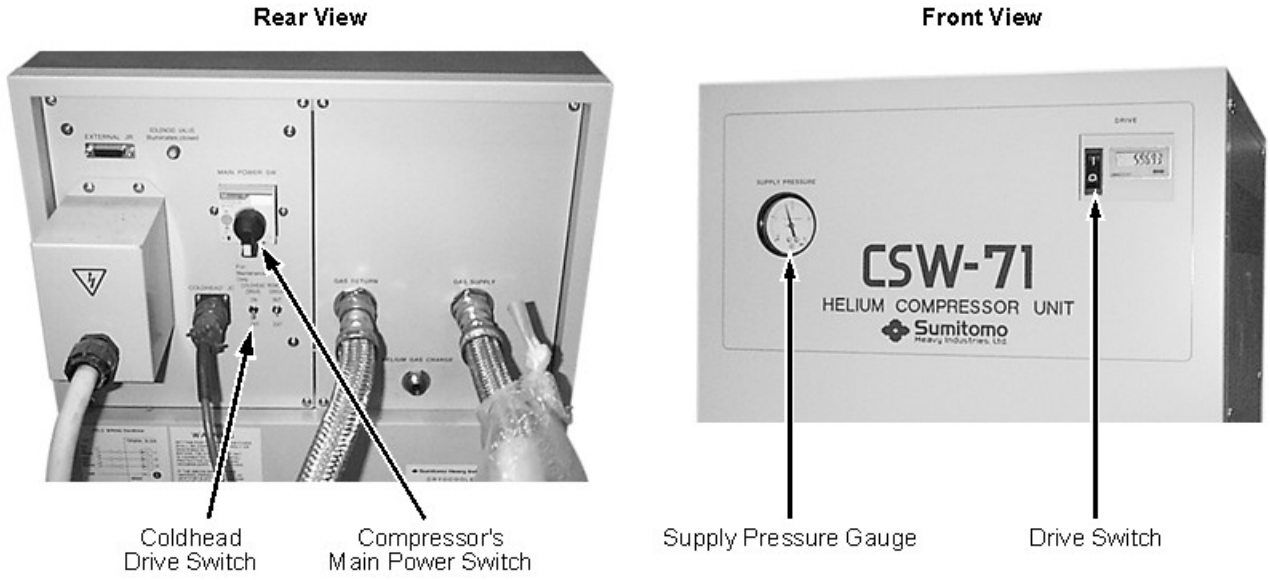
NOTICE

Make sure gas lines are removed immediately after power is disconnected to prevent contamination of gas lines and Compressor.

4. Immediately upon site arrival shut down the compressor as follows to prevent pressure build-up in the Coldhead:

   a. Turn 'ON' (upwards) the Coldhead Drive Switch on the Compressor's back panel. See Illustration 5-40.

Illustration 5-40: Views of CSW-71D Compressor



   b. Place the Drive Switch on the Compressor's front panel in the 'O' (off) position. See Illustration 5-40.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

c. Run the Coldhead for 10 seconds (only) with the Compressor turned off to prevent pressure build-up in the Coldhead, then turn 'OFF' the Coldhead Drive Switch and the Compressor's Main Power Switch. See Illustration 5-40.

WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR.

d. Disconnect and lockout/tagout input power to the Compressor. Verify that no voltage is present by using a DVM or equivalent measuring device.

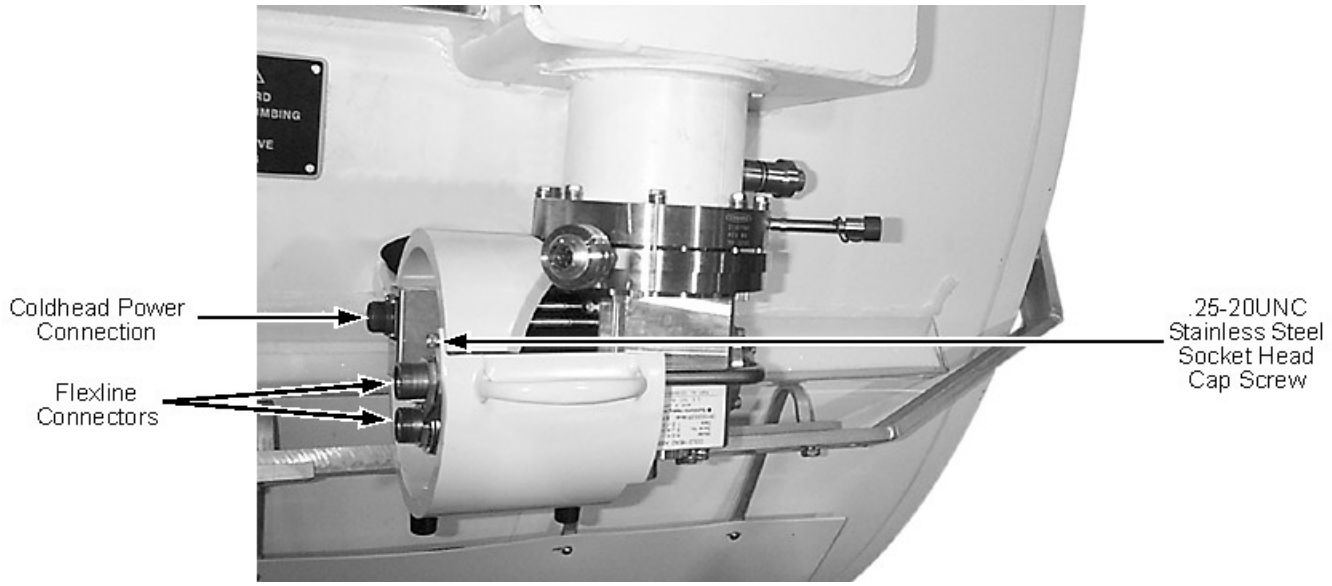
NOTICE

Do not put any bending force on Aeroquip fittings while connecting/disconnecting helium flexlines. A bending force will create difficulty in the rapid engagement/disengagement required to prevent helium loss and system contamination. Do support the gas lines when connecting/disconnecting to the Coldhead at the top of the magnet or to the Compressor.

5. Once Coldhead power is disconnected, immediately:

a. Disconnect the Coldhead power cable at the Coldhead. See Illustration 5-41.

Illustration 5-41: Coldhead Flexline and Power Connection Locations



b. Disconnect the helium gas lines at the Coldhead in conformance with Section 3, Helium Flexline Connections and Replacement. See Illustration 5-41.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6. Remove enclosures required for Coldhead access in conformance with Section 5, Upper and Side Enclosure Removal, or with Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, as appropriate.



WARNING

POTENTIAL PROJECTILE HAZARD
THE COLDHEAD MOTOR SHIELD IS MADE OF FERROMAGNETIC MATERIAL AND HAS A LARGE ATTRACTIVE FORCE TO THE MAGNET.
DO NOT LOOSEN OR REMOVE THE MOTOR SHIELD MOUNTING SCREWS UNDER ANY CIRCUMSTANCE!



WARNING

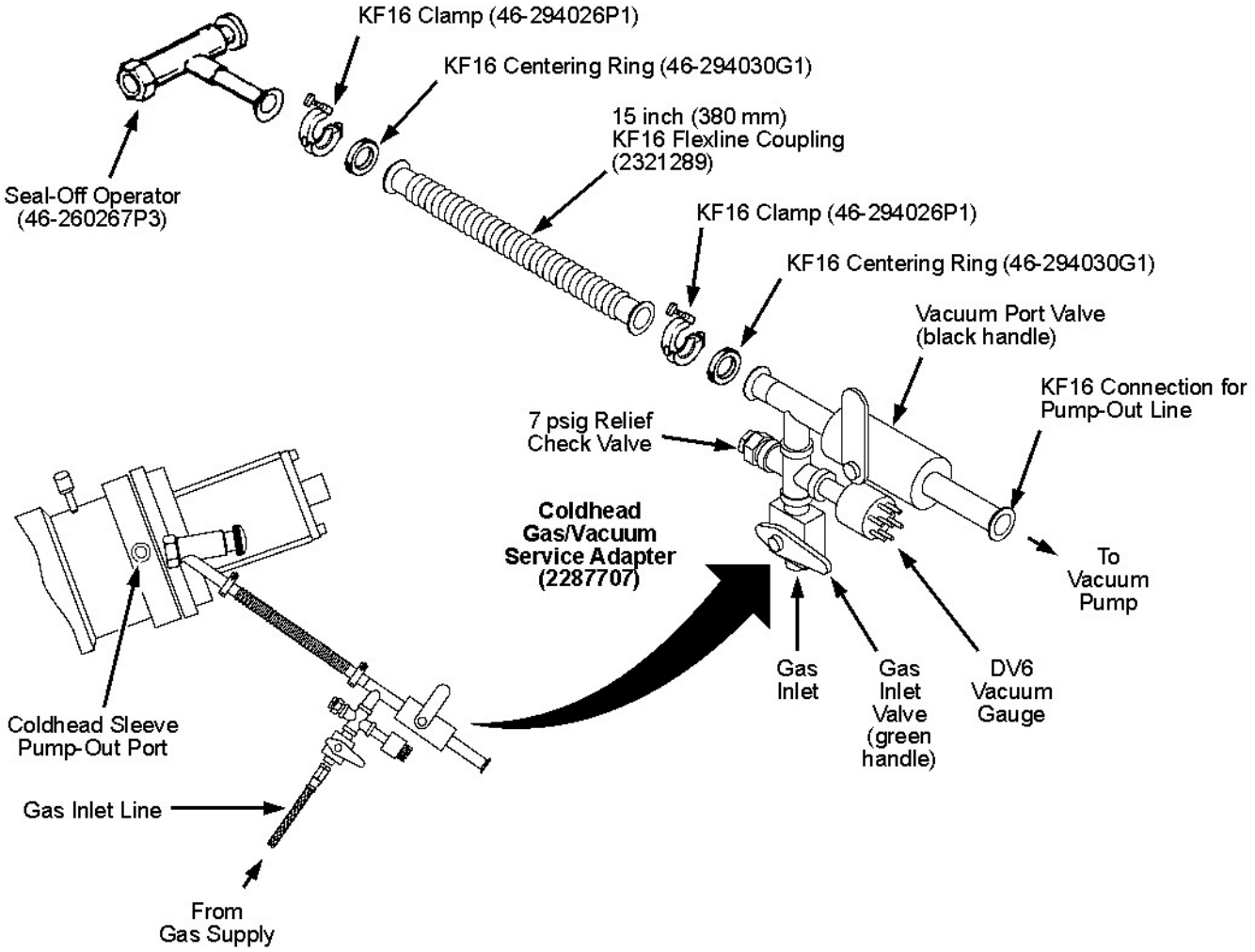
POTENTIAL CRUSH HAZARD
BECAUSE THE FERROMAGNETIC COLDHEAD MOTOR SHIELD IS ATTRACTED TO THE MAGNET, THE MOTOR SHIELD CAN PINCH/CRUSH FINGERS TRAPPED BETWEEN IT AND THE MAGNET.
WEAR LEATHER GLOVES AND USE EXTREME CAUTION WHEN PIVOTING THE MOTOR SHIELD'S TOP HALF TO EXPOSE THE COLDHEAD. DO NOT PUT FINGERS OR HANDS BETWEEN THE MOTOR SHIELD AND THE MOUNTING BRACKET.

7. Open the Coldhead motor shield by removing the .25-20UNC stainless steel socket head cap screw in the end of the motor shield. See Illustration 5-41. Put the screw in a secure place for replacement later.

8. Clean all vacuum fittings on the apparatus shown in Illustration 5-42. Then lightly coat o-rings with vacuum grease to make sure vacuum seals are tight.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-42: Coldhead Gas/Vacuum Service Apparatus



9. Attach the seal-off operator to the pump-out port on the Coldhead sleeve. See Illustration 5-42. Tighten the seal-off operator to the pump-out port by holding the body of the operator and tightening the nut with a wrench.

10. Connect the service adapter to the seal-off operator. See Illustration 5-42.

DANGER

FATAL EXPLOSIVE HAZARD!
GAS CYLINDER RUPTURE/DAMAGE OR OPENING CYLINDER VALVE FAST WILL RELEASE 2400 PSI GAS FROM CYLINDER.
MAKE SURE GAS CYLINDERS ARE SECURE FROM FALLS AND AWAY FROM MOVING OBJECTS BEFORE USING. ALWAYS OPEN CYLINDER VALVE SLOWLY.

11. If a nitrogen gas cylinder is available:

    a. Secure a nitrogen cylinder to a nonmagnetic gas cylinder cart.

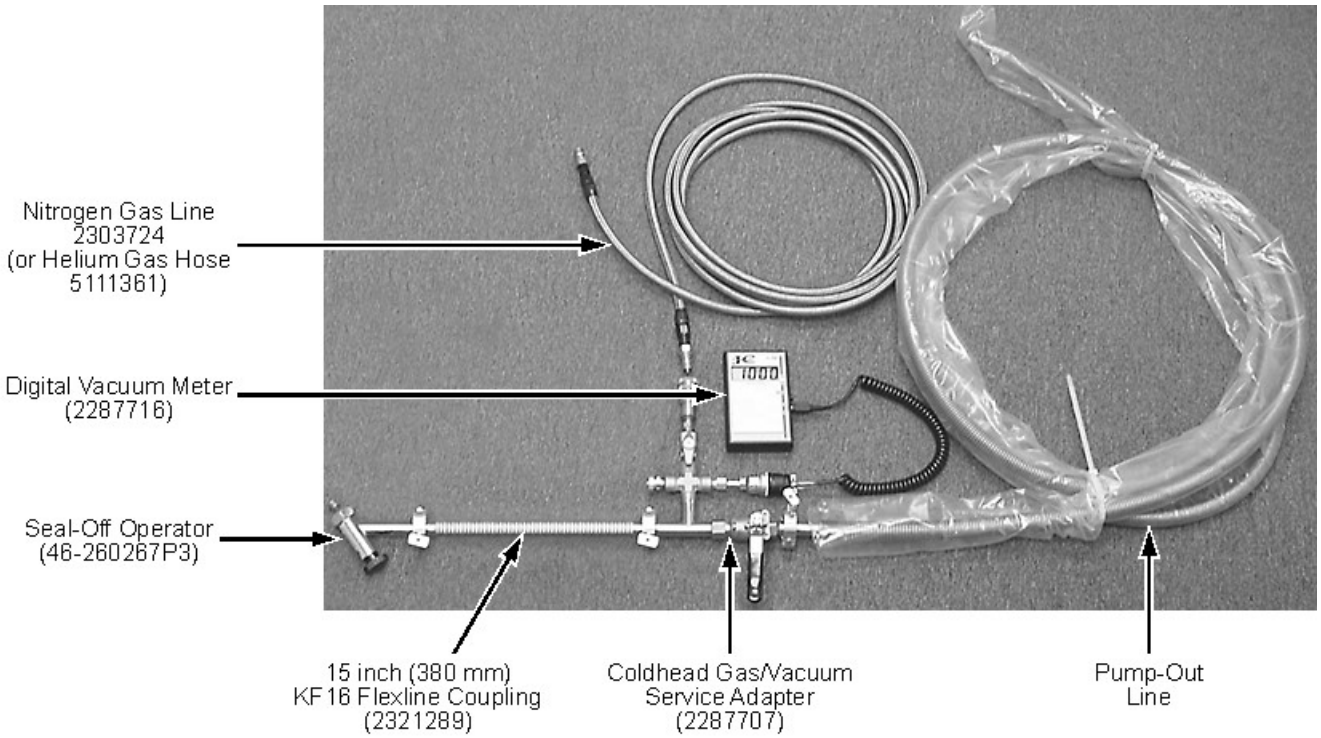
    b. Remove the cylinder cap.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

c. Connect the gas regulator to the nitrogen gas cylinder.

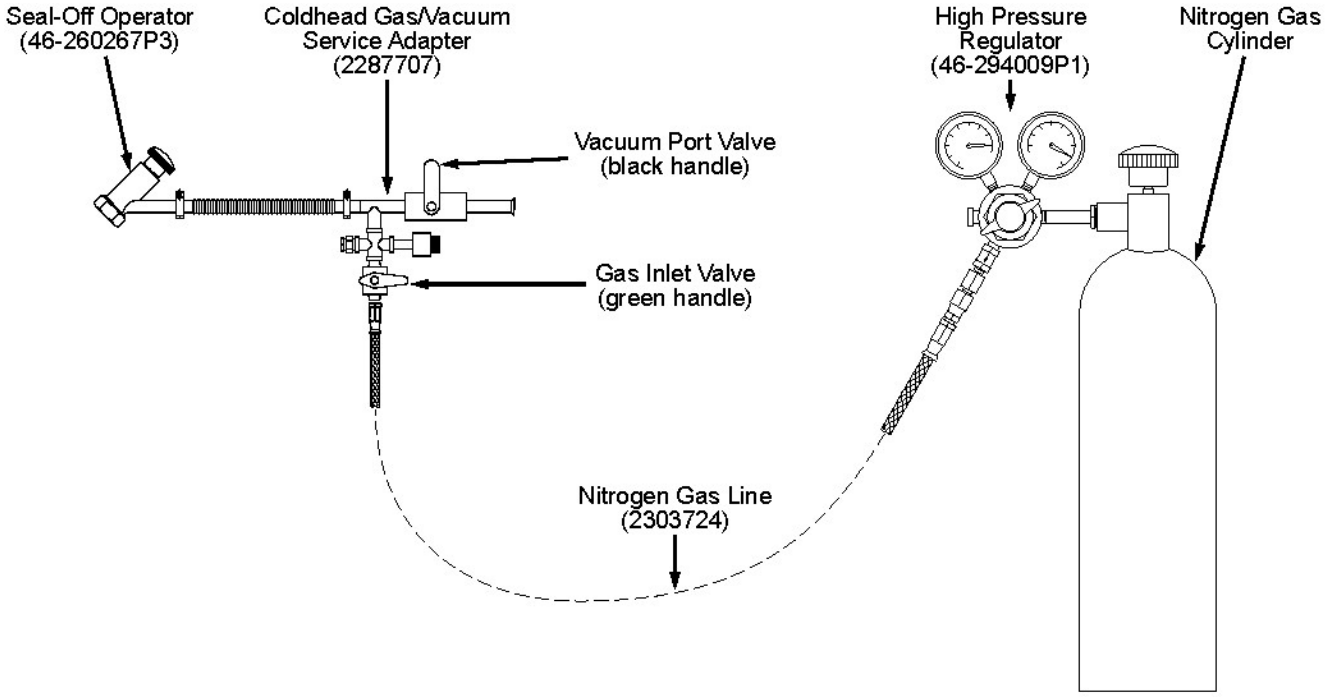
d. Connect the Nitrogen Gas Line (2303724) from the gas regulator to the Service Adapter's gas inlet valve (green handle). See Illustration 5-43 and Illustration 5-44.

Illustration 5-43: Coldhead Gas/Vacuum Service Adapter and Connections



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-44: Nitrogen Gas Cylinder to Service Adapter



e. 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 psig - 2400 psig if the cylinder is full.

f. Open the gas inlet valve and set a low pressure gas flow (1 psig), as indicated on the regulator gauge.

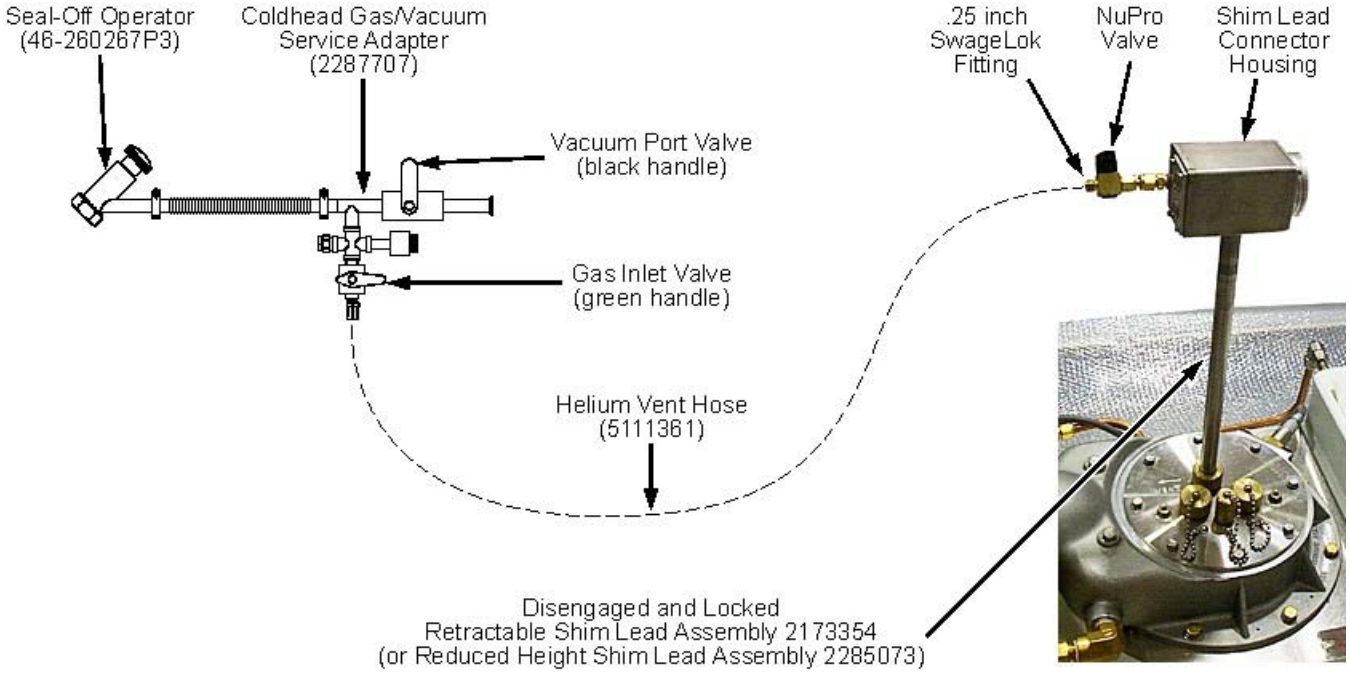
g. Continue with Step 13.

12. If a nitrogen gas cylinder is NOT available:

    a. Connect Helium Vent Hose 5111361 to the Shim Lead's Nupro Valve. See Illustration 5-45.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-45: Helium Gas Connection to Service Adapter



b. Connect the Helium Vent Hose's quick connect fitting to the Service Adapter's gas inlet valve (green handle). See Illustration 5-45.

c. Open the Nupro Valve.

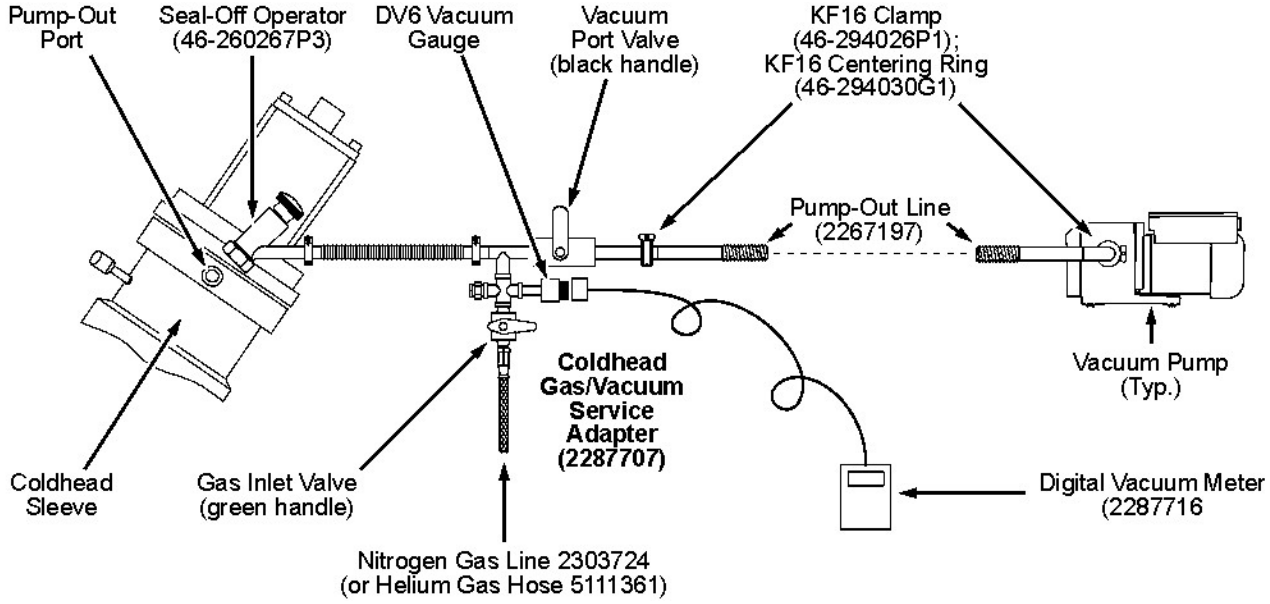
13. Open the vacuum port valve (black handle) on the adapter and allow gas to flow out for 30 seconds to purge the assembly of air.

14. Close the vacuum port and gas inlet valves.

15. Make sure the black and green handles on the Service Adapter are closed. Connect the vacuum pump apparatus as shown in Illustration 5-46. Apply a light coat of vacuum grease to the centering o-rings.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-46: Vacuum Pump Apparatus Set-Up



16. Turn on the vacuum pump, open the vacuum valve (black handle) on the Service Adapter and allow the pump to evacuate the vacuum line and Service Adapter to <20 millitorr (<20 microns), as read on the Digital Vacuum Meter. Then close the vacuum valve.

17. Repeat opening and closing the vacuum valve (black handle) two more times while pumping.

18. When 50 millitorr (50 microns) is reached, close the vacuum valve (black handle). Then observe the vacuum meter to make sure the Service Adapter and Seal-Off Operator are leak tight. If the gauge rises >200 millitorr (>200 microns) over 30 seconds, suspect a leak and:

    a. Turn off the vacuum pump and temporarily open the green handle to bring the apparatus to atmospheric pressure.

    b. Remove the vacuum line and reassemble the Seal-Off Operator and Service Adapter.

    c. Repeat Step 15 - Step 18 until the system is leak tight.

19. When the apparatus is leak tight, open the vacuum valve (black handle) and make sure the vacuum is ≤ 50 millitorr (≤ 50 microns) before continuing with Step 20.

20. 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.

21. Immediately check the vacuum on the digital vacuum meter for a reading of ≤50 millitorr (≤50 microns). A reading of >> 100 millitorr (>> 100 microns) indicates a poor vacuum in the sleeve that may cause cooling problems. If this condition occurs:

    a. Pump out the sleeve again to achieve a vacuum < 100 millitorr (< 100 microns).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

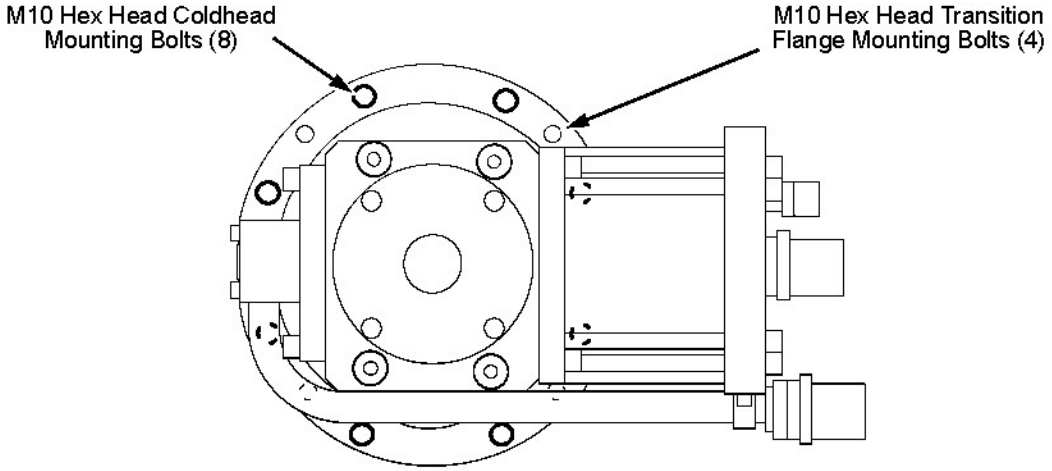
b. Operate the Coldhead to establish final temperature.

NOTE: The Service Adapter has a 5 psig relief valve to prevent the build-up of excess pressure in the Coldhead sleeve when any nitrogen, frozen to the Coldhead, regassifies during Coldhead warm-up. Some audible gas escaping may be encountered.

22. Loosen and remove the eight Coldhead mounting bolts and Belleville washers. See Illustration 5-47.

NOTE: Save the bolts and washers removed in Step 22, leaving the same number of washers on each bolt. These will be used to mount the new Coldhead and will make sure the proper interface spacing is maintained. Bolts are installed through the sleeve flange.

Illustration 5-47: Coldhead Mounting



23. Rethread two bolts without Belleville washers 3 - 4 threads deep into holes 180° apart.

NOTE: These two bolts ensure that the Coldhead can be contained when gas pressure is applied. Save these bolts and washers to mount the new Coldhead.

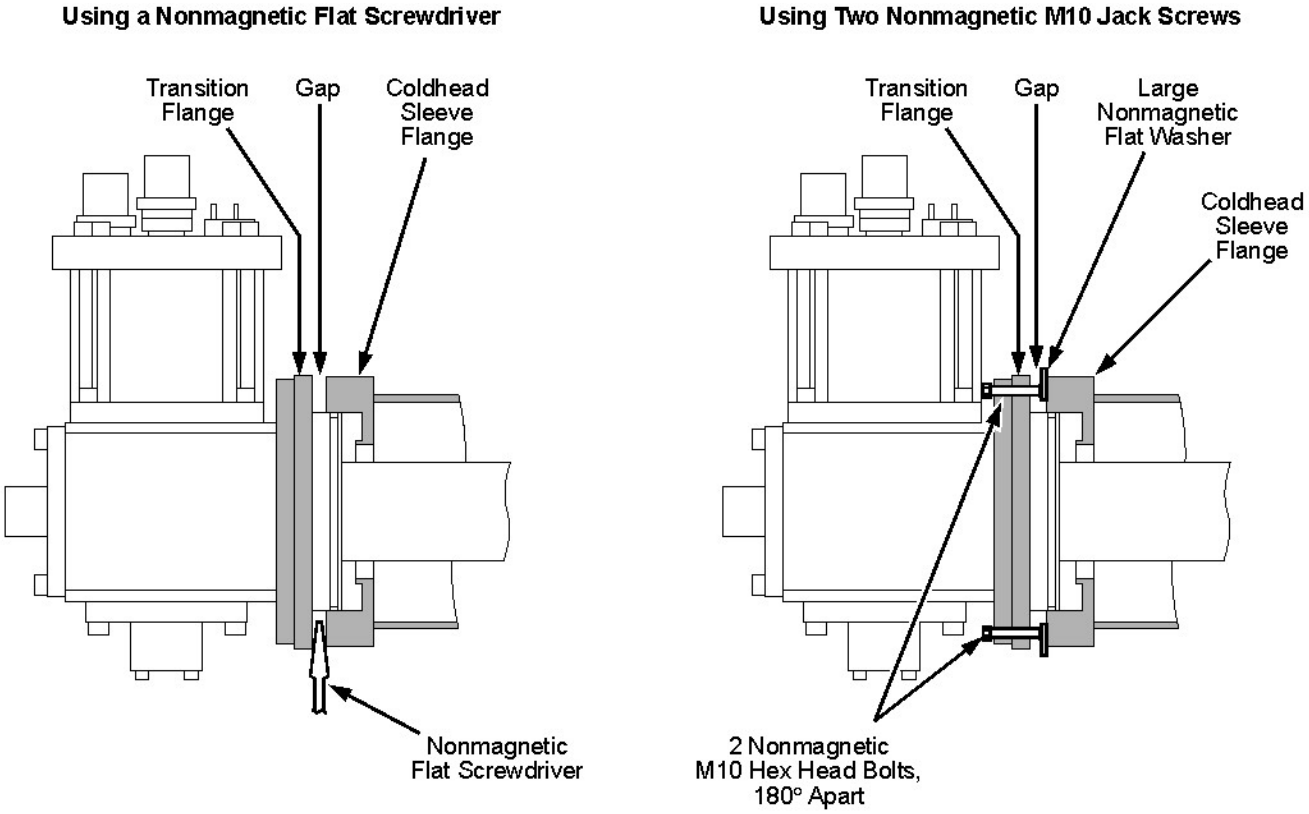
24. Close the vacuum valve (black handle). Then open the gas inlet valve (green handle) and fill the vacuum space in the sleeve with nitrogen gas at a small positive pressure (1 psig - 3 psig on the low-pressure regulator) to break the Coldhead away from the first and second stage contacts.

25. If required to dislodge the Coldhead, carefully insert a large **nonmagnetic** screwdriver or other similar wedge-shaped, **nonmagnetic** tool in the gap between the sleeve flange and transition flange. Gradually pry the transition flange away from the sleeve flange by tapping the end of a screwdriver or wedge while moving it around the circumference of the gap. Or use two **nonmagnetic** M10 bolts as a jackscrew to apply a separating force between the Coldhead sleeve flange and the transition flange. See Illustration 5-48.

NOTE: The jackscrew technique shown in Illustration 5-48 can be used to break the indium seal between the second-stage heat station of the sleeve and the Coldhead. Use two **nonmagnetic** M10 hex head bolts inserted 180° apart. Torque bolts to apply force between Coldhead sleeve flange and transition flange.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-48: Dislodging the Coldhead





⚠ WARNING

POTENTIAL COLD BURN HAZARD
UNPROTECTED SKIN WILL BE SEVERELY DAMAGED IF IT CONTACTS A REMOVED COLDHEAD'S FIRST OR SECOND STAGE STATIONS.
WEAR INSULATED LEATHER GLOVES AND PROTECTIVE CLOTHING (LONG-SLEEVE SHIRT, ETC.) WHEN REMOVING A COLDHEAD. DO NOT TOUCH THE FIRST OR SECOND STAGE STATIONS OF A REMOVED COLDHEAD.



⚠ WARNING

POTENTIAL IMPACT HAZARD
GAS PRESSURE DURING COLDHEAD REMOVAL MAY CAUSE THE COLDHEAD TO POP OUT, POTENTIALLY CAUSING INJURY UPON IMPACT.
KEEP AWAY FROM THE END OF A COLDHEAD DURING COLDHEAD REMOVAL.



NOTICE

Make sure nitrogen gas is flowing through the pump-out port connection and that the Plexiglas Cover Plate/Heater Assembly, the separate cover plate and the Coldhead Insertion/Removal Tool are within reach before proceeding.

26. When the Coldhead breaks away from the first and second stage contacts, remove the remaining two bolts and partially extract the Coldhead until the Transition Flange O-Ring is exposed.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

27. Extract the Coldhead from the sleeve in conformance with Section 10.4.1.2 for fixed sites or with Section 10.4.1.3 for mobile sites.

NOTE: Partial extraction of the Coldhead is required for Coldhead Insertion Fixture installation.

10.4.1.2 Coldhead Extraction, Fixed Site



⚠ WARNING

POTENTIAL COLD BURN HAZARD
UNPROTECTED SKIN WILL BE SEVERELY DAMAGED IF IT CONTACTS A REMOVED COLDHEAD'S FIRST OR SECOND STAGE STATIONS.
WEAR INSULATED LEATHER GLOVES AND PROTECTIVE CLOTHING (LONG-SLEEVE SHIRT, ETC.) WHEN REMOVING A COLDHEAD. DO NOT TOUCH THE FIRST OR SECOND STAGE STATIONS OF A REMOVED COLDHEAD.



⚠ WARNING

POTENTIAL IMPACT HAZARD
GAS PRESSURE DURING COLDHEAD REMOVAL MAY CAUSE THE COLDHEAD TO POP OUT, POTENTIALLY CAUSING INJURY UPON IMPACT.
KEEP AWAY FROM THE END OF A COLDHEAD DURING COLDHEAD REMOVAL.



NOTICE

Do not slide the Coldhead out too far in Step 1. Maintain contact between the Coldhead transition flange and the Sleeve cavity to prevent the Coldhead first stage from dropping onto the Sleeve.

1. Slide the Coldhead out 5/16 inches - 3/8 inches (8 mm - 10 mm) from the Sleeve to allow assembly of the Fixed Site Coldhead Insertion/Removal Fixture's sleeve clamp onto the sleeve flange. Position the clamp straddling the sleeve flange and aligned with the holes in the flange's bottom. Insert the clamping bolts and tighten. See Illustration 5-49 and Illustration 5-50.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-49: Major Components, LCC Coldhead Insertion/Removal Fixtures

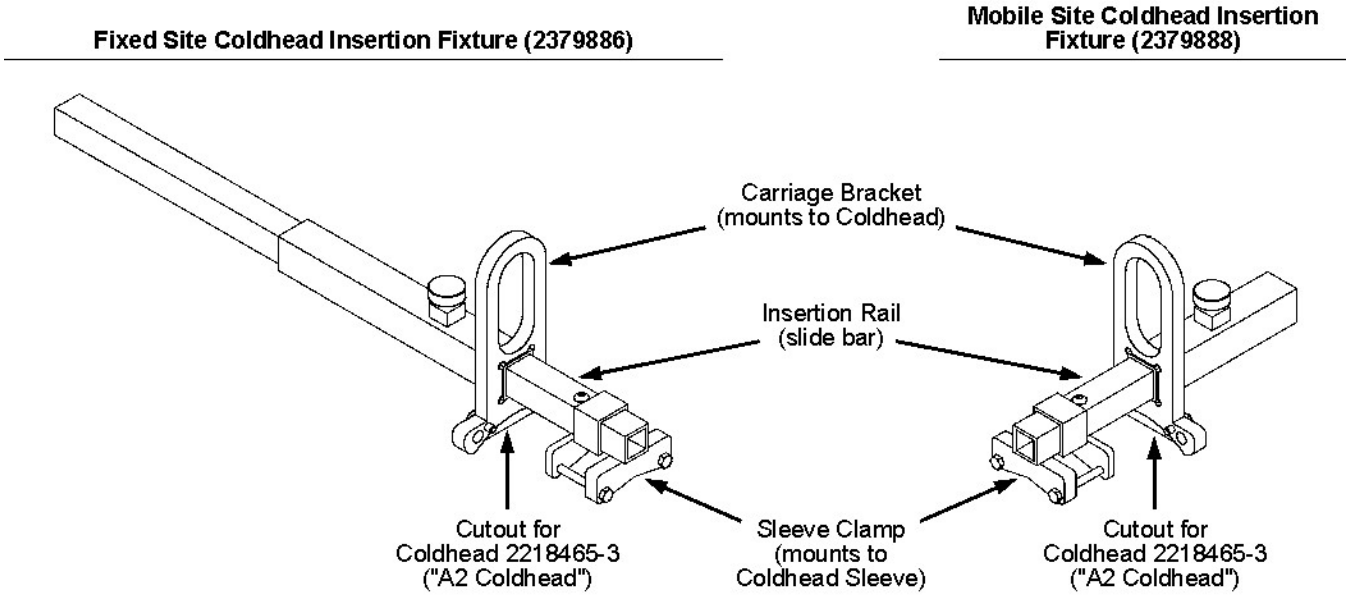
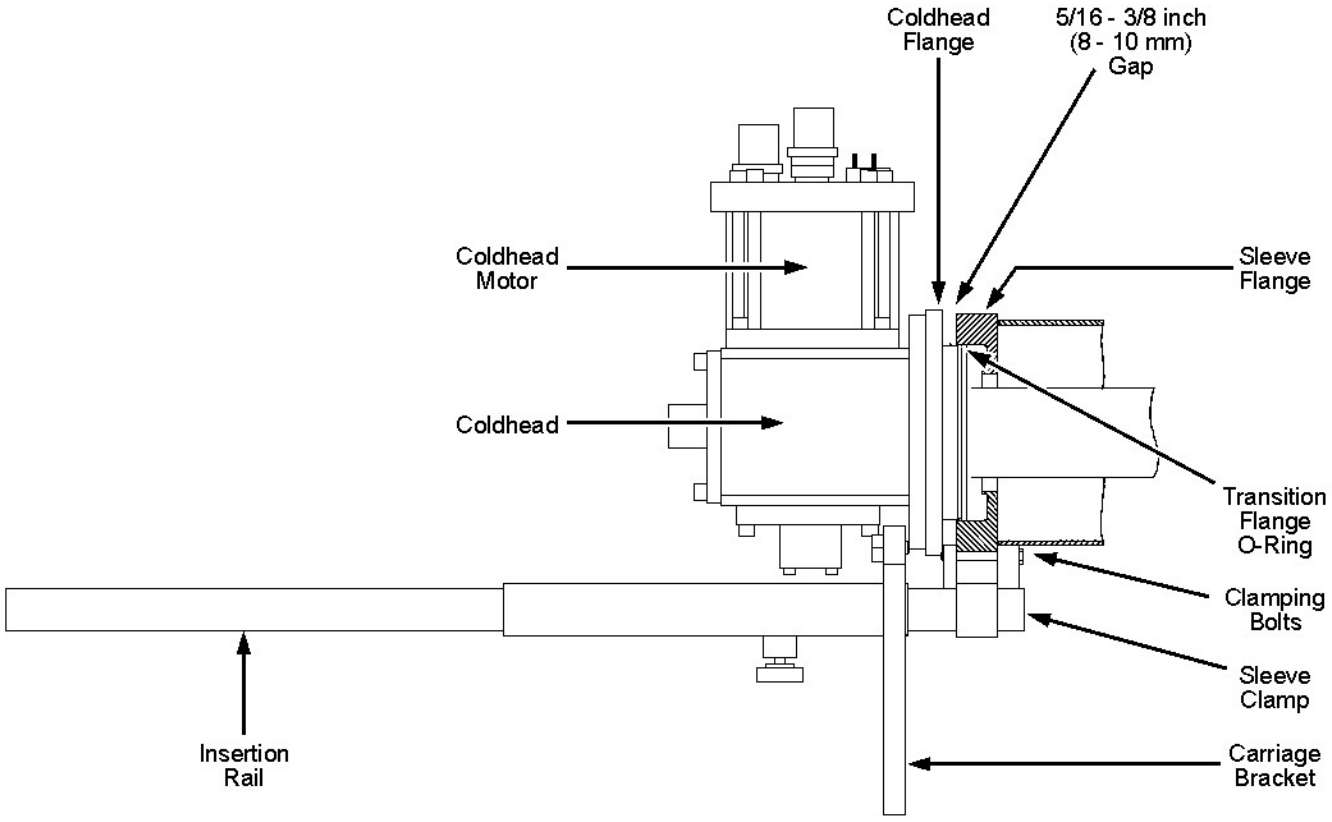


Illustration 5-50: Fixed Site Coldhead Insertion/Removal Fixture 2379886 Installation



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2. Slide the carriage bracket of the Insertion/Removal Fixture onto and along the insertion rail until it contacts the Coldhead flange. Tightly fasten the carrying bracket to the Coldhead transition flange's two bottom threaded holes using the bracket's bolts. See Illustration 5-50.

3. Pull the Coldhead and carriage bracket out to the end of the insertion rail.



CAUTION

Heavy Object
The Coldhead and carriage bracket together weigh approximately 50 pounds (22.7 kg).
Be prepared to support the weight when removing coldhead and bracket from the insertion rail's end.

4. Gradually pull the Coldhead and carriage bracket off the insertion bar, supporting the weight with the carriage bracket and the Coldhead Motor.

5. Work Assistant: Position a cardboard box (or proven nonmagnetic equivalent) on the floor at the end of the Service Ladder/Platform.



WARNING

POTENTIAL PERSONAL INJURY HAZARD
COLDHEADS CONTAIN FERROUS MATERIAL THAT WILL BE ATTRACTED TO A MAGNET AT FIELD. INJURIES CAN HAPPEN DURING THE FOLLOWING STEP IF NOT PERFORMED CAREFULLY.
DO NOT ALLOW THE COLDHEAD TO CONTACT THE MAGNET VESSEL DURING REMOVAL OR REPLACEMENT.



CAUTION

Potential Projectile Hazard
Coldheads contain ferrous material that will be attracted to a magnet at field. Always keep one hand supporting the Coldhead Motor, especially when near the magnet's rear.

6. Carefully lower the removed Coldhead off the service platform to the work assistant on the floor and then into the cardboard box.

7. Work assistant: Securely grip the cardboard box containing the removed Coldhead and carefully drag it to the wall and then outside the magnet room. Do not come near the magnet bore.

NOTE: It is not recommended to hand carry more than 35 pounds (15.9 kg). Dragging a cardboard box containing the 50 pound (22.7 kg) Coldhead and carriage bracket is preferred when moving a Coldhead to or from the magnet. Do not use a cart unless it is proven before use to not contain magnetic materials.

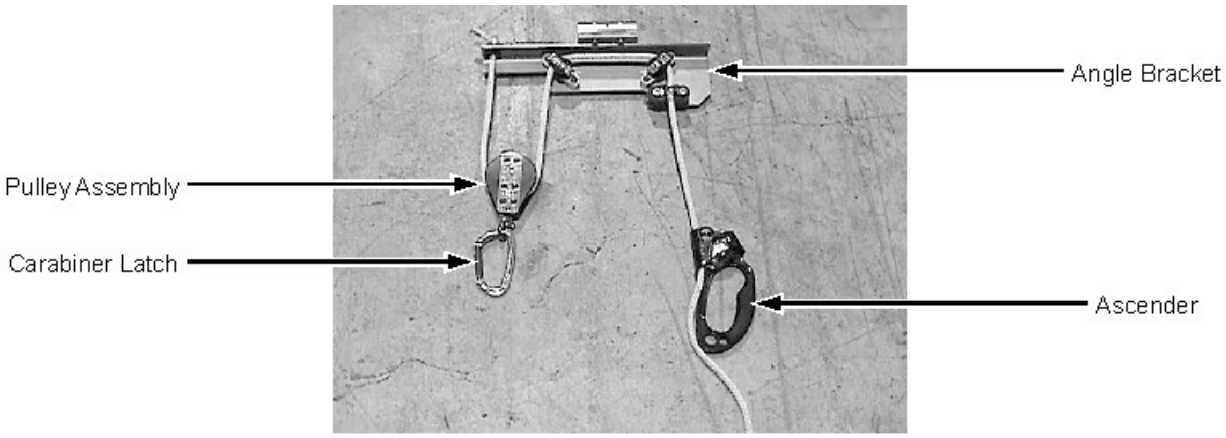
8. Continue with Section 10.4.2.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

10.4.1.3 Coldhead Extraction, Mobile Site

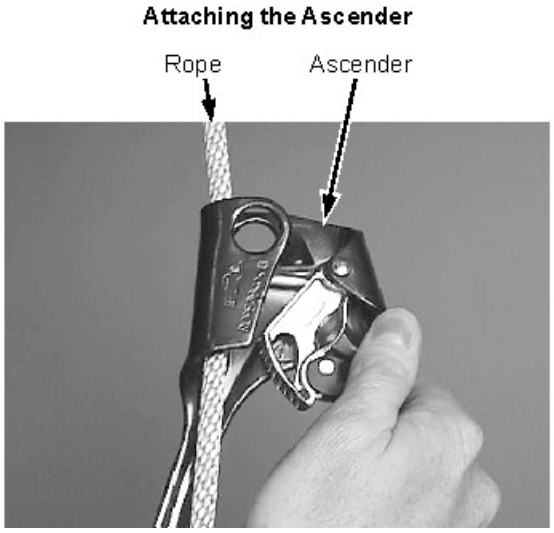
1. Attach the rope to the Mobile Site Coldhead Lifting Tool's angle bracket as shown in Illustration 5-51.

Illustration 5-51: Mobile Site Coldhead Lifting Tool 2258802



2. Attach the ascender to the rope as shown in Illustration 5-51 and Illustration 5-52 (left).

Illustration 5-52: Mobile Site Coldhead Lifting Tool: Ascender and Rail Stop





3. Raise the rail stop on the mobile site's rail by lifting the top section and rotating it. See Illustration 5-52 (right).

4. Slide the angle bracket onto the mobile site's rail. See Illustration 5-53.

NOTE: The magnet vent at AK mobile sites interferes with normal angle bracket mounting at AK mobile sites. Instead, mount the angle bracket backwards so that the pulleys and cleat are facing the right side of the mobile wall.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-53: Mobile Site Coldhead Lifting Tool: Angle Bracket Adjustment





⚠ CAUTION

Potential Personal Injury Hazard
Without the rail stop the angle bracket can run off the rail's end and cause personal injury below (due to weight) or towards the magnet (due to magnetic attraction). Make sure the Rail Stop is re-engaged once the angle bracket is mounted or the angle bracket can exit the rail's end.

5. Re-engage the rail stop so that the angle bracket cannot slide out of the rail.

NOTE: If the angle bracket does not fit onto the Rail Assembly, loosen the four Allen head screws on the bottom of the angle bracket. See Illustration 5-53.

6. Re-engage the rail stop.

7. In AK vans (only) the removable internal crossbeam must be dismounted:

   a. Position the Mobile Site Coldhead Lifting Tool's Pulley Assembly over the removable section of the AK van's internal crossbeam as in Illustration 5-54.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-54: AK Van's Removable Internal Crossbeam



WARNING

POTENTIAL PERSONAL INJURY HAZARD
REMOVING THE AK VAN CROSSBEAM WILL EXPOSE EDGES THAT MAY BE ROUGH.
WEAR GLOVES WHEN HANDLING THE REMOVABLE CROSSBEAM IN AN AK VAN.

b. Secure the removable section of the crossbeam to the Pulley Assembly using the end of the Mobile Site Coldhead Lifting Tool's rope not attached to the tool. See Illustration 5-54. Make sure there's enough loose rope between the two tied ends to reach the floor.

c. Remove the removable section's retaining bolts. There's three bolts at the van's exterior wall and two at the interior junction plate. See Illustration 5-54.

d. Carefully slide the removable crossbeam section on the Mobile Site Coldhead Lifting Tool to the rear of the mobile unit. Use one hand to support the crossbeam section and the other to control the pulley's rope and Ascender. Make sure the crossbeam section stays clear of the magnet and van walls.

e. Lower the crossbeam section to rest on the floor at the van's rear wall. Do not obstruct the exit path.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL COLD BURN HAZARD
UNPROTECTED SKIN WILL BE SEVERELY DAMAGED IF IT CONTACTS A REMOVED COLDHEAD'S FIRST OR SECOND STAGE STATIONS.
WEAR INSULATED LEATHER GLOVES AND PROTECTIVE CLOTHING (LONG-SLEEVE SHIRT, ETC.) WHEN REMOVING A COLDHEAD. DO NOT TOUCH THE FIRST OR SECOND STAGE STATIONS OF A REMOVED COLDHEAD.



WARNING

POTENTIAL IMPACT HAZARD
GAS PRESSURE DURING COLDHEAD REMOVAL MAY CAUSE THE COLDHEAD TO POP OUT, POTENTIALLY CAUSING INJURY UPON IMPACT.
KEEP AWAY FROM THE END OF A COLDHEAD DURING COLDHEAD REMOVAL.



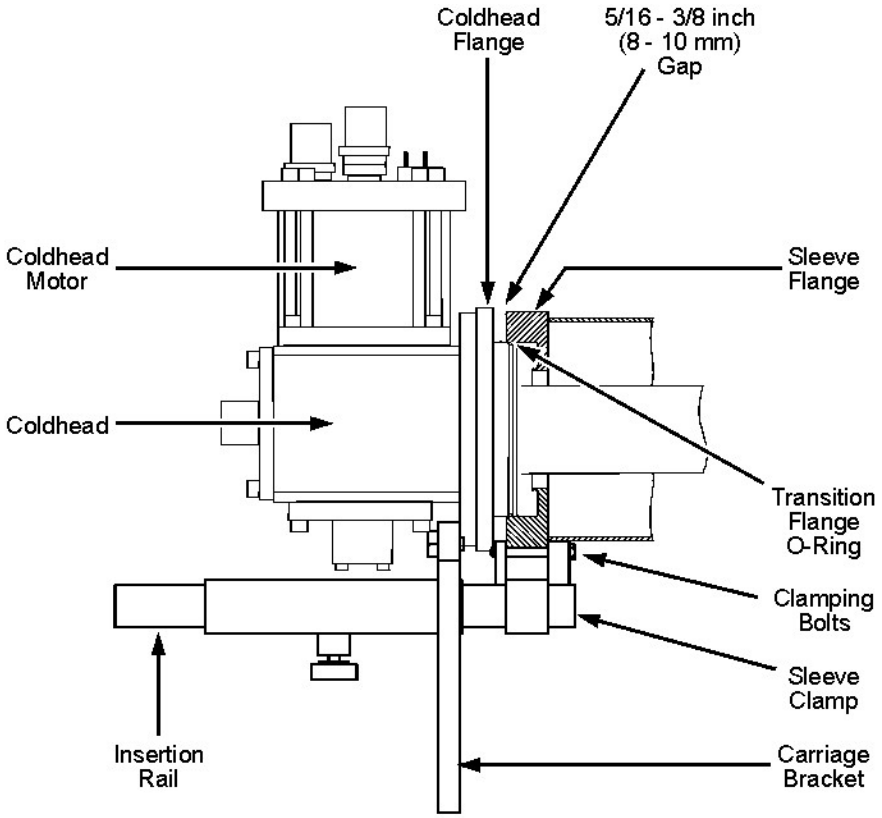
NOTICE

Do not slide the Coldhead out too far in Step 8. Maintain contact between the Coldhead transition flange and the Sleeve cavity to prevent the Coldhead first stage from dropping onto the Sleeve.

8. Slide the Coldhead out 5/16 inches - 3/8 inches (8 mm - 10 mm) from the Sleeve to allow assembly of the LCC Mobile Site Coldhead Insertion/Removal Fixture's sleeve clamp onto the sleeve flange. Position the clamp straddling the sleeve flange and aligned with the holes in the flange's bottom. Insert the clamping bolts and tighten. See Illustration 5-49 and Illustration 5-55.

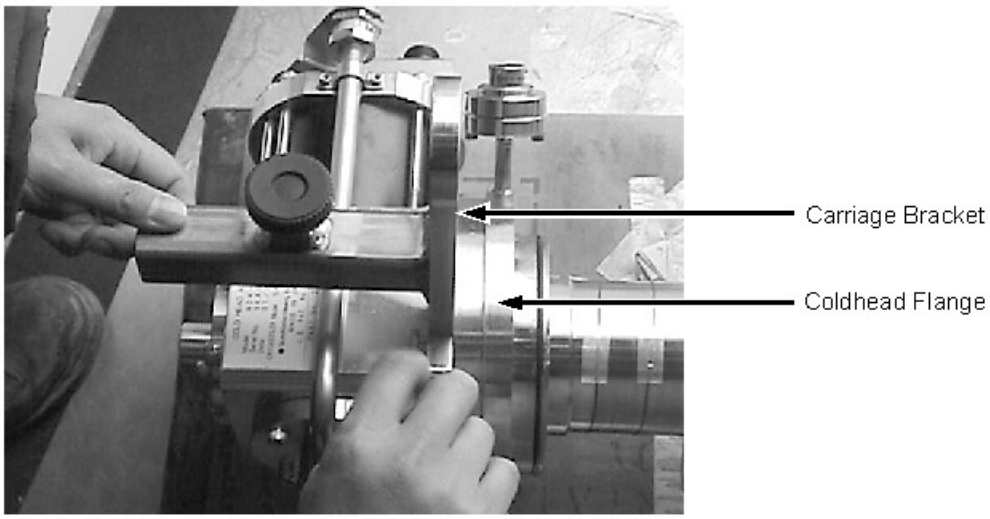
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-55: LCC Mobile Site Coldhead Insertion/Removal Fixture 2379888 Installation



9. Slide the carriage bracket of the Insertion/Removal Fixture onto and along the insertion rail until it contacts the Coldhead flange. Tightly fasten the carrying bracket to the Coldhead transition flange's two bottom threaded holes using the bracket's bolts. See Illustration 5-55 and Illustration 5-56.

Illustration 5-56: Attaching the Carriage Bracket (Example Shown Away From Magnet)



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



DANGER

PERSONAL INJURY HAZARD!
THE COLDHEAD CAN COME CRASHING DOWN (DUE TO WEIGHT) OR TOWARDS THE MAGNET (DUE TO MAGNETIC ATTRACTION) AND THUS CAUSE INJURY IF THE LCC MOBILE SITE COLDHEAD LIFTING TOOL'S ASCENDER IS NOT POSITIONED CORRECTLY WHEN THE COLDHEAD IS MOVED TO/FROM THE MAGNET.
MAKE SURE THE LCC MOBILE SITE COLDHEAD LIFTING TOOL'S ASCENDER IS POSITIONED CLOSE TO THE CLEAT ASSEMBLY BEFORE MOVING A COLDHEAD TO/FROM THE MAGNET. THE ASCENDER ACTS AS A SAFETY BACK-UP MECHANISM TO ASSURE THE COLDHEAD DOESN'T COME CRASHING DOWN.

10. Attach the carriage bracket to the Pulley Assembly's carabiner latch.

11. Rotate the Coldhead to clear the Coldhead Sleeve and mobile unit's walls.

12. Pull the Coldhead and carriage bracket out to the end of the insertion rail.



WARNING

POTENTIAL PERSONAL INJURY HAZARD
COLDHEADS CONTAIN FERROUS MATERIAL THAT WILL BE ATTRACTED TO A MAGNET AT FIELD. INJURIES CAN HAPPEN DURING THE FOLLOWING STEP IF NOT PERFORMED CAREFULLY.
DO NOT ALLOW THE COLDHEAD TO CONTACT THE MAGNET VESSEL DURING REMOVAL OR REPLACEMENT.



CAUTION

Heavy Object
The Coldhead and carriage bracket together weigh approximately 50 pounds (22.7 kg).
Support the Coldhead with the Mobile Site Coldhead Lifting Tool and one hand under the Coldhead motor.

13. Gradually pull the Coldhead and carriage bracket off the insertion bar, supporting the weight with the Mobile Site Coldhead Lifting Tool and one hand under the Coldhead Motor.



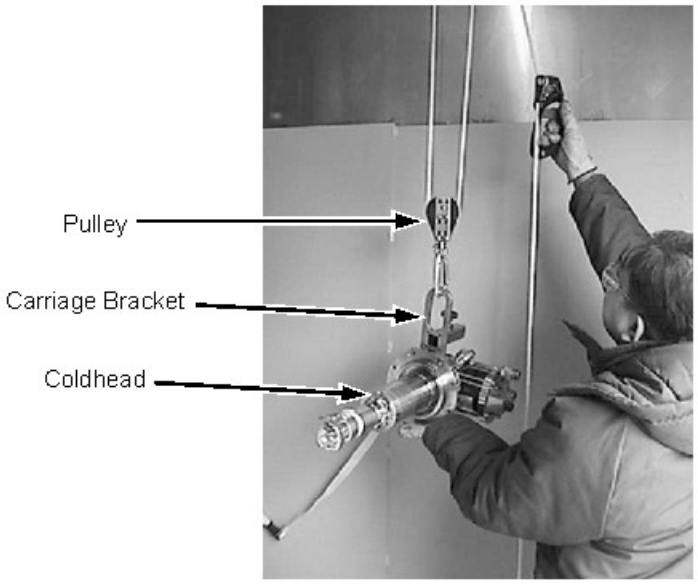
CAUTION

Potential Projectile Hazard
Coldheads contain ferrous material that will be attracted to a magnet at field. Always keep one hand supporting the Coldhead Motor, especially when near the magnet's rear.

14. Carefully slide the Coldhead on the Mobile Site Coldhead Lifting Tool to the rear of the mobile unit. When raising or lowering the Coldhead, use one hand to support the weight of the Coldhead and the other hand to raise or lower the Coldhead using the rope and Ascender. See Illustration 5-57.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-57: Raising & Lowering the Coldhead



15. Work Assistant: Position a cardboard box (or proven nonmagnetic equivalent) on the floor at the rear of the mobile unit.

16. When the Coldhead is at the rear of the mobile unit, carefully lower the Coldhead into a cardboard box on the floor.

17. Work assistant: Securely grip the cardboard box containing the removed Coldhead and carefully drag it to the wall and then outside the magnet room. Do not come near the magnet bore.

18. Continue with Section 10.4.2.

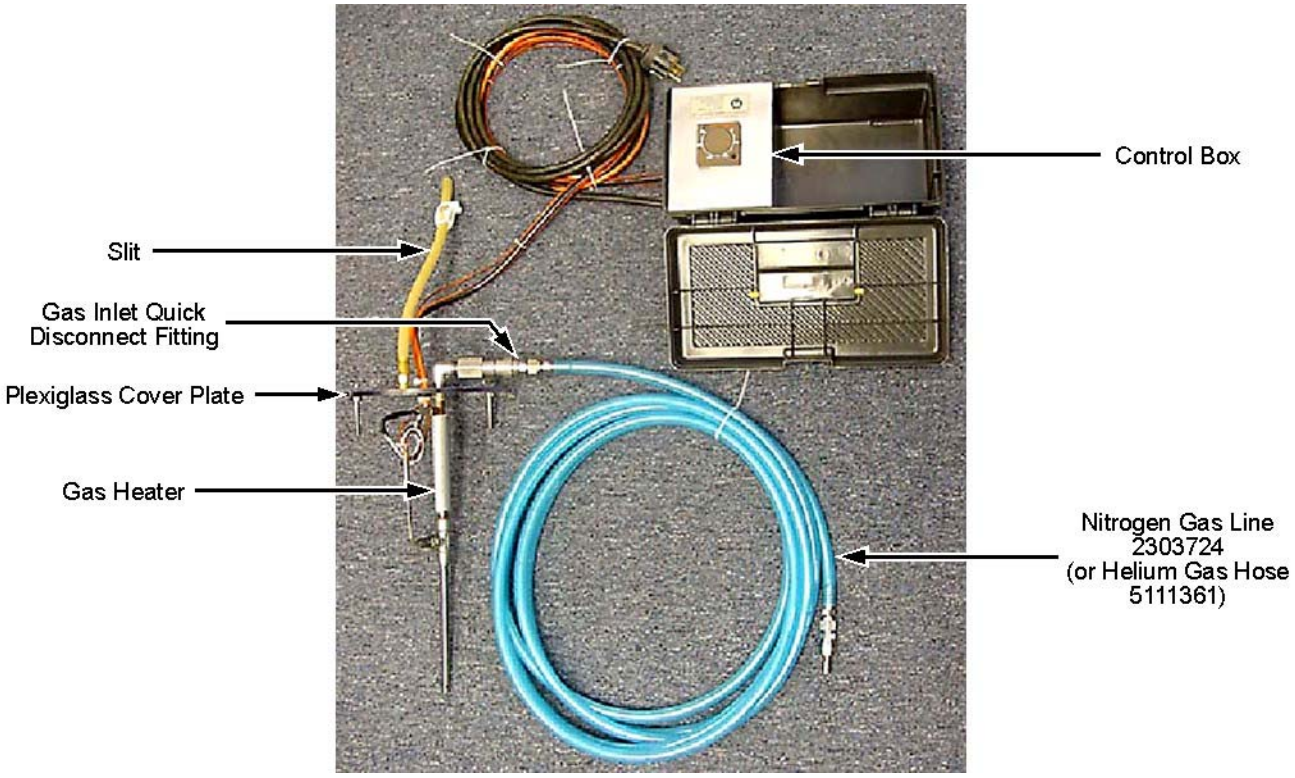
10.4.2 Sleeve Warm-Up

1. After the Coldhead is removed, immediately install the Plexiglas Cover Plate/Heater Assembly onto the Coldhead sleeve flange. See Illustration 5-58.

NOTE: The relief valve on the removed Coldhead may exhaust helium gas with a popping or hissing sound as it warms up.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-58: Plexiglas Cover Plate/Heater Assembly 2303715



2. Close gas inlet valve (green handle) on the Service Adapter.

3. Disconnect the gas line (Nitrogen Gas Line 2303724 or Helium Vent Hose 5111361, whichever is being used) from the Service Adapter and connect it to the gas line connection on the Plexiglas Cover Plate/Heater Assembly. See Illustration 5-58.

4. If using nitrogen gas, set the gas flow to 3 psig - 4 psig on the regulator low pressure gauge.

NOTE: If using helium gas from the magnet, gas pressure will equal magnet pressure. A pressure close to 4 psig speeds sleeve warm-up.



⚠ WARNING

POTENTIAL BURN HAZARD
SKIN BURNS CAN RESULT FROM CONTACT WITH THE HEATER OR THE EXITING GAS.
NO NOT TOUCH THE HEATER OR COME IN CONTACT WITH THE EXITING GAS.



NOTICE

Make sure gas is flowing before plugging in the heater. Gas flow helps prevent heater element burn-out.

Do not exceed a monitored Recondenser temperature of 285^{O} to prevent possible internal damage.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5. Plug in the gas heater and set gas temperature on the Plexiglas Cover Plate/Heater Assembly's control box to 110° F - 120° F. Make sure warmed gas is exiting the slit in the exhaust tubing on the Plexiglas Cover Plate/Heater Assembly. See Illustration 5-58.

6. Secure the Plexiglas Cover Plate/Heater Assembly's cover plate. Continue the gas flow to warm the sleeve and heat stations to the required temperature while preparing the new Coldhead.

7. Warm the sleeve's second stage to ~ 275 K as monitored by the Recondenser SI-410 Diode read-out on the Magnet Monitor.

NOTE: SI-410 temperatures can be monitored on a laptop computer connected to the Magnet Monitor.

8. When the sleeve in heated, shine flashlight light through the Plexiglas Cover to observe the first and second stage heat stations inside the Coldhead sleeve.



NOTICE

Do not keep the Plexiglas Cover off the sleeve flange for an extended time period (>1 minute at a time) to minimize cryopumping and icing of the first stage heat station.

9. If indium is present on the first or second stage heat stations inside the sleeve:

   a. Temporarily remove the Plexiglas Cover Plate/Heater Assembly and remove the indium with the Indium Removal Tool (2365037) or a nonmagnetic long-handled flat-head screwdriver, being careful not to scratch the copper heat station.

NOTE: Indium material on the heat station may be warmed using the warm gas from the nitrogen gas supply line to make it easier to remove. A separate cover plate is included in the Universal Coldhead Replacement Tool Kit that can be used while cleaning out the sleeve.

   b. When all indium is removed, use a Scotch Brite™ pad and long tweezers to polish the heat stations.



WARNING

POTENTIAL PROJECTILE HAZARD
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.
DO NOT BRING A SHOP VACUUM CLOSE TO A RAMPED MAGNET. LOCATE THE VACUUM CANISTER AWAY FROM THE FIELD AND USE A NONMAGNETIC EXTENSION HOSE AT LEAST 20 FEET (6 METERS) LONG.

   c. Evacuate all residue in the sleeve with a shop vacuum. Securely position the cannister of the vacuum away from the magnet's field and vacuum using a nonmagnetic extension hose at least 20 feet (6 meters) long.

10. If the old Coldhead will not be reinstalled, use the packaging materials from the new Coldhead to return the old Coldhead.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

10.4.3 New Coldhead Preparation

NOTICE

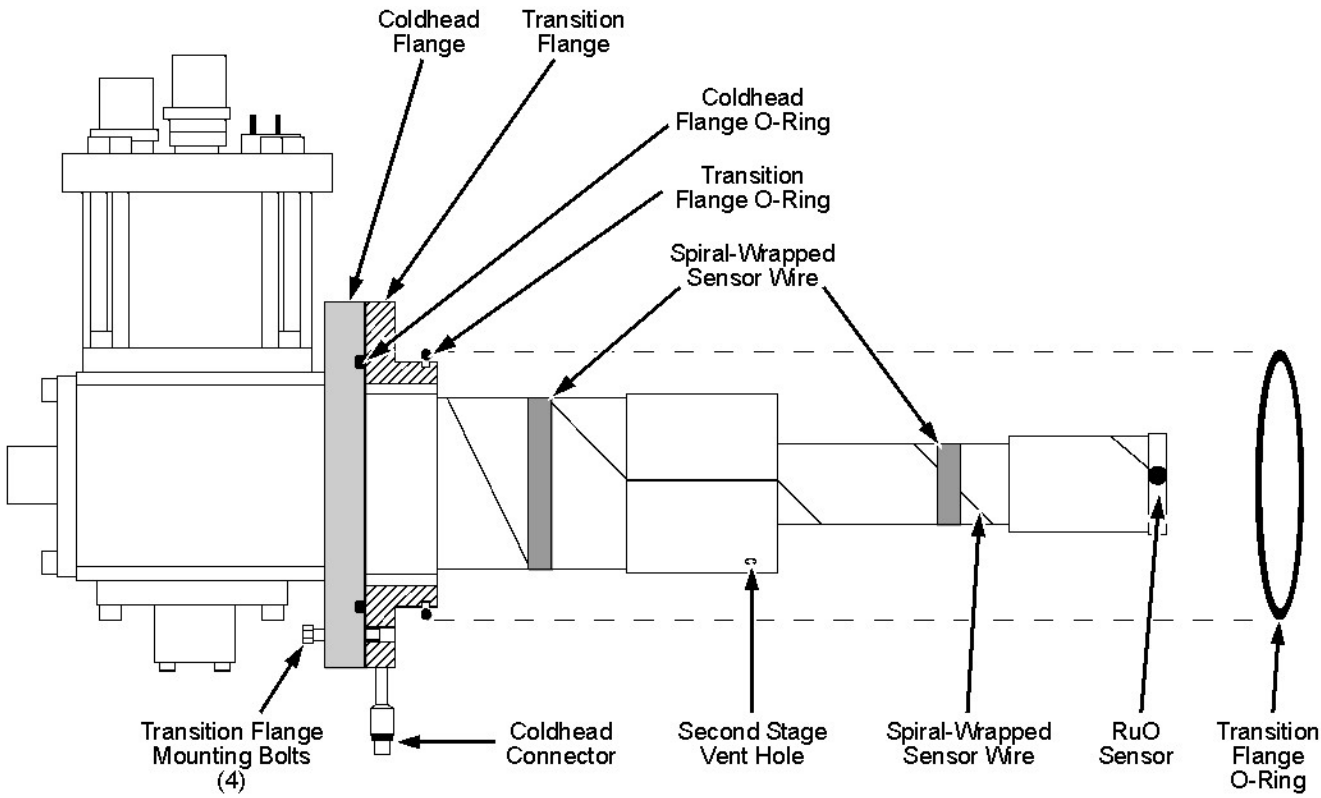
If the old Coldhead is being re-inserted, make sure it is at room temperature and free of moisture before starting this Coldhead Replacement procedure to prevent a poor interface and a contaminated sleeve. Warm the Coldhead with a heat gun if necessary. New gaskets, getter bag and o-ring are required.

1. Remove the new Coldhead and gasket kit from its packaging. Place these on the Coldhead Stand (Holding Tool). Save the shipping container and packing material for return if damage is found. If reinstalling the old Coldhead, make sure it is dry and at room temperature.

2. Inspect the Coldhead using Illustration 5-59 as a reference.

   - The items identified in the illustration must be present and installed approximately where shown.
   - The RuO sensor must be securely mounted in area shown.
   - The RuO wire wrapping may be slightly different than the configuration shown. Make sure the RuO sensor wires are not broken or disconnected, the insulation is intact and the tape/clamps are secure.

Illustration 5-59: Coldhead O-Ring Placement



3. Inspect the electrical cable and connector. Make sure it is not cracked or broken and that no wires are loose or exposed (insulation split or missing).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4. Remove the Transition Flange O-Ring (46-281247P1) from its packaging and inspect for any visible damage (i.e. broken, nicked, cut, etc.).

5. Clean the o-ring and the o-ring groove in the transition flange with a lint-free cloth or towel. Apply a thin film of vacuum grease to the entire surface of the o-ring.

6. Slide the lubricated o-ring over the two stations of the Coldhead and place in the groove of the transition flange. See Illustration 5-59.

7. Clean the first stage heat station with a Scotch Brite™ pad to remove all residue before installing its gasket.



NOTICE

Make sure the 0.125 inch (3.2 mm) wide aluminum tape strips are indented into the notches in the first stage surface and that the 0.25 inch (6.4 mm) wide circumferential tape wrap does not cover the second stage vent hole. Both are required to allow adequate second stage venting during vacuum pumping.

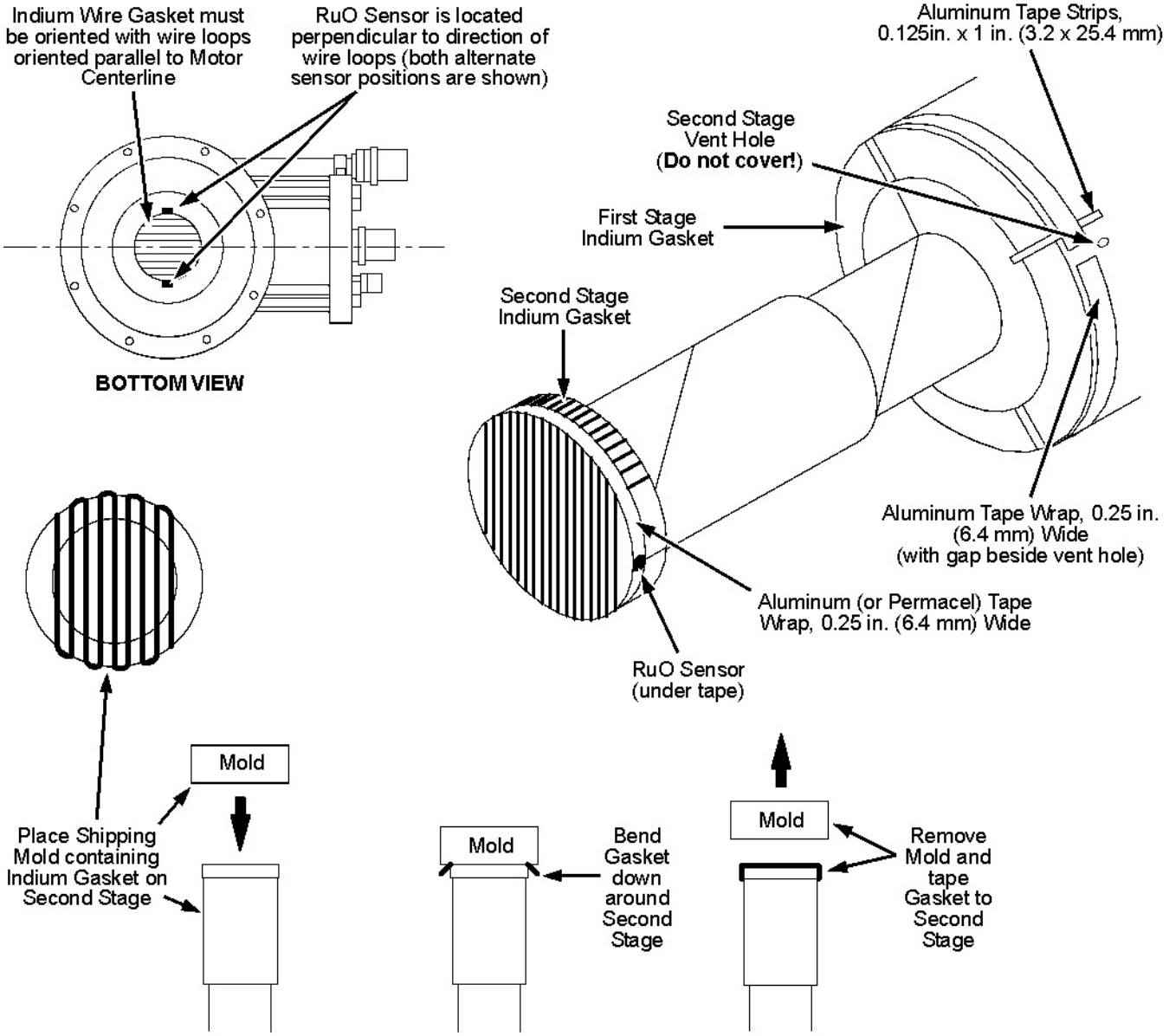
NOTE: While assembling the new indium gaskets on the first and second stage heat stations of the Coldhead, wear the cloth gloves provided in the Gasket Kit.

8. Place the large indium gasket on the large copper first stage heat station of the Coldhead. Secure the gaskets to the surface of the station by putting pressure on the gasket, forcing indium **INTO** the small notches in the surface of the station. To prevent the large gasket falling from off the Coldhead during installation, use 0.125 inch x 1 inch (3.2 mm x 25.4 mm) strips of aluminum tape (46-260802P6), followed by a 0.25 inch (6.4 mm) wide circumferential tape wrap (46-260802P1 cut lengthwise) with a gap left at the second stage vent hole. Make sure the second stage vent hole is **NOT** covered. Do not use Permacel tape (46-252282P1) on the first stage. See Illustration 5-60.

NOTE: Aluminum tape 46-260802P1 is 0.5 inch (12.6 mm) wide and must be cut lengthwise into 0.25 inch (6.4 mm) wide strips before usage.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-60: Installation of Indium Gaskets



9. Clean the second stage heat station with a Scotch Brite™ pad to remove all residue before installing its gasket.

10. Place the indium wire gasket over the Coldhead second stage, orienting the gasket's length with the motor and perpendicular to the RuO sensor. Fold the gasket's wire loops over the station's side. Tape circumferentially with 0.25 inch (6.4 mm) wide aluminum (46-260802P1 cut lengthwise) or Permacel (46-252282P1) tape. Be very careful not to damage the small RuO sensor wires. See Illustration 5-60.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

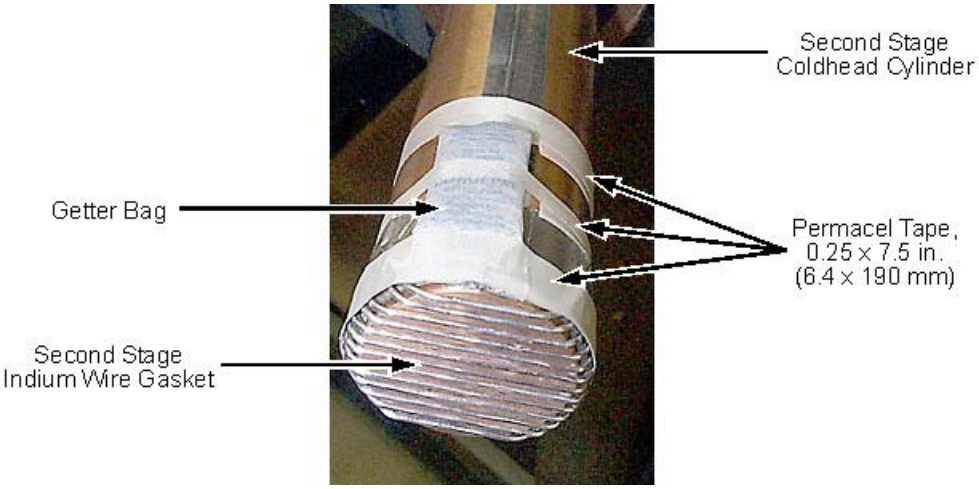
NOTE:

- On the first stage aluminum tape **MUST** be used. On the second stage either aluminum (46-260802P1) or Permacel (46-252282P1) tape can be used.
- Aluminum tape 46-260802P1 and Permacel tape 46-252282P1 are 0.5 inch (12.6 mm) wide and must be cut lengthwise into 0.25 inch (6.4 mm) wide strips before usage.

11. Install a getter bag to the side of the second stage with three circumferential wraps using 0.25 inch (6.4 mm) wide by 7.5 inch (190 mm) Permacel tape. **DO NOT** use aluminum tape to install the getter bag. Make sure the bag is tightly secured in place. See Illustration 5-61.

NOTE: Permacel tape 46-252282P1 is 0.5 inch (12.6 mm) wide and must be cut lengthwise into 0.25 inch (6.4 mm) wide strips before usage.

