GE Medical Systems

Technical Publications

Direction 2223170

Revision 13

Signa® EXCITE MR/*i* 1.5T

Pre–Installation

Architectural/Installation Planning Use Only

Operating Documentation

GE Medical Systems

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WARNING

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

AVERTISSEMENT

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

WARNUNG

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

AVISO

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

ATENÇÃO

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

AVVERTENZA

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

警告

・このサービスマニュアルには英語版しかありません。
・ＧＥＭＳ以外でサービスを担当される業者が英語以外の言語を要求される場合、翻訳作業はその業者の責任で行うものとさせていただきます。
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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。
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- 忽略本注意事项会对维修员，操作员或病人造成触电，机械伤害或其他伤害。

Revision History

REV	DATE	PRIMARY REASON FOR CHANGE
Prelim A	Aug 6, 1998	Initial preliminary version of Signa MR/*i* system with Wide Open Enclosure and Water Chiller for Body Coil cooling.
Prelim B	Sept. 14, 1998	Revised to elimination of customer power requirement for 50 Hz Water Chiller. Incorporated additional changes of common information with Direction 2120460, Rev 6 update.
0	Oct. 9, 1998	Initial full release of Signa MR/*i* system with Wide Open Enclosure and Water Chiller for Gradient Coil cooling.
1	Nov. 30, 1998	Corrected 1.0T LCC Magnet gauss plots.
2	Apr. 7, 1999	Recon Processor catalogs revised to ReFlex20, ReFlex50, and ReFlex100 offerings. Signa CV/*i* System catalogs & options added. Updated some System Options catalogs. Added Signa CV/*i* system & research option equipment throughout manual. Magnet Monitor proximity limit increased to 50 gauss. Deleted out–of–date Closed Circuit TV option info throughout manual. Added clearance dimension between Rear Pedestal & surface floor duct or access flooring. Water Chiller (WC1) for Gradient Coil Cooling Water dimension info updated. RF/Pen Cabinet for 1.5T front mounting hole height dimension changed. O W Table illustration added note for integral part of system. Added dimension illustrations for equipment position on top of OW Table. Revised Heat Output values. Revised Facility Input Power Requirements. Magnet Room grounding requirements changed to quantity 1 for Run 40 ground wire. Magnet moving dimensions revised for rear plenum protrusion. Updated tools lists, added new items and deleted obsolete items. Illustration A–1 Y–axis units corrected.
3	July 19, 1999	1.5T RF/PDU Cabinet information incorporated, RF Cabinet and Compact PDU information removed. Remote Keyboard Option updated to E catalogs. Updated MDC Catalog for unit with Shield Cooler Compressor Auto Restart function and clarified function requirement for MDC. Added VP Option information and deleted ADW Option information. Changed Broadband Spectroscopy title to Multi–Nuclear Spectroscopy (MNS). Clarified Main Disconnect Control capabilities for Auto Restart of Shield Cooler Compressor. Updated GE part number for Magnet Ramping Equipment Kit.
4	Feb 3, 2000	Sec 1: Corrected M1000ZB catalog for 1.5T Base with Phased Array, Added Signa NV/*i* information to Signa CV/*i* sections, Updated DC Lighting Control options catalogs. Sec 2: Added proximity limit for Heat Exchanger for Mobile System Gradient Coil Cooling, revised clearance dimension behind Magnet Enclosure Rear Pedestal, revised dimensions of suggested accessories & supplies storage shelf/cabinet, minor typo corrections incorporated. Sec 3: Updated redesigned 1.0T LCC Magnet smaller gauss plots. Sec 4: Updated temperature & humidity specifications, several minor corrections and clarifications incorporated, Magnet Room lighting requirements updated, Expanded Acoustic information. Revised vibration specs for LCC Magnets shipping with Gradient Isolation Kit. Sec 5: Reworded & reformatted Facility input power configurations for clarity & consistency with other MR products, reformatted Updated DC Lighting Control options info. Sec 6: Updated Magnet Monitor interconnects, typo corrections for VP Workstation option. Sec 7: Added rebar note to magnet mounting illustration, updated floor levelness info. Sec 9: Updated reference for telephones requirements. Appendix A: Title typo correction & updated LCC Magnet vibration specs illustrations.
5	Nov. 3, 2000	Revised Signa CV/i & Workstation option information throughout manual. Added MNS Spectroscopy information throughout manual. Sec 1: Updated system information for ASP Release catalogs. Added M3044PA & M3844PA Site Kit with long cable & revised IIP Global Modem catalog. Sec 2: Revised Telephone Lines Multiplexer box options. Updated dimension from magnet isocenter to rear wall. Added rebar detail callout to Magnet load pattern. Sec 5: Added note for phase conductors & ground conductor routing. Revised System Ground RF Power Filters note. Incorporated Phased Array Runs into system interconnect table. Sec 7: Clarified properties of Magnet Room finished flooring type. Sec 10: Deleted obsolete items in calibration tools list.
6	Mar. 17, 2001	Deleted discontinued Monochrome (B/W) Monitor information and a few minor typos throughout manual. SEC 1: Updated Recon Processor with BAM memory catalogs.. Added dimension for Low Ceiling Height Siting Option to magnet enclosure illustrations. SEC 2–7–7 Signa CV/i Workstation repeated Section 1–3–2 LCD monitor recommendation. Sec 4: Added illustrations for Wall Construction for Noise Control. Changed vibration values to G units of measure at Field's request. SEC 5: Updated Critical Power Requirements max. momentary demand for revised design specifications; Added WARNING for full system UPS needs to be compatible with system specs.; added 5–2–2 Power Demands Duration & Regulation to clarify power requirements for Signa system with ACGD. Critical Power Requirements Frequency tolerance changed to ± 3 Hz. Clarified "Emergency Stop" button function purpose. SEC 6: Updated Run numbers in a table note. Added M1090ZN to notes for Group 90, 91, & 92. Added note for groups that contain water line shall be routed separate from electrical lines. SEC 7: Corrected Ventglass information contacts. Updated magnet servicing ceiling requirement with Low Ceiling Height Siting Option. SEC 8: Deleted Monochrome (B/W) Monitor information.UpdatedMagnet moving dimension for design changes. SEC 10: Updated LCC Magnet Burst Disc & Gasket Assembly part number. Moved RUO Temperature Monitor to Cryogenic Equipment table. APPENDIX A: Changed vibration values to G units of measure at Field's request.

Revision History (Continued)

REV	DATE	PRIMARY REASON FOR CHANGE
7	Dec. 6, 2001	Deleted OW Color Monitor & added BrainWave Option information throughout the manual. **SEC 1:** Added Magnet Air Transport cart catalog; removed discontinued PowerTECH S/F catalogs; updated Van Manufacturers Contact Information. **SEC 2:** Added Low Ceiling Height Siting Option information to minimum room dimensions; Blower Box information revised for changed design & mounting; added Network connection and telephone lines option to system connectivity requirements; revised Suggestion For Accessories & Supplies Storage Shelf/Cabinet. **SEC 3:** Updated Magnet Room Temperature & Humidity Specifications to match system specifications. **SEC 4:** Updated Magnet Room Temperature & Humidity Specifications to match system specifications; updated System Acoustic Noise Level Operating Conditions & wall construction examples; clarified Magnet Room exhaust fan intake location requirement; added 14 inch (355.6 mm) & 16 inch (406.4 mm) cryogenic vent pressure drops matrix; revised Vibration definition & Image Quality Issues information. **SEC 5:** Updated Critical Power Requirements regulation, PDU voltage, max. momentary demand for revised design specifications; Updated MDC & PDU maximum wire size; updated Facility Ground Wire measurement techniques. **SEC 6:** Updated miscellaneous system interconnects. **SEC 7:** Updated task responsibilities for anchoring equipment inside RF Shielded Room; updated Magnet Dock anchor location determination. **SEC 9:** Added SAFETY subsection; updated all others subsections for safety changes. **SEC 10:** Added explanation to Nitrogen equipment only needed if magnet is warmer than nitrogen temperature. **APPENDIX A:** Revised Test Measurements information; revised Equipment (Spectral Analyzer) Set–Up information; revised Data Collection information.
8	April 19, 2002	Added 1.5T Signa MR/*i* with EXCITE Technology system information throughout the document. Other major changes listed by section include the following **Sec 1:** Deleted OW Color Monitor information. **Sec 2:** Revised Signa MR/*i* magnet room minimum service & room dimensions; Updated Gradient Coil Assembly, cradle & cart dimensions; Raised Floor changed to Access Floor per Installation Specialist recommendation. **Sec 4:** Revised Equipment Room temperature range per System Specifications; Deleted OW Color Monitor heat output; Added Propylene Glycol to Shield/Cryo Cooler Compressor water cooling specifications; Sample pressure drop calculation of cryogenic venting corrected value A number; Added Distance for AC fields sample calculation. **Sec 5:** Revised Voltage Transient specification; Added NEC 2002 Article references. **Sec 6:** Updated miscellaneous system interconnects. **Sec 7:** Added illustration of Magnet Minimum Ceiling height area requirement; Clarified RF Shield Room vendor responsibility to supply torque specifications for all anchors, studs, and fastening hardware to meet the clamping force specified. **Sec 8:** Added 1.5T Signa MR/*i* with EXCITE Technology information. **Sec 9:** Update SAFETY subsection for Exhaust Fan test report, Cryogenic Vent Inspection report, & plan to connect Cryogenic Vent to Magnet within 24 hours of delivery to Magnet Room. **Sec 10:** Added new & deleted obsolete test equipment & part numbers; Revised checklist item to inform outside emergency personnel precautions to take in event of emergencies in advance of magnet ramp–up.
9	Aug. 5, 2002	Replaced Direction 2128126 Rev 0 with Rev 1. **Sec 4:** Revised system acoustic noise levels. **Sec 6:** Updated Oxygen Monitor option plug pull information. **Sec 7:** Added use of Megger Insulation Tester to Electrical Isolation Measurement Method for Anchor Hardware Requirements for MR Equipment Inside RF Shielded Room. **Sec 10:** Added Resistance Meter to table of Rigger/Customer Supplied Equipment.
10	Nov. 20, 2002	Added 1.5T SRFD II Cabinet information throughout the manual. **Sec 1:** Added M1090ZP & M1090ZN OW ONLY Long Cables; Added UPS for Magnet Monitor to Mobile magnet catalogs. Facility Options added full system UPS and Bypass panel options catalogs. **Sec 2:**Added UPS for Magnet Monitor for True Mobile system configuration; Revised Water Chiller dimension information for new supplier unit; Update Magnet Monitor dimension illustration; Updated ACGD/PDU Cabinet weight & center of gravity values. **Sec 3:** Magnetic Isogauss line plots added 40mT & 200mT required by IEC 60601–2–33 6.8.3 bb. **Sec 4:** Updated 1.0T SRF Cabinet heat output; Added metric value for recommend Magnet Room ventilation; Exhaust Fan illustrations added Room Ventilation Requirements/Recommendations reference; Added roof hatch delivery situation to Cryogenic Vent inspection CAUTION; Added height requirement for RF Shielded Room Contractor supplied vent pipe/waveguide in Magnet Room. **Sec 5:** Added PDU feeder wiring requirement with full system UPS option; Clarified MDC requirement for 2 circuit breakers. Updated Common Ground Stud location dimension in Magnet Room Grounding Requirements illustration. **Sec 6:** Added notes to identified RF Transmit & RF Receive cables; Updated miscellaneous system interconnects. **Sec 7:** References typo error corrected. **Sec 8:** Added Transportation Environmental Conditions. **Appendix C:** Added REQUIREMENTS FOR EQUIPMENT ROOM SHARED BY MULTIPLE MR SYSTEMS.

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REV	DATE	PRIMARY REASON FOR CHANGE
11	May 1, 2003	**Sec 1:** Deleted Remote Keyboard Option for use with Operator Workspace PC LCD catalogs. **Sec 2:** BrainWave Cabinet weight increased and center of gravity location changed. Illustration 2–20 corrected Magnet Monitor vertical box and mounting flange dimensions. **Sec 4:** Table 4–2 added **bold** Note 2 air cooling load average of maximum values; Table 4–2 revised 1.0T SFR Cabinet maximum heat output value; Table 4–2 revised BrainWave Cabinet for increase heat output value. Table 4–4 Note 6 changed preferred concentration from 75/25% to 65/35%. Section 4–6–3 Design Guidelines for acoustics added Structural Vibration Control information, clarified STC values for RF doors. Section 4–8 Room Ventilation pressure equaliztion waveguide requirement added IEC regulation reference. Section 4–14–4 Transient Vibration specification added clarifications for measurements. **Sec 5:** Illustration 5–1 added SPLICE on Run 296 BLK wire connection. **Sec 6:** Ilustration 6–1 added Equipment Room and Control Area delinating lines (requested by Installation Specialist). Illustration 6–1, Tables 6–2 & 6–3 corrected cable Group 81 to connect between E02 and PP1. Table 6–3 Note 9 added M3044PC for increased usable length. Added Group 72 from MR1 to MG2 for with RF Transmits (removed from Groups 25 & 45).1.5T system RF Transmit interconnects changed for new material. 1.5T & 1.0T RF Transmit interconnects are cut to at site to length. 1.5T added note for M3044PA and M3044PC for increased usable length. BrainWave Option Interconnect List multiple updates incorporated. **Sec 8:** Updated BrainWave Cabinet increased weight. **Sec 9:** Changed hospital to facility in several items. **Sec 10:** Deleted RF survey apparatus no longer available from GE Medical Systems. Sec 9–4 items 1 & 2 grammar typos corrected.
12	Nov. 12, 2003	Signa CV/i offering discontinued, removed all associated information including manual title. Changed Signa 1.5T MR/*i* with EXCITE Technology system information to 1.5T Signa EXCITE II MR/*i* throughout the manual. Changed BrainWave Option information to BrainWaveHW Lite Option throughout the manual. Added MR Common Chiller Option information throughout the manual. **Sec 1:** Deleted Remote Keyboard Option for use with Operator Workspace PC LCD catalogs. **Sec 2:** Equipment Room Minimum Room Inside Clear Space Dimensions updated for Modality Installation Planning Services input. Deleted OW Table with Color Monitor floor bolted. MINIMUM SERVICE AREA illustration back wall to Magnet Enclosure front dimension corrected. **Sec 3:** Deleted “Magnet Rundown Unit initiated quenches WILL NOT cause the magnetic field to expand.” since such initiated quenches will allow field to expand within the bloom field dimensions. **Sec 4:** Section 4–4–2 Shield/Cryo Cooler Compressor Water Cooling Requirements, Water Cooling Specifications Table 4–4 Note 6 added Ethylene Glycol or Propylene Glycol wording and added internal pressure impact of 50/50 concentration. **Sec 5:** Updated facility zero voltage reference ground and wire requirements. Emergency off buttons mounting changed to “at a height specified by local/national codes“. Deleted NEC 1999 references per MR Safety & Regulatory Engineering direction. **Sec 6:** Restructured information for Locations 1, 2, 1/2, 3, 4, & 5 of interconnect and multiple lengths selections. **Sec 7:** RF Shielded Room Requirements added table Note for requirements applicability. **Sec 10:** Added AEMC Clamp–On Ground Rod Impedance Meter to Test Equipment.

Revision History (Continued)

REV	DATE	PRIMARY REASON FOR CHANGE
13	Aug. 10, 2005	**Throughout entire manual:** Discontinued catalogs (Signa 1.0T and Signa 1.5T EXCITE) and related information deleted therefore changed manual title to Signa EXCITE MR/*i* 1.5T. Added VibroAcoustic Damping Option catalog information. Added National Electrical Code (NEC) 2005 article references. Reformatted entire manual for Chapters in place of Section (Chapter numbers incremented by 1 compared to prior Section numbers due to addition of Chapter 1 Pre–Installation Introduction.) Change to chapters was made to enable common PIM document structure for Installation Services checklist referencing. **Chapter 1:** Added Crticial To Image Quality section. **Chapter 2:** Added Remote MRU M1060KN option. **Chapter 3:** Cabling Consideration subsection replaced with Sec 6 MR System Interconnects Routing subsection. Former Flooring section changed to Sec 7 Floors, requirements/ recommendation table added. Sec 8–3–2 MRCC Access & Air Considerations added airflow Notices. Sec 8–3–5: MRCC start Chiller tasks responsibility changed. Also updated Service Providers and contact information. Sec 9–1 Updated Blower Box mounting requirements. Sec 9–7 System Monitoring & Support Connectivity Requirements updated broadband info. Added Sec 9–9 Remote MRU Option. Sec 10 Architectural Reminders deleted GE Service documentation storage cabinet due to use of electronic service documentation. Sec 12: Magnet Load Pattern with VibroAccoustic Damping Option illustration deleted Magnet feet dimensions since VibroAcoustic Damping Option mats contact the floor of Magnet Mounting Recessed Area. Revised ACGD/PDU Cabinet weight to 838 kg**.** Revised MRCC Outdoor Mounting concrete pad dimensions for Front & Rear Views. Magnet Monitor dimension illusration updated to Magnet Monitor 3 appearance (no change to mounting holes dimensions). **Chapter 4:** Section 3 Structural Steel Evalutation Of Proporsed Sites added Notice for site with exisiting Magnetic Shield and revised actions to address steel in close proximity to magnet. Added magnet field plot front view illustration. **Chapter 5:** Added IEC EMC Compliance section per MR Safety & Regulatory Engineering. Clarified MR System Maximum Heat Output For Air Cooling table note for Equipment Room HVAC system must be sized to meet Temperature and Humidity specifications during working day. Section 7 Lighting updated requirements/recommendations. Section 8 Acoustics subsection added VibroAcoustic Damping Option catalog information. Section 9 Room Ventilation revised Exhaust fan capacity requirements per MR Safety & Regulatory Engineering. Section 10–2 Requirements For Outside Magnet Room clarified Vent Exit and Termination requirements and added Side Wall exit information. Section 10–3 Requirements For Inside Magnet Room Table 5–9 Vent Construction row added Note requiring no vertical or side load to waveguide or vent pipe. Section 15 Construction Materials section 15–2 Electrical Conduits and 15–3 Walls, Ceilings, and Fixtures updated to address potential RF broadband noise sources. **Chapter 6:** Changed Customer Require Power from PDU to MDP. Clarified GE pre–engineered MDP option provided Emergency Off buttons. **Chapter 7:** Table 7–2 L5 Relative Length Provided changed to "same length for all catalogs". Group 5 changed to Group 16 (MDP to MRCC Unit #2) to be consistent with 3T system group numbers for same function. Customer Supplied Interconnects table added missing Group 21 (Facility Water Supply to GWHX). Interconnects For Two & One MRCC Unit Located Outdoors Additional Interconnects details table for Customer Supplied Groups 49 and 50 the FROM, TO and Notes columns info of "for Gradient Coil" and "for Shield/Cryo Cooler Compressor" corrected to match Interconnect diagram. Groups 49 and 50 updated Notes for water lines, eliminated redudant words. Added Sec 10 Remote MRU Option Interconnects. **Chapter 8:** Entire RF Shielded Room chapter revised with background, definitions, and requirements to minimize the generation of signals within the RF Shield and Magnet Room which can adversely affect image quality. Sec 2–5 HVAC added honey comb–type waveguide accessibility. Section 6–5 Magnet Room Floors clarified specifications in new added requirements/ recommendation table includes added requirements for finished floor surface resistance and no carpeting . Sec 7 Anchor Hardware Requirements For MR Equipment Inside RF Shielded Room clarified requirement for two part type removable anchor and bolt/removable rods for equipment mounting. **Chapter 9:** Consolidated Shipment and Storage subsections into 1 subsection (Shipment) with same environmental conditions. Consolidated Magnet Considerations and Cold–Shipped Magnet Deliveries subsections into 1 subsectiondue to normal delivery method is cold–shipped magnet. **Chapter 11:** Table 10–1 deleted items 2 & 3 not used for Moving Metal Measurements.