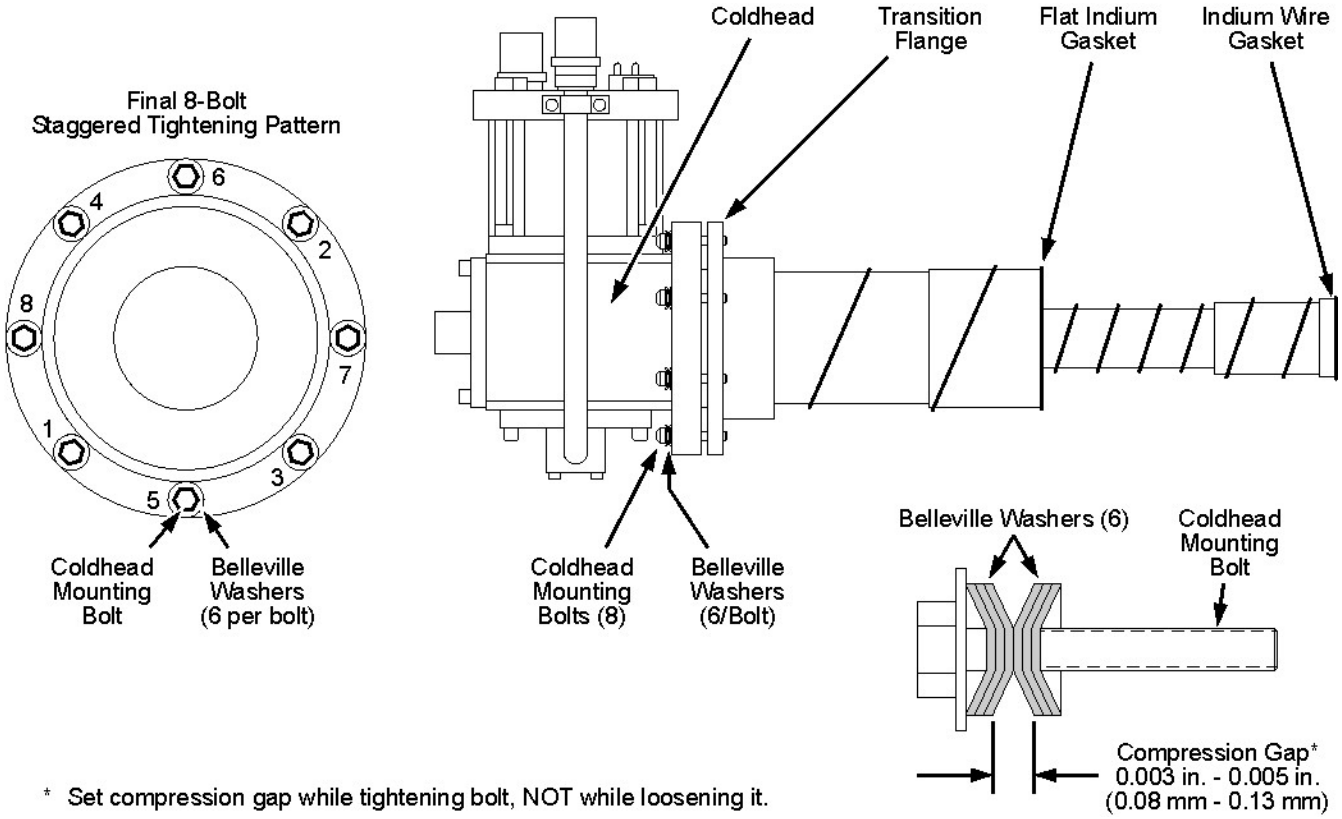
Illustration 5-61: Installed Getter Bag



12. Apply a thin film of anti-seize compound to the eight hex head bolts that were removed. Make sure that all bolts have the same number and orientation of washers shown in Illustration 5-62.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-62: Coldhead Mounting Bolt Gap Setting



10.4.4 Coldhead Replacement

10.4.4.1 Before Coldhead Insertion

NOTICE

Make sure the following critical conditions are confirmed prior to inserting new Coldhead into sleeve:

- **Make sure Recondenser temperature reading is approximately 275K on the RuO Temperature Monitor (2171219) or a Lakeshore 208 Digital Thermometer.**
- **Shine a flashlight through the plexiglas cover and make sure that no visible ice is present on the first and stage stage heat stations of the Coldhead sleeve before turning off gas flow and removing cover. If ice is present, remove it with warm nitrogen gas.**
- **Make sure a new Coldhead is completely prepared and ready for insertion before removing the plexiglas cover. Insert the new Coldhead immediately after cover removal to prevent cryopumping in the sleeve.**

NOTICE

Do not exceed a monitored Recondenser temperature of 285^{O} to prevent possible internal damage.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Read the recondenser temperature as monitored by the SI-410 Diode read-out on the Magnet Monitor. If the temperature is 275K (± 10K), turn off the flow of gas and then disconnect the gas hose.

NOTE: SI-410 temperatures can be monitored on a laptop computer connected to the Magnet Monitor.

2. Remove the Plexiglas Cover Plate/Heater Assembly.

3. Connect the gas hose to the gas inlet valve (green handle) on the Service Adapter.

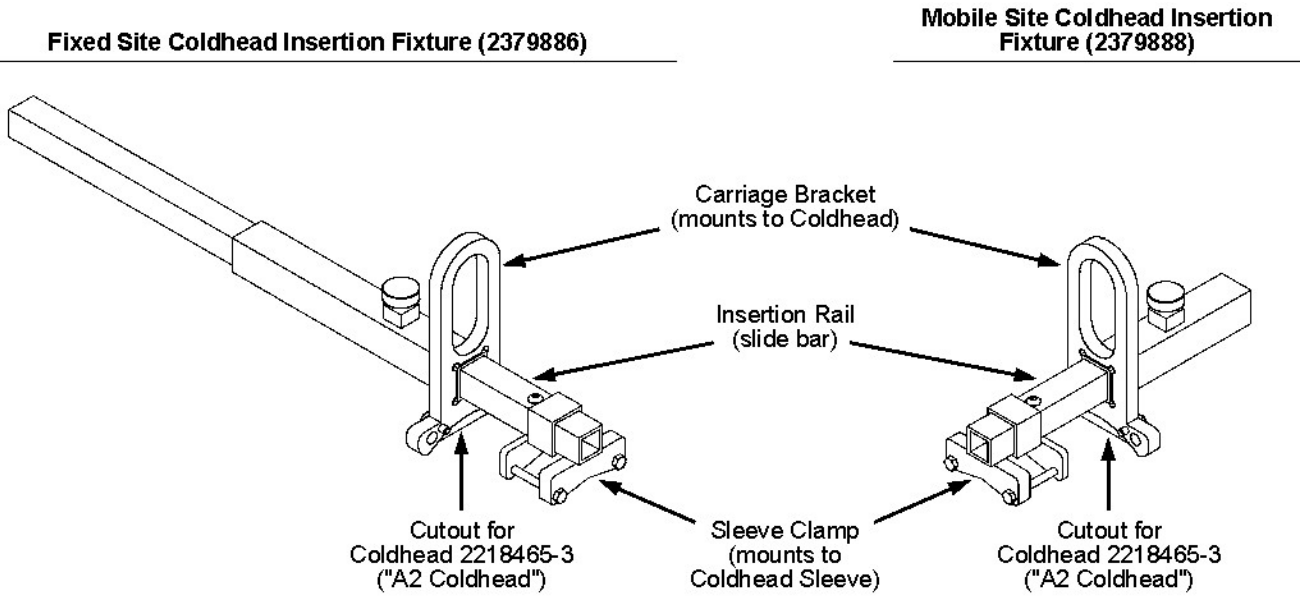
4. Open the gas valve (green handle). If using nitrogen gas, set the flow to 1 psig on the low pressure regulator. If using helium gas, the flow will be magnet pressure.

5. Lift and insert the new Coldhead into the sleeve in conformance with Section 10.4.4.2 for fixed sites or with Section 10.4.4.3 for mobile sites.

10.4.4.2 Coldhead Insertion, Fixed Site

1. Remove the carriage bracket from the insertion rail of the Fixed Site Coldhead Insertion Tool. See Illustration 5-63.

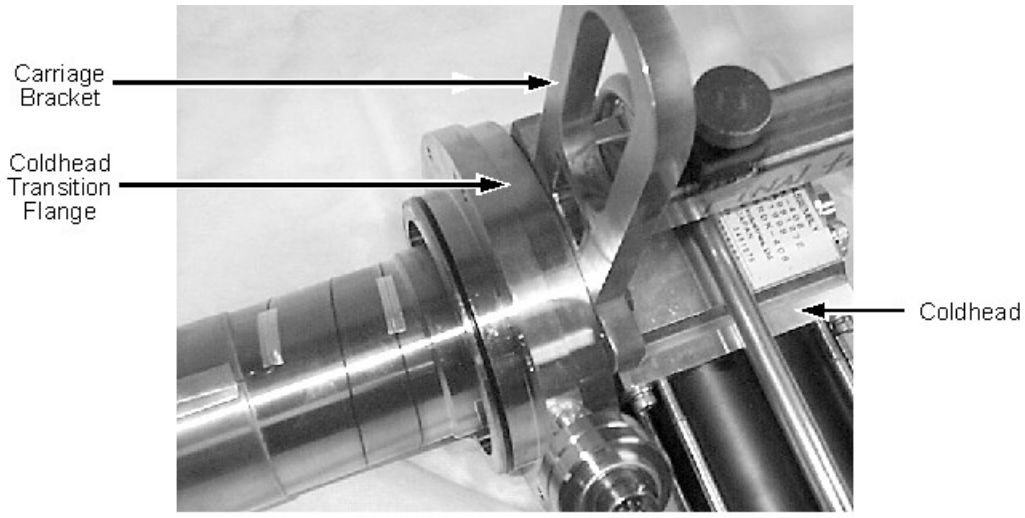
Illustration 5-63: Major Components, LCC Coldhead Insertion/Removal Fixtures



2. Assemble the carriage bracket onto the Coldhead transition flange by tightening the bracket's screws. See Illustration 5-64.

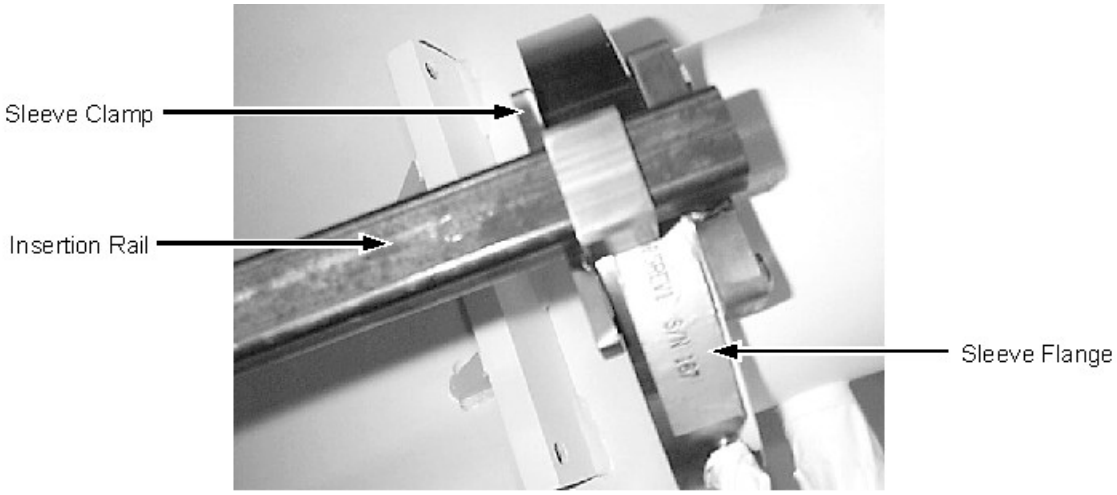
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-64: Connecting Carriage Bracket to Coldhead Tranisition Flange



3. Make sure the insertion rail's sleeve clamp is secured to the Coldhead sleeve. Tighten the clamp's screws to secure the rail to the sleeve, if not already tight. See Illustration 5-65.

Illustration 5-65: Connecting Insertion Rail to Sleeve Flange





⚠ CAUTION

Heavy Object
The Coldhead and carriage bracket together weigh approximately 50 pounds (22.7 kg).
It is not recommended to hand carry more than 35 pounds (15.9 kg). Dragging a cardboard box containing the Coldhead and carriage bracket is preferred when moving a Coldhead to or from the magnet. Do not use a cart unless it is proven before use to not contain magnetic materials.

4. Work Assistant: Position the prepared replacement Coldhead and carriage bracket in a cardboard box (or proven nonmagnetic equivalent).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL PROJECTILE HAZARD
FERROMAGNETIC OBJECTS IN A STRONG MAGNETIC FIELD CAN BECOME DANGEROUS PROJECTILES.
DO NOT LIFT OR CARRY A COLDHEAD DIRECTLY PAST THE END OF THE MAGNET TO PREVENT IT BEING DRAWN INTO THE BORE.



CAUTION

Potential Projectile Hazard
Coldheads contain ferrous material that will be attracted to a magnet at field. Always keep one hand supporting the Coldhead Motor, especially when near the magnet's rear.



CAUTION

Heavy Object
The Coldhead and carriage bracket together weigh approximately 50 pounds (22.7 kg).
Support the Coldhead with the Mobile Site Coldhead Lifting Tool and one hand under the Coldhead motor.



NOTICE

Transport new Coldhead to the Coldhead sleeve without delays and in strict conformance with this Coldhead Replacement procedure to minimize exposure to magnetic field and degassing of the motor.

5. Securely grip the cardboard box containing the Coldhead and carefully drag along the magnet room wall and then to the Service Ladder/Platform. Do not come near the magnet bore.

6. Carefully lift and place the Coldhead and carriage bracket onto the Service Ladder/Platform, keeping it away from the magnet bore and outer surface of the magnet.



WARNING

POTENTIAL PERSONAL INJURY HAZARD
COLDHEADS CONTAIN FERROUS MATERIAL THAT WILL BE ATTRACTED TO A MAGNET AT FIELD. INJURIES CAN HAPPEN DURING THE FOLLOWING STEP IF NOT PERFORMED CAREFULLY.
DO NOT ALLOW THE COLDHEAD TO CONTACT THE MAGNET VESSEL DURING REMOVAL OR REPLACEMENT.

7. Check the orientation of the Coldhead Motorshield and orient the Coldhead's motor to match. Then carefully lift and slide the Coldhead and carriage bracket onto the insertion rail with Coldhead Motor turned towards the plumbing area of the magnet.



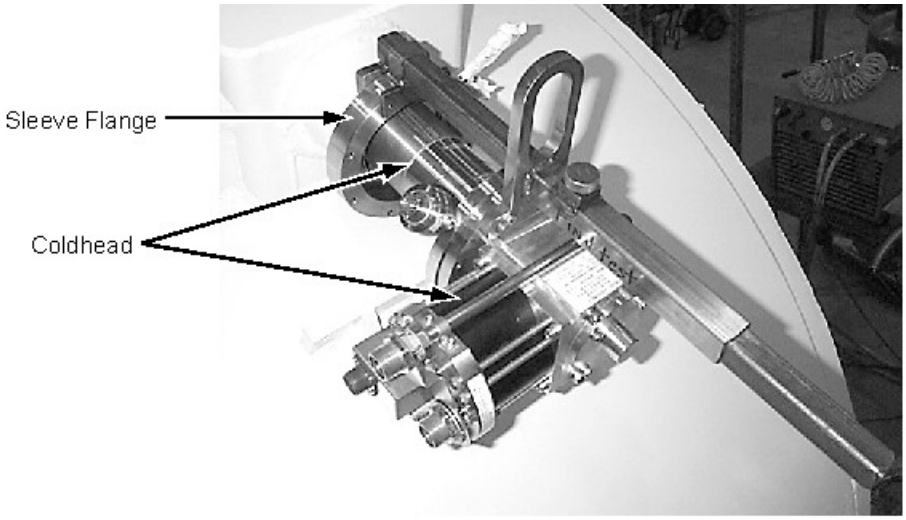
NOTICE

Make sure to NOT pinch the transition flange o-ring when inserting the Coldhead into the sleeve.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8. Slide the Coldhead and carriage bracket along the insertion rail until the Coldhead enters the sleeve, and the Transition Flange O-Ring is inside the sleeve flange. See Illustration 5-66.

Illustration 5-66: Inserting Coldhead into Sleeve



9. Remove the carriage bracket from the Coldhead flange.

10. Continue with Section 10.4.4.4.

10.4.4.3 Coldhead Insertion, Mobile Site

1. Temporarily remove the Belleville washers from two bolts. These will be used to insert the new Coldhead.

2. Assemble the carriage bracket of the LCC Mobile Site Coldhead Insertion Tool onto the Coldhead transition flange by tightening the bracket's screws. See Illustration 5-64.

3. Assemble the insertion rail's sleeve clamp onto the sleeve flange. Tighten the clamp's screws. See Illustration 5-65 and Illustration 5-66.

4. Make sure the Mobile Site Coldhead Lifting Tool has been assembled and the rail stops set in conformance with Section 10.4.1.3, Step 1 - Section 10.4.1.3, Step 6. If the site is an AK van, make sure the internal crossbeam section has been removed in conformance with Section 10.4.1.3, Step 7.



⚠ CAUTION

Heavy Object
The Coldhead and carriage bracket together weigh approximately 50 pounds (22.7 kg).
Support the Coldhead with the Mobile Site Coldhead Lifting Tool and one hand under the Coldhead motor.

5. Carefully attach the new Coldhead to the pulley of the Mobile Site Coldhead Lifting Tool at the rear of the mobile.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

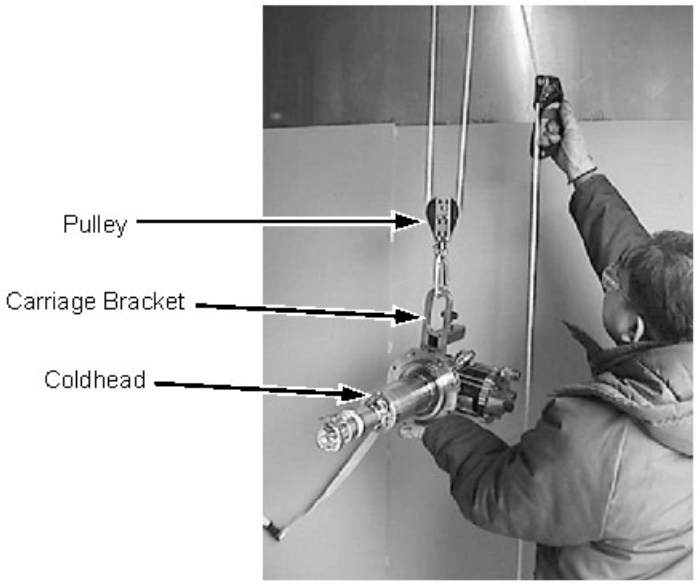


CAUTION

Potential Projectile Hazard
Coldheads contain ferrous material that will be attracted to a magnet at field. Keep the new Coldhead away from the magnet.

6. Raise the Coldhead until the pulley is at maximum height. See Illustration 5-67.

Illustration 5-67: Raising & Lowering the Coldhead





DANGER

PERSONAL INJURY HAZARD!
THE COLDHEAD CAN COME CRASHING DOWN (DUE TO WEIGHT) OR TOWARDS THE MAGNET (DUE TO MAGNETIC ATTRACTION) AND THUS CAUSE INJURY IF THE LCC MOBILE SITE COLDHEAD LIFTING TOOL'S ASCENDER IS NOT POSITIONED CORRECTLY WHEN THE COLDHEAD IS MOVED TO/FROM THE MAGNET.
MAKE SURE THE LCC MOBILE SITE COLDHEAD LIFTING TOOL'S ASCENDER IS POSITIONED CLOSE TO THE CLEAT ASSEMBLY BEFORE MOVING A COLDHEAD TO/FROM THE MAGNET. THE ASCENDER ACTS AS A SAFETY BACK-UP MECHANISM TO ASSURE THE COLDHEAD DOESN'T COME CRASHING DOWN.

7. Slowly move the Coldhead along the mobile site's rail system to the mounting location.



CAUTION

Potential Projectile Hazard
Coldheads contain ferrous material that will be attracted to a magnet at field. Always keep one hand supporting the Coldhead Motor, especially when near the magnet's rear.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

Transport new Coldhead to the Coldhead sleeve without delays and in strict conformance with this Coldhead Replacement procedure to minimize exposure to magnetic field and degassing of the motor.

8. Carefully slide the Coldhead and carriage bracket onto the insertion rail with Coldhead Motor turned towards the plumbing area of the magnet. Use the lifting tool to support the Coldhead's weight.

NOTICE

Make sure to NOT pinch the transition flange o-ring when inserting the Coldhead into the sleeve.

9. Slide the Coldhead and carriage bracket along the insertion rail until the Coldhead enters the sleeve, and the transition flange o-ring is inside the sleeve flange. See Illustration 5-66.

10. Remove the carriage bracket from the Coldhead flange.

11. Continue with Section 10.4.4.4.

10.4.4.4 After Coldhead Insertion

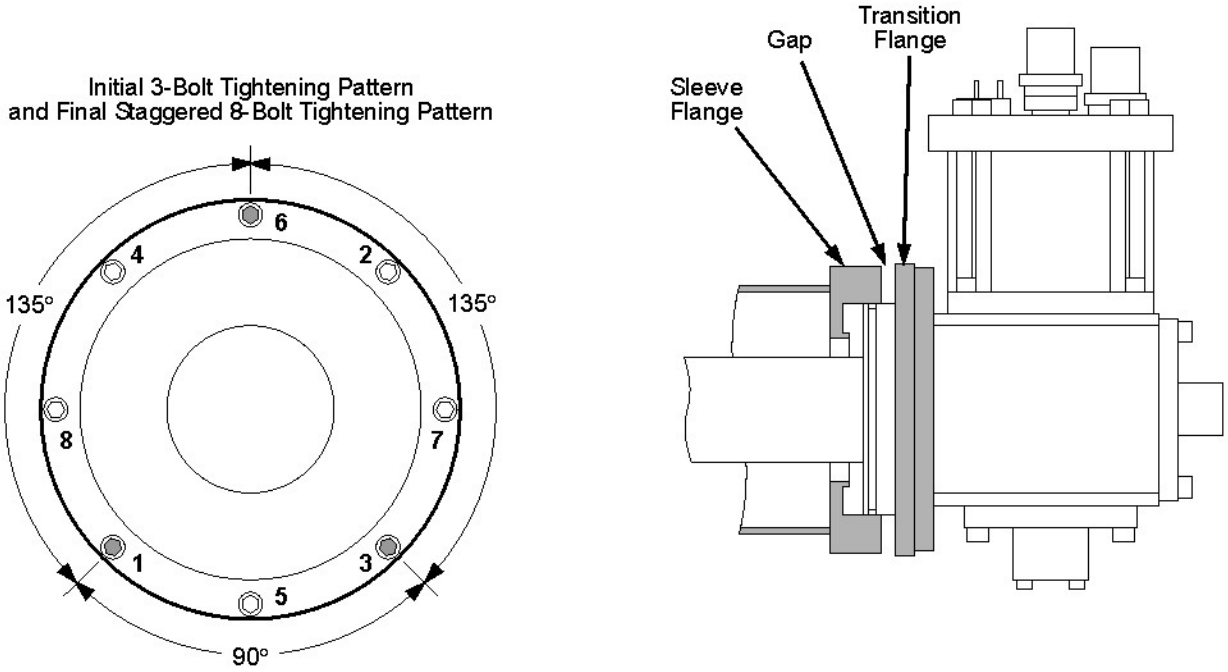
1. Temporarily remove the Belleville washers from three bolts.

2. Insert the three bolts prepared without Belleville washers in the mounting holes spaced 90°, 135° and 135° around the Coldhead flange. This is the initial 3-bolt tightening pattern shown in Illustration 5-68.

NOTE: Make sure to maintain an even gap between the transition and sleeve flanges around the full circumference during insertion and tightening. See Illustration 5-68.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-68: 3-Bolt and 8-Bolt Tightening Patterns; Sleeve and Transition Flange Gap

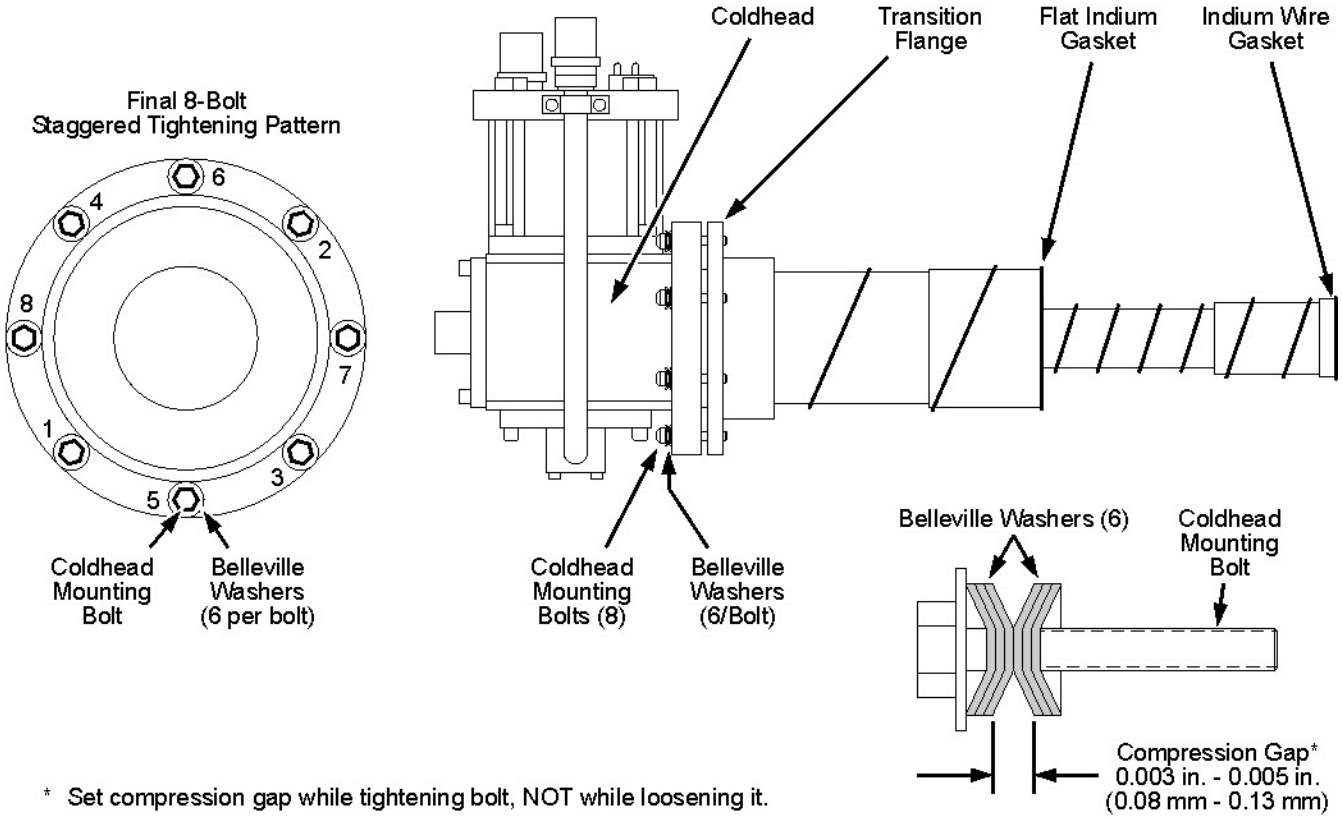


3. Thread and evenly tighten the three bolts, giving each a quarter-turn at a time, until the o-ring is fully captured into the sleeve. Immediately close the gas flow valve (green handle) on the Service Adapter.

4. Remove the three bolts and re-assemble with Belleville washers on each. Make sure the Belleville washers are in the proper orientation (as shown in Illustration 5-69) on all eight bolts.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-69: Coldhead Mounting Bolt Gap Setting



5. Thread and evenly tighten six Coldhead mounting bolts with Belleville washers into the Coldhead transition flange until a 0.015 inch (0.38 mm) gap exists between the Coldhead transition flange and the Coldhead Insertion/Removal Fixture mounting bracket.

NOTE: Two mounting holes are blocked by the Coldhead Insertion/Removal Fixture bracket.

6. Remove the insertion rail from the Coldhead sleeve, saving the clamping bolts in their holes in the insertions rail's sleeve clamp.

7. Assemble the remaining two mounting bolts with Belleville washers in the proper orientation into the Coldhead transition flange. See Illustration 5-69.

NOTICE

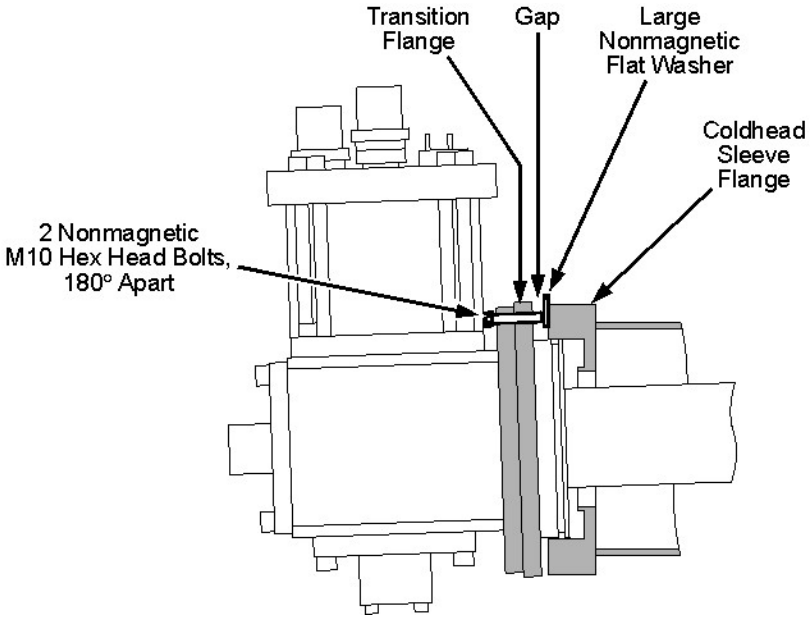
Make gap adjustments before the Belleville washers have been compressed. Make only small adjustments at a time to prevent cocking the Coldhead and placing a bending moment on the mounting bolts.

8. Continue tightening the Coldhead mounting bolts in the staggered pattern shown in Illustration 5-69 until the gap between the Belleville washer stacks on all bolts is 0.015 inch (0.38 mm).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTE: Gap adjustments can be made before fully tightening the mounting bolts by using two flathead screwdrivers wedged between the transition and sleeve flanges. Gap adjustments can also be made by temporarily removing the desired mounting bolt, inserting and fully threading a M10 x 50 mm (2 inch) long hex head bolt through the transition flange and using that bolt like a jack screw against a flat washer on the sleeve flange to wedge open the gap slightly. See Illustration 5-70.

Illustration 5-70: Adjusting Sleeve and Transition Flange Gap Using M10 Jackscrews



9. If using helium gas instead of nitrogen gas:

   a. Close the Nupro valve on the shim lead and then disconnect the helium vent hose from the Service Adapter's gas inlet valve (green handle).

   b. Connect the Backfill Air Hose (5111335) to the Service Adapter's gas inlet valve (green handle).

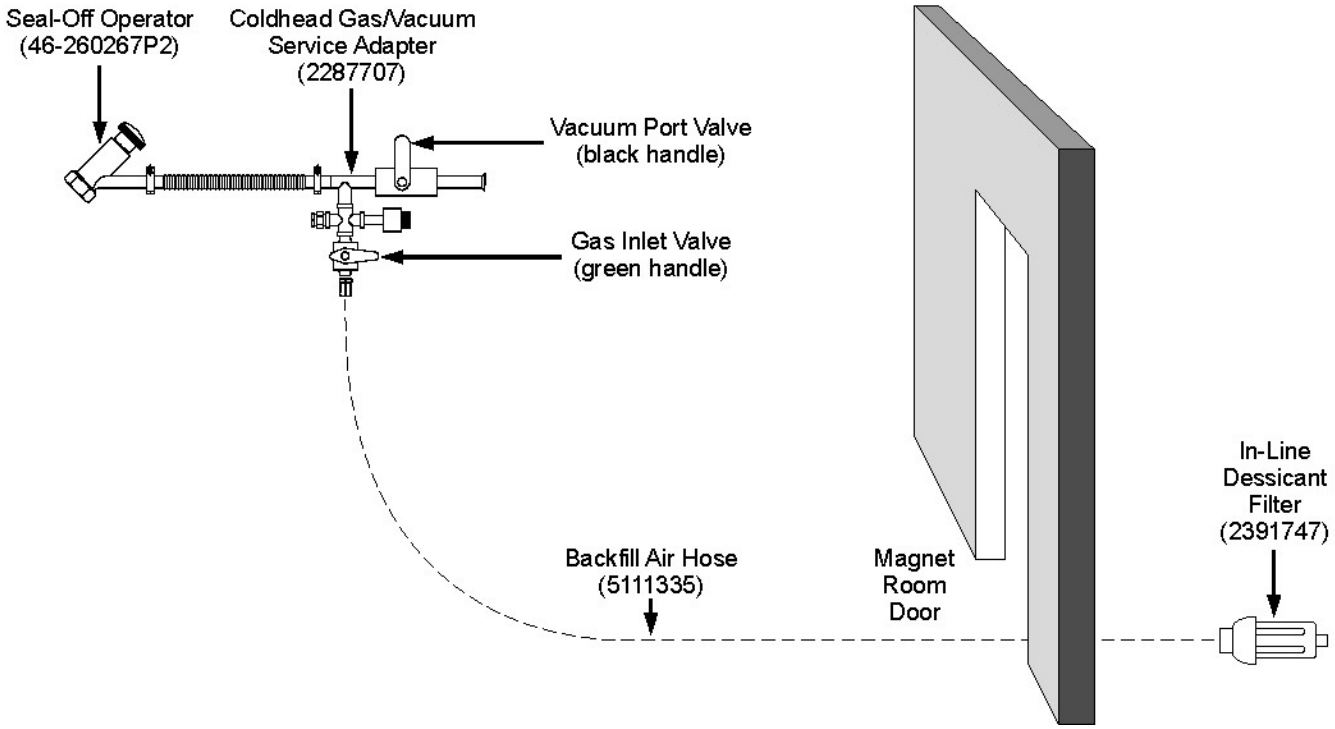
   c. Route the Backfill Air Hose to outside the magnet room.

   d. Connect the In-Line Dessicant Filter's (2391747) female fitting to the Backfill Air Hose's .25NPT pipe thread outside the magnet room. See Illustration 5-71.

NOTE: Make sure NOT to lose the plugs in either end of the In-Line Dessicant Filter. Replug the filter immediately after use to prevent filter contamination between uses.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-71: Air Backfill Connections



e. With the vacuum pump operating, open the Service Adapter's gas inlet valve (green handle) and vacuum valve (black handle). Evacuate the Backfill Hose for 10 seconds and then close the gas inlet valve (green handle).

f. Evacuate the sleeve space while the vacuum valve (black handle) remains open.

g. When the vacuum reaches 100 millitorr (100 microns), close the vacuum valve (black handle).

h. Open the Service Adapter's gas flow valve (green handle) to allow air from the Backfill Air Hose to flow into the sleeve

i. When the pressure within the sleeve reaches 1 atmosphere, close the gas flow valve (green handle).

j. Repeat Step 9.f - Step 9.i a total of ten times (i.e., ten evacuation/backfill cycles). After the tenth time, continue with Step 11.

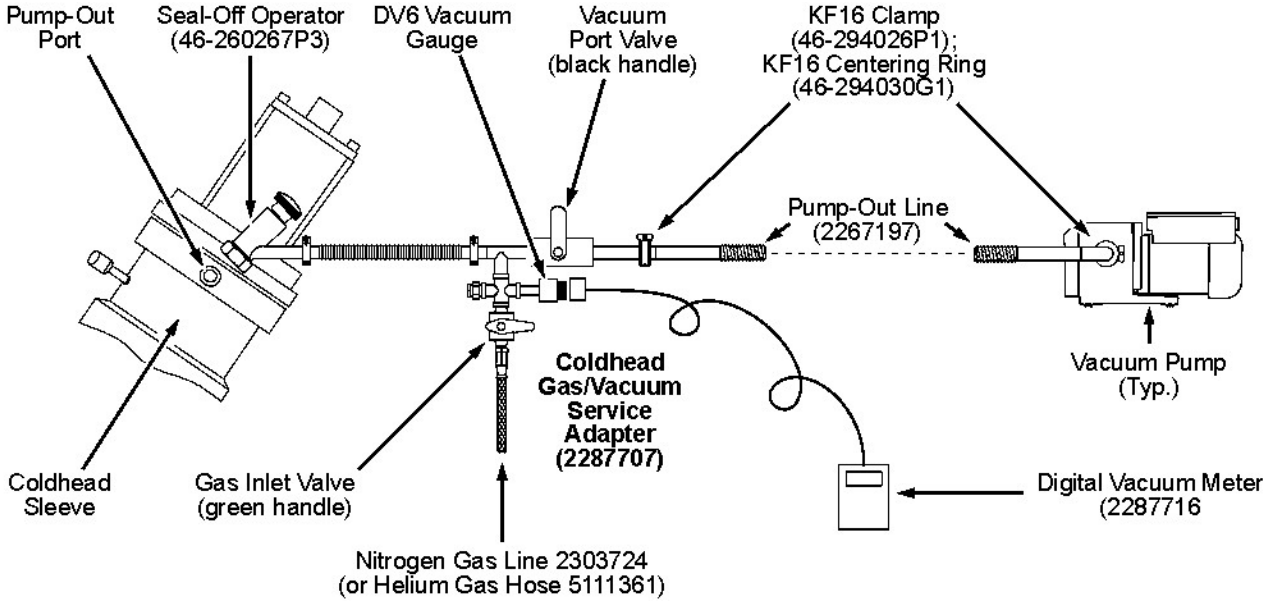
NOTE: If the time required for the fifth pumpdown/backfill cycle is not noticably less than for the first cycle, helium gas is contaminating the backfill. Verify that the Backfill Air Hose is reaching noncontaminated air and that all connections delivering air to the sleeve are air tight.

10. If using nitrogen gas:

a. With the vacuum pump operating, open the Service Adapter's vacuum valve (black handle) to evacuate the sleeve space. See Illustration 5-72.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-72: Vacuum Pump Apparatus Set-Up



b. When the vacuum reaches 50 millitorr (50 microns), close the vacuum valve (black handle).

c. Open the Service Adapter's gas flow valve (green handle) to allow nitrogen gas to flow into the sleeve.

d. When the pressure within the sleeve reaches 1 atmosphere, close the gas flow valve (green handle).

e. Repeat Step 10.a - Step 10.d a second time (i.e., two evacuation/backfill cycles).

11. Open the Service Adapter's vacuum valve (black handle) and continue evacuating the sleeve while performing Section 10.4.5.

10.4.5 Coldhead Interface Adjustment

NOTICE

- **It is very important to establish complete contact between the second stage heat station of the Coldhead and sleeve to have a minimal temperature gradient and good heat transfer from the Recondenser.**
- **A poor temperature gradient will result in increased cryostat pressure and less time between a Cryocooler shutdown from a power outage or improper cooling and the loss of helium through the relief valve.**
- **Observe second stage Coldhead and Recondenser temperatures to determine that complete contact is made. The temperature difference must be within specification.**

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

It is important to perform all Coldhead adjustments prior to turning the Coldhead on. This will allow the second stage gasket to compress and fill the gaps at the second stage interface before the gasket cools and hardens in the sleeve.

1. Tighten the Coldhead bolts a half-turn each in the staggered pattern shown in Illustration 5-69 to set the gap between Belleville washers on all bolts evenly with a 0.015 inch (0.38 mm) feeler gauge. Wait one minute, and repeat the bolt tightening, setting the gap between Belleville washers evenly with a 0.010 inch (.25 mm) feeler gauge. After another minute tighten all bolts again and use a 0.003 inch - 0.005 inch (0.08 mm - 0.13 mm) feeler gauge to set a 0.003 inch - 0.005 inch (0.08 mm - 0.13 mm) gap between Belleville washers on all bolts.

NOTE: Make sure an even gap is maintained between the transition and sleeve flanges around the full circumference.

2. Allow the Coldhead to sit “warm" and the sleeve to evacuate for 15 minutes, checking and maintaining a 0.003 inch - 0.005 inch (0.08 mm - 0.13 mm) Belleville washer gap on all Coldhead bolts.

NOTICE

Do not put any bending force on Aeroquip fittings while connecting/disconnecting helium flexlines. A bending force will create difficulty in the rapid engagement/disengagement required to prevent helium loss and system contamination. Do support the gas lines when connecting/disconnecting to the Coldhead at the top of the magnet or to the Compressor.

NOTICE

Make sure the helium flexlines are connected in the sequence stated below. Gas back pressure may prevent the Coldhead from starting if gas lines are connected in the reverse sequence. Order and technique are important when connecting helium flexlines to prevent inoperative Coldheads and system contamination.

NOTE: Make sure the o-ring on the female Aeroquip fitting at the Coldhead is present and in good condition.

3. During the 15 minute period the Coldhead sits “warm," connect the Coldhead gas lines in the following sequence:

   a. **FIRST**: connect the **return** flexline (green mark)

   b. **SECOND**: connect the **supply** flexline (yellow mark)

4. Make sure the digital vacuum meter reads < 20 millitorr (< 20 microns) and that the sleeve has been evacuated for at least 15 minutes, then close the Pump-Out Port Operator by pushing the knob in and gently rotating it clockwise (CW). Next rotate the knob counterclockwise (CCW) until the knob extension is fully disengaged from the pump-out port. Do **not** pull the knob out at this time.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5. When the Pump-Out Port Operator is closed, close the Service Adapter's vacuum valve (black handle). Observe the vacuum meter while pulling out the pump-out port knob about 2 inches (50 mm). A decreasing reading means the vacuum has increased due to the pump-out port plug moving during operation. If no change is observed, continue with Coldhead Replacement.

6. Remove lockout/tagout and connect the Coldhead power cable in conformance with Chapter 3, Section 1.5, Cryocooler Installation and Checkout.

7. Turn off the vacuum pump and open the gas inlet valve (green handle) to vent system. Disconnect and remove all apparatus.

NOTE: If helium gas was used, remember to disconnect and plug the dessicant filter and to reattach the quick disconnect fitting to the Service Adapter's gas inlet valve (green handle) using two wrenches.

8. Close the Coldhead motor shield and resecure using the .25-20UNC stainless steel socket head cap screws removed earlier.

9. Check the Belleville washer gaps. Tighten as necessary to achieve 0.003 inch - 0.005 inch (0.08 mm - 0.13 mm) gaps.

10. Turn the Cryocooler on. Connect Portable RuO Temperature Monitor 2171219 and monitor second stage temperatures for Coldhead and Recondenser cooldown.

11. When temperature equilibrium is reached, make sure:

    - The Recondenser temperature is < 4.4K.
    - The Coldhead - Recondenser second stage temperature difference is < 0.2K.

NOTE: The RuO sensor reading of second stage Coldhead temperature may show a small oscillation of 0.1K - 0.3K due to Displacer motion and sampling rate. If this occurs, average the maximum and minimum temperature readings.

12. If the readings found in Step 11 are out of acceptable range, make minor adjustments (if possible) and/or repeat the Coldhead replacement procedure with the same Coldhead.

13. Replace enclosures removed.

14. Return the Magnet Monitor to normal operation by reenabling the Magnet Monitor's Master Alarm and Vessel Pressure Control or by turning Magnet Monitor power on.

10.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

11 Burst Disc Replacement

11.1 Burst Disc (2349529) Replacement

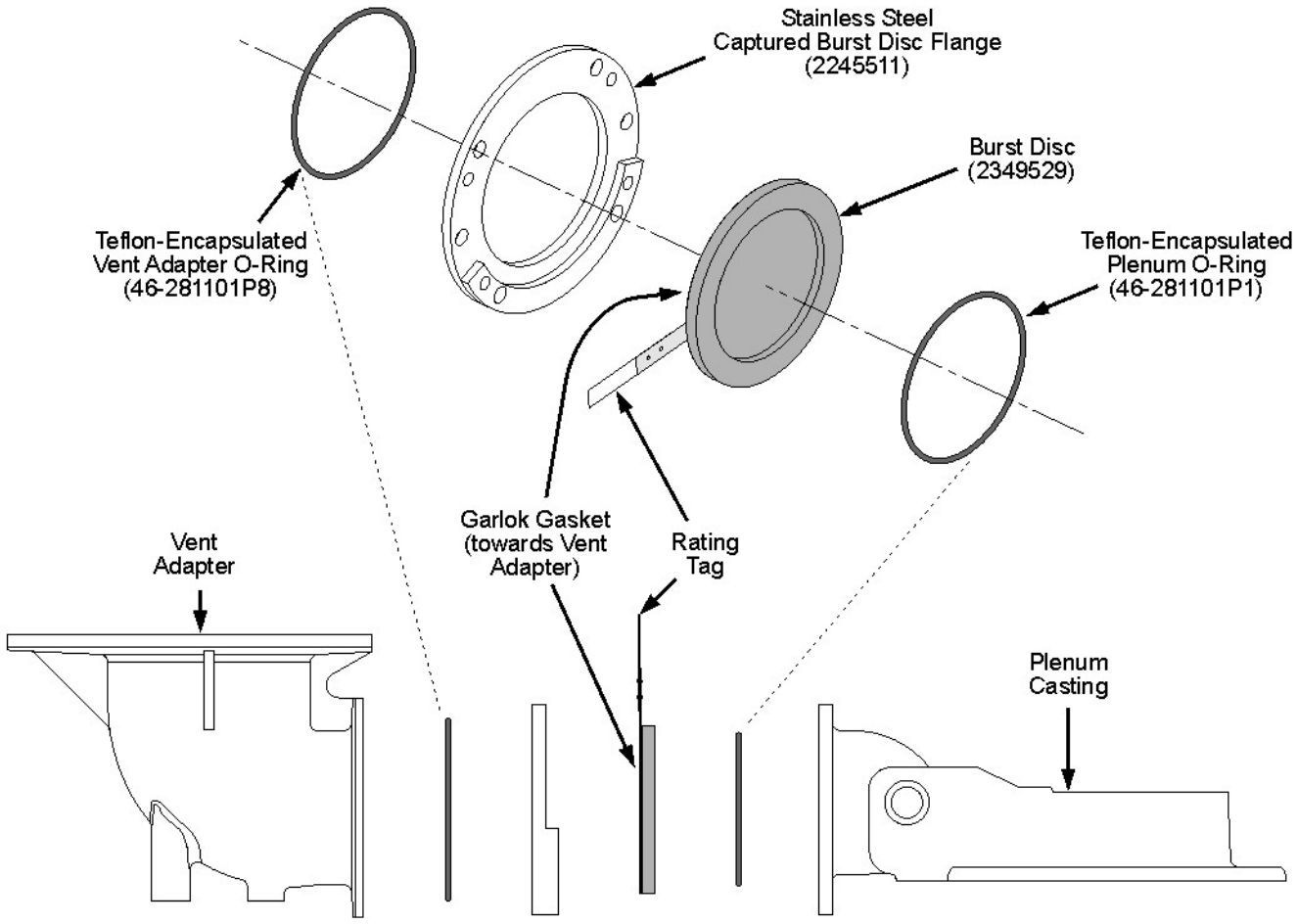
11.1.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	1 hour	Included in 'Procedure'

11.1.2 Overview

Burst Disc 2349529 replacement is required as a result of rupture during a magnet quench or as the result of a defect. The Burst Disc and retaining assembly has been designed to minimize gasket leaks and Burst Disc cracks which develop over time from exposure to cold helium during fill. Burst Disc 2349529 also eliminates thermal expansion prestress problems. The design, shown in Illustration 5-73, contains a Teflon encased o-ring mounted in the Plenum Flange to contact the cold/pressure side of the Burst Disc and a vertical "slide in" Burst Disc replacement significantly reducing gasket cracks and replacement difficulties.

Illustration 5-73: Burst Disc and Retaining Assembly



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTE: If the Burst Disc from the Field Spare Parts kit is used, order a new Burst Disc (2349529) for the kit.

11.1.3 Preliminary Requirements

11.1.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long-sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Digital Voltmeter (DVM), Volt-Ohm Meter (VOM) or non-contact voltage tester	1	-	-	-
Medium Grade Extension Cord, 12 feet - 20 feet (3.5 M - 6 M)	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Portable Oxygen Monitor	1	-	2287000	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
Helium Regulator and Hose Kit	1	-	46-306734G1	-
Nonmagnetic Helium Cylinder Cart	1	-	46-258150P1	-
Flexible Helium Gas Hose, 40 feet (12.2 meters) (optional)	1	-	46-271135P1	-
Heat Gun	1	-	46-306830G3	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Portable Leak Detector (optional)	1	-	2270571	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

11.1.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Vacuum Grease (included in Field Spares Kit 46-294744G5)	1	-	46-252065P24	-
99.999% (“five nines”) Helium Gas, 235 SCF Nonmagnetic Cylinder	1	-	-	-
Leak detection fluid (e.g., Snoop, Bird Dog Quart Spray (p/n DOG-1Q), Big Blue (p/n Rt100S or Rt100G) or Leak-Tec)	1	-	-	-

11.1.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
10 psig Burst Disc	1	-	2349529	-
Plenum O-Ring (included in Field Spares Kit 46-294744G5)	1	-	46-281101P1	-
Vent Adapter O-Ring	1	-	46-281101P8	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

11.1.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE BURST DISC (2349529) REPLACEMENT PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THE BURST DISC (2349529) REPLACEMENT PROCEDURE IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING THE BURST DISC (2349529) REPLACEMENT PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE BURST DISC (2349529) REPLACEMENT PROCEDURE.



WARNING

ASPHYXIATION HAZARD!
PROCEDURE GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR.
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE STARTING THE BURST DISC (2349529) REPLACEMENT PROCEDURE.



WARNING

ASPHYXIATION & COLD BURN HAZARD!
A MAGNET QUENCH DURING PROCEDURE COULD RESULT IN RAPID EXPULSION OF LIQUID HELIUM.
MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE STARTING THE BURST DISC (2349529) REPLACEMENT PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



⚠ WARNING

POTENTIAL COLD BURN OR ASPHYXIATION HAZARD
INTERNAL CRYOSTAT PRESSURE BUILD-UP TO > 5.25 PSIG WILL OPEN 5.25 PSIG RELIEF VALVE.
BEFORE REMOVING EITHER RAMP OR FILL PORT CAPS OR LOOSENING ANY COMPONENT RESULTING IN THE RELEASE OF CRYOGEN PRESSURE:

1. **OBSERVE THE INTERNAL CRYOSTAT PRESSURE GAUGE READING,**
2. **SET MAGNET MONITOR PRESSURE TO 0.5 PSIG AND**
3. **VENT CRYOSTAT DOWN TO 0.2 PSIG THROUGH VENT VALVE V2.**



⚠ WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE BURST DISC (2349529) REPLACEMENT PROCEDURE.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN REPLACING THE BURST DISC ON A COLD VENT SYSTEM.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.

NOTE: If the site has Magnet Monitor proprietary software, connect to Magnet Monitor and turn off the alarm for vessel pressure. Then turn the vessel pressure control to a high value of .5 psig and a low value of .4 psig.

11.1.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting the Burst Disc (2349529) Replacement procedure.	Chapter 1, Section 2	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Condition	Reference	Effectivity
The removal of some magnet enclosure components may be required to complete the Burst Disc (2349529) Replacement procedure. Refer to Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with Burst Disc (2349529) Replacement if cover removal is required.	Section 5	-
(continued)	Appendix A, Section 1.1	-
Make sure the magnet is at zero field in conformance with Section 6, Magnet Rampdown to Zero Field, before starting the Burst Disc (2349529) Replacement procedure.	Section 6	-
Make sure power to the Coldhead & Cryocooler is turned off before starting the Burst Disc (2349529) Replacement procedure to prevent migration of cryopumped moisture and ice formation in Recondenser.	-	-
Make sure the magnet room exhaust fan is on and operational before starting the Burst Disc (2349529) Replacement procedure.	-	-
Make sure the magnet room door is propped open before starting the Burst Disc (2349529) Replacement procedure.	-	-

11.1.4 Procedure

11.1.4.1 Preparation



WARNING

POTENTIAL ASPHYXIATION HAZARD
A MAGNET QUENCH DURING PROCEDURE WOULD RESULT IN EXTREMELY RAPID EXPULSION OF LIQUID HELIUM THROUGH THE PLENUM AND VENT ADAPTER AS THE INTERNAL ENERGY OF THE MAGNET QUICKLY DISSIPATES. MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE REMOVING/REPLACING BURST DISC.



NOTICE

To avoid cryopumping, replace a ruptured Burst Disc as soon as the vent pipe has no frost on it. Ice blocks can form inside the exhaust lines and Vertical Stack if the Burst Disc is not replaced promptly.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

Make sure power to the Coldhead & Cryocooler is turned off before starting the Burst Disc (2349529) Replacement procedure to prevent migration of cryopumped moisture and ice formation in Recondenser.

NOTICE

Make sure the area is secure and that ALL required Warning Signs are posted before removing/replacing the Burst Disc.

1. Determine if the magnet is ramped.

NOTE: Usually a Burst Disc failure is the result of a magnet quench.

NOTICE

Make sure resistance is within the “Ramping Circuit Voltage" specified for Ramp Leads in Chapter 4, Section 1, Magnet Functional Checks.

Before initiating rampdown make sure sufficient cold helium gas is exiting the Ramp Lead Extensions to cool the extensions.

If magnet rampdown is prevented because of ...

- **icing,**
- **open main heater circuits or**
- **insufficient resistance or lead extension cooling**

... then contact the Installed Base Group at the Florence, S.C., plant through the regional MAC Team representative or the On-Line Center before proceeding with the Burst Disc (2349529) Replacement procedure.

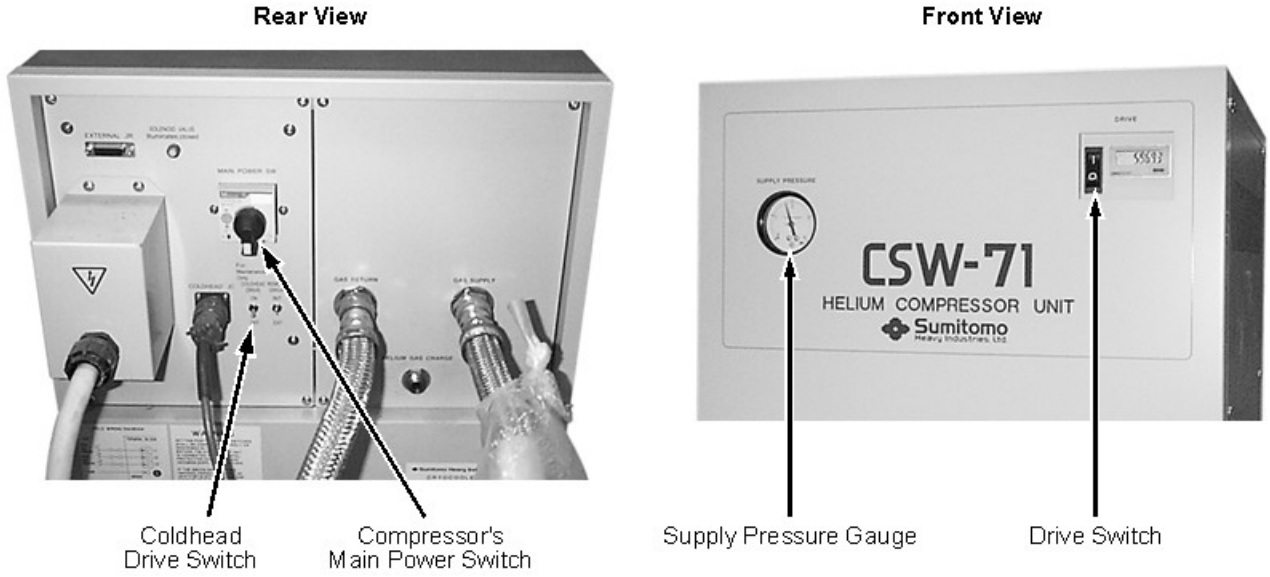
2. If the magnet is ramped, ramp the magnet down in conformance with Section 6, Magnet Rampdown to Zero Field.

3. Shut down the compressor as follows to prevent pressure build-up in the Coldhead:

   a. Turn 'ON' (upwards) the Coldhead Drive Switch on the Compressor's back panel. See Illustration 5-74.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-74: Views of CSW-71D Compressor



b. Place the Drive Switch on the Compressor's front panel in the 'O' (off) position. See Illustration 5-74.

c. Run the Coldhead for 10 seconds (only) with the Compressor turned off to prevent pressure build-up in the Coldhead, then turn 'OFF' the Coldhead Drive Switch and the Compressor's Main Power Switch. See Illustration 5-74.

WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR.

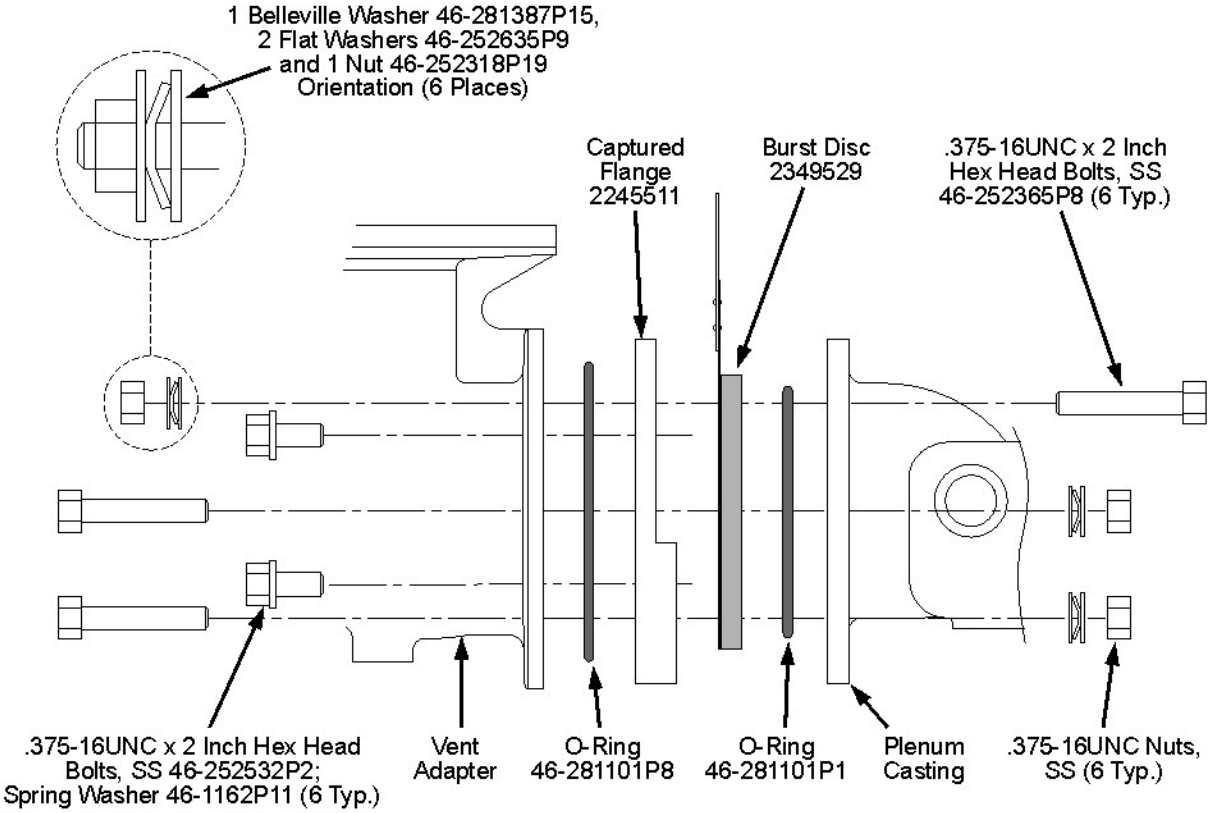
d. Disconnect and lockout/tagout input power to the Compressor. Verify that no voltage is present by using a DVM or equivalent measuring device.

11.1.4.2 Burst Disc Removal

1. Loosen all six retaining bolts on the Burst Disc Retaining Assembly sufficiently to prevent any binding when the Burst Disc is removed and replaced. See Illustration 5-75.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

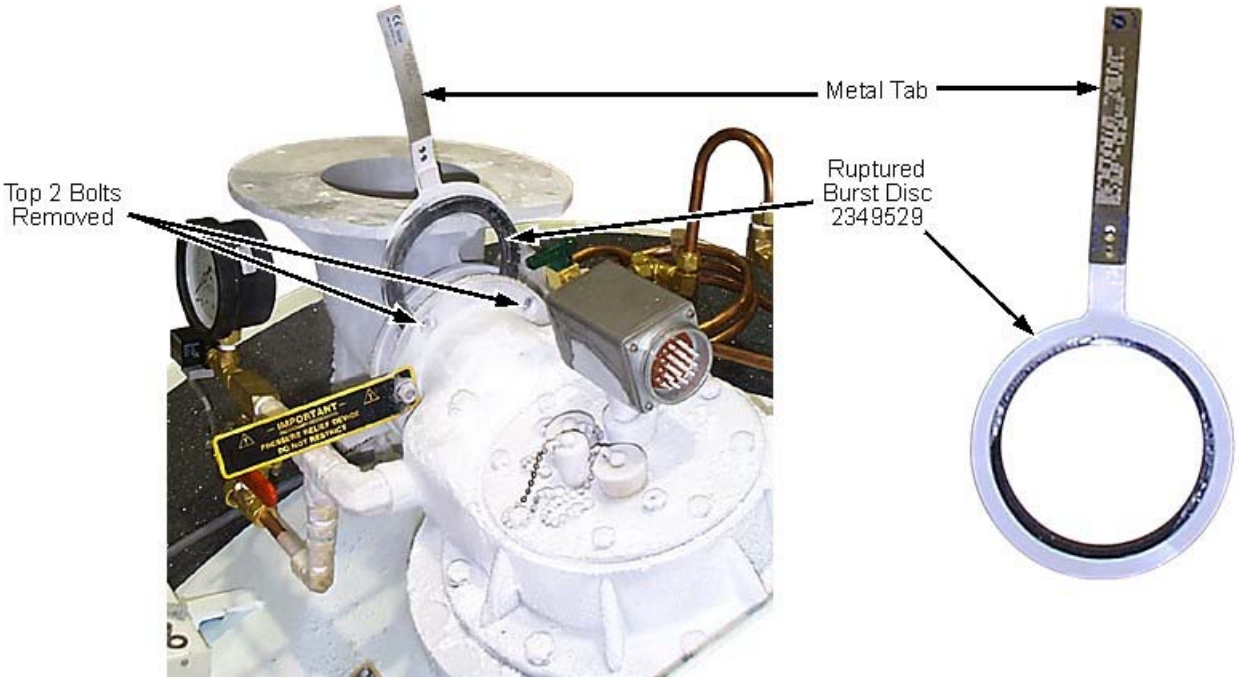
Illustration 5-75: Burst Disc Bolt & Washer Assembly



2. Remove the top two retaining bolts. Make sure the Belleville and flat washers are placed onto the bolts after removal in the same orientation as before removal and that the nuts are screwed onto the bolt to retain the hardware. See Illustration 5-76.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-76: Bolts and Burst Disc Removal



NOTICE

Be careful when removing the old Burst Disc and inserting the new Burst Disc so as not to dislodge the o-ring in the Plenum Flange or scratch the sealing surface of the Flange. If o-ring is dislodged, grease the o-ring with vacuum grease and firmly reinstall it in the groove of the Plenum Flange.

3. Grab the metal tab on the Burst Disc and pull straight up to remove the old Burst Disc. Note the orientation of the Disc. See Illustration 5-76.

NOTE: If the old Burst Disc binds during removal, gently spread the gap between the Plenum and the Captured Flange with a blunt object such as a box-end wrench.

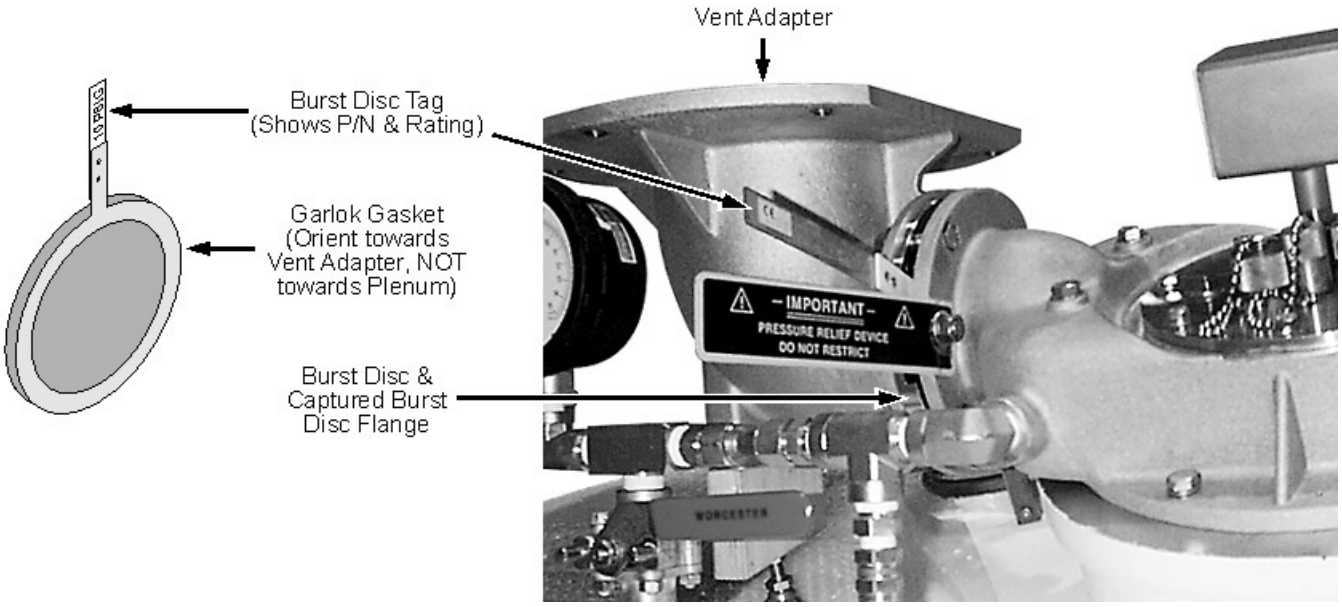
4. Clean any Burst Disc fragments out of the bottom of the Vent Adapter.

11.1.4.3 New Burst Disc Insertion

1. Orient the new Burst Disc with the Garlok Gasket facing the Vent Adapter and the metal tab oriented as in Illustration 5-77.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

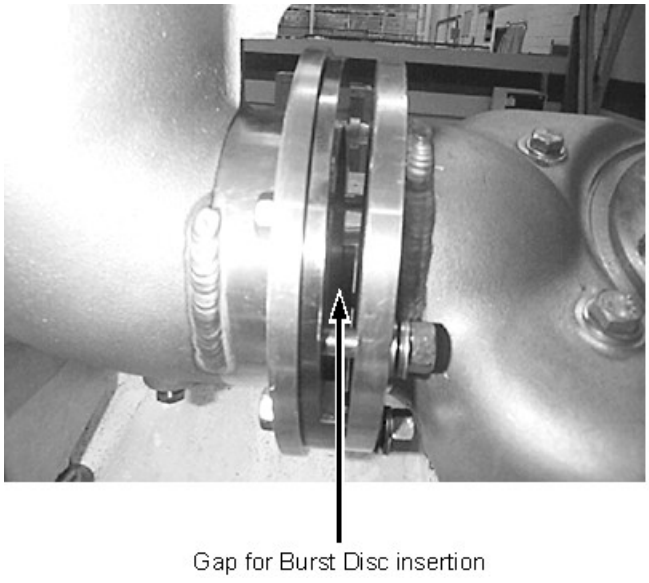
Illustration 5-77: Burst Disc Orientation

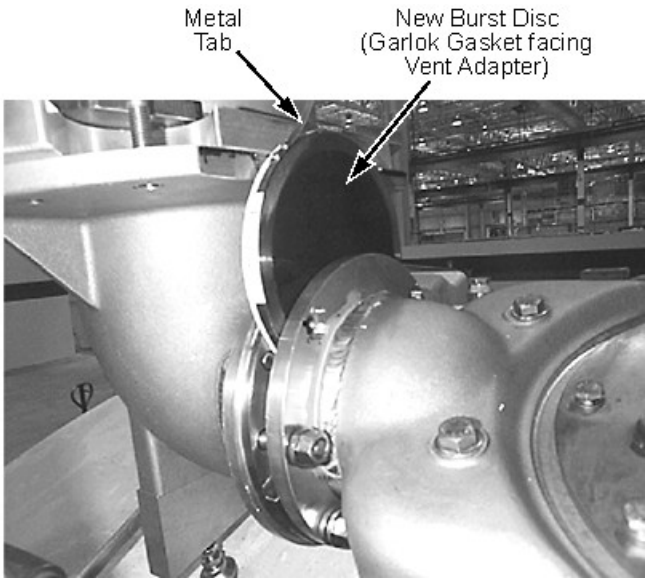


2. Insert the Disc by pushing it straight down into the gap left by the old Disc as shown in Illustration 5-78.

NOTE: If binding occurs, gently spread the gap between the Plenum and Captured Flange with a blunt object such as a nonmagnetic box-end wrench.

Illustration 5-78: Burst Disc Insertion





3. When the Burst Disc is fully in place, replace the top two retaining bolts and washers in the same orientation and position as they were removed.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

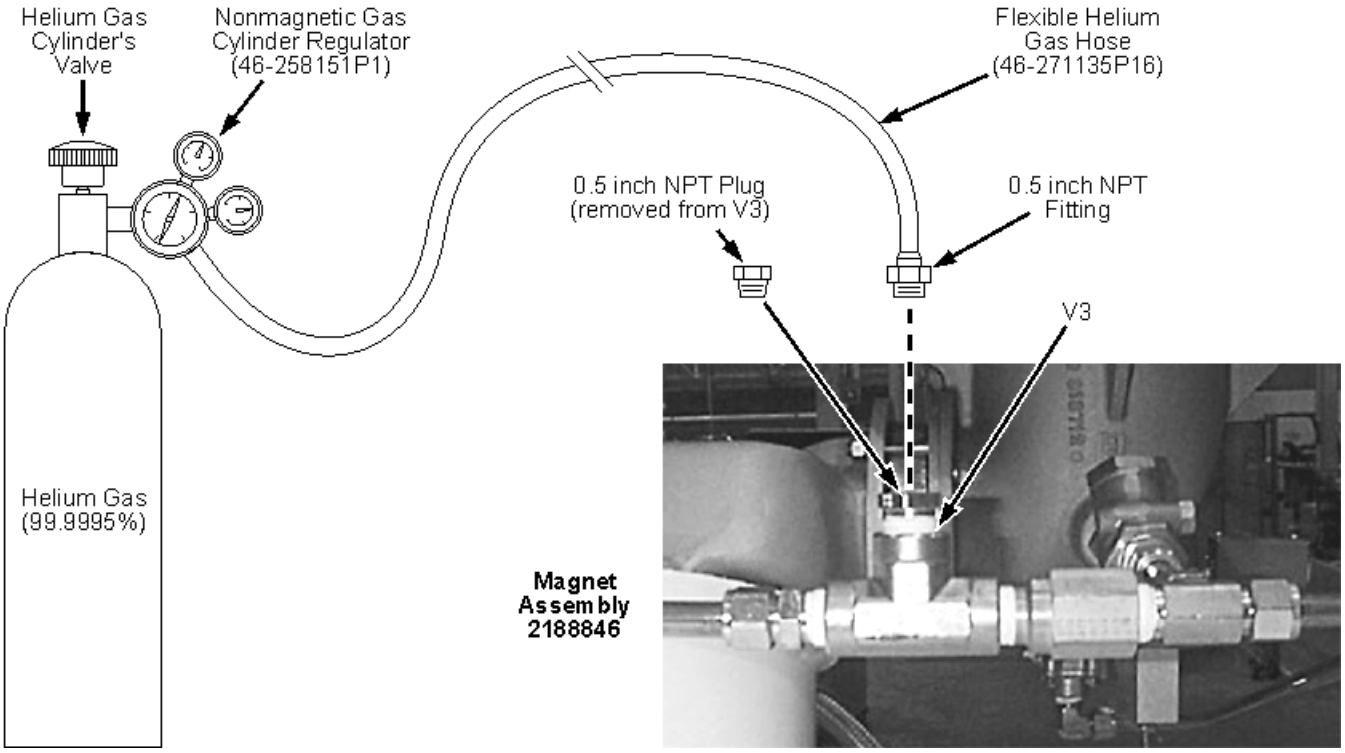
Do not over-tighten the retaining bolts in the following step. Continued tightening after the Belleville washers are flattened will result in over-torquing and may damage the Burst Disc.

4. Tighten the retaining bolts in a “star" pattern, 1/2 turn at a time, to obtain an even pressure between the o-ring seal and the Disc. Tighten the bolts only until the Belleville washer is just flattened; further tightening is not required. See Illustration 5-75.

11.1.5 Finalization

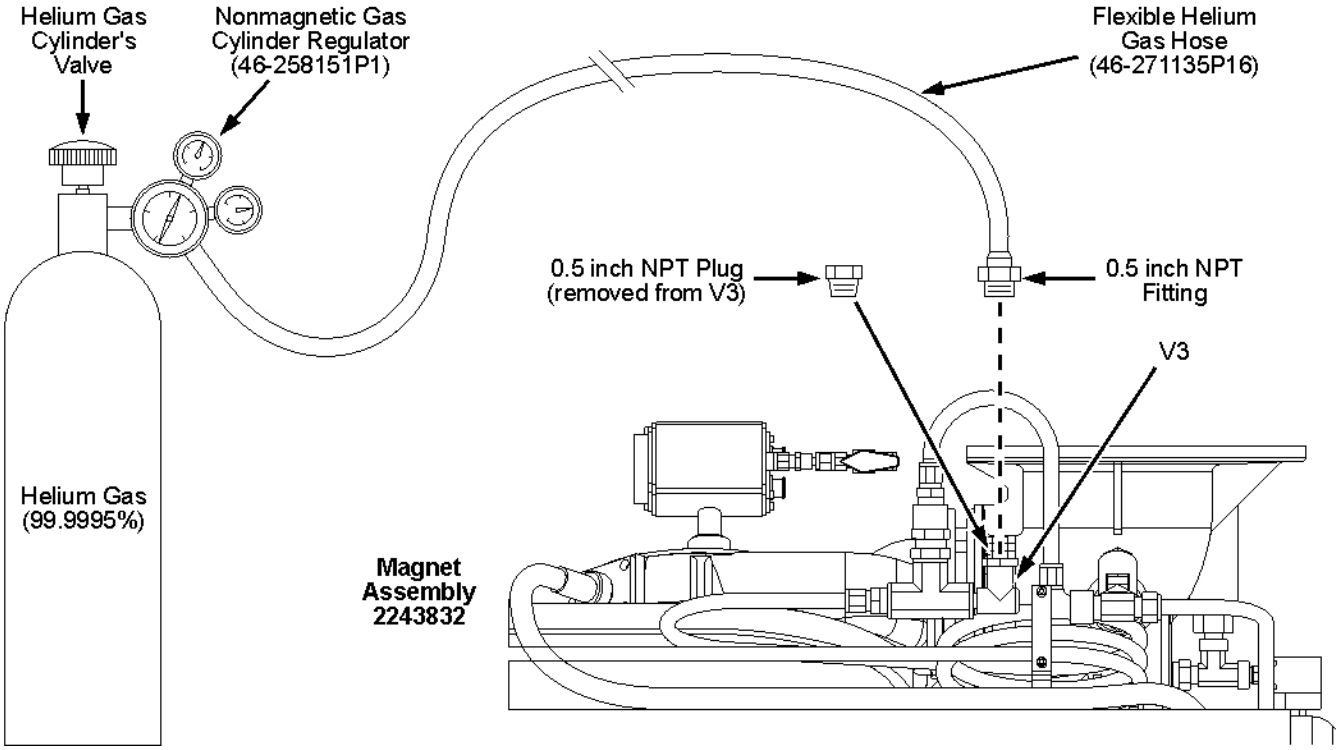
1. Leak test the plenum o-ring gasket side of the Burst Disc. Repair any leaks found.
2. If a magnet fill is not immediately scheduled at Disc replacement, pressurize the magnet with helium gas to 2 psig:
   a. Connect helium gas hose 46-271135P16 to a cylinder (with Regulator 46-258151P1) of "five nines" helium gas (99.999% GHe).
   b. Remove the .50 in. NPT plug on the V3 plumbing. See Illustration 5-79 and Illustration 5-80.

Illustration 5-79: Temporary Helium Gas Pressurization Set-Up, LCC Magnet Assembly 2188846



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-80: Temporary Helium Gas Pressurization Set-Up, LCC Magnet Assembly 2243832



c. Connect the helium hose's .5 inch NPT fitting to V3.

d. Open the cylinder's regulator and pressurize the magnet to 2 psig.

e. When 2 psig magnet pressure is reached, close the cylinder's regulator and disconnect the hose from the magnet.

3. Leak check the Burst Disc installation and the entire plumbing system in conformance with Chapter 4, Section 2, Temp., Pressure and Leak Troubleshooting.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

11.2 Burst Disc (2194545-7) Replacement

11.2.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	1 hour	Included in 'Procedure'

11.2.2 Overview

Burst Disc and Gasket Assembly 2194545-7 replacement is required as a result of rupture during a magnet quench or as the result of a defect. It is important to replace a ruptured Burst Disc (46-252838P7) 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, 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.

NOTE: If the Burst Disc from the spare parts kit is used, order a new Burst Disc and Gasket Assembly for the kit.

11.2.3 Preliminary Requirements

11.2.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long-sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Digital Voltmeter (DVM), Volt-Ohm Meter (VOM) or non-contact voltage tester	1	-	-	-
Medium Grade Extension Cord, 12 feet - 20 feet (3.5 M - 6 M)	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Portable Oxygen Monitor	1	-	2287000	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
Helium Regulator and Hose Kit	1	-	46-306734G1	-
Nonmagnetic Helium Cylinder Cart	1	-	46-258150P1	-
Flexible Helium Gas Hose, 40 feet (12.2 meters) (optional)	1	-	46-271135P1	-
Heat Gun	1	-	46-306830G3	-
Portable Leak Detector (optional)	1	-	2270571	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

11.2.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Vacuum Grease (included in Field Spares Kit 46-294744G5)	1	-	46-252065P24	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
99.999% (“five nines”) Helium Gas, 235 SCF Nonmagnetic Cylinder	1	-	-	-
Leak detection fluid (e.g., Snoop, Bird Dog Quart Spray (p/n DOG-1Q), Big Blue (p/n Rt100S or Rt100G) or Leak-Tec)	1	-	-	-

11.2.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
Burst Disc and Gasket Assembly	1	-	2194545-7	-
Vent Adapter O-Ring	1	-	46-281101P8	-

11.2.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE BURST DISC (2194545-7) REPLACEMENT PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THE BURST DISC (2194545-7) REPLACEMENT PROCEDURE IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING THE BURST DISC (2194545-7) REPLACEMENT PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE BURST DISC (2194545-7) REPLACEMENT PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



⚠ WARNING

ASPHYXIATION HAZARD!
PROCEDURE GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR.
MAKE SURE MAGNET ROOM DOOR IS SECURED IN THE OPEN POSITION AND THE EXHAUST SYSTEM VENT AND FANS ARE ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE STARTING THE BURST DISC (2194545-7) REPLACEMENT PROCEDURE.



⚠ WARNING

ASPHYXIATION & COLD BURN HAZARD!
A MAGNET QUENCH DURING PROCEDURE COULD RESULT IN RAPID EXPULSION OF LIQUID HELIUM.
MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE STARTING THE BURST DISC (2194545-7) REPLACEMENT PROCEDURE.



⚠ WARNING

POTENTIAL COLD BURN OR ASPHYXIATION HAZARD
INTERNAL CRYOSTAT PRESSURE BUILD-UP TO > 5.25 PSIG WILL OPEN 5.25 PSIG RELIEF VALVE.
BEFORE REMOVING EITHER RAMP OR FILL PORT CAPS OR LOOSENING ANY COMPONENT RESULTING IN THE RELEASE OF CRYOGEN PRESSURE:

1. **OBSERVE THE INTERNAL CRYOSTAT PRESSURE GAUGE READING,**
2. **SET MAGNET MONITOR PRESSURE TO 0.5 PSIG AND**
3. **VENT CRYOSTAT DOWN TO 0.2 PSIG THROUGH VENT VALVE V2.**



⚠ WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING THE BURST DISC (2194545-7) REPLACEMENT PROCEDURE.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN REPLACING THE BURST DISC ON A COLD VENT SYSTEM.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.

NOTE: If the site has Magnet Monitor proprietary software, connect to Magnet Monitor and turn off the alarm for vessel pressure. Then turn the vessel pressure control to a high value of .5 psig and a low value of .4 psig.

11.2.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting the Burst Disc (2194545-7) Replacement procedure.	Chapter 1, Section 2	-
The removal of some magnet enclosure components may be required to complete the Burst Disc (2194545-7) Replacement procedure. Refer to Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with the Burst Disc (2194545-7) Replacement procedure if cover removal is required.	Section 5	-
(continued)	Appendix A, Section 1.1	-
Make sure the magnet is at zero field in conformance with Section 6, Magnet Rampdown to Zero Field, before starting the Burst Disc (2194545-7) Replacement procedure.	Section 6	-
Make sure power to the Coldhead & Cryocooler is turned off before starting the Burst Disc (2194545-7) Replacement procedure to prevent migration of cryopumped moisture and ice formation in Recondenser.	-	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Condition	Reference	Effectivity
Make sure the magnet room exhaust fan is on and operational before starting the Burst Disc (2194545-7) Replacement procedure.	-	-
Make sure the magnet room door is propped open before starting the Burst Disc (2194545-7) Replacement procedure.	-	-

11.2.4 Procedure



WARNING

POTENTIAL ASPHYXIATION HAZARD
A MAGNET QUENCH DURING BURST DISC (2194545-7) REPLACEMENT WOULD RESULT IN EXTREMELY RAPID EXPULSION OF LIQUID HELIUM THROUGH THE PLENUM AND VENT ADAPTER AS THE INTERNAL ENERGY QUICKLY DISSIPATES. MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE REMOVING/REPLACING BURST DISC.



NOTICE

To avoid cryopumping, replace a ruptured Burst Disc as soon as the vent pipe has no frost on it. Ice blocks can form inside the exhaust lines and Vertical Stack if the Burst Disc is not replaced promptly.



NOTICE

Make sure power to the Coldhead & Cryocooler is turned off before starting the Burst Disc (2194545-7) Replacement procedure to prevent migration of cryopumped moisture and ice formation in Recondenser.



NOTICE

Make sure the area is secure and that ALL required Warning Signs are posted before removing/replacing the Burst Disc.

1. Determine if the magnet is ramped.

NOTE: Usually a Burst Disc failure is the result of a magnet quench.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

Make sure resistance is within the “Ramping Circuit Voltage" specified for Ramp Leads in Chapter 4, Section 1, Magnet Functional Checks.

Before initiating rampdown make sure sufficient cold helium gas is exiting the Ramp Lead Extensions to cool the extensions.

If magnet rampdown is prevented because of ...

- **icing,**
- **open main heater circuits or**
- **insufficient resistance or lead extension cooling**

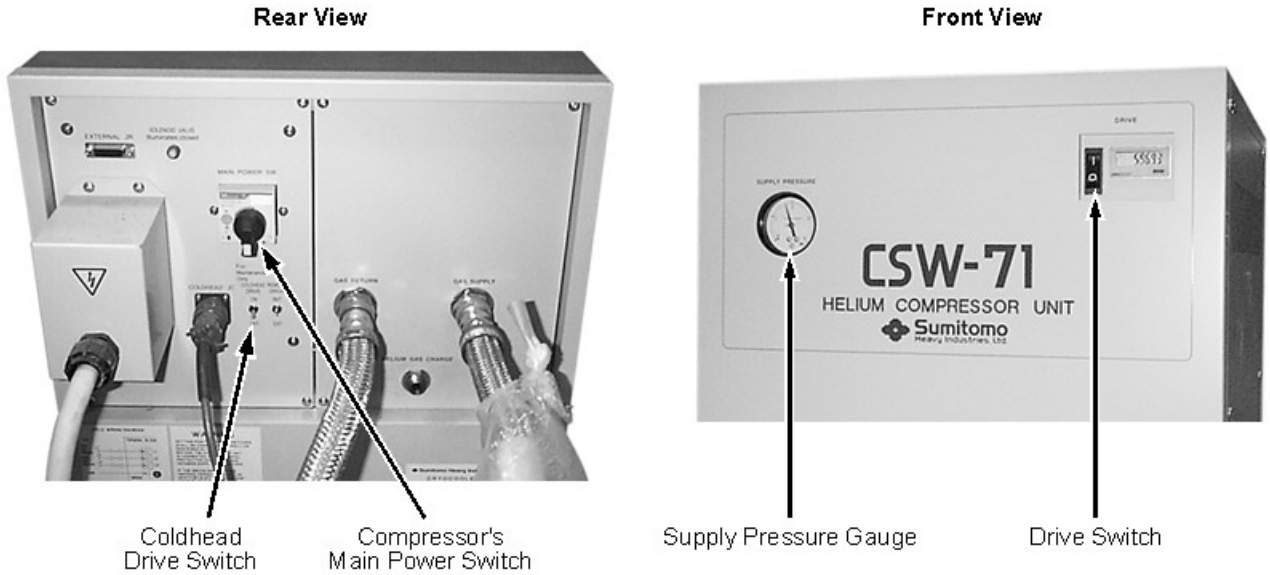
... then contact the Installed Base Group at the Florence, S.C., plant through the regional MAC Team representative or the On-Line Center before proceeding with the Burst Disc (2194545-7) Replacement procedure.

2. If the magnet is ramped, ramp the magnet down in conformance with Section 6, Magnet Rampdown to Zero Field.

3. Shut down the compressor as follows to prevent pressure build-up in the Coldhead:

   a. Turn 'ON' (upwards) the Coldhead Drive Switch on the Compressor's back panel. See Illustration 5-81.

Illustration 5-81: Views of CSW-71D Compressor



   b. Place the Drive Switch on the Compressor's front panel in the 'O' (off) position. See Illustration 5-81.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

c. Run the Coldhead for 10 seconds (only) with the Compressor turned off to prevent pressure build-up in the Coldhead, then turn 'OFF' the Coldhead Drive Switch and the Compressor's Main Power Switch. See Illustration 5-81.



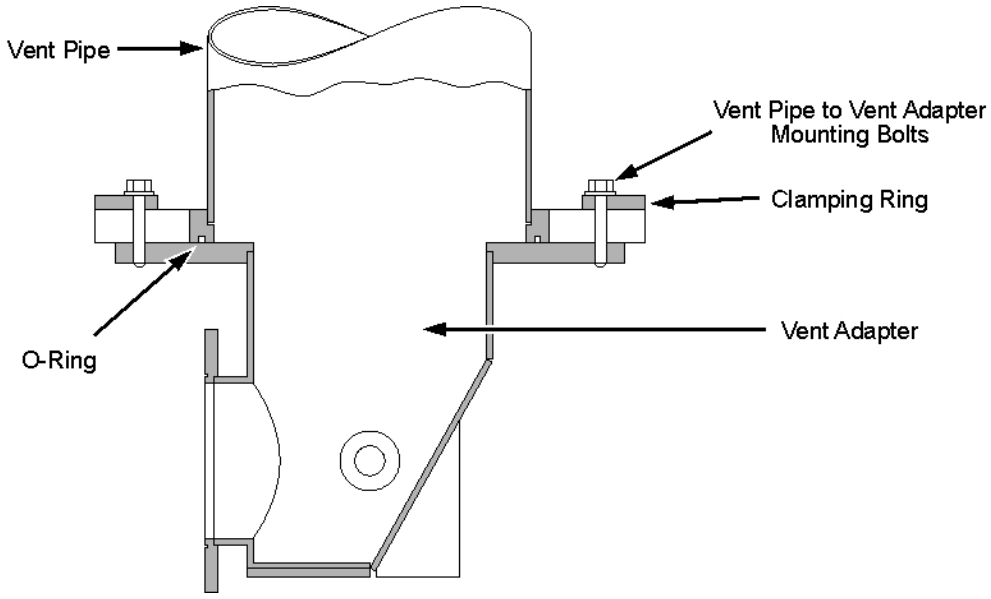
WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR.

d. Disconnect and lockout/tagout input power to the Compressor. Verify that no voltage is present by using a DVM or equivalent measuring device.

4. Loosen the 8 inch (203.2 mm) mounting bolts attaching the Vent Pipe to the Vent Adapter. See Illustration 5-82.

Illustration 5-82: Vent Adapter Cross-Sectional View



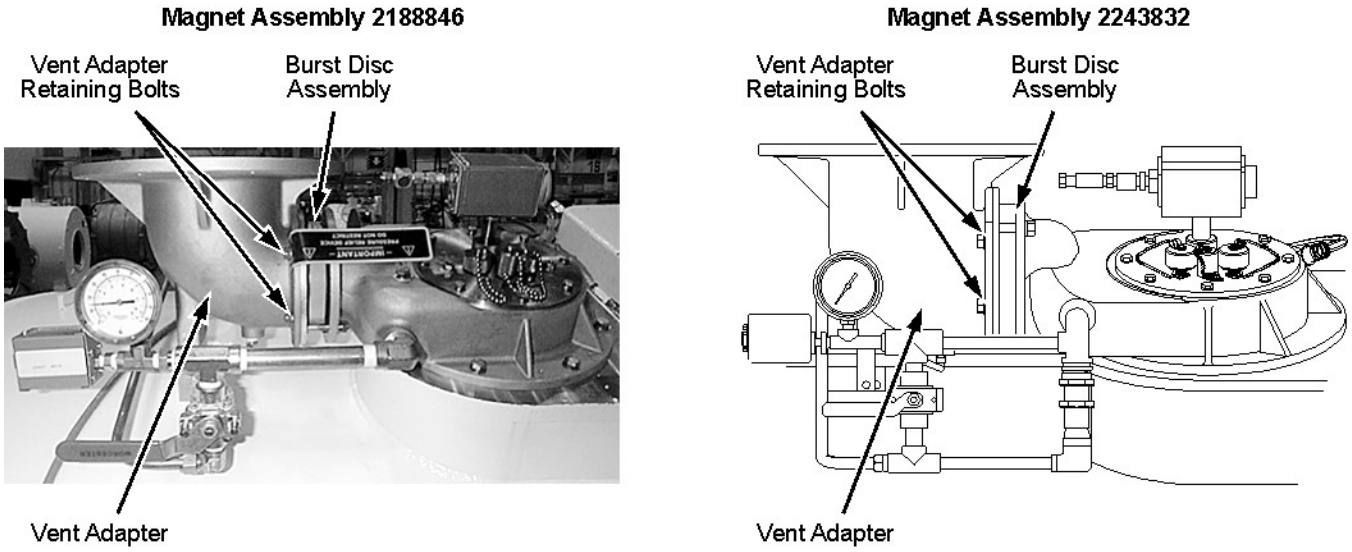
NOTE: A heat gun may be required to remove frost on the Vent Adapter before performing the next step.

5. Loosen and remove magnet's vent plumbing from the Vent Adapter.

6. Unbolt and remove the vent adapter mounting bolts to gain access to the Burst Disc Assembly and its retaining bolts. See Illustration 5-83.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

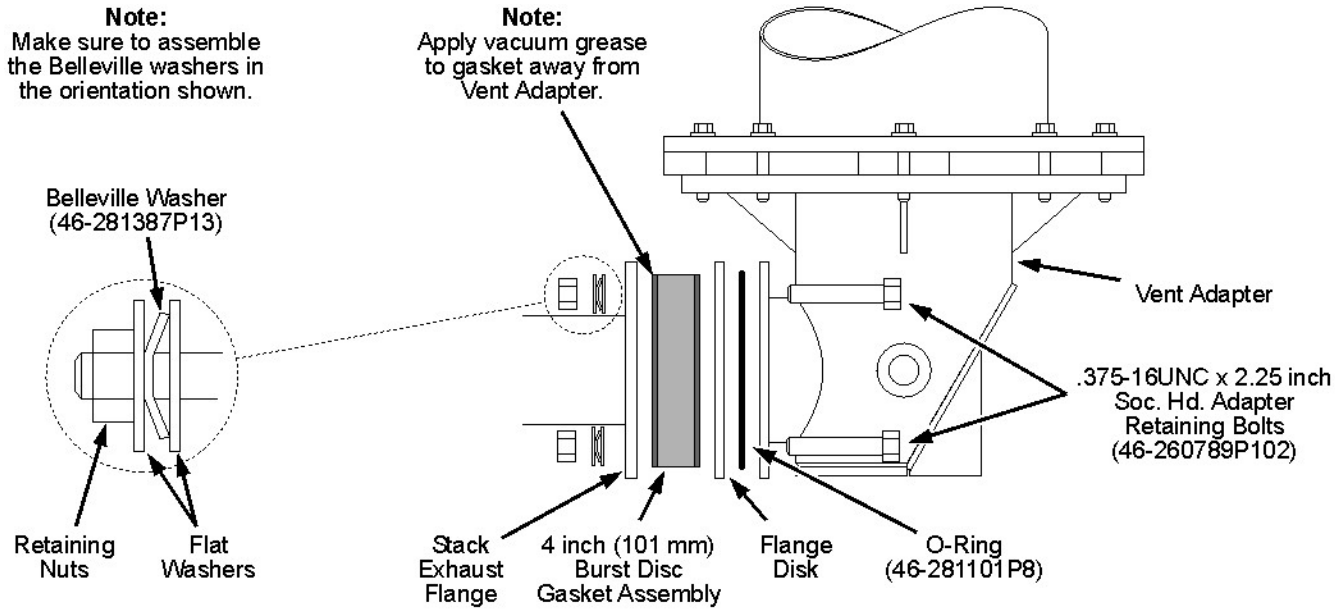
Illustration 5-83: Burst Disc Location



7. Loosen the four 3/8 inch retaining nuts. Remove the top two retaining nuts and the socket head Vent Adapter Retaining Bolts while holding the Burst Disc Assembly and Flange Disk to the stack exhaust flange. See Illustration 5-84.

NOTE: A 5/16 inch Allen wrench tool will be needed for the retaining bolts.

Illustration 5-84: Burst Disc and Gasket Assembly



8. Remove the ruptured Burst Disc. Clean any fragments out of vent system.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

9. Unpack and inspect the new Burst Disc for nicks, scratches or damage. Make sure the new Burst Disc has the proper part number and a 10 psi rating on its rating plate.

10. Install the new Burst Disc and Gasket Assembly with the flat face towards the Vent Adapter. Apply vacuum grease to the gasket on the vessel side of the Burst Disc Assembly, being careful not to get any on the surface of the Burst Disc.



NOTICE

Do not overtighten Belleville washers to prevent overtorquing of bolts. Discontinue tightening when the washers have been flattened.

11. Assemble and tighten the four retaining bolts sufficiently to flatten the Belleville washer (no gap). Do not tighten beyond flattening the washers.

12. Reassemble the Vent Adapter.

11.2.5 Finalization



CAUTION

Helium Gas Leakage
Small (micro) bubbles may appear between the gasket and flange. This is normal for this gasket material. Foam-like bubbles may be present also.
Make sure Belleville washers are flattened and that leaks (continous bubbles over 0.08 inch (2 mm) diameter) are not present.

1. Leak test the Burst Disc and Gasket Assembly installation Repair any leaks found..

2. Reassemble helium exhaust vent.

3. If a cryogen refill does not take place during the Burst Disc Assembly replacement service call, pressurize the helium vessel to prevent continued cryopumping and ice blocks in the helium exhaust lines:

   a. Connect helium gas hose 46-271135P16 to a cylinder (with Regulator 46-258151P1) of "five nines" helium gas (99.999% GHe).

   b. Remove plug on the plumbing tee on top of the magnet.

   c. Connect the helium hose's .5 inch NPT fitting to the tee.

   d. Allow gaseous helium to flow at 0.5 psi into the Vertical Stack.

4. If an ice block present, follow the procedure in Section 9.2, Ice Removal.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

This page left intentionally blank.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

12 Shim Lead and Baffle Replacement

12.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	1 hour	Included in 'Procedure'

12.2 Overview

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.

12.3 Preliminary Requirements

12.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbent protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Digital Voltmeter (DVM), Volt-Ohm Meter (VOM) or non-contact voltage tester	1	-	-	-
Flashlight	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
Sav-Con and Instrumentation Lead Installation/Removal Kit	1	-	46-294872G2	-
Helium Regulator and Hose Kit	1	-	46-306734G1	-
Nonmagnetic Gas Cylinder Cart	1	-	46-306717G1	-
Nonmagnetic Helium Cylinder Cart	1	-	46-258150P1	-
Flexible Helium Hose, 40 foot (12.2 M)	1	-	46-271135P1	-
Portable Leak Detector (optional)	1	-	2270571	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

12.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Gaseous Helium, 235 SCF Nonferrous Cylinder	1	-	-	-
Leak detection fluid (e.g., Snoop, Bird Dog Quart Spray (p/n DOG-1Q), Big Blue (p/n Rt100S or Rt100G) or Leak-Tec)	1	-	-	-
Anti-Seize Lubricant: Permatex, 1 oz. tube, 2119594, OR Bostik, 4 oz. can, 46-294151P8	1	-	-	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Vacuum Grease	1	-	46-252065P24	-
Teflon Tape; roll	1	-	-	-

12.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
Shim Lead Connector Housing Assembly 2180821 (included in Retractable Shim Lead Assembly 2173354) OR Reduced Height Shim Lead Connector Housing Assembly 2283170 (included in Retractable Shim Lead Assembly, Short, 2285073)	1	-	2180821 or 2283170	-
Baffle Assembly (included in Shim Lead Assemblies 2173354 and 2285073)	1	-	2180818	-
Teflon Shim Lead O-Ring (included in Field Spares Kit 46-294744G5)	1	-	46-281101P5	-

12.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE SHIM LEAD AND BAFFLE REPLACEMENT PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR THE SHIM LEAD AND BAFFLE REPLACEMENT PROCEDURE IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING THE SHIM LEAD AND BAFFLE REPLACEMENT PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE SHIM LEAD AND BAFFLE REPLACEMENT PROCEDURE.



WARNING

ASPHYXIATION & COLD BURN HAZARD!
A MAGNET QUENCH DURING PROCEDURE COULD RESULT IN RAPID EXPULSION OF LIQUID HELIUM THROUGH THE VERTICAL PENETRATION.
MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE STARTING THE SHIM LEAD AND BAFFLE REPLACEMENT PROCEDURE.



WARNING

ASPHYXIATION HAZARD!
PROCEDURE GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR.
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE STARTING THE SHIM LEAD AND BAFFLE REPLACEMENT PROCEDURE.



WARNING

POTENTIAL COLD BURN OR ASPHYXIATION HAZARD
INTERNAL CRYOSTAT PRESSURE BUILD-UP TO > 5.25 PSIG WILL OPEN 5.25 PSIG RELIEF VALVE.
BEFORE REMOVING EITHER RAMP OR FILL PORT CAPS OR LOOSENING ANY COMPONENT RESULTING IN THE RELEASE OF CRYOGEN PRESSURE:

1. **OBSERVE THE INTERNAL CRYOSTAT PRESSURE GAUGE READING,**
2. **SET MAGNET MONITOR PRESSURE TO 0.5 PSIG AND**
3. **VENT CRYOSTAT DOWN TO 0.2 PSIG THROUGH VENT VALVE V2.**



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING SHIM LEAD AND BAFFLE REPLACEMENT.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN PERFORMING THE SHIM LEAD AND BAFFLE REPLACEMENT PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR. EE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.

NOTE: If the site has Magnet Monitor proprietary software, connect to Magnet Monitor and turn off the alarm for vessel pressure. Then turn the vessel pressure control to a high value of .5 psig and a low value of .4 psig.

12.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting the Shim Lead and Baffle Replacement procedure.	Chapter 1, Section 2	-
The removal of some magnet enclosure components may be required to complete the Shim Lead and Baffle Replacement procedure. Refer to Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with the Shim Lead and Baffle Replacement procedure if cover removal is required.	Section 5	-
(continued)	Appendix A, Section 1.1	-
The magnet must be at zero field in conformance with Section 6, Magnet Rampdown to Zero Field, before starting the Shim Lead and Baffle Replacement procedure.	Section 6	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Condition	Reference	Effectivity
Make sure the magnet room exhaust fan is on and operational before starting the Shim Lead and Baffle Replacement procedure.	-	-
Make sure the magnet room door is propped open — or the hatch is opened if a mobile van — before starting the Shim Lead and Baffle Replacement procedure.	-	-

12.4 Procedure

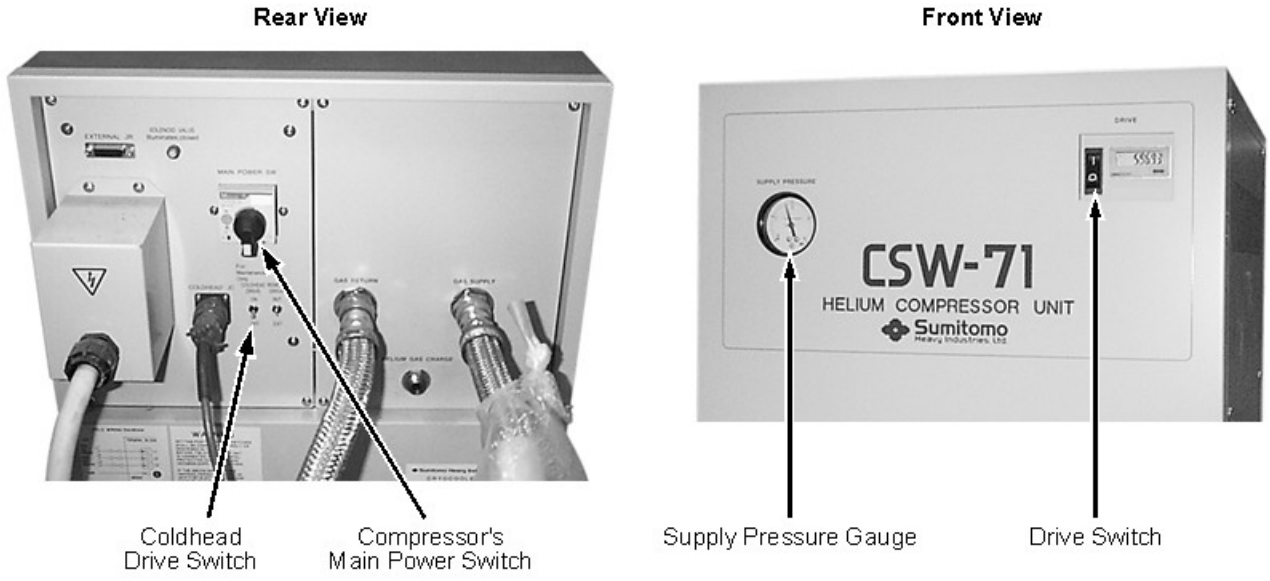
12.4.1 Shim Lead Assembly Removal

NOTICE

Make sure the Vertical Penetration is clear of any obstructions before inserting/extracting any tools/apparatus to prevent possible magnet damage.

1. Make sure the Shim Lead Assembly is “Engaged" in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement.
2. Ramp the magnet down to zero field in conformance with Section 6, Magnet Rampdown to Zero Field.
3. Shut down the compressor as follows:
   a. Turn 'ON' (upwards) the Coldhead Drive Switch on the Compressor's back panel. See Illustration 5-85.

Illustration 5-85: Views of CSW-71D Compressor



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

b. Place the Drive Switch on the Compressor's front panel in the 'O' (off) position. See Illustration 5-85.

c. Run the Coldhead for 10 seconds (only) with the Compressor turned off to prevent pressure build-up in the Coldhead, then turn 'OFF' the Coldhead Drive Switch and the Compressor's Main Power Switch. See Illustration 5-85.



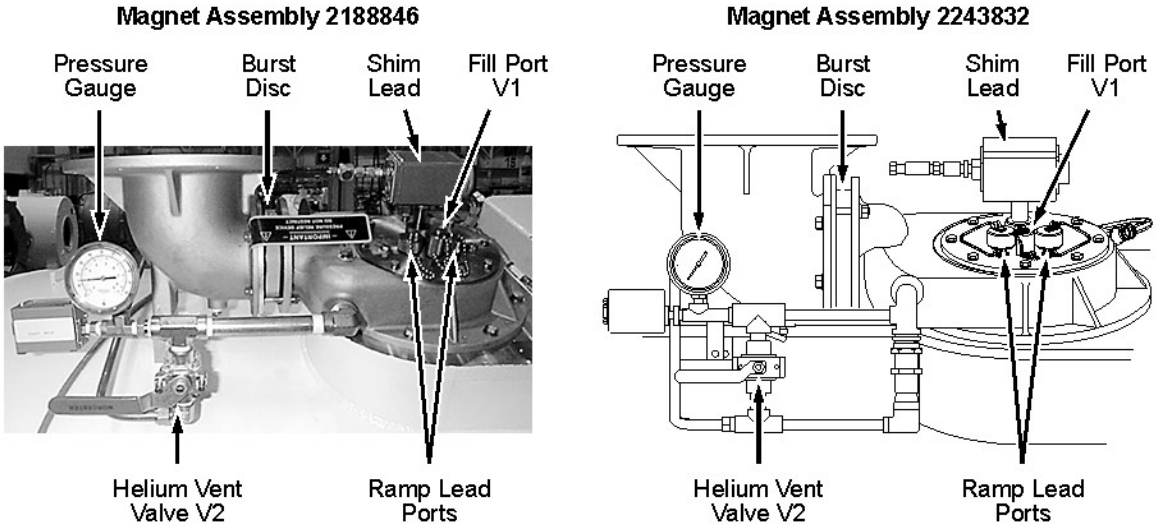
⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR.

d. Disconnect and lockout/tagout input power to the Compressor. Verify that no voltage is present by using a DVM or equivalent measuring device.

4. Slowly open Vent Valve V2 and vent the magnet until internal pressure is < 0.3 psig on the Cryostat Pressure Gauge. Close V2. See Illustration 5-86.

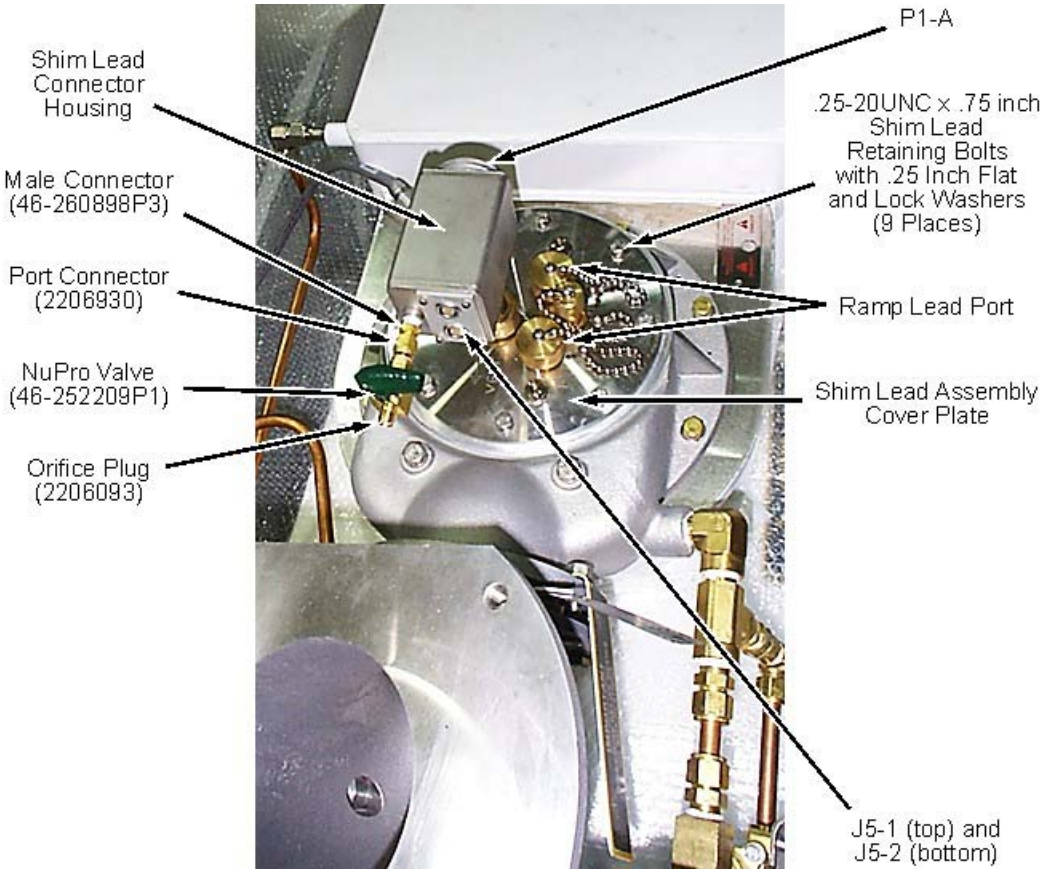
Illustration 5-86: Helium Vent Plumbing



5. Disconnect Connectors J1-A from P1-A and P5 from J5 on the Shim Lead Connector Housing. See Illustration 5-87.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-87: Shim Lead Assembly Orientation



6. Disengage the Shim Lead Assembly in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement.

NOTICE

Perform the following two steps rapidly to prevent cryopumping of air into the Vertical Penetration. Make sure the Lexan Cover Plate (46-294765G1) is on the Service Ladder/Platform before removing the Shim Lead Assembly.

7. Loosen and remove the eight .25-20UNC retaining bolts along with the eight 0.25 in. nominal flatwashers, and then remove the Shim Lead Assembly. See Illustration 5-87.

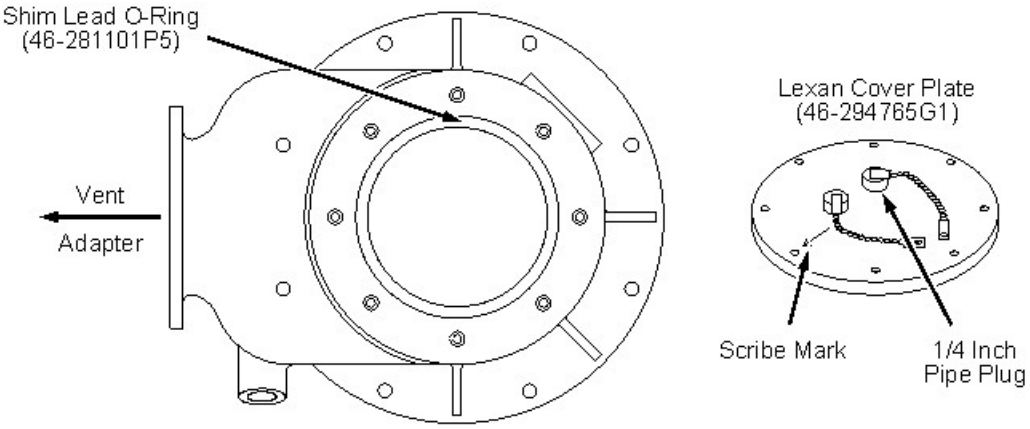
NOTICE

Make sure the Shim Lead's o-ring is in its Vertical Penetration groove before covering the Vertical Penetration.

8. Immediately cover the Vertical Penetration with the Lexan Cover Plate (46-294765G1). Alignment of the Lexan Plate's scribe mark to the Vent Adaptor is not necessary for the Shim Lead and Baffle Replacement procedure. See Illustration 5-88.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-88: Shim Lead O-Ring and Lexan Cover Plate



9. Secure the Lexan Cover Plate onto the Vertical Penetration with the eight .25-20UNC retaining bolts and the 0.25 in. nominal flatwashers removed in Step 7.

10. If the Baffle Tree Assembly needs replacement, continue with Section 12.4.2, Baffle Replacement. If not, continue with Section 12.4.3, Shim Lead Assembly Replacement.

12.4.2 Baffle Replacement

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

NOTICE

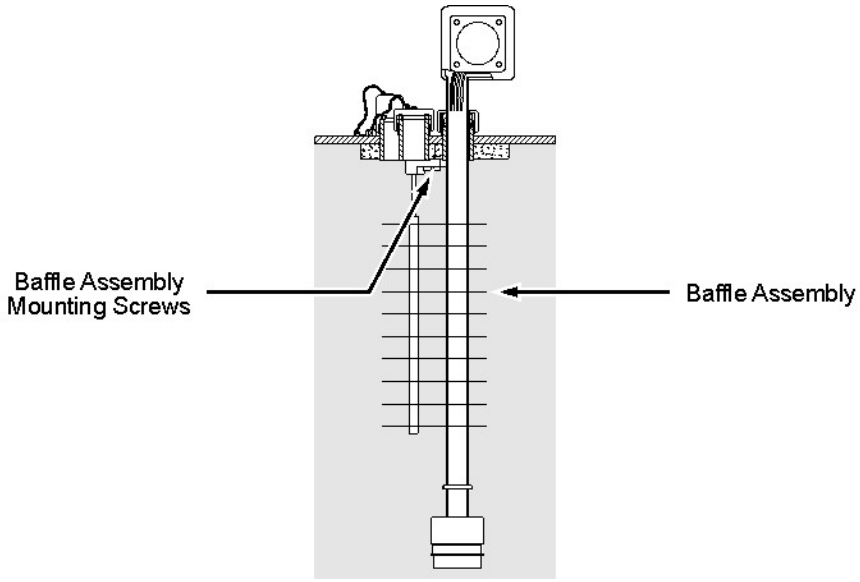
Make sure the Vertical Penetration is clear of any obstructions before inserting/extracting any tools/apparatus to prevent possible magnet damage.

1. Remove the Shim Lead Assembly in conformance with Section 12.4.1, Shim Lead Assembly Removal.

2. Place the Shim Lead Assembly in the “Engaged" position in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement. This is necessary in order for the Baffle Assembly to clear the stainless steel Guide Sleeve. See Illustration 5-89.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-89: Baffle Assembly Replacement



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.

5. Install the Baffle Assembly (2180818) by carefully lifting up near the slit of each baffle while simultaneously pushing the Baffle Assembly onto the Shim Lead Assembly. See Illustration 5-89. 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.

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

6. Secure the Baffle Assembly to the Shim Lead Assembly using the three screws removed in Step 3 above.

7. Place the Shim Lead Assembly in the “Disengaged" position in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement. Tighten the compression fitting on the Shim Lead Assembly.

8. Reinstall the Shim Lead Assembly in conformance with Section 12.4.3, Shim Lead Assembly Replacement.

12.4.3 Shim Lead Assembly Replacement

NOTICE

Make sure the Vertical Penetration is clear of any obstructions before inserting/extracting any tools/apparatus to prevent possible magnet damage.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

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 3 psig - 5 psig flow of warm helium gas at the 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.

3. If the Shim Lead is being replaced:

   a. Remove the Male Connector from the defective Shim Lead Assembly Connector Housing.

   b. Place two 1/4 inch Blank-Off Caps — if not already in place — on the open ends at the Male Connector.

   c. Wrap teflon tape onto the male threads of the Male Connector before threading into the replacement Shim Lead Connector Housing. See Illustration 5-87 for the Male Connector's location.

   d. Mount the Male Connector to the replacement Shim Lead Assembly Connector Housing (normal height housing: 2180821; reduced height housing: 2283170).

4. Make sure that a functional Shim Lead Assembly is on the Service Ladder/Platform and that the Shim Lead is in the retracted position.



NOTICE

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

5. Loosen and remove the eight .25-20UNC retaining bolts along with the eight 0.25 in. nominal flatwashers and remove the Lexan Cover Plate.

6. Inspect the Shim Lead O-Ring (46-281101P5) at the top of the Vertical Penetration. Replace if nicked, scratched or damaged. Use vacuum grease when installing the o-ring.



NOTICE

Make sure the Blank-Off Caps are in place and the Shim Lead is carefully inserted into the Vertical Penetration to prevent “cold shock" and possible permanent damage of the Shim Leads.

7. Carefully replace the Shim Lead Assembly into the Vertical Penetration. Make sure that the Shim Lead O-Ring (46-281101P6) is properly seated in the Vertical Penetration. See Illustration 5-87.

8. Align the scribe mark on the Shim Lead Assembly Cover Plate with the Vertical Penetration Exhaust Plenum. See Illustration 5-87.

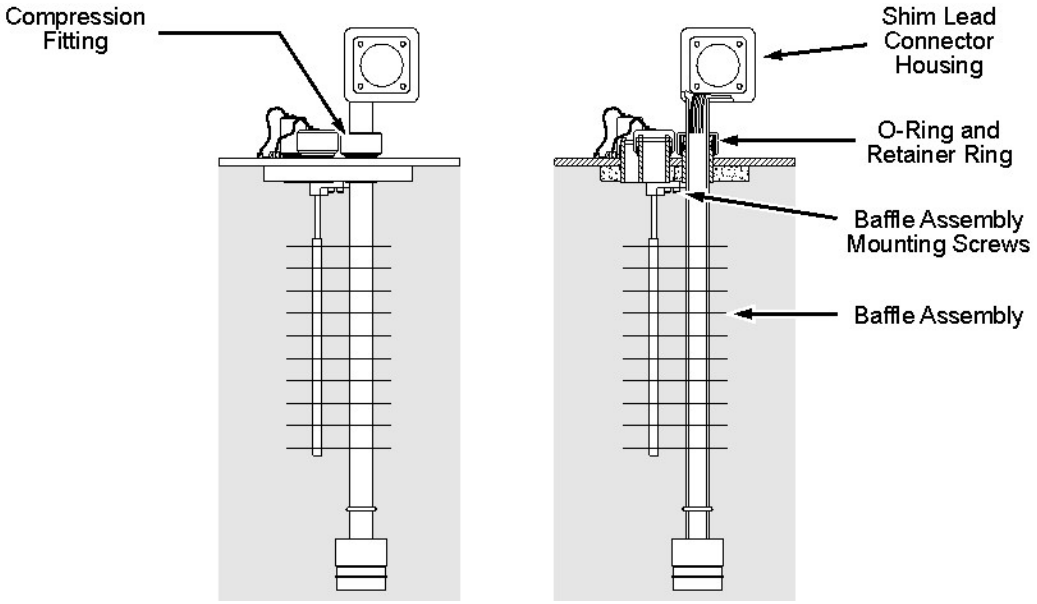
9. Secure the Shim Lead Assembly to the Vertical Penetration with the .25-20UNC retaining bolts and the 0.25 in. nominal flat and lock washers removed in Step 5. Use of Permatex (1 oz. tube: 2119594) or Bostik (4 oz. can: 46-294151P8) anti-seize lubricant is recommended.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTE: The Shim Lead Connector is keyed and must be aligned with the keyway in 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 (6 mm) to fully seat the connectors.

10. Loosen the compression fitting and push the Shim Lead down to engage the connector. See Illustration 5-90.

Illustration 5-90: Shim Lead Assembly



11. Tighten the compression fitting.

12. Open Helium Vent Valve V2 and vent the Cryostat down to 0.2 psig. See Illustration 5-86.

13. Remove the Blank-Off Cap and reconnect the 1/4 inch Shim Lead Exhaust Plumbing to the Male Connector on the Shim Lead Connector Housing. Tighten and leak test the fitting.

14. Allow the Cryostat to build pressure to 1 psig, then check for leaks around the o-ring in the Vertical Penetration and at the Shim Lead compression fittings. Repair any leaks found.

15. Engage the Shim Lead in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement.

16. Make sure Connectors J1-A and P5 are connected to the Shim Lead Connector Housing at P1-A and J5, respectively.

12.5 Finalization

1. Ramp the magnet in conformance with Chapter 3, Section 7.1, Ramping Magnet to Field.

2. After the magnet has been ramped and shimmed (if the Baffle Assembly was replaced) and is stable and all ramping and shimming cables are removed from the magnet, place

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

the Shim Lead Assembly in the “Disengaged" position in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

13 Sav-Con Connector Replacement

13.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	1.5 hours	Included in 'Procedure'

13.2 Preliminary Requirements

13.2.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbant protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Digital Voltmeter (DVM), Volt-Ohm Meter (VOM) or non-contact voltage tester	1	-	-	-
Flashlight	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
Sav-Con and Instrumentation Lead Installation/Removal Kit	1	-	46-294872G2	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Helium Regulator and Hose Kit	1	-	46-306734G1	-
Nonmagnetic Gas Cylinder Cart	1	-	46-306717G1	-
Nonmagnetic Helium Cylinder Cart	1	-	46-258150P1	-
Portable Leak Detector (optional)	1	-	2270571	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

13.2.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Gaseous Helium, 235 SCF Nonmagnetic Cylinder (with Regulator)	1	-	-	-
Leak detection fluid (e.g., Snoop, Bird Dog Quart Spray (p/n DOG-1Q), Big Blue (p/n Rt100S or Rt100G) or Leak-Tec)	1	-	-	-
Vacuum Grease	1	-	46-252065P24	-

13.2.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
Teflon Shim Lead O-Ring (included in Field Spares Kit 46-294744G5)	1	-	46-281101P5	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

13.2.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE SAV-CON CONNECTOR REPLACEMENT PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR SAV-CON CONNECTOR REPLACEMENT IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING THE SAV-CON CONNECTOR REPLACEMENT PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE SAV-CON CONNECTOR REPLACEMENT PROCEDURE.



WARNING

ASPHYXIATION & COLD BURN HAZARD!
A MAGNET QUENCH DURING PROCEDURE COULD RESULT IN RAPID EXPULSION OF LIQUID HELIUM THROUGH THE VERTICAL PENETRATION.
MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE STARTING THE SAV-CON CONNECTOR REPLACEMENT PROCEDURE.



WARNING

ASPHYXIATION HAZARD!
PROCEDURE GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR.
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE STARTING THE SAV-CON CONNECTOR REPLACEMENT PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



⚠ WARNING

POTENTIAL COLD BURN OR ASPHYXIATION HAZARD
INTERNAL CRYOSTAT PRESSURE BUILD-UP TO > 5.25 PSIG WILL OPEN 5.25 PSIG RELIEF VALVE.
BEFORE REMOVING EITHER RAMP OR FILL PORT CAPS OR LOOSENING ANY COMPONENT RESULTING IN THE RELEASE OF CRYOGEN PRESSURE:

1. **OBSERVE THE INTERNAL CRYOSTAT PRESSURE GAUGE READING,**
2. **SET MAGNET MONITOR PRESSURE TO 0.5 PSIG AND**
3. **VENT CRYOSTAT DOWN TO 0.2 PSIG THROUGH VENT VALVE V2.**



⚠ WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING SAV-CON CONNECTOR REPLACEMENT.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN PERFORMING THE SAV-CON CONNECTOR REPLACEMENT PROCEDURE.



⚠ WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.



NOTICE

Removal and replacement of the Sav-Con Connector must be performed quickly to prevent condensation and icing in the Vertical Penetration and on electrical connectors. Read and understand this Sav-Con Connector Replacement procedure and have all required tools and equipment on hand — including tool kit 46-294743G1, the tools shown in Illustration 5-93, helium gas, a heat gun, wrenches, a flashlight, Snoop, goggles and gloves — before starting.

NOTE: If the site has Magnet Monitor proprietary software, connect to Magnet Monitor and turn off the alarm for vessel pressure. Then turn the vessel pressure control to a high value of .5 psig and a low value of .4 psig.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

13.2.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting Sav-Con Connector Replacement.	Chapter 1, Section 2	-
The removal of some magnet enclosure components may be required to complete this Sav-Con Connector Replacement procedure. Refer to Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with Sav-Con Connector Replacement if cover removal is required.	Section 5	-
(continued)	Appendix A, Section 1.1	-
The magnet must be at zero field in conformance with Section 6, Magnet Rampdown to Zero Field, before starting the Sav-Con Connector Replacement procedure.	Section 6	-
The Shim Lead and Instrumentation Lead assemblies must be removed in conformance with Section 12, Shim Lead and Baffle Replacement, to access the Sav-Con Connector screws.	Section 12	-
Make sure the magnet room exhaust fan is on and operational before starting the Sav-Con Connector Replacement procedure.	-	-
Make sure the magnet room door is propped open — or the hatch is opened if a mobile van — before starting the Sav-Con Connector Replacement procedure.	-	-

13.3 Procedure

13.3.1 Sav-Con Connector Removal



NOTICE

Make sure the Vertical Penetration is clear of any obstructions before inserting/extracting any tools/apparatus to prevent possible magnet damage.

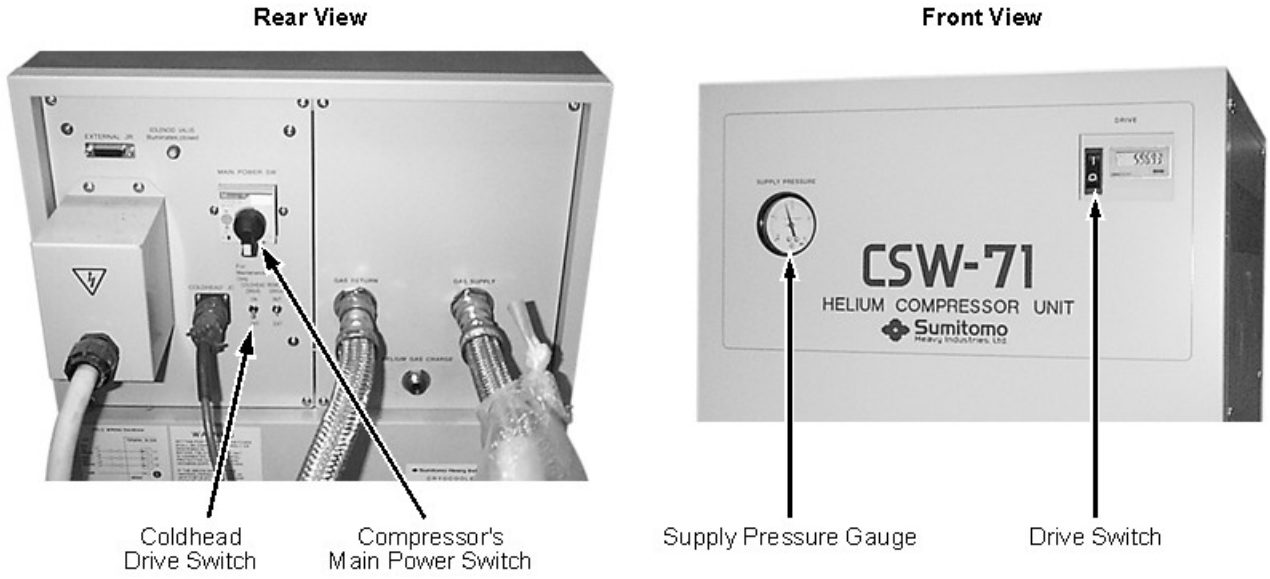
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Ramp the magnet down to zero field in conformance with Section 6, Magnet Rampdown to Zero Field.

2. Shut down the compressor as follows:

   a. Turn 'ON' (upwards) the Coldhead Drive Switch on the Compressor's back panel. See Illustration 5-91.

Illustration 5-91: Views of CSW-71D Compressor



   b. Place the Drive Switch on the Compressor's front panel in the 'O' (off) position. See Illustration 5-91.

   c. Run the Coldhead for 10 seconds (only) with the Compressor turned off to prevent pressure build-up in the Coldhead, then turn 'OFF' the Coldhead Drive Switch and the Compressor's Main Power Switch. See Illustration 5-91.



⚠ WARNING

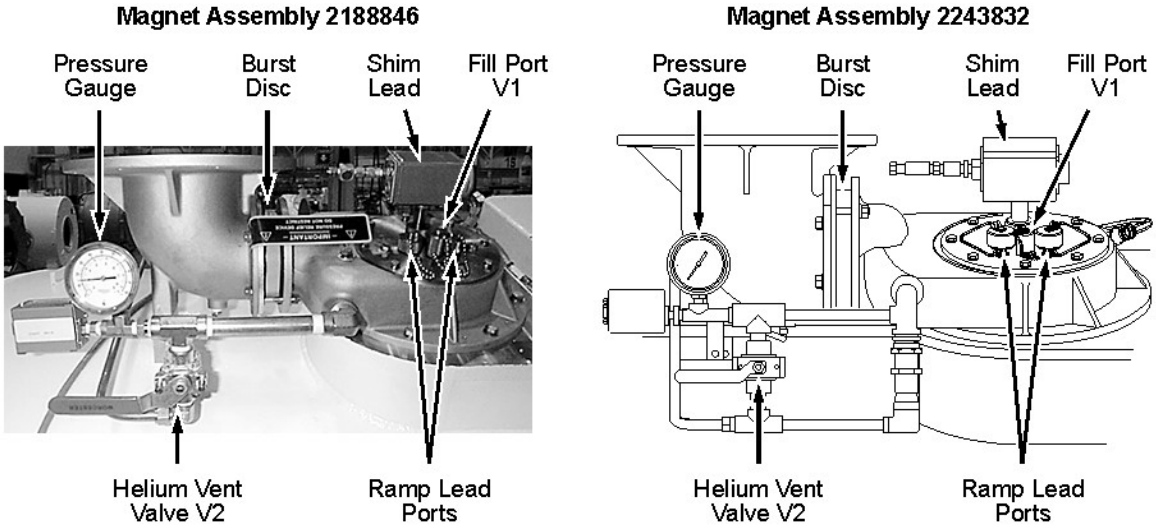
ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR.

   d. Disconnect and lockout/tagout input power to the Compressor. Verify that no voltage is present by using a DVM or equivalent measuring device.

3. Slowly open Vent Valve V2 (located in Illustration 5-92) and vent the magnet until internal pressure drops between 0.2 and 0.3 psig on the Cryostat Pressure Gauge. Close Valve V2.

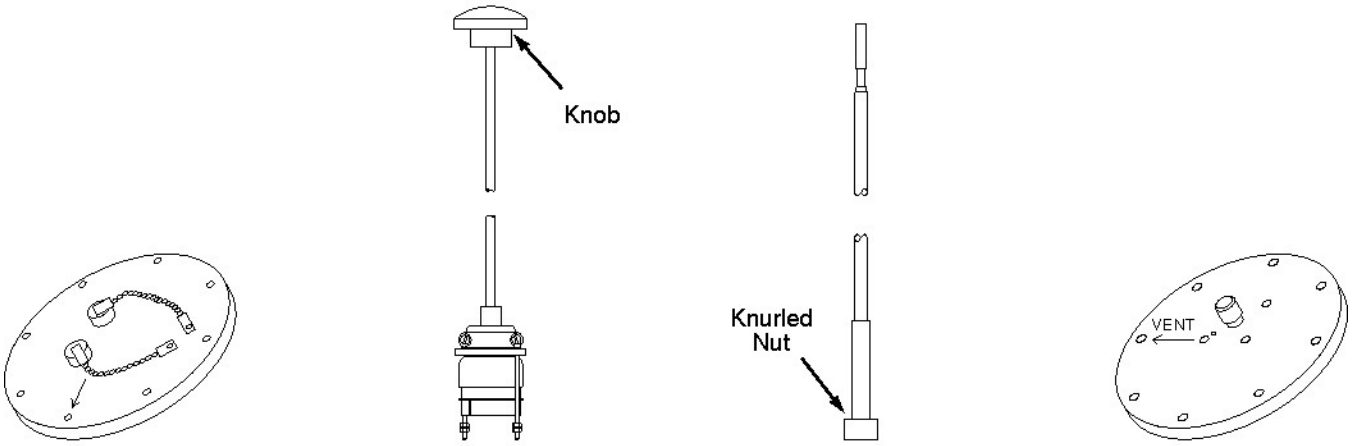
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-92: Helium Vent Plumbing



4. Assemble the Sav-Con Connector Insertion/Removal Tool (46-294310G1) to the Lexan Tool Plate (46-294306G1) by removing the knob on the tool shaft and inserting the shaft through the center hole in the Lexan plate. See Illustration 5-93.

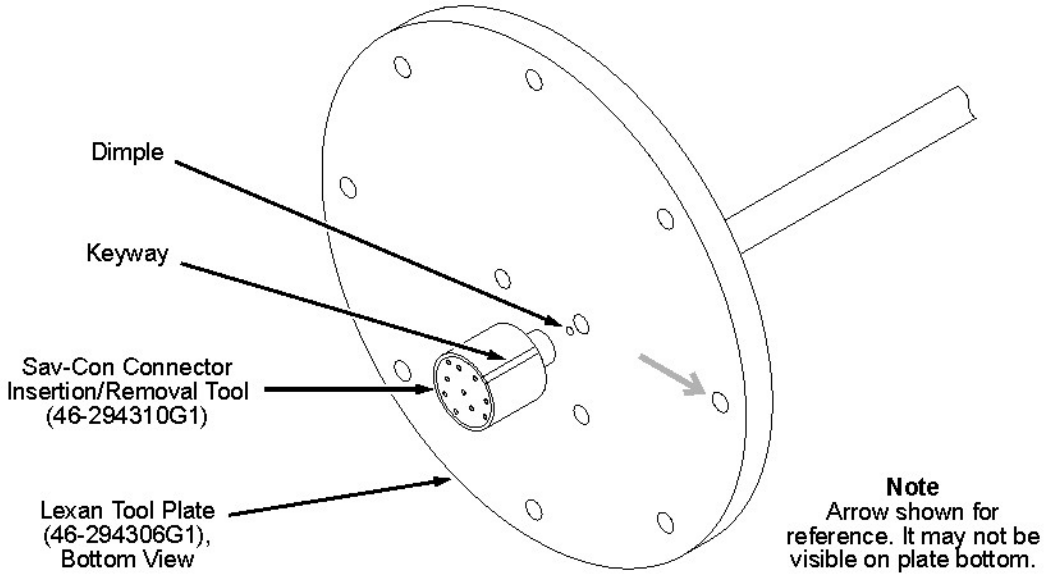
Illustration 5-93: Sav-Con Connector Replacement/Removal Tools (from Sav-Con and Instrumentation Lead Installation/Removal Kit 46-294872G2)



5. Position the connector end of the Sav-Con Connector Insertion/Removal Tool towards the Lexan Tool Plate and align the tool's keyway to the dimple shown in Illustration 5-94.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-94: Assembling the Sav-Con Tool and Plate



6. Tighten the knurled nut to hold the tool in place, then reassemble the knob to the tool's shaft.

NOTICE

Immediately after the Shim Lead Assembly is removed, quickly place the assembled Sav-Con Tool and Plate (Illustration 5-94) onto the Vertical Penetration to prevent icing.

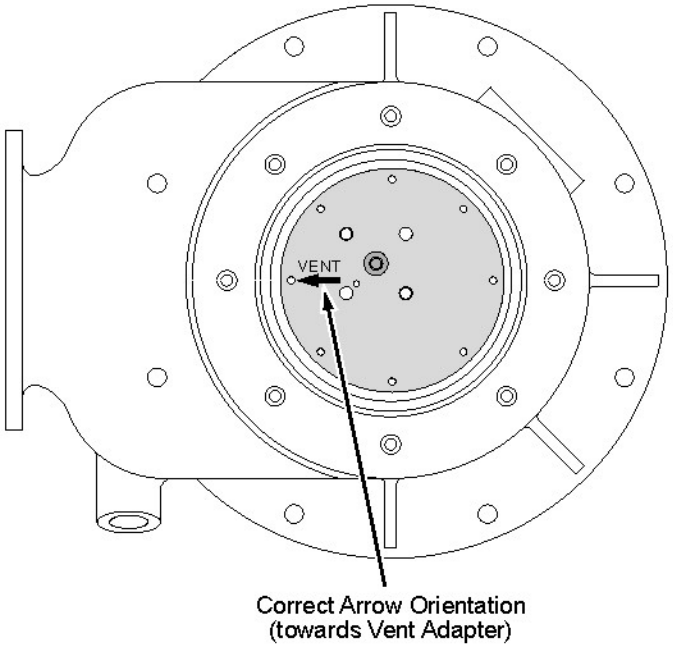
Always replace the Shim Lead O-Ring when performing Sav-Con Connector Replacement.

7. Remove the Shim Lead Assembly and Instrumentation Lead Assembly in conformance with Section 12, Shim Lead and Baffle Replacement, and Section 14, Instrumentation Lead Assembly Replacement, respectively. Store carefully.

8. Immediately position the assembled Sav-Con Tool and Plate (Illustration 5-94) on top of the Vertical Penetration with arrow oriented as in Illustration 5-95.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-95: Sav-Con Tool and Plate Assembly Alignment to Turret



9. Allow the flow of helium gas exiting through holes in the Lexan Tool Plate to subside.

10. Make sure a new Shim Lead O-Ring (46-281101P5) is in its groove on top of the Vertical Penetration and firmly sandwiched between the Sav-Con Tool Assembly and the Vertical Penetration.

11. Bolt the Sav-Con Tool Assembly's Lexan Plate in place using the bolts removed in Step 7.

NOTE: If ice builds up on the Sav-Con Connector or associated hardware during Sav-Con Connector Replacement, insert a helium gas tube through one of the holes in the Lexan Tool Plate to the iced area. Blow warm helium gas at 15 psig to remove the ice, then allow the flow of helium gas to subside.

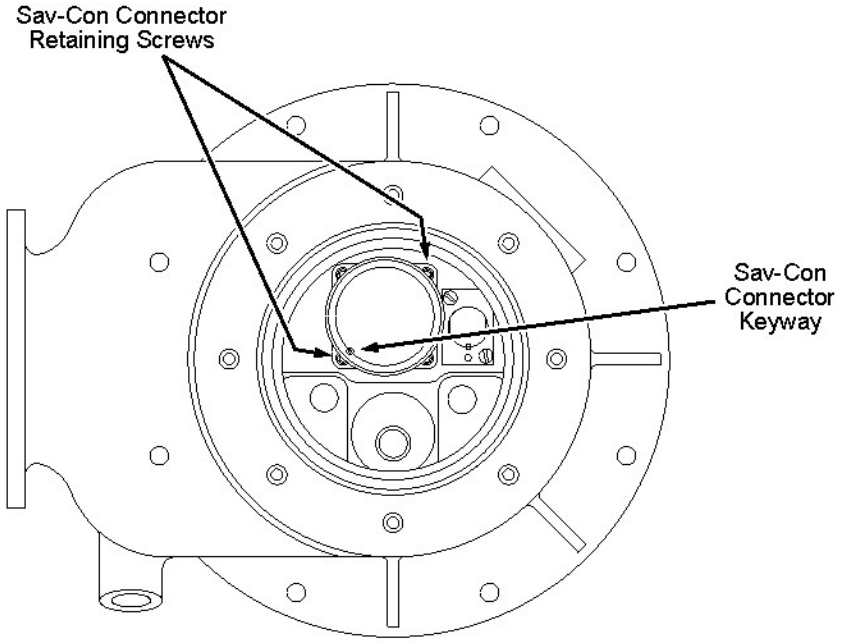
12. Shine a flashlight through the Lexan Tool Plate and locate the Sav-Con Connector and its retaining screws. Check for any ice build-up.

13. Locate the two Sav-Con Connector Retaining Screws directly below insertion holes in the Lexan Tool Plate. See Illustration 5-96.

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

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-96: Sav-Con Connector Retaining Screw & Keyway Locations



14. Lower the Screw Insertion/Removal Tool (46-294292G1) through one of the two appropriate holes to contact the Allen head on either Sav-Con Retaining Screw.

15. Push downward to engage the Screw Insertion/Removal Tool with a Sav-Con Retaining Screw and loosen each screw.

16. Withdraw the Screw Insertion/Removal Tool.

17. Loosen the knurled nut holding the Sav-Con Connector Insertion/Removal Tool.

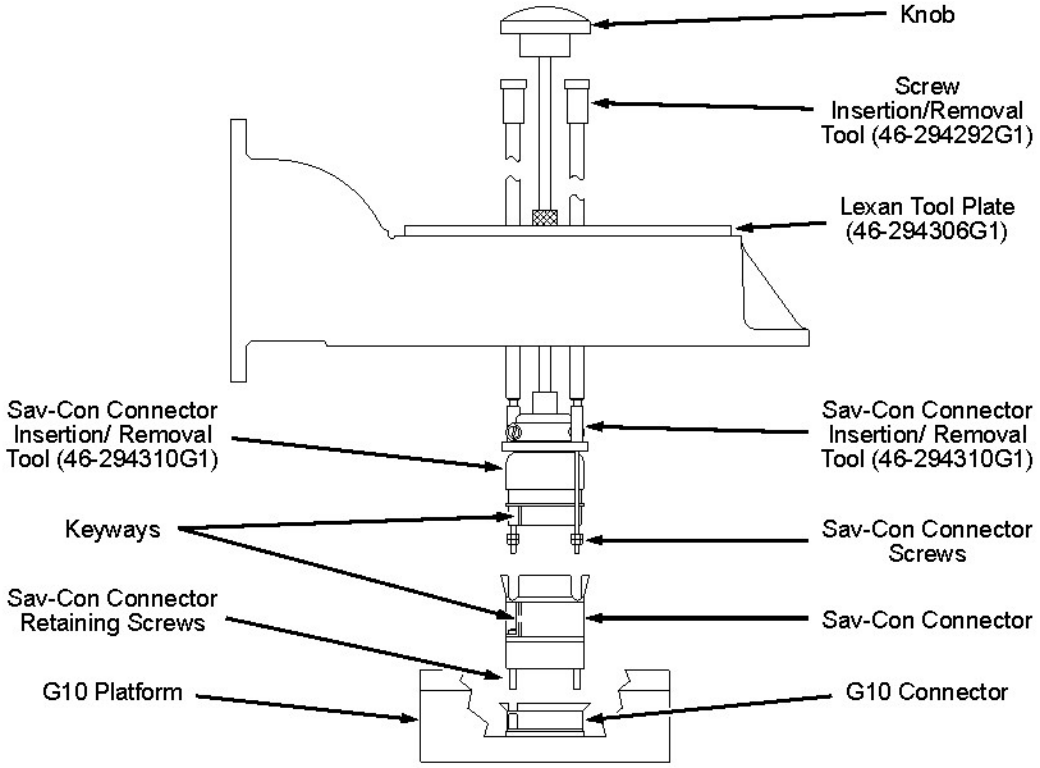
18. Push downward and carefully align the keyways of the two mating connectors, then seat the Sav-Con Connector Insertion/Removal Tool onto the Sav-Con Connector. See Illustration 5-97.

NOTE: Always make sure to align all keyways on all connectors.

NOTE: The Sav-Con Tool Screws are needed to grip the Sav-Con Connector for easy removal.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-97: Sav-Con Tool Assembly and Connector Mating



19. 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.

20. Carefully thread the Sav-Con Tool Screws into the threaded bolt heads of the Sav-Con Connector and tighten lightly.

21. Remove the Screw Insertion/Removal Tools.

22. Pull upward with the Sav-Con Tool to remove the Sav-Con Connector from the G10 Connector Platform. Tighten the knurled nut to secure the tool.

23. Remove the Lexan Tool Plate and Sav-Con Tool Assembly, and quickly replace with the Lexan Top Cover (46-294765G1; shown in Illustration 5-93).

13.3.2 Sav-Con Connector Replacement

NOTICE

Make sure the Vertical Penetration is clear of any obstructions before inserting/extracting any tools/apparatus to prevent possible magnet damage.

1. Remove the old Sav-Con Connector from the tool and insert a replacement Sav-Con Connector onto the Sav-Con Tool. Lightly tighten the tool's screws onto the Sav-Con threaded bolt-head screws.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2. Remove the Lexan Top Cover from the Vertical Penetration and immediately position the Sav-Con Tool Assembly (Illustration 5-97) over the Vertical Penetration. Orient the scribe mark on the Lexan Tool Plate towards the Vent Adapter.

3. Repeat Section 13.3.1, Step 9 through Section 13.3.1, Step 12.

4. Loosen the knurled nut and lower the Sav-Con Tool Assembly.



NOTICE

Make sure the keyways of the Sav-Con Connector and the mating G10 Connector are lined up before connecting the two together. Forcing the Sav-Con Connector onto the G10 Connector can result in bending the G10 Connector pins.

5. Carefully engage the Sav-Con Connector into the mating G10 platform connector.

NOTE: Always make sure to align all keyways on all connectors.

6. Locate the Sav-Con Connector Retaining Screws directly below insertion holes in the Lexan Tool Plate.

7. Lower the Screw Insertion/Removal Tool to contact the Sav-Con Retaining Screws' Allen head.

8. Engage and hand tighten the Sav-Con Retaining Screws.

9. Withdraw the Screw Insertion/Removal Tool.

10. Unscrew the Sav-Con Tool Assembly's screws from the Sav-Con Connector. Disengage, pull the Sav-Con Tool Assembly upward and secure it in place with the knurled nut.

11. Remove the Sav-Con Tool Assembly from the Vertical Penetration and replace with the Lexan Top Cover.

13.4 Finalization

1. Check for and remove any ice before reinstalling the Shim Lead Assembly.

2. Inspect the Shim Lead O-Ring (46-281101P6) at the top of the Vertical Penetration. Replace if nicked, scratched or damaged. Use vacuum grease when installing the o-ring.

3. Reinstall the Shim Lead Assembly in conformance with Section 12, Shim Lead and Baffle Replacement. Reinstall the Shim Lead exhaust plumbing.

4. Engage the Shim Lead in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement, before reramping the magnet.

5. Ramp the magnet in conformance with Chapter 3, Section 7.1, Ramping Magnet to Field.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

14 Instrumentation Lead Assembly Replacement

14.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	2 hours	Included in 'Procedure'

14.2 Overview

The Instrumentation Lead Assembly (G-10 Sleeve Assembly 2354044 or G10 Sleeve Assembly with Latching LEMO 5130298) must be replaced when electrical opens or shorts in the assembly have resulted in the inability to read temperatures, activate the Main Switch Heaters or perform an emergency rundown with the MRU.

NOTE:

- It is recommended that Instrumentation Lead Assembly replacement be performed by the MAC Team Representative. The procedure must be performed quickly to avoid excessive boil-off and frost/ice formation in the Vertical Penetration.
- The magnet must be ramped down to zero field in conformance with Section 6, Magnet Rampdown to Zero Field, before starting this Instrumentation Lead Assembly Replacement procedure.

14.3 Preliminary Requirements

14.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonabsorbant protective clothing (long sleeve shirt and pants); one set per person	1	-	-	-
Nonferrous Safety Shoes; one pair per person	1	-	-	-
Digital Voltmeter (DVM), Volt-Ohm Meter (VOM) or non-contact voltage tester	1	-	-	-
Nonmagnetic Pipe Wrench, 1.75 inch (45 mm) minimum jaw opening	1	-	-	-
2 Inch x 4 Inch x 24 Inch (50 mm x 100 mm x 600 mm) Lumber	1	-	-	-
Flashlight	1	-	-	-
Warning Sign & Label Kit	1	-	46-258770G4	-
Portable Oxygen Monitor	1	-	2287000	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Item	Qty	Effectivity	Part#	Manufacturer
Cryogen Safety Wear Kit; one kit per person	1	-	46-271137G1	-
Brass Master Padlock with Brass Shackle	1	-	46-194427P320	-
Brass Master Transition Padlock	1	-	2387081	-
Black & White on Red Lockout Tag, package of 25	1	-	46-194427P322	-
Transition LOTO Tag	1	-	46-194427P313	-
Line Cord Plug Cover, Plugs ≤ 3 in. (76 mm) wide x ≤ 5.875 in. (149 mm) long, Cords ≤ 1.25 in. (31 mm) dia.	1	-	46-194427P321	-
Sav-Con and Instrumentation Lead Installation/Removal Kit	1	-	46-294872G2	-
Latching LEMO Tool Kit	1	-	5158913	-
Helium Regulator and Hose Kit	1	-	46-306734G1	-
Nonmagnetic Gas Cylinder Cart	1	-	46-306717G1	-
Nonmagnetic Helium Cylinder Cart	1	-	46-258150P1	-
Heat Gun	1	-	46-306830G3	-
Portable Leak Detector (optional)	1	-	2270571	-
Nonmagnetic Tools Kit (magnets with magnetic fields ≤ 1.5T only)	1	-	46-320273G4	-
HDx Service Platform (can use Universal Service Ladder/Platform 2319156 or Service Ladder/Platform (Fixed Site, 2230707; Mobile Site, 2230707-2) if service space ≥ 30 inches (762 mm))	1	-	5155291 (or 2319156 or 2230707/2230707-2)	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

14.3.2 Consumables

Item	Qty	Effectivity	Part#	Manufacturer
Gaseous Helium, 235 SCF Nonmagnetic Cylinder (with Regulator)	1	-	-	-
Leak detection fluid (e.g., Snoop, Bird Dog Quart Spray (p/n DOG-1Q), Big Blue (p/n Rt100S or Rt100G) or Leak-Tec)	1	-	-	-
Vacuum Grease	1	-	46-252065P24	-
Teflon Tape, .5 inch (12.7 mm) wide; roll	1	-	46-252065P19	-
Masking Tape; roll	1	-	-	-

14.3.3 Replacement Parts

Item	Qty	Effectivity	Part#	Manufacturer
Instrumentation Lead Assembly (G10 Sleeve Assembly or G10 Sleeve Assembly with Latching LEMO)	1	-	2354044 or 5130298	-
Teflon Shim Lead O-Ring (included in Field Spares Kit 46-294744G5)	1	-	46-281101P5	-
Teflon Instrumentation Lead Connector Port O-Ring (included in Field Spares Kit 46-294744G5)	1	-	46-281101P9	-
Teflon Vertical Penetration O-Ring (included in Field Spares Kit 46-294744G5)	1	-	46-281101P6	-

14.3.4 Safety



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO REVIEW AND FULLY UNDERSTAND ALL SUPERCONDUCTING MAGNET PORTIONS OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE INSTRUMENTATION LEAD ASSEMBLY REPLACEMENT PROCEDURE.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



DANGER

POTENTIAL FATAL INJURY!
MAKE SURE TO FULLY COMPLY WITH ALL REQUIRED ITEMS FOR INSTRUMENTATION LEAD ASSEMBLY REPLACEMENT IN THE 'MAGNET & CRYOGEN SERVICE SAFETY REQUIREMENTS' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE AND WHILE PERFORMING THE INSTRUMENTATION LEAD ASSEMBLY REPLACEMENT PROCEDURE.



DANGER

POTENTIAL FATAL INJURY!
HAVE ALL “WORK ASSISTANTS” OR “WORK OBSERVERS” COMPLY WITH THE 'BUDDY SYSTEM REQUIREMENTS & CERTIFICATION' SUBSECTION OF CHAPTER 1, SECTION 2, 2301164PRE, MR MAGNET — SAFETY REQUIREMENTS, BEFORE STARTING THE INSTRUMENTATION LEAD ASSEMBLY REPLACEMENT PROCEDURE.



WARNING

ASPHYXIATION & COLD BURN HAZARD!
A MAGNET QUENCH DURING PROCEDURE COULD RESULT IN RAPID EXPULSION OF LIQUID HELIUM THROUGH THE VERTICAL PENETRATION.
MAKE SURE MAGNET IS RAMPED DOWN TO ZERO FIELD BEFORE REMOVING/REPLACING THE INSTRUMENTATION LEAD ASSEMBLY.



WARNING

ASPHYXIATION HAZARD!
INSTRUMENTATION LEAD ASSEMBLY REPLACEMENT GENERATES ODORLESS, COLORLESS HELIUM GAS THAT DISPLACES OXYGEN IN THE AIR.
MAKE SURE MAGNET ROOM VENT EXHAUST FAN IS ON — OR THE HATCH IS OPENED IF A MOBILE VAN — BEFORE STARTING THE INSTRUMENTATION LEAD ASSEMBLY REPLACEMENT PROCEDURE.



WARNING

POTENTIAL COLD BURN OR ASPHYXIATION HAZARD
INTERNAL CRYOSTAT PRESSURE BUILD-UP TO > 5.25 PSIG WILL OPEN 5.25 PSIG RELIEF VALVE.
BEFORE REMOVING EITHER RAMP OR FILL PORT CAPS OR LOOSENING ANY COMPONENT RESULTING IN THE RELEASE OF CRYOGEN PRESSURE:

1. **OBSERVE THE INTERNAL CRYOSTAT PRESSURE GAUGE READING,**
2. **SET MAGNET MONITOR PRESSURE TO 0.5 PSIG AND**
3. **VENT CRYOSTAT DOWN TO 0.2 PSIG THROUGH VENT VALVE V2.**

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



WARNING

POTENTIAL COLD BURN HAZARD
EXPOSURE TO CRYOGENS AND CONTACT WITH COLD OBJECTS IS POSSIBLE DURING INSTRUMENTATION LEAD ASSEMBLY REPLACEMENT.
WEAR PROTECTIVE CLOTHING, NONABSORBENT GLOVES AND GOGGLES WHEN PERFORMING THE INSTRUMENTATION LEAD ASSEMBLY REPLACEMENT PROCEDURE.



WARNING

ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR. SEE CHAPTER 1, SECTION 3, OSHA LOCKOUT TAGOUT REQUIREMENTS, AND CHAPTER 1, SECTION 4, LOCKOUT TAGOUT PROCEDURE AND CHECKLIST.

NOTE: If the site has Magnet Monitor proprietary software, connect to Magnet Monitor and turn off the alarm for vessel pressure. Then turn the vessel pressure control to a high value of .5 psig and a low value of .4 psig.

14.3.5 Required Conditions

Condition	Reference	Effectivity
Make sure the area is secure and that ALL required Warning Signs are posted to meet the safety requirements stated in Chapter 1, Section 2, 2301164PRE, MR Magnet — Safety Requirements, before starting Instrumentation Lead Assembly Replacement.	Chapter 1, Section 2	-
The removal of some magnet enclosure components may be required to complete this Instrumentation Lead Assembly Replacement procedure. Refer to Section 5, Upper and Side Enclosure Removal, (Wide Open enclosures) or to Appendix A, Section 1.1, Introduction to HDe, HDx Enclosures, (HDe/HDx enclosures) before continuing with Instrumentation Lead Assembly Replacement if cover removal is required.	Section 5	-
(continued)	Appendix A, Section 1.1	-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Condition	Reference	Effectivity
The magnet must be at zero field in conformance with Section 6, Magnet Rampdown to Zero Field, before starting the Instrumentation Lead Assembly Replacement procedure.	Section 6	-
Make sure the magnet room exhaust fan is on and operational before starting the Instrumentation Lead Assembly Replacement procedure.	-	-
Make sure the magnet room door is propped open — or the hatch is opened if a mobile van — before starting the Instrumentation Lead Assembly Replacement procedure.	-	-

14.4 Procedure

14.4.1 Instrumentation Lead Removal

14.4.1.1 Removal Preparation



NOTICE

Make sure the Vertical Penetration is clear of any obstructions before inserting/extracting any tools/apparatus to prevent possible magnet damage.

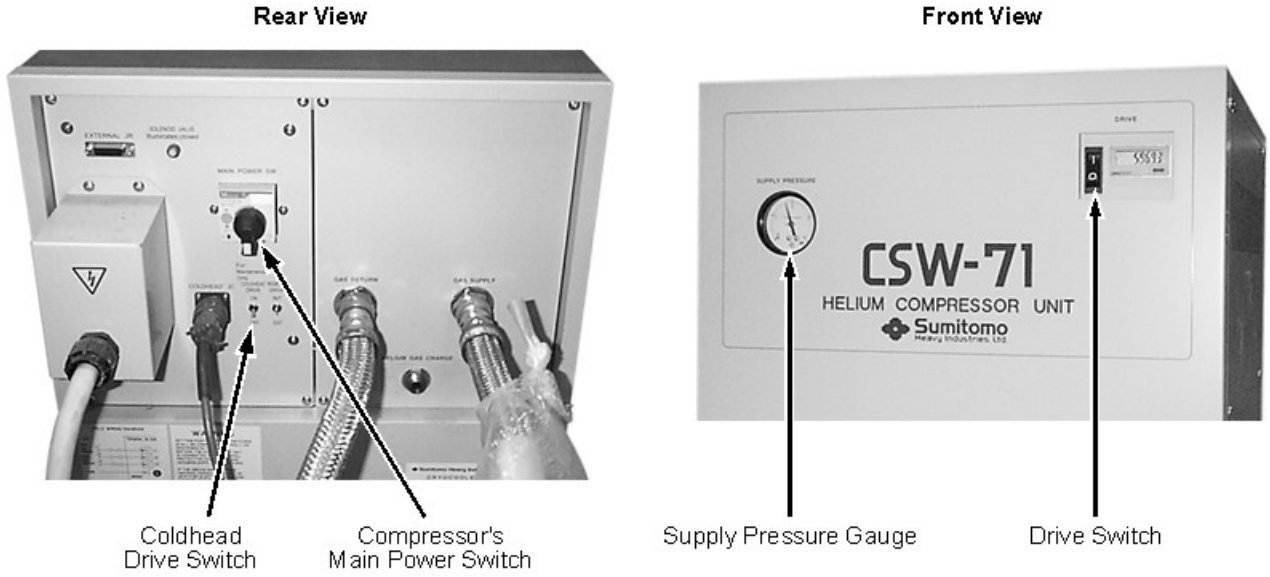
1. Ramp the magnet down to zero field in conformance with Section 6, Magnet Rampdown to Zero Field.

2. Shut down the compressor as follows:

   a. Turn 'ON' (upwards) the Coldhead Drive Switch on the Compressor's back panel. See Illustration 5-98.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-98: Views of CSW-71D Compressor



b. Place the Drive Switch on the Compressor's front panel in the 'O' (off) position. See Illustration 5-98.

c. Run the Coldhead for 10 seconds (only) with the Compressor turned off to prevent pressure build-up in the Coldhead, then turn 'OFF' the Coldhead Drive Switch and the Compressor's Main Power Switch. See Illustration 5-98.

WARNING

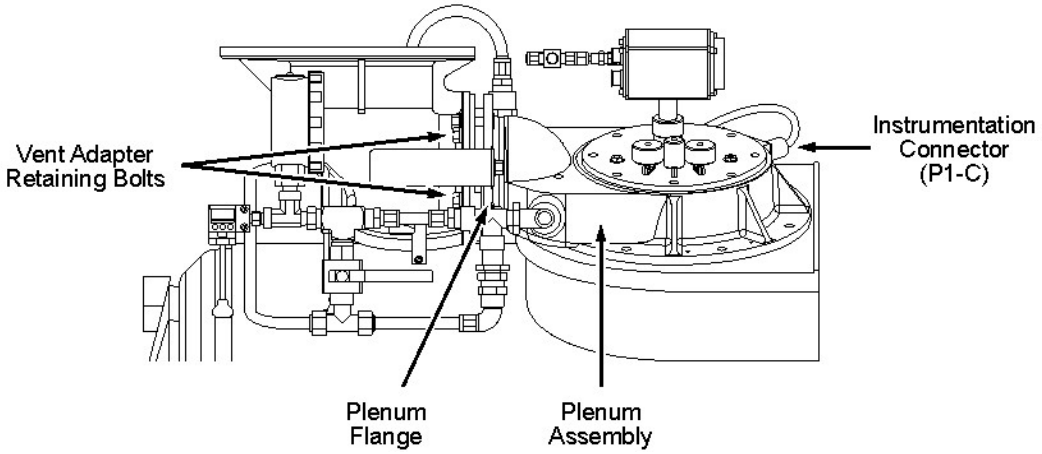
ELECTRICAL SHOCK HAZARD
CONTACT WITH CONNECTORS LEADING TO AN ENERGIZED COMPRESSOR CAN CAUSE ELECTRICAL SHOCK.
WHENEVER THE INPUT POWER TO THE COMPRESSOR IS DISCONNECTED, FOLLOW LOCKOUT/TAGOUT PROCEDURES TO MAKE SURE POWER IS NOT SUPPLIED TO THE COMPRESSOR.

d. Disconnect and lockout/tagout input power to the Compressor. Verify that no voltage is present by using a DVM or equivalent measuring device.

3. Turn off all level sensor, diode and main heater sources. Disconnect the Instrumentation Box Assembly (2204623) at connector P1-C. See Illustration 5-99.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

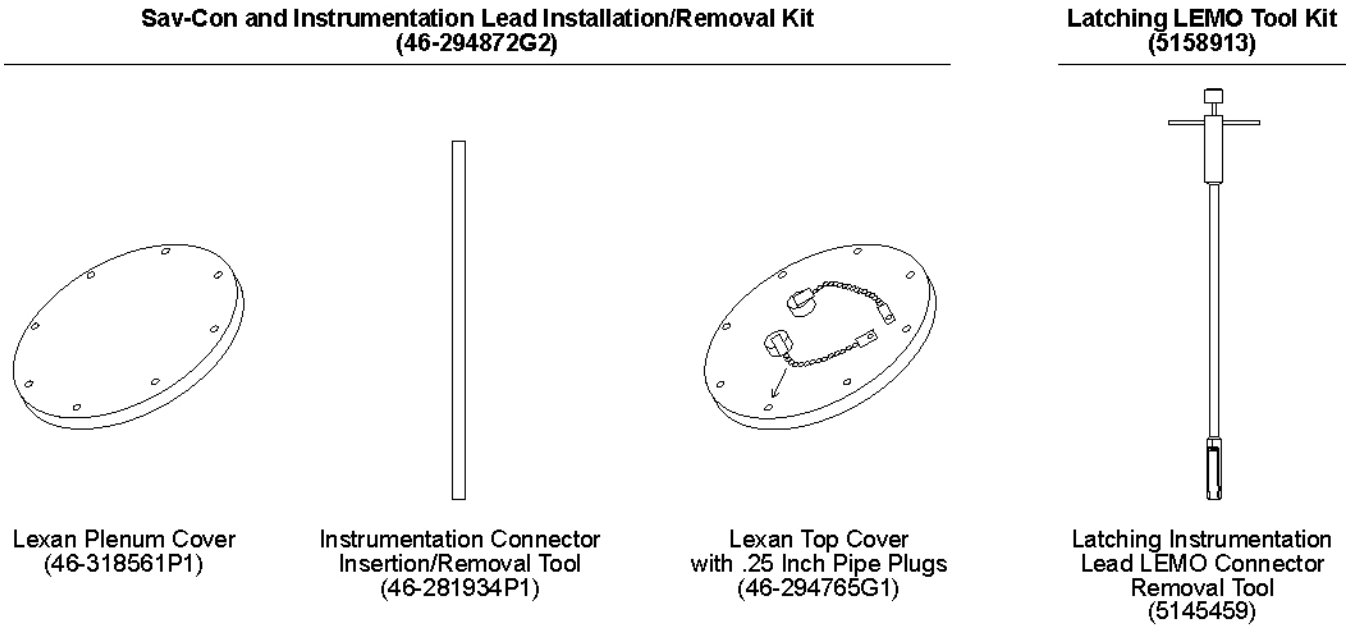
Illustration 5-99: Instrumentation Connector Location



4. Check the Instrumentation Connector Housing (identified in Illustration 5-102) at the Plenum (G-10 Sleeve) end after disconnecting P1-C. A red groove around the forward end of the housing indicates a 'locking' LEMO connector, which requires the use of Latching Instrumentation LEMO Connector Removal Tool 5145459 for removal. Otherwise, Instrumentation Connector Insertion/Removal Tool 46-281934P1 should be used. See Illustration 5-100.

5. Make sure Lexan Top Cover 46-294765G1 (with 1/4 inch Pipe Plugs already installed) is immediately accessible for mounting on the Plenum Assembly when the Shim Lead Assembly is removed. See Illustration 5-100.