* This revision number/letter corresponds to the indicated document's revision control system.

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Chapter 1 – Pre–Installation Introduction

1 Introduction

This document contains the physical, magnetic, cryogenic, plumbing and electrical data necessary for planning and preparing a site for a magnetic resonance system. “Preinstallation work” is done to prepare the customer’s premises for the installation of the products sold. It is the responsibility of the purchaser to arrange for performance of this work. Such work includes:

- Installation of the electrical conduit, junction boxes, ducts, surface raceways, outlets and line safety switches.
- Installation of wires not supplied by GE Healthcare such as: the facility input power line and ground conductor to the power distribution unit, as well as emergency power lines and facility power lines and ground conductor to the the Magnet Room. The electrical contractor shall ring out and tag all wires at both ends. Color–coded wires are recommended for easier identification. Wires shall be continuous without splices. Insulation on all equipment ground wires must be green with a yellow stripe.
- Installation of non–electrical lines such as: water plumbing, helium venting systems and air conditioning equipment. Also, installation of recommended air, vacuum and oxygen lines into the Magnet Room. All lines must be clearly labeled.
- Installation of RF shielding in Magnet Room and installation of equipment anchors.
- Acoustic properties of the MR Magnet Room including the RF Shield need to meet local regulations and customer requirements. All aspects of the room including the constructed walls and all purchased items such as windows, doors, vents, etc. need to be considered.
- Site construction or renovation.
- Installation of structural reinforcements as required.
- Installation and testing of selected magnetic shielding as required.
- Installation of water treatment equipment if necessary.
- Scheduling of riggers to move magnet (under GE Healthcare direction) into its final location within the Magnet Room.

All work MUST be in compliance with national and local building and safety codes.

A structural steel analysis may be necessary during site evaluation for a magnetic resonance system. All site plans and preliminary concepts should be reviewed by GE Healthcare MR Siting group prior to construction.

Unless specifically mentioned, GE Healthcare does not provide or install: the facility input power lines to the Main Disconnect Panel and Power Distribution Unit or the power lines required in the Magnet Room, nor raised flooring, conduit, junction boxes, room lighting, warning lights, ducts, plumbing, water treatment equipment, cryogenic venting outside the Magnet Room, non standard cryogenic venting inside the Magnet Room, acoustic treatment to contain acoustic noise (airborne and structureborne) within the RF shielded room, or the RF shielded room illustrated in this document.

Note

GE does offer the VibroAcoustic Damping Option to suppress LCC type Magnet generated vibration (this is not an acoustic treatment). All floor preparations for this option are the responsibility of the customer.

1 Introduction (Continued)

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

Pre–installation information is continually changing due to the evolution of the product. GE will make every reasonable effort to maintain accuracy of pre–installation information.

2 Critical To Image Quality

Certain aspects of the MR site have the potential to cause image quality issues. Table 1–1 lists the site aspects that have currently been identified as Critical To Image Quality (CTIQ).

TABLE 1–1
MR Site Critical To Image Quality

Number	Topic	Specifications
CTIQ#1	Vibration	Refer to Chapter 5, Section 16 Vibration
CTIQ#2	Magnetic Field	Refer to ● Chapter 3, Section 2 Proximity Limits ● Chapter 4: Section 1 Introduction, Section 2 Homogeneity Requirements, Section 3 Structural Steel Evaluation Of Proposed Sites, Section 4 Magnetic Shielding, Section 5 Magnetic Field, and Section 6 Exclusion Zone For 1.5T LCC (Active Shield) Magnets ● Chapter 5, Section 14 Changing Magnetic Environment Specifications
CTIQ#3	Structural Steel	Refer to ● Chapter 4, Section 3 ● Magnet Room Floors Magnetic Properties section in Chapter 5, Section 15 Construction Materials
CTIQ#4	Magnet Room Floor and Recessed Magnet Mounting Area	Refer to Chapter 8, Section 2–2 Determining Cryogenic Vent Location and Chapter 8, Section 6–5 Magnet Room Floors
CTIQ#5	Acoustics	Refer to Chapter 5, Section 8–3 System Acoustic Noise Levels and Chapter 5, Section 8–4 Design Guidelines
CTIQ#6	Power Quality	Refer to Chapter 6, Section 1 System Power Introduction and Chapter 6, Section 2 Critical Power Requirements
CTIQ#7	Lighting	Refer to Chapter 5, Section 7 Lighting
CTIQ#8	Multiple MR System Site	Refer to Chapter 3, Section 4–1 Two Magnet Site Layout and Section 4–2 Equipment Room Shared By Multiple MR Systems
CTIQ#9	Cryogenic Vent	Refer to ● Chapter 5, Section 10–1 Cryogenic Venting Introduction ● Chapter 5, Section 10–2 Requirements For Outside Magnet Room ● Chapter 5, Section 10–3 Requirements For Inside Magnet Room
CTIQ#10	Broadband Network Connection & Telephone	Refer to Chapter 3, Section 9–7 System Monitoring & Support Connectivity Requirements
CTIQ#11	Room Ventilation & Air Conditioning	Refer to ● Chapter 5, Section 9 Room Ventilation ● Chapter 5, Section 3 Temperature And Humidity Specifications and Chapter 5, Section 4 Air Cooling Requirements
CTIQ#12	Water Cooling	Refer to Chapter 5, Section 5–4 Shield/Cryo Cooler Requirements For Site Provided Water Cooling
CTIQ#13	Magnet Room Equipment Anchors Pull Test	Refer to Chapter 8, Section 7–4 Clamping Force (Tension) And Pull Test
CTIQ#14	Magnet Room Equipment Anchors Electrical Isolation	Refer to Chapter 8, Section 7–6 Electrical Isolation
CTIQ#15	Main Disconnect Panel (MDP)	Refer to Chapter 6, Section 1 System Power Introduction and Chapter 6, Section 2 Critical Power Requirements
CTIQ#16	Dust–Free Environment	Refer to Chapter 5, Section 13 Pollution

3 Glossary

BB – Abbreviation for Broad Band

ACGD – Abbreviation for Advanced Control Gradient Drivers

Cryogen – A substance for producing low temperatures. Liquid helium is the cryogen used to cool the magnet to approximately 4 Kelvin (–269°C or –452°F).

Cryostat – An apparatus maintaining a very low constant temperature. The cryostat consists of one concentric, cylindrical container housed in an outer vacuum tight vessel. The magnet and shim coils are mounted in the inner container. The container is filled with liquid helium. The shields surrounding the inner container are kept cold by a refrigeration device.

DEWAR – A container with an evacuated space between two highly reflective walls used to keep low temperature substances at near–constant temperatures. Liquid helium is usually stored and shipped in dewars.

Exclusion Zone – Area where the magnetic flux density is greater than five gauss. Personnel with cardiac pacemakers, neurostimulators and other biostimulation devices must NOT enter this zone. Signs are posted outside the five gauss line alerting personnel of this requirement. Since the magnetic field is three–dimensional, signs are also posted on floors above and below the Magnet Room in which the five gauss line exists.

Ferrous Material – Any substance containing iron which is strongly attracted by a magnetic field.

Gauss (G) – A unit of magnetic flux density. The earth's magnetic field strength is approximately one half gauss to one gauss depending on location. The internationally accepted unit is the tesla (1 Tesla = 10,000G and 1 milli Tesla = 10G).

Gradient – The amount and direction of the rate of change in space of the magnetic field strength. In the magnetic resonance system, gradient amplifiers and coils are used to vary the magnetic field strength in the x, y, and z planes.

Homogeneity – Uniformity. The homogeneity of the static magnetic field is an important quality of the magnet.

Isocenter – Center of the imaging volume ideally located at the magnet center.

Isogauss Line – An imaginary line or a line on a field plot connecting identical magnetic field strength points.

Magnetic Field (H) – A condition in a region of space established by the presence of a magnet and characterized by the presence of a detectable magnetic force at every point in the region. A magnetic field exists in the space around a magnet (or current carrying conductor) and can produce a magnetizing force on a body within it.

Magnetic Resonance (MR) – The absorption or emission of electromagnetic energy by nuclei in a static magnetic field, after excitation by a suitable radio frequency field.

Magnetic Shielding – Using material (e.g. steel) to redistribute a magnetic field , usually to reduce fringe fields.

Quench – Condition when a superconducting magnet becomes resistive thus rapidly boiling off liquid helium. The magnetic field reduces rapidly after a quench.

Radio Frequency (RF) – Frequency intermediate between audio frequency and infrared frequencies. Used in magnetic resonance systems to excite nuclei to resonance. Typical frequency range for magnetic resonance systems is 5–130 Mhz.

3 Glossary (Continued)

Radio Frequency Shielding – Using material (e.g. copper, aluminium, or steel) to reduce interference from external radio frequencies. A radio frequency shielded room usually encloses the entire magnet room.

Resonance – A large amplitude vibration caused by a relative small periodic stimulus of the same or nearly the same period as the natural vibration period of the system. In magnetic resonance imaging, the radio frequency pulses are the periodic stimuli which are at the same vibration period as the hydrogen nuclei being imaged.

Security Zone – Area within the Magnet Room where the magnet is located. Signs are posted outside the Magnet Room warning personnel of the high magnetic field existing in the Magnet Room and the possibility of ferrous objects becoming dangerous projectiles within this zone.

Shield Cooler Coldhead – An external refrigeration device which maintains the shields inside the cryostat at a constant temperature.

Shim Coils – Shim coils are used to provide auxiliary magnetic fields in order to compensate for inhomogeneities in the main magnetic field due to imperfections in the manufacturing of the magnet or affects of steel in the surrounding environment.

Shimming – Correction of inhomogeneity of the main magnetic field due to imperfections in the magnet or to the presence of external ferromagnetic objects.

Superconducting Magnet – A magnet whose magnetic field originates from current flowing through a superconductor. Such a magnet is enclosed in a cryostat.

Superconductor – A substance whose electrical resistance essentially disappears at temperatures near zero Kelvin. A commonly used superconductor in magnetic resonance imaging system magnets is niobium–titanium embedded in a copper matrix.

Tesla (T) – The internationally accepted unit of magnetic flux density. One tesla is equal to 10,000 gauss. One milli Tesla is equal to 10 gauss.

Chapter 2 – System Configuration

1 Introduction

The 1.5T Signa EXCITE MR/*i* Magnetic Resonance (MR) system is documented throughout this publication.

Note

There are some naming differences between the sales literature documents and the technical documentation. Listed below are the corresponding names. The Pre–Installation document uses the technical document names.

SALES LITERATURE NAME	=	TECHNICAL DOCUMENT NAME
Signa Infinity 1.5T with EXCITE	=	1.5T Signa EXCITE II MR/*i*
CX 150 Magnet with K4 Technology	=	1.5T LCC (Active Shield) Magnet

2 Basic System

The basic system for fixed site operation consists of the following major equipment:

Note

True Mobile system water cooling for the Gradient Coil and the Shield/Cryo Cooler Compressor is provided by the Mobile Van equipment.

- 15 kilogauss (1.5T) LCC (Active Shield) Magnet & Magnet Enclosure
- Magnet and Magnet Accessories
- Shield/Cryo Cooler Compressor Cabinet
- Gradient (BRM) and RF body coils and 1.5T Quad Head Coil
- Penetration Panel for MR system interconnects in the RF Shield
- Main Disconnect Panel customer supplied (GE design available or customer custom design dependent on Illustration 1–1 flowchart decisions)
- System electronics cabinets: ACGD/PDU Cabinet, 1.5T SRFD II Cabinet and the System Cabinet which contains the Multi Generational Data Acquisition (MGD) chassis, Remote RF chassis, Driver Module, and Terminal Server
- Operator Workspace equipment consisting of the Global Operator Console (GOC) Computer Cabinet with Linux PC, SCSI Tower, Mouse and Mouse Pad, LCD panel, and chair
- Pneumatic Patient Alert System
- Patient Transport Table
- Patient accessories

The tables in this section list the major equipment which comprise the Signa EXCITE MR/*i* systems. Illustration 2–1 shows the major equipment of the EXCITE Signa MR/*i* system.

TABLE 2–1
SYSTEM ELECTRONICS MAJOR EQUIPMENT

CATALOG	DESCRIPTION
M3000NB SmartSpeed Phased Array with EXCITE II	● System Cabinet consisting of MGD chassis, Remote RF chassis, and Driver Module. ● The equipment listed in Note 1 ● 1.5T Quad Head Coil
M3000DC HiSpeed Plus Phased Array with EXCITE II	● System Cabinet consisting of MGD chassis, Remote RF chassis, and Driver Module. ● The equipment listed in Note 1 ● 1.5T Quad Head Coil
M3000DD EchoSpeed Plus Phased Array with EXCITE II	● System Cabinet consisting of MGD chassis, Remote RF chassis, and Driver Module. ● The equipment listed in Note 1 ● 1.5T Quad Head Coil

Note 1 The following major equipment is included in above EXCITE II catalogs:

- ACGD/PDU Cabinet containing ACGD Gradient drivers and Power Distribution Unit module with unregulated transformer 200/380/400/415/480Volt, 50/60 Hz with power filter.
- Pneumatic Patient Alert System.
- Operator Workspace equipment: GOC Computer Cabinet, SCSI Tower, Mouse and Mouse Pad, LCD panel, and chair. Note, refer to Tables 2–3, 2–4, and 2–9 for catalog choices required to complete Operator Workspace equipment.
- Patient Transport Table and cradle.
- Patient accessories such as: a phantom kit, patient log book, head cushion and sponges, chin and forehead straps, body wedges, knee cushions, and security/restraint straps.
- Gating accessories which include: patient cardiac leads, peripheral gating probe, and respiratory bellows.

2 Basic System (Continued)

TABLE 2–2
1.5T SIGNA EXCITE II MR/*i* SRFD CABINET (SELECT ONE)

CATALOG	DESCRIPTION
M3090LK	● Standard 1.5T SRFD II Cabinet containing the RF Amplifiers, RF Power Monitor, power supplies for the Magnet Enclosure system components.
M3090LJ	● MNS 1.5T SRFD II Cabinet containing the RF Amplifiers, RF Power Monitor, power supplies for the Magnet Enclosure system components, and MNS Amplifier. *See Note 1*
Note 1 MNS option also requires M3090LB Signa EXCITE MNS Kit which provides MNS LPCC, additional SRFD Cabinet equipment, software, and interconnect cables.	

TABLE 2–3
OPERATOR WORKSPACE MONITOR

CATALOG	DESCRIPTION
M1000NT	● LCD Color Monitor

TABLE 2–4
OPERATOR WORKSPACE TABLE (One Required For Fixed Site, Not Applicable To T/R & True Mobile)

CATALOG	DESCRIPTION
M1000MW	● Table for Operator Workspace *See Note 1*
Note 1 OW Table is an integral part of the regulatory approved system. OW Table provides mounting for several assemblies (e.g. OW Interface Module, OW Power Distribution Box, Modem, DASM) and cable routing for OW interconnects.	

TABLE 2–5
1.5T INTEGRATED BODY MODULE (SELECT ONE)

CATALOG	DESCRIPTION
M1085BG	● 1.5T Advanced 60 cm Integrated Body Module (BRM–F)

2 Basic System (Continued)

TABLE 2–6
1.5T MAGNET SUBSYSTEM (SELECT ONE)

CATALOG	DESCRIPTION
M1060LA	● 15 kilogauss (1.5T) LCC (Active Shield) Magnet for Fixed Site or Transportable/Relocatable Mobile (See Note 1). Includes partial Enclosure installed on magnet, Magnet Rundown Unit and Magnet Monitor (performs cryogen meter function and magnet pressure control). (**See Notes 2 & 3**)
M1061LA	● 15 kilogauss (1.5T) LCC (Active Shield) Magnet for True Mobile (See Note 1). Includes partial Enclosure installed on magnet, Magnet Rundown Unit, Magnet Monitor (performs cryogen meter function and magnet pressure control), and UPS for Magnet Monitor equipment. (**See Note 2**).
Note 1 For Mobiles (Transportable, Relocatable, and True Mobile) contact your selected Van Manufacturer for site pre–installation, refer to Section 5, Van Manufacturers Contact Information. 2 **M1060JW Shield/Cryo Cooler Compressor (water cooled) must be ordered for LCC Magnet. The Shield/Cryo Cooler Compressor is not part of the LCC Magnet Catalogs but is required at magnet delivery to minimize cryogen consumption. Refer to Chapter 6 Power Requirements and Chapter 5 Section 5 Water Cooling Requirements for details of compressor 24 hour power and water cooling needs.** 3 If M1060LA or M1860LA Magnet is to be shipped by air then must order M1060SC Magnet Air Transport Crate (not required within Continental USA).	

TABLE 2–7
LCC MAGNET 2.5 METER CEILING HEIGHT KIT (OPTIONAL)

CATALOG	DESCRIPTION
M1060SR	● LCC Magnet Low Ceiling Height (2.5 Meter) Siting Option **Note:** This option reduces the minimum required ceiling height for the Magnet Room to 2.5 meters from 2.67 meters. Check with GE Installation Specialist to determine if this is a required option.

TABLE 2–8
RECON PROCESSOR WITH BAM MEMORY (SELECT ONE)

CATALOG	DESCRIPTION
M3000RH	● EXCITE ReFlex200 with 1 GB memory
M3000RJ	● EXCITE ReFlex400 with 2 GB memory

2 Basic System (Continued)

TABLE 2–9
COUNTRY KITS (SELECT ONE)

CATALOG	DESCRIPTION
M1000MN	● English Keyboard
M1000MP	● French Keyboard
M1000MR	● German Keyboard
M1000MS	● Scandinavian Keyboard
M1000NH	● Italian Keyboard
M1000NJ	● Portuguese Keyboard
M1000NK	● Spanish Keyboard

TABLE 2–10
PHYSICIAN CHAIR (SELECT ONE)

CATALOG	DESCRIPTION
E8803BE	● Physician chair

TABLE 2–11
IIP GLOBAL MODEM (ONE REQUIRED)

CATALOG	DESCRIPTION
M1000NW	● MR InSite Interactive Platform Global Modem; An external InSite modem is required to be available during system installation and warranty time.

TABLE 2–12
FILMING INTERFACE (SEE NOTE 1 IN TABLE)

CATALOG	DESCRIPTION
M1000MK	● Digital DASM
Note 1 Must choose one Filming DASM Board unless DICOM Print will be used exclusively for software filming to DICOM print peripheral devices.	