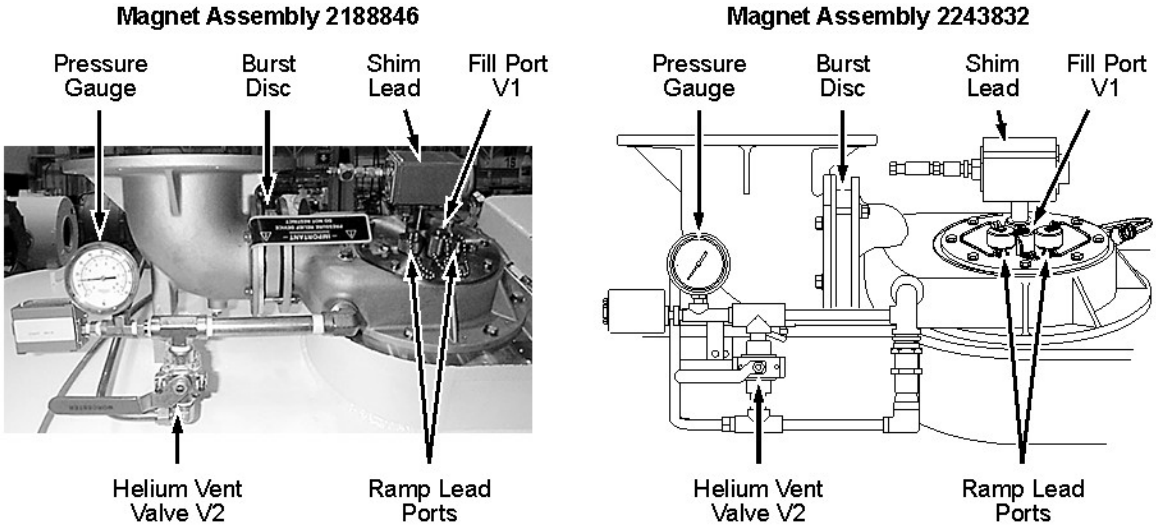
Illustration 5-100: Tools Used, Sav-Con and Instrumentation Lead Installation/Removal Kit (46-294872G2) and Latching LEMO Tool Kit (5158913)



6. Open Vent Valve V2 to depressurize the Cryostat to 0.25-0.30 psig. Close V2. See Illustration 5-101.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-101: Helium Vent Plumbing



7. Loosen and remove the four retaining bolts holding the Vent Adaptor to the Plenum Assembly. See Illustration 5-99.

8. Remove the Shim Lead Assembly according to Section 12, Shim Lead and Baffle Replacement.

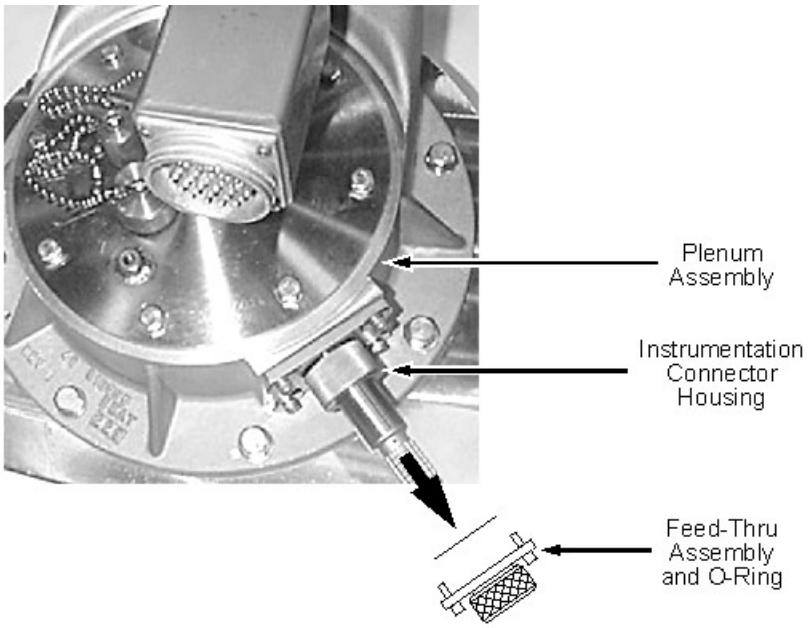
9. Then immediately place the Lexan Top Cover over the opening and secure with the eight bolts removed in Step 7. Tighten finger tight.

NOTE: Aligning the scribe mark on Lexan Top Cover towards the Vent is not necessary for this Instrumentation Lead Assembly Replacement procedure.

10. Disconnect the .25 inch (6 mm) Instrumentation Lead Vent Line from the Male Connector on top of the Instrumentation Connector Housing. See Illustration 5-102.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-102: Instrumentation Lead Male Connector Location



11. Loosen and remove the Male Connector from the top of the defective Instrumentation Lead Assembly.

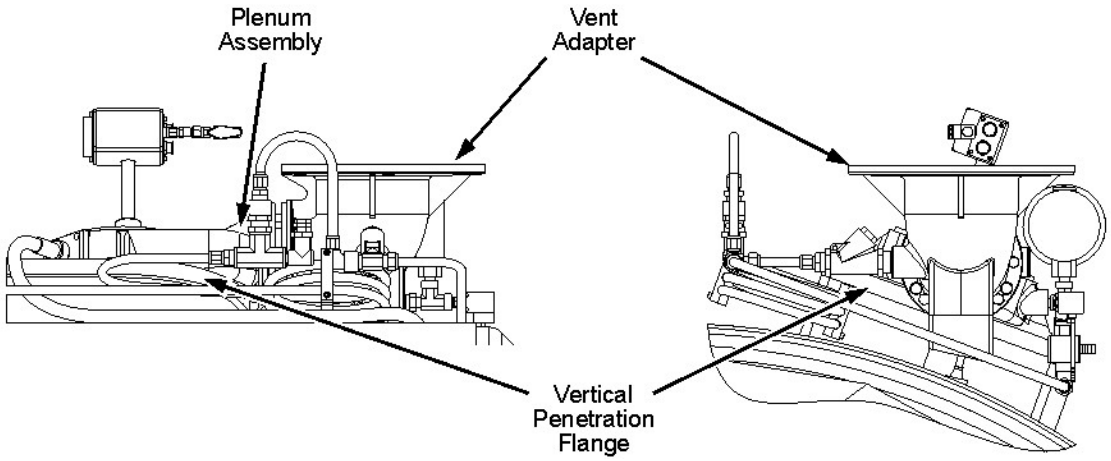
12. Loosen the compression fitting and remove the four socket head bolts holding the Feed-Thru Assembly to the Plenum Assembly. See Illustration 5-102.

13. Remove the Feed-Thru Assembly and O-Ring from the Instrumentation Lead Assembly.

14. Disconnect the union ball joint on the 1/2 inch plumbing from the Plenum Assembly using a pipe wrench. See Illustration 5-103.

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

Illustration 5-103: Magnet Plumbing Views

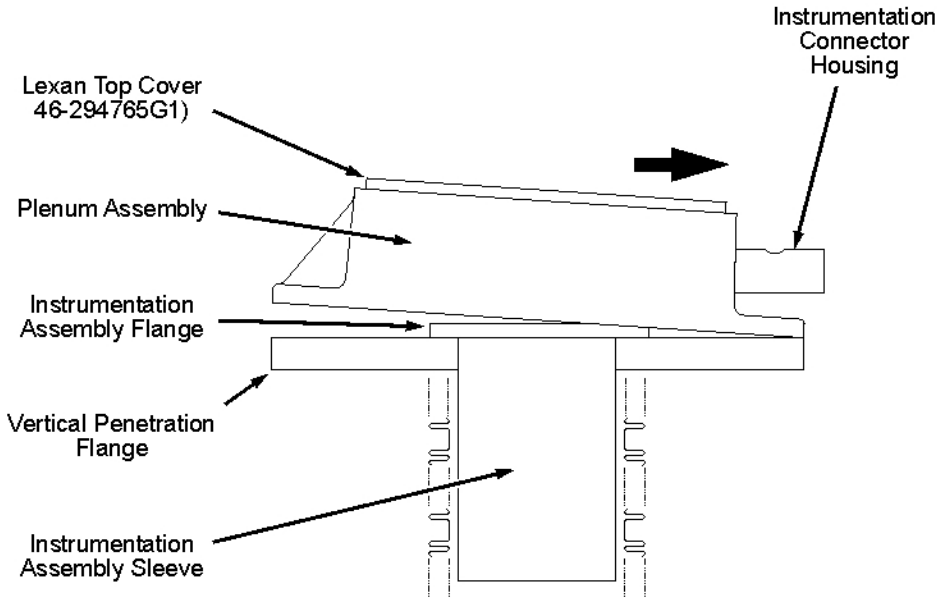


Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

15. Remove the eight bolts securing the Plenum Assembly to the Vertical Penetration Flange.

16. Remove the Plenum Assembly by carefully lifting the edge away from connector just enough to clear the flange of the Instrumentation Lead Assembly and slide it off the end of the Instrumentation Connector Housing. See Illustration 5-104.

Illustration 5-104: Plenum Assembly Removal



NOTE: If there is no red groove around the Instrumentation Connector Housing, remove the Instrumentation Lead LEMO Connector (P101) in conformance with Section 14.4.1.2, Removal Using Instrumentation Connector Insertion/Removal Tool 46-281934P1. Otherwise, remove it in conformance with Section 14.4.1.3, Removal Using Latching Instrumentation LEMO Connector Removal Tool 5145459.

14.4.1.2 Removal Using Instrumentation Connector Insertion/Removal Tool 46-281934P1

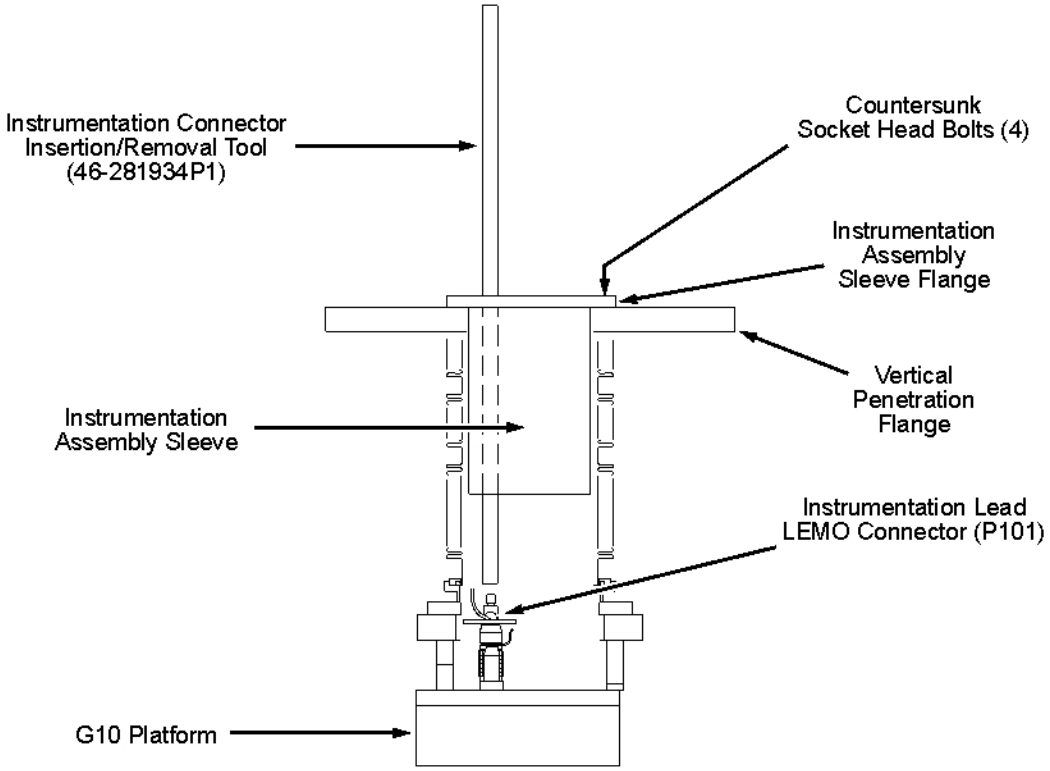
NOTICE

Section 14.4.1.2 must be performed rapidly to prevent cryopumping and frost build-up.

1. Loosen and remove the four bolts holding the Instrumentation Assembly Sleeve to the Vertical Penetration Flange. See Illustration 5-105.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-105: Attaching the Connector Insertion/ Removal Tool



NOTICE

Make sure there is no moisture or other contamination on the Connector Insertion/Removal Tool. Any moisture remaining on the tool may result in the tool freezing to the connector.

2. Locate the Connector Insertion/Removal Tool (46-281934P1). Warm it with the heat gun to remove any moisture.

3. Shine a flashlight through the Instrumentation Assembly Sleeve and inspect the Instrumentation Lead Connector for frost. Remove visible frost by inserting a helium gas hose and blowing warm helium gas at 15 psig on the frosted location.

4. With the flashlight still shining through the Instrumentation Assembly Sleeve, align the end of the Connector Insertion/Removal Tool with the threaded top on Connector P101 at the bottom of the Vertical Penetration. See Illustration 5-105.

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.

5. Thread the Connector Insertion/Removal Tool onto Connector P101 (clockwise) until snug and then back off (counterclockwise) a quarter turn. Pull upward on the tool until the connector disengages.

6. The Connector Insertion/Removal Tool and Instrumentation Lead Assembly can now be removed.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7. Immediately place the Lexan Plenum Cover (46-318561P1) over the Vertical Penetration Flange and secure with the bolts removed in Section 14.4.1.1, Step 15.

8. Continue with Section 14.4.2, Instrumentation Lead Replacement.

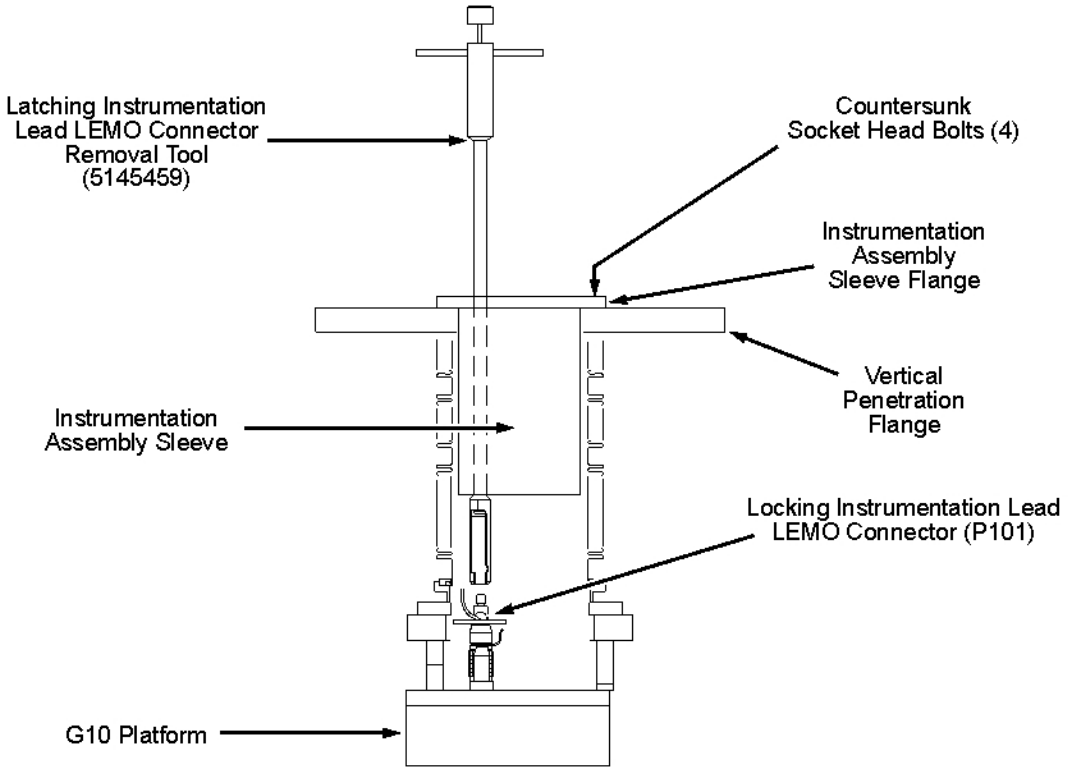
14.4.1.3 Removal Using Latching Instrumentation LEMO Connector Removal Tool 5145459

NOTICE

Section 14.4.1.3 must be performed rapidly to prevent cryopumping and frost build-up.

1. Loosen and remove the four bolts holding the Instrumentation Assembly Sleeve to the Vertical Penetration Flange. See Illustration 5-106.

Illustration 5-106: Attaching Latching Instrumentation LEMO Connector Removal Tool 5145459



NOTICE

Make sure there is no moisture or other contamination on the Connector Insertion/Removal Tool. Any moisture remaining on the tool may result in the tool freezing to the connector.

2. Locate Latching Instrumentation LEMO Connector Removal Tool 5145459. Warm it with the heat gun to remove any moisture.

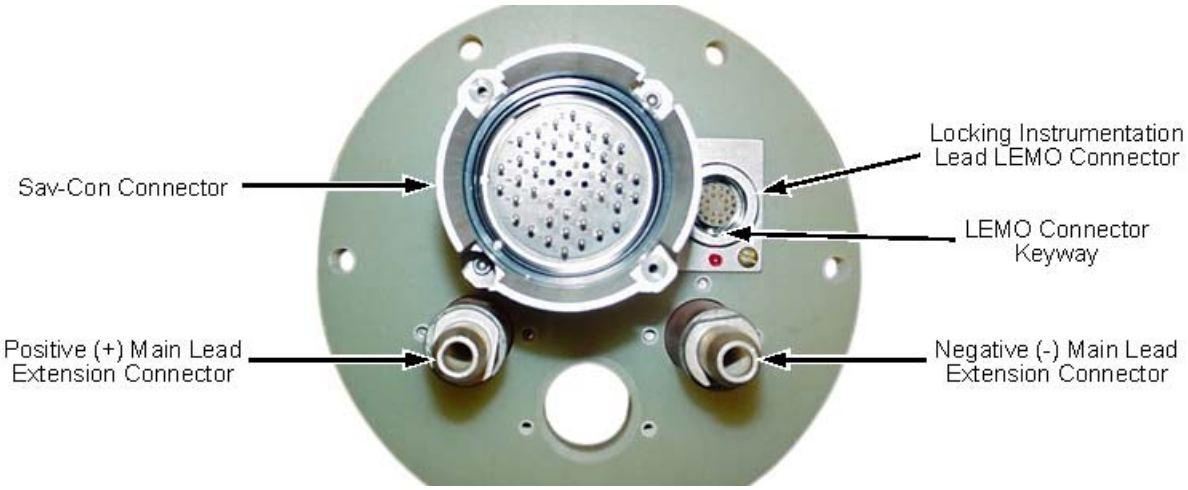
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3. Shine a flashlight through the Instrumentation Assembly Sleeve and inspect the Instrumentation Lead Connector for frost. Remove visible frost by inserting a helium gas hose and blowing warm helium gas at 15 psig on the frosted location.

4. With the flashlight still shining through the Instrumentation Assembly Sleeve, insert the Latching Instrumentation LEMO Connector Removal Tool into the Vertical Penetration, down between the Instrumentation Lead Connector and the Negative (-) Main Lead Extension Connector. See Illustration 5-106 and Illustration 5-107.

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.

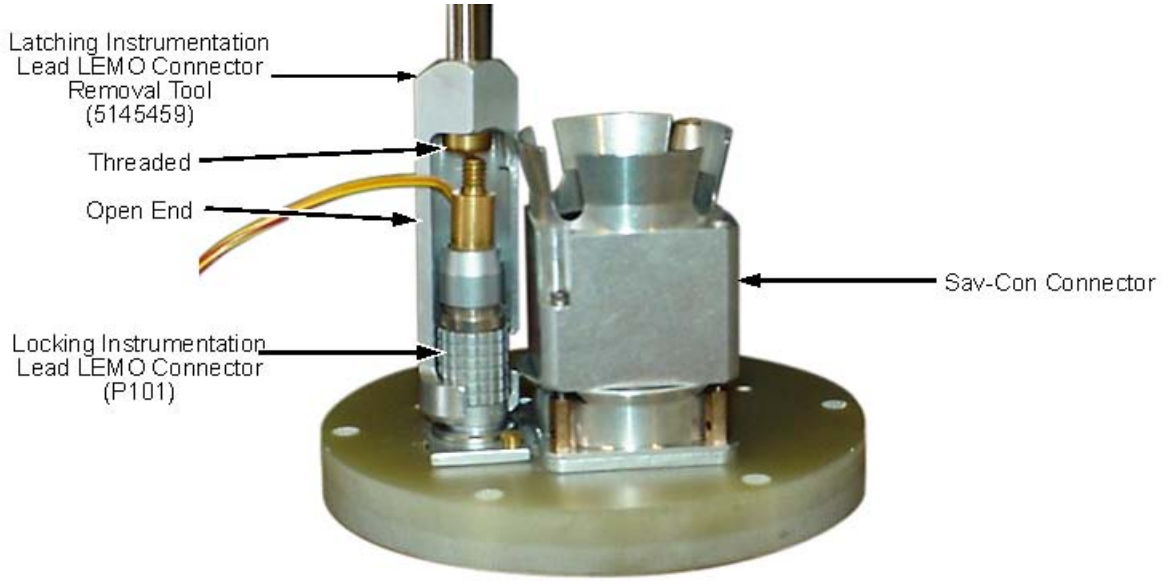
Illustration 5-107: G10 Platform Connectors



5. With the open section of the holder facing towards the LEMO connector, turn the Latching Instrumentation LEMO Connector Removal Tool counterclockwise (CCW) and forward, snapping the tool onto the LEMO connector. See Illustration 5-108.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-108: Attaching Latching Instrumentation LEMO Connector Removal Tool 5145459 to Instrumentation Lead Connector



6. Press the knob down and turn the knob clockwise (CW) to screw the Latching Instrumentation LEMO Connector Removal Tool onto the LEMO connector, until fully engaged.

7. Press the knob down and pull the handle upward, until the LEMO connector disengages.

8. The Latching Instrumentation LEMO Connector Removal Tool and the Instrumentation Lead Assembly can now be removed.

9. Immediately place the Lexan Plenum Cover (46-318561P1) over the Vertical Penetration Flange and secure with the bolts removed in Section 14.4.1.1, Step 15.

10. Continue with Section 14.4.2.

14.4.2 Instrumentation Lead Replacement

NOTICE

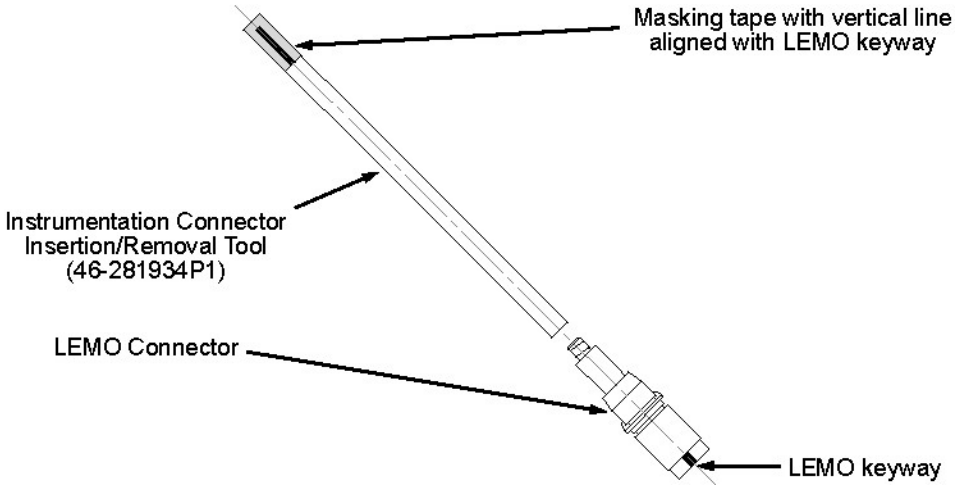
Make sure the Vertical Penetration is clear of any obstructions before inserting/extracting any tools/apparatus to prevent possible magnet damage.

1. Wrap a piece of masking tape around the end of the Connector Insertion Removal Tool opposite the threaded end. The tape will be used to mark the location of the LEMO Connector keyway in Section 14.4.1.1, Step 10.

2. Screw the Connector Insertion/Removal Tool onto the new LEMO Connector. Place a mark on the masking tape to indicate the location of the LEMO Connector keyway. See Illustration 5-109.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-109: LEMO Connector Keyway Identification



3. Remove the Lexan Plenum Cover installed in Section 14.4.1.2, Step 7/Section 14.4.1.3, Step 9.

4. Install a new Turret O-Ring (46-281101P6) on the Vertical Penetration Flange for the new Instrumentation Lead Assembly. Use vacuum grease when installing the new o-ring.

5. Warm the insertion end of the Instrumentation Lead Assembly and the Connector Insertion/Removal Tool to remove any moisture.

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

7. Secure the new Instrumentation Lead Assembly to the Penetration Flange with the four bolts removed in Section 14.4.1.2, Step 1/Section 14.4.1.3, Step 1.

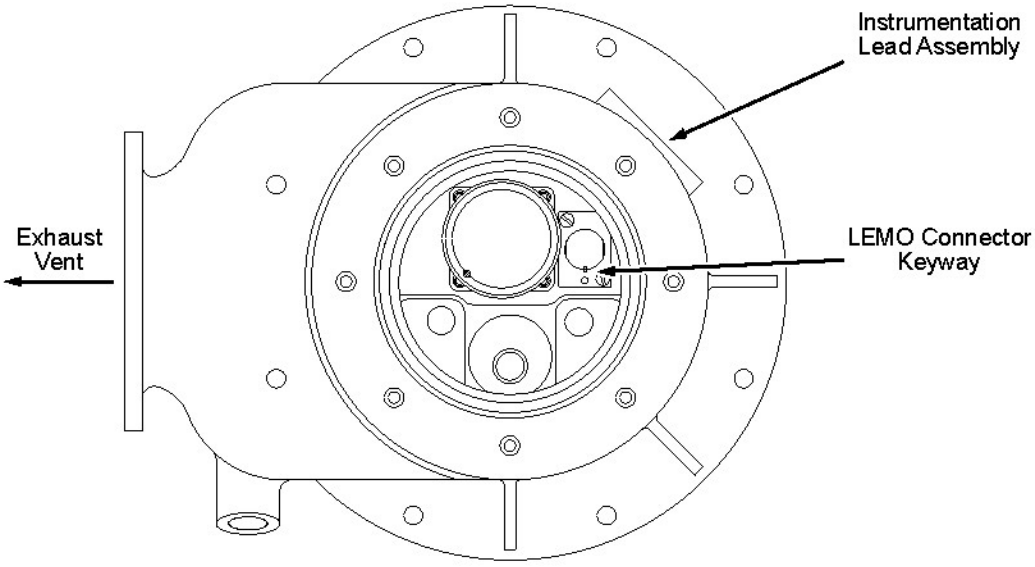
NOTE: Before connecting the Instrumentation Lead's LEMO Connector (P101) to J101, make sure there is no ice build-up on J101.

NOTE: Study the location of the keyways on the Connector P101 and on J101 for easy installation.

8. Shine a flashlight into the Vertical Penetration. Position the Instrumentation Lead Connector — using the previously attached Connector Insertion/Removal Tool — at the bottom of the Vertical Penetration and insert into J101 until properly seated. See Illustration 5-110 for keyway alignment.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 5-110: Position of LEMO Connector Keyway



9. Unscrew the Connector Insertion/Removal Tool from the Instrumentation Lead Connector and remove.

10. Quickly replace the Turret O-Ring (46-281101P6) and mount the Plenum Assembly with its new Instrumentation Lead Assembly onto the Vertical Penetration Flange using the bolts removed during Section 14.4.1.1, Step 15.

NOTE: Apply vacuum grease to the o-ring before replacement.

11. Install a new Instrumentation Lead Connector Port O-Ring (46-281101P9) and the Feed-thru Assembly that was removed in Section 14.4.1.1, Step 12. Tighten the compression nut.

12. Clean the threads of the Male Connector removed in Section 14.4.1.1, Step 11 and wrap with Teflon Tape. Install the Male Connector on the new Instrumentation Lead Assembly and tighten until snug.

13. Attach the .25 inch (6 mm) Instrumentation Vent Line removed in Section 14.4.1.1, Step 10.

14. Reconnect the union ball joint.

15. Reconnect the Vent Adaptor to the Plenum Assembly with the bolts removed in Section 14.4.1.1, Step 7.

NOTE: The Vent Adapter will sag due to the weight of the vent and will make reconnection difficult. Use 2 x 4 x 24 inch (50 x 100 x 600 mm) lumber to assist in leveraging the Vent Adapter to align bolt holes.

16. Remove the Lexan Top Cover that was installed in Section 14.4.1.1, Step 9.

17. Prepare the Shim Lead Assembly by replacing the old o-ring with a new Shim Lead O-Ring (46-281101P5). Use vacuum grease when installing the o-ring.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTICE

Carefully lower the Shim Lead Assembly into the Vertical Penetration to prevent damage to the baffles.

NOTE: The Shim Lead Assembly must be in the “Disengaged" position.

NOTE: Check for ice build-up on the mating Shim Lead Assembly Connector J100 before installing the Shim Lead Assembly.

18. Immediately install the Shim Lead Assembly into the Vertical Penetration with the scribe mark on the Shim Lead Cover Plate aligned with the Vertical Penetration Exhaust Plenum. Secure with the eight 1/4-20 screws and washers removed previously.

19. Reconnect the .25 inch (6 mm) Exhaust Plumbing to side of the Shim Lead Receptacle Box.

20. Leak test the Instrumentation Lead and Shim Lead Assembly mountings and all plumbing connections using Snoop Liquid Leak Detector (46-252065P71). Correct any leaks found.

21. Reconnect P1-C to J1-C and perform the checks as outlined in Chapter 4, Section 3, Temperature Sensor Checks.

22. Engage the Shim Lead Assembly in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement.

23. Ramp the magnet back up to field in conformance with Chapter 3, Section 7.1, Ramping Magnet to Field.

24. Disengage the Shim Lead Assembly in conformance with Chapter 3, Section 5, Shim Lead Engagement and Disengagement.

NOTICE

Perform all MRU checks in Chapter 4, Section 6, Magnet Rundown Unit (MRU) Checks, upon completion of Instrumentation Lead Assembly replacement to make sure no Instrumentation Lead or LEMO connector damage has occurred. Correct any damage found by reconnecting the LEMO connector or replacing the Instrumentation Lead Assembly.

25. Check the Instrumentation Lead and LEMO connector for damage by performing the MRU checks in Chapter 4, Section 6, Magnet Rundown Unit (MRU) Checks.

14.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

15 Preparation for Site Removal

15.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
2	Included in 'Procedure'	30 hours	Included in 'Procedure'

15.2 Preliminary Requirements

15.2.1 Tools and Test Equipment

No tools or test equipment required.

15.2.2 Consumables

No consumables required.

15.2.3 Replacement Parts

No replacement parts required.

15.2.4 Safety

No general safety information.

15.2.5 Required Conditions

No required conditions.

15.3 Procedure

1. Perform the following procedures from this manual (Direction 2192624) in sequence:

   a. Ramp down the magnet in conformance with Section 6, Magnet Rampdown to Zero Field.

   b. If the magnet is to be moved by air or sea or over land inside a closed container such as an “ISO" box, remove the liquid helium from the helium vessel using the procedure in Section 7, Cryostat Warm-Up, to warm the magnet to > 5K. Large quatities of liquid helium in the helium vessel may be recovered using the procedure in Section 7, Cryostat Warm-Up, if empty helium Dewars are available.



NOTICE

When the bottom diode temperature starts to rise the liquid helium has been removed and the procedure may be stopped.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



NOTICE

Removal of helium from the helium vessel by breaking magnet vacuum will result in large quantities of helium gas being vented through the magnet vent system and damage to the internal magnet insulation.

2. Move the magnet in conformance with Direction 2192625, *GE 1.0T & 1.5T LCC Active Shield Magnet Delivery & Installation*, Direction 2226318, *GE 1.5T & 1.0T Magnet Delivery and Installation* (Wide Open enclosures) or Direction 5154839, *GE HDe & HDx 1.5T LCC Magnet Delivery & Installation*, all three available at http://www.gehealthcare.com/company/docs/siteplanning.html#mr.

15.4 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

This page left intentionally blank.

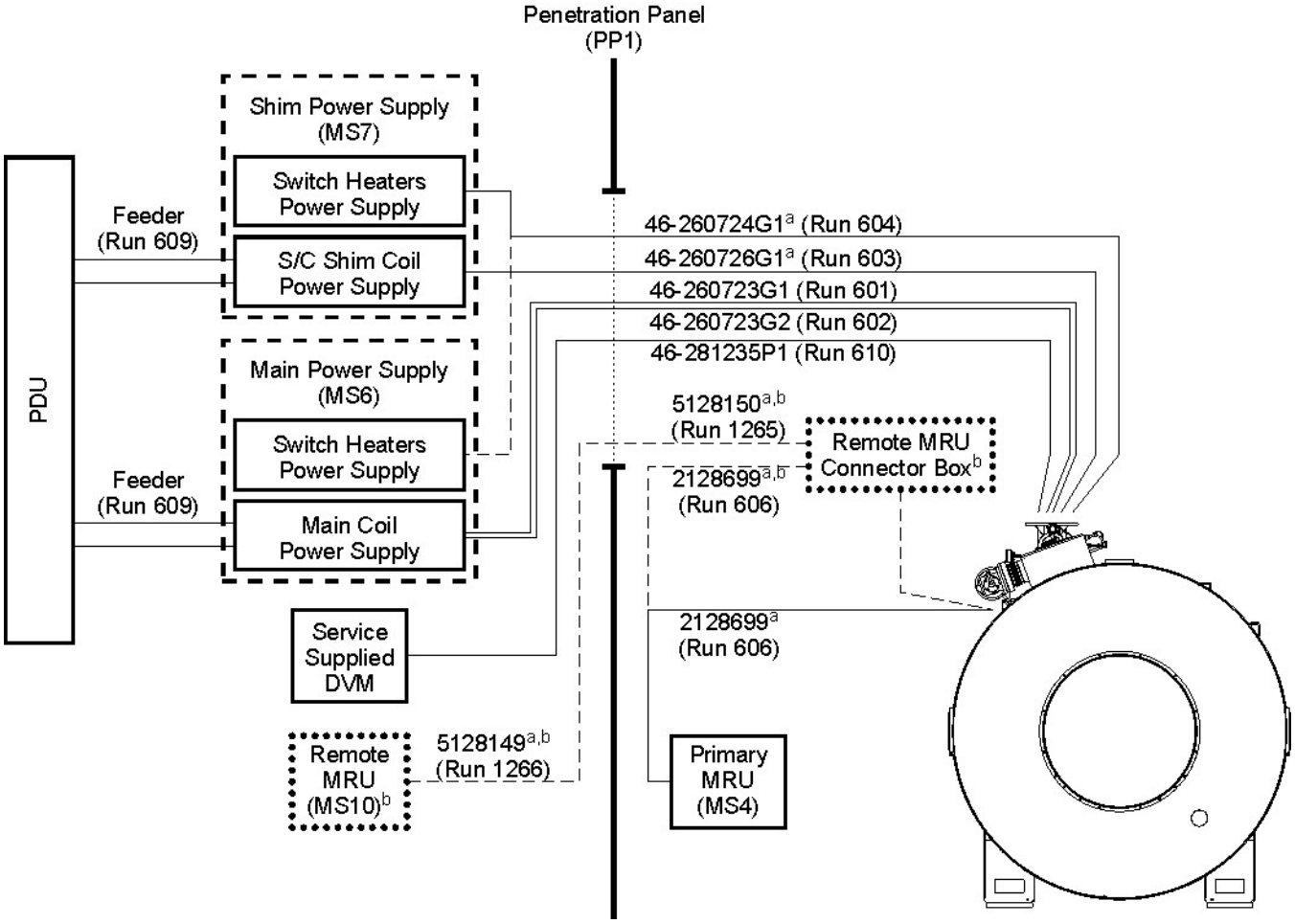
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Chapter 6 Schematics & Interconnects

1 Interconnect Diagrams

1.1 Magnet System Interconnects

Illustration 6-1: Magnet System Interconnect Diagram



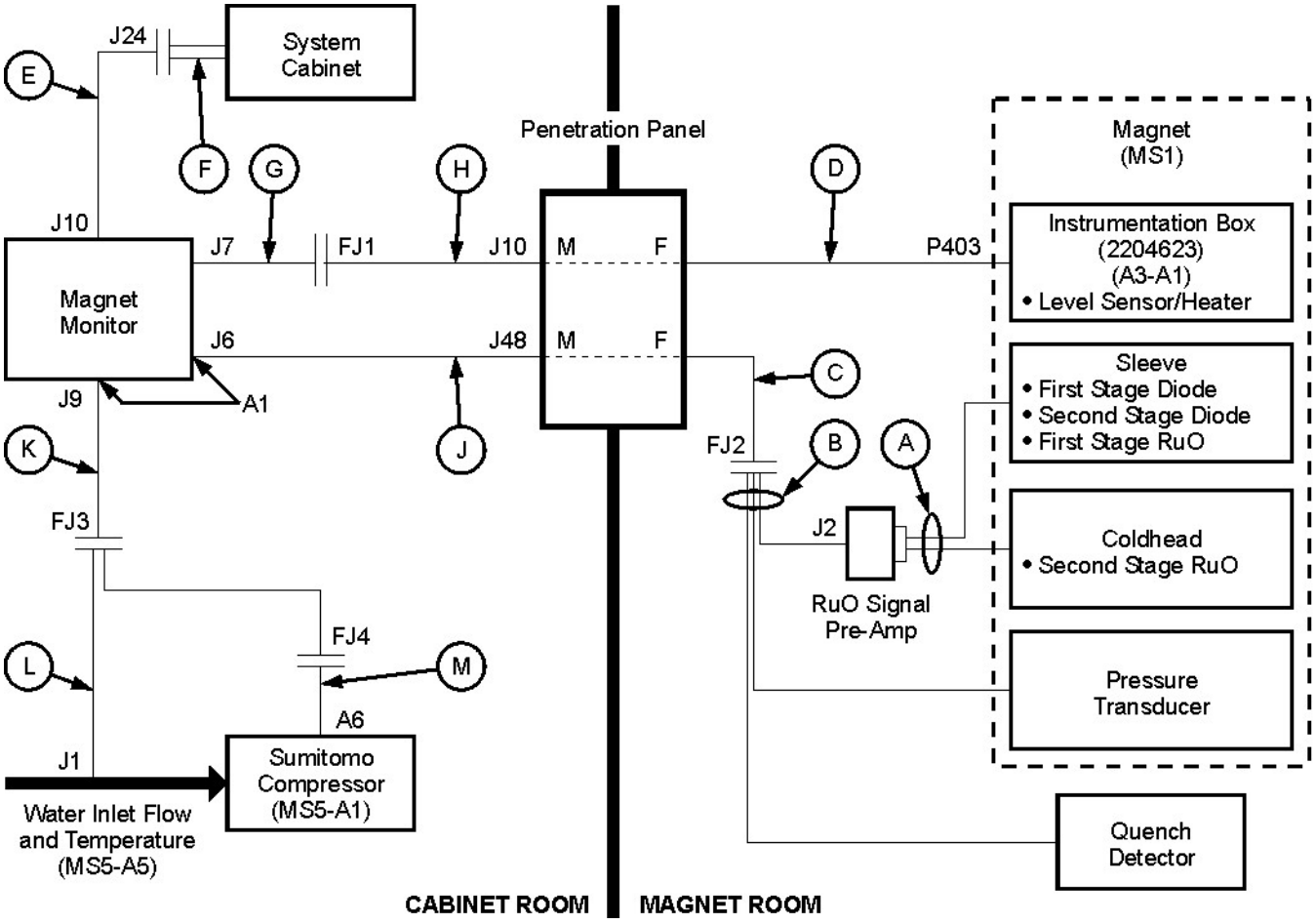
a Cable schematic shown in Section 2.1, *Magnet System Wiring*.

b Item/configuration only at sites with a Remote MRU. At single MRU sites Cable 2128699 connects directly to the Instrumentation Connector Box. See Chapter 3, Section 1.6, Magnet Rundown Unit (MRU) Installation.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.2 Magnet Monitor Interface

Illustration 6-2: Magnet Monitor Interface Diagram



Cabinet Room					Magnet Room			
Cable	**Part Number**	**Run**	**Length**		**Cable**	**Part Number**	**Run**	**Length**
G	46-328000G980	831			A	2214062[b]	832	1.5 ft (458 mm)
H[a]	46-328000G975	824	60 ft. (18.3 M)		B	2222797[b]	830	18 ft. (5.5 M)
J[a]	46-328000G977	825	60 ft. (18.3 M)		C	46-328000G976	829	60 ft. (18.3 M)
K	46-328000G978	826	60 ft. (18.3 M)		D	46-328000G974	828	60 ft. (18.3 M)
L	46-328578P1[b]	827	3 ft. (1 M)		E	46-328000G979	823	60 ft. (18.3 M)
M	46-328000G981	833			F	2204485[b]		

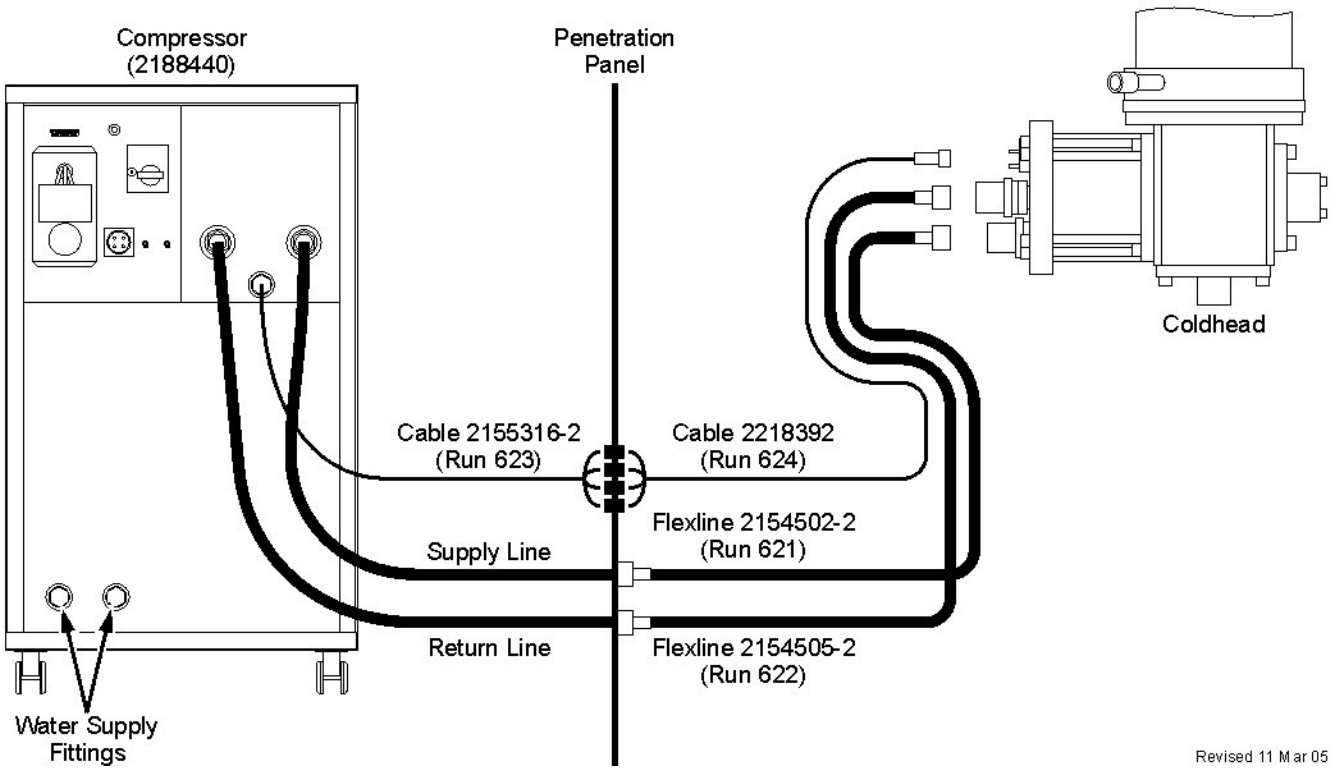
[a] Cable numbers for mobiles and translocatables are H: 46-317359G975 and J: 46-317359G977.

[b] Cable schematic shown in Section 2.3, *Magnet Monitor Cables*.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.3 Cryocooler System Interconnects

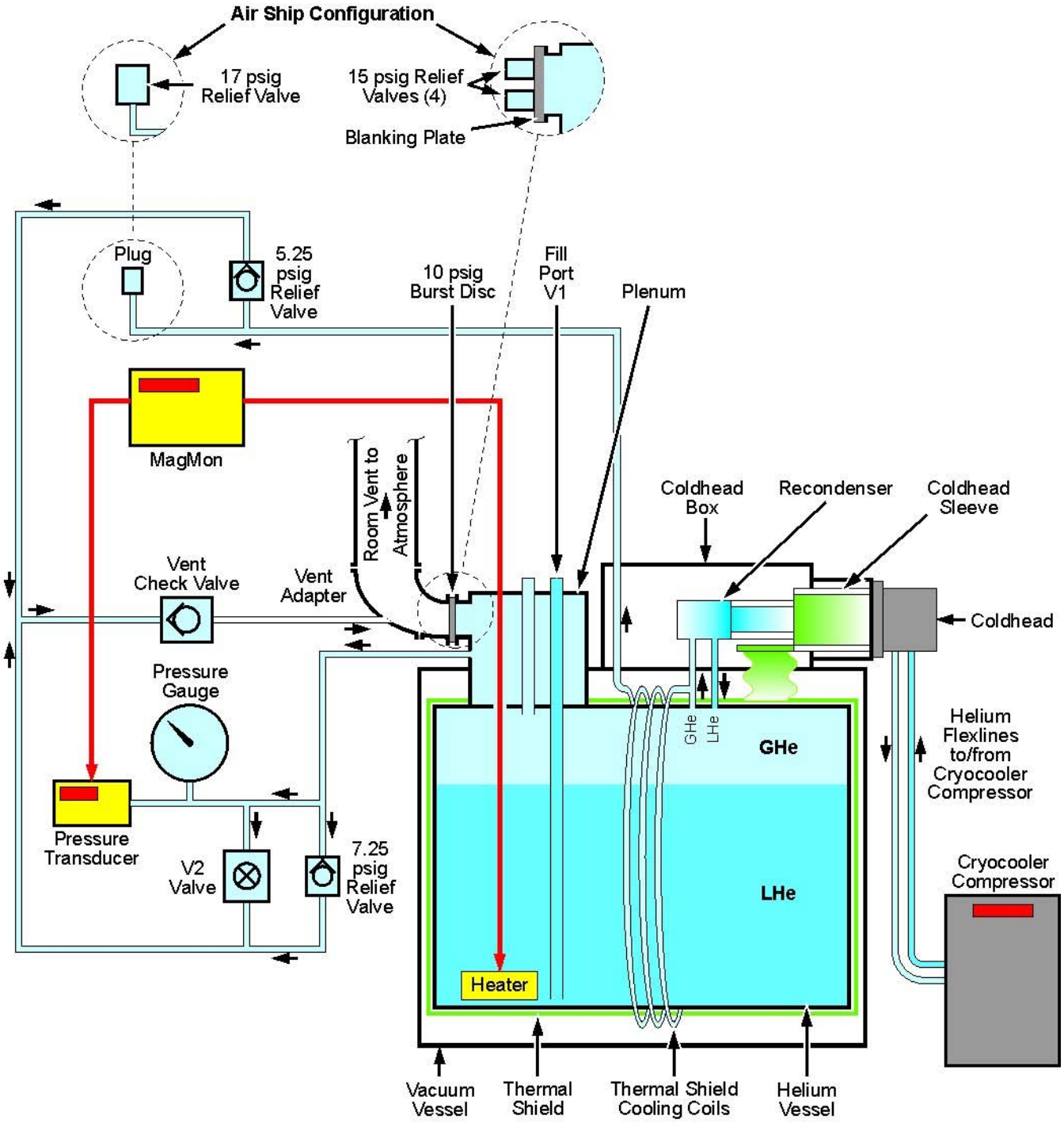
Illustration 6-3: Cryocooler System Interconnects



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.4 Magnet Thermal System Schematic

Illustration 6-4: Helium Path Schematic

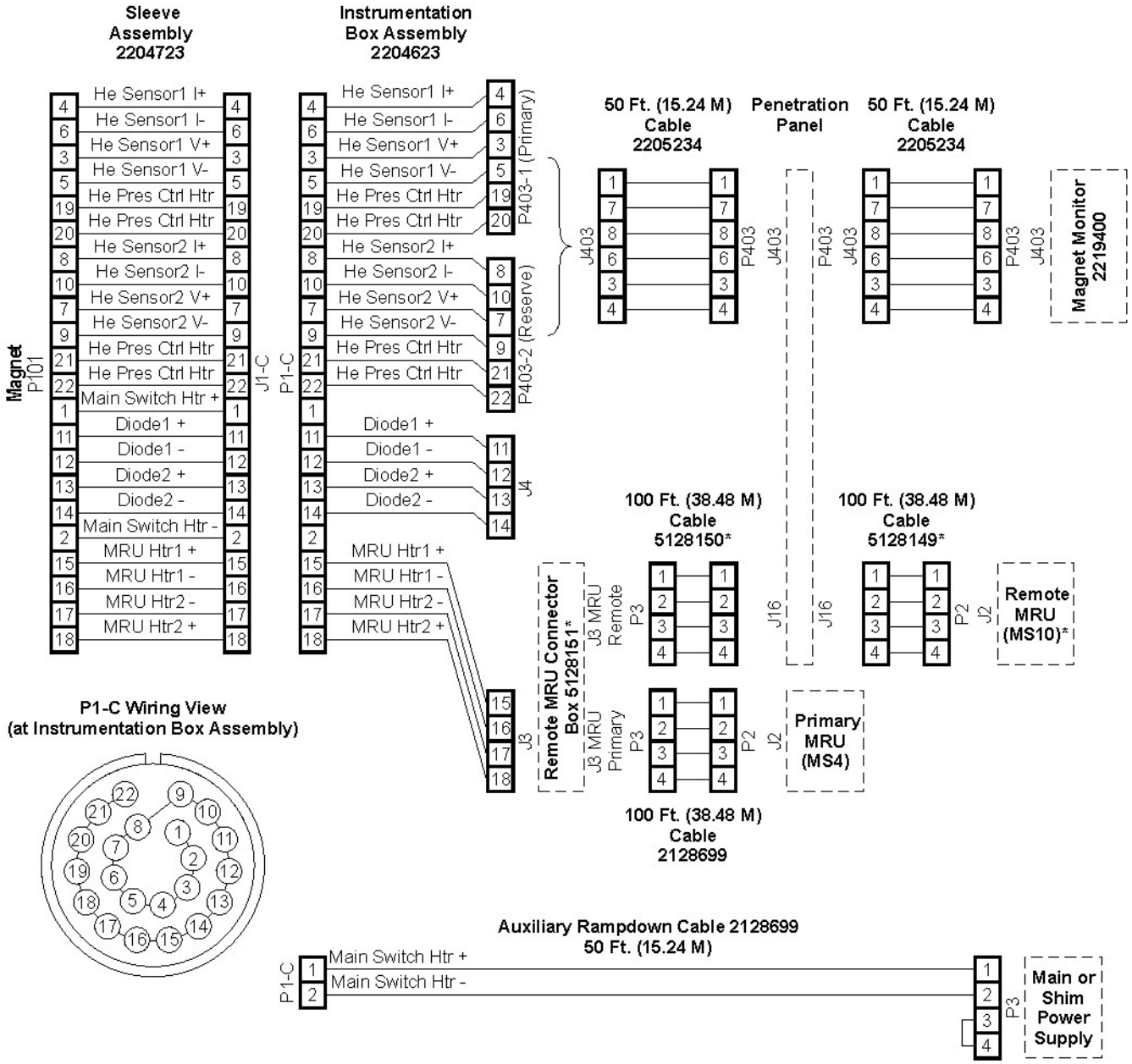


Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2 Wiring Diagrams

2.1 Magnet System Wiring

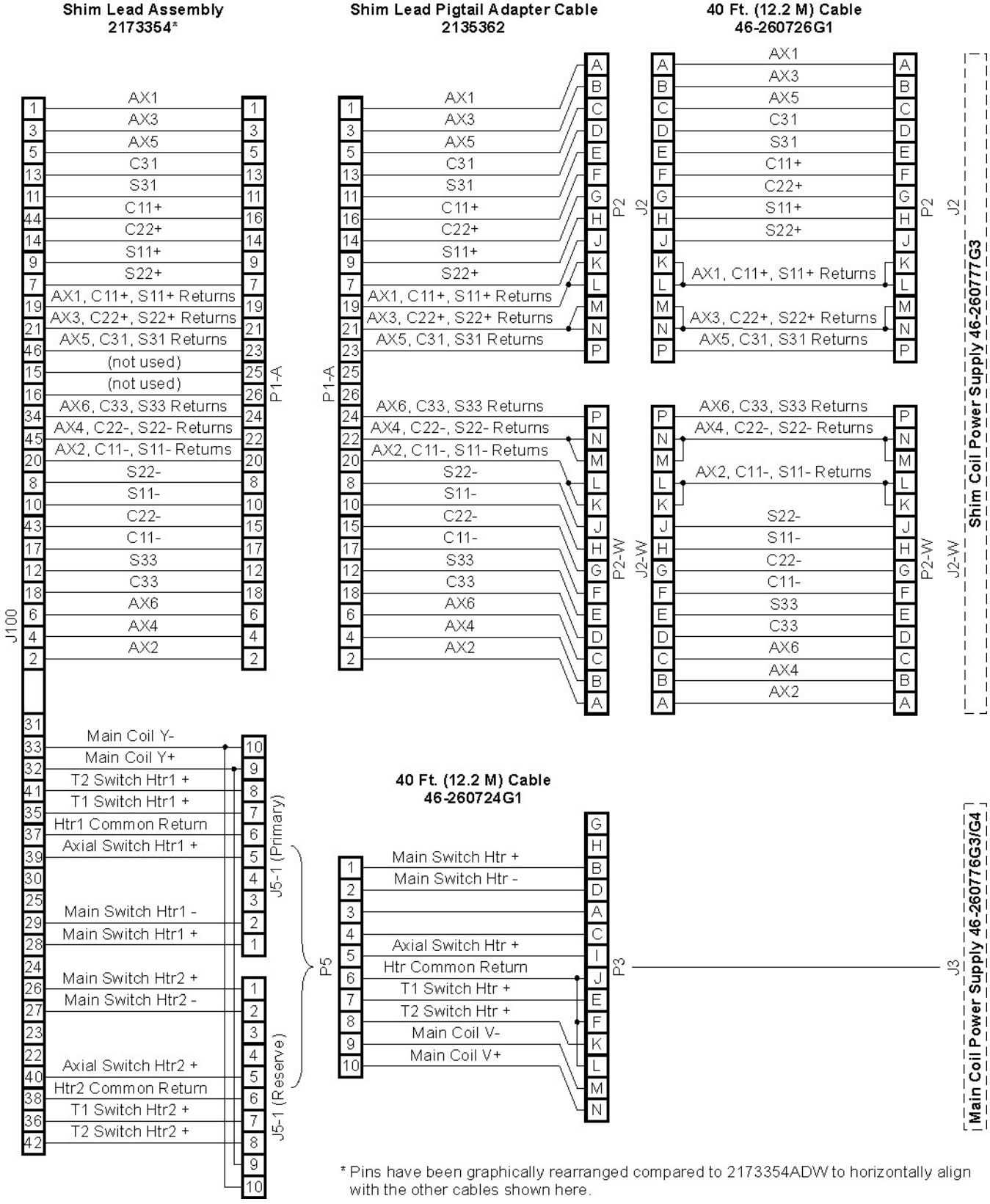
Illustration 6-5: Magnet System Wiring: Sleeve Connections



* Required to install Secondary MRU in addition to Primary (magnet room) MRU, but not required to install single MRU.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

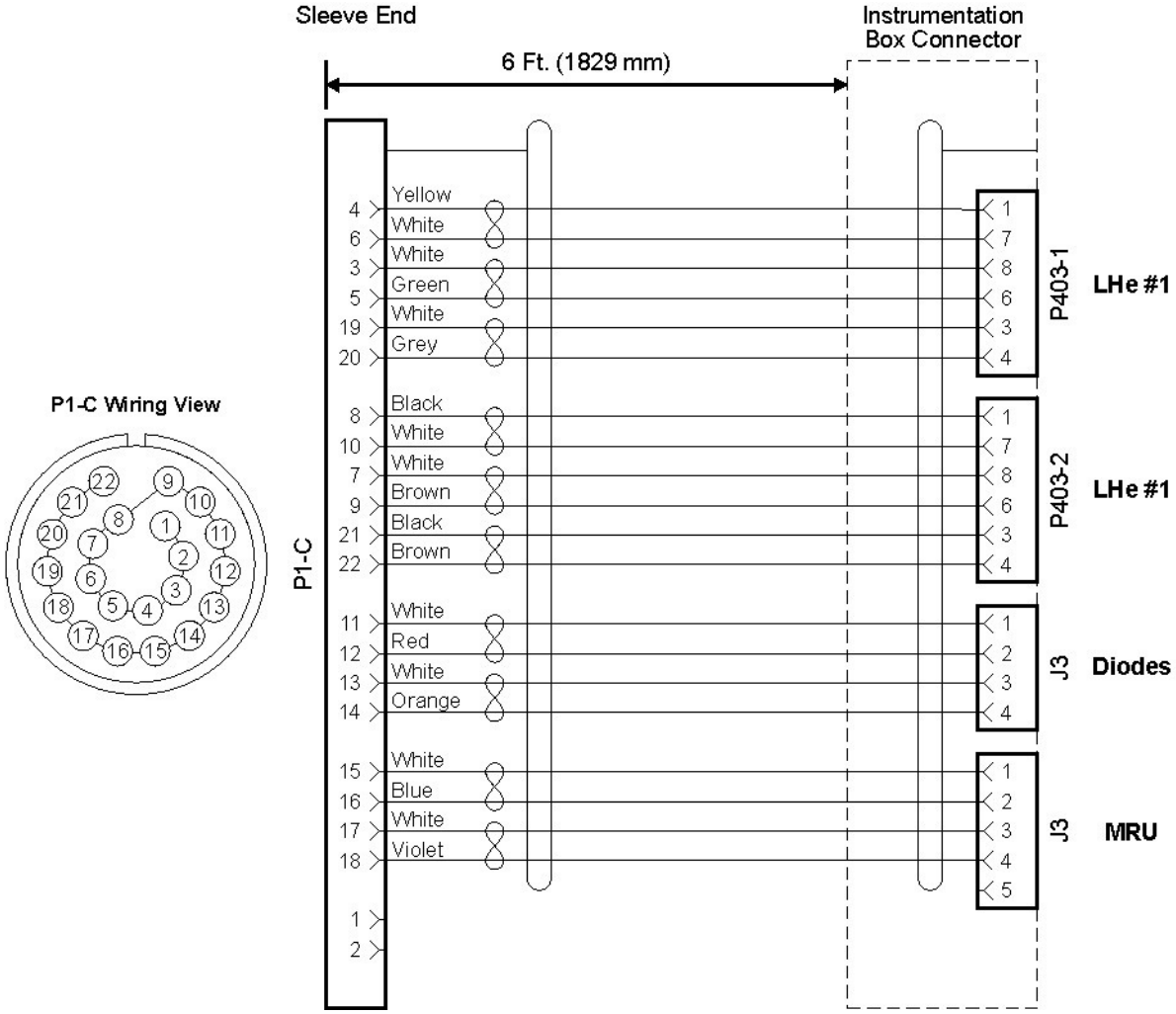
Illustration 6-6: Magnet System Wiring: Shim Lead Connections



* Pins have been graphically rearranged compared to 2173354ADW to horizontally align with the other cables shown here.

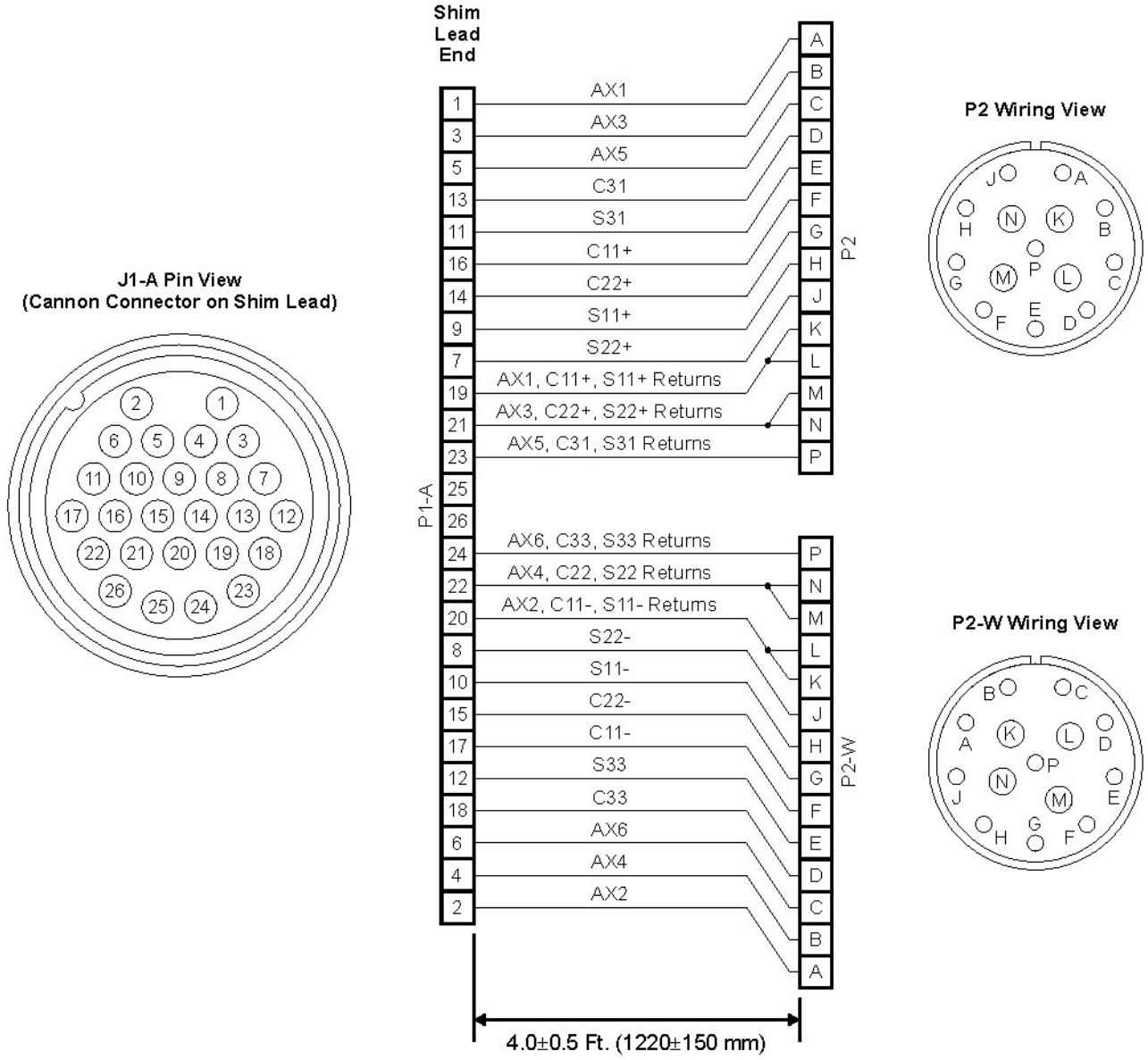
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-7: Instrumentation Box Assembly 2204623 Wiring



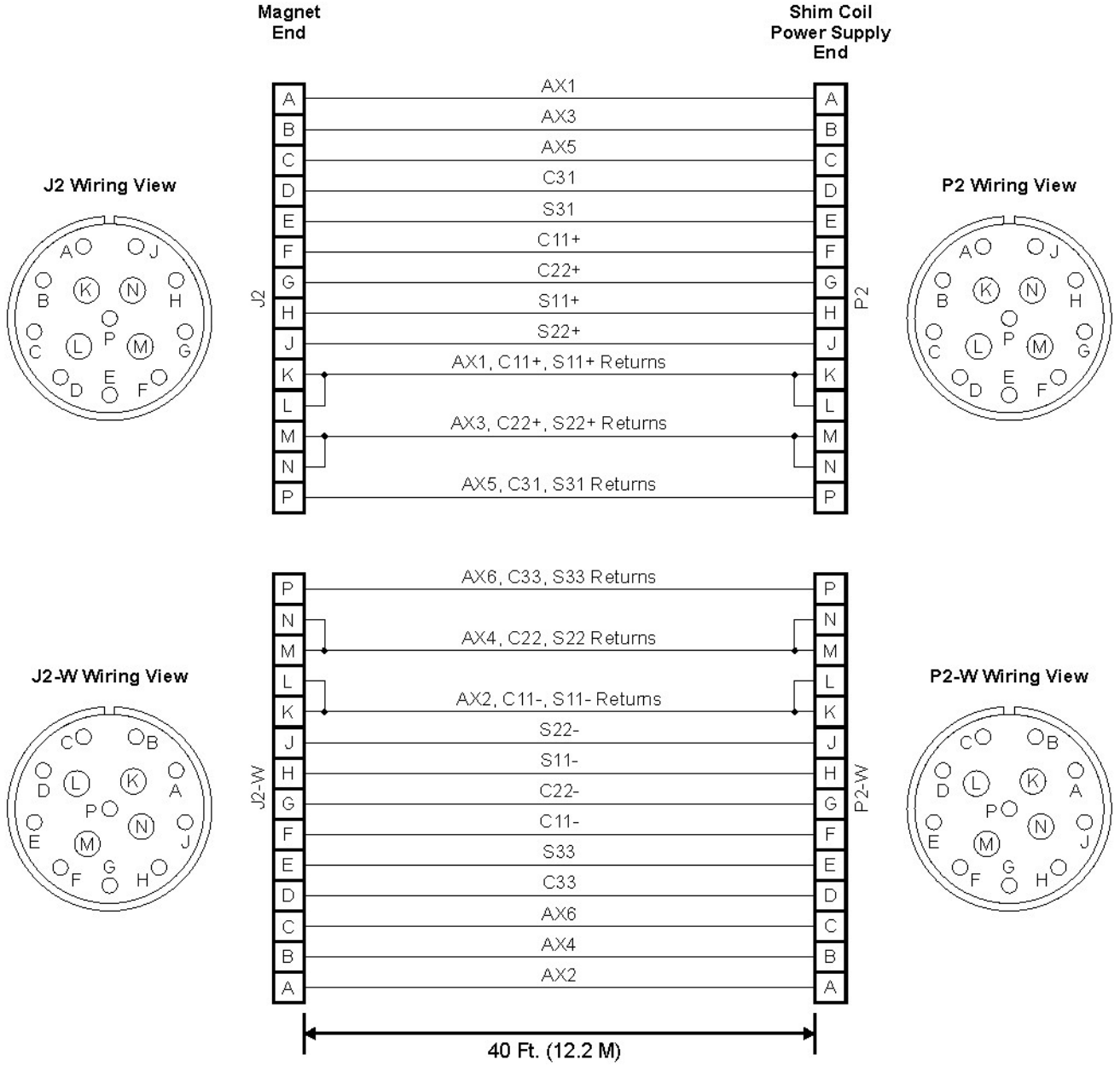
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-8: Shim Lead Pigtail Adapter Cable 2135362 Wiring



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-9: Shim Coil Power Supply Cable 46-260726G1



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-10: Voltage Monitor & Switch Heaters Cable (46-260724G1)

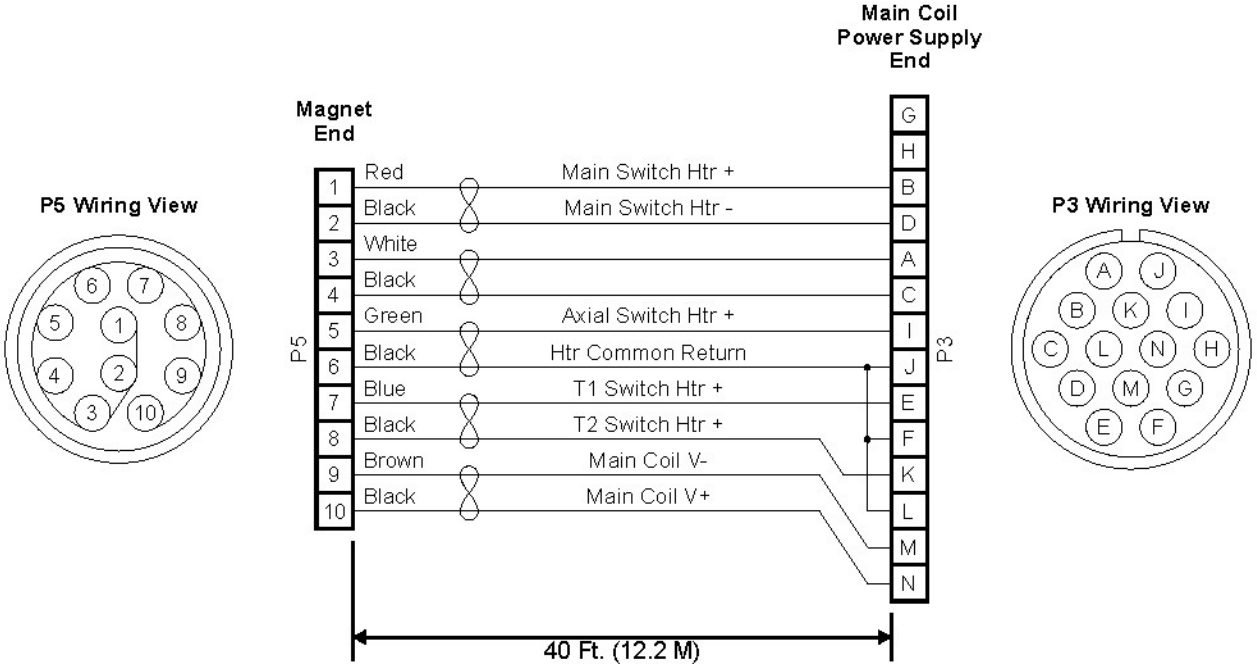
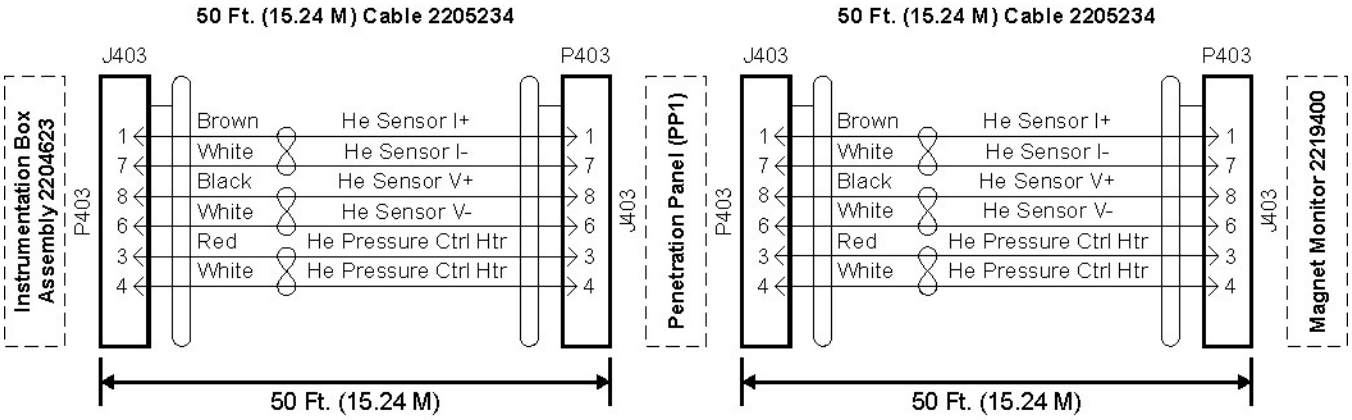
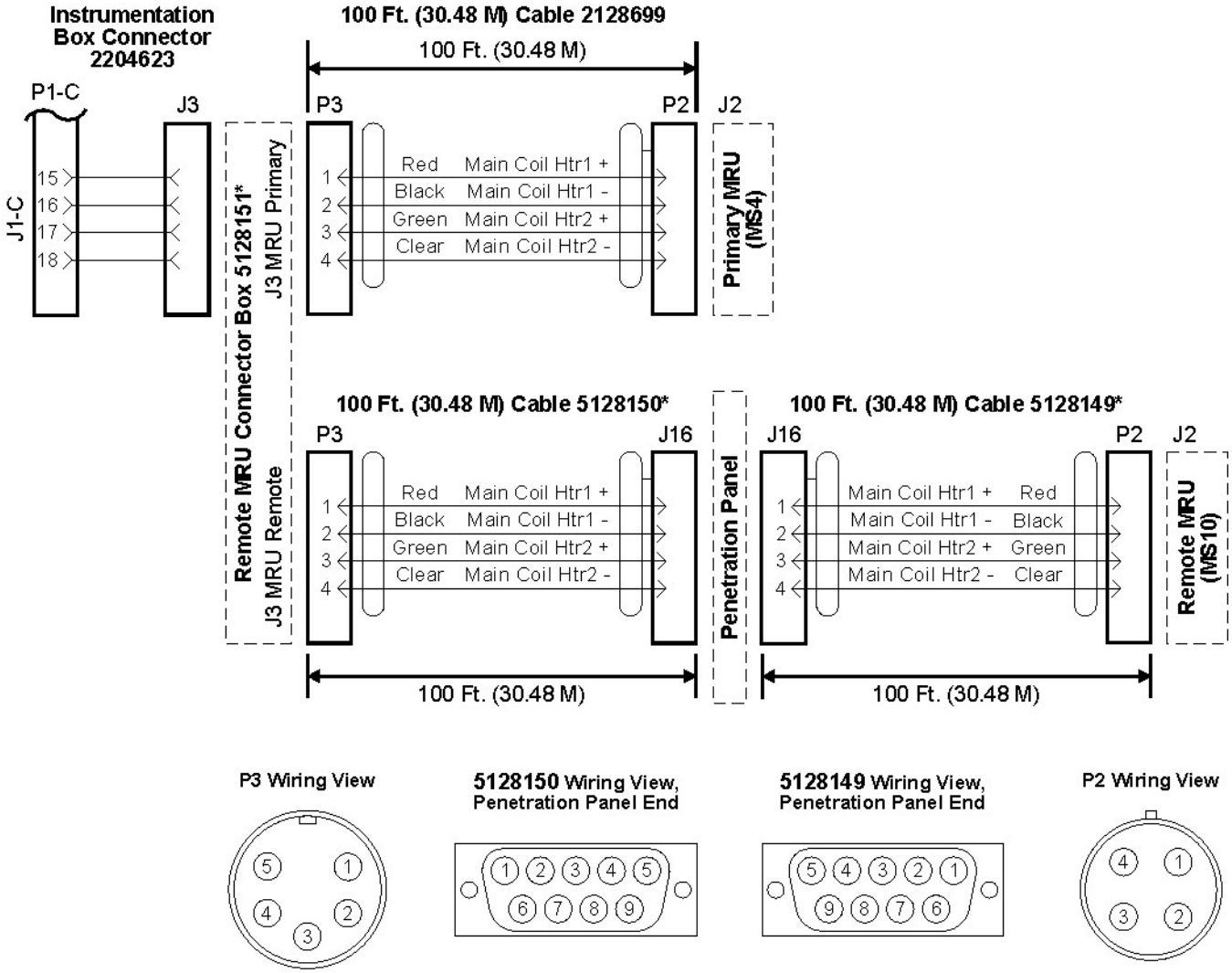


Illustration 6-11: Liquid Helium Monitor Circuit Wiring (Cables 2205234)



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-12: Main Coil Heater Rundown Wiring



* Required to install Secondary MRU in addition to Primary (magnet room) MRU, but not required to install single MRU only.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.2 RuO Circuits and Pinouts

Illustration 6-13: RuO Circuit & Pinouts, Recondenser Vacuum Sleeve

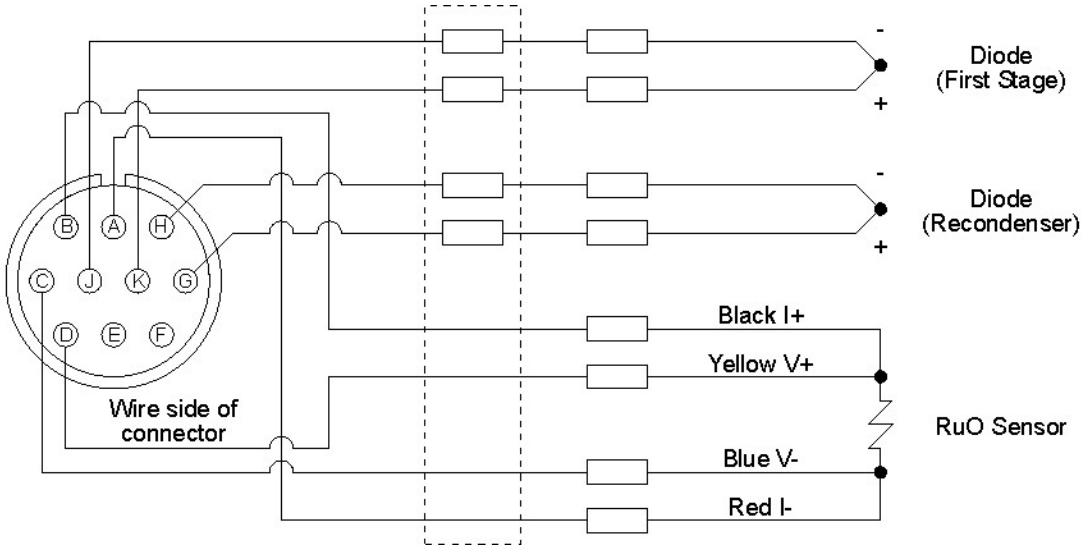
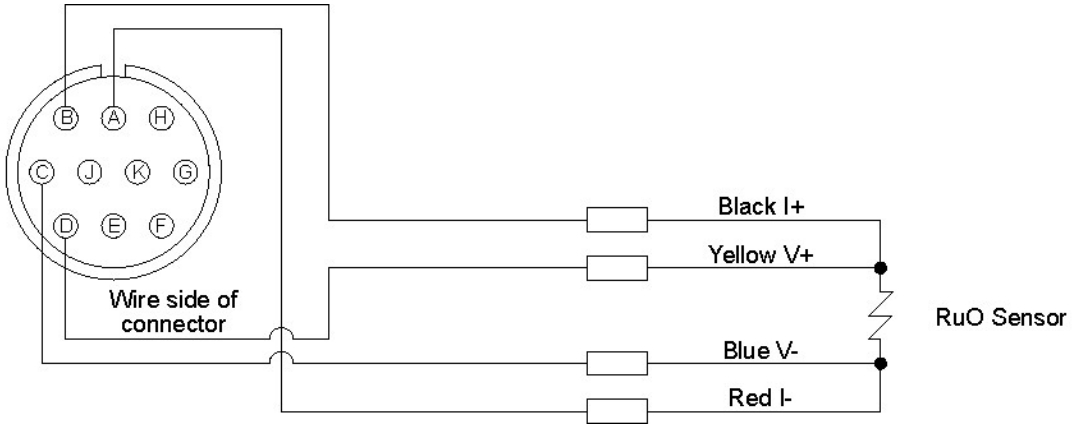


Illustration 6-14: RuO Circuit & Pinouts, Coldhead Transition Flange



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.3 Magnet Monitor Cables

Illustration 6-15: Magnet Monitor Cable A (Run 832): 2214062

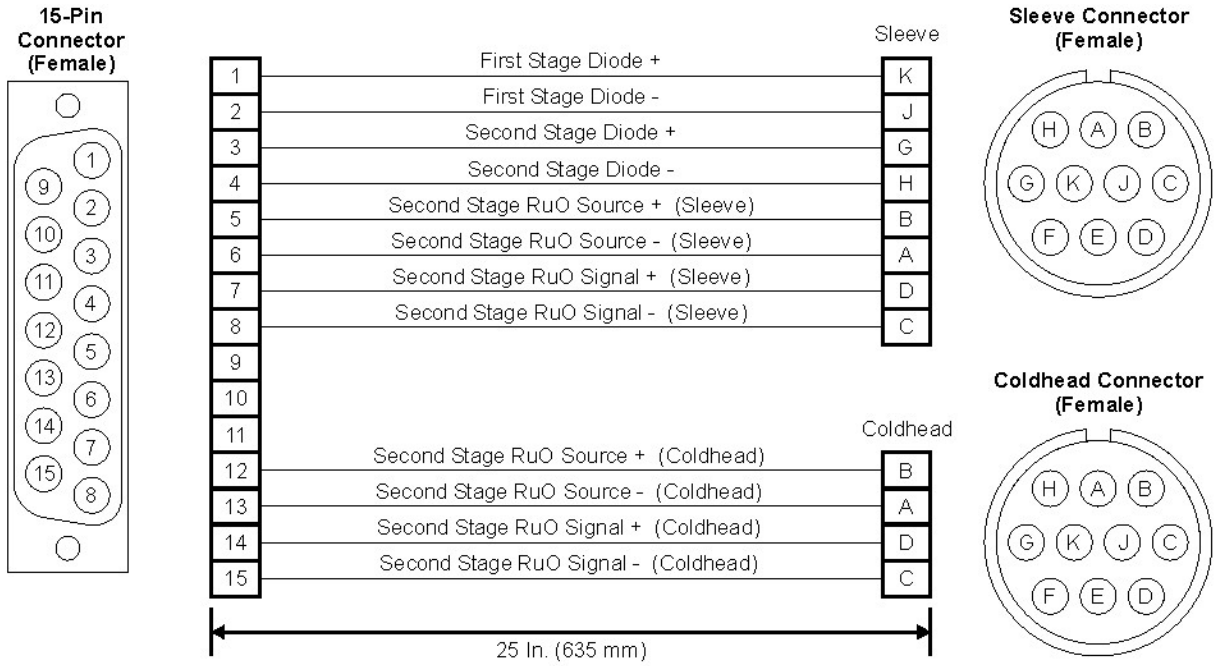
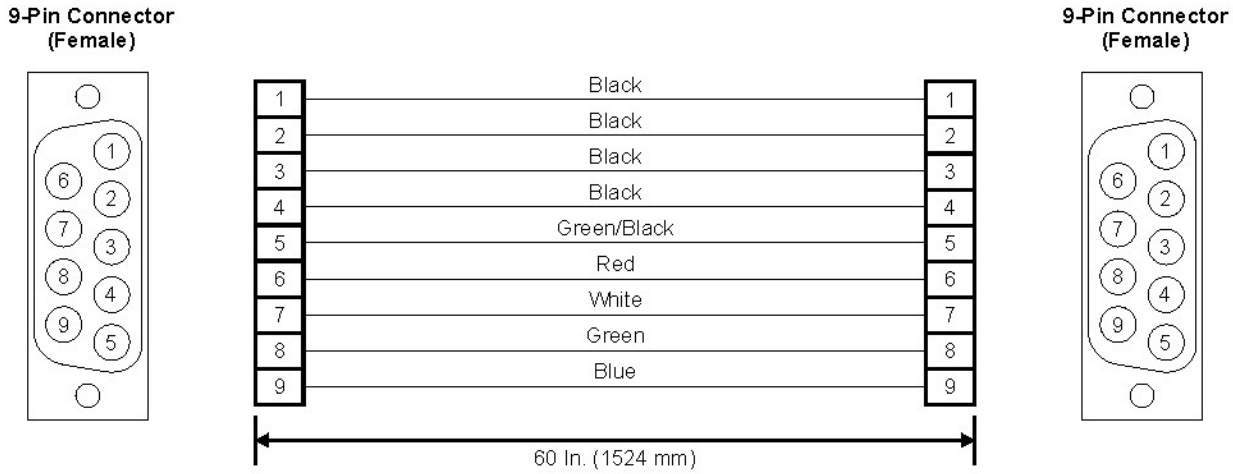
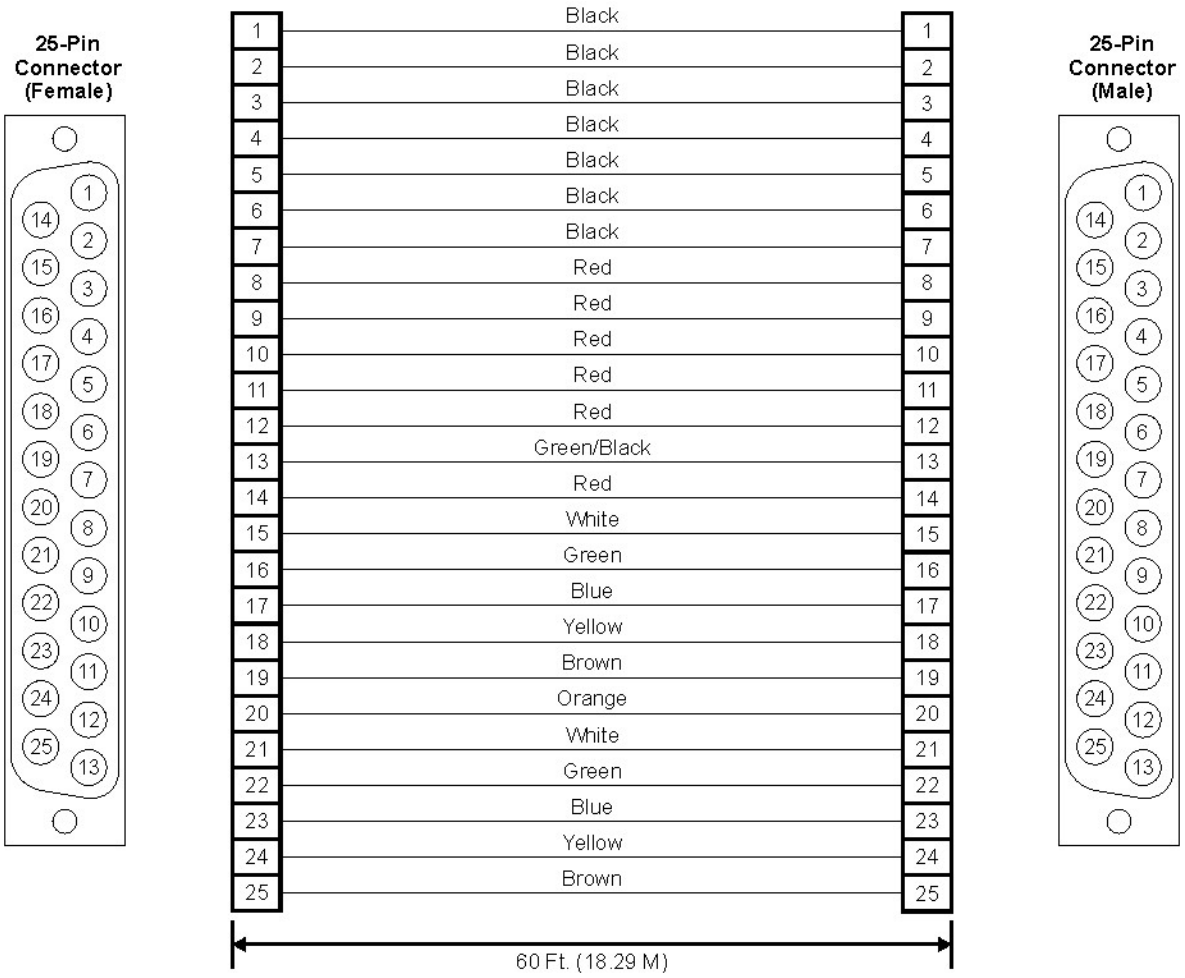


Illustration 6-16: Magnet Monitor Cables D (Run 828) and H (Run 824): 46-271609G29



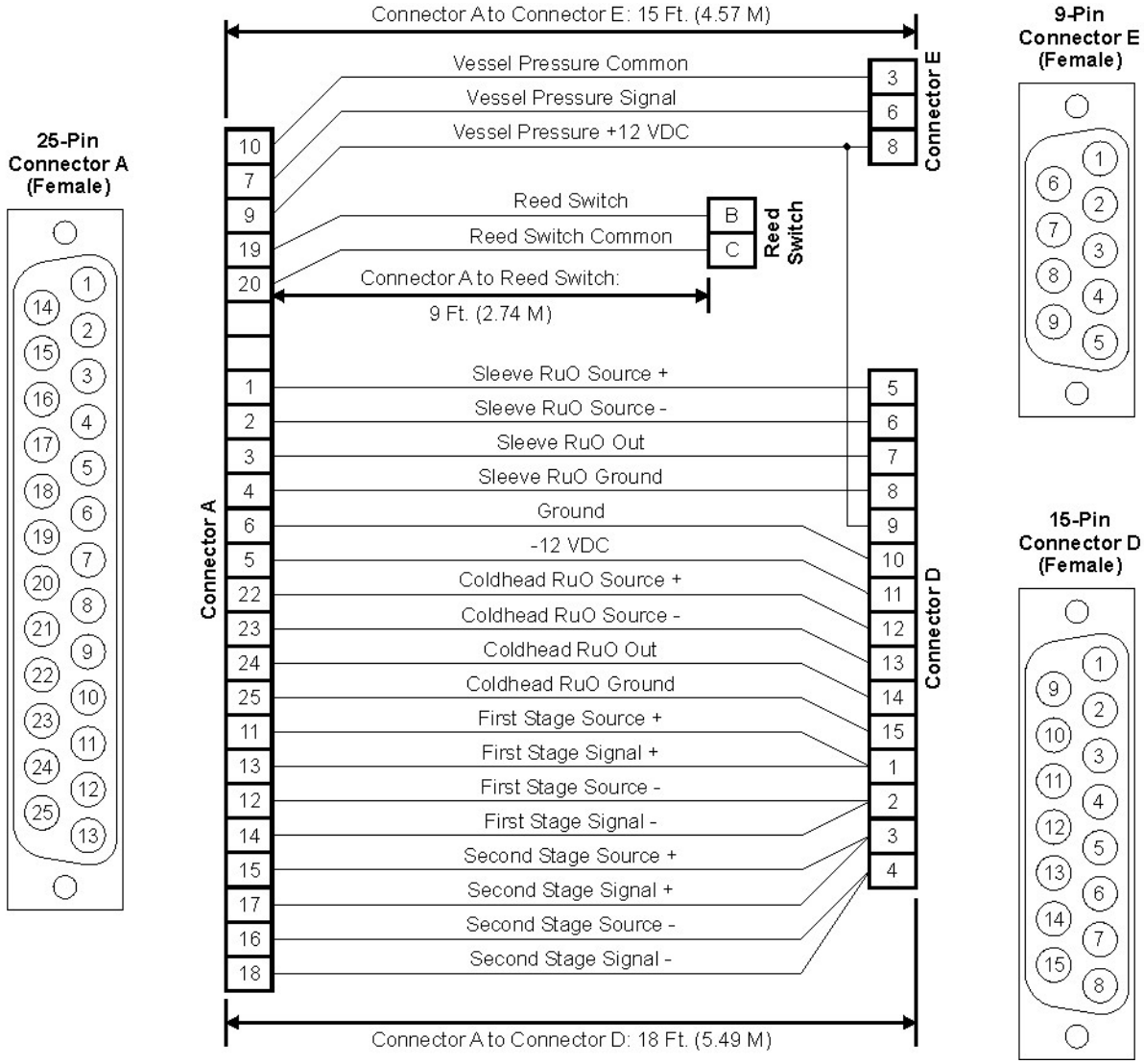
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-17: Magnet Monitor Cable C (Run 829): 46-271601G29



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-18: Magnet Monitor Cable B (Run 830): 2222797



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-19: Magnet Monitor Cable E (Run 823) and K (Run 826): 46-271603G29

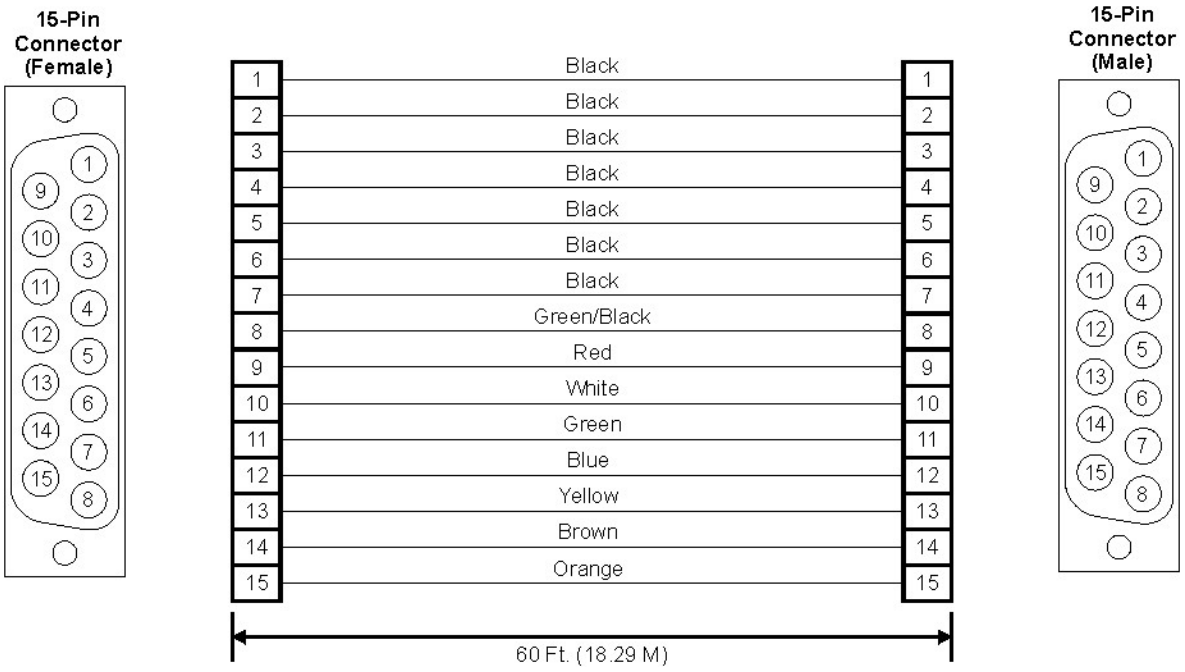
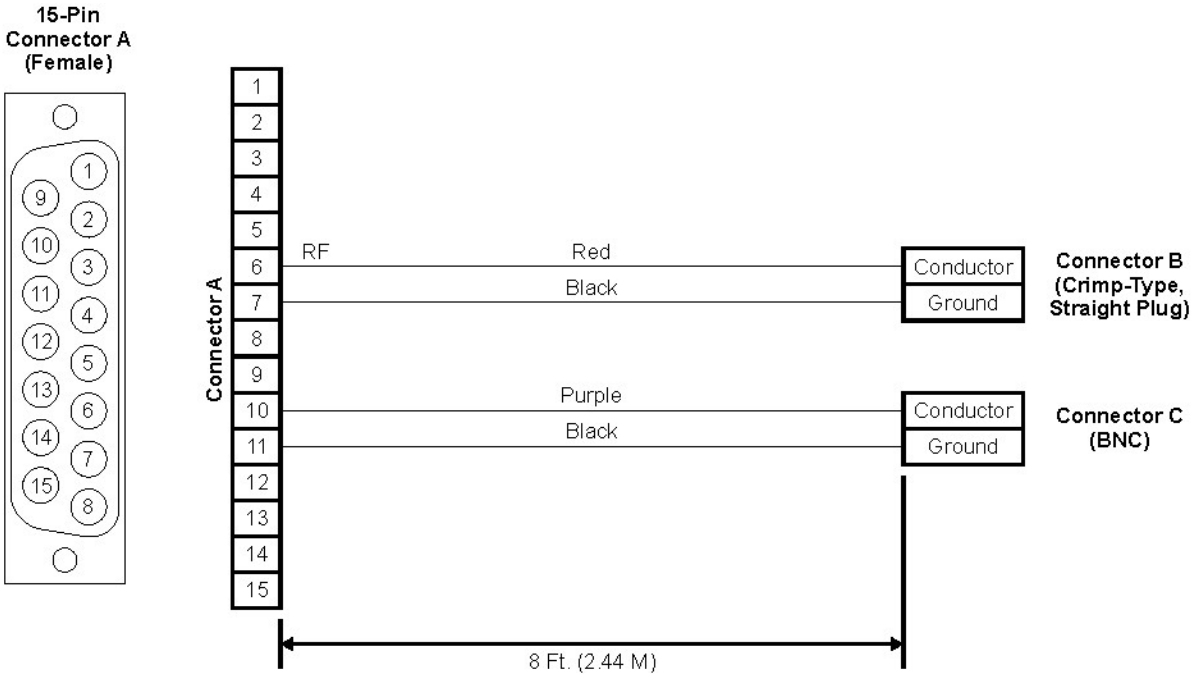
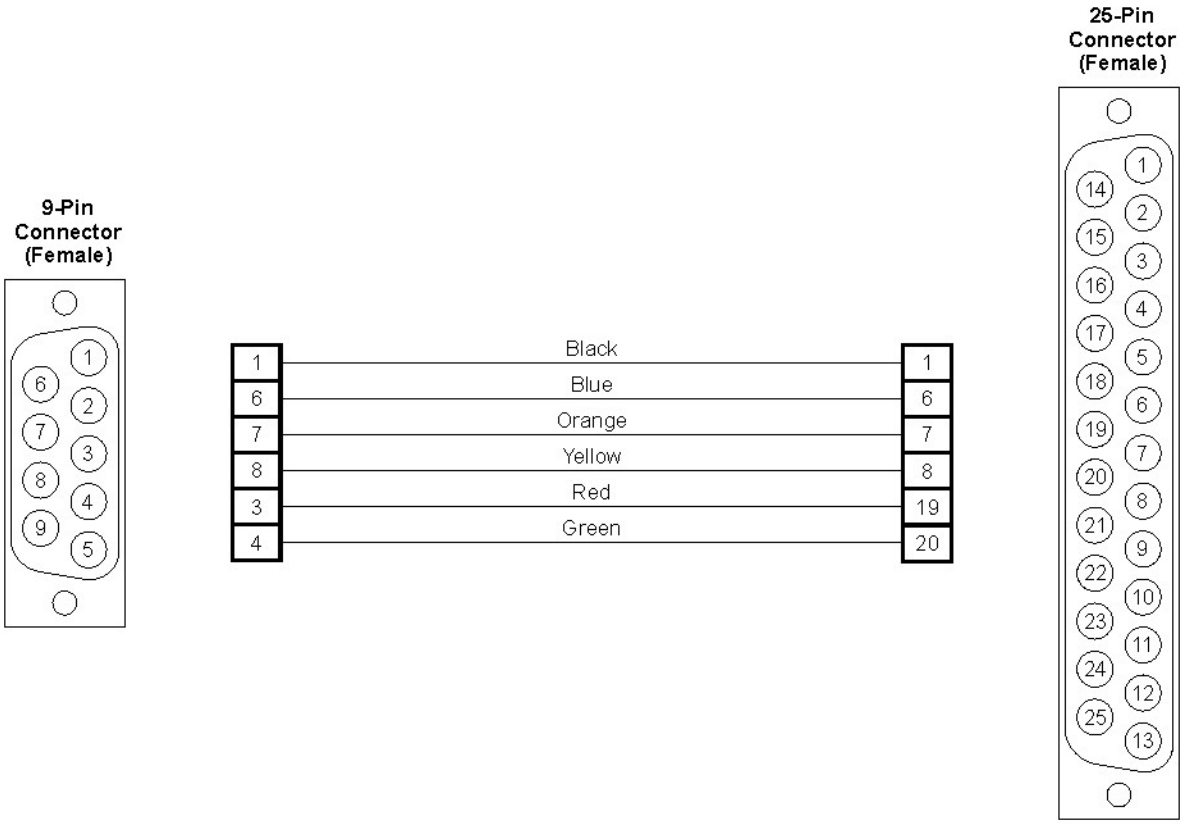


Illustration 6-20: Magnet Monitor Cable F: 2204485



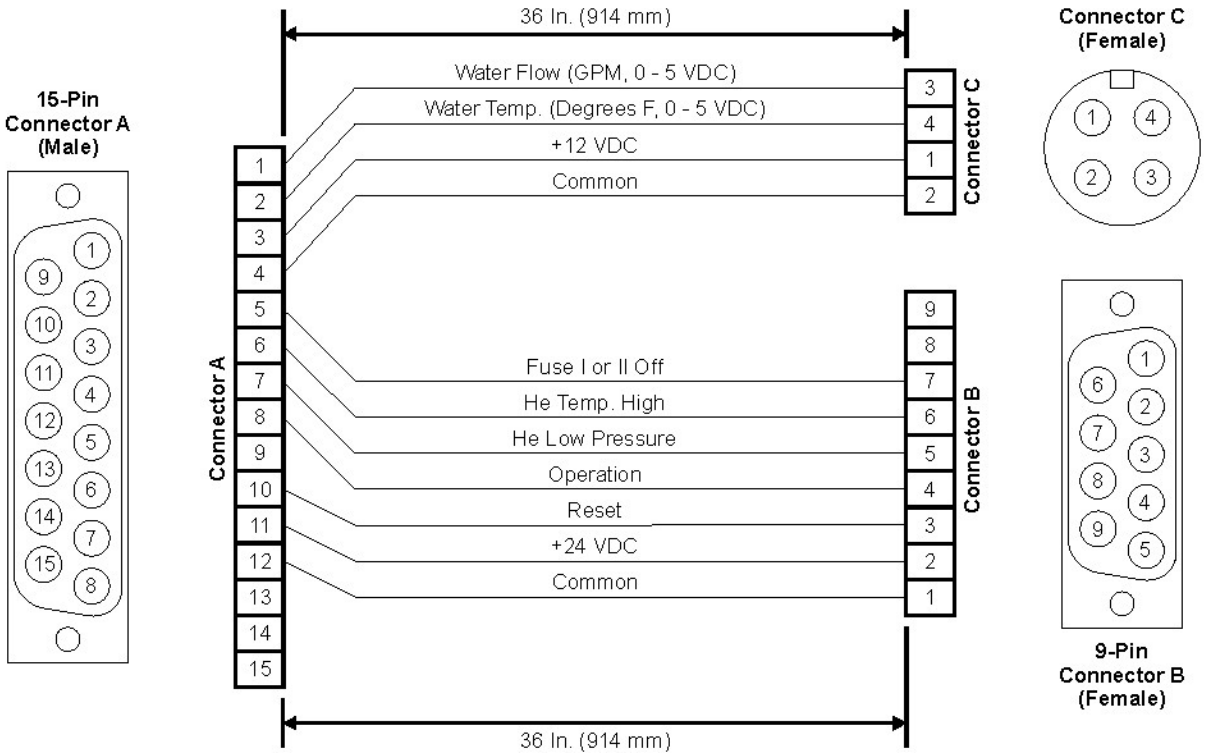
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-21: Magnet Monitor Cable G (Run 831): 2204488-5



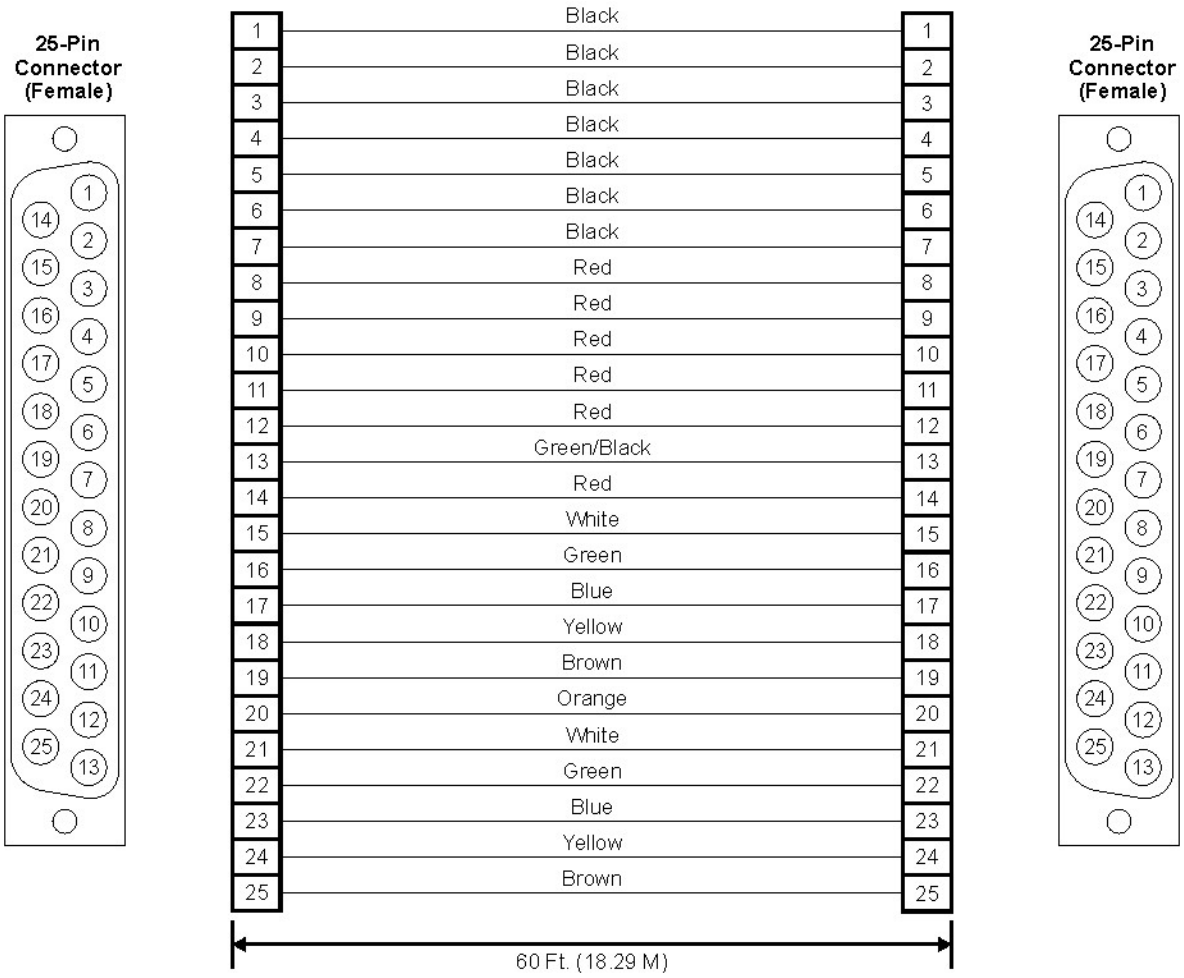
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-22: Magnet Monitor Cable L (Run 827): 46-328578P1



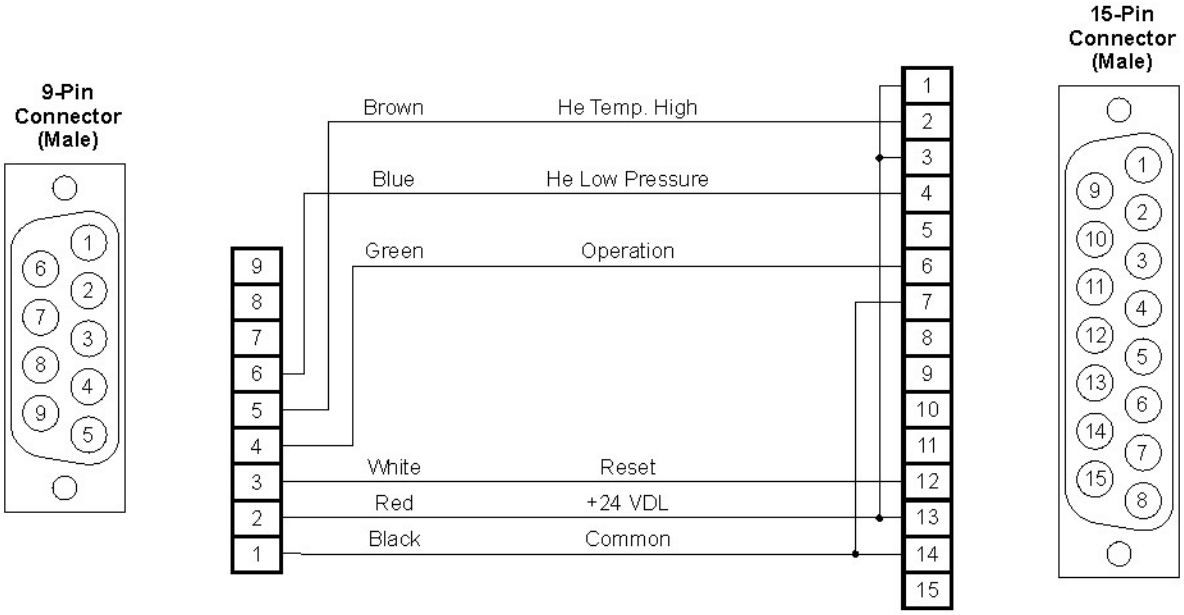
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-23: Magnet Monitor Cable J (Run 825): 46-271600G29



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-24: Magnet Monitor Cable M (Run 833): 2225805-1

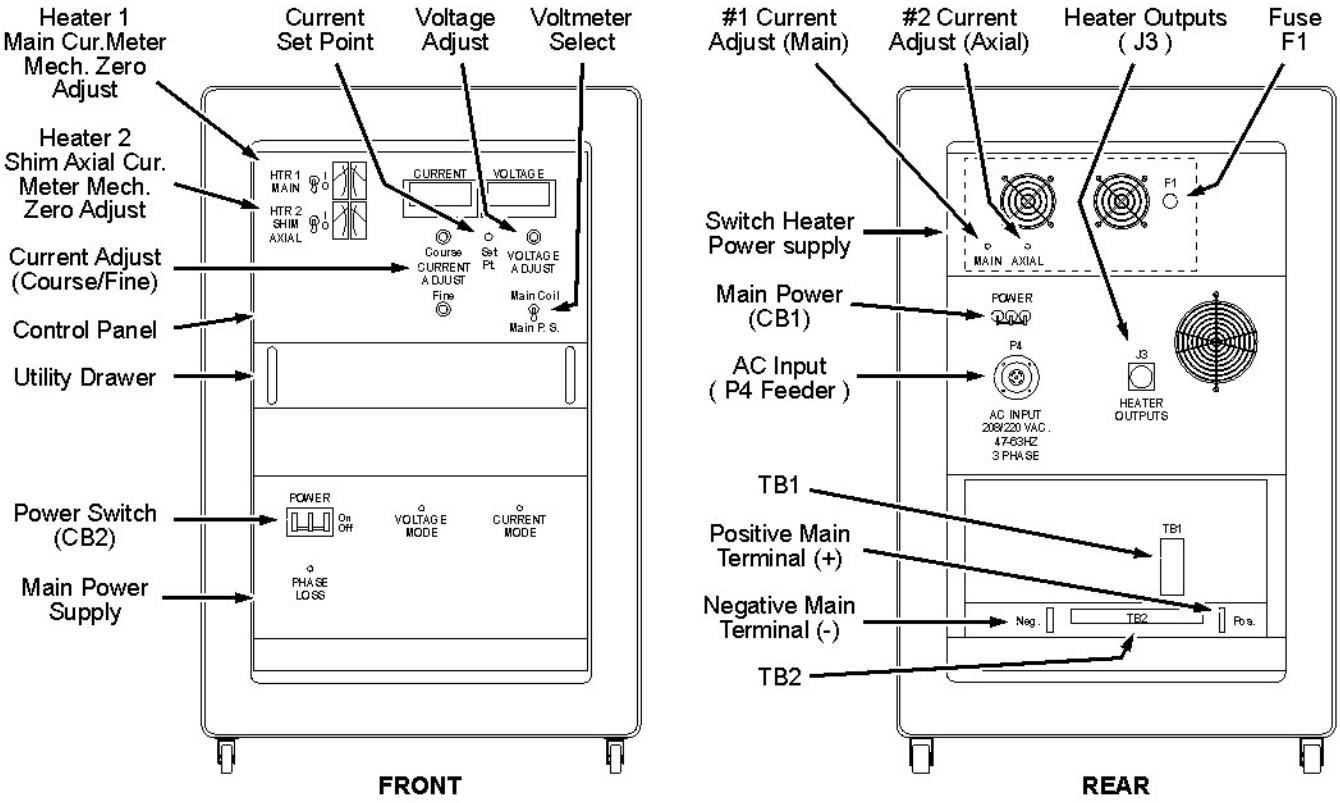


Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3 Power Supplies

3.1 750 Amp Main Coil Power Supply

Illustration 6-25: 750 Amp Superconducting Main Coil Service Power Supply Cabinet Model TCR 7.5T750 (46-260776G3)

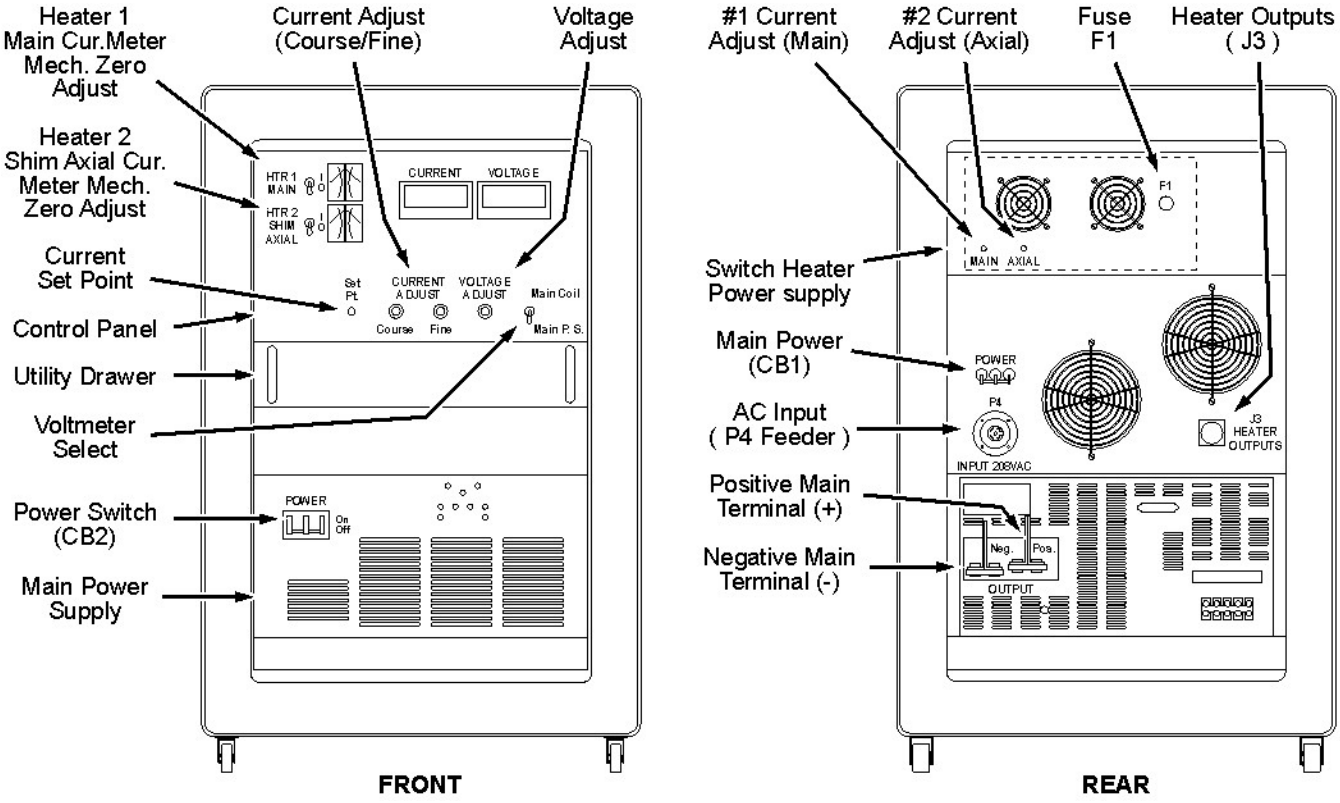


	Designator	Rating and Type	Connection
Input Power	P4	208/220 VAC, 50 - 60 Hz	—
	TB1	30 Amp, 602Y	AC Input, Main Power Supply
Output Connections	Main Terminal Positive (+)	750 Amp Bus Bar	Red (+) Main Lead Extension (MS3-A2)
	Main Terminal Negative (-)	750 Amp Bus Bar	Black (-) Main Lead Extension (MS3-A2)
	J3	1 Amp, MS3106A20-27P	Heater Wire Harness (MS3-A5) P3
Fuses and Circuit Breakers	CB1 Cabinet	3 Pole, 25 Amp, 250 VAC	—
	CB1 Supply	3 Pole, 25 Amp, 250 VAC	
	F1	4 Amp, 250 VAC, MDA	

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.2 1000 Amp Main Coil Power Supply

Illustration 6-26: 1000 Amp Superconducting Main Coil Service Power Supply Cabinet Model ESS 7.5-1000-2-D-1236 (46-260776G4)

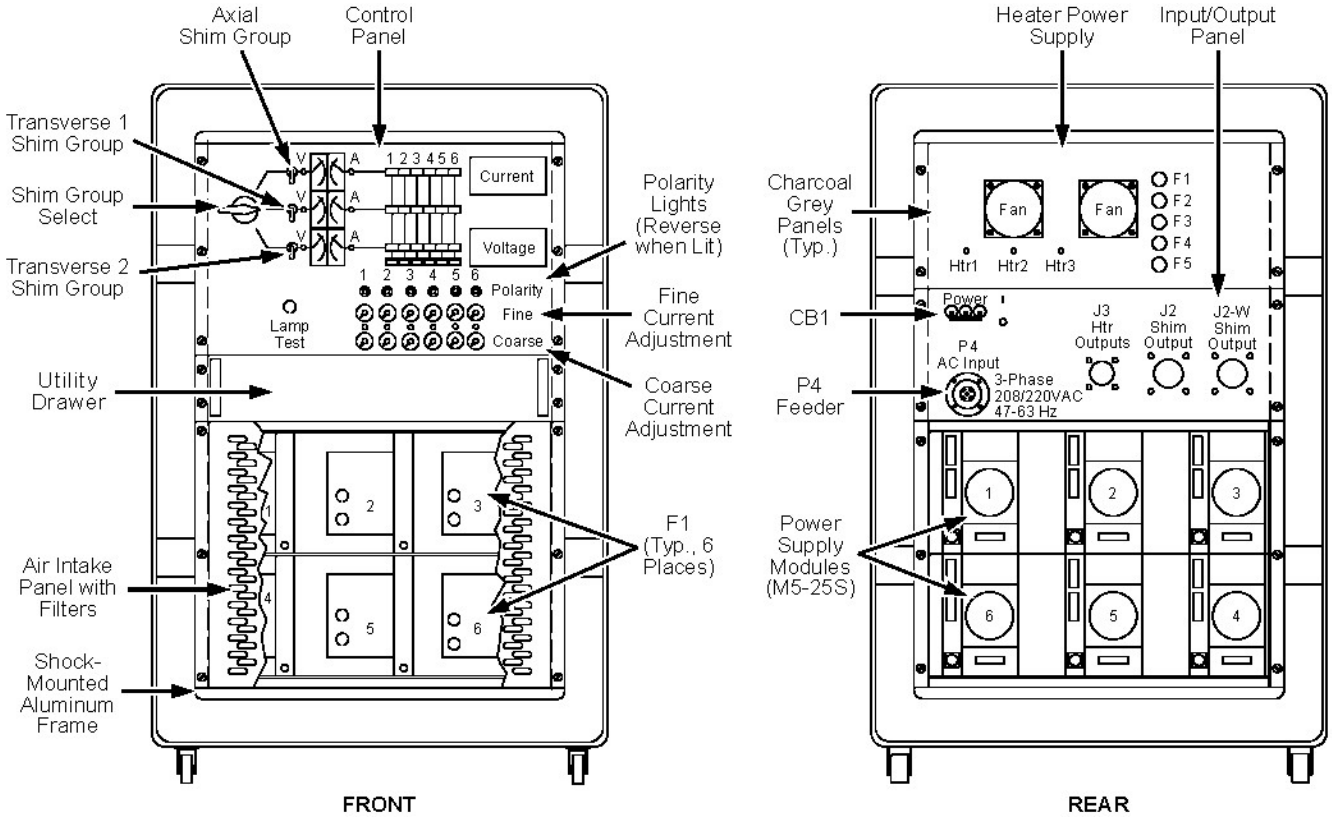


	Designator	Rating and Type	Connection
Input Power	P4	208/220 VAC, 50 - 60 Hz	—
	TB1	30 Amp, 602Y	AC Input, Main Power Supply
Output Connections	Main Terminal Positive (+)	1000 Amp Bus Bar	Red (+) Main Lead Extension (MS3-A2)
	Main Terminal Negative (-)	1000 Amp Bus Bar	Black (-) Main Lead Extension (MS3-A2)
	J3	1 Amp, MS3106A20-27P	Heater Wire Harness (MS3-A5) P3
Fuses and Circuit Breakers	CB1 Cabinet	3 Pole, 25 Amp, 250 VAC	—
	CB1 Supply	3 Pole, 25 Amp, 250 VAC	
	F1	1 Amp, 250 VAC, MDA	

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.3 Shim Coil Power Supply

Illustration 6-27: Superconducting Shim Coil Service Power Supply Cabinet (46-260777G3)

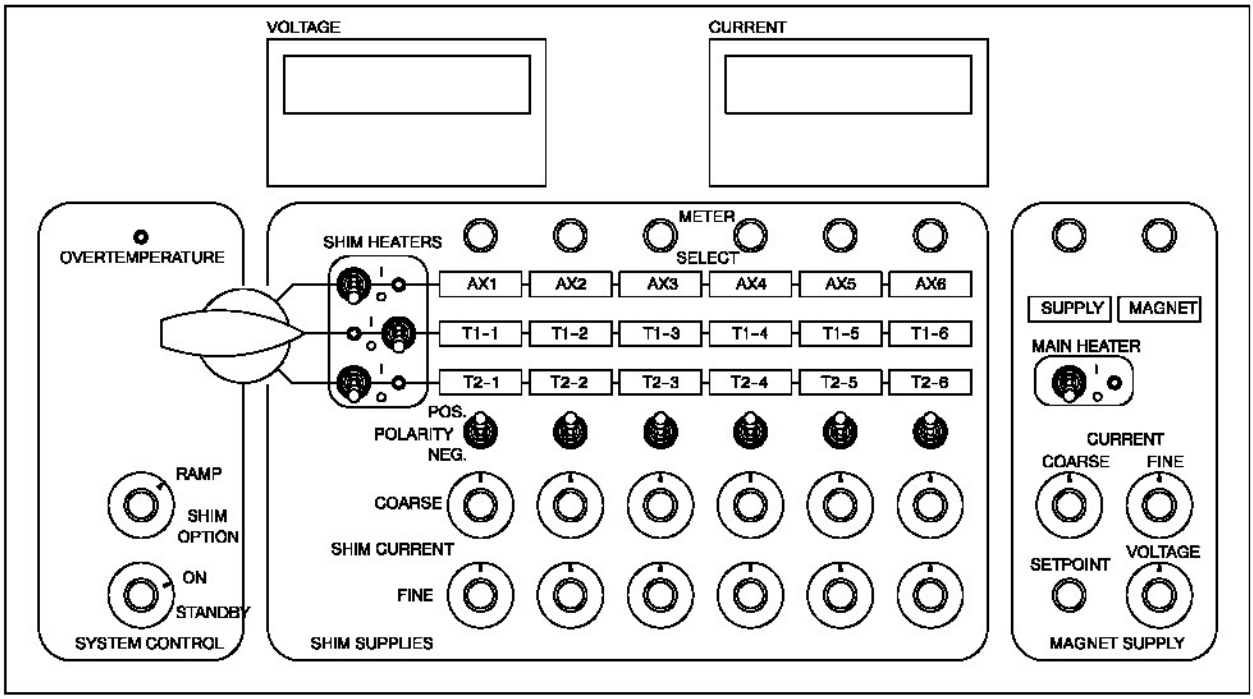


	Designator	Rating and Type	Connection
Input Power	P4	208/220 VAC, 50 - 60 Hz	—
Output Connections	J2	25 Amp, MS3012A28-20S	S/C Shim Coil Wire Harness (MS3-A4) P1
	J2-W	25 Amp, MS3012A28-20S	S/C Shim Coil Wire Harness (MS3-A4) P2
	J3	1 Amp, MS3106A20-27P	Heater Wire Harness (MS3-A5) P3
Fuses and Circuit Breakers	CB1	3 Pole, 25 Amp, 250 VAC	—
	F1 (Typ., 6 Places)	6.25 Amp, 250 Volt, MDA	
	F1, F5	4 Amp, 250 Volt, MDA	
	F2, F3, F4	1 Amp, 250 Volt, MDA	

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.4 Phase III-A Power Supply

Illustration 6-28: Magnet/Shim Phase III-A Power Supply Control Panel



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.5 Power Supply Connector Pinouts

Illustration 6-29: P4 — Shim and Main Coil Power Supply AC Inputs

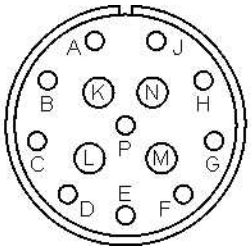


Pin	Signal
G	Ground
W	Neutral
X	Phase A
Y	Phase B
Z	Phase C

4 Pole, 5 Wire
Twist-Lock Flange Inlet
30A 120/208V 3 Phase Y
NEMA L21-30R

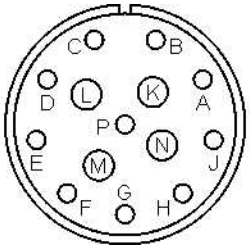
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-30: J2 — Shim Coil Power Supply Output (MSA3102A28-20S)



Pin	Signal	Pin	Signal	Pin	Signal
A	AX1	D	T1-1	K/L*	AX1, T1-2, T2-2 Returns
B	AX3	E	T2-1	M/N*	AX3, T1-3, T2-3 Returns
C	AX5	F	T1-2	P	AX5, T1-1, T2-1 Returns
		G	T1-3		
		H	T2-2		
		J	T2-3		
* Pins paralled.					

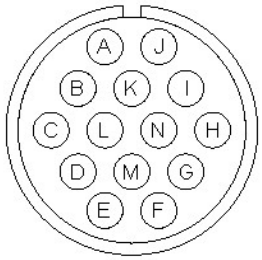
Illustration 6-31: J2-W — Shim Coil Power Supply Output (MSA3102A28-20S)



Pin	Signal	Pin	Signal	Pin	Signal
A	AX2	D	T1-6	K/L*	AX2, T1-4, T2-4 Returns
B	AX4	E	T2-6	M/N*	AX4, T1-5, T2-5 Returns
C	AX6	F	T1-4	P	AX6, T1-6, T2-6 Returns
		G	T1-5		
		H	T2-4		
		J	T2-5		
* Pins paralled.					

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

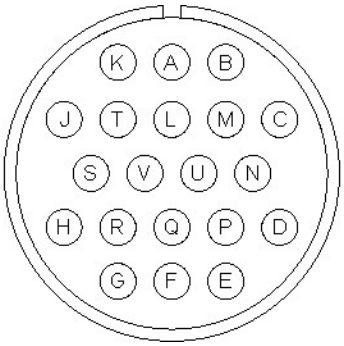
Illustration 6-32: J3 — Switch Heater Output (MSA3102A20-27S)



Phase III Power Supply			Shim Coil Service Power Supply			Main Coil Service Power Supply	
Pin	**Signal**		**Pin**	**Signal**		**Pin**	**Signal**
A	—		A	—		A	—
B	Main Switch Htr +		B	—		B	Main Switch Htr +
C	—		C	—		C	—
D	Main Switch Htr -		D	—		D	Main Switch Htr -
E	Transverse 1 +		E	Transverse 1 +		E	—
F	Transverse 1 -		F	Transverse 1 -		F	—
G	—		G	—		G	—
H	—		H	—		H	—
I	Axial Switch Htr +		I	Axial Switch Htr +		I	Axial Switch Htr +
J	Axial Switch Htr -		J	Axial Switch Htr -		J	Axial Switch Htr -
K	Transverse 2 +		K	Transverse 2 +		K	—
L	Transverse 2 -		L	Transverse 2 -		L	—
M	Main Coil V+		M	—		M	Main Coil V+
N	Main Coil V-		N	—		N	Main Coil V-

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 6-33: Optional Shim Coil Power Supply Output (MSA3102A20-27S)



Pin	Signal	Pin	Signal	Pin	Signal
A	Channel A = ZY	H	ZX Return	Q	Channel F = Z3
B	ZY Return	J	—	R	Z3 Return
C	—	K	—	S	Channel E = Z2
D	—	L	Channel D = X2-Y2	T	Z2 Return
E	Channel B = XY	M	X2-Y2 Return	U	—
F	XY Return	N	—	V	—
G	Channel C = ZX	P	—		

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Chapter 7 Renewal Parts

1 Magnet System

1.1 Magnet Model and Assembly Numbers

Table 7-1: Magnet, Magnet Model and Magnet Assembly Number

Magnet	Magnet Model Number	Magnet Assembly Number	
1.5T LCC, Fixed Site	2226300 (YR Series: 2226300-2)	2188846	2243832
1.5T LCC, Mobile Site	2226322 (YR Series: 2226322-2)		
1.0T LCC, Fixed Site	2226333 (YQ Series: 2226333-2)		
1.0T LCC, Mobile Site	2226334 (YQ Series: 2226334-2)		

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.2 Magnet System Shipping Collectors

Table 7-2: HDe/HDx LCC Fixed Site Shipping Collector 5162573 Rev.1

Item	Part Number	Quantity	Description	Spare
—	2188846	1	GE LCC Magnet Assembly (see Section 2.1)	—
	2243832		GE LCC Magnet Assembly (see Section 2.1)	
2	46-260888G4	1	LCC Magnet Leveling Kit (see Section 3.1)	Y
3	46-318057G6	1	Helium Vent Kit, Fixed Site (see Section 3.2.1)	Y
4	46-258770G4	1	Safety Signage Kit (see Section 4.1.1)	Y
5	2128700	1	MRU Kit Assembly (see Section 3.4.1)	Y
8	46-294744G5	1	Field Spares Kit (see Section 3.10)	N
9	46-318565G1	1	Vacuum Tool Kit	Y
10	2349529	1	10 psig Burst Disc	Y
11	2251611	2	Flexible Raceway, Insulated	Y
12	5155291	1	HDx Service Platform	Y
13	2226264	1	Wide Open Dock Mount & Control Box	Y
14	46-271260G4	1	Wide Open Dock Assembly	N

Table 7-3: Wide Open LCC Fixed Site Shipping Collector 2226311 Rev. 9

Item	Part Number	Quantity	Description	Spare
—	2188846	1	GE LCC Magnet Assembly (see Section 2.1)	—
	2243832		GE LCC Magnet Assembly (see Section 2.1)	
2	46-260888G4	1	LCC Magnet Leveling Kit (see Section 3.1)	Y
3	46-318057G6	1	Helium Vent Kit, Fixed Site (see Section 3.2.1)	Y
4	46-258770G4	1	Safety Signage Kit (see Section 4.1.1)	Y
5	2128700	1	MRU Kit Assembly (see Section 3.4.1)	Y
8	46-294744G5	1	Field Spares Kit (see Section 3.10)	N
9	46-318565G1	1	Vacuum Tool Kit	Y
10	2226264	1	Wide Open Dock Mount & Control Box	Y
11	46-271260G4	1	Wide Open Dock Assembly	N
12	2251611	2	Flexible Raceway, Insulated	Y
13	2319156	1	Universal Service Ladder/Platform	Y
14	2349529	1	10 psig Burst Disc	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-4: Wide Open LCC Mobile Site Shipping Collector 2226326 Rev. 6

Item	Part Number	Quantity	Description	Spare
—	2188846	1	GE LCC Magnet Assembly (see Section 2.1)	—
	2243832		GE LCC Magnet Assembly (see Section 2.1)	
2	46-260888G4	1	LCC Magnet Leveling Kit (see Section 3.1)	Y
3	46-318057G2	1	Helium Vent Kit, Mobile Site (see Section 3.2.3)	Y
4	46-258770G4	1	Safety Signage Kit (see Section 4.1.1)	Y
5	2128700	1	MRU Kit Assembly (see Section 3.4.1)	Y
8	46-294744G5	1	Field Spares Kit (see Section 3.10)	N
9	46-318565G1	1	Vacuum Tool Kit	Y
11	2230707-2	1	Mobile Site Service Ladder/Platform	Y
12	2251611	2	Flexible Raceway, Insulated	Y
13	2226264	1	Wide Open Dock Mount & Control Box	Y
14	46-271260G4	1	Wide Open Dock Assembly	N
15	2217622	1	Shim Lead Mounting Bracket	Y
16	2349529	1	10 psig Burst Disc	Y

Table 7-5: LCC Fixed Site Shipping Collector 2211456 Rev. 2

Item	Part Number	Quantity	Description	Spare
—	2188846	1	GE LCC Magnet Assembly (see Section 2.1)	—
	2243832		GE LCC Magnet Assembly (see Section 2.1)	
2	46-260888G4	1	LCC Magnet Leveling Kit (see Section 3.1)	Y
3	46-318057G1	1	Helium Vent Kit (see Section 3.2.2)	Y
4	46-258770G4	1	Safety Signage Kit (see Section 4.1.1)	Y
5	2128700	1	MRU Kit Assembly (see Section 3.4.1)	Y
6	2156980	1	Spike Noise Insulation Kit	Y
8	46-294744G5	1	Field Spares Kit (see Section 3.10)	N
9	46-318565G1	1	Vacuum Tool Kit	Y
12	2114744-5	1	Service Platform Step	Y
13	2195887-2	1	Service Platform	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-6: LCC Mobile Site Shipping Collector 2216340 Rev. 3

Item	Part Number	Quantity	Description	Spare
—	2188846	1	GE LCC Magnet Assembly (see Section 2.1)	—
	2243832		GE LCC Magnet Assembly (see Section 2.1)	
2	46-260888G4	1	LCC Magnet Leveling Kit (see Section 3.1)	Y
3	46-318057G2	1	Helium Vent Kit, Mobile Site (see Section 3.2.3)	Y
4	46-258770G4	1	Safety Signage Kit (see Section 4.1.1)	Y
5	2128700	1	MRU Kit Assembly (see Section 3.4.1)	Y
6	2156980	1	Spike Noise Insulation Kit	Y
8	46-294744G5	1	Field Spares Kit (see Section 3.10)	N
9	46-318565G1	1	Vacuum Tool Kit	Y
12	2114744-5	1	Service Platform Step	Y
15	2217622	1	Shim Lead Mounting Bracket	Y
16	2195887-2	1	Service Platform	Y
17	2171719	1	Ramp & Shim Cable Kit (see Section 3.6)	N

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.3 GE and Vendor Manuals

Table 7-7: LCC Wide Open Manual Collector 2226310 Rev. 5

Item	Part Number	Revision	Quantity	Description	Spare
1	2192624	10	1	GE 1.5T & 1.0T LCC Active Shield Magnet and Cryogens Subsystem Manual	N
2	2226318	5	1	GE 1.5T & 1.0T LCC Magnet Delivery & Installation Manual	N
2A*	2192625	2	—	GE 1.5T & 1.0T Active Shield Delivery & Installation Manual	N
3	2230681	4	1	GEMS Magnet Monitoring Hardware (SHEM) Installation	N
4	46-318393	10	1	Magnet Rundown Unit (MRU) Service Manual	N
5	46-318394	6	1	Magnet Rundown Unit (MRU) Operation Manual	N
6	2229090-100	1	1	Magnet Monitor Operator's Manual	N
7*	2262271	1	—	SRDK Cryocooler Service Manual	N
* Shown for reference only.					

Table 7-8: HDe/HDx LCC Manual Collector 5159275 Rev. 1

Item	Part Number	Revision	Quantity	Description	Spare
1	2192624	10	1	GE 1.5T & 1.0T LCC Active Shield Magnet and Cryogens Subsystem Manual	N
2	5154839	1	1	GE HDe & HDx 1.5T LCC Magnet Delivery & Installation Manual	N
3	2230681	4	1	GEMS Magnet Monitoring Hardware (SHEM) Installation	N
4	46-318393	10	1	Magnet Rundown Unit (MRU) Service Manual	N
5	46-318394	6	1	Magnet Rundown Unit (MRU) Operation Manual	N
6	2229090-100	1	1	Magnet Monitor Operator's Manual	N
7*	2262271	1	—	SRDK Cryocooler Service Manual	N
* Shown for reference only.					

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2 Magnet Components

2.1 LCC Magnet Assemblies

Illustration 7-1: Components Common to All LCC Magnets, Part 1

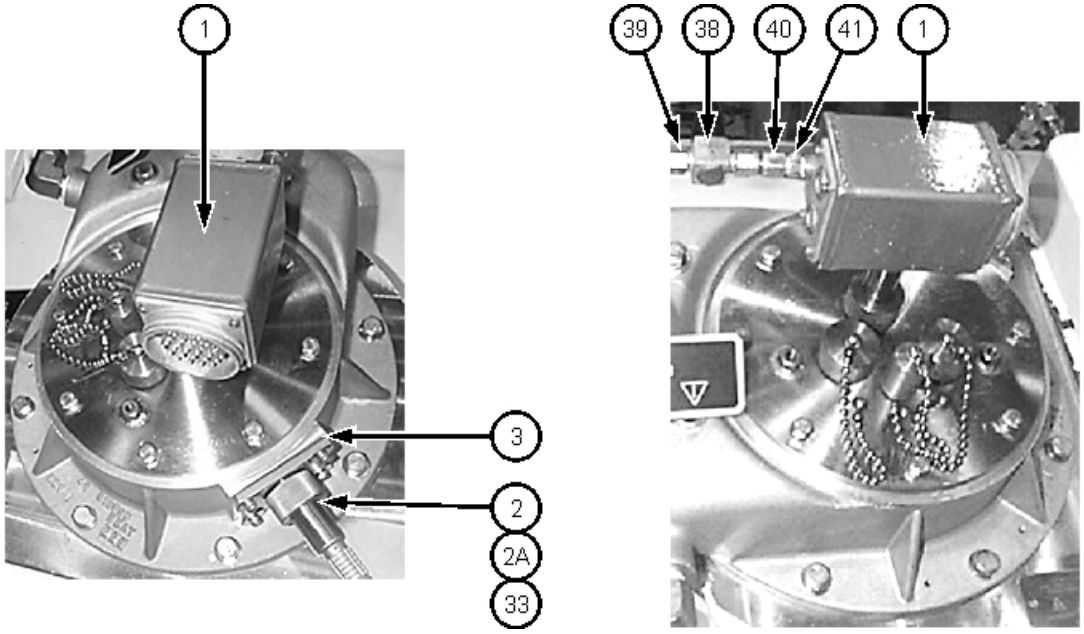
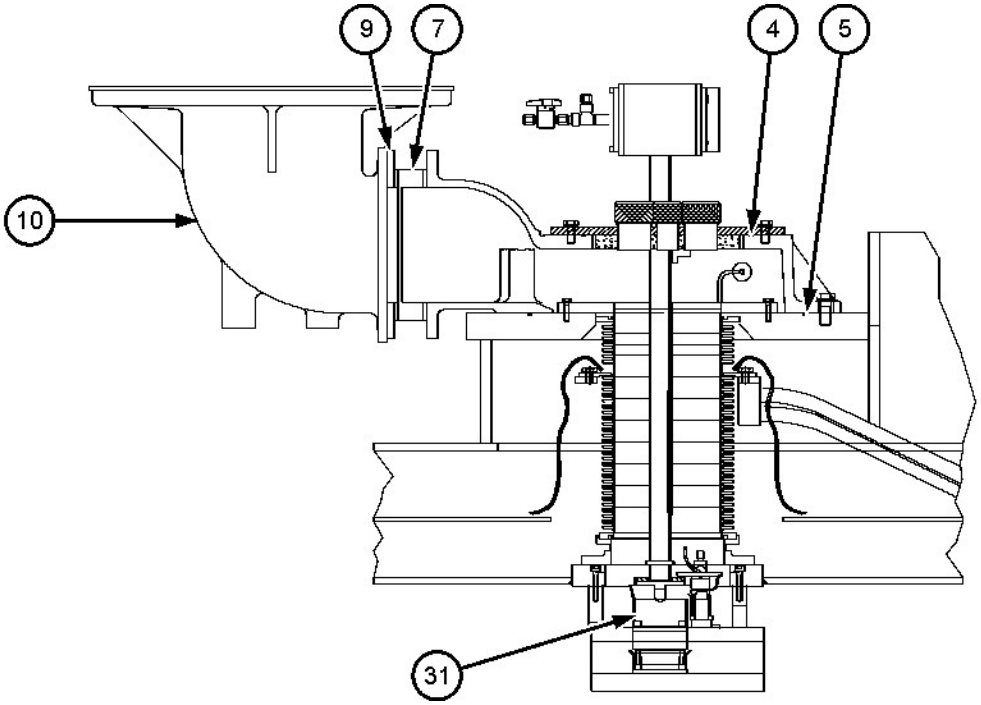


Illustration 7-2: Components Common to All LCC Magnets, Part 2



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 7-3: Components Common to All LCC Magnets, Part 3

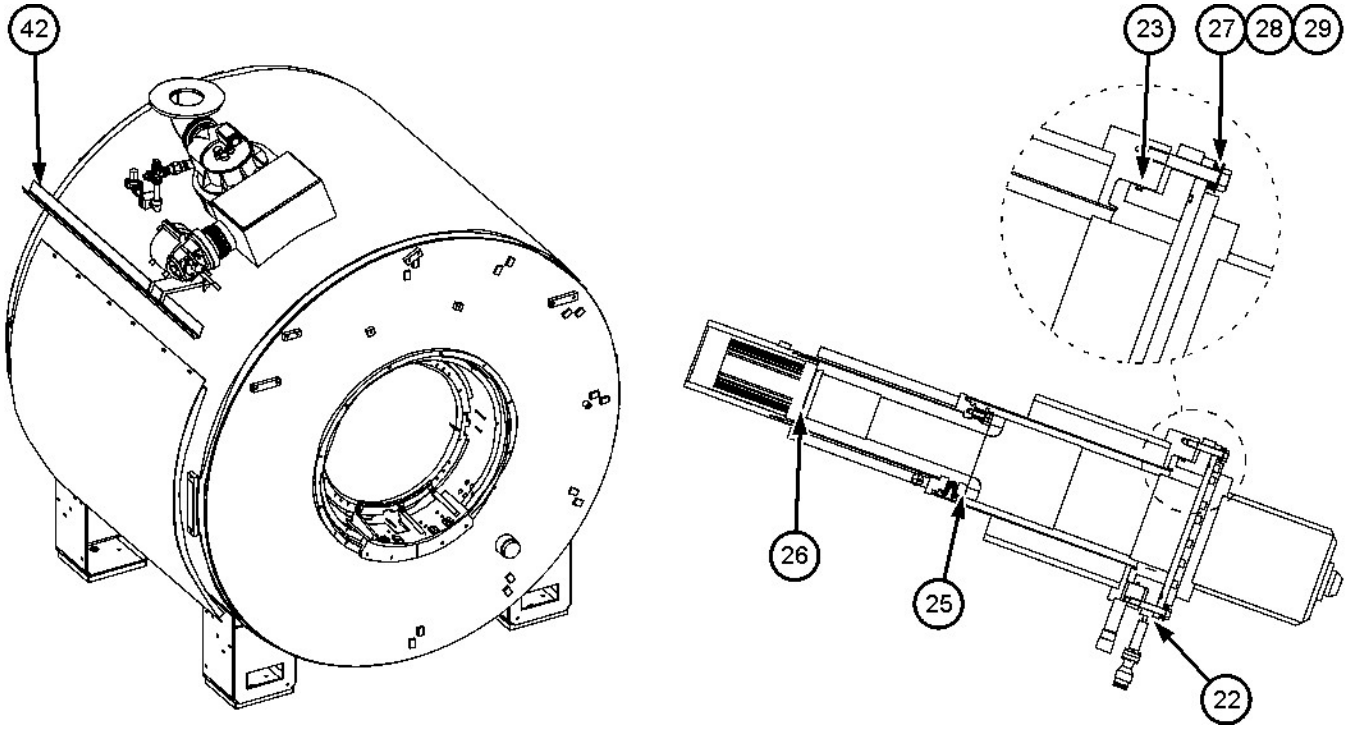
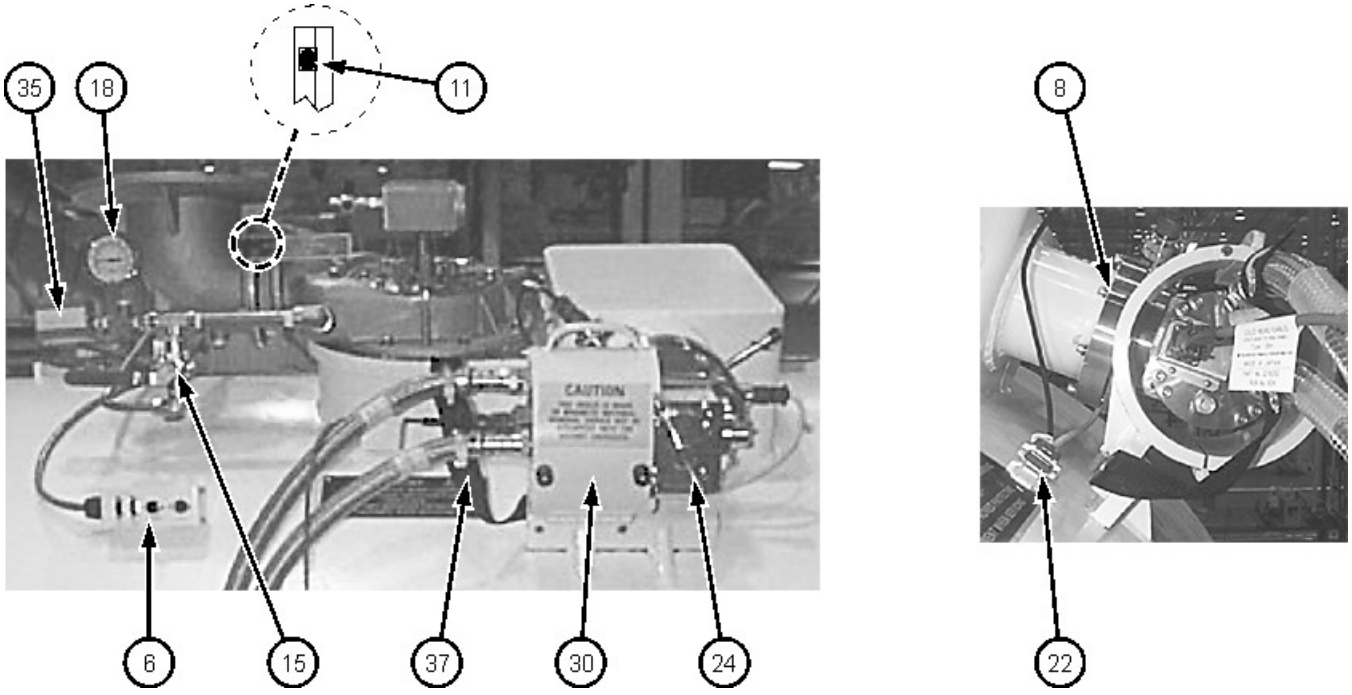


Illustration 7-4: Magnet Assembly 2188846 Components, Part 1



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 7-5: Magnet Assembly 2188846 Components, Part 2

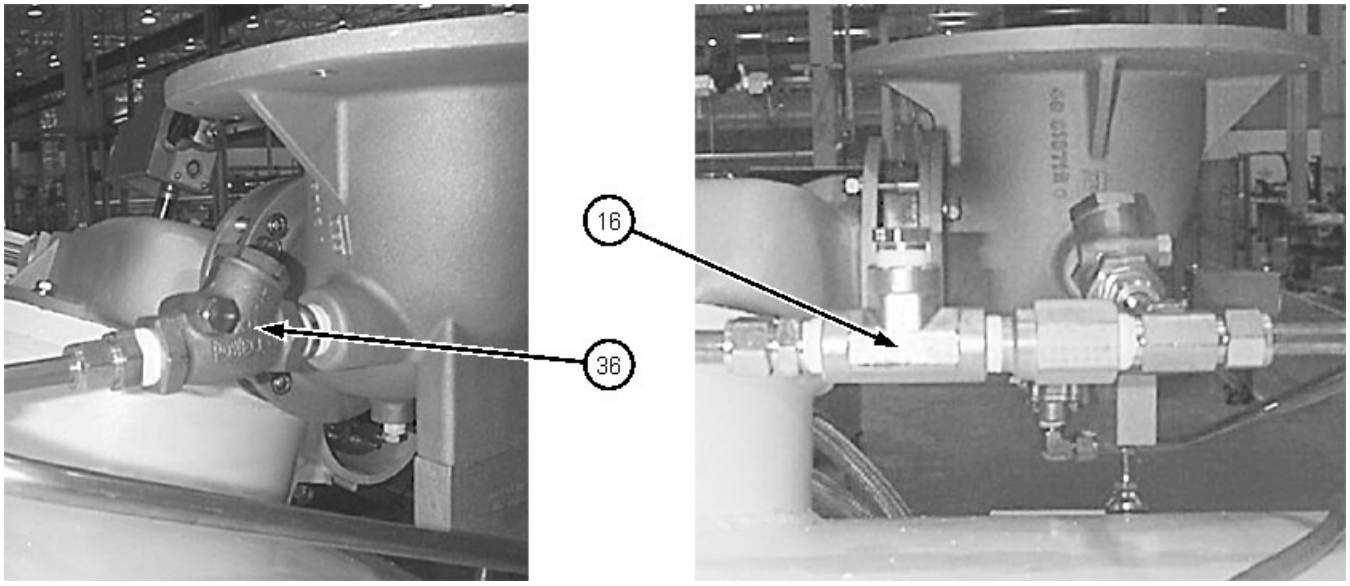
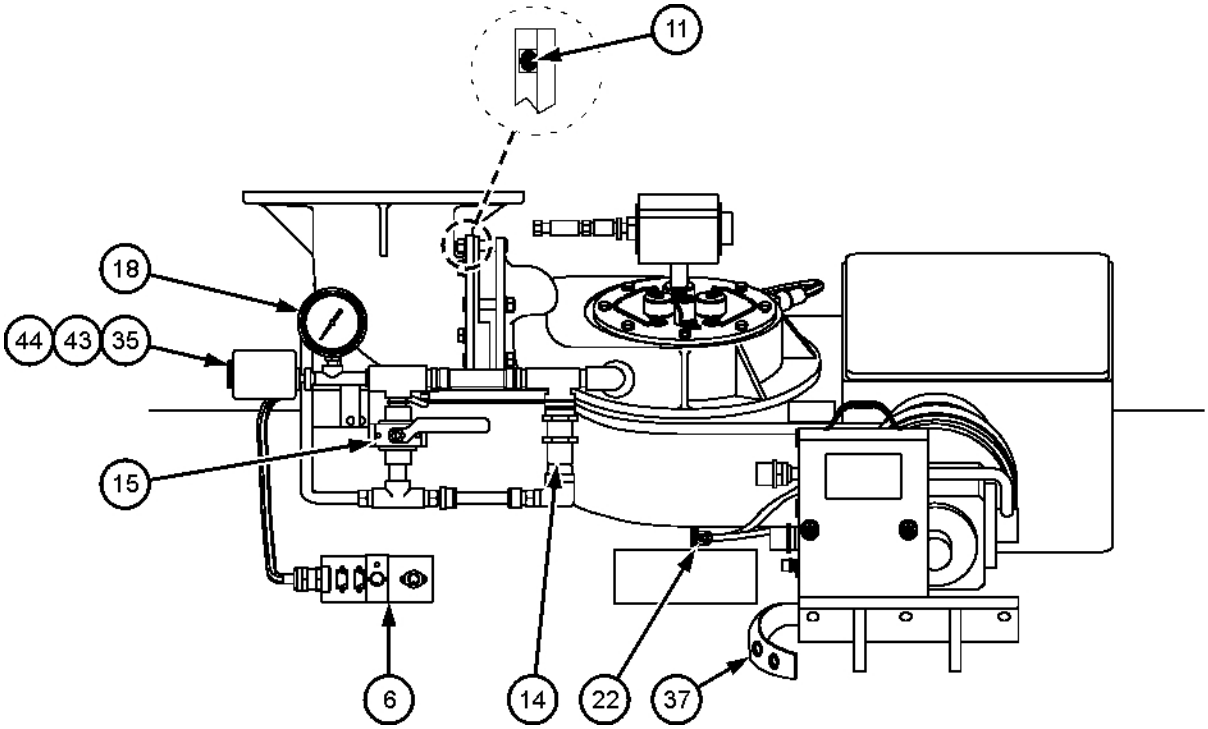


Illustration 7-6: Magnet Assembly 2243832 Components, Part 1



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration 7-7: Magnet Assembly 2243832 Components, Part 2

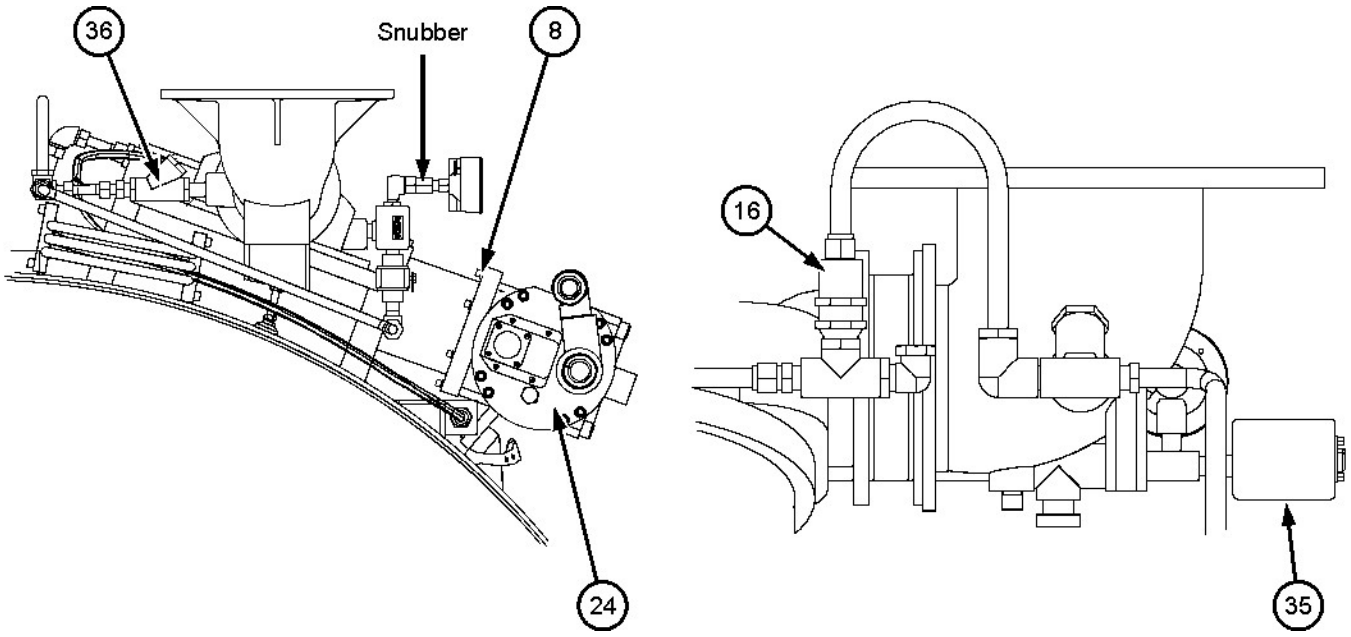


Table 7-9: LCC Magnet Assembly 2188846 Rev. 13

Item	Part Number	Quantity	Description	Spare
1	2173354	1	Retractable Shim Lead Assembly	Y
2	2204723	1	Instrumentation & Electrical Lead Assembly (G-10 Sleeve Assembly)	Y
3	46-281101P9	1	Teflon O-Ring, #2-128, 1.487 in. ID x .103 in. thick	Y
4	46-281101P5	1	Teflon O-Ring, #2-162, 5.737 in. ID x .103 in. thick	Y
5	46-281101P6	1	Teflon O-Ring, #2-177, 9.487 in. ID x .103 in. thick	Y
6	2204623	1	Instrument Box Assembly	Y
7	2194545-7	1	Burst Disc & Gasket Assembly, 10 psig	Y
8	46-281387P13	8	Belleville Washer, .375 in. nominal	Y
9	46-260420P2	1	Burst Disc Flange, 6.5 in. OD x 4.25 in. ID	Y
10	46-318712G1	1	Vent Adapter, 8 Inch	N
15	46-252223P1	1	Cryogenic Ball Valve, .50 in. NPT	Y
16	2237498	1	Relief Valve, .50 in. NPT, 5 psig	Y
18[a]	2249367	1	Pressure Gauge, 0 - 15 psi, 4.5 in. dia.	Y
22	2214062	1	Sleeve/Coldhead Adapter Cable (Run 832)	Y
23	46-281247P1	1	BUNA O-Ring, #2-159, 4.987 in. ID x .103 in. thick	Y
24	2218465	1	Sumitomo Two-Stage Coldhead Assembly	Y
25	46-281241P1	1	Indium Gasket, 3.37 in. OD	Y
26	46-294878P13	1	Indium Wire, .06 in. x 3.5 ft.	Y
27	46-318764P6	4	Socket Head Cap Screw, M6 x 25 mm	Y
28	2224726	8	Hex Head Screw, M6 X 60 mm	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-9: LCC Magnet Assembly 2188846 Rev. 13 (cont'd)

Item	Part Number	Quantity	Description	Spare
29	2173358	48	Belleville Washer, 12.5 mm OD x 6.2 mm ID	Y
30	2187575	1	Sumitomo Coldhead Motor Shield	Y
31[b]	46-318060P1	1	Sav-Con Connector	Y
33	2142318	1	Instrumentation Lead Coupling Nut	Y
35	2216027	1	Pressure Transducer Box Assembly	Y
36	46-260926P1	1	Swing Check Valve, .75 in. NPT	Y
37	2219776	1	Strain Relief, Compressor Line	Y
38	46-252209P1	1	Nupro Valve, .25 in. Orifice (part of Shim Lead plumbing)	Y
39	2206093	1	Swagelock Plug (part of Shim Lead plumbing)	Y
40	2206930	1	Port Connector (part of Shim Lead plumbing)	Y
41	46-260898P3	1	Male Connector (part of Shim Lead plumbing)	Y
42	2237254	1	Drip Trough with Sponge	N

[a] Snubber 46-281283P1 must be removed when Pressure Gauge 46-281282P2 is replaced with Pressure Gauge 2249367.

[b] Included in Penetration Receptacle Platform Assembly 2247590, part of Magnet Cartridge Assemblies.

[c] Included in Enclosure Assembly.

Table 7-10: LCC Magnet Assembly 2243832 Rev. 21

Item	Part Number	Quantity	Description	Spare
1	2173354	1	Retractable Shim Lead Assembly	Y
2[a]	5130298	1	G10 Sleeve Assembly with Latching LEMO	Y
3	46-281101P9	1	Teflon O-Ring, #2-128, 1.487 in. ID x .103 in. thick	Y
4	46-281101P5	1	Teflon O-Ring, #2-162, 5.737 in. ID x .103 in. thick	Y
5	46-281101P6	1	Teflon O-Ring, #2-177, 9.487 in. ID x .103 in. thick	Y
6	2204623	1	Instrument Box Assembly	Y
7[b]	2349529	1	Burst Disc, 10 psig	Y
8[b]	46-281387P15	6	Belleville Washer, .375 in. nominal	Y
9[b]	2245511	1	Burst Disc Flange	Y
10[b]	2253376	1	Vent Adapter, Cast	N
11[b]	46-281101P8	1	Teflon O-Ring, #2-048, 4.739 in. ID x .070 in. thick	Y
12[b]	46-281101P1	1	Teflon O-Ring, #2-046, 4.239 in. ID x .070 in. thick	Y
14[b]	2242756	1	Relief Valve, .375 in. NPT, 7.0 psig	Y
15[b]	46-252223P1	1	Cryogenic Ball Valve, .50 in. NPT	Y
16[b]	2237498	1	Relief Valve, .50 in. NPT, 5 psig	Y
18[b]	2249367	1	Pressure Gauge, 0 - 15 psi, 4.5 in. dia.	Y
22	2214062	1	Sleeve/Coldhead Adapter Cable (Run 832)	Y
23	46-281247P1	1	BUNA O-Ring, #2-159, 4.987 in. ID x .103 in. thick	Y
24	2218465-3	1	Sumitomo Two-Stage Coldhead Asm., High Efficiency	Y
25	46-281241P1	1	Indium Gasket, 3.37 in. OD	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-10: LCC Magnet Assembly 2243832 Rev. 21 (cont'd)

26	46-294878P13	1	Indium Wire, .06 in. x 3.5 ft.	Y
27	46-318764P6	4	Socket Head Cap Screw, M6 x 25 mm	Y
28	2224726	8	Hex Head Screw, M6 X 60 mm	Y
29	2173358	48	Belleville Washer, 12.5 mm OD x 6.2 mm ID	Y
30	2187575	1	Sumitomo Coldhead Motor Shield	Y
31[c]	46-318060P1	1	Sav-Con Connector	Y
33	2142318	1	Instrumentation Lead Coupling Nut	Y
35[b]	2299843-2	1	Pressure Transducer	Y
36[b]	46-260926P1	1	Swing Check Valve, .75 in. NPT	Y
37	2219776	1	Strain Relief, Compressor Line	Y
38	46-252209P1	1	Nupro Valve, .25 in. Orifice (part of Shim Lead plumbing)	Y
39	2206093	1	Swagelock Plug (part of Shim Lead plumbing)	Y
40	2206930	1	Port Connector (part of Shim Lead plumbing)	Y
41	46-260898P3	1	Male Connector (part of Shim Lead plumbing)	Y
42[d]	2237254	1	Drip Trough with Sponge	N
43	2369032	1	Pressure Transducer RF Shield	Y
44	46-260793P11	2	Round Head Screw, #4-40 x .25 Inch, Brass	Y
100[e]	2194003-2	1	Coldhead and Gasket Kit	Y

[a] Was LCC300 G-10 Sleeve Assembly 2354044 before 2243832 rev. 21.

[b] Included in Assembly 2243832 as part of subassembly Plumbing Assembly, PED Certified, 2281696-2.

[c] Included in Penetration Receptacle Platform Assembly 2247590, part of Magnet Cartridge Assemblies.

[d] Included in Enclosure Assembly.