2 Basic System (Continued)

TABLE 2–13
1.5T SYSTEM SITE COLLECTOR KIT WITHOUT CABLES (SELECT ONE)

CATALOG	DESCRIPTION
M3043PD	● LCC (Active Shield) Magnet Fixed Site Wide Open Enclosure ● Penetration Panel with Phase Array hardware integrated and Penetration Panel Covers ● SPT Phantom Set with Shipping/Storage Cart
M3053PD	● LCC (Active Shield) Magnet True Mobile Site Wide Open Technology Enclosure ● Penetration Panel with Phase Array hardware integrated ● True Mobile Site system interconnect cables including Phased Array Option ● True Mobile Site Power Distribution Unit cables ● SPT Phantom Set
M3063PD	● LCC (Active Shield) Magnet Transportable/Relocatable Mobile Site Wide Open Enclosure ● Penetration Panel with Phase Array hardware integrated ● Transportable/Relocatable Mobile Site system interconnect cables including Phased Array Option ● Transportable/Relocatable Mobile Site Power Distribution Unit cables ● SPT Phantom Set with Shipping/Storage Cart

TABLE 2–14
CABLE COLLECTOR FOR 1.5T SIGNA MR/*i* WITH EXCITE II (SELECT ONE)

CATALOG	DESCRIPTION
M3143PD	● Fixed Site system interconnect cables for configuration A lengths (refer to Chapter 7 Section 4–2 Cable Groups Length Provided)
M3144PD	● Fixed Site system interconnect cables for configuration B lengths (refer to Chapter 7 Section 4–2 Cable Groups Length Provided)
M3145PD	● Fixed Site system interconnect cables for configuration C lengths (refer to Chapter 7 Section 4–2 Cable Groups Length Provided)
M3153PD	● True Mobile system interconnect cables
M3163PD	● Transportable/Relocatable Mobile system interconnect cables

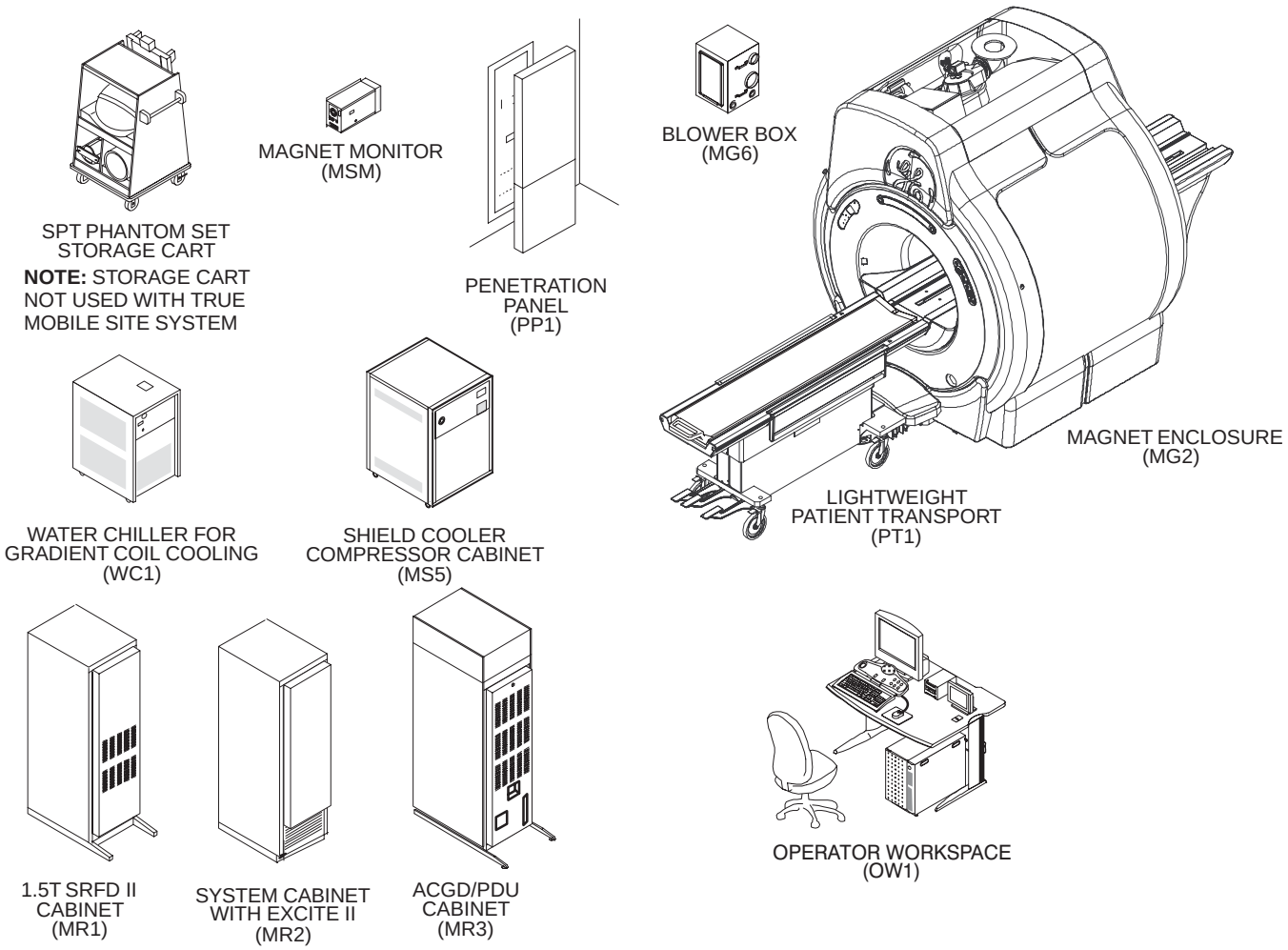
TABLE 2–15
WATER CHILLER FOR GRADIENT COIL COOLING (SELECT ONE)

CATALOG	DESCRIPTION
M1085KC	● 60 Hz Water–to–Air Chiller for Gradient Coil Cooling *See Note 1*
M1085KB	● 50 Hz Water–to–Air Chiller for Gradient Coil Cooling *See Note 1*
M1085KF	● 50/60 Hz Water–to–Water Heat Exchanger for Mobile systems Gradient Coil Cooling *See Note 2*

Note 1 Fixed Site must order Water Chiller for their power frequency (60 or 50 Hz). Mobile (True, Transportable, Relocatable) systems do not require this chiller, Gradient Coil chilled water will be provided by Van chilled water system.

2 True Mobile, Transportable and Relocatable systems require this heat exchanger. The Mobile van will provide chilled water for the heat exchanger operation.

2 Basic System (Continued)



1.5T SIGNA EXCITE II MR/*i* SYSTEM
ILLUSTRATION 2–1

3 System Options

This section lists options for Signa MR/*i* systems which may have site preparation impact.

- The VibroAcoustic Damping Option (M1060MA) provides a method to reduce the probability of acoustic structureborne transmission throughout the customer facility.
- EXCITE 8 Channel Option (M3033CB)
- Bar Code Reader (M1090PM) for use in conjunction with HIS/RIS software option.
- Additional Patient Transport table with cradle for WideOpen Enclosure (M1090TL).
- The BrainWave®HW Lite Option (M1033BL) option provides software and hardware stimulus components which are intended to be used in conjunction with 3rd party MR compatible audio and video stimulus devices (headphones, goggles, etc.) to produce brain activation images from MR Blood Oxygen Level Dependent (BOLD) scan data. The hardware components provided includes the Stimulus PC, keyboard, and monitor as well as the cabinet that houses them. The package also includes push button response boxes, a standard interface panel that is added to the MR System Penetration Panel, and interconnecting cables. The Stimulus software provided with the BrainWave HW Lite option package resides on the Stimulus PC. M1033BL requires BrainWaveRT (M1033BT) software on the MR system host computer.
- Remote MRU (M1060KN) provides a second Magnet Rundown Unit (MRU) which can be located outside the Magnet Room.
- Advantage Windows Workstation
- Other hard copy devices and patient accessories.
- Cryogen refill service.
- Various GE Healthcare service contracts.

4 Facility Options

- Direct current (DC) lighting controller for the magnet room (each system requires 208 VAC 3 phase 4 wire 60Hz power):
  - E4503AD 20 Amp Maximum Constant Lighting Level System, surface/semi–flush mount
  - E4503AF 20 Amp Maximum Variable Lighting Level System, surface/semi–flush mount
  - E4503AW 28 Amp Maximum Constant Lighting Level System, surface/semi–flush mount
  - E4503AY 28 Amp Maximum Variable Lighting Level System, surface/semi–flush mount. 50 Hz designs are available by special order.

Note

DC Lighting Controller 50 Hz designs are available by special order, for more information contact:

Dwight Gilbert,GE Supply	414–527–6638	Dwight.Gilbert@supply.ge.com
Lou Hernandez, GE Industrial Systems	262–797–4910	lou.hernandez@indsys.ge.com

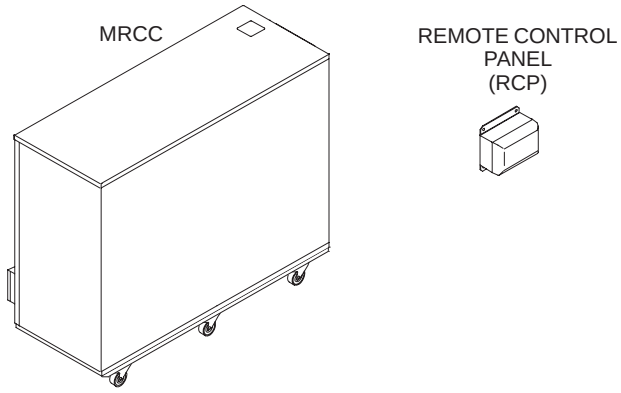
- GE pre–engineered MR Signa Main Disconnect Panel with shield cooler compressor auto restart accessory (E4503AT) for 480/277 VAC wye 5 wire or grounded delta 4 wire, surface/semi–flush mount.

- Digital Energy SG Series UPS 100KVA (E4502FB) provides reliable, clean, constant voltage power for the complete MR system. The use of a full system UPS enables the system imaging to be completed after loss of supply power and allows for saving of valuable data and orderly system shutdown. Also recommend installing a 100KVA UPS Bypass Panel (E4504CG) which feeds power to the UPS in the normal mode and enables the imaging system to operate when the UPS is in manual bypass mode for routine servicing of the UPS.

Note

GE MDP (E4503AT) option does not support the Coldhead Chiller (MRCC) option. Customer is responsible for the power requirements for MRCC (M3088TL).

- MR Common Chiller (MRCC) (M3088TL)
  The MRCC is a single–loop 10KW 50/60 Hz water chiller that can be used to provide water cooling for the Shield/Cryo Cooler Compressor. The MRCC can be installed either indoors or outdoors. There is a Remote Panel to be installed in the MR system Equipment Room that can stop or restart the chiller and can display supply water temperature, chiller setpoints and alarms (see Illustration 2–2) . This chiller will be serviced by a third party vendor.



MR COMMON CHILLER (M3088TL)
ILLUSTRATION 2–2

4 Facility Options (Continued)

- Signa System Seismic Anchorage Service (R4390JA).

Note

Magnet Seismic anchoring is the customer's responsibility to coordinate magnet mounting methods with the RF shielded room vendor to prevent RF leaks and secondary grounding problems. Refer to Chapter 8 Section 7 Anchor Hardware Requirements For MR Equipment Inside RF Shielded Room for details**.**

- Oxygen Monitor Kit (M1060KM) which includes Oxygen Monitor and Remote Oxygen Monitor Module.

Note

The Oxygen Monitor does not bear a CE monogram and therefore may not be acceptable in all European countries.

5 Van Manufactures Contact Information

Pre–Installation requirements may vary for specific Mobile configuration (True Mobile, Transportable, or Relocatable) and between Van Manufacturers. Listed below is contact information for GE Van Manufacturers.

- Ellis & Watts
  4400 Glen Willow Lake Lane — Telephone: 513–752–9000
  Batavia, OH 45103 — FAX: 513–752–4983
  USA

- PDC Facilities
  700 Walnut Ridge Drive, PO Box 900 — Telephone: 262–367–7700
  Hartland, WI 53029–0900 — FAX: 262–367–7744
  USA

- SMIT Mobile Equipment
  Buys Ballotstraat 6
  3261 La Oud–Beijerland — Telephone: (31) 186–6–14322
  Holland — FAX: (31) 186–6–19367

- AK Specialty Vehicles
  16745 South Lathrop Avenue — Telephone: 708–596–5066
  Harvey, IL 60426 — FAX: 708–596–2480
  USA
  AK Specialty Vehicles is also the contact for used Calumet Coach trailers.

4 Facility Options (Continued)

- Signa System Seismic Anchorage Service (R4390JA).

Note

Magnet Seismic anchoring is the customer's responsibility to coordinate magnet mounting methods with the RF shielded room vendor to prevent RF leaks and secondary grounding problems. Refer to Chapter 8 Section 7 Anchor Hardware Requirements For MR Equipment Inside RF Shielded Room for details**.**

- Oxygen Monitor Kit (M1060KM) which includes Oxygen Monitor and Remote Oxygen Monitor Module.

Note

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  AK Specialty Vehicles is also the contact for used Calumet Coach trailers.

Chapter 3 – Room Layouts

1 Introduction

When laying out a floor plan there are special considerations that must be taken into account due to the magnetic field effect on certain medical implants (including cardiac pacemakers, neurostimulators, and biostimulation devices) and the environmental effect (motors, steel, etc.) on the magnet field homogeneity. The maximum magnetic field in which the equipment can be located is listed in Table 3–1. Selected magnetic shielding of some devices and equipment is possible but must be handled on an individual basis. Refer to Chapter 7 Interconnect Data for cable length considerations.

The RF shielded room (Magnet Room) is unique in that the room must be shielded from outside radio frequency interference. This is done by enclosing the room with metal walls, floors and ceiling. These shielding requirements impose special considerations which are addressed in Chapter 8 RF Shielded Room.

The Magnet Room can be magnetically shielded to reduce the magnet fringe field or to shield the magnet from the effects of the external environment. Refer to Chapter 4 Section 4 Magnetic Shielding for magnet shielding considerations.

2 Proximity Limits

The maximum magnetic field in which the equipment can be located is listed in Table 3–1.

TABLE 3–1
PROXIMITY LIMITS

GAUSS (mT) LIMIT See Notes 1 & 2	EQUIPMENT	
0.5 GAUSS (0.05mT) OR LESS See Note 4	• Nuclear cameras	
1 GAUSS (0.1mT) OR LESS See Note 4	• Positron Emission Tomography scanner • Linear Accelerator • Cyclotrons • Accurate Measuring scale • Image intensifiers • Color TV	• Video display (color, B/W, monochrome) • CT scanner • Ultrasound • Lithotriptor • Electron microscope • Advantage Workstation with CRT Monitor
3 GAUSS (0.3mT) OR LESS See Note 4	• Power transformers • Main electrical distribution transformers • Moving steel equipment such as: – Vehicular traffic – Fork lift trucks – Dumb waiters – Electric transport carts	 – Loading dock (truck traffic) – Elevators – Escalators – Helicopters (See Note 3)
5 GAUSS (0.5mT) OR LESS	• Cardiac pacemakers • Neurostimulators	• Biostimulation devices
10 GAUSS (1mT) OR LESS	• Magnetic tapes and floppy discs • Hard copy imagers • Line printers • Video Cassette Recorder (VCR) • Film processor • Credit cards, watches, and clocks • Telephone switching station • Water cooling equipment • HVAC equipment	• Major mechanical equipment room • Large steel equipment such as: – Emergency generators – Commercial laundry equipment – Food preparation area – Air conditioning chiller – Fuel storage tanks – Motors greater than 5 horsepower • X–ray tubes
30 GAUSS (3mT) OR LESS	• System Control Cabinet • MR Common Chiller (MRCC) equipment (option)	• Heat Exchanger for Mobile System Gradient Coil Cooling
50 GAUSS (5mT) OR LESS	• GOC Computer Cabinet • Operator Workspace Cabinet • LCD Color Monitor for OW (See note 5) • SRFD II Cabinet • ACGD/PDU Cabinet • Water Chiller for Gradient Coil Cooling	• GE Main Disconnect Panel • Magnet Monitor • Telephones • Metal detector for screening • LCD Color Monitor for Advantage Workstation • Brainwave HW Lite Cabinet (option)
100 GAUSS (10mT) OR LESS	• Service Tool Magnet Power Supply Cabinet • Service Tool Shim Power Supply Cabinet	• Shield/Cryo Cooler Compressor Cabinet • Oxygen Monitor • Pneumatic Patient Alert Control Box
200 GAUSS (20mT) OR LESS	• Penetration Panel • Blower Box	• Magnet Rundown Unit • Remote Oxygen Sensor Module

Note 1 Refer to Chapter 4 Magnetic Field Considerations for magnet field plots.

2 Recommended limits given above are based on general MR site planning guidelines. Actual susceptibility of specific devices may vary significantly depending on electrical design orientation of the device relative to the magnetic field and the degree of interference considered unacceptable.

3 Verify operating limits with provider of helicopter service

4 The 0.5 gauss (0.05 mT), 1 gauss (0.1 mT), and 3 gauss (0.3 mT) or less proximity limits. Refer also to Chapter 5 Section 14 Changing Magnetic Environment Specifications additional proximity limits information.

5 If gauss limit is more than indicated for OW with LCD Color Monitor then contact GE to determine impacts on OW equipment.

3 Room Sizes

Table 3–2 contains minimum room dimensions necessary for an MR suite. Table 3–2 also contains issues which are created by reduction in service access, operator access, and equipment space.

TABLE 3–2
MINIMUM ROOM INSIDE CLEAR SPACE DIMENSIONS

SYSTEM CONFIGURATION	FINISHED EQUIPMENT ROOM MINIMUM VALUES See Note 6 & 7		FINISHED MAGNET ROOM MINIMUM VALUES See Note 4			FINISHED CONTROL ROOM MINIMUM VALUES See Note 7		TOTAL SYSTEM AREA ft^2 (m^2)
	W x D ft–in. (m)	AREA ft^2 (m^2)	W x D ft–in. (m)	AREA ft^2 (m^2)	CEILING HEIGHT ft–in. (m)	W x D ft–in. (m)	AREA ft^2 (m^2)	
System without a MRCC unit or MRCC located outdoors	8–0 x 12.0 (2.438 x 3.658) See Note 8	96.0 (8.919) See Note 8	10–11.27 X 19–7.4 (3.334 x 5.980) See Note 1, 2, 3, 5	214.6 (19.94)	8–9 (2.67) See Note 9	5* x 7 (1.52* x 2.13)	35 (3.24)	345.636 (32.111) See Note 8
System with 1 MRCC located in indoor	8–0 x 16–0 (2.438 x 4.88) See Note 8	136.0 (12.635) See Note 8						350.636 (32.575) See Note 8

Note * Width is dependent on Magnet Room door location and customer's approval of limited space available for operator.

1 Must locate magnet in the side–to–side center of magnetic room shield.

2 Minimum dimensions dependent on the magnetic field containment requested and dimensions of magnetic shield design.

3 Room dimensions in front of LCC Magnet MUST allow for Gradient Coil Assembly and split bridge installation/servicing. LCC Magnets MUST USE special Gradient Coil Replacement Tool Kit for replacing the Gradient Coil Assembly. The Gradient Coil Replacement Tool Kit is shipped in a wooden crate on casters. Utilization of Gradient Coil Replacement Tool requires 107.75 in. (2737 mm) clear space in front of magnet. Note split bridge servicing requires 77.5 in. (1969 mm) clear space in front of the magnet.

4 Absolute Minimum Magnet Room dimensions will result in limited operator clearances and increased Magnet Service time. Illustration 3–9 shows only 1.5 ft (0.46 m) clearance at end of Patient Transport.

5 Room dimensions do not contain 5 gauss line to room.

6 Equipment Room contents for the listed dimensions include ACGD/PDU Cabinet, EXCITE System Cabinet, SRFD II Cabinet, Water Chiller for Gradient Coil Cooling, Shield/Cryo Cooler Compressor Cabinet, MDP, Magnet Monitor, and DC Lighting Controller and Autotransformer option. The minimum room dimensions do not permit space for any optional equipment such as Advantage Workstation, Laser Camera, etc.

7 Minimum Equipment Room and Control Room dimensions do not permit placement of air conditioning units in room.

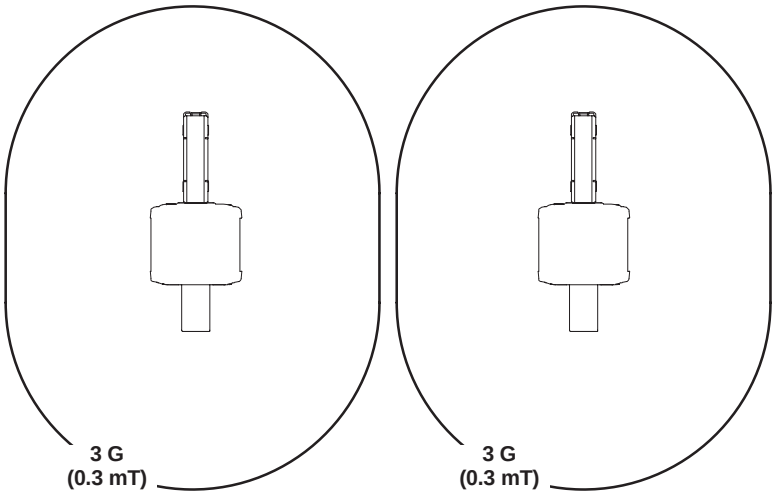
8 When the MRCC option is not selected then the customer site must still provide water cooling for the LCC Magnet Shield/Cryo Cooler Compressor Cabinet. Minimum Equipment Room for system without does not permit placement of equipment which will provide water cooling for Shield/Cryo Cooler Compressor.

9 Magnet Room minimum ceiling height is 8 ft 2.5 in. (2.50 meter) when Low Ceiling Height Siting Option (M1060SR) is installed. Refer to Chapter 8 Section 6–3 Ceiling Height.

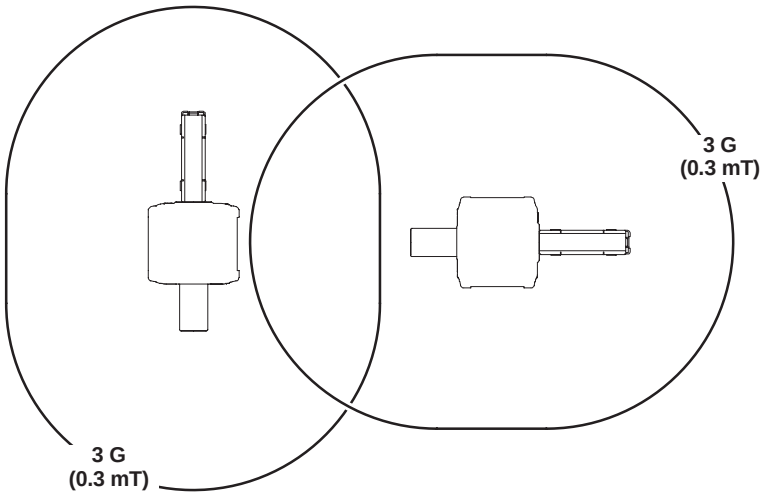
4 Multiple MR Systems Site

4–1 Two Magnet Site Layout

For two magnet installations interaction can occur between the magnetic fields. For two magnets not to interact at all (including when bringing magnet to field) the 3 gauss lines of each magnet must not intersect. If the 3 gauss lines intersect but remain outside each magnet's cryostat there will be interaction between the magnets when bringing to field. The orientation of the magnets is irrelevant. Consult the GE Healthcare MR Siting & Shielding group for closer proximity of magnets.



NO INTERACTION



INTERACTION WHEN BRINGING MAGNET TO FIELD

TWO MAGNET INSTALLATION
ILLUSTRATION 3–1

4–2 Equipment Room Shared By Multiple MR Systems

4–2–1 Introduction

When the Equipment Room is shared by two or more MR systems of the same field strength there is a potential for cross–talk of RF energy between the MR systems. RF cross–talk may cause noise artifacts in images. Proper planning and installation of the multiple systems in the shared Equipment Room can reduce the potential for cross–talk.

The potential for cross–talk exists when the RF transmit cables and equipment of two or more MR systems are located in the same Equipment Room. For example, when one system is transmitting, the other system could be in receive mode and therefore pick up the RF energy being transmitted resulting in a cross–talk scenario.

Note

The potential for cross−talk exists for RF transmit cables and equipment that produces RF that are part of a non−GE MR System of the same field strength.

Notice!

The RF Screen of the Magnet Room for each system needs to meet the RF Attenuation specifications in Chapter 8 Section 1 RF Shielded Room Requirements.

The following subsections provide requirements for shared Equipment Room design, layout, and installation which reduce the potential for RF cross–talk.

4–2–2 Equipment Cabinets Relative Locations

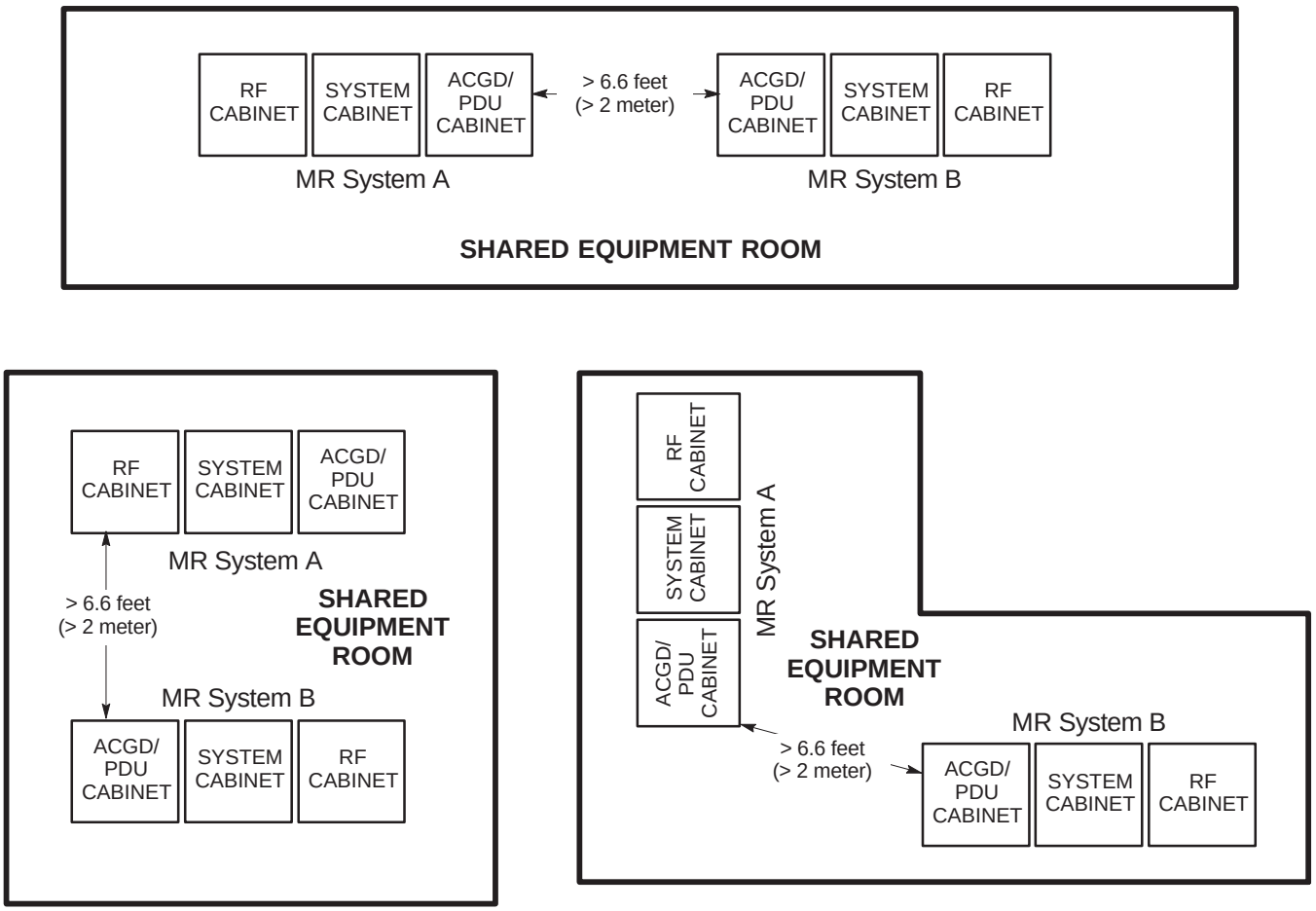
The following are requirements for locating equipment cabinet of one MR system relative to the other MR system equipment cabinets.

- Maximize separation distance between the RF transmitter (RF Amplifier) of one MR system and the RF receiver (RRF Chassis in the System Cabinet) of the other MR system of the same field strength.
- The RF transmitter (RF Amplifier) of one MR system and the RF receiver (RRF Chassis) of the other MR system of the same field strength must be separated by a minimum of > 6.6 feet (2 meters) in all directions, see Illustration 3–2.
- Signa EXCITE MR/*i* 1.5T Release 11.x the RF Amplifier is located in the SRFD II Cabinet and the RRF Chassis is located in the EXCITE System Cabinet.

Note

Relative placement should not be an issue for chillers, compressors, and other equipment which does not produce RF.

4–2–2 Equipment Cabinets Relative Locations (Continued)

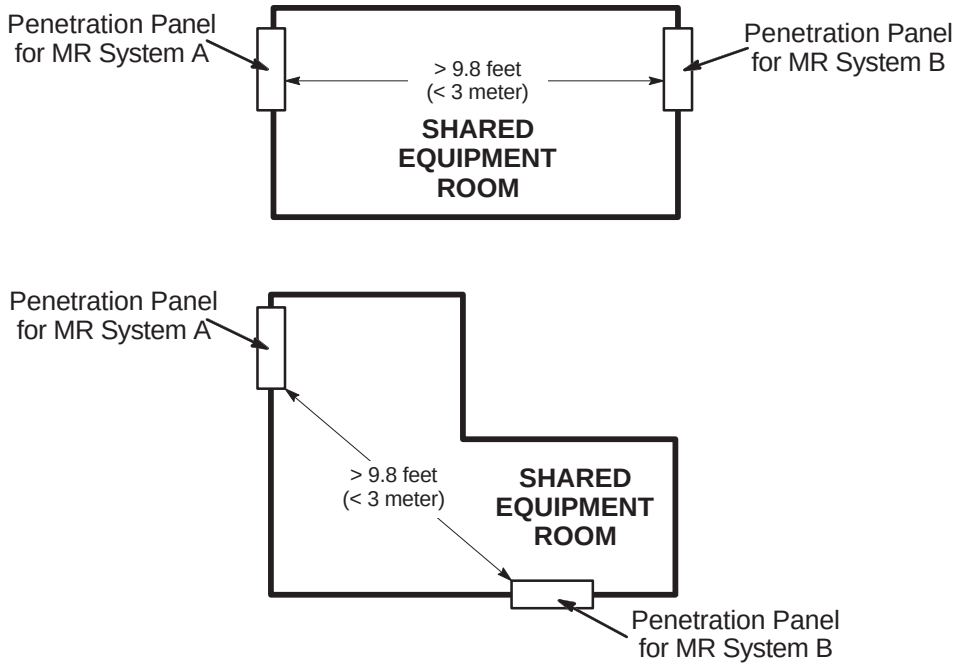


MULTIPLE MR SYSTEMS ELECTRONICS CABINETS SPACING
ILLUSTRATION 3–2

4–2–3 Penetration Panels Location

The following are requirements for locating the RF Shielded Room Penetration Panel of one MR system relative to the other MR system RF Shielded Room Penetration Panel.

- There must be > 9.8 feet (3 meters) separation between the Penetration Panels of each system sharing the Equipment Room space, see Illustration 3–3.

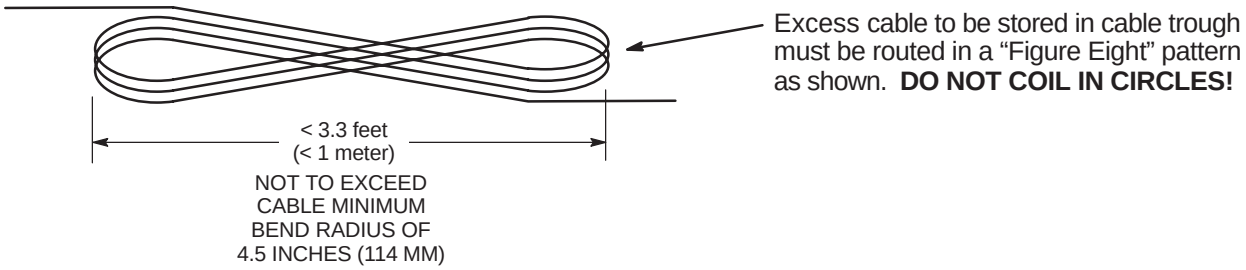


MULTIPLE MR SYSTEMS PENETRATION PANEL SPACING
ILLUSTRATION 3–3

4–2–4 System Cables Requirements

The following are requirements for locating and managing excess RF Receive and Transmit cables of the MR systems sharing the Equipment Room.

- In the shared Equipment Room there must be > 6.6 feet (2 meters) separation between the RF receive cables of one system and the RF transmit cable of the other system. Refer to Chapter 7 Interconnect Data for Receive and Transmit cable Run Numbers.
- There must be > 6.6 feet (2 meters) separation between the system interconnect cables of each system sharing the Equipment Room space.
- Transmit cables in the Equipment Room must be cut to length to minimize excess cable length reducing the potential for signal coupling with other cables. No excess transmit cable can be stored in the Equipment Room.
- Receive cables excess length must be stored in a “figure 8” with overall dimension of < 3.3 feet (1 meter), see Illustration 3–4.



PROPER STORAGE OF EXCESS RECEIVE CABLES
ILLUSTRATION 3–4

5 Delivery Route Requirements

5–1 Minimum Delivery Route Sizes and Capacity

Table 3–3 lists minimum actual clearance opening dimensions for doors and hallways required by Signa equipment. Installation or replacement of components listed in Table 3–4 must be taken into consideration when determining hallway and door dimensions. Clearance for maneuvering around corners or turns must also be taken into consideration. Refer to Chapter 9 Shipping And Delivery Data for Signa Component shipping dimensions.

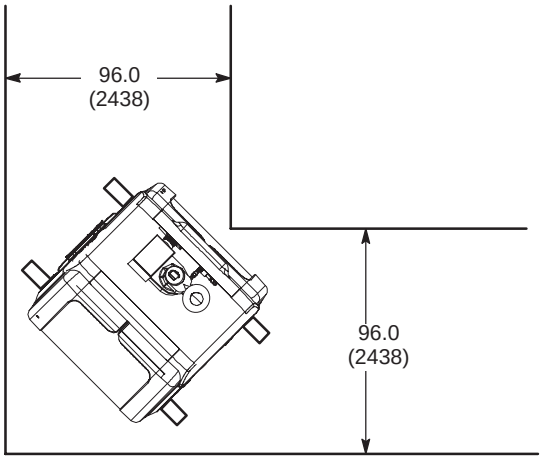
TABLE 3–3
MINIMUM HALLWAY/DOOR DIMENSIONS

COMPONENT	MINIMUM HALLWAY/ DOOR WIDTH* in. (mm)	MINIMUM HALLWAY/ DOOR HEIGHT* in. (mm)	COMMENTS
Operator Workspace Table	32 (813)	80 (2032)	
Equipment Cabinets	36 (914)	80 (2032)	
Cryogen delivery route and Storage Room	43 (1092)	80 (2032)	Width requirements due to size of 500 liter dewars. Width and height requirements vary dependent on the dewars used. Check with cryogen supplier.
Magnet	Refer to Note 1	Refer to Note 2	Refer to Table 3–4 for uncrated magnet dimensions.
RF Room Door	Refer to Section 8 RF Shielded Room	Refer to Section 8 RF Shielded Room	

Note * Minimum hallway and door dimensions are actual clearance openings. Width and height of rigging equipment is not included in above dimension.

1 Minimum width depends on access route to removable panels of RF shielded room wall. For straight path (i.e. no bends or turns) recommended to allow 6 in. (153 mm) on both sides of magnet. Appropriate calculations must be performed if turns exist along proposed magnet delivery route. Illustration 3–5 shows dimensions for 90° turn.

2 Final dimension is dependent on rigger equipment used, refer to Chapter 9 Shipping And Delivery Data.



NOTE:
- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.

MAGNET MINIMUM DOOR/HALLWAY DIMENSIONS 90° TURN
ILLUSTRATION 3–5

5–1 Minimum Delivery Route Sizes and Capacity (Continued)

TABLE 3–4
COMPONENT DIMENSIONS FOR INSTALLATION/REPLACEMENT

COMPONENT	APPROXIMATE WEIGHT lbs (kg)	OVERALL DIMENSIONS W x D x H in. (mm)	COMMENTS
Magnet (uncrated)	Refer to comments.	Refer to comments.	Refer to Chapter 9 Shipping And Delivery Data for dimensions, illustrations and weights.
Bridge (LCC Magnet Enclosure)	75 (34)	19.5 x 117.3, x 6 (495 x 2980 x 152.4)	Room dimensions in front of LCC Magnet MUST allow for bridge installation/servicing and Gradient Coil Replacement, See Note 3.
Replacement RF Gradient Coil	200 (91)	38 x 70 x 44 (965 x 1778 x 1118)	
Replacement Gradient (BRM) Coil Assembly on a Shipping Cradle/Cart	See Note 1	35 x 96.09 x 55.88 (889 x 2441 x 1420) See Note 2 & 3	Initial BRM Gradient Coil Assembly is shipped installed in the Magnet. Shipping/installation cart is used to install replacement coil assembly only. Refer to Section 5–2, Gradient Coil Assembly, Cradle, & Cart Requirements. The Short Room Gradient Coil Cart must be used to replace the BRM when the distance in front of the magnet is less than 117.6 inch (2987).
Gradient (BRM) Coil Replacement Tool Kit Crate for LCC Magnets	660 (300)	30 x 86 x 28 (762 x 2184 x 711)	See Note 3.

Note 1 The replacement BRM Gradient Coil Assembly weight is approximately 2300 lbs (1045 kg), the shipping cradle is 125 lbs (57 kg), and the Gradient Coil Assembly shipping/installation cart weighs 855 lbs (389 kg). Therefore total shipping weight is 3280 lbs (1490 kg). The coil assembly outside diameter x length dimensions are 35.1 x 73.5 in. (892 x 1867 mm).