[e] Included for reference purposes only.

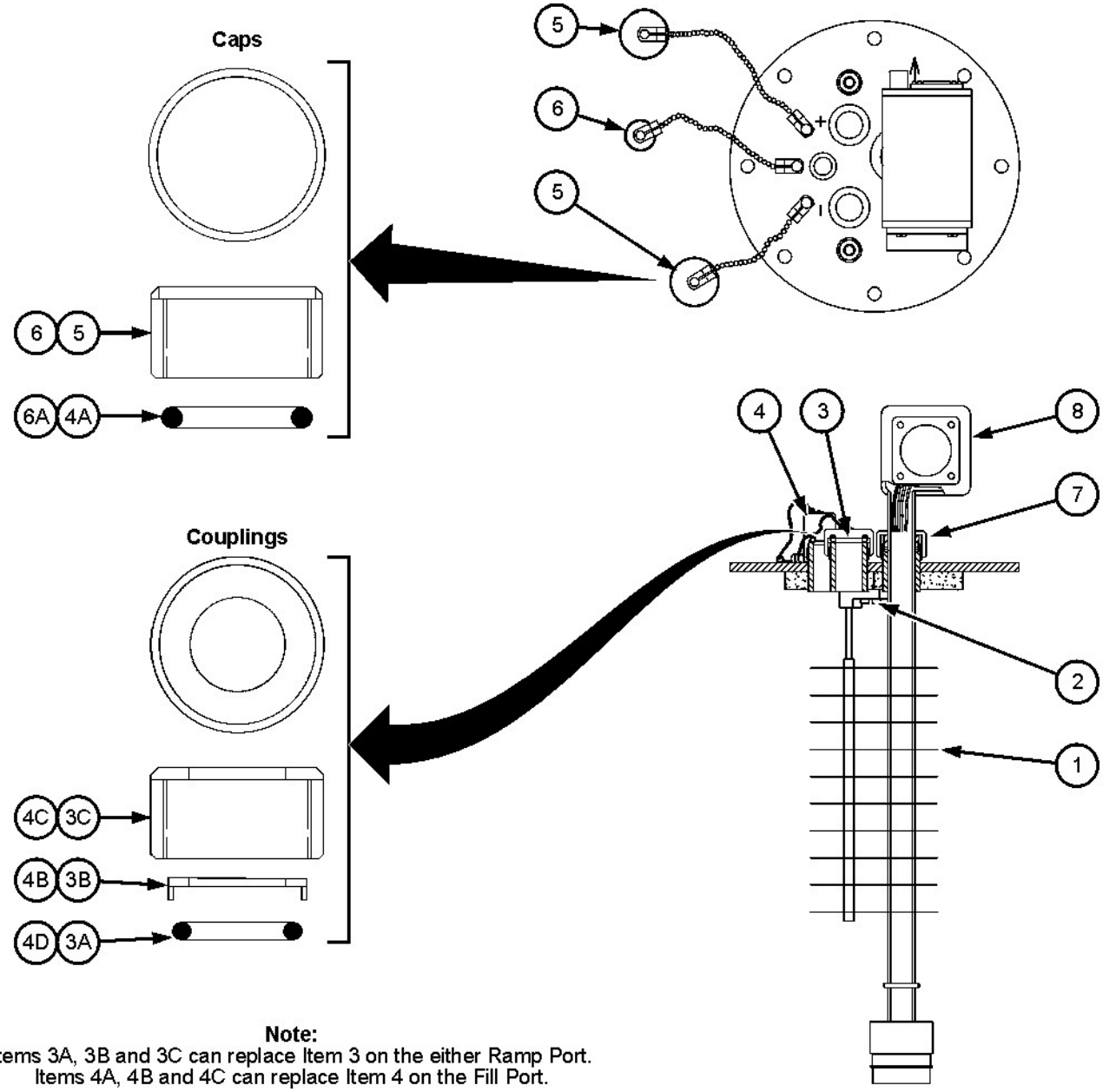
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.2 Shim Lead Assemblies

2.2.1 Shim Lead Assembly 2173354

See also Section 2.2.2, Shim Lead Assembly, Short 2286073.

Illustration 7-8: Retractable Shim Lead Assembly 2173354 Components



Note:
Items 3A, 3B and 3C can replace Item 3 on the either Ramp Port.
Items 4A, 4B and 4C can replace Item 4 on the Fill Port.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-11: Retractable Shim Lead Assembly 2173354 Rev. 7

Item	Part Number	Quantity	Description	Spare
1	2180818	1	LCC Shim Lead Baffle Assembly (removable)	N
2	46-260789P18	8	Socket Head Screw, #6-32UNC x .50 in.	N
3	2184241	2	Vacuum Coupling Sleeve, .75 in.	N
3A[a]	46-260389P3	4	BUNA-N O-Ring, .736 in. ID x .103 in. thick	Y
3B[a]	46-294105P1	3	Retaining Ring, Brass, 1.109 in. OD	Y
3C[a]	46-294104P1	3	Knurled Coupling Nut, Brass, 1.187-20UNC	Y
4	2184241-2	1	Vacuum Coupling Sleeve, .50 in.	N
4A[b]	46-260342P10	2	Silicone O-Ring, Parker #2-112 (for cap)	Y
4B[b]	46-260272P1	1	Retaining Ring, Stainless Steel, .687 in. OD	Y
4C[b]	46-318619P1	1	Extended Knurled Coupling Nut, Brass, .75-20UNEF	Y
4D[b]	46-260342P9	2	Silicone O-Ring, Parker #2-014 (for coupling nut)	Y
5	2184199	2	Tube Cap, Brass	N
6	2326325	1	Extended Cap Assembly	Y
6A[c]	46-260389P4	1	Silicon O-Ring, Parker #2-205	Y
7[d]	2203803	2	Split O-Ring	N
8	2180821	1	Connector Housing Assembly	N

[a] Can be used to replace items shipped with Vacuum Coupling Sleeve 2184241.

[b] Can be used to replace items shipped with Vacuum Coupling Sleeve 2184241-2.

[c] Included in Extended Cap Assembly 2326325.

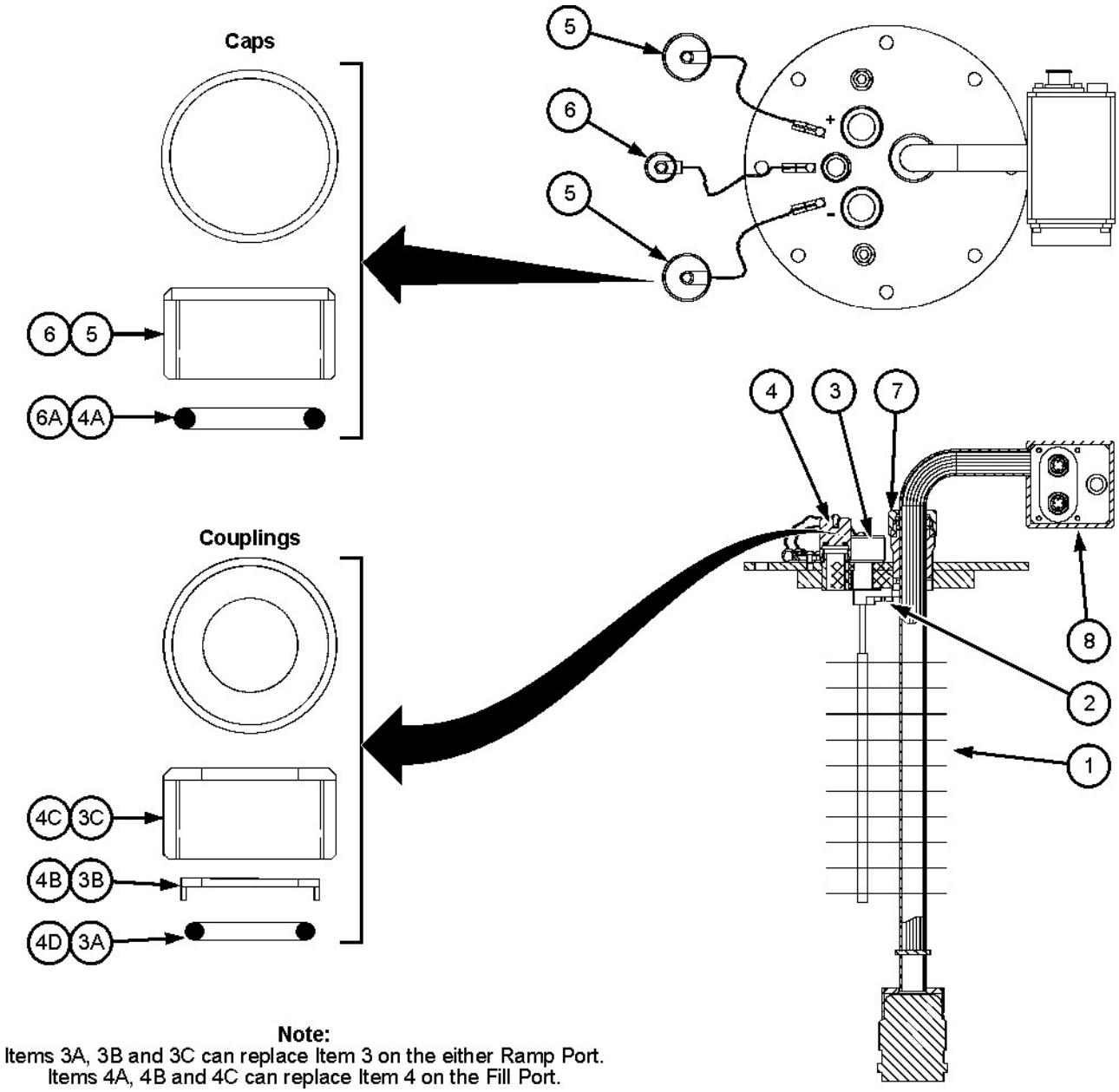
[d] Included in Section 3.10, Field Spares Kit 46-294744G5, but not shipped as part of 2173354 or 2285073.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2.2.2 Shim Lead Assembly, Short 2285073

See also Section 2.2.1, Shim Lead Assembly 2173354.

Illustration 7-9: Retractable Shim Lead Assembly, Short, 2285073 Components



Note:
Items 3A, 3B and 3C can replace Item 3 on the either Ramp Port.
Items 4A, 4B and 4C can replace Item 4 on the Fill Port.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-12: Retractable Shim Lead Assembly, Short, 2285073 Rev. 3

Item	Part Number	Quantity	Description	Spare
1	2180818	1	LCC Shim Lead Baffle Assembly (removable)	N
2	46-260789P18	8	Socket Head Screw, #6-32UNC x .50 in.	N
3	2184241	2	Vacuum Coupling Sleeve, .75 in.	N
3A[a]	46-260389P3	4	BUNA-N O-Ring, .736 in. ID x .103 in. thick	Y
3B[a]	46-294105P1	3	Retaining Ring, Brass, 1.109 in. OD	Y
3C[a]	46-294104P1	3	Knurled Coupling Nut, Brass, 1.187-20UNC	Y
4	2184241-2	1	Vacuum Coupling Sleeve, .50 in.	N
4A[b]	46-260342P10	2	Silicone O-Ring, Parker #2-112 (for cap)	Y
4B[b]	46-260272P1	1	Retaining Ring, Stainless Steel, .687 in. OD	Y
4C[b]	46-318619P1	1	Extended Knurled Coupling Nut, Brass, .75-20UNEF	Y
4D[b]	46-260342P9	2	Silicone O-Ring, Parker #2-014 (for coupling nut)	Y
5	2184199	2	Tube Cap, Brass	N
6	2326325	1	Extended Cap Assembly	Y
6A[c]	46-260389P4	1	Silicon O-Ring, Parker #2-205	Y
7[d]	2203803	2	Split O-Ring	N
8	2283170	1	Connector Housing Assembly, Reduced Height	N

[a] Can be used to replace items shipped with Vacuum Coupling Sleeve 2184241.

[b] Can be used to replace items shipped with Vacuum Coupling Sleeve 2184241-2.

[c] Included in Extended Cap Assembly 2326325.

[d] Included in the Section 3.10, Field Spares Kit 46-294744G5, but are not shipped as part of 2173354 or 2285073.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3 Magnet Accessories

3.1 Magnet Leveling Kit 46-260888G4

Illustration 7-10: Magnet Leveling Kit 46-260888G4 Components

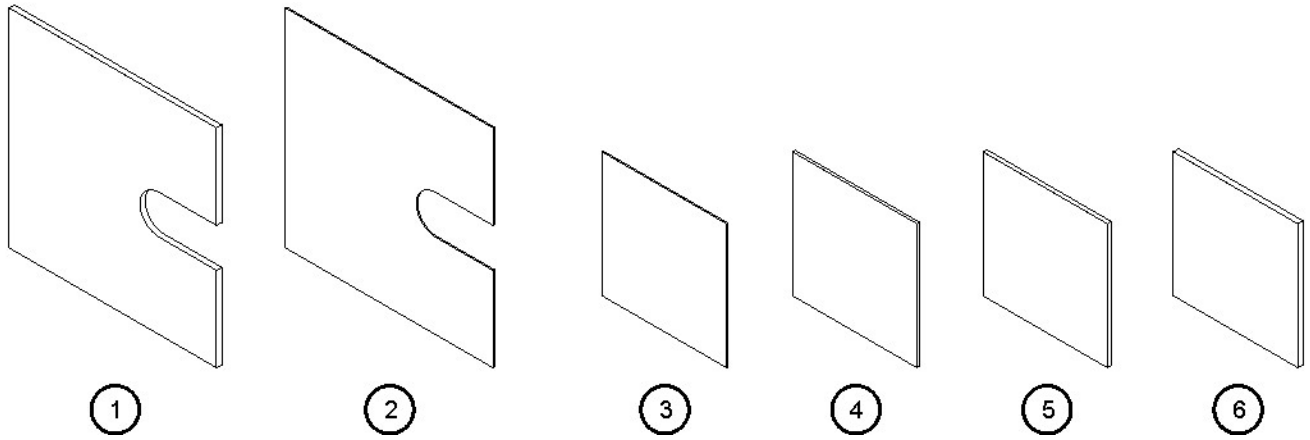


Table 7-13: Magnet Leveling Kit 46-260888G4 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2213945	12	Leveling Plate, Alum. Alloy, .062 in. thick	Y
2	2213945-2	8	Leveling Plate, Alum. Alloy, .020 in. thick	Y
3	2180016	24	Shim, Aluminum, 6 x 6 x .020 in.	Y
4	2180016-2	16	Shim, Aluminum, 6 x 6 x .032 in.	Y
5	2180016-3	8	Shim, Aluminum, 6 x 6 x .040 in.	Y
6	2180016-4	4	Shim, Aluminum, 6 x 6 x .063 in.	Y

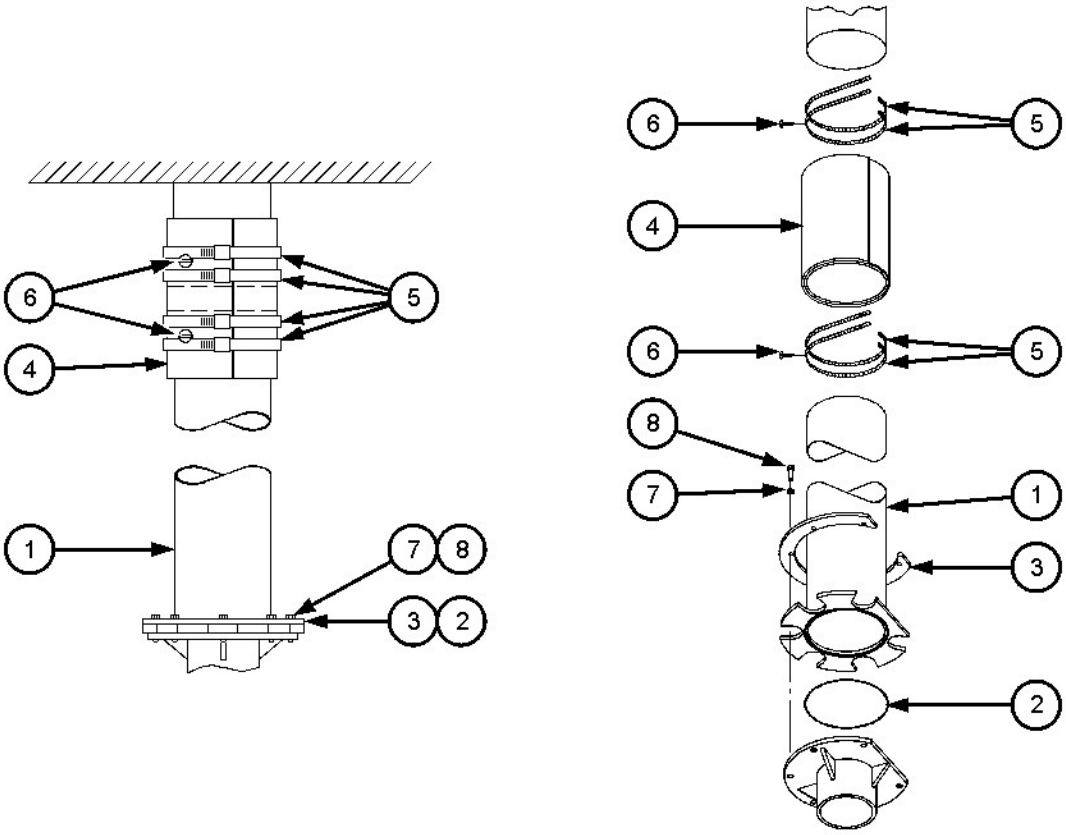
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.2 Helium Vent Kits

3.2.1 Helium Vent Kit 46-318057G6

For fixed sites.

Illustration 7-11: Helium Vent Kit 46-318057G6 Components



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-14: Helium Vent Kit 46-318057G6 Rev. 2

Item	Part Number	Quantity	Description	Spare
1	2258644	1	Vertical Vent Pipe, 8 in. OD x 24 in.	Y
2	46-281101P2	1	O-Ring, #2-172, 8.237 in. ID x .103 in. thick, teflon	Y
3	2262680	1	Clamp Ring, Aluminum	Y
4	46-281971P2*	2	VentGlas Fiberglass Connector Sleeve 8 in. x 80 in.	Y
5	46-281972P2*	8	Hose Clamp, SS	Y
6	46-318057P1*	4	Pan Head Screw, #10-16 x 1 in., self-tapping, SS	N
7	46-252635P9	6	Washer, .375 in. nom., SS	Y
8	46-281046P38	6	Hex Head Cap Screw, .375-16 x 1.75 in., brass	N
* For isolation joints above and below the Magnet Room's ceiling.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.2.2 Helium Vent Kit, Fixed Sites 46-318057G1

Table 7-15: Helium Vent Kit, Fixed Sites 46-318057G1 Rev. 3

Item	Part Number	Quantity	Description	Spare
1	46-318051G1	1	Vertical Vent Pipe, 8 in. OD x 48 in.	N
2	46-281101P2	1	O-Ring, #2-172, 8.237 in. ID x .103 in. thick, teflon	Y
3	2262680	1	Clamp Ring, Aluminum	Y
4	46-281971P2*	2	VentGlas Fiberglass Connector Sleeve 8 in. x 80 in.	Y
5	46-281972P2*	8	Hose Clamp, SS	Y
6	46-318057P1*	4	Pan Head Screw, #10-16 x 1 in., self-tapping, SS	N
7	46-252635P9	6	Washer, .375 in. nom., SS	Y
8	46-281046P38	6	Hex Head Cap Screw, .375-16 x 1.75 in., brass	N
* For isolation joints above and below the Magnet Room's ceiling.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.2.3 Helium Vent Kit, Mobile Sites 46-318057G2

For mobile sites.

Illustration 7-12: Helium Vent Kit, Mobile Sites 46-318057G2 Components

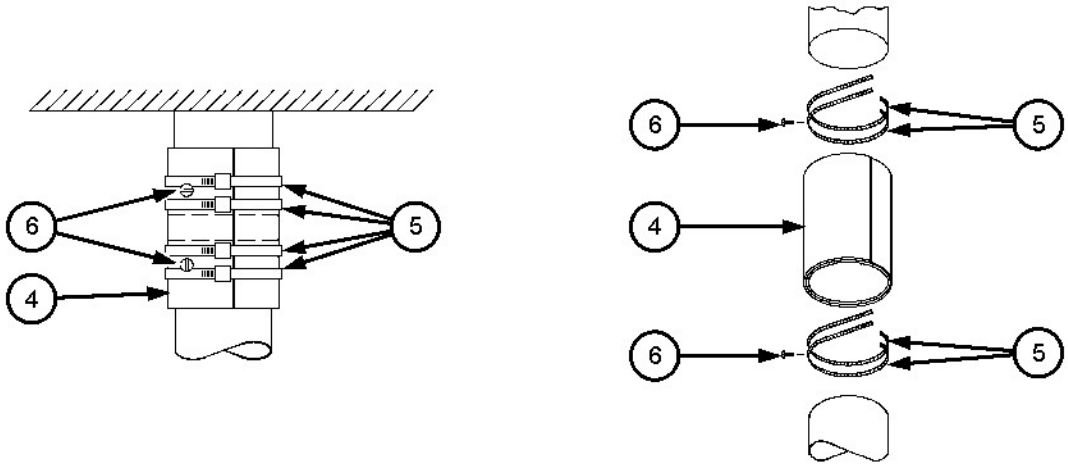


Table 7-16: Helium Vent Kit 46-318057G2 Rev. 0

Item	Part Number	Quantity	Description	Spare
4	46-281971P2	2	VentGlas Fiberglass Connector Sleeve 8 in. x 80 in.	Y
5	46-281972P2	8	Hose Clamp, SS	Y
6	46-318057P1	4	Pan Head Screw, #10-16 x 1 in., self-tapping, SS	N

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.3 Cryogen Monitor 2122498

Table 7-17: Cryogen Monitor 2122498 Rev. 0, Supplier to GE Part Number Cross Reference

Item	Suppier Part Number*	GE Part Number	Description	Spare
1	EF-1000	2122500-2	Fuse, 0.3A, 250V, 3AG, 100-115 VAC	Y
2	EF-1520	2122500-3	Fuse, 0.2A, 250V, 3AG, 200-230 VAC	Y
3	BM / 111GE / PCB	2122500-4	Main Printed Circuit Board	Y
4	EM-1015	2122500-5	Display Meter	Y
* Supplier parts shown in supplier service manual.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.4 Magnet Rundown Unit (MRU)

3.4.1 MRU Kit Assembly 2128700

Table 7-18: MRU Kit Assembly 2128700 Rev. 4

Item	Part Number	Quantity	Description	Spare
1	46-294231G1	1	Magnet Rundown Unit (Primary)[a]	Y
2	2128699	1	Shielded Cable, Run 606, Magnet to ERU/MRU	Y
[a] See Section 3.4.3, MRU 46-294231G1, for Magnet Rundown Unit 46-294231G1 renewal parts.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.4.2 Remote MRU Kit 5128755

Table 7-19: Remote MRU Kit for LCC, G3 and HFO Magnets 5128755 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	46-294231G1	1	Magnet Rundown Unit (Primary)[a]	Y
2	5128151	1	Remote MRU Connector Box	Y
3	5128150	1	Cable, MRU Connector Box to Pen Panel (Run 1265)	Y
4	5128149	1	Cable, Remote MRU to Pen Panel (Run 1266)	Y
5	5128562	1	Label, “Danger: Strong Magnetic Field”	Y
6	46-252755P3	2	#6-32UNC x .375 Hex Hd. Screw, SS304	Y
8	5128738	2	Remote MRU Box Spacer, HFO[b]	Y
9	46-252755P9	2	#6-32UNC x .75 Hex Hd. Screw, SS304[b]	Y
20	5128755-2	1	Remote MRU Installation Instructions	N

[a] See Section 3.4.3, MRU 46-294231G1, for Magnet Rundown Unit 46-294231G1 renewal parts.

[b] Only used with Instrumentation Box Assembly 2248447 (GE 0.7T OpenSpeed magnets).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.4.3 MRU 46-294231G1

Table 7-20: Magnet Rundown Unit 46-294231G1 Rev. 6, Supplier to GE Part Number Cross Reference

Item	Suppier Part Number*	GE Part Number	Description	Spare
1	EF1001	46-294231P1	Fuse, F1, 110VAC .400 GDC time lag	Y
2	EF1002	46-294231P2	Fuse, F1, 220VAC .125 GDC time lag	Y
3	EF1008	46-294231P3	Fuse, F2, 2.5A GDC time lag	Y
4	EF1004	46-294231P4	Fuse, F3/F4, 1.25A GDB time lag	Y
5	GS4063	46-294231P5	Battery, Gel Cel 6V 1.2AH YUSA NP1.2-6	Y
6	EC1140	46-294231P6	Capacitor, CI, 470µF, 50V	Y
* Supplier parts shown in supplier service manual.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.5 Magnet Monitor Kits

3.5.1 Magnet Monitor Kit, Fixed TRM 2304069

Table 7-21: Magnet Monitor Collector, Fixed TRM Site 2304069 Rev. 3

Item	Part Number	Quantity	Description	Spare
1	2219400	1	Magnet Monitor	Y
2	2350809	1	Core Cable Kit (see Section 3.5.6)	Y
3	2219341	1	RuO Sensor Amplifier	Y
4	2245794	1	Global Modem Kit (see Section 3.5.5)	Y
5	2229090-100	1	Magnet Monitor Operator's Manual	N
6	2230681	1	Magnet Monitor Hardware Installation Manual	N
7	2350813	1	TRM Cable Kit (see Section 3.5.7)	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.5.2 Magnet Monitor Kit, Mobile TRM 2304069-2

Table 7-22: Magnet Monitor Collector, Mobile TRM Site 2304069-2 Rev. 5

Item	Part Number	Quantity	Description	Spare
1	2219400	1	Magnet Monitor	Y
2	2350809	1	Core Cable Kit (See Section 3.5.6)	Y
3	2219341	1	RuO Sensor Amplifier	Y
5	2266628	1	Magnet Monitor Remote Alarm Box	N
6	2276094	1	Uninterruptible Power Supply	Y
7	2229090-100	1	Magnet Monitor Operator's Manual	N
8	2230681	1	Magnet Monitor Hardware Installation Manual	N
10	2350818	1	Mobile Site TRM Cable Kit (See Section 3.5.8)	Y
13	2350813	1	TRM Cable Kit (See Section 3.5.7)	Y
15	2385399	1	Mobile Satellite Modem Kit	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.5.3 Magnet Monitor Kit, Fixed BRM-CRM 2222520

Table 7-23: Magnet Monitor Collector, Fixed BRM/CRM Site 2222520 Rev. 4

Item	Part Number	Quantity	Description	Spare
1	2219400	1	Magnet Monitor	Y
2	2350809	1	Core Cable Kit (See Section 3.5.6)	Y
3	2219341	1	RuO Sensor Amplifier	Y
4	2245794	1	Global Modem Kit (See Section 3.5.5)	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.5.4 Magnet Monitor Kit, Mobile BRM-CRM 2222520-2

Table 7-24: Magnet Monitor Collector, Mobile BRM/CRM Site 2222520-2 Rev. 5

Item	Part Number	Quantity	Description	Spare
1	2219400	1	Magnet Monitor	Y
2	2350809	1	Core Cable Kit (See Section 3.5.6)	Y
3	2219341	1	RuO Sensor Amplifier	Y
6	2276094	1	Uninterruptible Power Supply	Y
8	2385399	1	Mobile Satellite Modem Kit	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.5.5 Global Modem Kit 2245794

Table 7-25: Global Modem Kit 2245794 Rev. 2

Item	Part Number	Quantity	Description	Spare
1	2245773	1	Global Modem, Multi-Tech	Y
2	2253088	1	Label, “Customer Property"	N
3	2216697	1	Cable, RJ11, 25 ft. (7.62 M)	Y
4	2255874	1	Cable, RJ11, 6-Conductor, 7 ft. (2.13 M)	N
5	2249450	1	Global Modem Adapter, Europe	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.5.6 Core Cable Kit 2350809

Table 7-26: Core Cable Kit 2350809 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	46-317359G975	1	Cable (Run 824TR), PP1-J10 to FJ1	Y
2	46-328000G976	1	Cable (Run 829), MS1-FJ2 to PP1-J48	N
3	46-317359G977	1	Cable (Run 825TR), PP1-J48 to MSM1-A1-J8	Y
4	46-328000G980	1	Cable (Run 831), FJ1 to MSM1-A1-J7	N
5	46-328000G978	1	Cable (Run 826), FJ3 to MSM1-A1-J9	N
6	46-328578P1	1	Cable (Run 827), FJ3 to FJ4 & MS5A5	Y
7	46-328000G979	1	Cable (Run 823), MSM1-J10 to MR2-A11-J24	N
8	2204485	1	SYSCAB Interface Cable	Y
9	46-328000G981	1	Cable (Run 833), FJ4 to MS5-A1-A6-JR	Y
10	2333825	1	Turbine Water Flow & Temperature Sensor Assembly	Y
11	46-265067P1	10	I/F Panel Cable Screwlock Connector	Y
12	46-328000G974	1	Cable (Run 828), MS1-A3-A1-J403 to PP1-J10	N
13	2222797	1	Magnet Room Interface Cable (Run 830)	Y
14	46-296816P1	1	BNC Tee Adapter, 50 Ohm, Amphenol 31-200	Y
15	2276568	1	Cable (Run 940), MSM3-RS-232 to MSM1-J1	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.5.7 TRM Cable Kit 2350813

Table 7-27: TRM Cable Kit 2350813 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2263200-39	1	Cable (Run 941), MSM1-J11 to SCC-J1	N
2	2271497	1	Ethernet Cable (Run 942)	N

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.5.8 Mobile TRM Cable Kit 2350818

Table 7-28: Mobile TRM Cable Kit 2350818 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2263160	1	Cable (Run 915), MSM1A2-J1 to FJ6	Y
2	2263159	1	Cable (Run 916), MSM1-J7 to FJ1, FJ5 & FJ6	N
3	2276569	1	Cable (Run 939), MDP-UPS Out to MSM4	N
4	2279530	1	Strain Relief, UPS Input Cable	N
5	2279530-2	1	Strain Relief, UPS Output Cable	N
6	2279530-3	1	Strain Relief, MUX Input Cable	N
7	2279530-4	2	Strain Relief, Modem/Magnet Monitor Input Cable	N

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.6 Ramp and Shim Cable Kit 2171719

Table 7-29: Ramp and Shim Cable Kit 2171719 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	46-260724G1	2	Switch Heaters Cable (Run 604)	Y
2	46-281235P1	1	Voltage Sense Lead Cable, 40 ft. (12.2 M)	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.7 Gradient Collectors

3.7.1 Fixed TRM Gradient Collector 2297123

Table 7-30: Fixed TRM Gradient Collector 2297123 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	2297122	1	TRM Enclosure, Fixed Site	N
2	2232300	1	Protective Poly Bubble Shroud	Y
3	2297692	1	TRM Installation Collector	N
998	2213762	Ref.	LCC Air Ship Configuration	N
999	2226240	Ref.	LCC Domestic Air Ship Crate	N

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.7.2 Mobile TRM Gradient Collector 2297124

Table 7-31: Mobile TRM Gradient Collector 2297124 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	2297122-2	1	TRM Enclosure, Mobile Site	N
2	2232300	1	Protective Poly Bubble Shroud	Y
3	2297692	1	TRM Installation Collector	N
999	2226240	Ref.	LCC Domestic Air Ship Crate	N

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.7.3 Fixed BRM-F Gradient Collector 2222521

Table 7-32: Fixed BRM-F Wide Open Gradient Collector 2222521 Rev. 4

Item	Part Number	Quantity	Description	Spare
1	2214166-4	1	BRM-F Installation Collector, Fixed Site	Y
2	2222558	1	Wide Open Enclosure, Fixed Site	N
3	2226240	1	Domestic Shipping Crate	Y
4	2232300	1	Protective Poly Bubble Shroud	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.7.4 Mobile BRM-F Gradient Collector 2222560

Table 7-33: Mobile BRM-F Wide Open Gradient Collector 2222560 Rev. 4

Item	Part Number	Quantity	Description	Spare
1	2214166-5	1	BRM-F Installation Collector, Mobile Site	Y
2	2222558-2	1	Wide Open Enclosure, Mobile Site	N
3	2226240	1	Domestic Shipping Crate	Y
4	2232300	1	Protective Poly Bubble Shroud	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.7.5 Fixed CRM-WO Gradient Collector 2230589

Table 7-34: Fixed CRM Wide Open Gradient Collector 2230589 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	2200563-5	1	Gradient Isolation Installation, Fixed Site	N
2	2235160	1	Cardiac Wide Open Enclosure, Fixed Site	Y
3	2226240	1	Domestic Shipping Crate	Y
4	2232300	1	Protective Poly Bubble Shroud	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.7.6 Mobile CRM-WO Gradient Collector 2230589-2

Table 7-35: Mobile CRM Wide Open Gradient Collector 2230589-2 Rev. 2

Item	Part Number	Quantity	Description	Spare
1	2200563-6	1	Gradient Isolation Installation, Mobile Site	N
2	2235160-2	1	Cardiac Wide Open Enclosure, Mobile Site	Y
3	2226240	1	Domestic Shipping Crate	Y
4	2232300	1	Protective Poly Bubble Shroud	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.8 Compressor Kits

3.8.1 SHI Shield Cooler Compressor 2188440-2

Table 7-36: Sumitomo Shield Cooler Compressor 2188440-2 Rev. 2, SHI to GE Part Number Cross Reference

Item	Suppier Part Number*	GE Part Number	Description	Spare
1	RE71TN0408	2172241	Adsorber	Y
2	RE38VT0689	2205309	Hose nipple, 12 x .375 in.	N
3	RE71WT0600	2191112	Fuse, 2A	Y
4	RE71WT0602	2191112-2	Class G fuse, 2A	Y
5	RE71WT0601	2191112-3	Class G fuse, 3A	Y
6	RE71WT0603	2191112-4	Class G fuse, 5A	Y
7	RE71WN0538	2191112-5	Phase failure relay	Y
8	RD42ZT0697	2191112-6	O-Ring	Y
9	RE71WT701	2191112-7	Class G fuse, 4A	Y
10	H7ET-FBV	2191112-8	Hour meter	Y
11	RE71WT0768	2191112-9	Class G fuse, 1A	Y
12	RE71WT0767	2191112-10	Glass body fuse, 1A	Y
13	—	2191112-11	250 VAC fuse, 4A	Y
14	—	2191112-12	600 VAC fuse, 2A	Y
* Supplier parts shown in supplier service manual.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.8.2 SHI WC, HV Compressor Cable Kit 2211446

Table 7-37: Sumitomo Water-Cooled, High Voltage Compressor Cable Kit 2211446 Rev. 1

Item	Part Number	Quantity	Description	Spare
2	2154502-2	1	Helium supply line, 65.6 ft. (20 M), Run 621	Y
3	2154505-2	1	Helium return line, 65.6 ft. (20 M), Run 622	Y
4*	2259837	1	Coldhead Control Cable Assembly	Y
4A*	2155316-2	1	Cable (Run 623), Compressor to Penetration Panel	Y
4B*	2218292	1	Coldhead Control Cable (Run 624), Penetration Panel to Coldhead	Y
6	2200835	1	CSW-71D HV Compressor Power Cable, 32.8 ft. (10 M)	Y
* Item 4 consists of items 4A and 4B, which can be ordered separately.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.8.3 SHI WC, HV Compressor Cable Kit 2274978

Table 7-38: Sumitomo Water-Cooled, High Voltage Compressor Cable Kit 2274978 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2154502-2	1	Flexible Gas Supply Line, 20 M (65.6 Ft.)	Y
2	2154505-2	1	Flexible Gas Return Line, 20 M (65.6 Ft.)	Y
3	2259837	1	Coldhead Control Cable Assembly	N
4	2274831	1	High Voltage Compressor Power Input Cable, 5 M (16.4 Ft.)	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.9 Coldheads and Gaskets

3.9.1 Coldhead and Gaskets Kit 2194003

Table 7-39: Coldhead and Gaskets Kit 2194003 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	2218465	1	Cryocooler Coldhead Assembly (See Section 3.9.3)	Y
2	2171620	1	Cryocooler Replacement Gaskets Kit (See Section 3.9.5)	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.9.2 Coldhead and Gaskets Kit 2194003-2

Table 7-40: Coldhead and Gaskets Kit 2194003-2 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	2218465-3	1	High Efficiency Cryocooler Coldhead Assembly (See Section 3.9.4)	Y
2	2171620	1	Cryocooler Replacement Gaskets Kit (See Section 3.9.5)	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.9.3 Coldhead Assembly 2218465

Illustration 7-13: Cryocooler Coldhead Assembly 2218465 Components

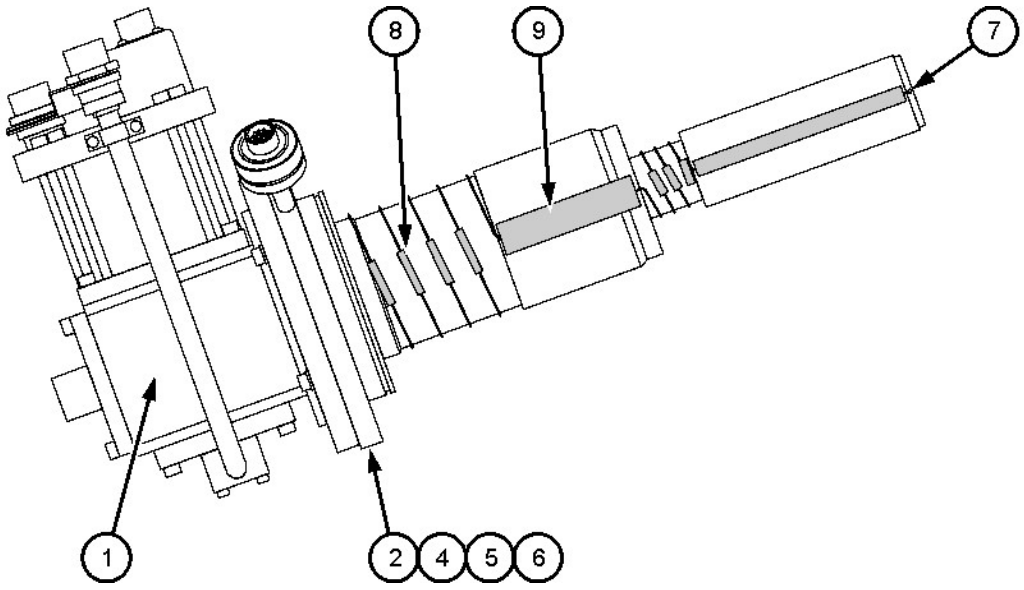


Table 7-41: Cryocooler Coldhead Assembly 2218465 Rev. 5

Item	Part Number	Quantity	Description	Spare
1	2218291	1	Cryocooler Coldhead, Sumitomo RDK-408-C	Y
2	2153638	1	Coldhead Transition Sleeve Assembly	Y
4	46-318764P6	4	M6 x 25mm Socket Head Cap Screw	Y
5	2109878-3	4	Plain Washer, 6.4 x 12 mm Nom.	Y
6	46-252065P24	1 tube	Vacuum Grease	Y
7	2173694	1	Ruthinium Oxide (RuO) Sensor	Y
8	46-260802P6	1 roll	Aluminum Foil Tape, 0.125 in. (3 mm) wide	Y
9	46-260802P1	1 roll	Aluminum Foil Tape, Alloy 1145-0, 0.5 in. (12.7 mm) wide	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.9.4 High Efficiency Coldhead Assembly 2218465-3

Illustration 7-14: High Efficiency Cryocooler Coldhead Assembly 2218465-3 Components

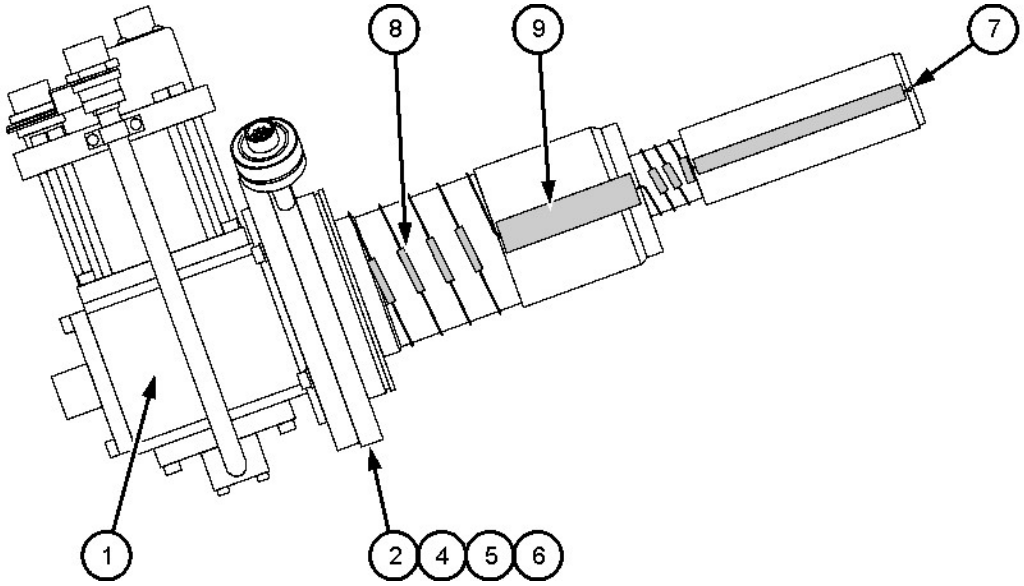


Table 7-42: Cryocooler Coldhead Assembly 2218465-3 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	2218291-3	1	High Efficiency Cryocooler Coldhead, Sumitomo RDK-408A2	Y
2	2153638	1	Coldhead Transition Sleeve Assembly	Y
4	46-318764P6	4	M6 x 25mm Socket Head Cap Screw	Y
5	2109878-3	4	Plain Washer, 6.4 x 12 mm Nom.	Y
6	46-252065P24	1 tube	Vacuum Grease	Y
7	2173694	1	Ruthinium Oxide (RuO) Sensor	Y
8	46-260802P6	1 roll	Aluminum Foil Tape, 0.125 in. (3 mm) wide	Y
9	46-260802P1	1 roll	Aluminum Foil Tape, Alloy 1145-0, 0.5 in. (12.7 mm) wide	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.9.5 Cryocooler Replacement Gaskets Kit 2171620

Illustration 7-15: Cryocooler Replacement Gaskets Kit 2171620 Components

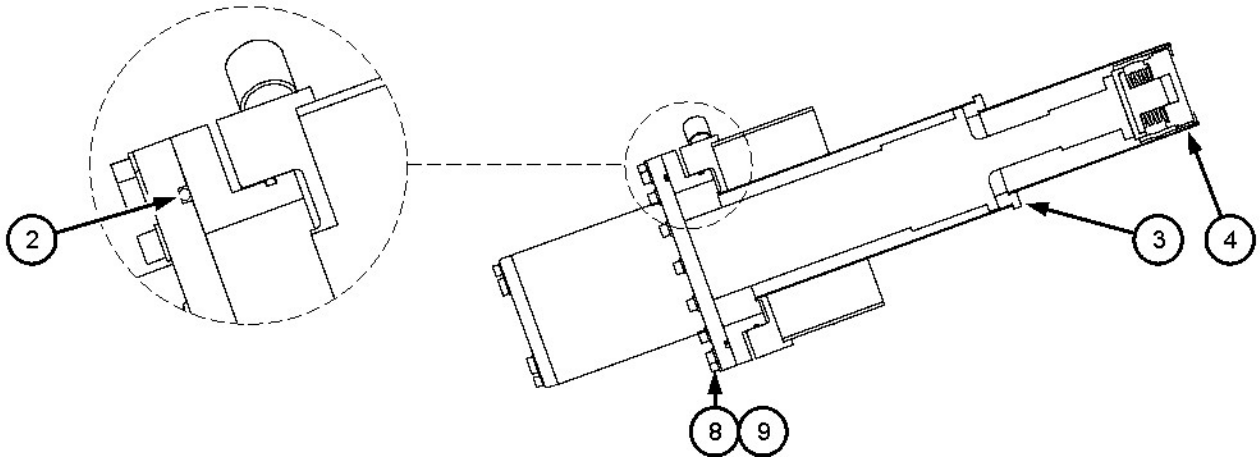


Table 7-43: Cryocooler Replacement Gaskets Kit 2171620 Rev. 4

Item	Part Number	Quantity	Description	Spare
2	46-281247P1	1	O-Ring, #2-159, 4.987 in. ID x .103 in. thick	Y
3	46-281241P1	1	Indium Gasket, 3.37 in. OD	Y
4	2171621	1	Indium Wire Gasket Kit	Y
4A[b]	2151863	1	Indium Gasket Mold	Y
4B[b]	46-294878P13	1	Indium Wire, .06 in. x 3.5 ft.	Y
5	46-252065P64	1	Cotton Gloves	Y
6	2188185	1	Feeler Gauge, 0.003 in., Green	Y
7	2188185-2	1	Feeler Gauge, 0.005 in., Blue	Y
8[a]	2224726	8	Hex Head Cap Screw, M6 x 60 mm	Y
9[a]	2173358	48	Belleville Washer, 12.5 mm OD x 6.2 mm ID .70 mm thick	Y
10	2290272	1	Charcoal Packet Kit	Y
10A[c]	2191112-6	3	Charcoal Packet (getter bag)	Y
11	2191112-6	1	O-Ring, Sumitomo #RD42ZT0697	Y
12	2391747	1	Disposable In-Line Dessiccant Filter	Y

[a] Not included in this kit.

[b] Item 4 consists of items 4A and 4B, which can be ordered separately.

[c] Item 10 consists of item 10A.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.10 Field Spares Kit 46-294744G5

Table 7-44: Field Spares Kit 46-294744G5 Rev. 9

Item	Part Number	Quantity	Description	Spare
1[a]	2349529	1	Burst Disc, 10 psig	Y
2	2203803	2	Split O-Ring	Y
3	46-281101P9	2	O-Ring, #2-128, 1.487 in. ID x 0.103 in. thick	Y
4	46-281101P5	2	O-Ring, #2-162, 5.737 in. ID x 0.103 in. thick	Y
5	46-281101P6	2	O-Ring, #2-177, 9.487 in. ID x 0.103 in. thick	Y
6	46-294104P1	2	Quick Coupling Vacuum Nut	Y
7	46-294105P1	2	Quick Coupling Retaining Ring	Y
8	46-260389P1	4	Silicone O-Ring, #2-116, 0.737 in. ID x 0.103 thick	Y
9	46-260389P2	2	Silicone O-Ring, #2-014, 0.489 in. ID x 0.070 thick	Y
10	46-260902P5	1	Swagelok Plug, .25 in. OD tube	Y
11	2218148	14	Cold-Shrink Connector Insulator	Y
12	2218149	2	Two-Way Compression Splicer, Copper	Y
13	46-318068P1	6	Bronze Wool, 4 - 5 in. x 12 in.	Y
14	46-252283P58	4	Cable Ty-Wrap	Y
15	46-260342P10	5	Quick Seal Connector O-Ring, Silicone, Parker 2-112	Y
16	46-252065P24	1	Vacuum Grease	Y
17	46-260389P4	1	O-Ring, #2-209, 0.421 in. ID x 0.139 thick	Y
18	46-252065P141	1	Aeroquip O-Ring	Y
19[b]	46-281101P10	2	O-Ring, #2-164, 6.237 in. ID x .103 in. thick	Y

[a] No longer included in Field Spares Kit 46-294744G5.

[b] Listed for reference.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3.11 Miscellaneous Items

Table 7-45: Items listed for reference only

Item	Part Number	Quantity	Description	Spare
1	2236606	1	Coldhead Sleeve Seal-Off Valve Plug Replacement (Plug is not shipped with magnet; shown here for reference only.)	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4 Service Tool Kits and Components

4.1 Safety Items

4.1.1 Safety Signage Kit 46-258770G4

Table 7-46: Safety Signage Kit 46-258770G4 Rev. 3

Item	Part Number	Quantity	Description	Spare
1	46-255326P1	10	Sign, Warning: 5-Gauss Exclusion Zone	Y
2	46-255325P1	2	Sign, Warning: Magnetic Field Security Zone	Y
3	46-255813P1	50	5 x 3 inch (127 x 76 mm) Label, Warning: No Magnetic Objects	Y
4	2289812	2	Floor Sign, Warning: Authorized Personnel Only	Y
5	46-255814P1	50	2.5 x 1.5 inch (63.5 x 38 mm) Label, Warning: No Magnetic Objects	Y
6	46-282214P1	2	Coolant Caution Label	Y
7	46-301671P1	1	Placard, Warning: Low Oxygen Level Alarm	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.1.2 Cryogen Safety Wear Kit 46-271137G1

Table 7-47: Cryogen Safety Wear Kit 46-271137G1 Rev. AB

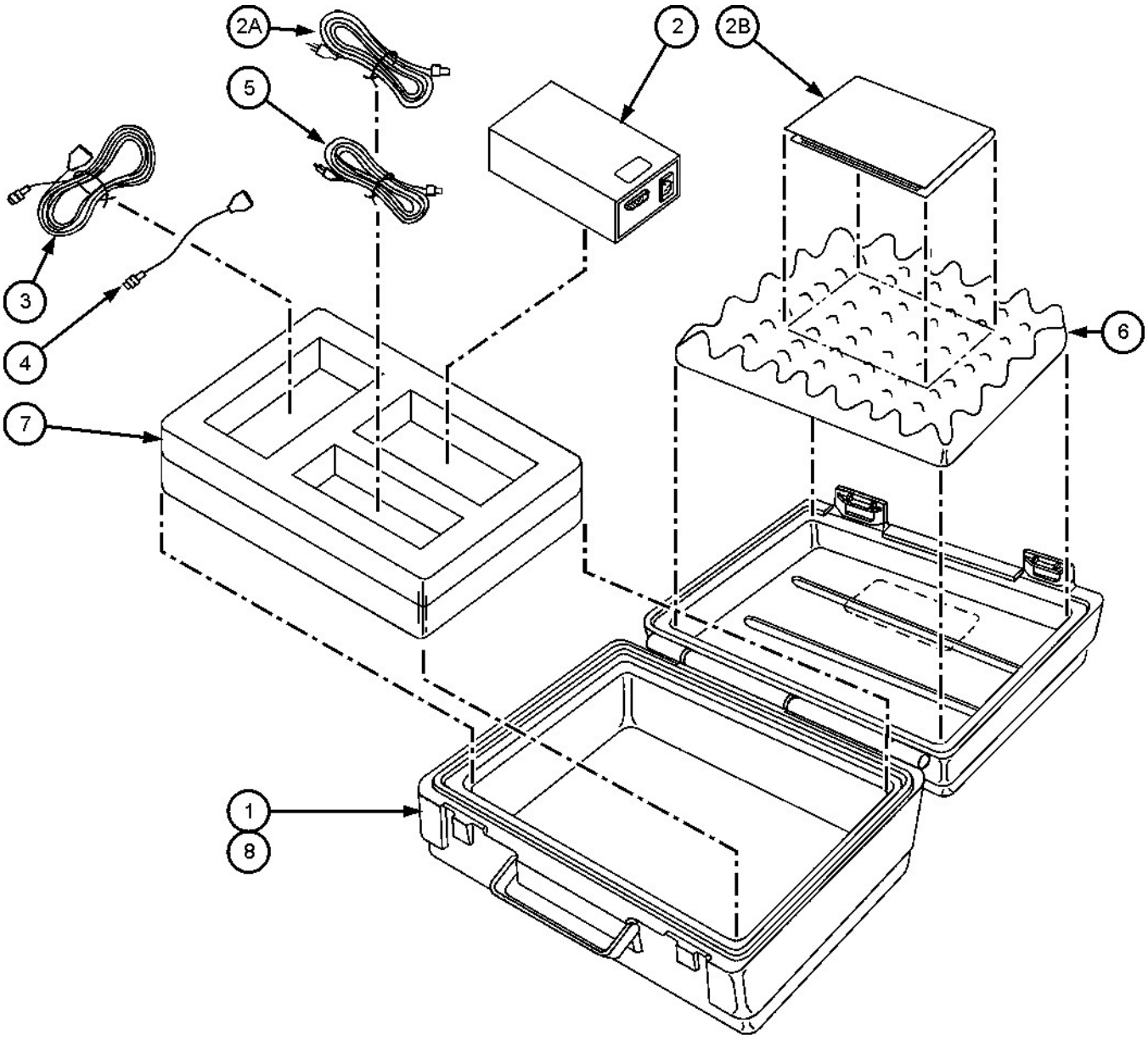
Item	Part Number	Quantity	Description	Spare
1	46-271135P10	1	Head Gear without visor	Y
2	46-271135P11	1	Vision Shield for 46-271135P10	Y
3	46-271135P12	1	Safety Glasses	Y
4	46-258217P2	1	Cryogen Handling Gloves	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2 Measuring and Monitoring Tools

4.2.1 Digital Thermometer Kit 46-301477G2

Illustration 7-16: Lakeshore 208 Digital Thermometer Kit 46-301477G2 Components



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-48: Lakeshore 208 Digital Thermometer Kit 46-301477G2 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	46-301453P6	1	Blow-Molded Case	N
2*	46-301478P1	1	Digital Thermometer, 3W, 4-digit display	Y
2A*	—	—	Power Cord for Digital Thermometer	—
2B*	—	—	Operator's Manual for Digital Thermometer	—
3	46-301619P1	1	Interconnecting Cable to Balzer Diodes	Y
4	46-301620P1	1	Interface Cable to GE Magnet	Y
5	2129919	1	Interface Cable to GE Magnet w / DIN Connector	Y
6	46-301618P1	1	Convoluted Top Foam	Y
7	46-301618P2	1	Two-Layered Bottom Foam	Y
8	2139962	1	Kit Label	N
* Items 2A and 2B are included in item 2.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2.2 RuO Temperature Monitor Kit 2183710

Illustration 7-17: RuO Temperature Monitor (Magnet Specialty Tools) Kit 2183710 Components

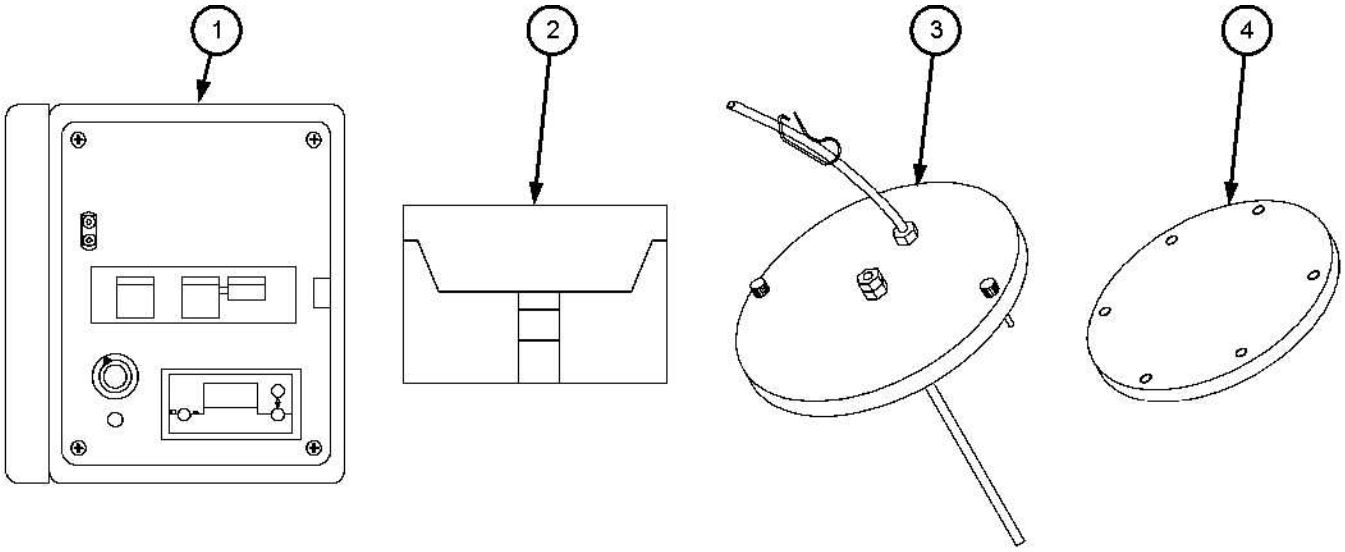


Table 7-49: RuO Temperature Monitor (Magnet Specialty Tools) Kit 2183710 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2171219	1	RuO Temperature Monitor	Y
2	2167169	1	Battery Charger Kit (for RuO Temperature Monitor)	Y
3	2174214	1	Purge Cover Plate for heat exchanger	Y
4*	2183760	1	Coldhead Sleeve Cover Plate & O-Ring	Y
4A*	2181961	1	Coldhead Sleeve Cover Plate	Y
4B*	46-252841P12	1	Cover Plate O-Ring	Y
5	2183709	1	Carrying Case	Y
* Item 4 is composed of items 4A and 4B.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2.3 Temperature Diode Box 46-317543G1

Table 7-50: Temperature Diode Box 46-317543G1 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	46-317537P1	1	Current Source Meter	N
2	46-317537P2	1	Meter Cable	Y
3	46-317537P3	1	Carrying Case	N

See also Section 4.2.4, Temperature Diode Box 46-317543G2.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2.4 Temperature Diode Box 46-317543G2

Table 7-51: Temperature Diode Box 46-317543G2 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	46-317537P1	1	Current Source Meter	N
2	46-317537P2	1	Meter Cable	Y
3	46-317537P3	1	Carrying Case	N
4	2136506	1	Cable	Y
5	2131412	1	SI-410 Diode Voltage &Temperature Characteristics Tag	Y

See also Section 4.2.3, Temperature Diode Box 46-317543G1.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2.5 TAO Monitor 46-281406G1

Illustration 7-18: TAO Monitor 46-281406G1 Components

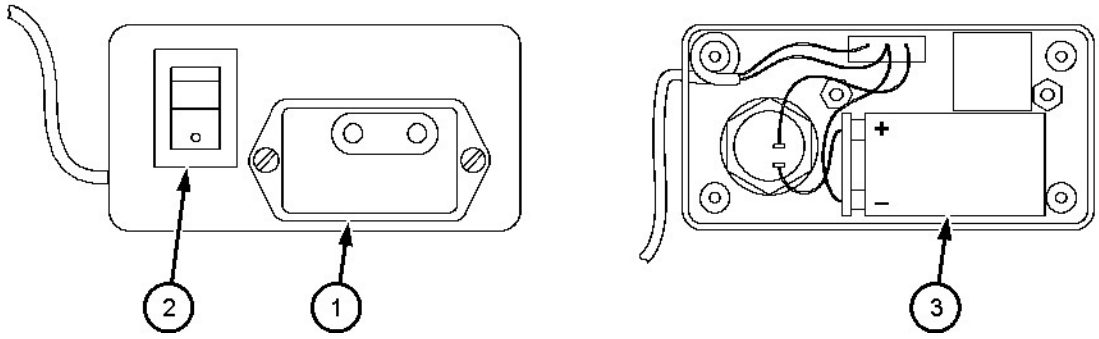


Table 7-52: TAO Monitor 46-281406G1 Rev. AA

Item	Part Number	Quantity	Description	Spare
1*	46-281406P2	1	Low Pressure Differential Transducer, Range 0 in. - 27.68 in. H_20, Omega PX162-027D5V	Y
2*	46-281406P5	1	Rocker Switch, SPST, 6A AT 125VAC, Radio Shack 275-690	Y
3*	46-281406P7	1	Battery, 9V Rect., Radio Shack 23-464 or equiv.	Y
* Not available as individual items, only as assembled part.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2.6 Fill Line Adapter for TAO 46-281232G1

Illustration 7-19: Fill Line Adapter for TAO 46-281232G1 Components

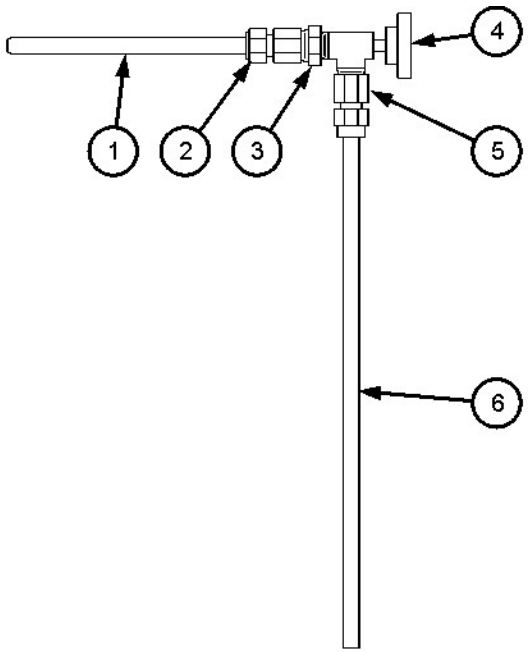


Table 7-53: Fill Line Adapter for TAO 46-281232G1 Rev. 0

Item	Part Number	Quantity	Description	Spare
1*	46-281232P1	1	Stainless Steel Tubing, .50 in. OD x .049 in. wall	Y
2*	46-260912P1	1	Female Connector, .50 in. OD x 1.5 in. NPT brass	Y
3*	46-252204P3	1	Reduction Bushing, 2 in. - 1 in. NPT brass	Y
4*	46-281109P1	1	Angle-Fill Line Dampener Valve	Y
5*	46-281169P1	1	Female Connector, .25 in. ODT x .25 in. NPT brass	Y
6*	46-252065P45	1	Polyethylene Tubing, .25 in. OD x .040 in. wall, Imperial #44-P NATURAL	Y
* Parts not available seperately.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2.7 Shield Cooler Test Kit 46-318784G2

Illustration 7-20: Shield Cooler Test Kit 46-318784G2 Components

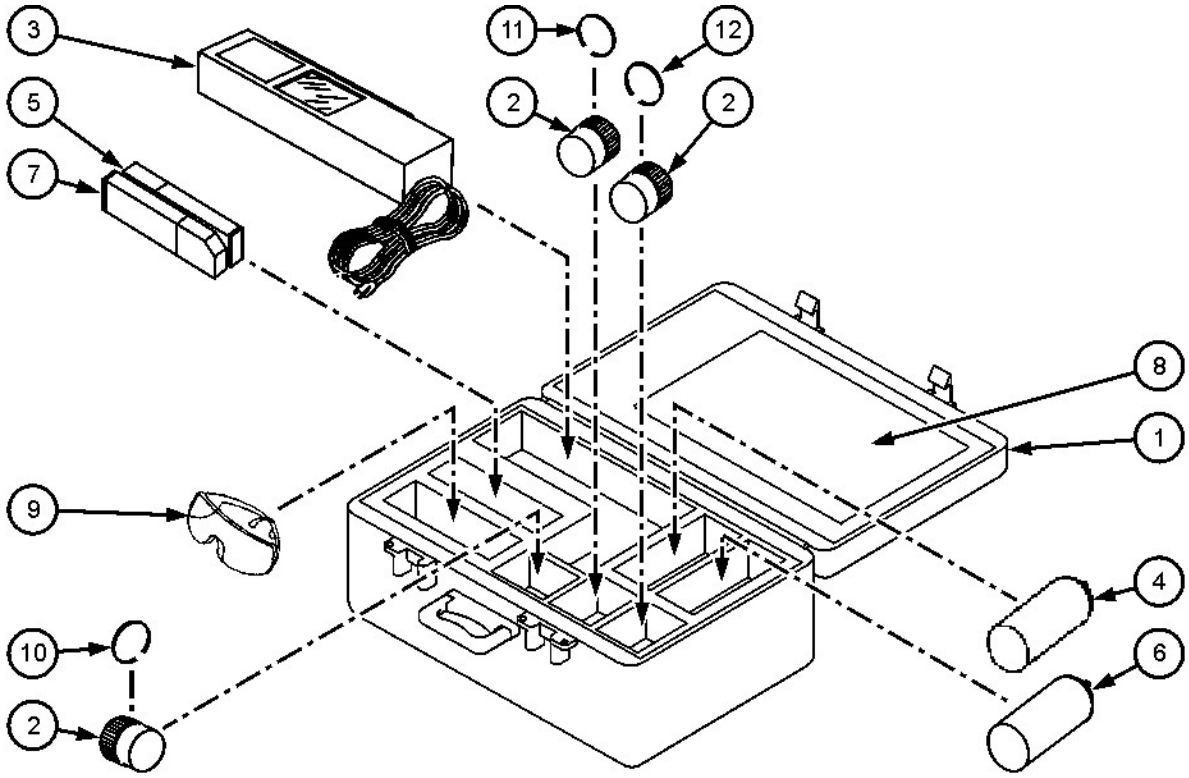


Table 7-54: Shield Cooler Test Kit 46-318784G2 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	2100644	1	Kit Case Assembly	N
2*	2100660	3	Specimen Container	Y
3	2100976	1	UV Light & Label	N
4*	2100661	1	Solution for Solids	Y
5	46-318649P1	1	Dissolved Solids Tester	Y
6*	2100662	1	Solution for Ph	Y
7	46-318648P1	1	Ph Meter	Y
8	2101994	1	Kit Operating Instructions	N
9	46-318829P1	1	UV Light Safety Goggles	N
10*	2101986	1	Adhesive-Backed Label: Sample	Y
11*	2101987	1	Adhesive-Backed Label: Solids	Y
12*	2101988	1	Adhesive-Backed Label: Ph	Y
* One each of these comprise the Shield Cooler Test Kit Consumables Kit (223529).				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

This page left intentionally blank.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2.8 Water Tee Assembly 46-318696G1

Illustration 7-21: Water Tee Assembly 46-318696G1 Components

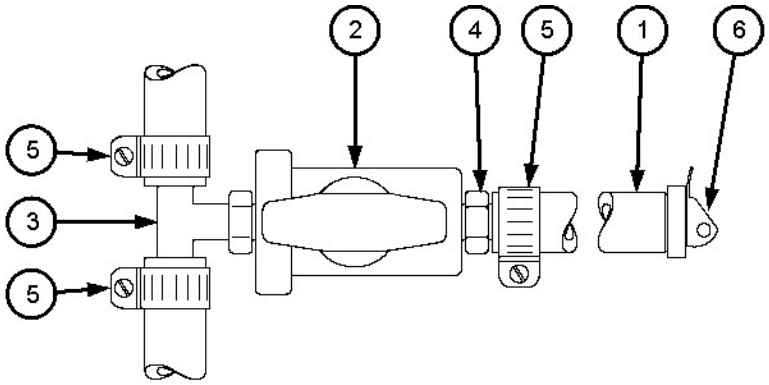


Table 7-55: Water Tee Assembly 46-318696G1 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	46-294167P9	1	Clear PVC Tubing, .50 in. ID x 12 in.	N
2	46-294167P10	1	PVC Ball Valve, .50 in. ID pipe	N
3	46-294167P11	1	Male Tee Fitting, .50 in. ID x .50 in. ID x .50 in. NPT nylon hose	N
4	46-294167P12	1	Male Nipple Fitting, .50 in. ID x .50 in. NPT nylon hose	N
5	46-294167P13	3	Hose Clamp	N
6	46-294167P16	1	Quicksnap Expandable Plug for .50 in. ID hose	N
7	2102426	1	Assembly Instructions	N

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2.9 Water Flow Meter Kit 46-294052G1

Illustration 7-22: Water Flow Meter Kit 46-294052G1 Components

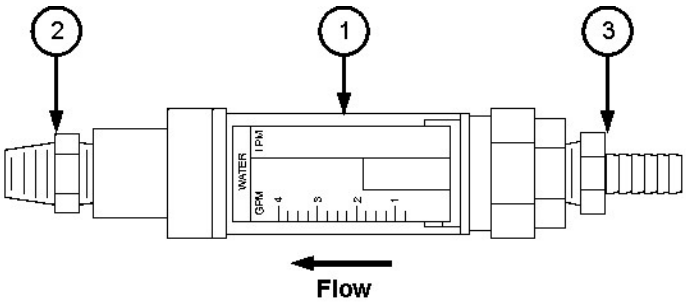


Table 7-56: Water Flow Meter Kit 46-294052G1 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	46-294052P1	1	Inline Flowmeter, 0.5 - 4.0 gpm	N
2	46-294052P2	1	Hex Nipple, Brass, .50 in. NPT x .50 in. NPT	N
3	46-294052P3	1	Hose Connector, Brass, .50 in. NPT x .50 in. ID	N
4	46-252065P19	AR	Teflon Tape, .50 in. wide	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.3 Cryogen Service Tools and Equipment

4.3.1 Universal Fill Line Kit 46-294705G1

Illustration 7-23: Universal Fill Line Kit 46-294705G1 Components

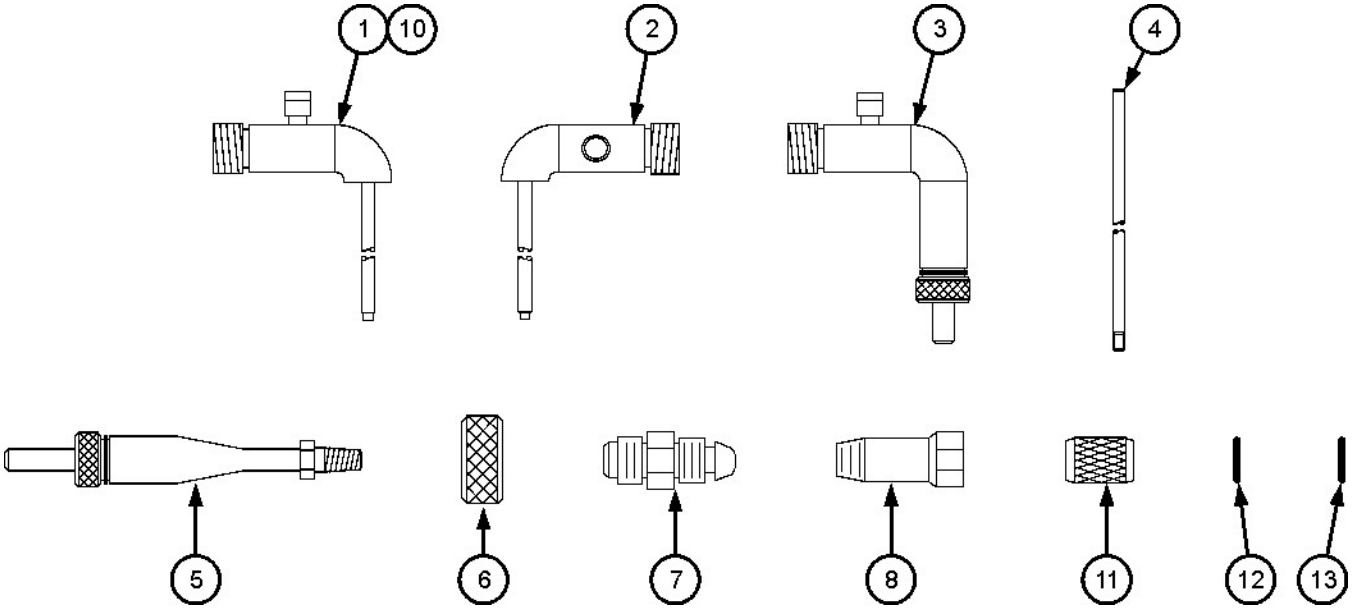


Table 7-57: Universal Fill Line Kit 46-294705G1 Rev. 4

Item	Part Number	Quantity	Description	Spare
1	46-294512P3	1	Cryostat Stinger, 7 in., Air Products #CSA-7	Y
2	46-294512P4	1	Cryostat Stinger, 14.75 in., Air Products #CSA-14	Y
3	46-294512P5	1	Reducer, .50 in. x 3.00 in. male bayonet, Air Products #MBR-6-3	Y
4	46-294512P122	1	Cryostat Stinger Extension, 16 in. with teflon tip, Air Products #CSE-16	Y
5	46-294512P13	1	Purge/Precool Adapter, Air Products #PPA-1	Y
6	46-294512P15	1	Blanking Cap, 1.5 in. OD knurled brass, Air Products #BBC-1.5	Y
7	46-294512P16	1	Nitrogen Fill Line Adapter, Air Products #FLA-1	Y
8	46-294512P17	1	Helium Fill Line Adapter, Air Products #GLA-1	Y
9	46-294512P14	1	Black Carrying Case, Air Products #PCC-27	Y
10	46-294512P25	1	Cryostat Stinger Assembly, 17 in., Air Products #CSE-17	Y
11*	46-318619P1	1	Extended Coupling Nut, .75-20UNEF knurled brass	Y
12*	46-260272P1	1	Retaining Ring, .687 in. OD stainless steel	Y
13*	46-260342P9	1	O-Ring, BUNA-N, .489 in. ID x .625 in. OD	Y
* Not included in 46-294705G1 Rev. 4.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.3.2 Liquid Helium Transfer Line Kit 46-294513G1

4.3.2.1 Dewar Stingers, Helium and Nitrogen Transfer Lines

Illustration 7-24: Dewar Stingers, Helium and Nitrogen Transfer Lines included in Liquid Helium Transfer Line Kit 46-294513G1

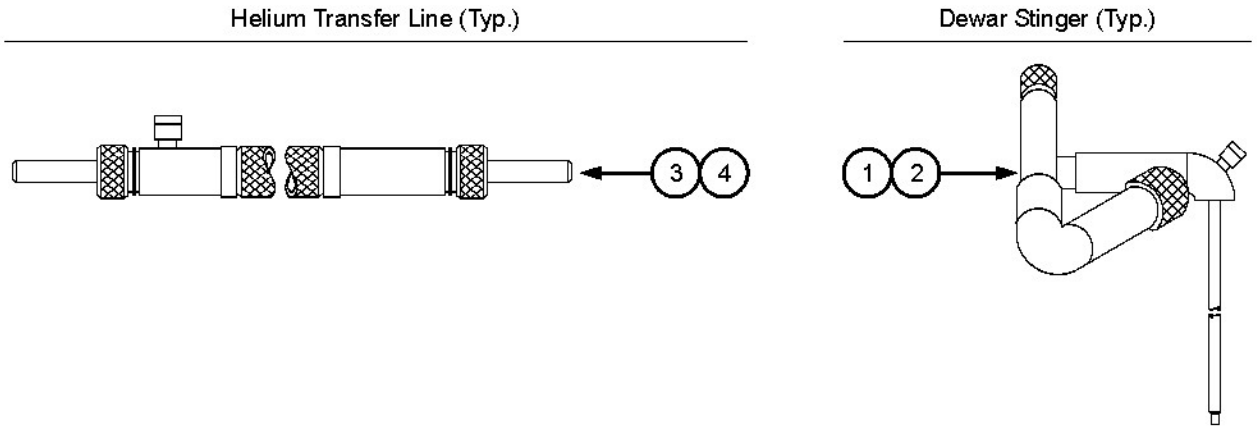


Table 7-58: Dewar Stingers, Helium and Nitrogen Transfer Lines included in Liquid Helium Transfer Line Kit 46-294513G1 Rev. 3

Item	Part Number	Quantity	Description	Spare
1	46-294511P1	1	250 Liter Helium Dewar Stinger, Air Products #DSA-59	Y
2	46-294511P2	1	500 Liter Helium Dewar Stinger, Air Products #DSA-64	Y
3	46-294512P12	1	12 Ft. Flexible Helium Transfer Line, Air Products #FS-12-2B6	Y
4	46-294512P2	1	8 Ft. Flexible Helium Transfer Line, Air Products #FS-8-2B6	Y
5	46-252805P2	1	10 Ft. Nitrogen Transfer Line	Y
6	46-252805P3	1	15 Ft. Nitrogen Transfer Line	Y
7*	46-271135P1	1	Flex Hose with NPT Fittings for Helium Bottle	Y
* Not included in Liquid Helium Transfer Line Kit 46-294513G1.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.3.2.2 Helium Transfer Line Kit Renewal Parts

Illustration 7-25: Helium Transfer Line Kit Renewal Parts included in Liquid Helium Transfer Line Kit 46-294513G1

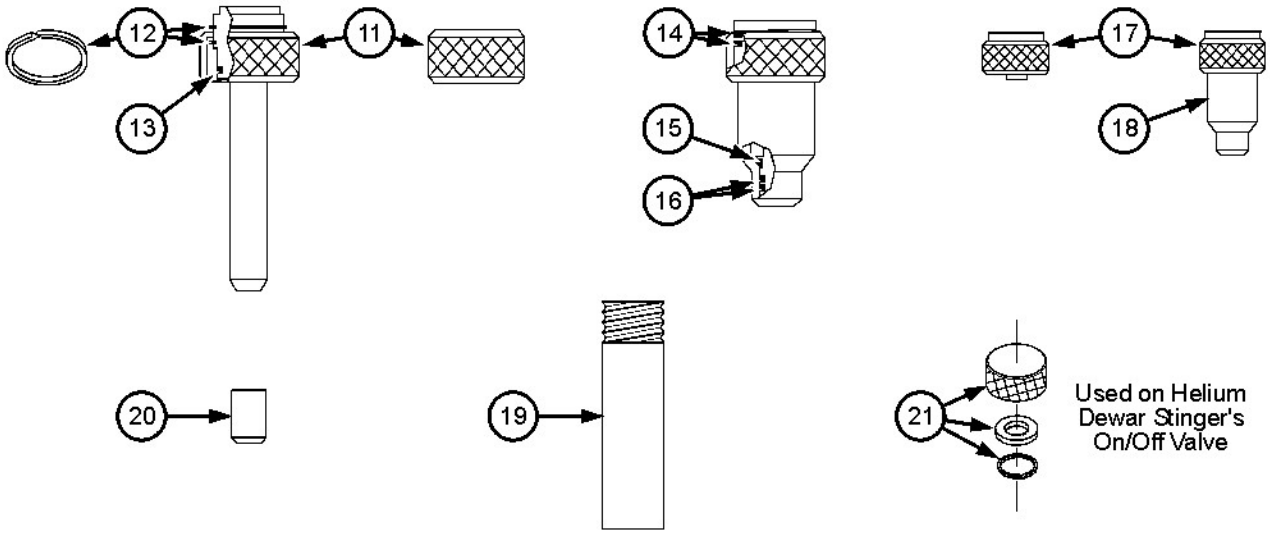


Table 7-59: Helium Transfer Line Kit Renewal Parts included in Liquid Helium Transfer Line Kit 46-294513G1 Rev. 3

Item	Part Number	Quantity	Description	Spare
11	46-294512P6	1	Male Bayonet Coupling Nut, Air Products #BCN-1	Y
12	46-294512P7	1	Male Bayonet Nut Retainer Ring, Air Products #BRR-1	Y
13	46-294512P8	1	Male Bayonet O-Ring, Air Products #BOR-1	Y
14	46-294512P9	2	VAC Port & Relief Valve O-Ring, Large, AP #VPOR-1	Y
15	46-294512P10	1	VAC Port & Relief Valve O-Ring, Med., AP #VPOR-2	Y
16	46-294512P11	2	VAC Port & Relief Valve O-Ring, Small, AP #VPOR-3	Y
17	46-294512P18	1	VAC Port Cap, Air Products #VPC-1	Y
18	46-294512P19	1	VAC Port Valve, Air Products #VPV-1	Y
19	46-294512P20	1	Bayonet Protector, set of 2, Air Products #BP-PVC	Y
20	46-294512P21	1	Teflon Tip, set of 2, Air Products #STT-1	Y
21	46-294512P22	1	Valve Stem Cap Kit, Air Products #VSC-K	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.3.3 Other Helium Transfer Service Items

Table 7-60: Other Helium Transfer Service Items (Available Seperately)

Item	Part Number	Quantity	Description	Spare
1	46-271137G1	1	Safety Wear Kit, Air Products #295-A-MRK500	Y
2	46-265286G1	1	GE Magnet Helium Resistance Box	Y
3	46-306734G1	1	Nonmagnetic Helium Regulator And Hose Kit	Y
4	46-258150P1	1	Nonmagnetic Cylinder Cart	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.4 Ramping Tools and Equipment

4.4.1 Magnet Ramping Equipment Kit 46-260703G5

Illustration 7-26: Magnet Ramping Equipment Kit 46-260703G5 Components

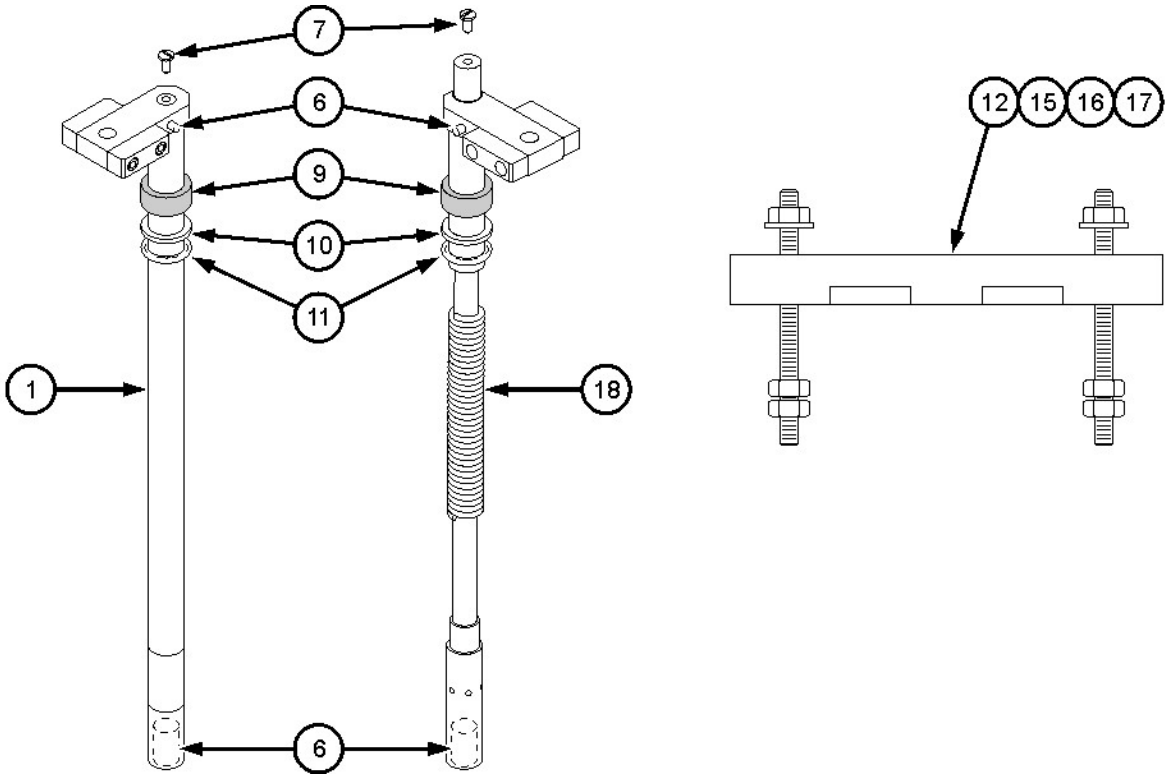


Table 7-61: Magnet Ramping Equipment Kit 46-260703G5 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	46-260817G3	2	Main Lead Extensions	Y
2	46-252366P4	3	Cap Screw, .375-16 x 1.00 in.	Y
3	46-252320P19	6	Nut, Brass, .375-16	Y
4	46-252322P8	12	Washer, Brass, .375 in.	Y
5	46-281046P35	3	Cap Screw, Brass, .375-16 x 1.250 in.	Y
6	46-252351P2	4	Round Head Screw, Brass, #10-24 x .500 in.	Y
7	46-252351P51	4	Round Head Screw, Brass, #10-32 x .438 in.	Y
8	46-281256P1	20	Main Lead Extension Contact Bands	Y
9	46-294104P1	4	Knurled Quick-Coupling Retaining Nut, Brass	Y
10	46-294105P1	4	Quick-Coupling Retaining Ring, Stainless Steel	Y
11	46-260389P1	8	Silicon O-Ring, #2-116	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-61: Magnet Ramping Equipment Kit 46-260703G5 Rev. 0 (cont'd)

Item	Part Number	Quantity	Description	Spare
12[a]	2142687	1	Ramp Lead Hold-Down Tool, Signa V	Y
12A[a]	46-252365P35	1	Hex Head Screw, Stainless Steel, .375-16 x 5 in.	Y
12B[a]	46-281003P19	2	Threaded Rod, Brass, .25-20 x 4.5 in.	N
12C[a]	46-252320P15	6	Hex Nut, Brass, .25-20	N
12D[a]	46-252322P7	2	Washer, Brass, .31	N
13	46-294236G1	1	Storage Case	Y
14	46-294204G1	2	Main Lead Extensions, SIV	Y
15[a,b]	2152359	1	Ramp Lead Fixture	Y
15A[a]	2152320	1	Ramp Lead Hold-Down Block	N
15B[a]	46-281003P5	2	Threaded Rod, Brass, .25-20 x 7.12 in.	N
15C[a]	46-252320P15	6	Hex Nut, Brass, .25-20	N
15D[a]	46-252322P7	2	Washer, Brass, .31	N
16[a,b]	2185743	1	Ramp Lead Fixture, Conquest	Y
17[a,b]	2193922	1	Ramp Lead Fixture, LCC	Y
18[c]	2287029	2	Flexible Ramp Lead Extensions (2.5M ceiling)	Y

[a] Item 12 includes hardware items 12A, 12B, 12C and 12D. Item 15 includes Ramp Lead Block 2152320 and hardware items 15A, 15B ,15C and 15D. Items 16 and 17 do not include hardware.