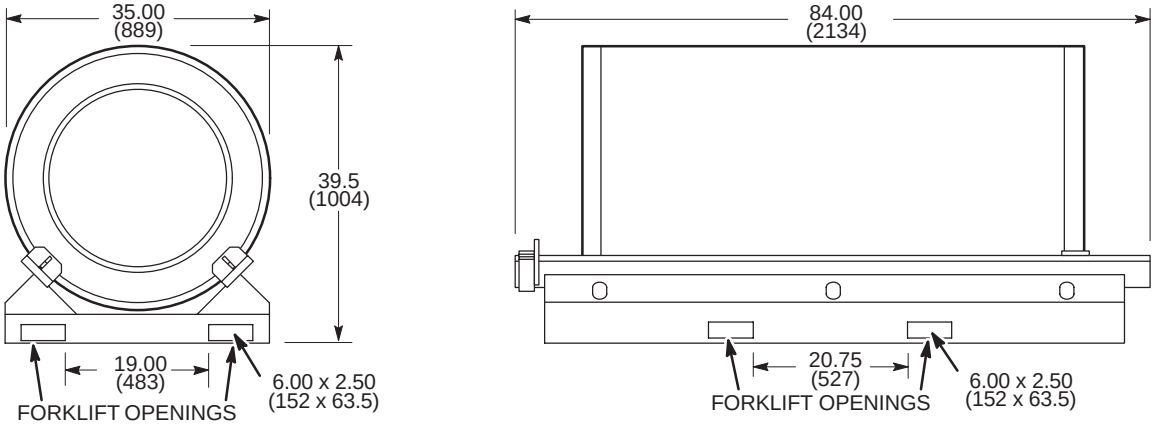
2 Gradient (BRM) Coil Assembly and shipping cart dimensions are with cart in lowest position. Cart can be adjusted to maximum height of 61.88 in. (1572 mm).

3 LCC Magnets MUST USE GE Service Tool Gradient Coil Replacement Kit for replacing the Gradient Coil Assembly. The Gradient Coil Replacement Tool Kit is shipped in a wooden crate on casters. Utilization of Gradient Coil Replacement Tool requires 117.6 in. (2987 mm) clear space in front of magnet (same clearance as Bridge installation).

5–2 Gradient Coil Assembly, Cradle, & Cart Requirements

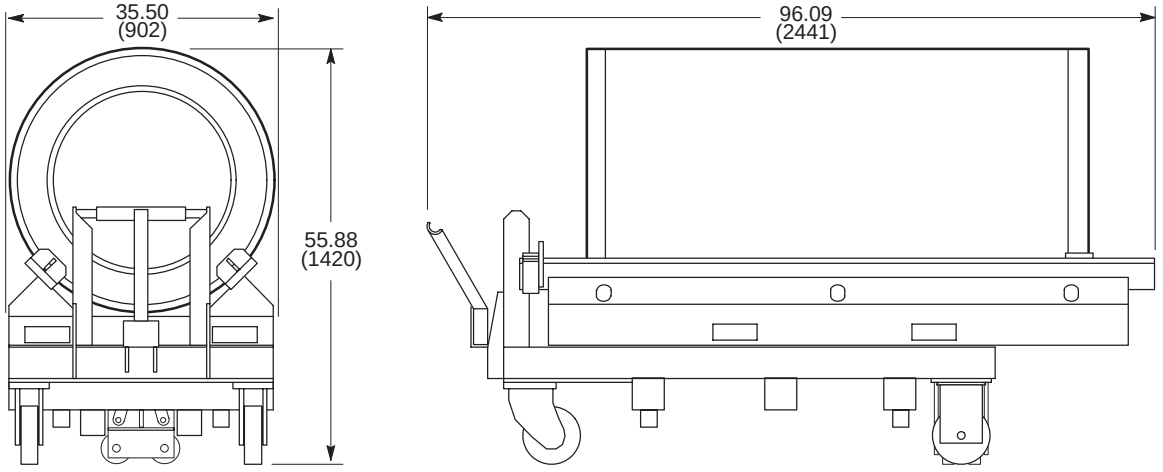
Initial Gradient (BRM or CRM)) Coil Assembly is shipped installed in the Magnet. Shipping/installation cart is used to install replacement coil assembly only. The Gradient Coil Assembly will be delivered on an aluminium (re–useable) cradle. A forklift or crane/hoist rated for 4000 lbs (1818 kg) may be required to position the coil/cradle assembly onto the cart for installing the coil into the magnet, see Illustrations 3–6 and 3–7.

NOTE:
- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT: WITH BRM 2425 lbs (1102 kg)



REPLACEMENT GRADIENT (BRM OR CRM) COIL ASSEMBLY & CRADLE
ILLUSTRATION 3–6

NOTE:
- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT WITH BRM 3275 lbs (1486 kg)



SHORT ROOM REPLACEMENT GRADIENT (BRM) COIL ASSEMBLY & CRADLE ON CART
ILLUSTRATION 3–7

6 MR System Interconnects Routing

The customer, architect/consultant, and contractor must consider the design/method for routing the MR system interconnects to minimize potential adverse performance impact. Refer to Table 3–5 for MR system interconnects routing requirements and recommendation.

TABLE 3–5
MR SYSTEM INTERCONNECTS ROUTING REQUIREMENTS/RECOMMENDATIONS

AREA	REQUIREMENTS	RECOMMENDATIONS
Entire MR System	• Cable routing throughout the system including Magnet Room must be in accordance with local and national codes. • Consult local/national code for interconnects separation requirements (i.e. signal, power, water, air, etc.). • Must protect fiber optic interconnects, water lines, hoses and tubing from physical damage including liquids (i.e. condensation, coolants, etc.) • The majority of MR system cables used are pre–terminated to simplify interconnection but requires routing to accommodate dimensions of the connectors. Refer to Chapter 7 Interconnect Data for dimensions. – Raceway or conduit for routing interconnects must be sized to allow for the dimension of the connectors and the possibility of additional cables being added as the system is upgraded in the future. – Raceway or conduit always to be sized to allow the cable to pass through with all other cables already installed. • Interconnect routing design must consider the MR system interconnect cables are FT4 or equivalent rated, not plenum rated. • The area under access flooring if used for an air plenum, the cables may have to be in raceway depending on local and national codes. • MR system interconnects must be accessible for equipment servicing including troubleshooting and future enhancements or upgrades.	• Access flooring (i.e. removable panel flooring) is recommended for use in both the Equipment and Magnet Rooms due to the number and size of cables in the system. Cable accessibility and ease of alteration are just a few advantages of using access flooring.
Magnet Room	• Only non–magnetic metal material (e.g. aluminum) can be used when routing cables in the Magnet Room. • Electrically conductive materials and method (raceway, access flooring) utilized for interconnects routing must comply with Table 8–1 requirements to minimize the possibilities of electrical discharge which can cause RF broadband noise. • Site constructed or purpose built interconnect raceways must meet all construction and material requirements contained in this table to avoid the potential of becoming an RF broadband noise source. Note: Access flooring removable panels are known sources of RF broadband noise. The use of non–magnetic metal material (e.g. aluminum) must have individual or potentially loose parts (i.e. nuts, panel to panel joints, panel to standoffs or supports, etc.) electrically isolated or fully grounded. • Floor ducts/raceways used in the Magnet Room must meet the requirements in Chapter 8 Section 1–2 RF Shielded Room Requirements and Chapter 8 Section 6–5 Floors. • MR personnel must have an unobstructed path from the patient table to the area directly behind the Magnet Enclosure Rear Pedestal. Therefore cable routing methods must not interfere with this pathway.	• Conduit should not be used for running the main GE MR system cables in the Magnet Room due to the number and size of conduits needed. • Surface–mounted raceways are not recommended for routing cables and other interconnects within the Magnet Room due the trip hazard of the raceway.

7 Flooring

Flooring consists of all materials above the structural floor support including subflooring and magnet support/mounting. Refer to Table 3–6 for requirements and recommendations.

TABLE 3–6
MR SYSTEM FLOORING REQUIREMENTS/RECOMMENDATIONS

AREA	REQUIREMENTS	RECOMMENDATIONS
Entire MR System	• Flooring materials must support the MR system equipment weight, refer to Section 11 Floor Loading And Weights. • Floors must support the equipment and any transport device needed to move the equipment. • Flooring throughout the system including Magnet Room must be in accordance with local and national codes. • Floor design must consider the MR system interconnect cables are FT4 or equivalent rated, not plenum rated.	• The area under access flooring if used for an air plenum is recommended to provide a minimum 10 in. (254mm) of clear space. Cabling, plumbing (water lines), etc. routed under the access floor may affect air flow and needs to be considered if used as an air conditioning plenum.
Magnet Room	Refer to Chapter 8 Section 6–5 Magnet Room Floors.	

8 System Cooling Equipment Siting Considerations

8–1 System Cooling Equipment Configurations

The system requires water cooling for the BRM Gradient Coil located in the Magnet bore and the LCC Magnet Shield/Cryo Cooler Compressor Cabinet. The following system cooling equipment is available with the MR system:

- A dedicated, closed loop, chilled water cooling system for the BRM Gradient Coil. Fixed site systems include this chiller system. The system consists of an indoor water–to–air Water Chiller (WC1), two flexible vinyl hoses, and de–ionized water and anti–freeze (provided with the MR system).
- The MR Common Chiller (MRCC) option is a single–loop device that can be used to provide constant temperature water for the Shield/Cryo Cooler Compressor Cabinet water cooling.

Note

Gradient Coil water cooling must be supplied by cooling equipment (WC1) supplied with the MR system to prevent contamination/damage to the coil and for proper image quality.

Note

If the MRCC option is not used then the customer must provide water cooling for the Shield/Cryo Cooler Compressor.

Note

True Mobile and Transportable/Relocatable Mobile systems water cooling for the Gradient Coil Heat Exchanger and the Shield/Cryo Cooler Compressor is provided by the Mobile Van equipment.

Continuous water cooling is critical for the Shield/Cryo Cooler Compressor and therefore MUST be available 24 hours per day / 7 days per week to maximize proper uninterrupted magnet operation. Water cooling is required immediately upon magnet arrival. Therefore the MRCC or customer provided water cooling for the Shield/Cryo Cooler Compressor and Main Disconnect Panel (MDP) must be installed and operational prior to magnet arrival.

Note

Consult local/national code for interconnects separation requirements (i.e. signal, power, water, etc.).

Note

Customer provided temporary backup water cooling is recommended for the Shield/Cryo Cooler Compressor Cabinet. Refer to Chapter 5 Section 5–4 **Shield/Cryo Cooler Requirements for Site Provided Water Cooling**.

8–2 Water Chiller Siting Considerations

The Water Chiller (WC1) is an indoor dedicated, closed loop, chilled water cooling system for the Gradient Coil provided with the system for fixed site systems. The system consists of a water–to–air Water Chiller (WC1), two flexible vinyl hoses, and de–ionized water and anti–freeze (provided with the coil). See Illustration 3–15 dimension information.

8–2–1 WC1 and MR System Interconnects

The two flexible hoses (supply and return) are to be routed from the Water Chiller (WC1) through waveguides in the Penetration Panel (PP1), through the Rear Pedestal (MG3), and connect to the rear of the Gradient Coil with supplied adjustable compression clamps. The Water Chiller will be powered from the PDU via a supplied power cord. Refer to Chapter 7 Section 4–5 Location 1 / Location 2 – Interconnects Shared Between Magnet Room & Equipment Room Through PP1 and Chapter 7 Section 4–6 Location 3 – Interconnects Between Components Within Equipment Room for additional cable information.

8–2–2 WC1 and MR System Separation Limitations

- The Fixed Site Water Chiller (WC1) for Gradient Coil Cooling must not be located below the Magnet Room floor level.
  The Water Chiller reservoir tank has a low pressure vent plug which relieves pressure from thermal expansion of water and activates when tank pressure reaches 3–5 psi (0.2–0.3 bar). The vent plug could allow fluid to leak if located below the MR system level. The reservoir tank vented plug can not be replaced with a non–vented type, damage to the tank may occur.

- The Water Chiller may be located one floor level above the MR system.

8–3 MRCC Siting Considerations

8–3–1 MRCC Interconnects/Separation Limitations

Location of the MRCC must meet the following limitations for the water lines:

- MRCC located outdoors and the Shield/Cryo Cooler Compressor Cabinet must not be separated by a distance greater than 200 ft (61 m) water line length. Outdoor water line (pipe) must be thermal insulated.
- MRCC located indoors and the Shield/Cryo Cooler Compressor Cabinet must not be separated by a distance greater than 100 ft (30.5 m) water line length.
- Maximum vertical separation from the Gradient Coil located inside the magnet or the Shield/Cryo Cooler Compressor is not to exceed 98 ft (30 m) with the MRCC above the MR system or 10 ft (3.1 m) with the MRCC below the MR system.
- MRCC and the Remote Control Panel (RCP) must not be separated by a distance greater than 100 ft (30.5 m) total interconnect length.

The MRCC is powered from customer supplied power. The GE MDP E4503AT option does not support the Coldhead Chiller option.

8–3–2 MRCC Access & Air Considerations

Ensure there is easy access to the top cover of the unit. The air inlet and outlet are located on the unit front and rear respectively. Restricting airflow into or out of the MRCC will impair performance. The minimum clearances shown in Illustration 3–38 are required on each side and top to ensure adequate airflow.

Notice!

MRCC must be positioned so input air temperature does not exceed specifications, See Chapter 5 Section 3 Temperature And Humidity Specifications. For example, air output of another unit or heat generating device must not be allowed to input to the MRCC.

Notice!

MRCC must operate within temperature specifications in Chapter 5 Section 3 Temperature And Humidity Specifications. If the potential exists for exceeding ambient limits, actions must be taken to maintain temperature and humidity specifications. For example, MRCC located in a location with the potential for high ambient temperatures my need sun barrier to reduce input temperature.

An MRCC unit installed in a high airflow area may be affected by the seasonal winds. In such environments it is recommended to install wind breaks for the MRCC.

Notice!

Precautions must be taken to prevent ingress of weather elements (i.e. rain, snow, hail, sand, etc.) and foreign material debris (i.e. leaves, bird nests, etc.) into the air intake of the MRCC uint. For example, if the MRCC is located outside in an area where potential sandstorms occur, barriers or wind shields must prevent debris from entering the MRCC air input while maintaining the Service Clearance specifications shown in Illustration 3–38.

8–3–3 MRCC Outdoor Installation Mounting

The MRCC must be located on a strong, level surface, see Illustration 3–39 for concrete pad requirements for one MRCC unit. A chiller mounted on a slab on grade or rooftop will have the casters removed and be bolted down using the six middle holes to rigidly mount the unit.

8–3–4 MRCC Indoor Installation

Customer site provided air cooling is required for MRCC units installed indoors. Indoor installation requires the unit to be located on a strong level surface, 0.4 inches over 118 inches (1 cm over 300 cm), with the casters locked.

8–3–5 Responsibility For Installation Tasks For MRCC Equipment

The MRCC subsystem equipment installation requires specific tasks to be performed by the Customer Contractor, GE Service, and Service provider (dependent on site location, refer to Table 3–8). Table 3–7 lists the responsibility for the specific tasks. Refer to vendor manual for additional information concerning tasks.

TABLE 3–7
MRCC EQUIPMENT RESPONSIBILITY FOR INSTALLATION TASKS WHEN USED FOR SHIELD/CRYO COOLER COMPRESSOR PRIOR TO MAGNET DELIVERY & WHEN MAGNET IS DELIVERED/INSTALLED

TASK	RESPONSIBLE TO PERFORM TASK			PAYS FOR TASK & MATERIALS
	CUSTOMER	GE SERVICE	SERVICE PROVIDER See Note *	
Unload chiller from truck	X			Customer
Move chiller to MR Equipment Room or Outdoor concrete pad and mount in accordance with local and national codes.	X			Customer
Connect customer supplied power from MDP to chiller	X			Customer
Install water lines to chiller	X			Customer
Install Remote Control Panel in Equipment Room	X			Customer
Fill chiller with glycol	X			Provided with MRCC
Start chiller, verify no leaks found (GE or Service Provider may assist).	X			N/A
Perform final Inspection of chiller and verify proper operation.			X	Service Provider
Note * The Service Provider are listed in Table 3–8.				

TABLE 3–8
MRCC SERVICE PROVIDERS

LOCATION	SERVICE PROVIDER ADDRESS	TELEPHONE	FAX
USA, Canada, & Mexico	Ellis & Watts International Inc. 4400 Glen Willow Lake lane Batavia, Ohio 45103	1–888–744–3195 or 1–513–768–3195	1–513–752–4983
Europe & other Americas countries	Advanced Cooling Technologies, LLC 2478 Armstrong Street Livermore, California 94551 USA	1–877–428–0402	1–925–875–0002
Asia and all other countries	Lu Gu St. Shi Jingshan Dist. Beijing P.R. China	86–10–68656161	86–10–68652453

9 Special Siting Considerations

The following system accessories or options have special siting concerns which need to be considered.

9–1 Blower Box (MG6)

The Blower Box (MG6) provides cooling air for the RF/Gradient Body Coil and the Patient Comfort Module in the Magnet Enclosure. The Blower Box will be mounted within the RF Shielded Room and connect to the Gradient Coil and the Patient Comfort Module by 6.5 inch (165.1 mm) OD and 4.5 inch (114.3 mm) OD flexible vinyl air ducting.

CAUTION

The Blower Box contains magnetic material which can be attracted to the magnet. The Blower Box must be securely mounted to the floor of the Magnet Room or a support shelf on the Magnet Room wall or ceiling with support provided under the box.

Notice !

Since the Blower Box must be securely mounted per preceding Caution, therefore the Blower Box must not be on a raised floor section within the Magnet Room. RF Shield integrity must be maintained for mounting the Blower Box within the Magnet Room, refer to Chapter 8 Section 7–2 Physical Characteristics, Chapter 8 Section 7–5 RF Shield Integrity, and Chapter 8 Section 7–6 Electrical Isolation.

The flexible vinyl air duct routes from the Blower Box through the Magnet Enclosure Rear Pedestal cable access and connects to the Patient Comfort Module in the Magnet Enclosure. Refer to Illustrations 3–16 for Blower Box and mounting dimensions.

Note

Blower Box mounting requires customer supplied hardware (ie. lag bolts, screws, etc.) appropriate for the surface on which the box will be mounted.

9–2 Pneumatic Patient Alert (PA1)

The Pneumatic Patient Alert system is a stand alone system that will allow the Patient to contact the Operator even when the intercom volume is turned down. The Control Box is to be located near the Operator Workspace. The Control Box audible and visual alarm will be activated by the patient squeeze bulb which is located on the Magnet Enclosure and connected by pneumatic tubing through the Penetration Panel to the Control Box. The Control Box should be mounted with consideration for ease of use by operator, remaining within sight of operator, and within 5 ft (1.5 m) of an electrical outlet. The Control Box can be powered from an outlet on the Operator Workspace. Refer to Illustration 3–29 for Control Box mounting dimensions.

9–3 SPT Phantom Set Shipping/Storage Cabinet

System Performance Test provides the customer and GE Service with a means to quickly verify whether critical parameters affecting image quality are within specifications. The test uses a set of phantoms and a nesting plate for proper positioning of the phantoms on the Patient Table. The phantom set and nesting plate are provided in a cabinet which protects the pieces during shipment and storage at site. The cabinet is not magnetic therefore it can be stored inside the Magnet Room if so desired and moved to the Patient Table for ease of positioning the phantoms. See Illustration 3–31 for dimensions information.

9–4 Oxygen Monitor (OM1) (Optional)

The optional Oxygen Monitor should be mounted near the Operator Workspace. The Oxygen Monitor alarm will be activated by the remote oxygen sensor located in the Magnet Room. All cellular telephones, even if not in use, should be kept at least 20 feet (6.1 meters) away from the Oxygen Monitor to prevent possible false trips of Oxygen Monitor alarms.

9–5 Multi–Nuclear Spectroscopy (MNS) (Optional)

The MNS option provides a 1.5T MNS Amplifier in the SFRD II Cabinet (see Illustration 3–17) which utilizes standard system cabling with a few additional cables. Refer to Chapter 7 Section 6 Spectoscopy Interconnects cable length information and other cable data.

9–6 Magnet Monitor

The Magnet Monitor performs the functions of a cryogen meter and Magnet pressure control with readout display capability on the unit and allows for remote monitoring during system warranty period or available as part of a GE Magnet Maintenance contract. Refer to Section 9–7 System Monitoring & Support Connectivity Requirements for broadband connectivity requirements.

Magnet Monitor remote monitoring operation is valuable to maximize proper uninterrupted magnet operation. The Magnet Monitor is powered by facility supplied receptacle and power, refer to Chapter 6 Section 1 System Power Introduction for required customer power.

The Magnet Monitor should be mounted approximately 60 in. (1524 mm) above the floor in the Equipment Room but outside the 10 gauss zone.

Refer to Chapter 7 Interconnect Data for details of Magnet Monitor and system interconnects.

Note

True Mobile configurations include a UPS for the Magnet Monitor equipment.

9–7 System Monitoring & Support Connectivity Requirements

One of the system monitoring and support connectivity configurations listed in Table 3–9 must be provided for system installation and serviceability purposes. The network connection (if selected configuration) and telephone lines are to be provided and paid for by the customer.

TABLE 3–9
SYSTEM MONITORING & SUPPORT CONNECTIVITY REQUIREMENTS

CONFIGURATION	PHONE LINE	USE/LOCATION
Broadband Network Connection & Telephone Line **(Recommended)**	Two Broadband Internet Accessible Virtual Private Network (VPN) connections with individual Static IP addresses See Note 1	One access located near the Operator Workspace (OW) in the Control Room.
		One access located near the Magnet Monitor (MSM) in the Equipment Room for remote monitoring. This Ethernet connection must not lose power when the MR system is shutdown.
	One voice–grade telephone line (voice line)	Available for Service Personnel use, located in the Control Room
Multiple telephone lines **(Alternate)**	One voice–grade telephone line (voice line)	Available for Service Personnel use, located in the Control Room
	One line must be a dedicated direct–distance–dialing voice–grade line (data line)	Access located near the Operator Workspace (OW) in the Control Room. **See Note 2 & 3**
	One line must be a dedicated direct–distance–dialing voice–grade line (data line)	Access located near the Magnet Monitor (MSM) in the Equipment Room for remote monitoring. **See Note 2 & 3**

Note 1 **For Europe:** An ISDN Connection with static IP addresses may be substituted for VPN connections.

2 A dedicated direct–distance–dialing voice–grade telephone line can be shared for Operator Workspace (OW) and Magnet Monitor (MSM) requirement through the use of a multiplexer box. The following multiplexer boxes are available for customer purchase.
46–328475P1 4 Line Phone Multiplexer box; 115 VAC input power
46–328475P3 4 Line Phone Multiplexer box; 220 VAC input power
If the customer chooses not to purchase the multiplexer box then the customer must provide an additional line for each requirement as stated in this table.

3 If a Multiplexer Box is used then the Magnet Monitor MUST be Channel 1 to allow for call out after a power outage.

9–8 BrainWaveHW Lite Option

The BrainWaveHW Lite Option (M1033BL) option provides software and hardware stimulus components which are intended to be used in conjunction with 3rd party MR compatible audio and video stimulus devices (headphones, goggles, etc.) to produce brain activation images from MR Blood Oxygen Level Dependent (BOLD) scan data. The hardware components provided includes the Stimulus PC, keyboard, and monitor as well as the cabinet that houses them. The package also includes push button response boxes, a standard interface panel that is added to the MR System Penetration Panel, and interconnecting cables. The Stimulus software provided with the BrainWaveHW Lite option package resides on the Stimulus PC. BrainWaveRT (M1033BT) software resides on the MR system host computer and is a prerequisite required for the M1033BL catalog.

The Brainwave HW Lite options consists of the following major items:

- BrainWaveHW Lite Cabinet
  Located in the Equipment Room, the BrainWaveHW Lite Cabinet contains the Stimulus PC, LCD Display, keyboard and mouse for the Stimulus PC, and Response Interface Module.

- Interconnect cables
  The BrainWaveHW Lite Cabinet is powered from the Signa System Cabinet. Refer to Chapter 7 Section 9 BrainWaveHW Lite Option Interconnects for additional interconnects information and requirements.

The BrainWaveHW Lite Cabinet has three USA standard 3–prong configuration power outlets available that can be utilized for 3rd party provided audio–visual equipment to be added to the cabinet. These AC outlets are 115V, 50/60 Hz, 7 Amps RMS total current.

9–9 Remote MRU Option

The Remote MRU Option provides a second Magnet Rundown Unit (MRU) which can located outside the Magnet Room. The Remote MRU is powered by facility supplied receptacle and power, refer to Chapter 6 Section 1 System Power Introduction for required customer power.

The option also provides the Remote MRU Connector Box with hardware to mount to the Magnet and system interconnects to enable system connection of both the primary MRU (provided with the Magnet) and the secondary MRU. Refer to Chapter 7 Section 6 Remote MRU Option Interconnects for cable length information and other cable data.

10 Architectural Reminders

1. Pay attention to isogauss limits, not only for placement of equipment in rooms, but also for isogauss limits with respect to outside environment.

2. The customer is responsible for establishing protocols to warn persons with cardiac pacemakers, neurostimulators, and biostimulation devices of the potential danger of entering magnetic fields greater than 5 gauss (exclusion zone).

3. Due to the periodic cryogen servicing of the magnet, consideration must be given to the delivery route of the cryogens to the Magnet Room. The service route should be level and therefore steps or steep ramps must be avoided. Maximum acceptable incline along dewar delivery route is 1:12 (5°).

3A. Cryogen dewars must not be stored within the Magnet Room due to the safety issues of seismic considerations, spillage effects, fire hazards and explosive effects of compressed gas. Also the magnetic field inhomogeneity is affected by the physical shape of the non–magnetic dewars. If the magnet is shimmed with no dewars in the Magnet Room, the magnetic field inhomogeneity will slightly change once dewars are moved into the room (or vise versa). All dewars must be stored outside of the Magnet Room and more than 10 ft (3.05 m) from isocenter of the magnet in all directions.

3B. Means must be provided to secure gas cylinders used for cryogen transfills in an upright position using a removable chain or strap. This is to prevent the cylinders from falling, which may cause injury or damage.

4. If elevators are to be used along cryogen delivery route, verify that elevator dimensions and weight capacity is sufficient to handle the cryogen dewars. Also, elevator must be dedicated with restricted access during cryogen transport (will not allow stops between initial start and final floor destination).

5. The operator seated at the Operator Workspace should have an unobstructed view of the patient on the transport table when table is docked to the magnet.

6. It is recommended that the Magnet Room viewing window be of fine mesh screening material (as opposed to a “honeycomb–type pattern”) for better visibility of the patient from the Operator Workspace.

7. Operators in Magnet Room must have easy access to the scan control switches located on both front side panels of the magnet enclosure.

8. A patient preparation/emergency area should be located near the Magnet Room and direct patient access must be available from the Magnet Room to the patient preparation/emergency area.

9. Customer provided and paid for telephone lines must be supplied for system installation and serviceability purposes per Section 9–7 System Monitoring & Support Connectivity Requirements.

10. Corrosive chemicals must not be stored or used in the Equipment Room. These include chemicals used for film processor storage tanks, processor chemical recovery systems, etc. Such chemicals can contribute to increased equipment failures, increased system downtime, and decreased reliability. Film processor equipment installation must meet the manufacturer’s requirements (e.g. ventilation specifications) and all applicable national and local codes. Also, consideration should be given to the location of this equipment and chemical fumes relative to human contact as it relates to locating this equipment and chemicals in the control area.

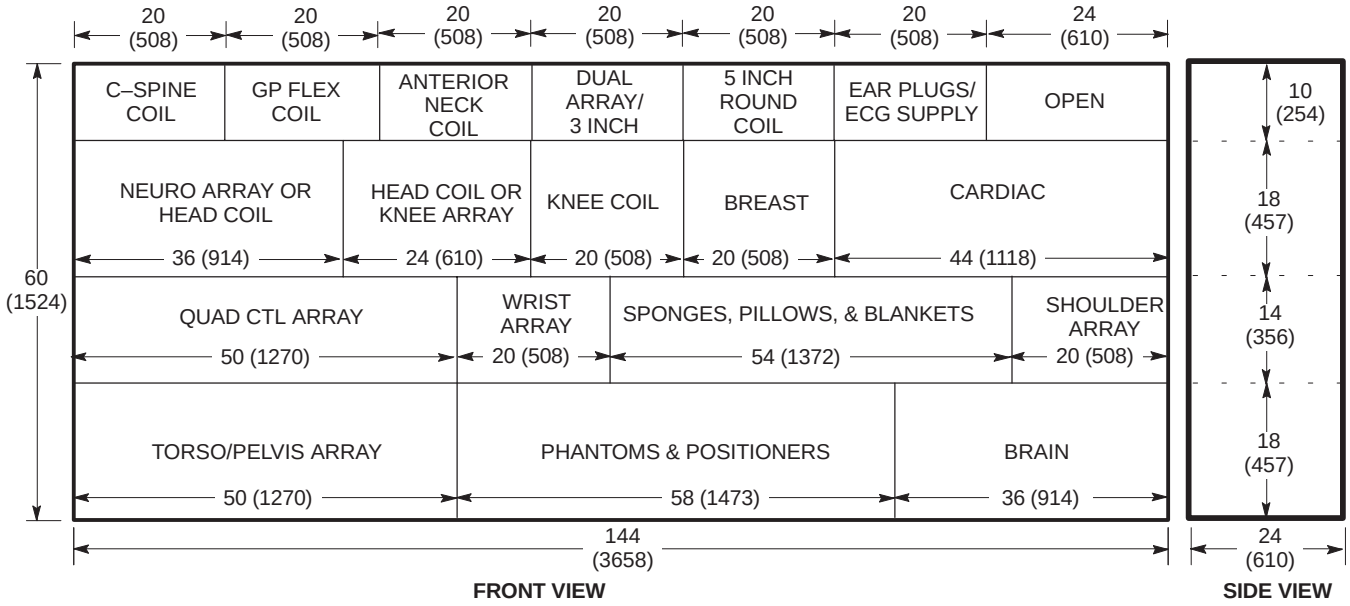
10 Architectural Reminders (Continued)

11. Storage space for system accessories and supplies should be planned for and included in room layout drawings. Illustration 3–8 shows a suggestion for a shelf/cabinet arrangement.

12. Recommend protecting floors while moving heavy pieces of equipment (e.g. ACGD/PDU Cabinet, Body Coil Assembly).

NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- PERIPHERAL VASCULAR ARRAY IS NOT INCLUDED IN THE BELOW STORAGE SHELF/CABINET. CONTACT GE MEDICAL SYSTEMS ACCESSORIES FOR PV ARRAY STORAGE RACK OPTION AND DIMENSION INFORMATION FOR THE STORAGE RACK.



SUGGESTION FOR ACCESSORIES & SUPPLIES STORAGE SHELF/CABINET
ILLUSTRATION 3–8

11 Floor Loading And Weights

This section contains loading considerations for the MR system. Listed in Table 3–10 are the weights, floor loading, and normal mounting methods for MR components.

TABLE 3–10
FLOOR LOADING

COMPONENT	NET WT lbs (kg) See Note 2 & 3	OVERALL DIMENSIONS W x D x H in. (mm)	LOAD PATTERN in. (mm) See Note 3	NORMAL MOUNTING METHOD
1.5T LCC Magnet, RF/Gradient Body Coils (BRM), and Enclosure including Table Dock and Rear Pedestal	See Notes 1 & 4	83.27 x 75.19 x 94.96 (2115 x 1910 x 2412)	See Illustration 3–13 See Illustration 8–1	Magnet & Table Dock Asm. resting on base, for mounting requirements refer to: • Section 11–1 Magnet and Dock Mounting With VibroAcoustic Damping Option • Section 11–2 Magnet and Dock Mounting Without VibroAcoustic Damping Option • Rear Pedestal floor mounting must meet requirements in Note 9.
Patient Table (See Note 5)	630 (286)	27 x 89 x 38 (686 x 2261 x 965)	Rectangular base 23 x 65 (584 x 1651). Four casters 8 (203) dia. x 1.5 (38) wide.	Mobile.
Blower Box	47 (21)	16 x 16 x 22 (406 x 406 x 559)	Square base 15 x 15 (381 x 381)	Anchor to floor or shelf; see Note 9 for additional mounting requirements.
Shield/Cryo Cooler Compressor Cabinet *See Note 8*	275 (125)	17.72 x 19.7 x 26.93 (450 x 500 x 684)	Rectangular base 17.72 x 19.7 (450 x 500). Four casters 3 (76) dia. x .75 (19) wide.	Set on floor and rest on casters.
Water Chiller for Gradient Coil	295 (134)	21.4 x 27.7 x 31.9 (544 x 705 x 811)	Rectangular base 21.4 x 27.7 (544 x 705). Four casters 3 (76) dia. x .75 (19) wide.	Set on floor and rest on casters.
Standard SRFD II Cabinet	495 (225)	23.46 x 45.5 x 71.06 (596 x 1156 x 1805)	Rectangular base 22 x 33.5 (559 x 851). Four casters each 2.5 (63.5) dia. x 1.75 (44.5) wide.	Set on floor on casters.
SRFD II Cabinet with MNS Option	560 (254)	23.46 x 45.5 x 71.06 (596 x 1156 x 1805)	Rectangular base 22 x 33.5 (559 x 851). Four casters each 2.5 (63.5) dia. x 1.75 (44.5) wide.	Set on floor on casters.
EXCITE II System Cabinet	468 (213)	23.25 x 42 x 76.5 (591 x 1067 x 1943)	Rectangular base 22 x 30 (584 x 762). Four casters each 2.5 (63.5) dia. x 1.75 (44.5) wide.	Set on floor on casters.
ACGD/PDU Cabinet	1847 (838)	23.5 x 37.25 x 85.6 (597 x 927 x 2174) See Note 6	Rectangular base 33.5 x 22 (851 x 559). Four casters each 3.0 (76.2) dia. x 1.82 (46.2) wide.	Set on floor on casters.
Operator Workspace Table with LCD Color Monitor (See Note 7)	175 (80)	54 x 43 x 52 (1372 x 1092 x 1321)	See Illustration 3–24	Set on floor: Table on leveling pads & Cabinet rest on casters.
GOC Computer Cabinet (See Note 7)	198 (90)	17.01 x 31.22 x 25.63 (432 x 793 x 651)	See Illustration 3–25.	Set on floor and rest on casters.

(Continued)

11 Floor Loading And Weights (Continued)

TABLE 3–10 (Continued)
FLOOR LOADING

COMPONENT	NET WT lbs (kg) See Note 2	OVERALL DIMENSIONS W x D x H in. (mm)	LOAD PATTERN in. (mm)	NORMAL MOUNTING METHOD
MR Common Chiller* (MRCC) *See Note 8*	685 (310)	55.34 x 26.94 x 45.47 (1406 x 684 x 1155)	See Illustration 3–38.	Indoors: Set on floor and rest on casters. Outdoors: Bolted to mounting pad on ground level external to building or roof mounting pad or structure.Seismic: Chiller mounting requires the casters to be removed and the unit bolted to the floor or pad using holes shown in Illustration 3–39.
BrainWaveHW Lite Cabinet* (See Note 10)	257 (117)	23.25 x 22 x 71 (591 x 559 x 1803)	Rectangular base 23 x 22 (584 x 559). Four leveling pads each 1.5 (38) dia.	Casters for location. Set on floor on leveling pads.
500 Liter Helium Dewar**	812 (369)	42 dia. x 67.5 high (1067 x 1715)	Mobile.	Four casters.
250 Liter Helium Dewar**	519 (236)	36 dia. x 64.0 high (914 x 1626)	Mobile.	Four casters.

Note 1 Weight of 1.5T LCC magnet with Enclosure, RF/Gradient (BRM) Body Coil, and cryogens with the VibroAcoustic Damping Option mats is 13,116 lbs (5949 kg).
Weight of 1.5T LCC magnet with Enclosure, RF/Gradient (BRM) Body Coil, and cryogens is 12,606 lbs (5719 kg).
The Rear Pedestal installed weight is 153 lbs (69.4 kg).

2 Consult a structural engineer on method of calculating proper weight/unit area for floor loading.

3 The center of gravity for MR system components are given in the illustration for use in seismic calculations. If the MR cabinets are required by code to be anchored, refer to seismic drawings available on request from your local GE Healthcare Installation Specialist.

4 Refer to Section 5–1 MINIMUM DOOR/HALLWAY SIZES for Gradient Coil Assembly replacement weight and dimension requirements.

5 630 lbs (286 kg) includes 350 lbs (159 kg) patient.

6 ACGD/PDU Cabinet height with Fan Module removed is 74.8 inches (1900 mm).

7 The GOC Computer Cabinet minimum area location is under the Workspace Table, see Illustration 3–24. An alternate location is possible with the Operator Workspace Cabinet located against the right side (preferred) or left side of the Workspace Table.

8 The MR System requires water cooling for the Gradient Coil and the Shield/Cryo Cooler Compressor.
- Gradient Coil water cooling must be supplied by Water Chiller (WC1) supplied with the MR system to prevent contamination/damage to the coil and for proper image quality.
- The Shield/Cryo Cooler Compressor water cooling can be provided by a separate MRCC or by customer provided facility water cooling, refer to Chapter 5 Section 5–4 Shield/Cryo Cooler Requirements For Site Provided Water Cooling

Sites requiring seismic anchoring by code for MRCC option should have the site architect and engineer review the response spectra and/or International Builders Code (IBC) for their location and then contact MRCC Service Provided for assistance in seismic planning of the site. The Service Provider for the chiller is listed in Section 8–3 MRCC Siting Considerations.

9 Blower Box mounting must meet the requirements in the following sections:
- Chapter 8 Section 7–1 Anchor Hardware For MR Equipment Inside RF Shield
- Chapter 8 Section 7–2 Physical Characteristics
- Chapter 8 Section 7–3 Anchor Location and Installation
- Chapter 8 Section 7–4 Clamping Force (Tension) And Pull Test
- Chapter 8 Section 7–5 RF Shield Integrity
- Chapter 8 Section 7–6 Electrical Isolation

10 Up to approximately 75 lbs. (34 kg) of 3rd party provided audio–visual equipment may be added to the BrainWaveHW Lite Cabinet.

* Optional Equipment.

** Dewar specifications may vary. Check with cryogen supplier for exact weight and dimensions.

11–1 Magnet and Dock Mounting With VibroAcoustic Damping Option

The LCC Magnet installed with the VibroAcoustic Damping Option (M1060MA) has the VibroAcoustic Damping mats resting directly on the recessed Magnet mounting area floor. The LCC Magnet is leveled and bolted to the VibroAcoustic mats stainless steel top plate. The VibroAcoustic mats do not require anchors into the Magnet Room floor In non–seismic areas. For additional Magnet Room floor requirements for VibroAcoustic mats refer to Chapter 8 Section 6–5 Magnet Room Floors.

The Table Dock is still required to be anchored to the Magnet Room floor per the RF Shielded Room Chapter 8 Section 7 Anchor Hardware Requirements For MR Equipment Inside RF Shielded Room.