[b] Section 4.4.3, Hold-Down Tool Hardware Kit 2236233, is available for these kits.

[c] Not included in Magnet Ramping Equipment Kit 46-260703G5, but included in Section 4.4.2, 2.5M Ceiling Height Kit M1060SR.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.4.2 2.5M Ceiling Height Kit M1060SR

Table 7-62: 2.5M Ceiling Height Kit M1060SR Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2287029	2	Flexible Ramp Lead Extensions (2.5M ceiling)	Y
2[a]	2285073	1	Retractable Shim Lead Assembly, Short	Y
3[b]	2276755	1	Ramp Lead Fixture, Short (2.5M ceiling)	Y

[a] See Section 2.2.2, Shim Lead Assembly, Short 2286073.

[b] Also available in Section 4.4.4, LCC Hold-Down Tool Assembly 2279142.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.4.3 Hold-Down Tool Hardware Kit 2236233

Table 7-63: Hold-Down Tool Hardware Kit 2236233 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	46-281003P5	2	Threaded Rod, Brass, .25-20UNC x 7.12 in.	N
2	46-252320P15	6	Hex Nut, Brass, .25-20	N
3	46-252322P7	2	Washer, Brass, .31	N

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.4.4 LCC Hold-Down Tool Assembly 2279142

Table 7-64: LCC Hold-Down Tool Assembly 2279142 Rev. A

Item	Part Number	Quantity	Description	Spare
1	2276755	1	Ramp Lead Fixture, Short (2.5M ceiling)	Y
2	46-281003P5	2	Threaded Rod, Brass, .25-20 x 7.12 in.	N
3	46-252320P15	6	Hex Nut, Brass, .25-20	N
4	46-252322P7	2	Washer, Brass, .31	N

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.5 Power Supply Service

4.5.1 Main and Shim Coil Power Supplies

Table 7-65: Power Supplies

Item	Part Number	Quantity	Description	Spare
1	46-260776G3	1	750 Amp Main Coil Power Supply	Y
2	46-260776G4	2	1,000 Amp Main Coil Power Supply	Y
3	46-260777G3	1	Shimming Power Supply	Y

See also Section 4.5.2, Power Supply Renewal Parts.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.5.2 Power Supply Renewal Parts

Table 7-66: Renewal Parts for Service Power Supplies 46-260776G3, G4, 46-260777G3

GE to Supplier Part Number Cross Reference					
	Item	GE Part Number	Supplier Part Number[a]	Description	Spare
46-281468P... Series	1	46-281468P1	12-452-028	Control Panel Assembly	Y
	2	46-281468P2	12-452-026	Heater, P/S, Heater & 24 VDC PS	Y
	3	46-281468P3	25-611-000	Input/Output Connection Panel	Y
	4	46-281468P4	00-467-498	TCR 7.5T750 Main Coil Power Supply	Y
	5	46-281468P5	58-005-010	Fuse, MDA 4A, 250V	Y
	6	46-281468P6	20-292-002	PWB, Printed Circuit Board Assembly	Y
	7	46-281468P7	20-230-000	PWB, +24 & ±15 Power Supply Assembly	Y
	8	46-281468P8	66-065-006	Analog Voltmeter, 0-36 VDC	Y
	9	46-281468P9	62-062-009	Analog Ammeter, 0-1 ADC	Y
	10	46-281468P10	66-082-007	Digital Volmeter, 3.5 Digits	Y
	11	46-281468P11	66-082-008	Digital Ammeter, 5.5 Digits	Y
	12	46-281468P12	67-055-007	10-Turn Potentiometer, 5K, WW	Y
	13	46-281468P13	68-004-001	Toggle Switch, DPDT	Y
	14	46-281468P14	68-008-003	Toggle Switch, DPDT, Locking	Y
	15	46-281468P15	20-354-000	PWB, Printed Circuit Board P-Set Amplifier	Y
	16	46-281468P16	58-006-010	Fuse, MDV 0.125A, 250V	Y
	17	46-281468P17	58-001-008	Fuse, AGC 2A, 250V	Y
	18	46-281468P18	20-137-087	Printed Circuit Board, A100 Control	Y
	19	46-281468P19	54-072-002	Capacitor, 350 KMF/10V	Y
	20	46-281468P20	61-011-001	SCR, Dual Pack	Y
	21	46-281468P21	56-069-004	Breaker, 3-Pole, 30A	Y
	22	46-281468P22	67-023-005	Resistor, 3 Ohm, 25W	Y
	23	46-281468P23	63-004-001	LED Indicator, Red	Y
	24	46-281468P24	51-009-001	Biscuit Fan	Y
	25	46-281468P25	56-001-002	Breaker, 3-Pole, 30A	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-66: Renewal Parts for Service Power Supplies 46-260776G3, G4, 46-260777G3 (cont'd)

GE to Supplier Part Number Cross Reference					
	Item	GE Part Number	Supplier Part Number[a]	Description	Spare
46-281469P... Series	101	46-281469P1	12-452-027	Control Assembly Panel	Y
	102	46-281469P2	58-005-013	Fuse, MDA 6.25A, 250A	Y
	103	46-281469P3	12-452-025	Switch Heater & Internal Power Supply	Y
	104	46-281469P4	25-612-000	Input/Output Panel	Y
	105	46-281469P5	00-452-084	Shim Power Supply Module, #1 thru #6	Y
	106	46-281469P11	58-005-006	Fuse, MDA 1A, 250V	Y
	107	46-281469P12	60-010-001	Diode, Dual Pak, 600V, 15A	Y
	108	46-281469P13	20-292-001	PWB, A700 Printed Circuit Board Assembly	Y
	109	46-281469P14	65-047-001	Relay, DPDT, 24VDC	Y
	110	46-281469P15	66-082-012	Digital Voltmeter, 4.5 Digits	Y
	111	46-281469P16	66-082-011	Digital Ammeter, 4.75 Digits	Y
	112	46-281469P17	68-037-007	Selector Switch, *8PL, 6STN	Y
	113	46-281469P18	67-055-011	10-Turn Potentiometer, 2000 Ohm	Y
	114	46-281469P19	65-024-007	Relay, 4PDT, 25A	Y
	115	46-281469P20	68-008-001	Thermostat N/O 195° F	Y
	116	46-281469P21	62-005-020	Transistor, 2N5685	Y
	117	46-281469P22	62-005-014	Transistor, MJ2955	Y
	118	46-281469P23	68-002-002	Thermostat, N/C, 210° F	Y
	119	46-281469P24	20-350-001	PWB, A100 Assembly	Y
	120	46-281469P25	67-055-005	10-Turn Potentiometer, 20K, 2W	Y
46-260219P... Series	201	46-260219P2	51-002-002	Fan, 4.68 in. sq., 220V	Y
	202	46-260219P12	51-001-001	Fan, 3.12 in., 115V	Y
	203	46-260219P20	51-002-001	Fan, 4.68 in. sq., 115V	Y
	204	46-260219P27	71-024-000	10-Turn Locking Indicator Dial	Y
	205	46-260219P33	68-012-005	Pushbutton Switch, MOM SPDT without White Lamp	Y
	206	46-260219P113	00-481-1305	Main Coil Power Supply, ESS7.5-1000-2-D-1236	Y
	207	46-260219P114	67-136-001	10-Turn Potentiometer, 100 Ohm WW	Y
	208	46-260219P115	66-062-009	Analog Ammeter, 0.0 - 1.0 ADC	Y
	209	46-260219P116	66-082-014	Digital Voltmeter/Ammeter, 5.5 Digit	Y
	210	46-260219P117	80-001-013	PS1 Meter, P.S. ± 12, +5	Y
	211	46-260219P118	67-136-002	10-Turn Potentiometer, 5K, WW, Oil-Filled	Y

[a] Supplier parts shown in supplier service manual.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.5.3 Power Supply Calibration Kit 2101360

Table 7-67: Power Supply Calibration Kit 2101360 Rev. 4

Item	Part Number	Quantity	Description	Spare
1	2103227	1	Kit Case	N
2	2101358	1	Type B DC Ammeter Shunt	Y
3	46-252322P8	6	.375 Inch Flat Washer	Y
4	46-281046P38	4	.375-16UNC x 1.75 Inch HH Cap Screw, Brass	N
5	46-260942P3	6	.375-16UNC Hex Nut, Brass	N
6	46-294167P14	4	#10 Internal Tooth Lockwasher	N
7	2101361	4	#10 Solder Lug	N
8	46-294167P15	1	X1 Monolithic Probe	N
9	46-281468P26	1	10-Turn, 100 Ohm WW Potentiometer	Y
10	46-281468P12	1	10-Turn, 5K WW Potentiometer	Y
11	46-294167P17	4	.5 x .75 Inch Hex Key Allen Wrench	N

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.6 Cable Kits

4.6.1 750A Ramp Cable Kit 2135435

Illustration 7-27: 750A Ramp Cable Kit 2135435 Components

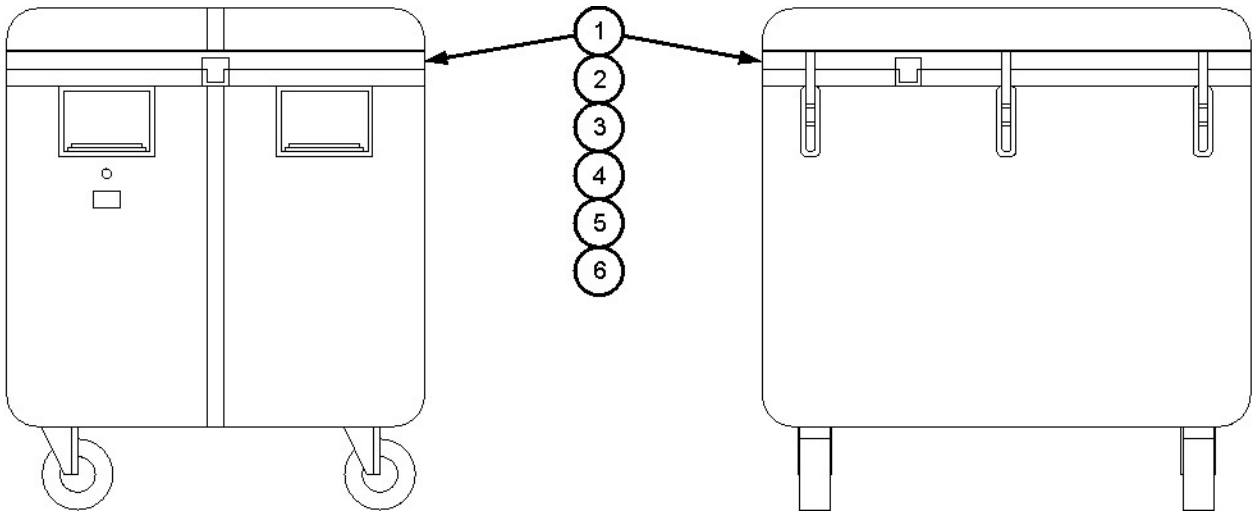


Table 7-68: 750A Ramp Cable Kit 2135435 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2135434	1	Ramp Cable Cart	Y
2	46-260723G1	2	Power Cable, Positive 4/0	Y
3	46-260723G2	2	Power Cable, Negative 4/0	Y
4	46-260724G1	1	Switch Heaters Cable	Y
5	46-281667G1	1	Switch Heaters Cable, RJC & RJD	Y
6	46-281235P1	1	Voltage Sense Lead, 40 feet	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.6.2 1000A Ramp Cable Kit with Ground 2353394

Illustration 7-28: 1000A Ramp Cable Kit with Ground 2353394 Components

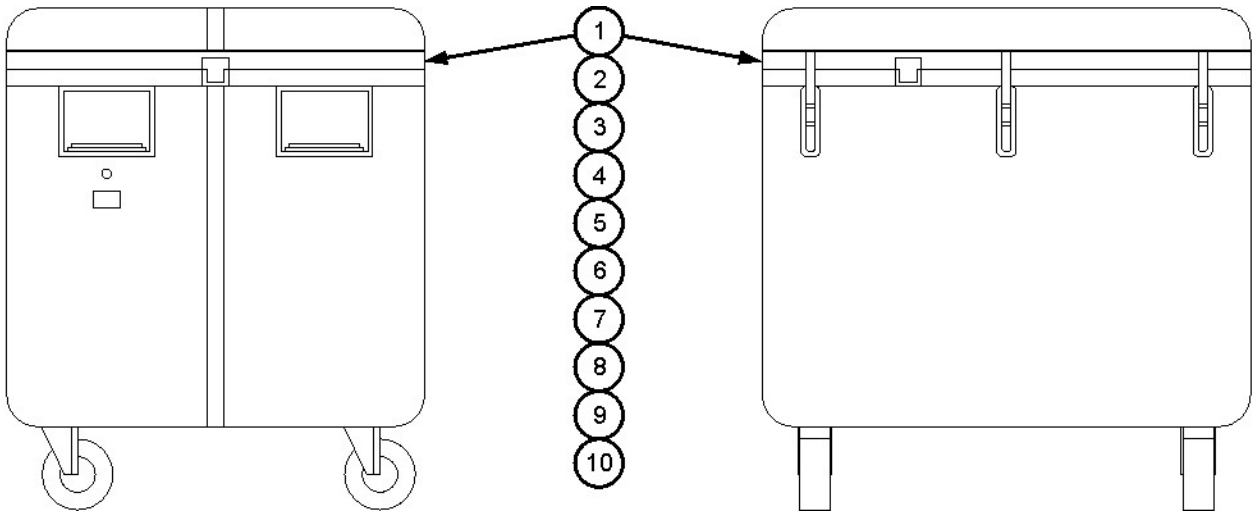


Table 7-69: 1000A Ramp Cable Kit with Ground 2353394[a] Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2135434	1	Ramp Cable Cart	Y
2	46-260723G1	3	Power Cable (601), Positive 4/0	Y
3	46-260723G2	3	Power Cable (602), Negative 4/0	Y
4	46-260724G1	1	Switch Heaters Cable (604)	Y
5	46-281667G1	1	Switch Heaters Cable, RJC & RJD	Y
6	46-281235P1	1	Voltage Sense Lead, 40 feet	Y
7	46-294167P20	1	Black & Yellow Checkered Tape, roll	Y
8	2353392	1	Label, “Ramp Cable Cart Kit 2353394"	Y
9[b]	2351842	1	Power Supply Grounding Cable	Y
10[b]	2351843	1	Power Supply Jumper Cable	Y

[a] Consists of 1000 Amp Ramp Cable Kit 2180589 plus HFO Pre-Ramp Grounding Cable Kit 2351844.

[b] Components of HFO Pre-Ramp Grounding Cable Kit 2351844.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.6.3 2135435 to 2353394 Upgrade Kit 2353397

Table 7-70: Components of Ramp Cart/Cable Kit Upgrade Kit 2353397 Rev. 0, 750 Amp (2135435) to 1,000 Amp w/ Ground (2353394)

Item	Part Number	Quantity	Description	Spare
1	46-260723G1	1	Power Cable Assembly, Positive 4/0	Y
2	46-260723G2	1	Power Cable Assembly, Negative 4/0	Y
3	46-294167P20	1	Black & Yellow Checkered Tape, roll	Y
4	2353392	1	Label, “Ramp Cable Cart Kit 2353394"	Y
5	2351842	1	Power Supply Grounding Cable	Y
6	2351843	1	Power Supply Jumper Cable	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.6.4 Shim Cable Kit 2135558

Illustration 7-29: Shim Cable Kit 2135558 Components

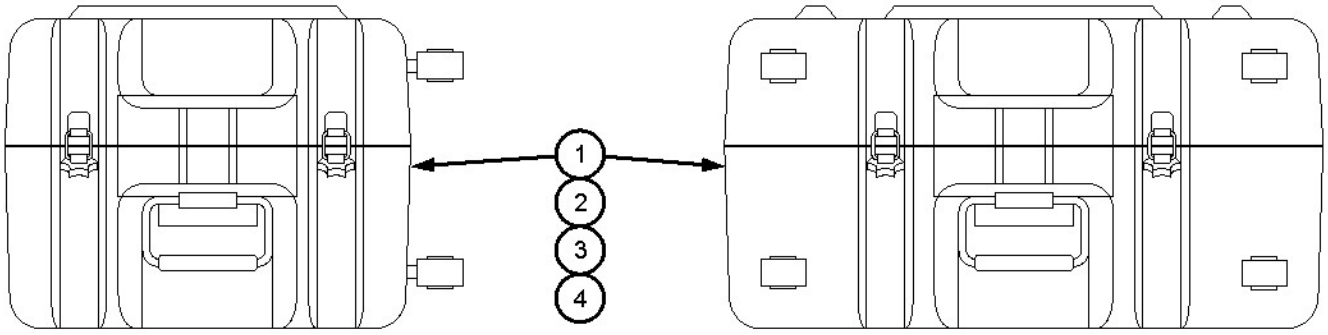


Table 7-71: Shim Cable Kit 2135558 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2135557	1	Shim Cable Case	Y
2	46-260726G1	1	Shim Coil Cable Assembly	Y
3	46-260724G1	1	Switch Heaters Cable	Y
4	2135362	1	Shim Lead Adapter Cable, Signa V	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.6.5 Auxiliary Rampdown Cable 2217315

Table 7-72: Auxiliary Rampdown Cable 2217315 Rev. 0

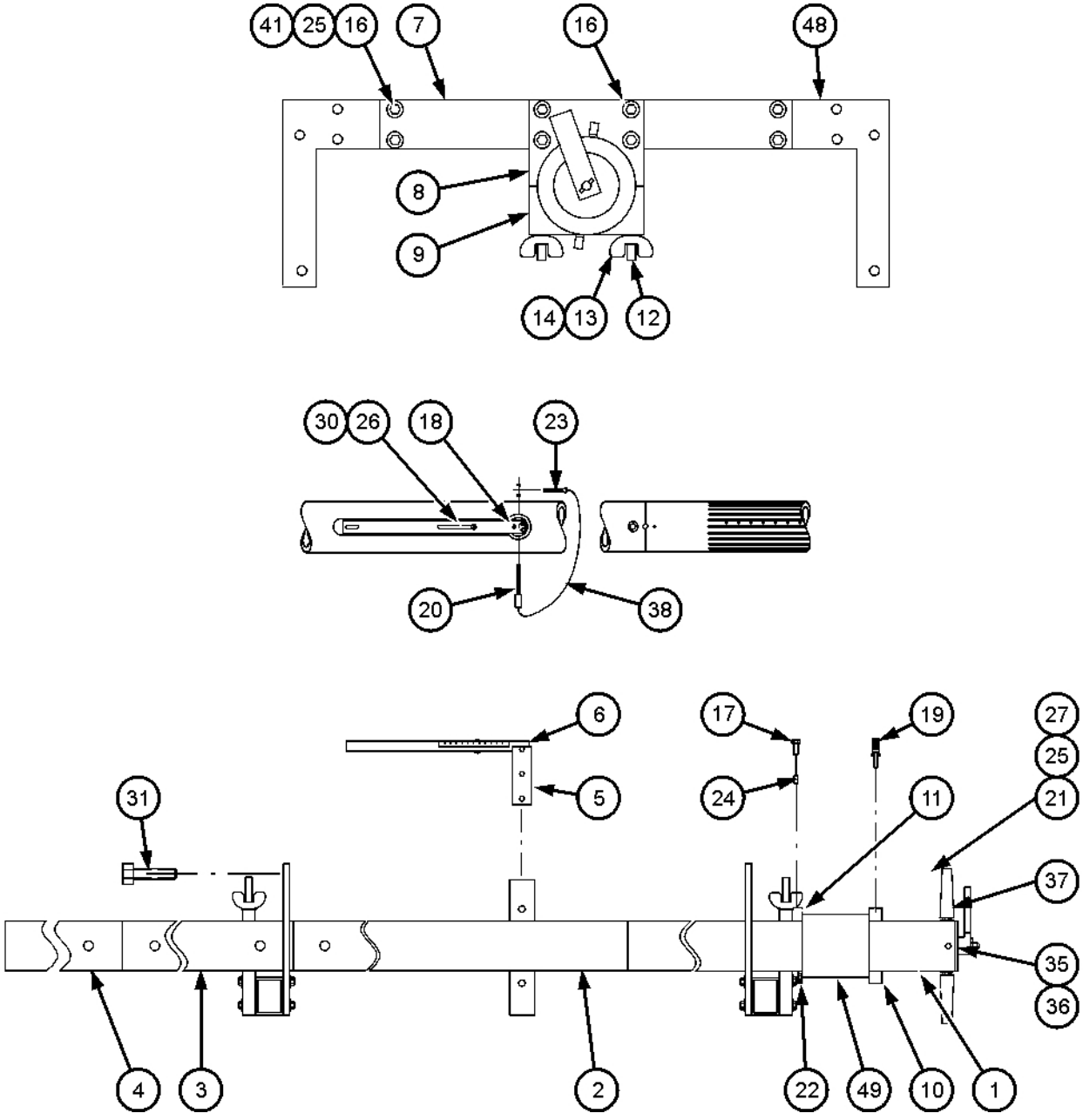
Item	Part Number	Quantity	Description	Spare
1	2217315	1	Auxiliary Rampdown Cable	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.7 Field Measurement and Mapping Tools

4.7.1 Field Mapping Fixture 46-294060G4

Illustration 7-30: Field Mapping Fixture 46-294060G4 Components



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-73: Field Mapping Fixture 46-294060G4 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2142701	1	Front Support Tube	N
2	46-294055G1	1	Magnetometer Support	N
3	46-294062G1	1	Rear Support Tube	N
4	46-294063G1	1	Rear Tube Extension	N
5	2142703	1	Radial Slider	N
6	46-281418P1	1	Magnetometer Support	Y
7	46-294553G2	2	Horizontal Support Frame	N
8	46-281408P1	2	Bearing, Top Half	Y
9	46-281437P1	2	Bearing, Bottom Half	Y
10	2142702	1	Axial Positioning Ring	N
11	46-281330P1	1	Plunger Ring	Y
12	46-252188P7	4	Threaded Rod, Brass	N
13	46-281435P7	5	Wing Nut, .50-13	Y
14	46-252322P10	5	Washer, Brass	Y
15	46-281046P71	10	Cap Screw, 3/8-16 x 3.50 in.	Y
16	46-252320P19	12	Nut, 3/8-16, Brass	Y
17	46-281046P31	1	Screw, 3/8-16 x .74 in., Brass	Y
18	46-252338P9	3	Flat Head Screw, 6-32 x .812 in.	Y
19	46-294058G1	2	Pin	Y
20	46-281334P2	1	Radial Positioning Pin	Y
21	46-294167P1	2	Tube Handle	Y
22	46-281046P36	6	Cap Screw, 3/8-16	Y
23	46-260422P3	1	Cotter Pin, .078 in. dia.	Y
24	46-252065P57	1	Ball Plunger, Stainless Steel	Y
25	46-252322P8	32	Washer	Y
26	46-252320P13	1	Hex Nut, #10-24, Brass	Y
27	46-252188P6	2	Threaded Rod, 3/8-16 x 2.00 in.	Y
28	46-281464P1	1	Centerline Label	Y
29	46-281465P1	1	Scale Label	Y
30	46-252352P24	1	Screw, 10-24 x 2.00 in.	Y
31	46-281046P37	10	Hex Head Screw, 3/8-16 x 1.50 in., Brass	Y
32	46-294019P1	2	Torquing Bar, .63 in. dia. x 24 in.	Y
33	46-252065P65	1	Noalox, 8 Oz. Bottle	Y
34	46-294059P1	5	Nylon Rings, .010 in. thick	Y
35	46-294057P1	1	Threaded Rod, .75 in., Brass	N
36	46-252322P12	1	Washer, .75 in., Brass	N
37	46-294072P1	1	Barnut .75-10	N
38	46-294167P2	1	Stretch Cord, .042 in. dia.	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-73: Field Mapping Fixture 46-294060G4 Rev. 0 (cont'd)

Item	Part Number	Quantity	Description	Spare
39	46-294048G1	1	Crate	N
40	46-294059P2	8	Nylon Spacer Shim	Y
41*	46-281046P68	4	Screw, 3/8 x 3.00 in., Brass	Y
42	46-252320P19	2	Nut, 3/8-16, Brass	Y
43*	46-252322P8	2	Washer	Y
44	46-294151P2	AR	Loctite #242	Y
45	46-294137G1	1	Radial Slider	Y
46	46-294056P1	1	Axial Positioning Ring	N
47	2144081	1	45CM Mapping Fixture Block Set	N
48*	2158587	4	Mounting Plate	Y
49*	2154411	1	Spacer Tube	Y
50*	2143827-2	1	Crate Label, G4 version kit	N
51*	46-318508P19	8	Hex Head Cap Screw, M10 x 20 mm	Y
52	46-294168P1	1	Assembly Instructions	N

* Items may be ordered as Mapping Fixture Upgrade Kit 2163971 (Section 4.7.2) for Mapping Fixture 46-294060G3.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.7.2 Mapping Fixture Upgrade Kit 2163971

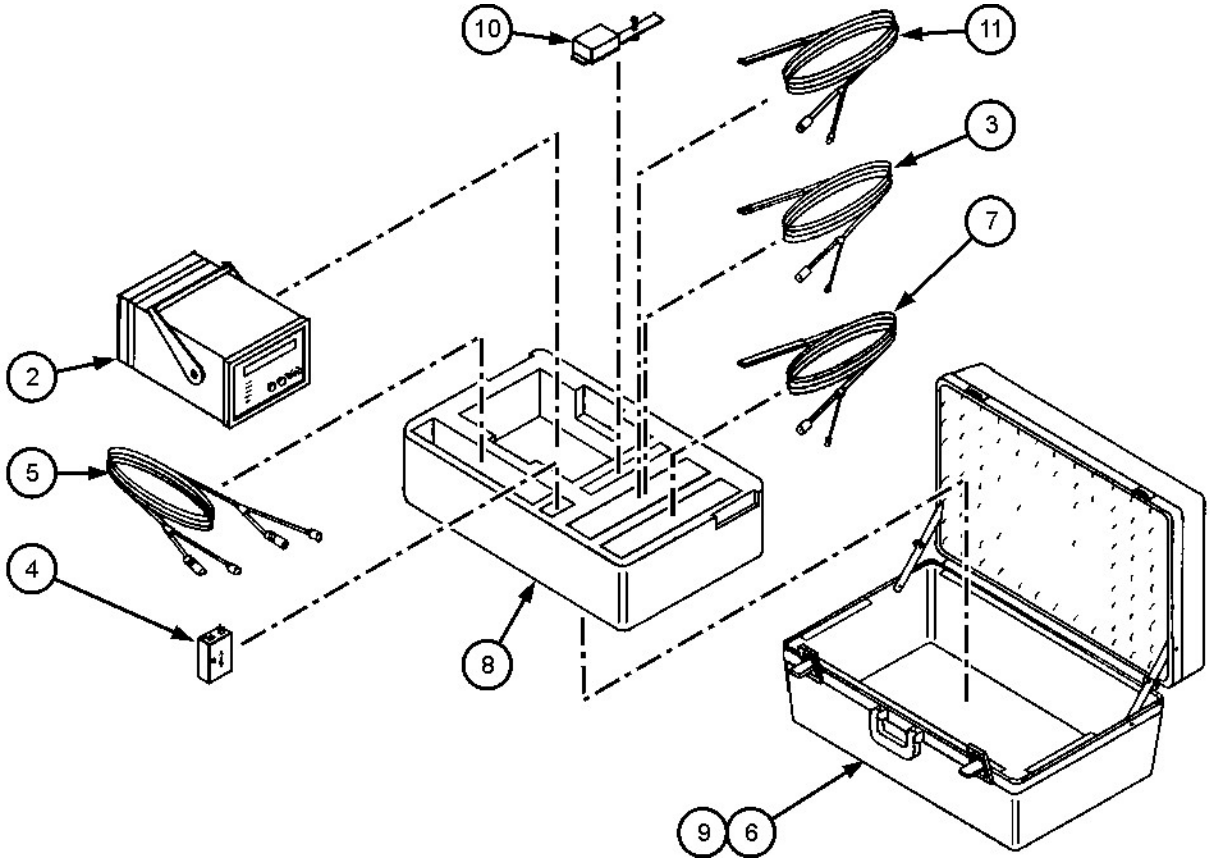
Table 7-74: Mapping Fixture Upgrade Kit 2163971 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2158587	4	Mounting Plate	Y
2	2154411	1	Spacer Tube	Y
3	2143827-2	1	Crate Label, G4 version kit	N
4	46-318508P19	8	Hex Head Cap Screw, M10 x 20 mm	Y
5	46-281046P68	4	Hex Head Screw, 3/8 x 3.00 in., Brass	Y
6	46-252322P8	2	Washer	Y
7	2193026	1	Mapping Fixture Upgrade Instructions	

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.7.3 Metrolab Teslameter Kit 46-251865G4

Illustration 7-31: Metrolab Teslameter Kit 46-251865G4 Components



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-75: Metrolab Teslameter Kit 46-251865G4 Rev. 1

Item	Part Number	Quantity	Description	Spare
2	46-255839P2	1	Teslameter, MetroLab 2025	Y
3	46-255839P104	1	#5 Probe, without amplifier	Y
4[a]	—	—	Battery	—
5	46-255939P121	1	Cable, Teslameter to Preamp	Y
6[b]	46-255839P200	1	Carrying Case	N
7	46-255839P103	1	#4 Probe, without amplifier	Y
8[b]	46-306832P1	1	Foam Insert	N
9[b]	46-306813P3	1	Kit Identification Label	N
10	46-306836G1	1	Probe Holder	Y
11	46-255839P102	1	#3 Probe, without amplifier	Y
12	2378859	1	Tool Data Sheet	N

[a] Not included in kit.

[b] Can be ordered assembled as 46-251865G50.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.8 Region Shim Kit 2181921

Table 7-76: Region Shim Kit 2181921 Rev. 0

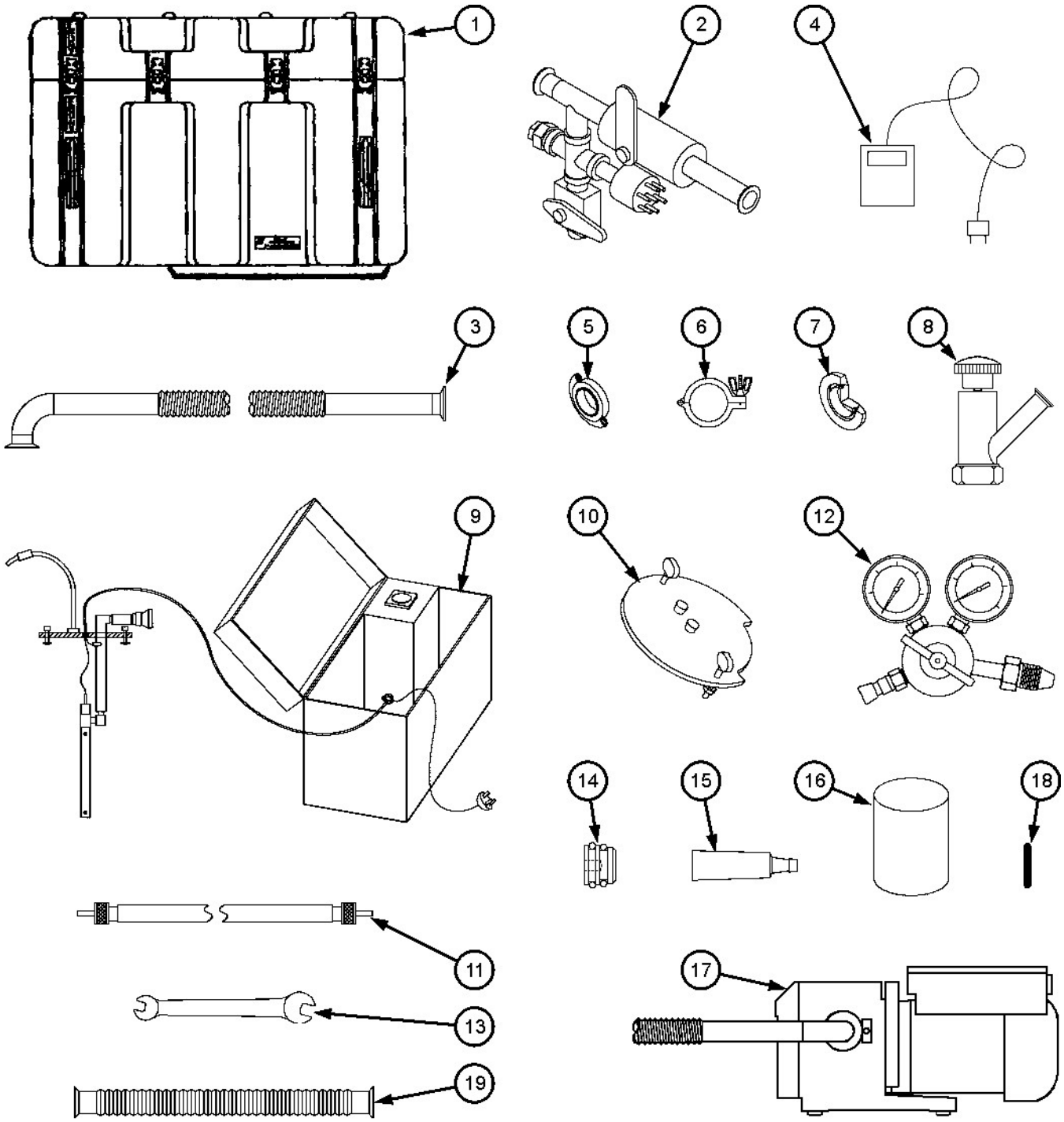
Item	Part Number	Quantity	Description	Spare
1	46-318830P1	1	Case	Y
2	46-294126P201	75	Shim, .200 in. x .001 in., Carbon Steel	Y
3	46-294126P401	75	Shim, .400 in. x .001 in., Carbon Steel	Y
4	46-294126P901	75	Shim, 1.00 in. x .001 in., Carbon Steel	Y
5	46-294126P903	75	Shim, 1.00 in. x .003 in., Carbon Steel	Y
6	46-294126P910	50	Shim, 1.00 in. x .010 in., Carbon Steel	Y
7	46-294128P2	25	Shim Cover, 1.00 in. x .062 in., Aluminum	Y
8	46-294125P3	100	Broaching Fastener, #6-32UNC x .44 in.	Y
9	46-252320P9	100	Nut, #6-32UNC, Brass	Y
10	2163409	200	Spacer, Nylon	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.9 Coldhead Service Tools

4.9.1 Coldhead Replacement Tool Kit 2300306-2

Illustration 7-32: Universal Coldhead Replacement Tool Kit 2300306-2 Components



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

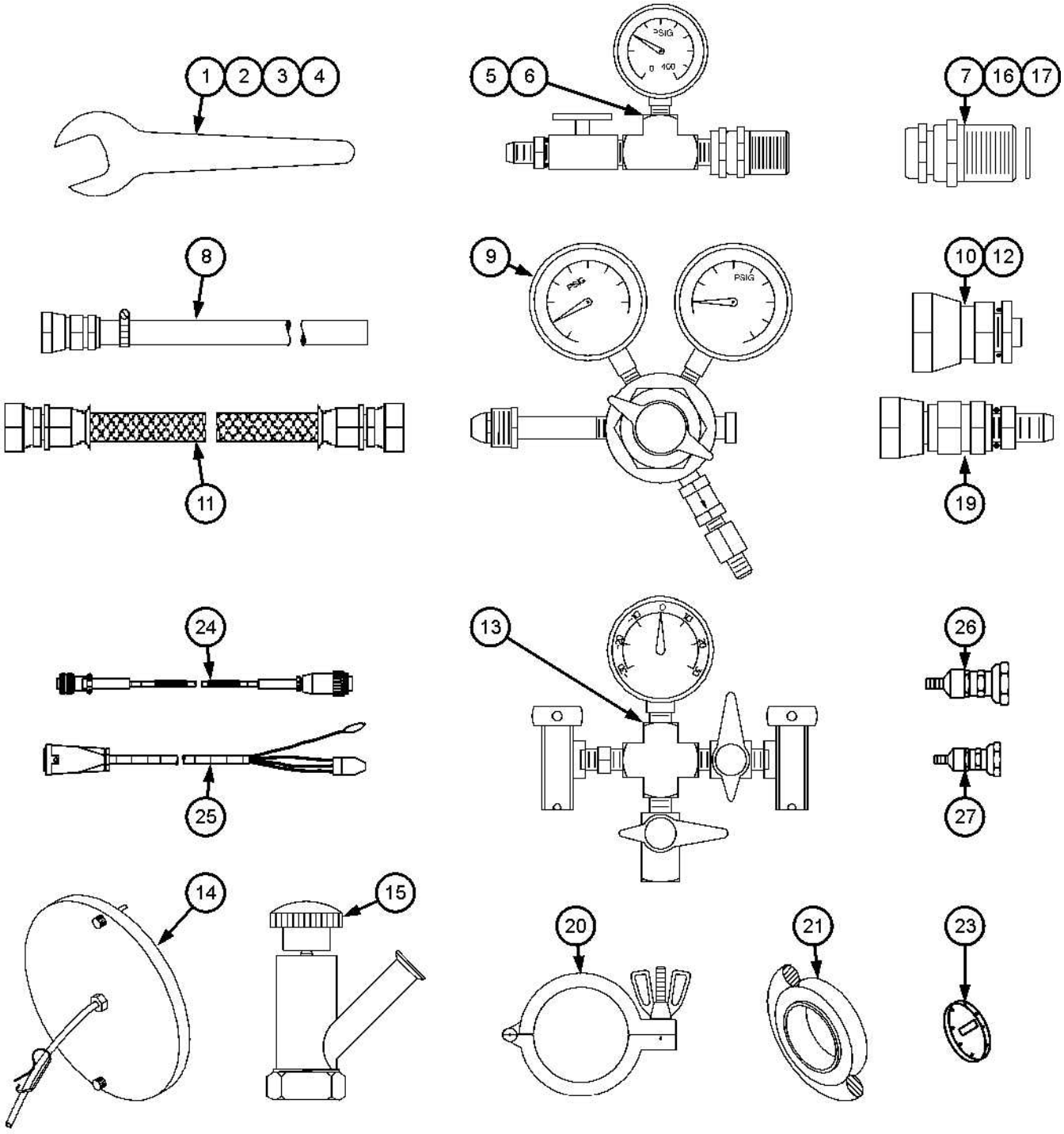
Table 7-77: Universal Coldhead Replacement Tool Kit 2300306-2 Rev. 2

Item	Part Number	Quantity	Description	Spare
1	2306020-2	1	Case with Label	Y
2	2287707	1	Coldhead Service Adapter	Y
3	2267197	1	Coldhead Sleeve Pump-Out Line	Y
4	2287716	1	Digital Vacuum Instrument	Y
5	46-294030G1	7	KF16 Centering Ring	Y
6	46-294026P1	7	KF16 Clamp	Y
7	46-294028P1	2	Blanking flange	Y
8	46-260267P3	1	Sleeve Seal-Off Operator	Y
9	2303715	1	Plexiglas Cover Plate & Heater Assembly	Y
10	2303728	1	Lexan Cover Plate	Y
11	2303724	1	Nitrogen Gas Line	Y
12	2303731	1	Regulator / Flowmeter with quick connect	Y
13	46-320472P5	1	Open End Wrench, 8 mm x 10 mm	Y
14	2236606	1	Double O-Ring Plug	Y
15	46-252065P24	1	Vacuum Grease	Y
16	46-294041P5	1	DuoSeal SWSII Oil, quart	Y
17	2305056PSP	1	Vacuum Pump Specification	N
18	46-260342P2	2	O-Ring, .612 in. I.D. x .818 in. O.D.	Y
19	2321289	1	KF16 Flexline Coupling, 15 in.	Y
20	2365037	1	Indium Removal Tool, with case	Y
21	5111335	1	Backfill Air Hose, 25 feet (7620 mm)	Y
22	5111361	1	Helium Vent Line, 5 feet (1524 mm)	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.9.2 Coldhead, Compressor Service Kit 46-281088G3

Illustration 7-33: Coldhead & Compressor Installation & Maintenance Kit 46-281088G3 Components



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-78: Coldhead & Compressor Installation & Maintenance Kit 46-281088G3 Rev. 6

Item	Part Number	Quantity	Description	Spare
1	46-294150P13	1	1 in. Open End Wrench, Leybold #722-81-018	Y
2	46-294150P14	2	1 3/16 in. Open End Wrench, Leybold #722-81-019	Y
3	46-294150P15	1	1 3/8 in. Open End Wrench, Leybold #722-81-020	Y
4	46-294150P16	2	1 5/8 in. Open End Wrench, Leybold #722-81-021	Y
5	46-317904P1	2	#8 (1/2 in.) Male Aeroquip Purge Tool with 0 - 400 psig Gauge	Y
6	46-317904P2	2	#12 (3/4 in.) Male Aeroquip Purge Tool with 0 - 400 psig Gauge	Y
7	46-294937P1	1	#4 Male Aeroquip Coupling with Tube Adapter	Y
8	46-294003P1	1	Oil Charging Hose w/ #4 Fitting	Y
9	46-294009P1	1	Helium High Pressure Regulator	Y
10	46-294936P1	1	#8 Female Aeroquip Coupling with Tube Adapter	Y
11	46-294002P1	1	Line Adapter Hose	Y
12	46-294006G1	1	#12 Aeroquip Discharge Tool Assembly	Y
13	46-294007G1	1	Coldhead Change (Pump-Out Port) Adapter	Y
14	46-294010G1	1	Plexiglass Cover Plate	Y
15	46-260267P3	1	Sleeve Seal-Off Operator	Y
16	46-294000G1	1	#12 Aeroquip Male Fitting	Y
17	46-281999G1	1	#8 Aeroquip Male Fitting	Y
18	46-252065P63	1	Welder's Brush	Y
19	46-294005G1	1	#4 Aeroquip Fitting	Y
20	46-294026P1	1	KF16 Clamp	Y
21	46-294030G1	1	KF16 Centering Ring	Y
22	46-294939G50	1	Carrying Case for Tools	Y
23	46-281989G1	1	Coldhead Port Cover	Y
24	46-318911P1	1	Balzer Compressor to Coldhead Power Cable	Y
25	46-318910P1	1	Leybold Compressor to Coldhead Power Cable	Y
26	2100316	1	Aeroquip to Helium Line Adapter Fitting, Large	Y
27	2100317	1	Aeroquip to Helium Line Adapter Fitting, Small	Y
29	2102181	1	Shield Cooler Tool Kit Upgrade Label	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.9.3 Fixed Site Coldhead Changeout Kit 2232674

Illustration 7-34: Fixed Site Coldhead Insertion and Purge Cover Tool Kit 2232674 Components

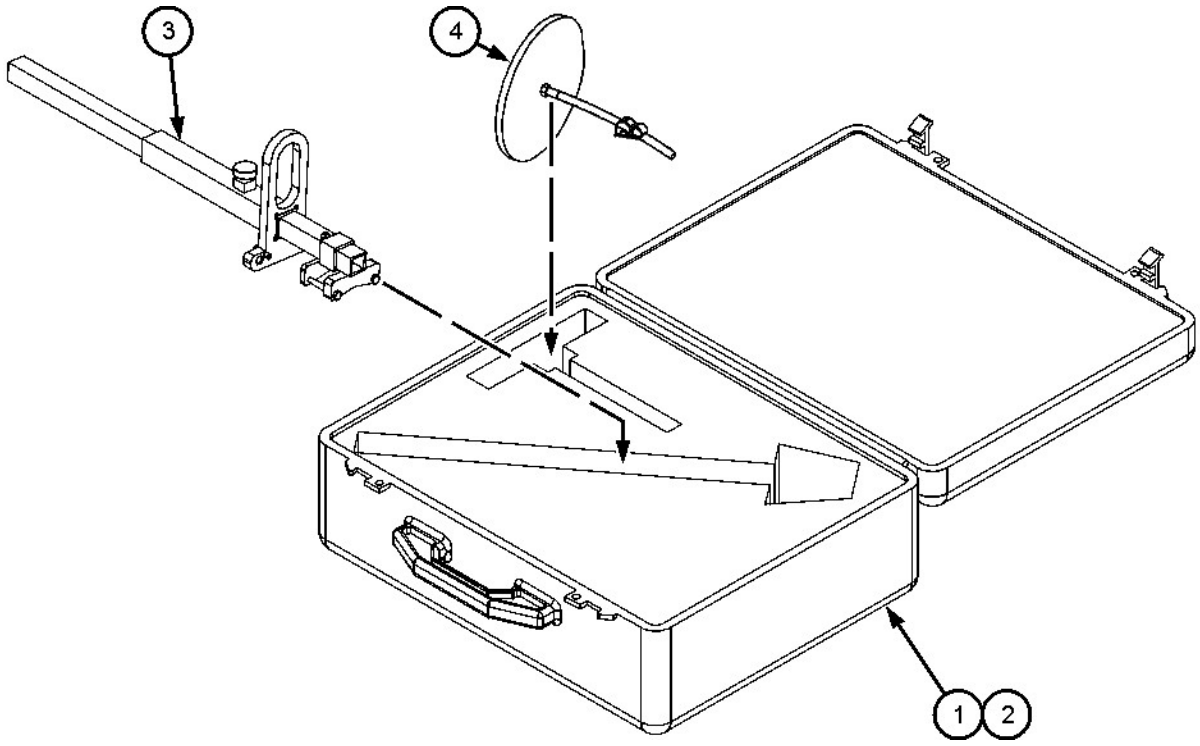


Table 7-79: Fixed Site Coldhead Insertion and Purge Cover Tool Kit 2232674 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2232677	1	Tool Kit Case	N
2	2232673	1	Tool Kit Label	N
3	2228876	1	Fixed Site Coldhead Insertion Tool	Y
4	2232560	1	Lexan Purge Cover Plate Assembly	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.9.4 Mobile Site Coldhead Changeout Kit 2275779

Illustration 7-35: Mobile Site Coldhead Insertion and Purge Cover Tool Kit 2275779 Components

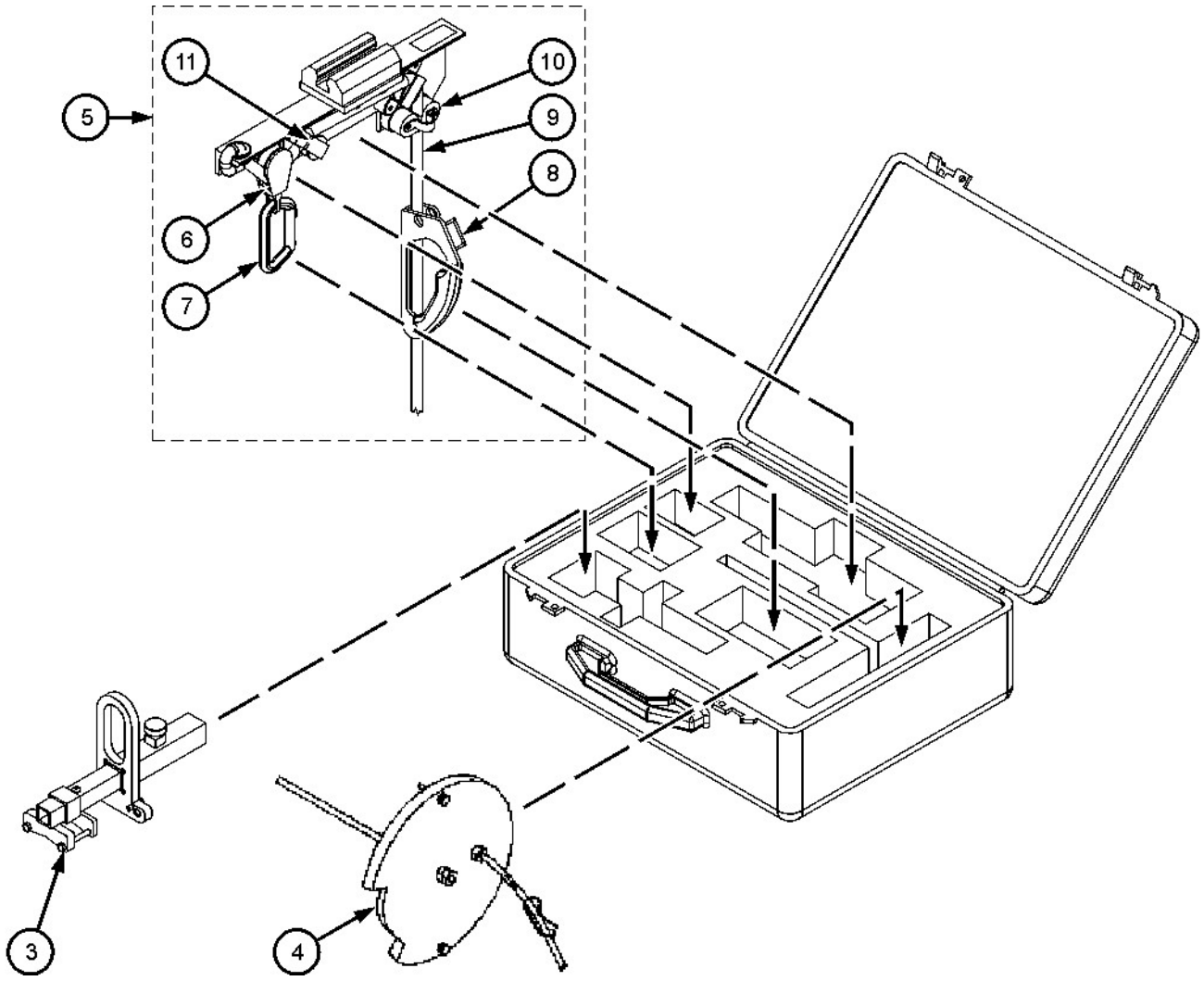


Table 7-80: Mobile Site Coldhead Insertion and Purge Cover Tool Kit 2275779 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2275777	1	Tool Kit Case	Y
2	2275778	1	Tool Kit Label	N
3	2275599	1	Mobile Site Coldhead Insertion Tool	Y
4	2275776	1	Lexan Purge Cover Plate Assembly	Y
5	2258802	1	Mobile Site Coldhead Lifting Tool	Y
6*	2279647		Harken Pulley	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-80: Mobile Site Coldhead Insertion and Purge Cover Tool Kit 2275779 Rev. 0 (cont'd)

Item	Part Number	Quantity	Description	Spare
7*	2279646		Carabiner Rope Clip	Y
8*	2279643		REI Rope Ascender	Y
9*	2270738		Nylon rope, .50 in. dia. x 25 feet	Y
10*	2275600		Cam-matic	N
11*	2279642		Bullet Block	N
* Components of Mobile Site Coldhead Lifting Tool (2258802).				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.9.5 Other Coldhead, Compressor Service Items

Table 7-81: Other Equipment Needed to Service Coldhead and Compressor

Item	Part Number	Quantity	Description	Spare
1	46-306734G1	1	Helium Tank Regulator and Hose Kit	Y
1A*	46-258151P1	1	Nonmagnetic Gas Cylinder Regulator	Y
1B*	46-271135P16	1	20 Foot (7 M) Hose Assembly, Dewar to Gas Cylinder	Y
2	46-294047G1	1	Shield Cooler Vacuum Pump Kit	Y
* Included in 46-306734G1.				

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.10 Vacuum Tools and Equipment

4.10.1 Shield Cooler Vacuum Pump Kit 46-294047G1

Illustration 7-36: Shield Cooler Vacuum Pump Kit 46-294047G1 Components

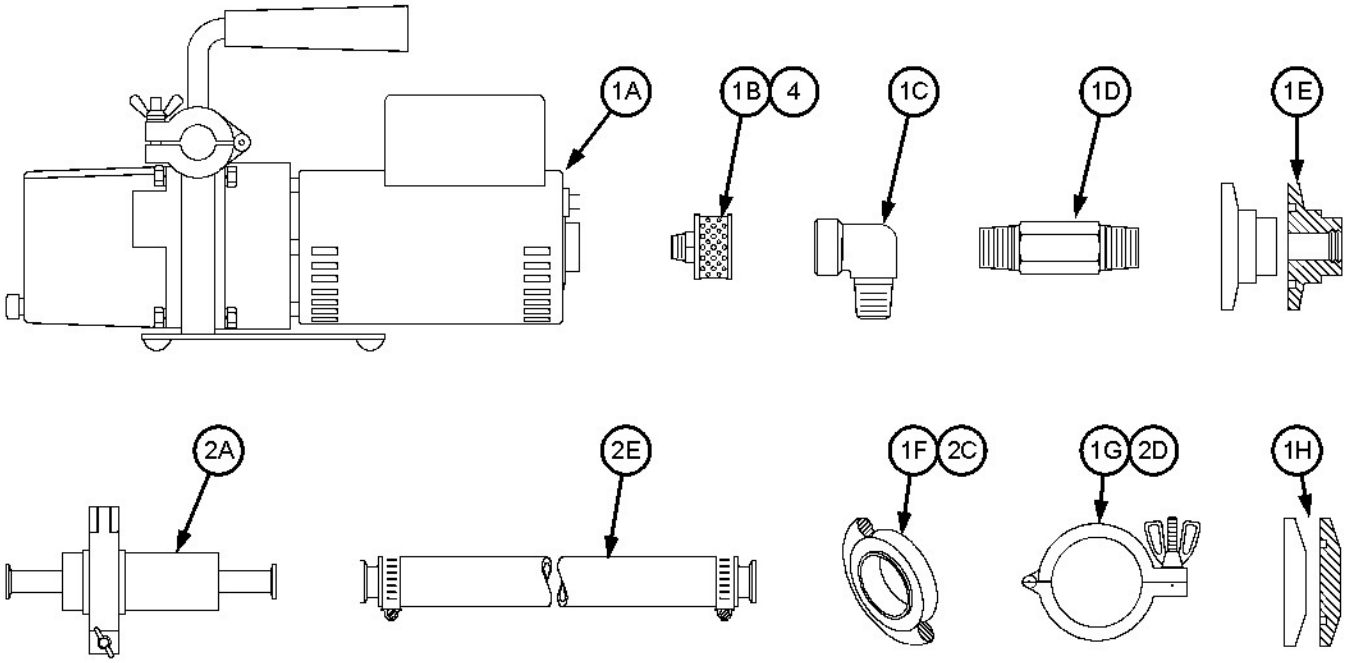


Table 7-82: Shield Cooler Vacuum Pump Kit 46-294047G1 Rev. AE

Item	Part Number	Quantity	Description	Spare
1	46-294833G1	1	Shield Pump Kit	N
1A[a]	46-294041P1	1	Sargent-Welch Vacuum Pump	Y
1B[a]	46-294041P2	2	Exhaust Filter	Y
1C[a]	46-252557P2	1	905 Plumbing Elbow	Y
1D[a]	46-294029P1	1	2 in. Nipple	Y
1E[a]	46-294027P1	1	Adapter, KF16 to .25 in. NPT	Y
1F[a]	46-294030G1	1	KF16 Centering Ring with O-Ring	Y
1G[a]	46-294026P1	1	KF16 Hose Clamp	Y
1H[a]	46-294028P1	1	KF16 Blanking Flange	Y
2	46-294834G1	1	Hose & Filter Assemble	N
2A[b]	46-294041P3	1	Inlet Foreline Oil Trap	Y
2B[b]	46-294041P4	1	Replacement Filter Cartridge for Oil Trap	Y
2C[b]	46-294030G1	1	KF16 Centering Ring with O-Ring	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-82: Shield Cooler Vacuum Pump Kit 46-294047G1 Rev. AE (cont'd)

Item	Part Number	Quantity	Description	Spare
2D[b]	46-294026P1	2	KF16 Hose Clamp	Y
2E[b]	46-294040G1	1	Vacuum Pump-Out Port Hose Assembly	Y
3	46-294041P5	1	Vacuum Pump Oil, one quart	Y
4	46-294041P2	2	Exhaust Filter	Y
5	46-294837G50	1	Vacuum Pump Case Assembly	Y

[a] Included in 46-294047G1 via 46-294833G1.

[b] Included in 46-294047G1 via 46-294834G1.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.10.2 Vacuum Maintenance Equipment

Table 7-83: Vacuum Maintenance Equipment

Item	Part Number	Quantity	Description	Spare
1	46-252210P1	1	3 in. Port Valve Operator	2
2	46-265273G1	1	Helium Level Meter	2
3	46-265387G1	1	Helium Gauge Assembly	2
4	46-251867G1	1	Magnet Vacuum Pumpdown Kit	2
5	46-260201P1	1	N2 Precool Syphon	2
6	46-260267P3	1	1 in. Instrument Port Seal-Off Operator	2

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.11 Connector Tools

4.11.1 Sav-Con, Inst. Lead Tool Kit 46-294872G3

Illustration 7-37: Sav-Con & Instrumentation Lead Installation & Removal Kit 46-294872G3 Components

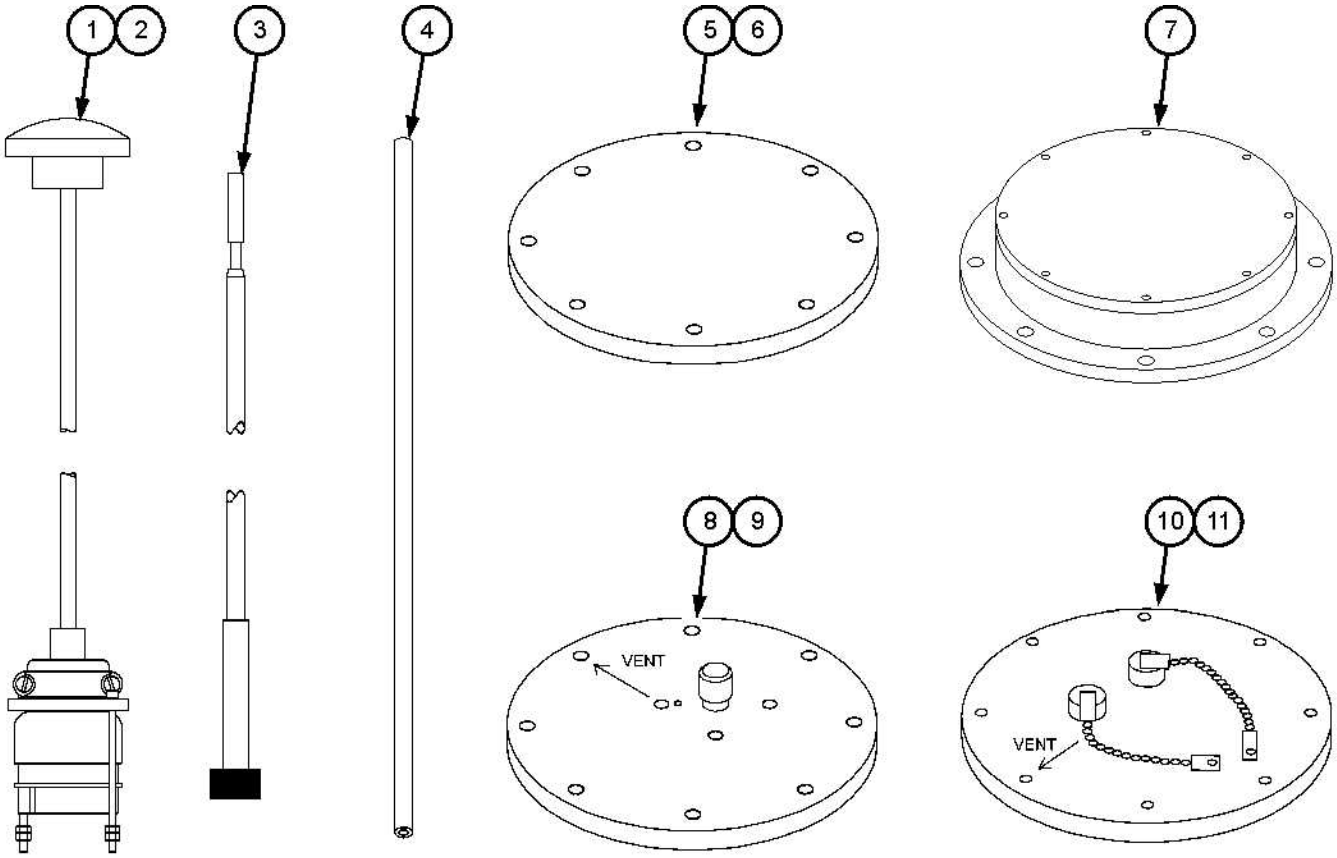


Table 7-84: Sav-Con & Instrumentation Lead Installation & Removal Kit 46-294872G3 Rev. 2

Item	Part Number	Quantity	Description	Spare
1	46-294310G1	1	Sav-Con Installation/Removal Tool, SIV	—
2	46-294310G2	1	Sav-Con Installation/Removal Tool, SII, MAX	Y
3	46-294292G1	1	Extended Sav-Con Allen Head Screw Removal Tool	Y
4	46-281934P1	1	Instrumentation Lead Removal Tool	Y
5	46-318561P1	1	Lexan Vertical Penetration Blanking Plate, SIV	Y
6	46-260963P2	1	Lexan Blanking Plate, SII, MAX	Y
7	2119965	1	Bellows Cover Assembly	Y
8	46-294306G1	1	Lexan Cover Plate/Tool Guide, SIV	Y
9	46-318241G1	1	Lexan Cover Plate/Tool Guide, SII, MAX	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-84: Sav-Con & Instrumentation Lead Installation & Removal Kit 46-294872G3 Rev. 2 (cont'd)

Item	Part Number	Quantity	Description	Spare
10	46-294765G1	1	Lexan Vertical Penetration Cover, SIV	Y
11	2117683	1	Penetration Cover Assembly	Y
12	46-318612G51	1	Case and Foam Assembly	N

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.11.2 Latching LEMO Tool Kit 5158913

Illustration 7-38: Latching LEMO Tool Kit 5158913 Component

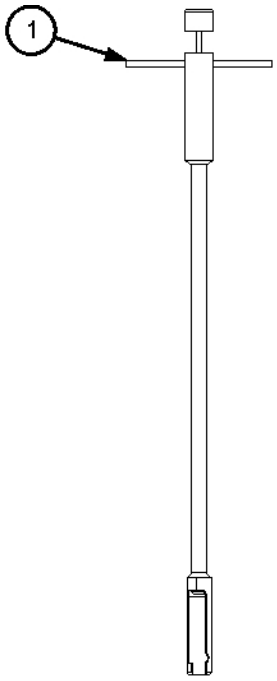


Table 7-85: Latching LEMO Tool Kit 5158913 Rev. 1

Item	Part Number	Quantity	Description	Spare
1	5145459	1	Latching Instrumentation Lead LEMO Connector Removal Tool	N
2	46-328349P1	4	Plastic Arrow Clip, .248 (6.3 mm) Body x .54 (13.7 mm) Length	N
3	5103265-5	1	Black Plastic Case	N
4	5158912	1	Latching LEMO Tool Lit Label	N
5	5158913-2	1	Latching LEMO Tool Instructions	N

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.12 Gradient Insertion Tool Kit 2164744-5

Table 7-86: 3T TRM Gradient Insertion Tool & Lift Kit 2164744-5 Rev. 0

Item	Part Number	Quantity	Description	Spare
1	2284928	1	Insertion Tool Support Plate	Y
2	2284929	1	Insertion Tool Male Tube Assembly	Y
3	2284930	1	Insertion Tool Female Tube Assembly	Y
4	2164707	2	BRM Insertion Tool Tube Guide Roller Assembly	Y
5	2290367	1	Insertion Tool Tube Jacking Assembly	Y
6	46-318508P20	4	Hex Head Cap Screw, M10 x 25 mm, stainless steel	Y
7	46-318508P59	10	Hex Head Cap Screw, M10 x 80 mm, stainless steel	Y
8	2121111	2	Body Coil Wheel Housing Assembly	Y
9	2180498	16	Stud, M10 x 120 mm, stainless steel	Y
10	2109875-4	24	Hex Nut, M10, stainless steel	Y
11	2109878-4	24	Flat Washer, 10.5 mm nominal, 20 mm, stainless steel	Y
12	46-318508P25	10	Hex Head Cap Screw, M10 x 50 mm, stainless steel	Y
13	2188986	1	Rope And Snap Assembly	Y
14	46-328430P8	8	Plain Washer, 13 mm I.D., 24 mm O.D., stainless steel	Y
15	46-252065P118	2	Cotter Hairpin, 125 in. dia. stainless steel wire	Y
16	2116325-2	6	Stud, M10 x 65 mm, stainless steel	Y
17	2187590	2	CRM Insertion Tool Mounting Bracket	Y
18	2385374	1	3T TRM Insertion Tool Patient End Roller Assembly	Y
19	2385374-2	1	3T TRM Insertion Tool Service End Roller Assembly	Y
20	2224994	8	Wing Nut, .375-16, steel	Y
21	2224996	2	Spacer, .375 in. x .75 in. x 3 in., steel	Y
22	2109866-24	10	Hex Head Cap Screw, M10 x 50 mm	Y
23	2172196	1	BRM Insertion Tool Crate	N
24	2280510	1	Identification Label, BRM Insertion Tool	N
25	2326753	1	Gradient Coil Lift Kit	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.13 Service Ladder-Platform 2230707, 2230707-2

Illustration 7-39: Fixed Site Service Ladder-Platform 2230707 & Mobile Site Service Ladder-Platform 2230707-2 Components

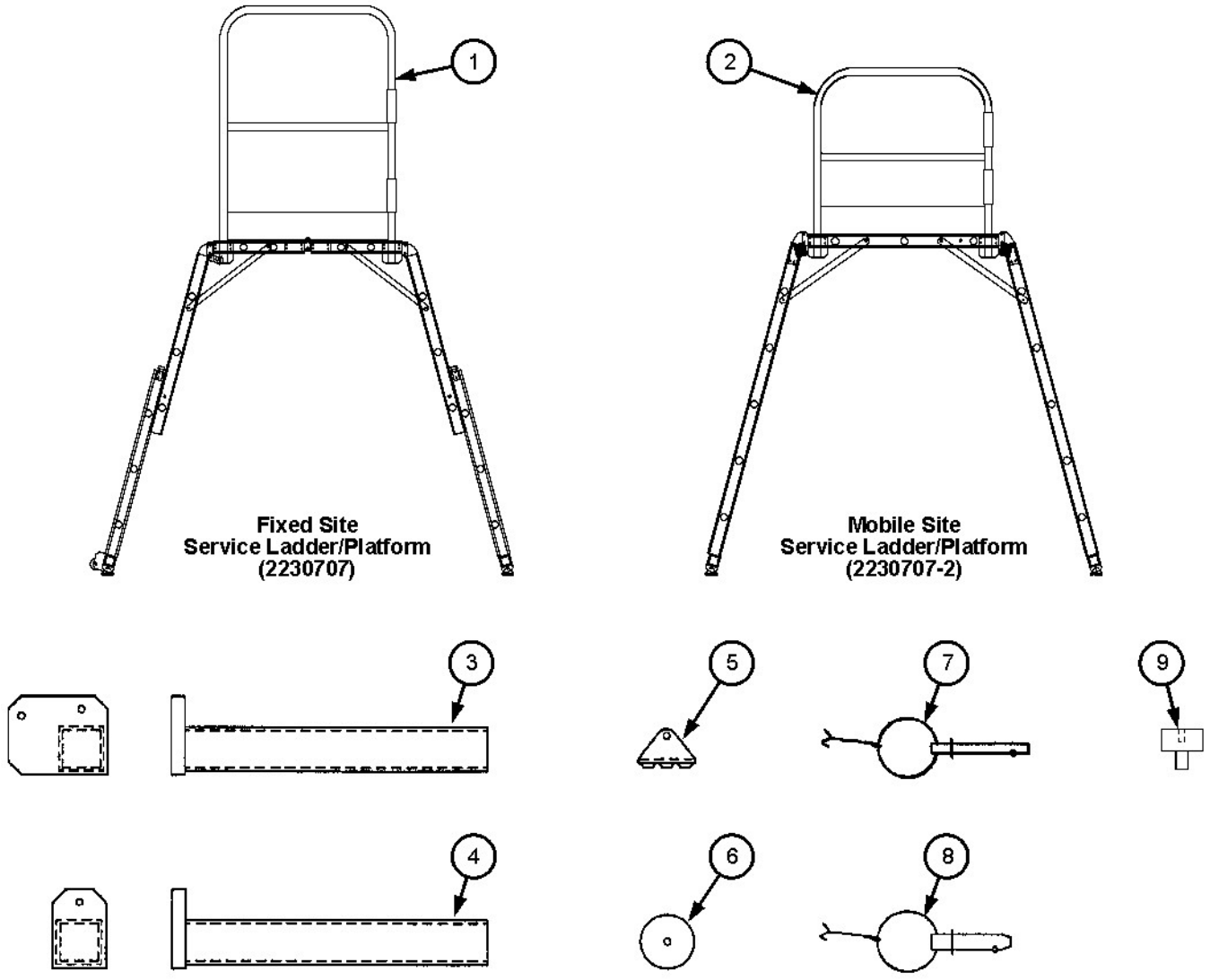


Table 7-87: Fixed Site Service Ladder-Platform 2230707 Rev. 1; Mobile Site Service Ladder-Platform 2230707-2 Rev. 0

Item	Supplier Part Number[a]	GE Part Number	Description	Spare
1	GEM-F-HR	2248188	Fixed Unit Handrail	2
2	GEM-M-HR	2248188-2	Mobile Unit Handrail	2
3	GEM-F-TLW	2248188-3	Telescoping Leg with Wheel/Foot Mounting Plate	2

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-87: Fixed Site Service Ladder-Platform 2230707 Rev. 1; Mobile Site Service Ladder-Platform 2230707-2 Rev. 0 (cont'd)

Item	Supplier Part Number[a]	GE Part Number	Description	Spare
4	GEM-TL	2248188-4	Telescoping Leg with Foot Mounting Plate	2
5	GEM-SF	2248188-5	Swivel Foot with Spacers	2
6	GEM-W	2248188-6	Wheel	2
7	GEM-P4	2248188-7	Locking Pin with Lanyard, .25 in.	2
8	GEM-P8	2248188-8	Locking Pin with Lanyard, .375 in.	2
9	GEM-TSO	2248188-9	Thumbscrew, .25 in. dia.	2

[a] Supplier parts shown in supplier service manual.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.14 General Tools

4.14.1 Nonmagnetic Tools Kit 46-320273G4



NOTICE

Do not use Nonmagnetic Tools Kit 46-320273G4 near magnets with magnetic field strengths ≥ 3.0 Tesla.

Table 7-88: Nonmagnetic Tools Kit 46-320273G4 Rev. 0

Item	Part Number	Quantity	Description	Spare
2	46-216784P12	1	Tool Case	N
3	2168869	1	Case Label	N
4	46-320270P1	1	No description provided	N
5	46-320718G1	1	Nonmagnetic Metric Tools, Base Set (Table 7-89)	Y
6	46-320719G1	1	Nonmagnetic Inch Tools, Base Set (Table 7-90)	Y
22	46-320688P3	1	#2 Phillips Screwdriver, 6 In. Long	Y
23	46-320474P2	1	8 In. (200 mm) Adjustable Wrench	Y
24	46-320474P1	1	10 In. (250 mm) Adjustable Wrench	Y
25	46-320475P1	1	10 In. (250 mm) Slip Joint Piers	Y
26	46-320475P2	1	Needle Nose Pliers	Y
27	46-320475P3	1	Side Cutter	Y
28	46-320475P4	1	Stripper	Y
29	46-320476P1	1	1 Pound (0.45 g) Ballpeen Hammer	Y
30	46-320477P1	1	Half-Round File, 13 In. (330 mm) Long	Y
31	46-320687P3	1	9 mm Combination Wrench	Y
32	46-320687P4	1	11 mm Combination Wrench	Y
33	46-320687P5	1	14 mm Combination Wrench	Y
34	46-320687P6	1	17 mm Combination Wrench	Y
35	46-320687P7	1	19 mm Combination Wrench	Y
36	46-320472P1	1	6 mm x 7 mm Open End Wrench	Y
37	46-320472P4	1	8 mm x 9 mm Open End Wrench	Y
38	46-320472P5	1	8 mm x 10 mm Open End Wrench	Y
39	46-320472P11	1	12 mm x 13 mm Open End Wrench	Y
40	46-320472P13	1	14 mm x 15 mm Open End Wrench	Y
41	46-320472P16	1	16 mm x 18 mm Open End Wrench	Y
42	46-320686P2	1	5/16 In. x 5/16 In. Combination Wrench	Y
43	46-320686P3	1	3/8 In. x 3/8 In. Combination Wrench	Y
44	46-320686P4	1	7/16 In. x 7/16 In. Combination Wrench	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-88: Nonmagnetic Tools Kit 46-320273G4 Rev. 0 (cont'd)

Item	Part Number	Quantity	Description	Spare
45	46-320686P5	1	1/2 In. x 1/2 In. Combination Wrench	Y
46	46-320686P6	1	9/16 In. x 9/16 In. Combination Wrench	Y
47	46-320686P7	1	5/8 In. x 5/8 In. Combination Wrench	Y
48	46-320686P8	1	11/16 In. x 11/16 In. Combination Wrench	Y
49	46-320686P9	1	3/4 In. x 3/4 In. Combination Wrench	Y
50	46-320471P1	1	7/32 In. x 1/4 In. Open End Wrench	Y
51	46-320471P2	1	1/4 In. x 5/16 In. Open End Wrench	Y
52	46-320687P1	1	6 mm Combination Wrench	Y
53	46-320687P2	1	7 mm Combination Wrench	Y
54	46-328349P1	4	Plastic Arrow Clip, .248 In. (6.3 mm) Body x .54 In. (13.7 mm) Long	Y
55	46-320475	1	15 In. (380 mm) Slip Joint Piers	Y

Table 7-89: Nonmagnetic Metric Tools, Base Set 46-320718G1 Rev. 0

Item	Part Number	Quantity	Description	Spare
2	46-320738P1	1	Compartment Box, 14 x 6.25 x 2.5 In. (355 x 160 x 65 mm)	N
3	46-320804P1	1	No description provided	Y
4	46-320806P1	1	No description provided	Y
5	46-320809P1	1	No description provided	Y
6	46-320468P3	1	8 mm Socket, 3/8 In. Drive	Y
7	46-320468P4	1	9 mm Socket, 3/8 In. Drive	Y
8	46-320468P5	1	10 mm Socket, 3/8 In. Drive	Y
9	46-320468P6	1	11 mm Socket, 3/8 In. Drive	Y
10	46-320468P7	1	12 mm Socket, 3/8 In. Drive	Y
11	46-320468P8	1	13 mm Socket, 3/8 In. Drive	Y
12	46-320468P9	1	14 mm Socket, 3/8 In. Drive	Y
13	46-320468P10	1	15 mm Socket, 3/8 In. Drive	Y
14	46-320468P11	1	16 mm Socket, 3/8 In. Drive	Y
15	46-320468P12	1	17 mm Socket, 3/8 In. Drive	Y
16	46-320468P13	1	18 mm Socket, 3/8 In. Drive	Y
17	46-320468P14	1	19 mm Socket, 3/8 In. Drive	Y
18	46-320808G2	1	Nonmagnetic Metric Allen Wrench Kit	Y
18A[a]	46-320807P2	1	No description provided	N
18B[a]	46-320470P1	1	1.5 mm Allen Wrench	Y
18C[a]	46-320470P2	1	2 mm Allen Wrench	Y
18D[a]	46-320470P3	1	2.5 mm Allen Wrench	Y
18E[a]	46-320470P4	1	3 mm Allen Wrench	Y
18F[a]	46-320470P5	1	3 mm Allen Wrench, Short	Y
18G[a]	46-320470P6	1	4 mm Allen Wrench	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-89: Nonmagnetic Metric Tools, Base Set 46-320718G1 Rev. 0 (cont'd)

Item	Part Number	Quantity	Description	Spare
18H[a]	46-320470P7	1	4 mm Allen Wrench, Short	Y
18J[a]	46-320470P8	1	5 mm Allen Wrench	Y
18K[a]	46-320470P9	1	5 mm Allen Wrench, Short	Y
18L[a]	46-320470P10	1	6 mm Allen Wrench	Y
18M[a]	46-320470P11	1	7 mm Allen Wrench	Y
18N[a]	46-320470P12	1	8 mm Allen Wrench	Y
18P[a]	46-320470P13	1	9 mm Allen Wrench	Y
18Q[a]	46-320470P14	1	10 mm Allen Wrench	Y
18R[a]	46-320470P15	1	11 mm Allen Wrench	Y
18S[a]	46-320470P16	1	12 mm Allen Wrench	Y
18T[a]	46-320470P17	1	14 mm Allen Wrench	Y
19	46-320948P1	1	No description provided	Y
[a]Included in Nonmagnetic Metric Allen Wrench Kit 46-320808G2.				