11–2 Magnet and Dock Mounting Without VibroAcoustic Damping Option

Notice !

It is the customer's responsibility to coordinate magnet mounting methods with the RF shielded room vendor to prevent RF leaks and secondary grounding problems.

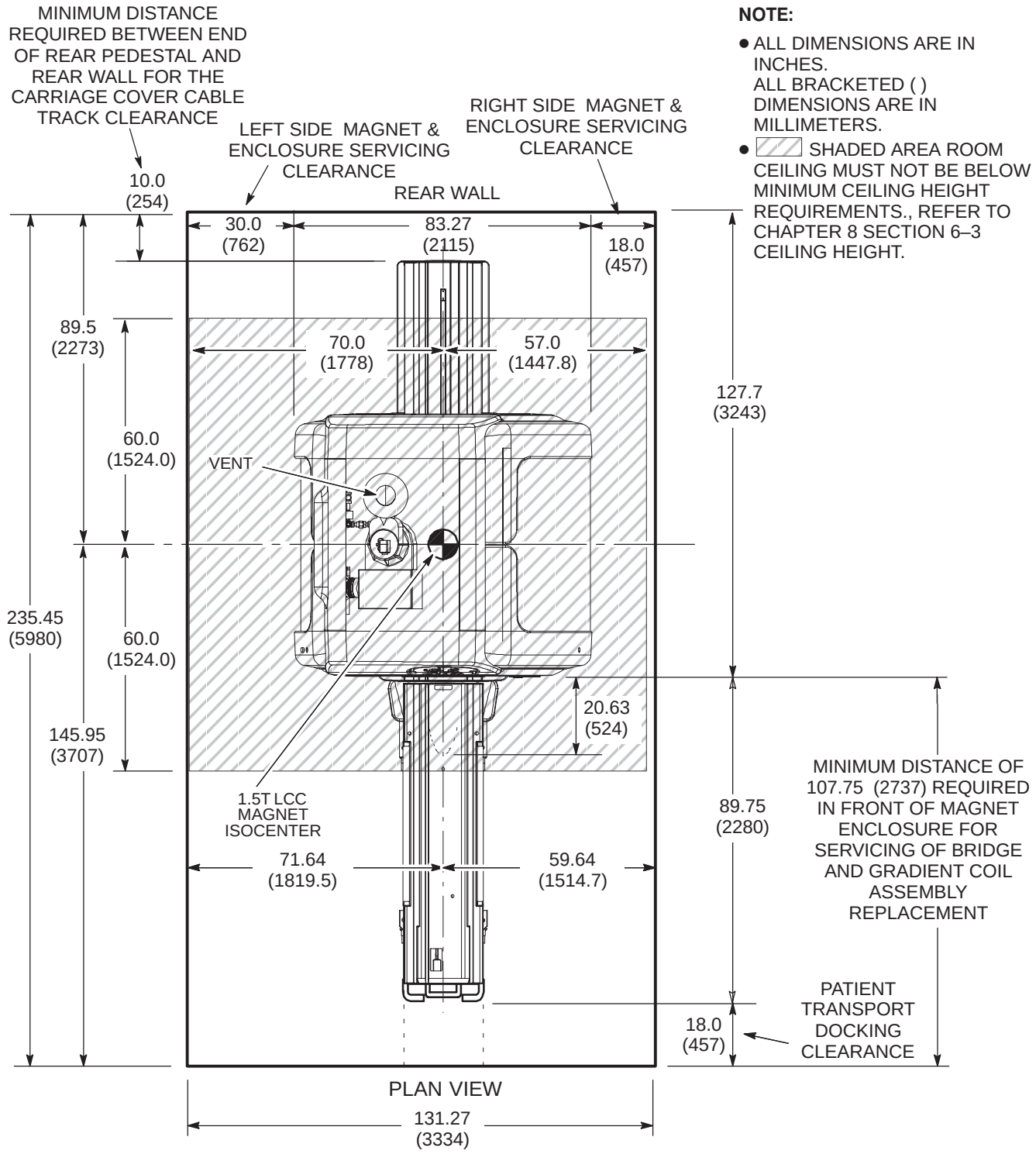
The LCC Magnet installed without the VibroAcoustic Damping Option (M1060MA) must be bolted to the floor, refer to Chapter 5 Section 16 Vibration. Bolt hole openings in the magnet base are to be used to anchor the magnet, refer to RF Shielded Room Chapter 8 Section 7 Anchor Hardware Requirements For MR Equipment Inside RF Shielded Room.

12 Component Dimensions

To assist in completing your room layout, refer to Table 3–11 for list of component Illustrations.

TABLE 3–11
MR SYSTEM COMPONENT ILLUSTRATIONS LIST

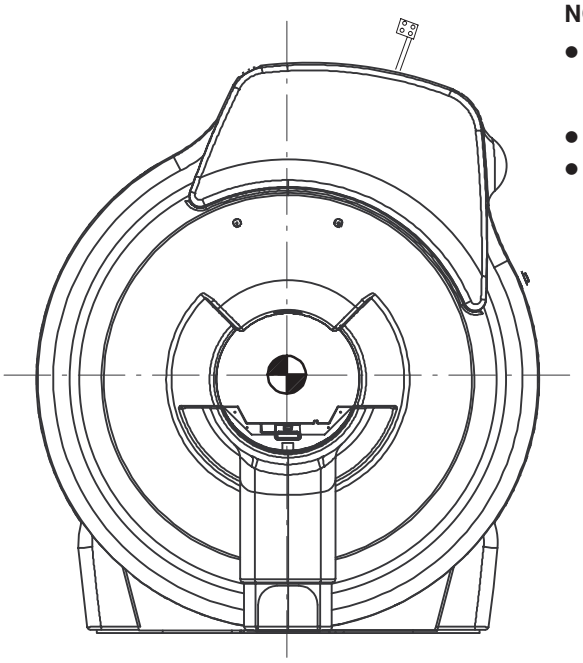
ILLUSTRATION NAME	ILLUSTRATION NUMBER
SIGNA EXCITE MR/*i* 1.5T LCC (ACTIVE SHIELD) MAGNET (MINIMUM SERVICE AREA)	3–9
1.5T LCC (ACTIVE SHIELD) MAGNET ENCLOSURE (FRONT AND REAR VIEWS)	3–10
1.5T LCC (ACTIVE SHIELD) MAGNET CABLE ACCESS	3–11
Signa EXCITE MR/*i* 1.5T LCC Magnet Load Pattern with VibroAccoustic Damping Mats Option	3–12
Signa EXCITE MR/*i* 1.5T LCC Magnet Load Pattern without VibroAccoustic Damping Mats Option	3–13
SHIELD/CRYO COOLER COMPRESSOR CABINET (MS5)	3–14
WATER CHILLER (WC1) FOR GRADIENT COIL COOLING WATER	3–15
BLOWER BOX (MG4)	3–16
1.5T SRFD II CABINET (MR1)	3–17
ACGD/PDU CABINET (MR3)	3–18
EXCITE SYSTEM CABINET (MR2)	3–19
MAGNET MONITOR (MSM)	3–20
PATIENT TRANSPORT TABLE (PT1)	3–21
PENETRATION PANEL (PP1)	3–22
PENETRATION PANEL COVER	3–23
OPERATOR WORKSPACE (OW1)	3–24
GOC COMPUTER CABINET (OW1 A2)	3–25
OPERATOR WORKSPACE COMPONENTS POSITIONED ON TABLE TOP – HOST LCD DISPLAY OPTION	3–26
OPERATOR WORKSPACE COMPONENTS POSITIONED ON TABLE TOP – SCSI TOWER & LCD DISPLAY	3–27
OPERATOR WORKSPACE COMPONENTS POSITIONED ON TABLE TOP – KEYBOARD	3–28
PNEUMATIC PATIENT ALERT CONTROL BOX (PA1)	3–29
MAGNET RUNDOWN UNIT (MS4)	3–30
SPT PHANTOM SET SHIPPING/STORAGE CART	3–31
MAIN DISCONNECT CONTROL R4503AT – OPTIONAL	3–32
DC LIGHTING CONTROLLER – OPTIONAL	3–33
OXYGEN MONITOR (OM1) – OPTIONAL	3–34
REMOTE OXYGEN SENSOR MODULE (OM3) – OPTIONAL	3–35
UPS FOR MAGNET MONITOR – STANDARD FOR TRUE MOBILE	3–36
BRAINWAVEHW LITE CABINET – BrainWaveHW Lite OPTION	3–37
MR COMMON CHILLER (MRCC) – OPTION FOR SHIELD/CRYO COOLER COMPRESSOR WATER COOLING	3–38
MRCC OUTDOOR MOUNTING	3–39
REMOTE CONTROL PANEL (RCP) FOR MRCC	3–40



NOTE:

- ALL DIMENSIONS ARE IN INCHES.
  ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- SHADED AREA ROOM CEILING MUST NOT BE BELOW MINIMUM CEILING HEIGHT REQUIREMENTS., REFER TO CHAPTER 8 SECTION 6–3 CEILING HEIGHT.

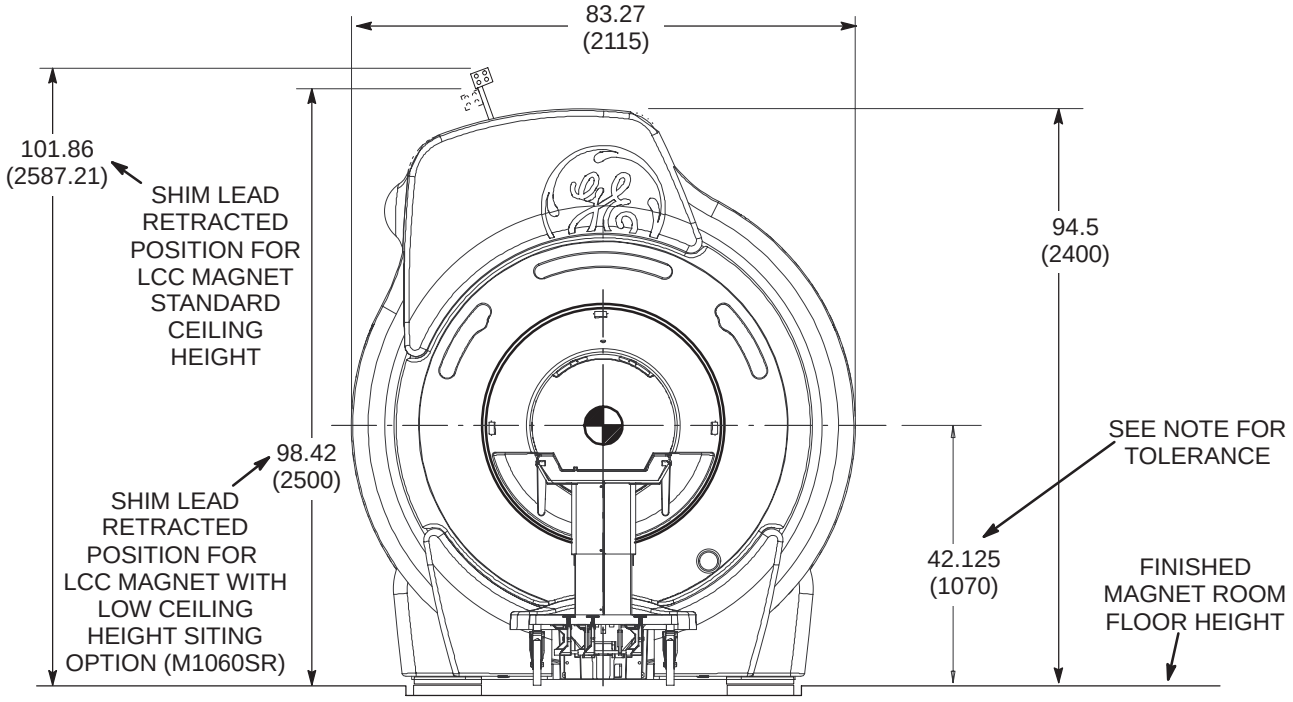
SIGNA EXCITE MR/*i* 1.5T LCC (ACTIVE SHIELD) MAGNET (MINIMUM SERVICE AREA)
ILLUSTRATION 3–9



REAR VIEW

NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- INDICATES MAGNET ISOCENTER
- FINISHED FLOOR TO MAGNET CENTER LINE HEIGHT DIMENSION MUST BE 42.125±0.25 in. (1070±6.35 mm) TO ALLOW PATIENT TABLE TO PROPERLY DOCK TO THE ENCLOSURE.

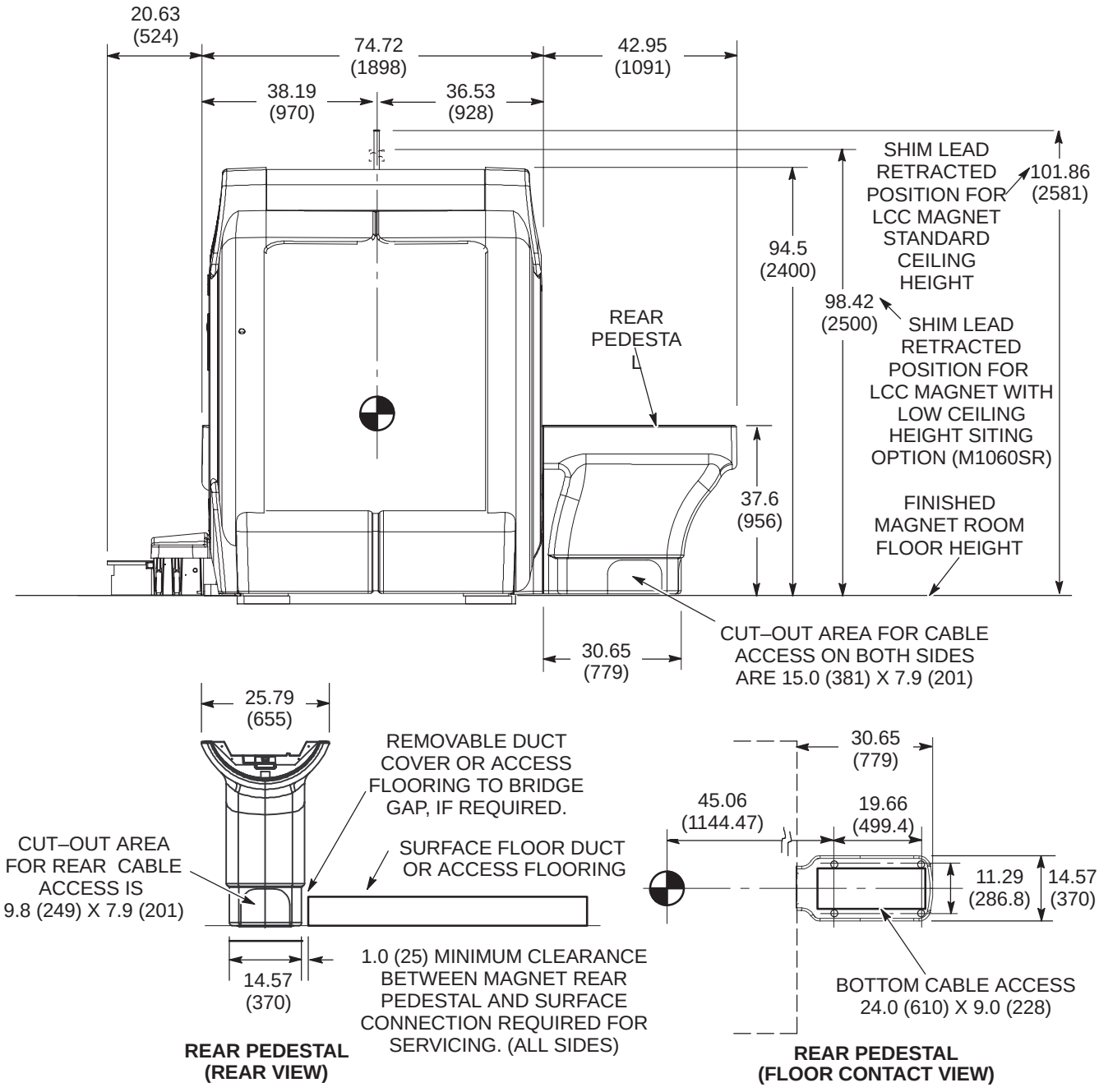


FRONT VIEW

1.5T LCC (ACTIVE SHIELD) MAGNET ENCLOSURE (FRONT AND REAR VIEWS)
ILLUSTRATION 3–10

NOTE:

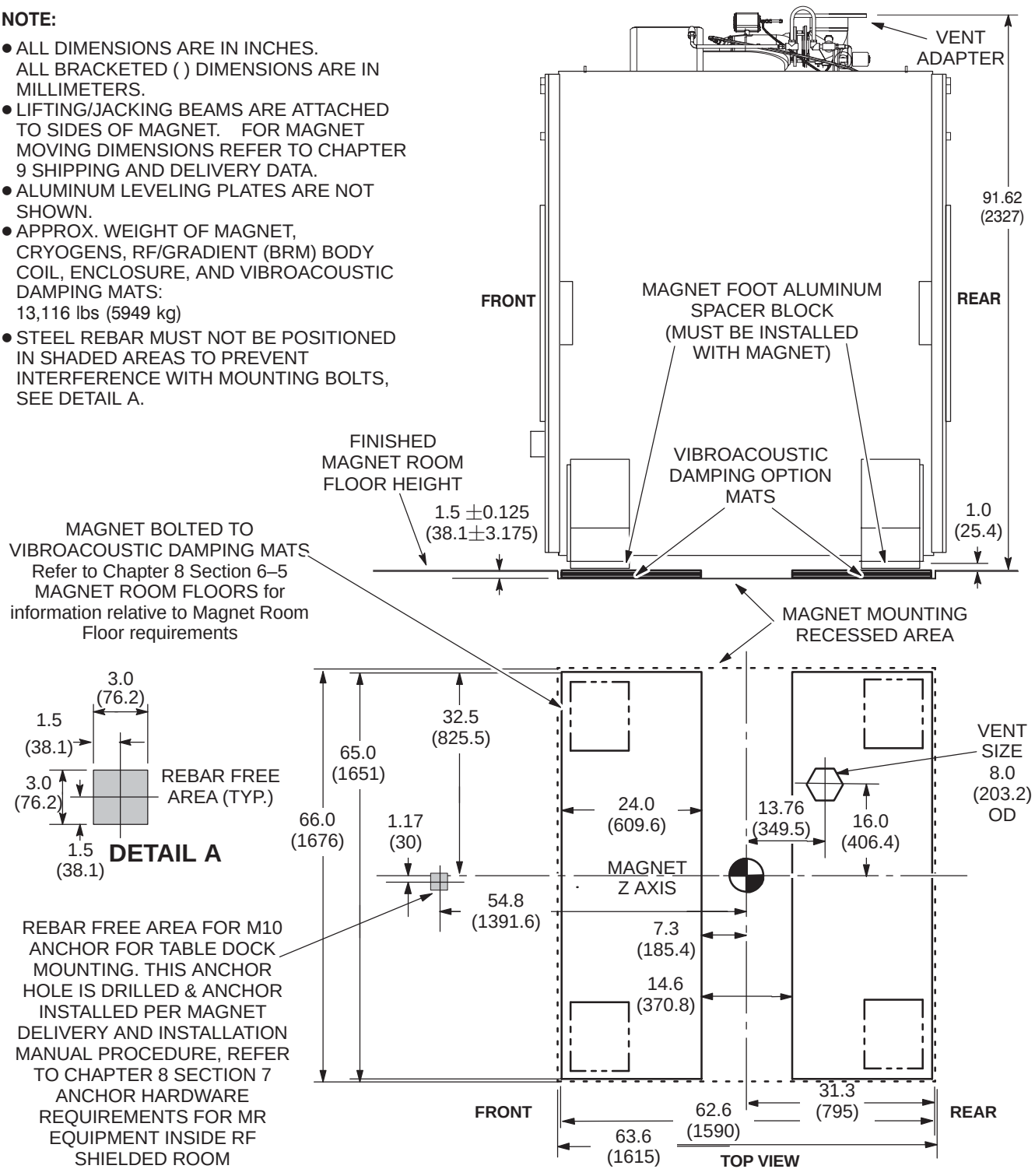
- ALL DIMENSIONS ARE IN INCHES.
  ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- INDICATES MAGNET ISOCENTER