Table 7-90: Nonmagnetic Inch Tools, Base Set 46-320719G1 Rev. 0

Item	Part Number	Quantity	Description	Spare
2	46-320738P1	1	Compartment Box, 14 x 6.25 x 2.5 In. (355 x 160 x 65 mm)	N
3	46-320804P1	1	No description provided	Y
4	46-320805P1	1	No description provided	Y
5	46-320810P1	1	No description provided	Y
6	46-320467P2	1	3/8 In. Socket, 3/8 In. Drive	Y
7	46-320467P3	1	7/16 In. Socket, 3/8 In. Drive	Y
8	46-320467P4	1	1/2 In. Socket, 3/8 In. Drive	Y
9	46-320467P5	1	9/16 In. Socket, 3/8 In. Drive	Y
10	46-320467P6	1	5/8 In. Socket, 3/8 In. Drive	Y
11	46-320467P7	1	11/16 In. Socket, 3/8 In. Drive	Y
12	46-320467P12	1	1-1/16 In. Socket, 3/8 In. Drive	Y
13	46-320467P13	1	1-1/4 In. Socket, 3/8 In. Drive	Y
14	46-320808G1	1	Nonmagnetic Inch Allen Wrench Kit	Y
14A[a]	46-320807P1	1	No description provided	N
14B[a]	46-320469P1	1	0.050 In. Allen Wrench	Y
14C[a]	46-320469P2	1	1/16 In. Allen Wrench	Y
14D[a]	46-320469P3	1	5/64 In. Allen Wrench	Y
14E[a]	46-320469P4	1	3/32 In. Allen Wrench	Y
14F[a]	46-320469P5	1	7/64 In. Allen Wrench	Y
14G[a]	46-320469P6	1	1/8 In. Allen Wrench	Y
14H[a]	46-320469P7	1	9/64 In. Allen Wrench	Y
14J[a]	46-320649P8	1	5/32 In. Allen Wrench	Y
14K[a]	46-320469P9	1	3/16 In. Allen Wrench	Y

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Table 7-90: Nonmagnetic Inch Tools, Base Set 46-320719G1 Rev. 0 (cont'd)

Item	Part Number	Quantity	Description	Spare
14L[a]	46-320469P10	1	7/32 In. Allen Wrench	Y
14M[a]	46-320469P11	1	1/4 In. Allen Wrench	Y
14N[a]	46-320469P12	1	5/16 In. Allen Wrench	Y
14P[a]	46-320469P13	1	3/8 In. Allen Wrench	Y
14Q[a]	46-320469P14	1	7/16 In. Allen Wrench	Y
14R[a]	46-320469P15	1	1/2 In. Allen Wrench	Y

[a] Included in Nonmagnetic Inch Allen Wrench Kit 46-320808G1.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Chapter 8 Data Sheets

1 Magnet Commissioning Log

Date	Cryostat Pressure	Compressor Static Pressure Reading	Coldhead Temperatures		Recondenser
			First Stage (Shield)	Second Stage (Recondenser)	

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2 Liquid Helium Refill Log

Filled By:

Date:

Dewar Serial Number	Time		Dewar Weight (Pounds)		LHe Used (L_U) (Δ lbs x 3.63)	Helium Level (L_l) Top				Transfer Efficiency ($\Delta L_l/L_U$)
						Start		Finish		
	Start	Finish	Start	Finish		Meter %	Amt (L)	Meter %	Amt (L)	

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

3 Helium Fill Data

3.1 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 Helium Transfer Volume (Line 10 - Line 11)	
13	Transfer Efficiency (Line 12/Line 9)	
14	Fill Time from Fill History (T! - T1)	
NOTE: Volumetric conversion of liquid helium level is provided in Section 4, Volumetric Conversion of Helium Level.		

3.2 Fill History

	Start Time	Start %	Gas PSI	Magnet PSI
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
END T!				

Predicted Monitor Reading[a]:	
Volume of Helium Gas Used[b]:	

[a] 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 your predicted meter reading.

[b] Record and note the amount of helium gas used by the pressure level gauge on the helium gas tanks.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4 Volumetric Conversion of Helium Level

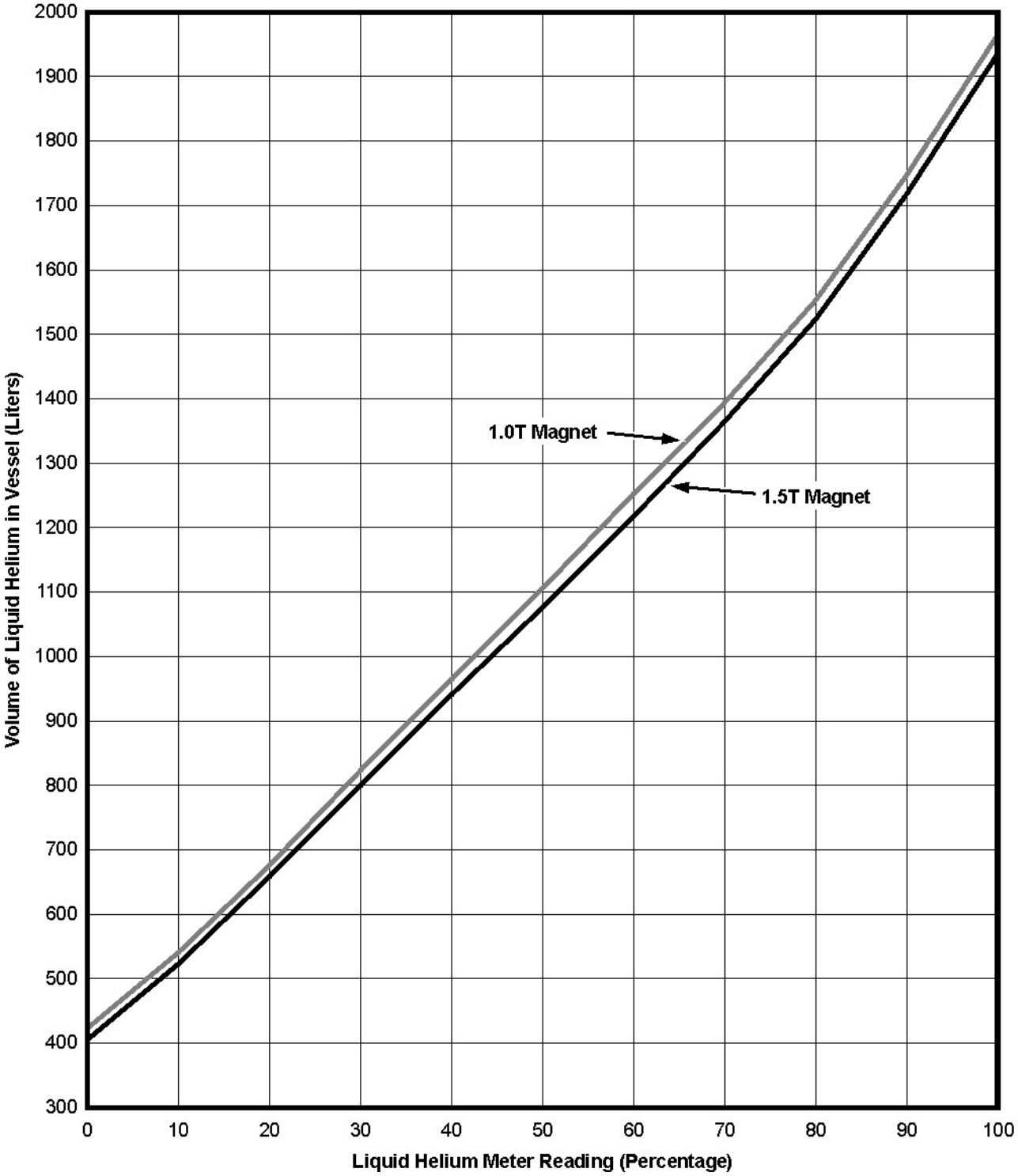
4.1 Volumetric Conversion of Liquid Helium Level (Liquid Helium Meter Reading to Liquid Liters Correlation)

	Liquid Helium (liters)			Liquid Helium (liters)			Liquid Helium (liters)			Liquid Helium (liters)	
%	1.5T	1.0T	%	1.5T	1.0T	%	1.5T	1.0T	%	1.5T	1.0T
0	412	429	25	736	755	50	1080	1110	75	1450	1480
1	424	441	26	750	769	51	1094	1125	76	1466	1496
2	435	452	27	764	784	52	1108	1140	77	1482	1512
3	447	464	28	778	798	53	1112	1155	78	1498	1528
4	459	476	29	792	813	54	1136	1170	79	1514	1544
5	471	488	30	806	827	55	1150	1185	80	1530	1560
6	482	499	31	820	841	56	1164	1200	81	1549	1579
7	494	511	32	834	856	57	1178	1215	82	1568	1598
8	506	523	33	848	870	58	1192	1230	83	1587	1617
9	517	534	34	862	885	59	1206	1245	84	1606	1636
10	529	546	35	876	899	60	1220	1260	85	1625	1655
11	543	560	36	889	913	61	1235	1274	86	1644	1674
12	556	573	37	903	928	62	1250	128	87	1663	1693
13	570	587	38	917	942	63	2365	1302	88	1682	1712
14	584	601	39	931	957	64	1280	1316	89	1701	1731
15	598	615	40	945	971	65	1295	1330	90	1720	1750
16	611	628	41	959	985	66	1310	1344	91	1742	1772
17	625	642	42	972	999	67	1325	1358	92	1764	1794
18	639	656	43	986	1013	68	1340	1372	93	1786	1816
19	652	669	44	999	1027	69	1355	1386	94	1808	1838
20	666	683	45	1013	1040	70	1370	1400	95	1830	1860
21	680	697	46	1026	1054	71	1386	1416	96	1852	1882
22	694	712	47	1040	1068	72	1402	1432	97	1874	1904
23	708	726	48	1053	1082	73	1418	1448	98	1896	1926
24	722	741	49	1067	1096	74	1434	1464	99	1918	1948
									100	1940	1970

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

4.2 Volumetric Conversion of Liquid Helium Level

Illustration 8-1: Volumetric Conversion of Liquid Helium Level



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

5 Magnet Ramping and Parking Current Log

Magnet Model No. :

Magnet Serial No. :

Service Engineer :

Date	Time	Connection Polarity Normal: (+/-) Reverse (-/+)	Lead Extension Voltage Drop (mV)	Parking Current (A)	Magnetic Field Strength ...		
					Before Shimming Hz (Gauss)	After Mechanical Shimming Hz (Gauss)	With Shim Currents Removed Before Ramping Down or Reparking Hz (Gauss)

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

6 Magnet Uncompensated Drift Log

Magnet Model No. :

Magnet Serial No. :

Service Engineer :

Date	Time	Frequency 1	Frequency 2

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

7 Shim Plot Data

Date:		Plot #
Magnet:		Base Frequency:
Location:		Point 1 (R = 0, Z = -24.0 cm):
		Point 2 (R = 0, Z = +24.0 cm):
		Point 3 (R = 0, Z = -22.5 cm):
		Point 4 (R = 0, Z = +22.5 cm):

Rotation	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 (round off to the nearest 10 Hz)													

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8 Calculated Shim Coil Correction Currents

Date:

Plot No.

Magnet Serial No.

Output File:

Power Supply # (Name)	Total Current (Amps)	+	Δ Change (Amps)	=	Total Current (Amps)	+	Δ Change (Amps)	=	Total Current (Amps)	+	Δ Change (Amps)
T1-1 (C31)											
T1-2 (C11+)											
T1-3 (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											
Gradient Offsets											
X											
Y											
Z											
Predicted											
Inhomogeneity											

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

9 Shim Size and Location Map

Shim Size/Location (MILS)												
	Rotation											
Z	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												

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

10 Magnet Temperature and Pressure Data

Magnet Model No.

Magnet Serial No

Service:

Engineer:

Date	Coldhead 2nd Stage (RuO-A) Temperature (K)	Recondenser (RuO-B) Temperature (K)	Coldhead/ Recondenser ΔT (K)	Coldhead Sleeve Temperature (K)	Cryostat Pressure (psig)

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

This page left intentionally blank.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

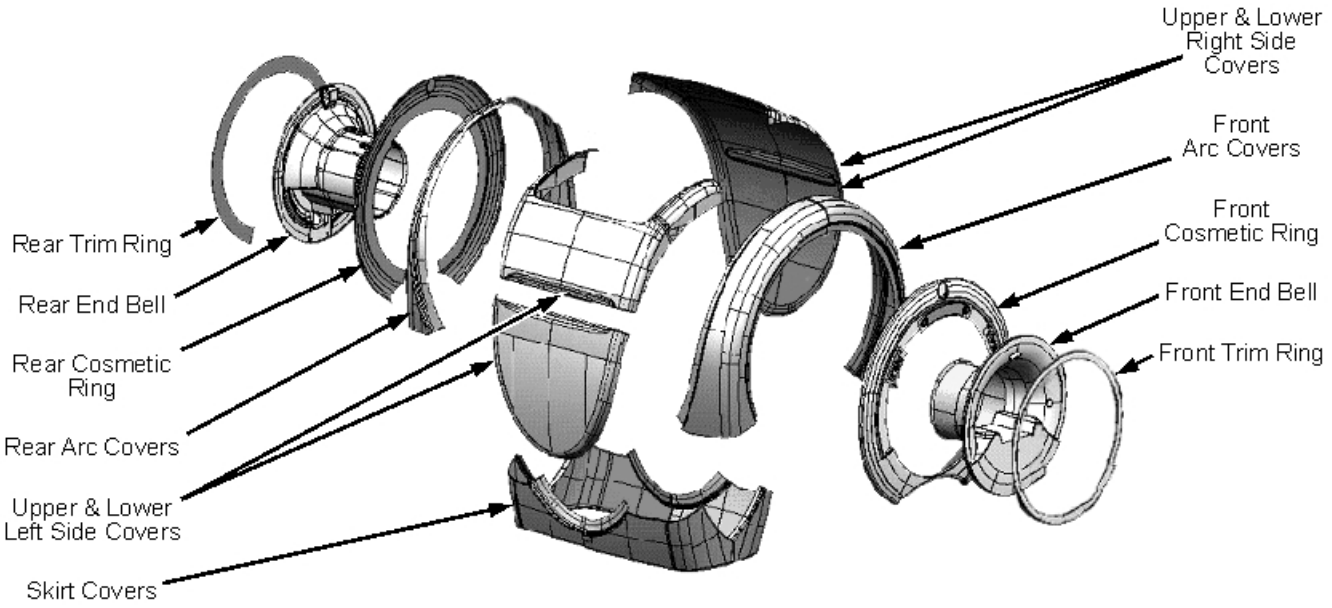
Appendix A Magnet Enclosures

1 HDe/HDx Magnet Enclosure Removal/Installation

1.1 Introduction to HDe, HDx Enclosures

HDe and HDx magnet enclosures differ from previous enclosures. The major components of HDe/HDx enclosures are shown in Illustration A-1.

Illustration A-1: Major Components of HDe/HDx Enclosures



Those procedures listed in Table A-1 are reproduced her from the Service Methods documentation for the magnet. Always use the latest release of the Service Methods documentation, which can be obtained through GE Healthcare Field Service Representatives.

Table A-1: Enclosure Component Removal & Installation Procedures

Major Component	Procedure
Upper & Lower Left Side Covers	Section 1.2, Side Cover Removal and Install
Upper & Lower Right Side Covers	
Skirt Covers	Section 1.3, Skirt Cover Removal and Install
Front End Bell	Section 1.4, Front End Bell Removal and Install
Front Cosmetic Covers	Section 1.5, Front Cover Removal and Installation
Front Trim Ring	
Rear End Bell	Section 1.6, Rear End Bell Removal and Install
Rear Cosmetic Cover	Section 1.7, Rear Cosmetic Ring Removal and Install
Rear Trim Ring	

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.2 Side Cover Removal and Install

1.2.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Not Applicable	3 mins	Not Applicable

1.2.2 Preliminary Requirements

1.2.2.1 Tools and Test Equipment

Item
Qty
Effectivity
Part#
Manufacturer

1.2.2.2 Consumables

No consumables required.

1.2.2.3 Replacement Parts

No replacement parts required.

1.2.2.4 Safety



DANGER

STRONG MAGNETIC FIELD!
FERROUS MATERIALS CAN BECOME DANGEROUS PROJECTILES IN THE PRESENCE OF THE MAGNETIC FIELD PRODUCED BY THE SIGNA MAGNET. DO NOT BRING ANY FERROMAGNETIC TOOLS OR EQUIPMENT INTO THE MAGNET ROOM.

1.2.2.5 Required Conditions

No required conditions.

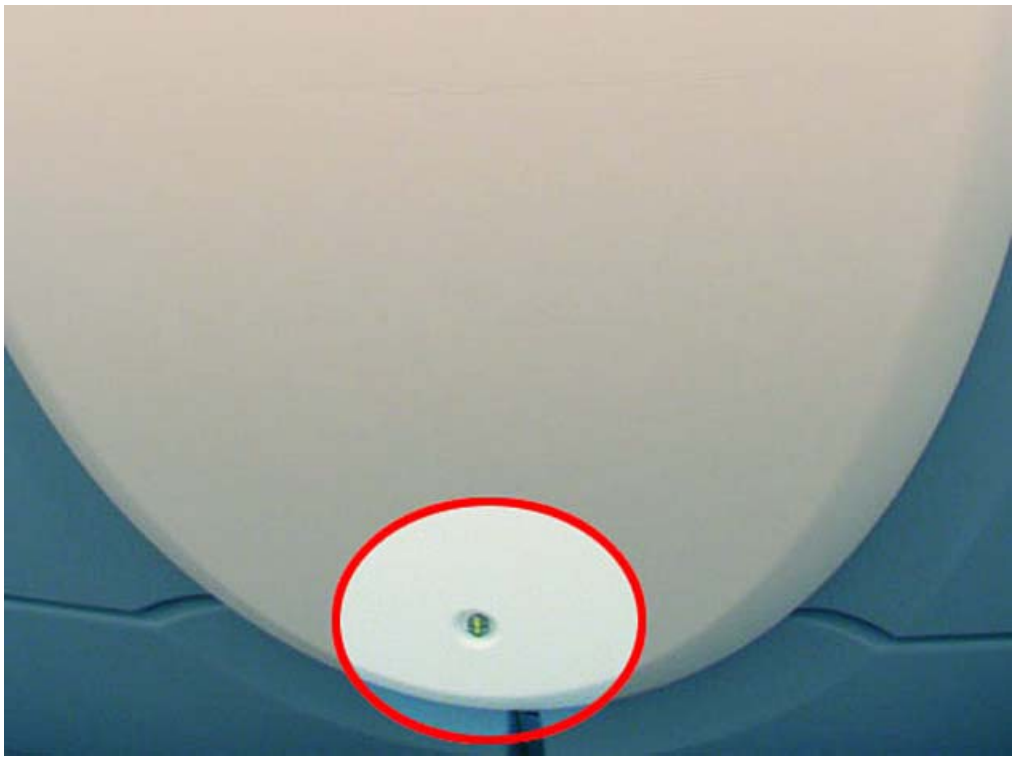
1.2.3 Procedure

1.2.3.1 Removing Left Side Covers

1. Loosen the large screw on lower portion of the lower side cover by using a non-ferrous screwdriver and turning the screw counter-clockwise (see Illustration A-2).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-2: Side Cover Screw



2. Grab sides of lower cover and lift upwards until the cover is released from the upper cover. Set lower cover aside (see Illustration A-3).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-3: Removing Left Side Cover



3. The upper cover is secured to the arc covers primarily by two round feet on the lower portion of the side cover. To remove the cover, grab the two handles on the upper cover firmly and push the cover up and then pull out away from the enclosure. This should release the cover's feet and allow you to move it freely (see Illustration A-4).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

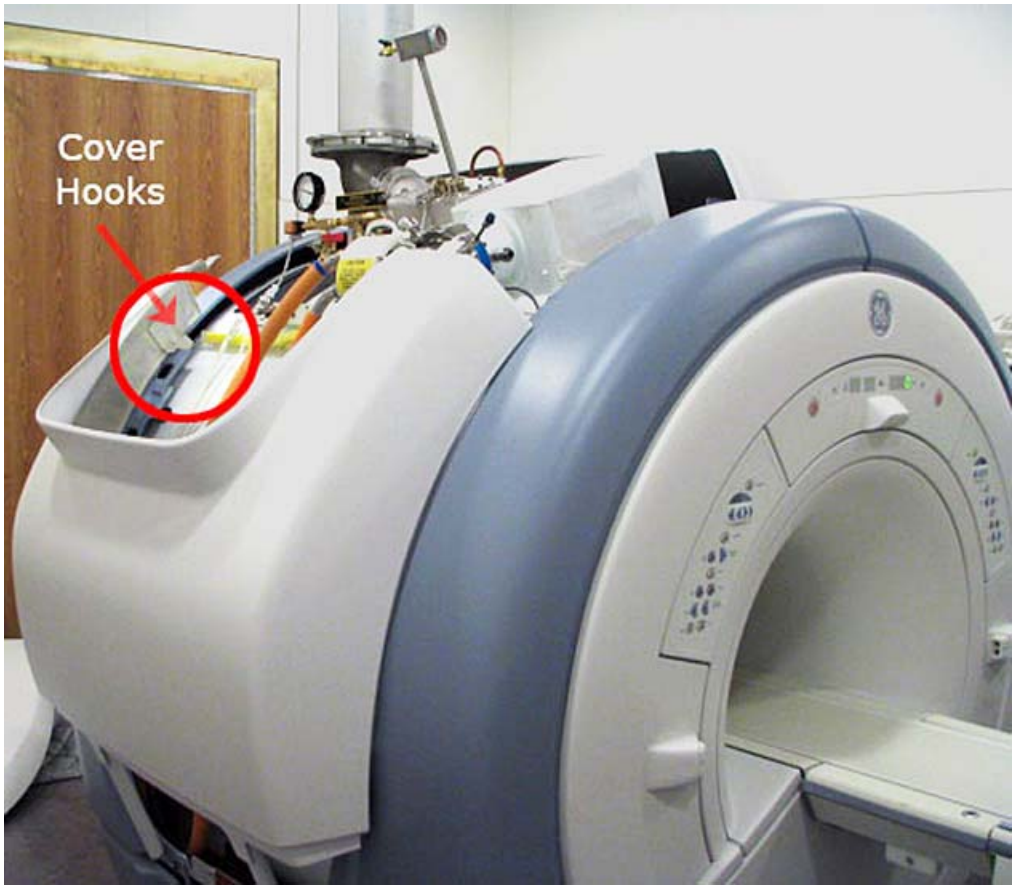
Illustration A-4: Removing Left Top Side Cover



4. Once the feet are released, use the arc cover as a guide rail, and allow the cover to slide down the side of the enclosure. Once the cover clears the fixtures on the upper portion of the magnet, the cover can either be safely set aside or it can be rested on the side of the magnet using the cover's hooks that latch on to the arc covers (see Illustration A-5).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-5: Resting Top Cover on Side of Magnet



1.2.3.2 Installing Left Side Covers

NOTE: To replace the left side covers, the top right side cover must be installed.

1. Using the arc covers as guide rails, slide the side cover up to meet he right side cover at the top of the magnet (see Illustration A-6).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-6: Using the Arc Covers as Guide Rails



2. Hold the handles away from the enclosure to ensure that the alignment tabs get properly slotted under the right side's slot (see Illustration A-7).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-7: Slide Alignment Tabs below Right Side Cover



NOTE: This is not easily accomplished since you cannot see all the alignment tabs while holding on to the cover's handles. Before proceeding to install the lower side cover, go over to the front and rear of the magnet and visually verify that the alignment tabs have been properly inserted and are not protruding over the top of the right side cover (see Illustration A-8)..

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

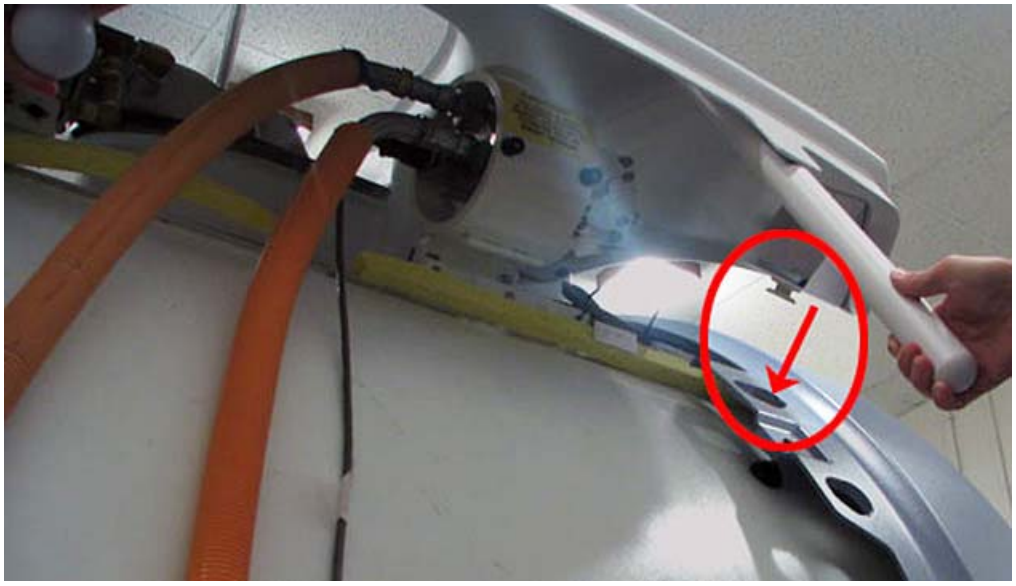
Illustration A-8: Ensure Tab Is Properly Placed



3. Set the round foot on the enclosure-side of the cover into the upper oval on the arc cover (see Illustration A-9). Snap into place.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-9: Place Round Foot in Arc Cover's Oval Hole



4. Hold the sides of the Lower Cover and align the round feet on the enclosure-side of the lower cover with the arc cover's ovals (see Illustration A-10). Snap into place.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

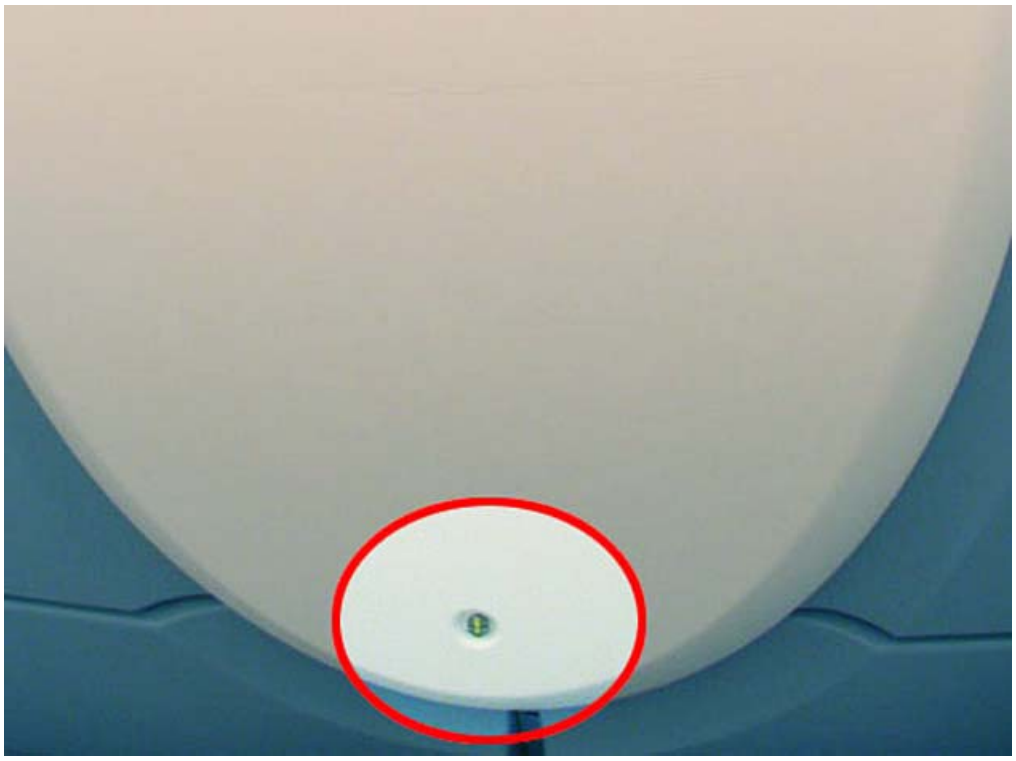
Illustration A-10: Installing Left Side Cover



5. Latch the cover into place by turning the screw clockwise so the latch is secure (see Illustration A-11).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-11: Side Cover Screw



1.2.4 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.3 Skirt Cover Removal and Install

1.3.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Not Applicable	1 min	Not Applicable

1.3.2 Preliminary Requirements

1.3.2.1 Tools and Test Equipment

No tools or test equipment required.

1.3.2.2 Consumables

No consumables required.

1.3.2.3 Replacement Parts

No replacement parts required.

1.3.2.4 Safety



DANGER

STRONG MAGNETIC FIELD!
FERROUS MATERIALS CAN BECOME DANGEROUS PROJECTILES IN THE PRESENCE OF THE MAGNETIC FIELD PRODUCED BY THE SIGNA MAGNET. DO NOT BRING ANY FERROMAGNETIC TOOLS OR EQUIPMENT INTO THE MAGNET ROOM.

1.3.2.5 Required Conditions

No required conditions.

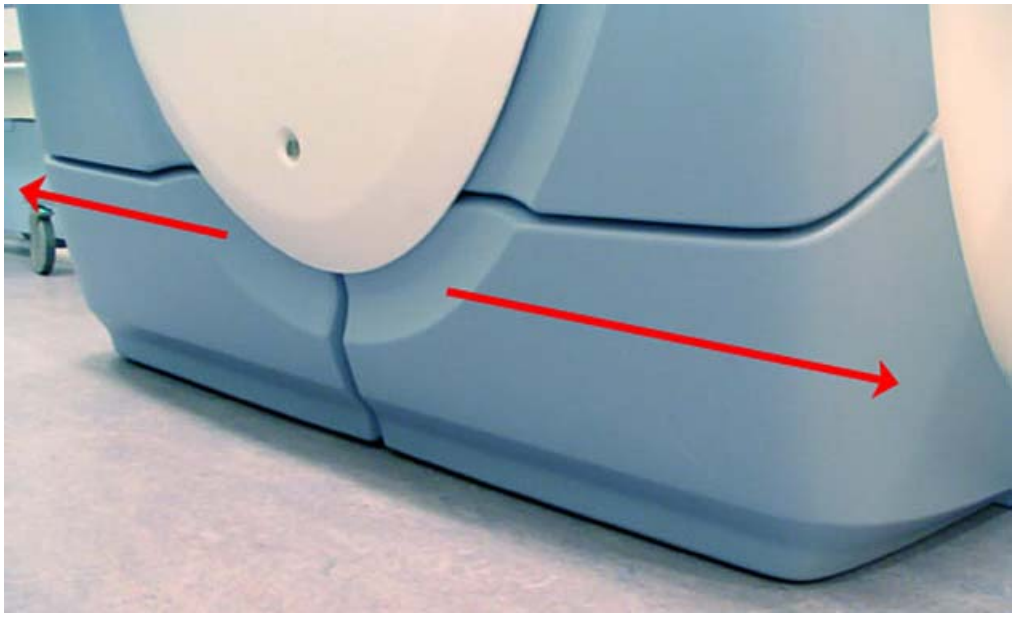
1.3.3 Procedure

1.3.3.1 Remove Skirt Covers

1. The skirt covers are held into place primarily using poppers. To remove a skirt cover, simply slide it towards the front (or, in the case of the back covers, to the rear) of the magnet (see Illustration A-12).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-12: Removing Skirt Covers



1.3.3.2 Install Skirt Covers

1. Align fastener on skirt cover to the notch on the arc cover and slide cover towards the center of the magnet (see Illustration A-13).

Illustration A-13: Aligning the Skirt's Hook with the Arc Cover's Slot



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2. Align tabs so to interlock with tabs on adjoining skirt cover (see Illustration A-14).

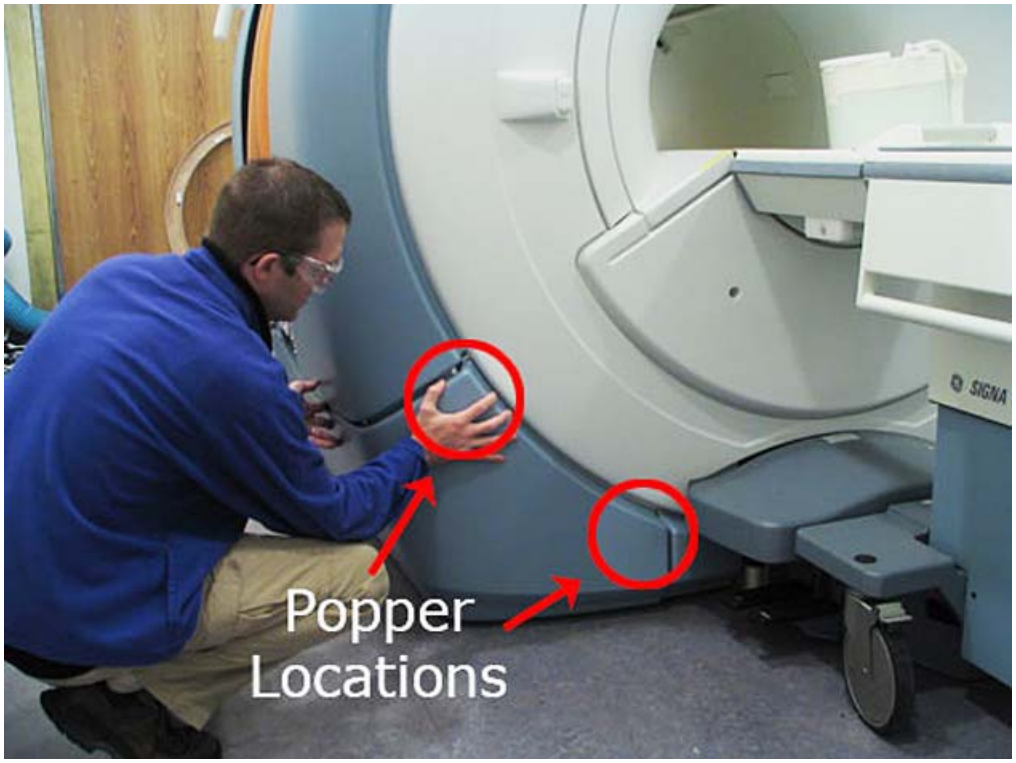
Illustration A-14: Aligning Skirt Tabs



3. Snap poppers on the front end of arc cover into place (see Illustration A-15).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-15: Popper Location



1.3.4 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.4 Front End Bell Removal and Install

1.4.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Not Applicable	3 hours	Not Applicable

1.4.2 Preliminary Requirements

1.4.2.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Nonferrous M5 Allen Wrench	1	-	-	-
Nonferrous M4 Allen Wrench	1	-	-	-

1.4.2.2 Consumables

No consumables required.

1.4.2.3 Replacement Parts

No replacement parts required.

1.4.2.4 Safety



DANGER

STRONG MAGNETIC FIELD!
FERROUS MATERIALS CAN BECOME DANGEROUS PROJECTILES IN THE PRESENCE OF THE MAGNETIC FIELD PRODUCED BY THE SIGNA MAGNET. DO NOT BRING ANY FERROMAGNETIC TOOLS OR EQUIPMENT INTO THE MAGNET ROOM.

1.4.2.5 Required Conditions

No required conditions.

1.4.3 Procedure

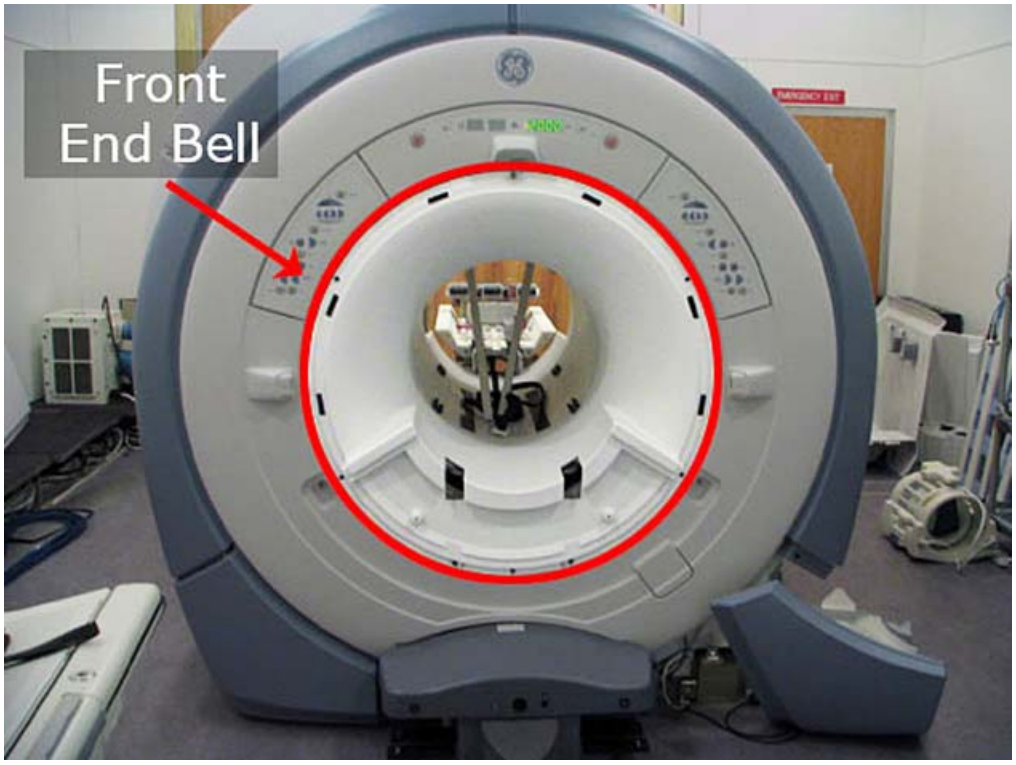
1. Follow all Lock Out and Tag Out procedures by turning off the applicable breaker in the PDU (see Chapter 1, Section 4).

NOTE: The Front Cosmetic Ring Cover and the Front End Bell can be removed independently of each other.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

2. Move patient table away from the magnet. Drive LPCA towards rear of bridge.

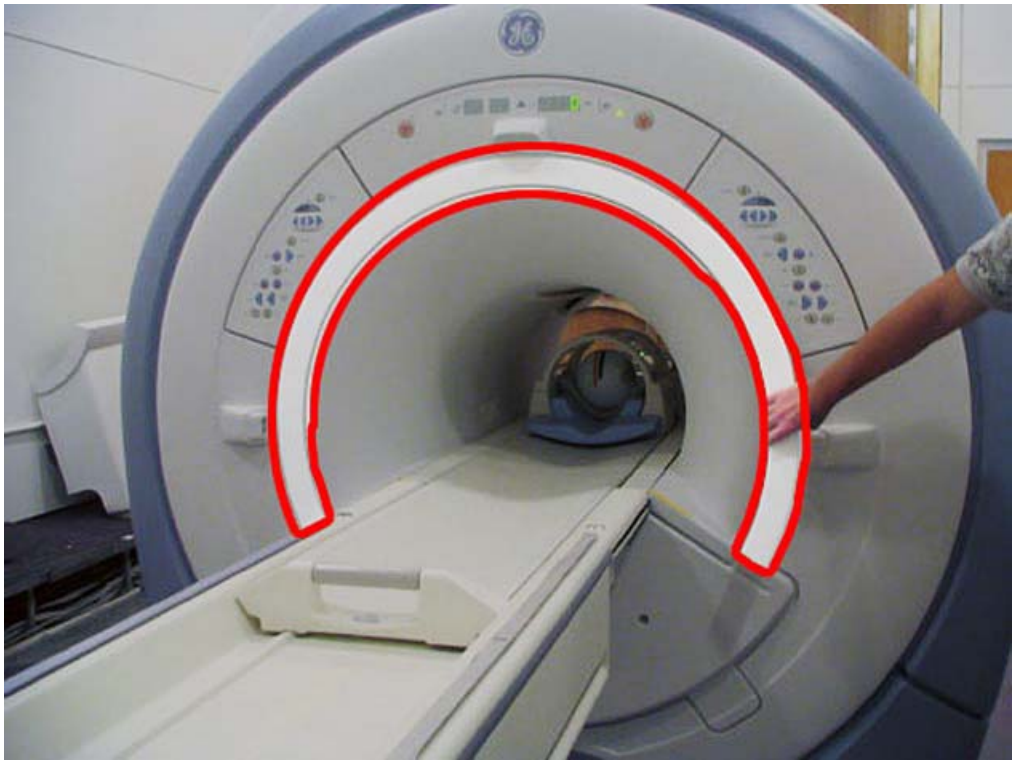
Illustration A-16: Front End Bell



3. Remove Front Trim Ring by pulling it away from the enclosure. There are no bolts holding it into place (see Illustration A-17).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

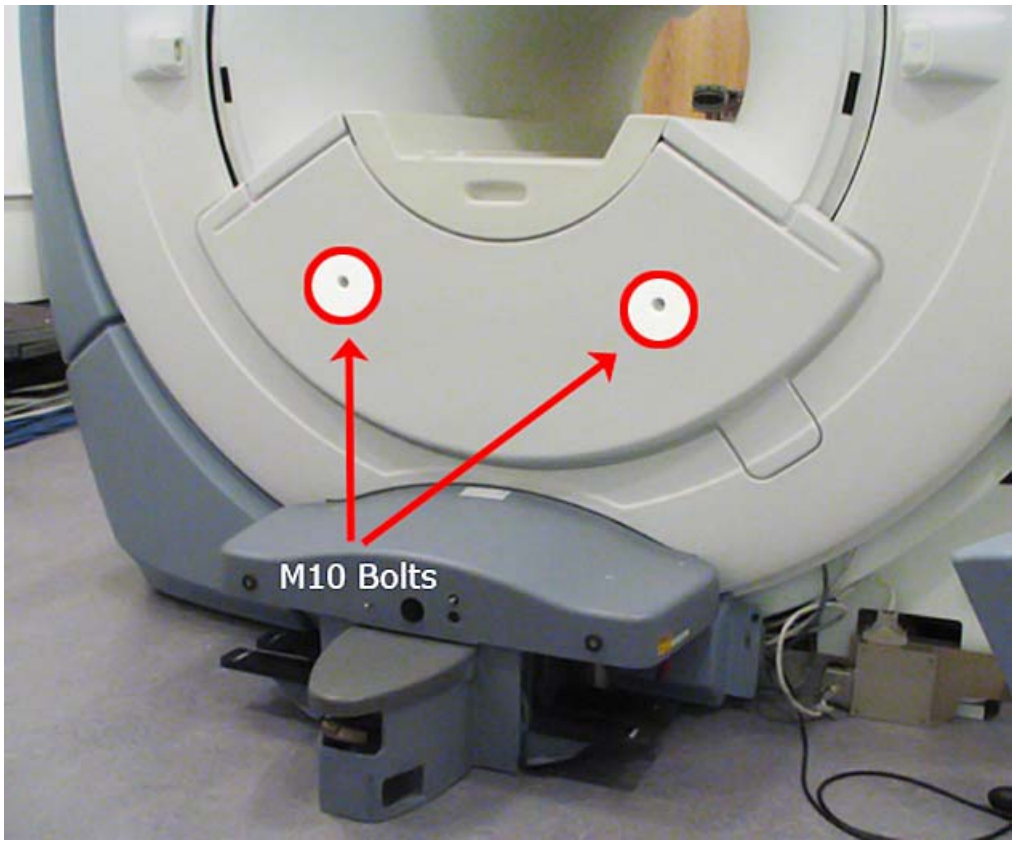
Illustration A-17: Remove Trim Ring



4. Using an M10 Allen wrench, remove the two (2) bolts holding the Lower Cosmetic Cover in place (see Illustration A-18) and remove the cover (see Illustration A-19).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-18: Lower Cosmetic Cover



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-19: Lower Cosmetic Cover Removed

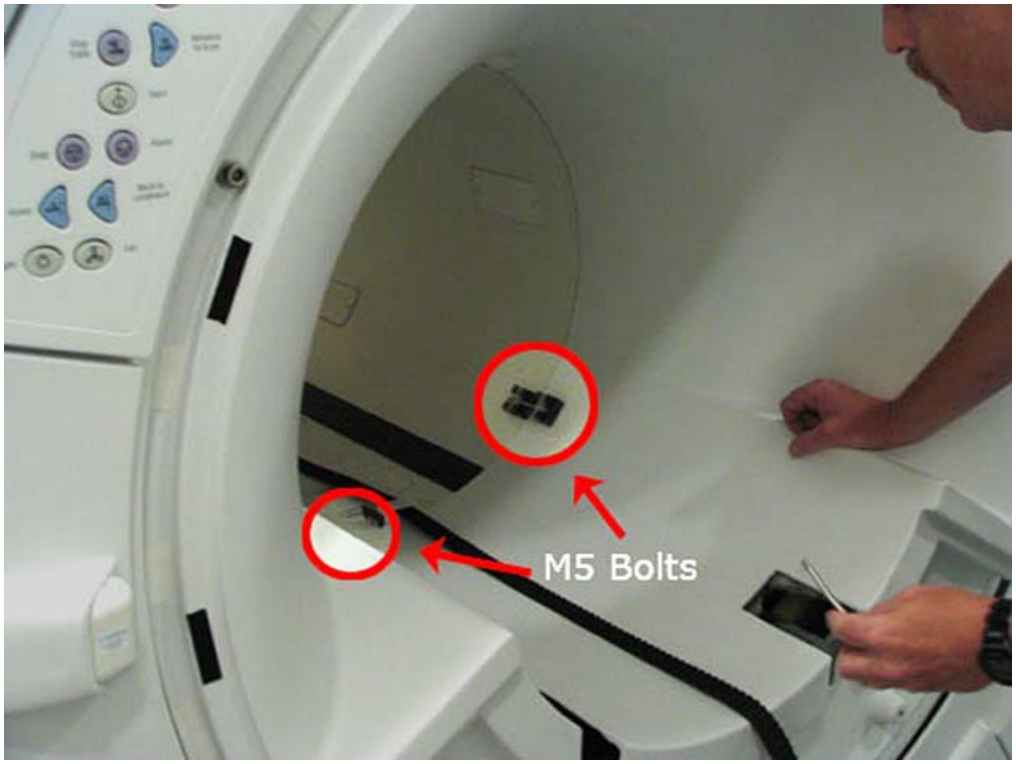


5. Remove the front portion of the split bridge (see , Section)

6. Using an M5 Allen wrench, remove the two (2) lower black fasteners which connect the RF coil and the front end bell (see Illustration A-20).

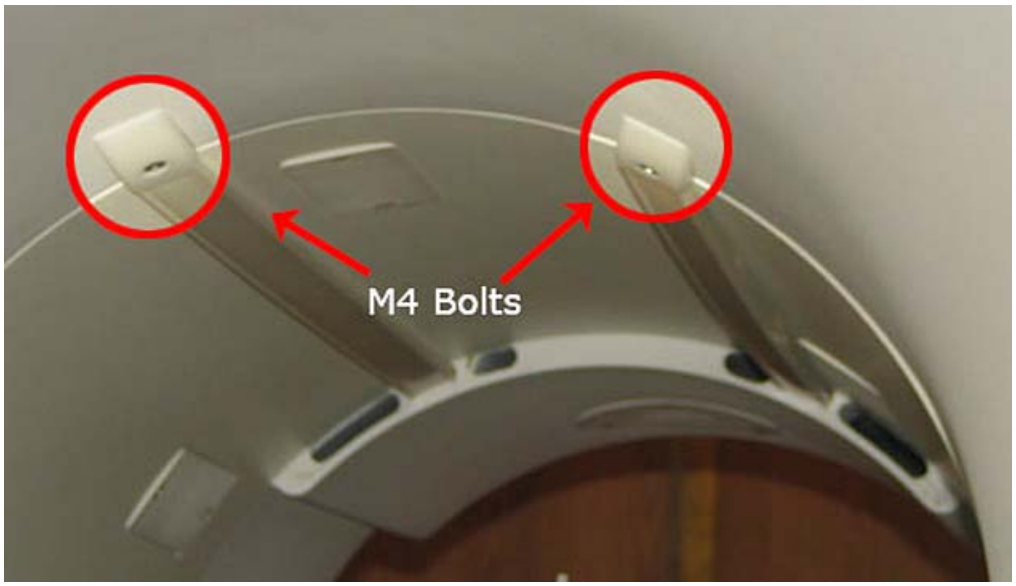
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-20: Lower End Bell Fasteners



7. Using a M4 Allen wrench, loosen the two (2) upper bolts that secure the long bands that connect the RF coil and the front end bell (see Illustration A-21).

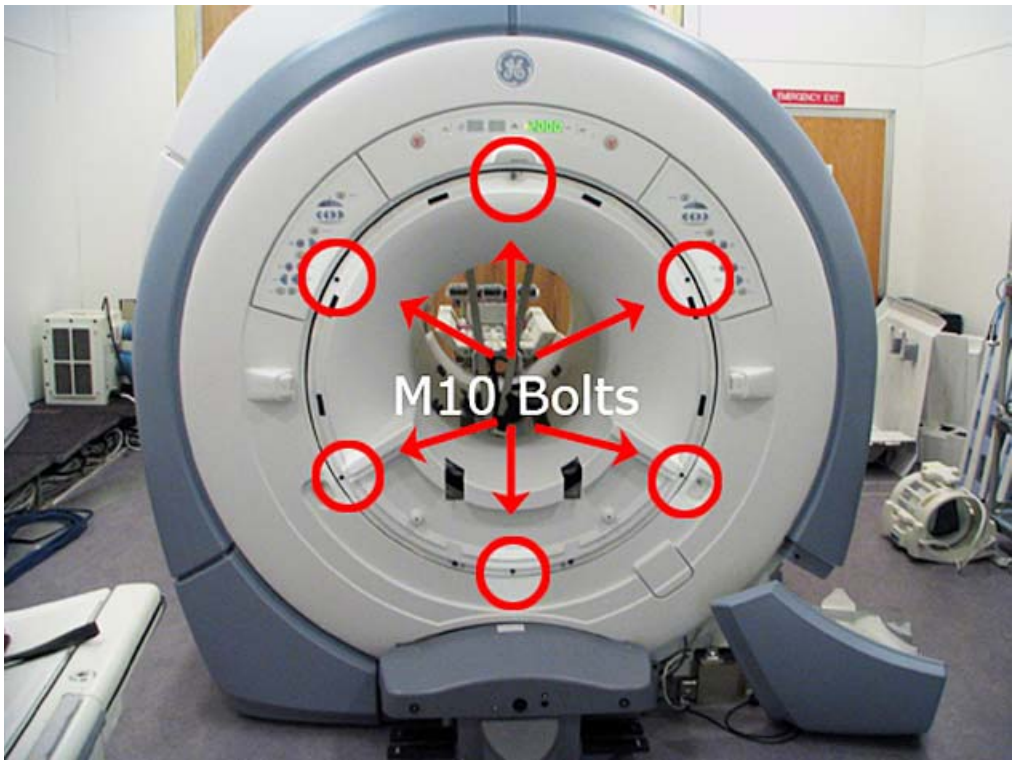
Illustration A-21: Upper End Bell Fasteners



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

8. Remove the six (6) M10 bolts which attach the front end bell to the turtle bracket (see Illustration A-22).

Illustration A-22: Front End Bell Bolts



9. Remove the end bell.

10. Reverse steps to install replacement Front End Bell.

1.4.4 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.5 Front Cover Removal and Installation

1.5.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Not Applicable	15 (see Procedure Overview for details)	Not Applicable

1.5.2 Overview

Removal of the Front Cover typically takes less than 15 minutes if the front end of the split bridge has already been removed (see Step 4). If this step has not been performed you should plan on at least 90 minutes to remove and replace the Front Cover.

1.5.3 Preliminary Requirements

1.5.3.1 Tools and Test Equipment

Item	Qty	Effectivity	Part#	Manufacturer
Non ferrous M5 Allen wrench	1	-	-	-

1.5.3.2 Consumables

No consumables required.

1.5.3.3 Replacement Parts

No replacement parts required.

1.5.3.4 Safety



DANGER

STRONG MAGNETIC FIELD!
FERROUS MATERIALS CAN BECOME DANGEROUS PROJECTILES IN THE PRESENCE OF THE MAGNETIC FIELD PRODUCED BY THE SIGNA MAGNET. DO NOT BRING ANY FERROMAGNETIC TOOLS OR EQUIPMENT INTO THE MAGNET ROOM.

1.5.3.5 Required Conditions

No required conditions.

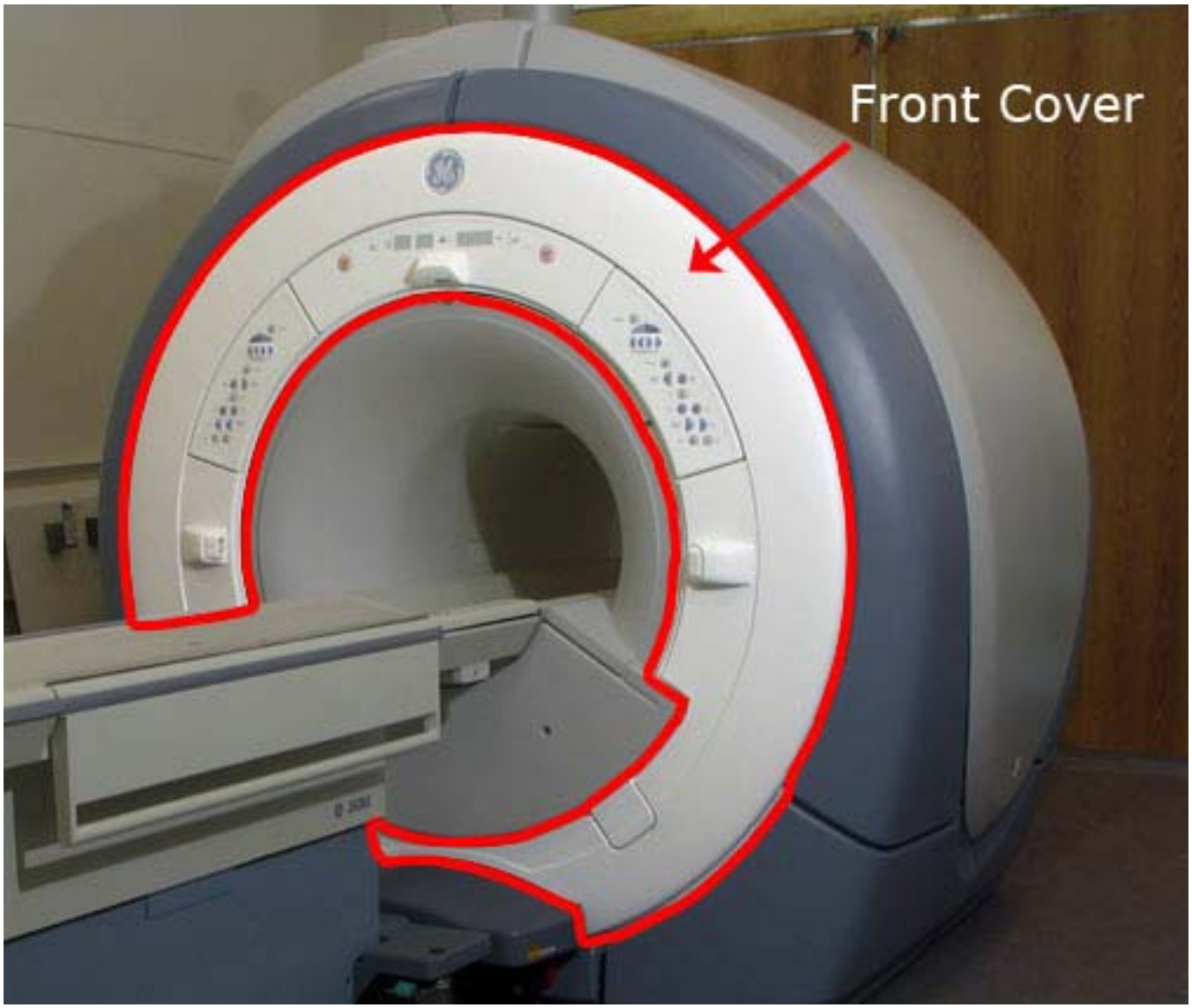
1.5.4 Procedure

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Follow all Lock Out and Tag Out procedures by turning off the applicable breaker in the PDU (see Chapter 1, Section 4).

NOTE: The Front Cover and the Front End Bell can be removed independently of each other.

Illustration A-23: Front Cosmetic Cover

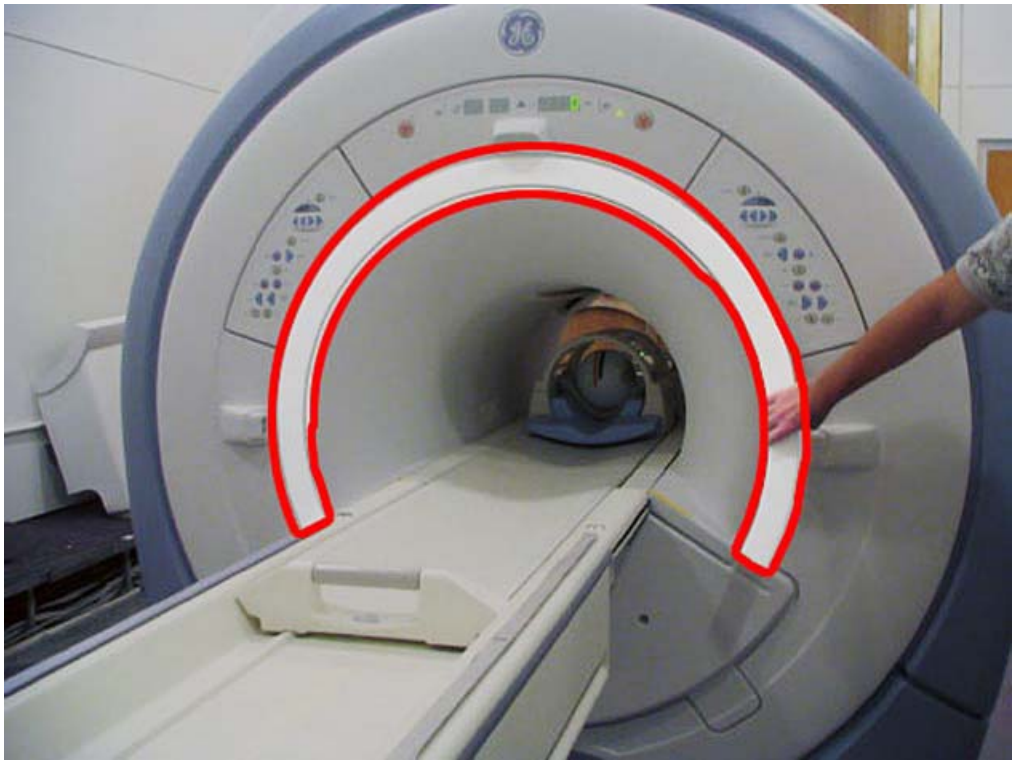


2. Undock patient table, and position table away from the magnet.

3. Remove Front Trim Ring by pulling it away from the enclosure. There are no bolts holding it into place (see Illustration A-24).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-24: Remove Trim Ring



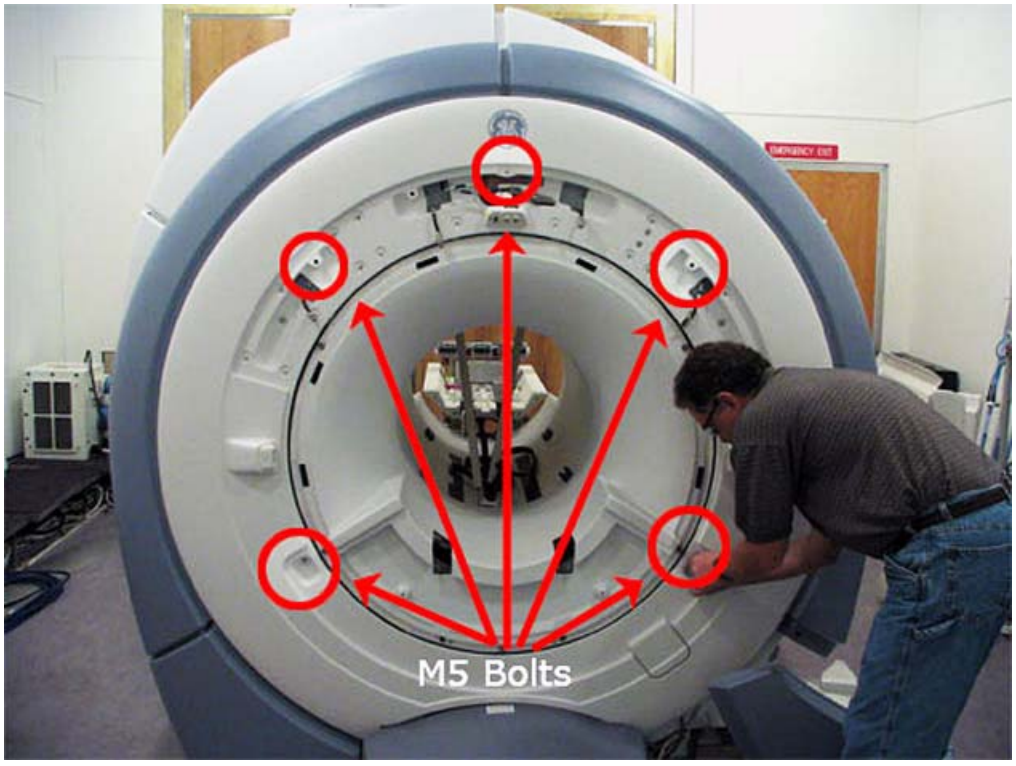
4. Remove the front portion of the split bridge (see , Section)

5. Remove Control Panels (see , Section).

6. Using an M5 Allen wrench, remove the five (5) bolts which attach the Front Cover to the turtle bracket (see Illustration A-25).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-25: Unbolting the Front Cover



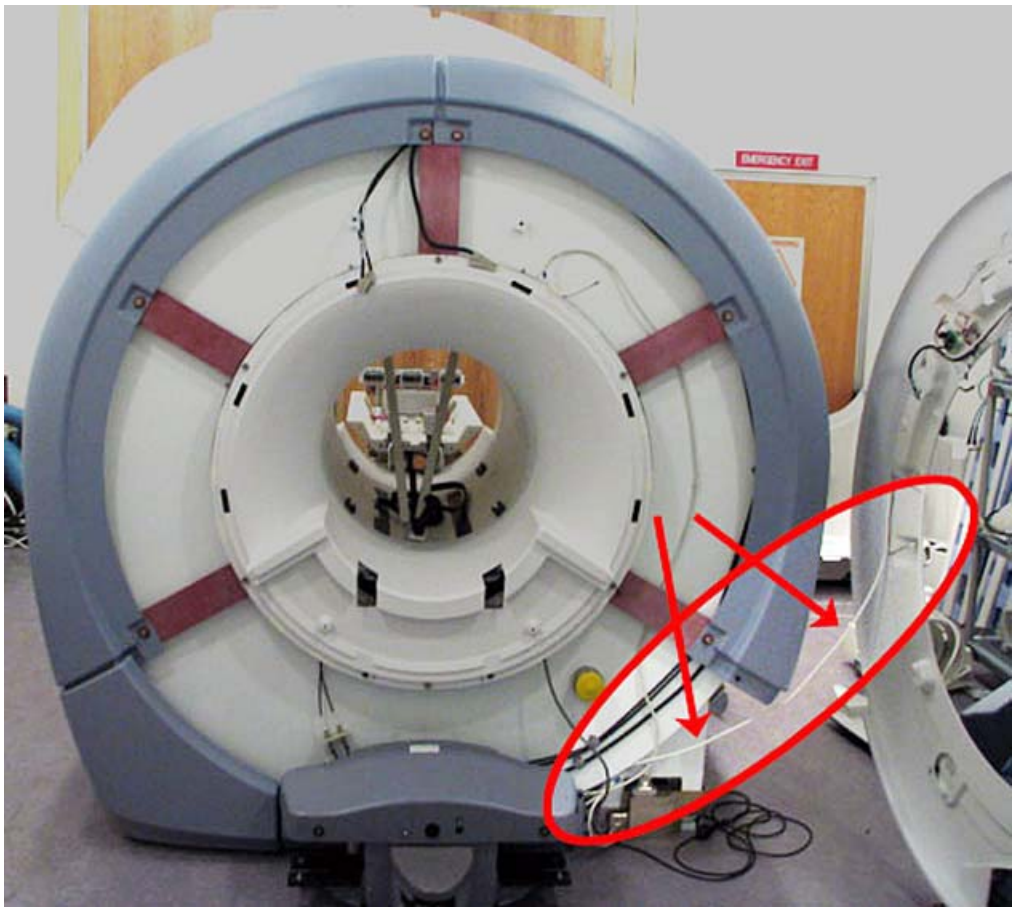
7. Once the five (5) bolts have been removed pull the Front Cover slightly away from the magnet and identify the Conquest Voltage Regular Board on the upper right side. Carefully remove JP1 from the board.

Illustration A-26: Voltage Conquest Board on back of Front Cover

8. Remove the Front Cover; ensure the microphone cable connected to the lower right side of the cover is not pulled (see Illustration A-27).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-27: Microphone Cord Attached to Cover



9. To free the Front Cover from the microphone cord, you can either disconnect it from the rear pedestal (connector J9 on the Remote Intercom Board), or detach it from the Front Cover by following , Section .

10. Reverse the steps to install replacement Front Cover.

1.5.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.6 Rear End Bell Removal and Install

1.6.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Not Applicable	5 hours	Not Applicable

1.6.2 Preliminary Requirements

1.6.2.1 Tools and Test Equipment

Item
Qty
Effectivity
Part#
Manufacturer

1.6.2.2 Consumables

No consumables required.

1.6.2.3 Replacement Parts

No replacement parts required.

1.6.2.4 Safety



DANGER

STRONG MAGNETIC FIELD!
FERROUS MATERIALS CAN BECOME DANGEROUS PROJECTILES IN THE PRESENCE OF THE MAGNETIC FIELD PRODUCED BY THE SIGNA MAGNET. DO NOT BRING ANY FERROMAGNETIC TOOLS OR EQUIPMENT INTO THE MAGNET ROOM.

1.6.2.5 Required Conditions

No required conditions.

1.6.3 Procedure

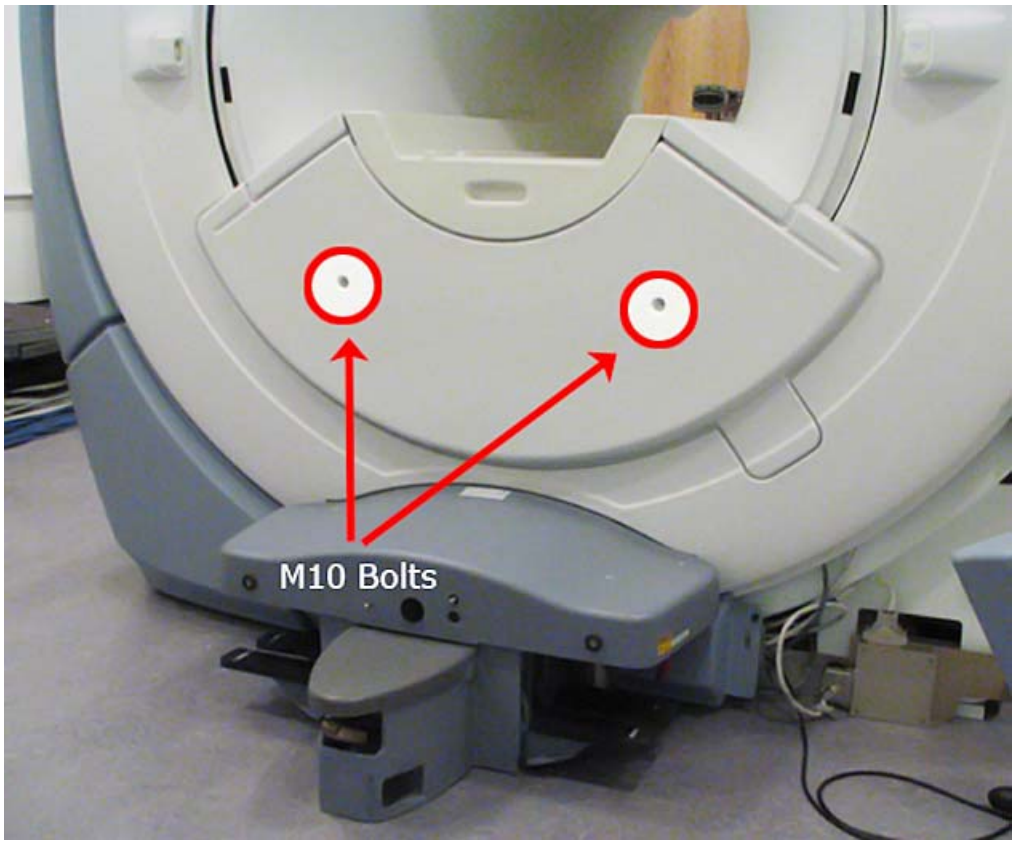
NOTE: The Rear Cosmetic Ring Cover and the Rear End Bell can be removed independently of each other.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1. Follow all Lock Out and Tag Out procedures by turning off the applicable breaker in the PDU (see , Section).

2. Using an M10 Allen wrench, remove the two (2) bolts holding the Lower Cosmetic Cover in place (see Illustration A-28) and remove the cover (see Illustration A-29).

Illustration A-28: Lower Cosmetic Cover



Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-29: Lower Cosmetic Cover Removed



3. Remove the front portion of the split bridge (see , Section)

4. Remove Rear Trim Ring by pulling it away from the enclosure. There are no bolts holding it into place (see Illustration A-30).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-30: Remove Trim Ring

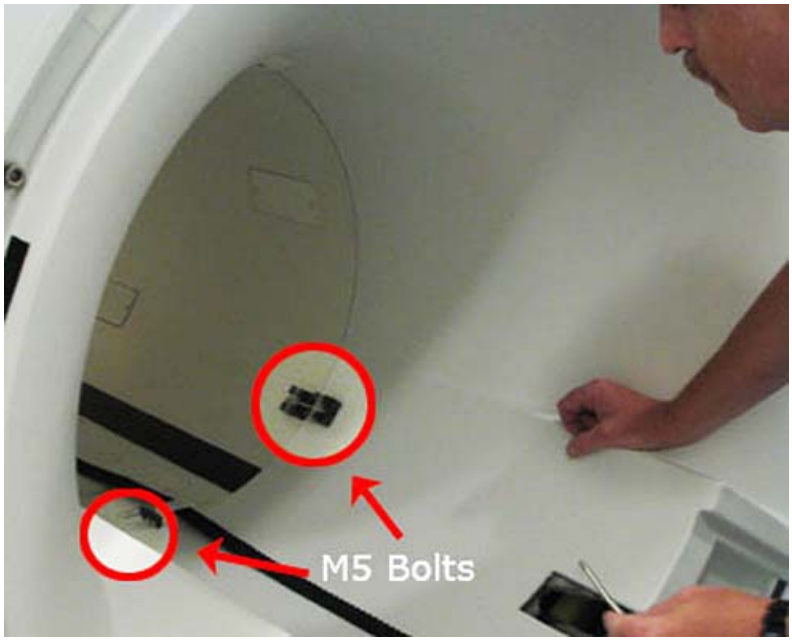


5. Remove the rear pedestal (see , Section).

6. Using an M5 Allen wrench, remove the two (2) lower black fasteners which connect the RF coil and the rear end bell (see Illustration A-31).

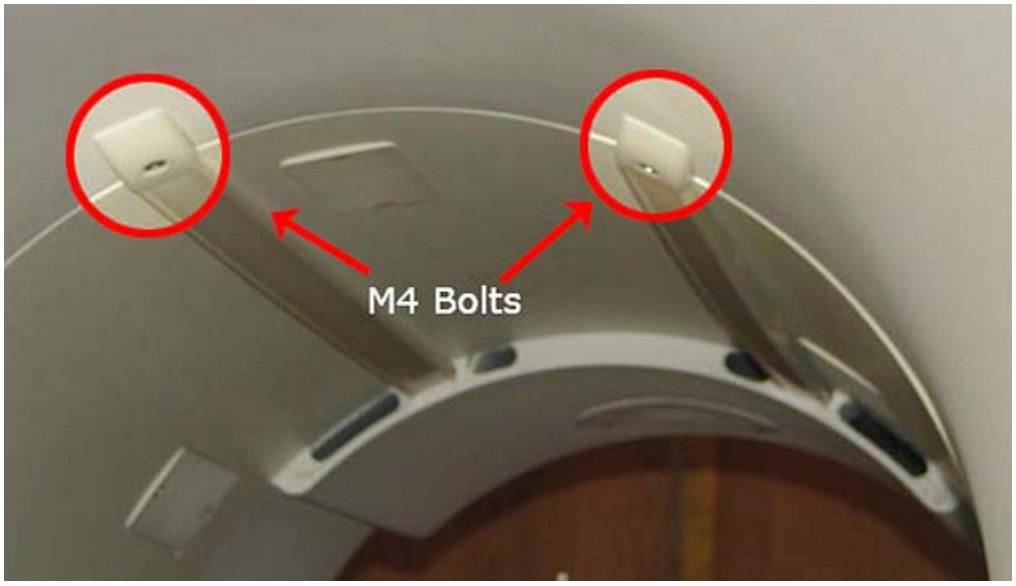
Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-31: Lower End Bell Fasteners



7. Using a M4 Allen wrench, loosen the two (2) upper bolts that secure the long bands that connect the RF coil and the front end bell. These bolts are accessible from the front of the magnet (see Illustration A-32).

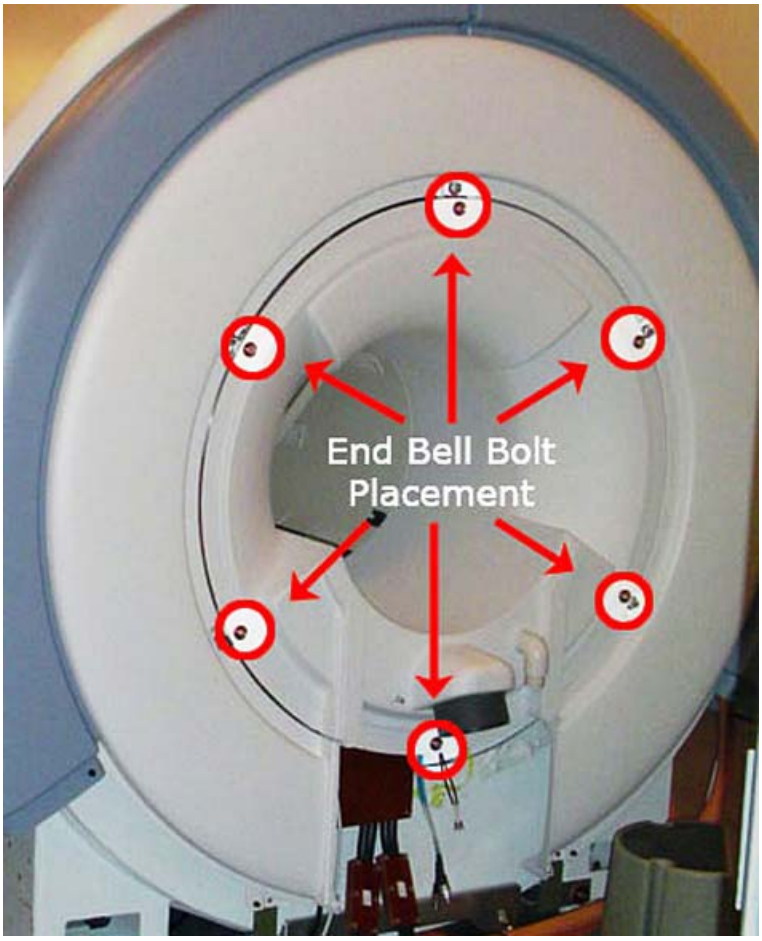
Illustration A-32: Upper End Bell Fasteners



8. Remove the six (6) M10 bolts which attach the rear end bell to the turtle bracket (see Illustration A-33).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-33: Rear End Bell Bolts



9. Remove the end bell and the gasket ring.

NOTE: There are several hoses and cables hidden behind the rear end bell. Be careful when removing the end bell so not to inadvertently tug on any cables or hoses.

10. Reverse steps to install replacement Rear End Bell.

1.6.4 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

1.7 Rear Cosmetic Ring Removal and Install

1.7.1 Personnel Requirements

Required Persons	Preliminary Reqs	Procedure	Finalization
1	Not Applicable	2 hours	Not Applicable

1.7.2 Overview

Removing the Rear Cosmetic Ring is needed when replacing the gradient coil.

1.7.3 Preliminary Requirements

1.7.3.1 Tools and Test Equipment

Item
Qty
Effectivity
Part#
Manufacturer

1.7.3.2 Consumables

No consumables required.

1.7.3.3 Replacement Parts

No replacement parts required.

1.7.3.4 Safety



DANGER

STRONG MAGNETIC FIELD!
FERROUS MATERIALS CAN BECOME DANGEROUS PROJECTILES IN THE PRESENCE OF THE MAGNETIC FIELD PRODUCED BY THE SIGNA MAGNET. DO NOT BRING ANY FERROMAGNETIC TOOLS OR EQUIPMENT INTO THE MAGNET ROOM.

1.7.3.5 Required Conditions

No required conditions.

1.7.4 Procedure

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

NOTE: The Rear Cosmetic Ring Cover and the Rear End Bell can be removed independently of each other.

1. Remove Rear Trim Ring by pulling it away from the enclosure (see Illustration A-34). There are no bolts holding it into place.

Illustration A-34: Remove Rear Trim



2. The cosmetic cover is held on by 5 (five) bolts and 5 (five) poppers. Remove 5 (five) bolts (see Illustration A-35).

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

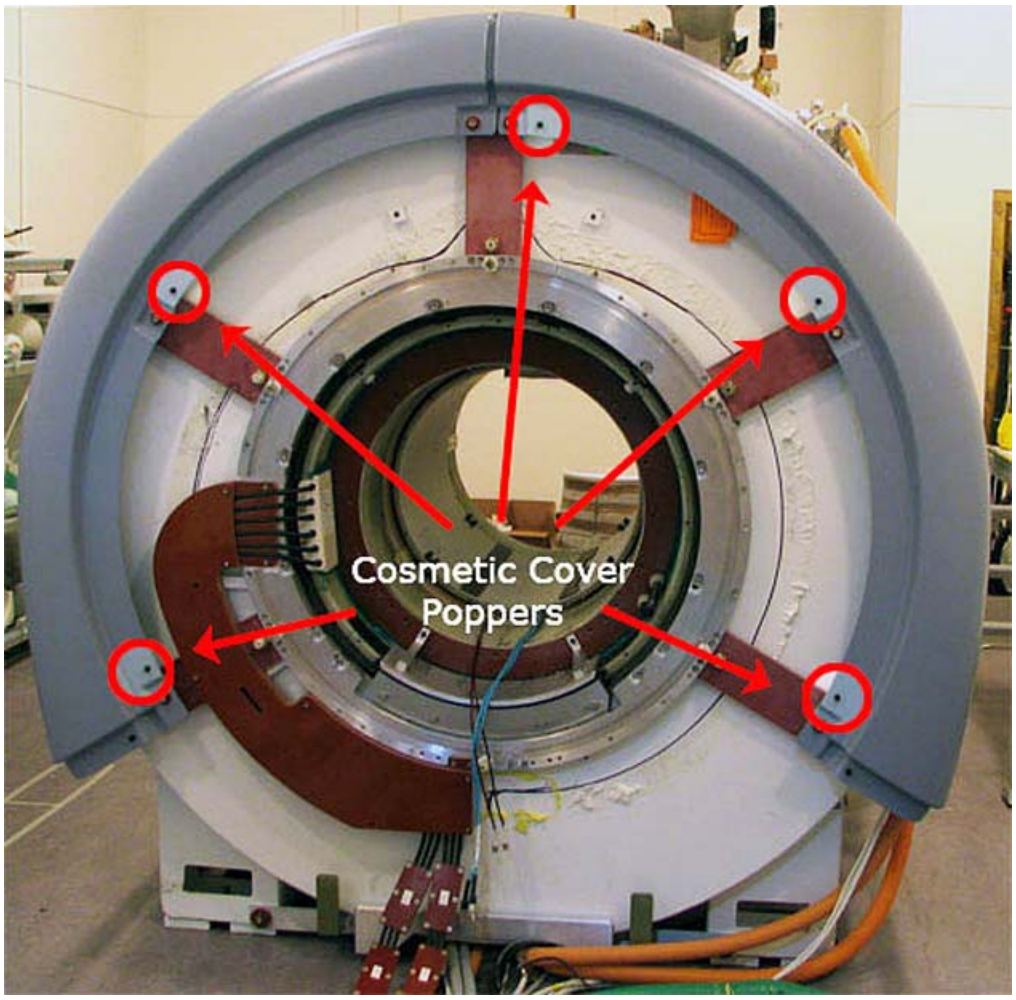
Illustration A-35: Cosmetic Cover Bolts



3. Pull cover away from magnet to release the cover from the poppers. (Illustration A-36 shows the location of the poppers)

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.

Illustration A-36: Popper Placements (with Cosmetic Cover and End Bell Removed



4. To install the Cosmetic Cover reverse the removal procedures.

1.7.5 Finalization

No finalization steps.

Copyright © 2006 by General Electric Company Inc. All Rights Reserved.



GE MEDICAL SYSTEMS

GE MEDICAL SYSTEMS - AMERICAS: FAX 262.312.7434
3000 N. GRANDVIEW BLVD., WAUKESHA, WI 53188 U.S.A.

GE MEDICAL SYSTEMS - EUROPE: FAX 33.1.40.93.33.33
PARIS, FRANCE

GE MEDICAL SYSTEMS - ASIA: FAX 65.291.7006
SINGAPORE

http://www.gemedicalsystems.com