1.5T LCC (ACTIVE SHIELD) MAGNET CABLE ACCESS
ILLUSTRATION 3–11

NOTE:

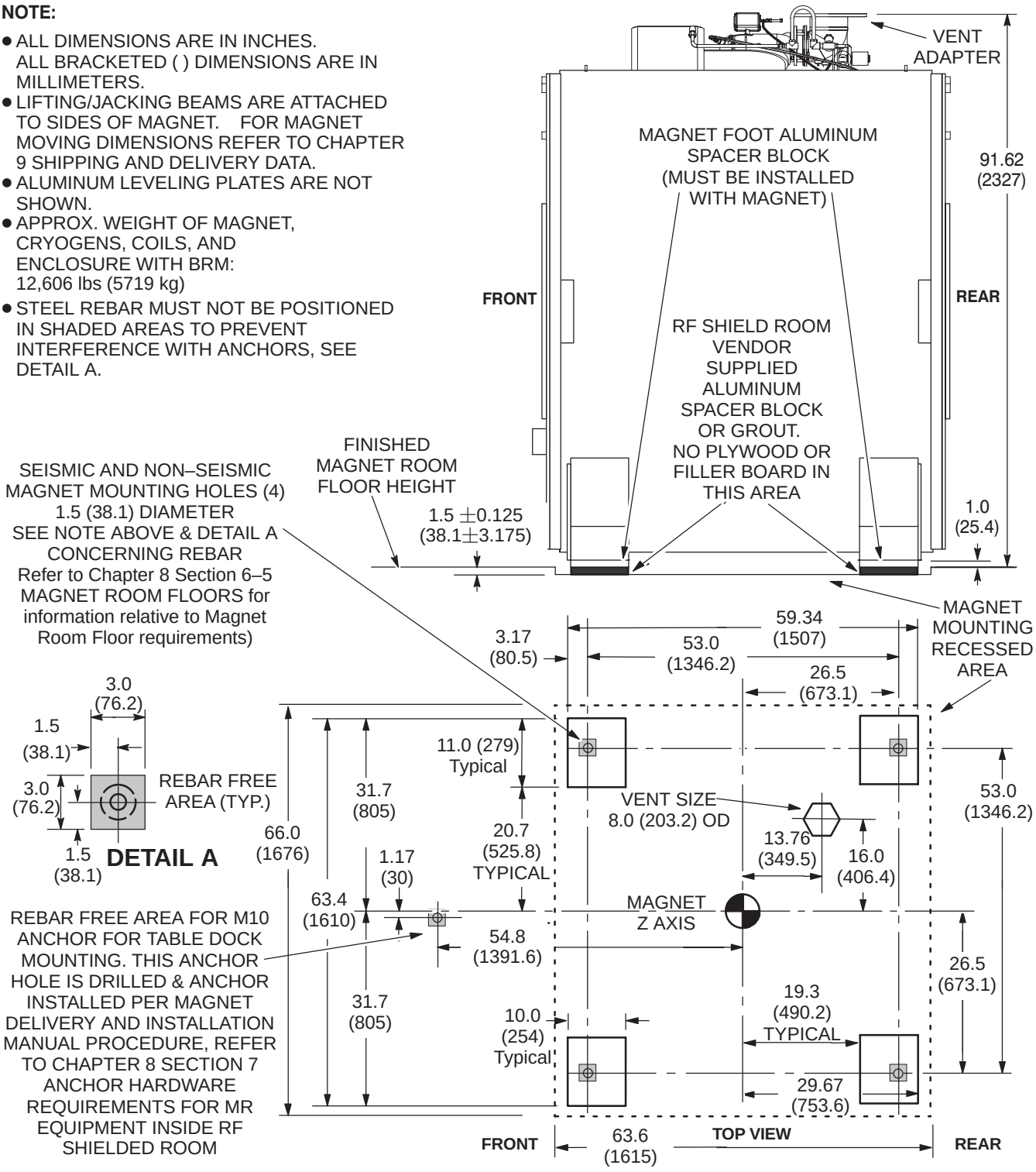
- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- LIFTING/JACKING BEAMS ARE ATTACHED TO SIDES OF MAGNET. FOR MAGNET MOVING DIMENSIONS REFER TO CHAPTER 9 SHIPPING AND DELIVERY DATA.
- ALUMINUM LEVELING PLATES ARE NOT SHOWN.
- APPROX. WEIGHT OF MAGNET, CRYOGENS, RF/GRADIENT (BRM) BODY COIL, ENCLOSURE, AND VIBROACOUSTIC DAMPING MATS: 13,116 lbs (5949 kg)
- STEEL REBAR MUST NOT BE POSITIONED IN SHADED AREAS TO PREVENT INTERFERENCE WITH MOUNTING BOLTS, SEE DETAIL A.



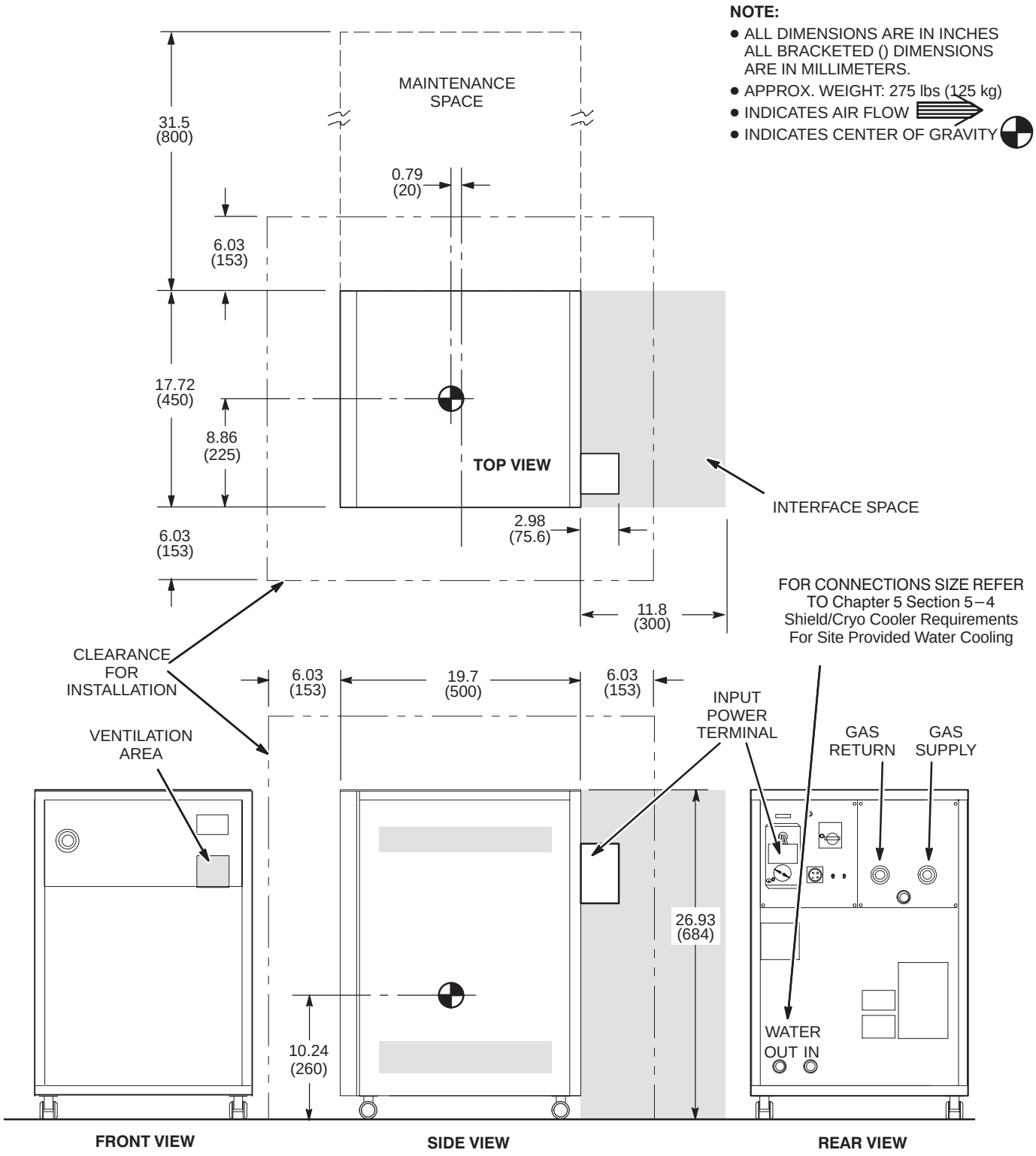
Signa EXCITE MR/*i* 1.5T LCC Magnet Load Pattern with VibroAccoustic Damping Option
ILLUSTRATION 3–12

NOTE:

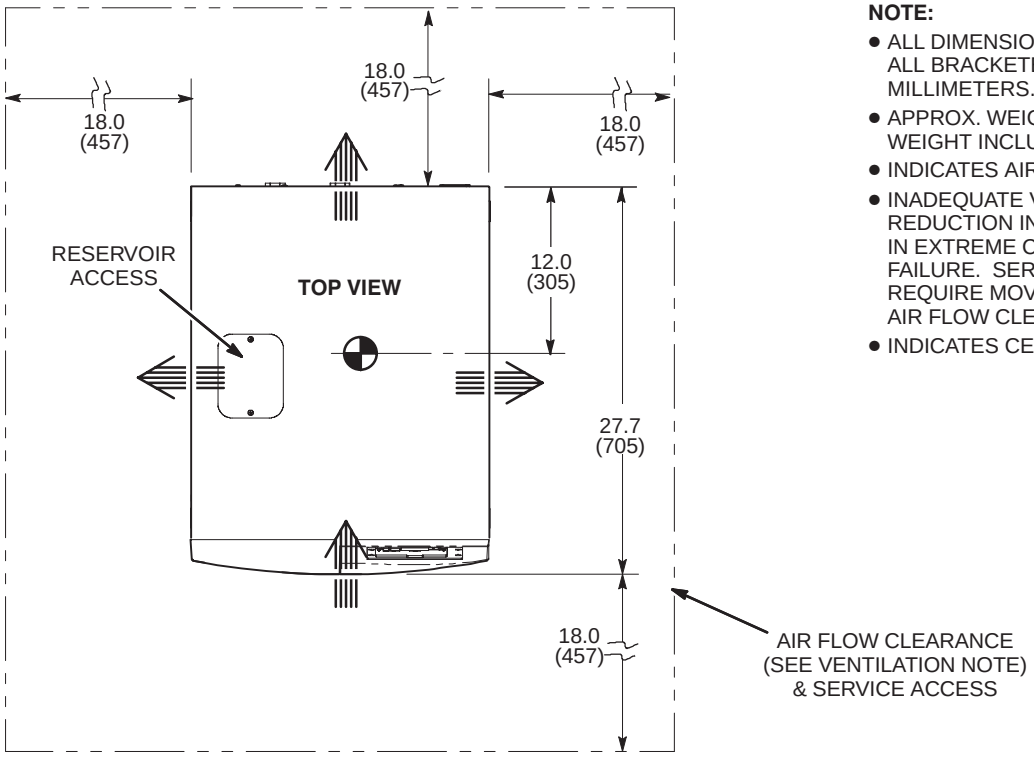
- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- LIFTING/JACKING BEAMS ARE ATTACHED TO SIDES OF MAGNET. FOR MAGNET MOVING DIMENSIONS REFER TO CHAPTER 9 SHIPPING AND DELIVERY DATA.
- ALUMINUM LEVELING PLATES ARE NOT SHOWN.
- APPROX. WEIGHT OF MAGNET, CRYOGENS, COILS, AND ENCLOSURE WITH BRM: 12,606 lbs (5719 kg)
- STEEL REBAR MUST NOT BE POSITIONED IN SHADED AREAS TO PREVENT INTERFERENCE WITH ANCHORS, SEE DETAIL A.



Signa EXCITE MR/*i* 1.5T LCC Magnet Load Pattern without VibroAccoustic Damping Option
ILLUSTRATION 3–13

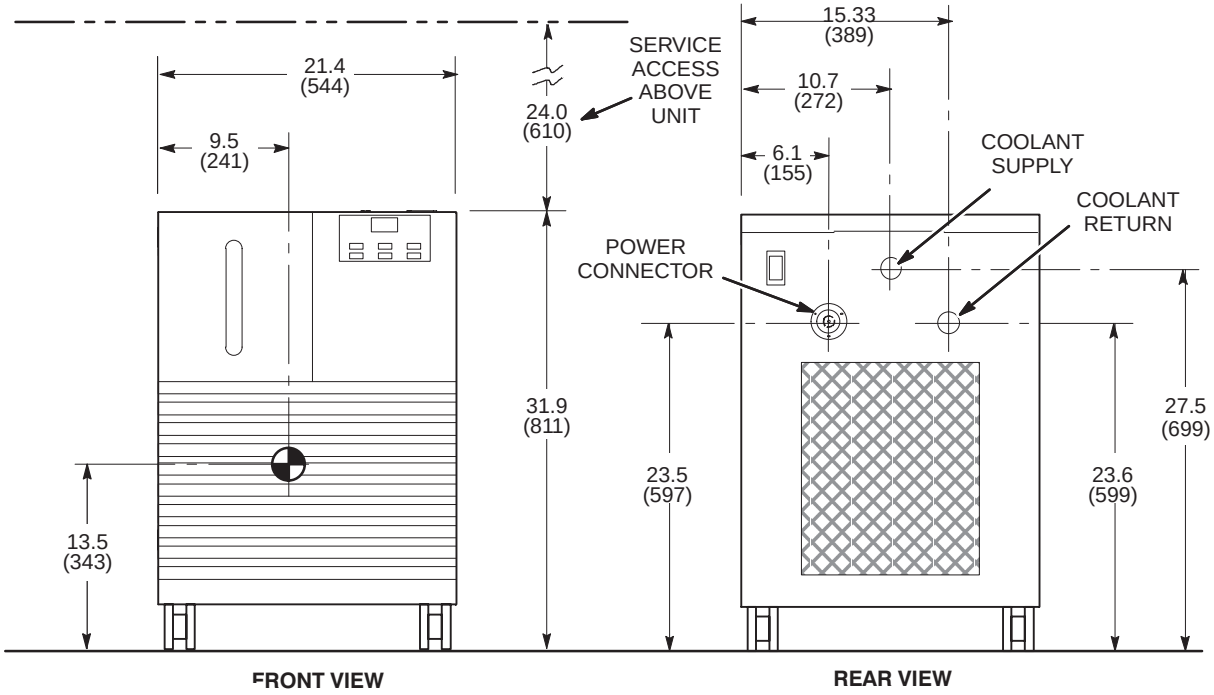


SHIELD/CRYO COOLER COMPRESSOR CABINET (MS5)
ILLUSTRATION 3–14

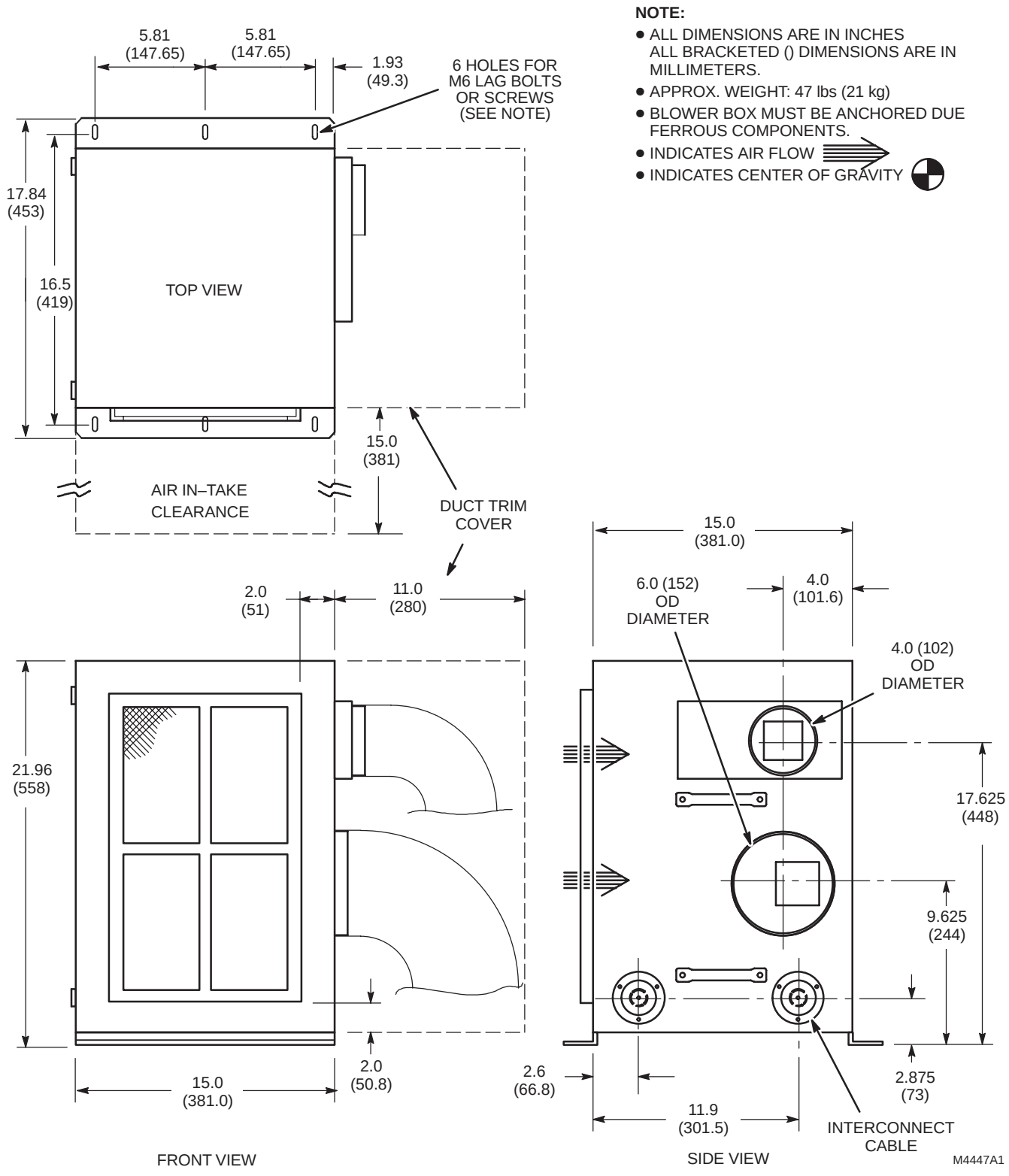


NOTE:

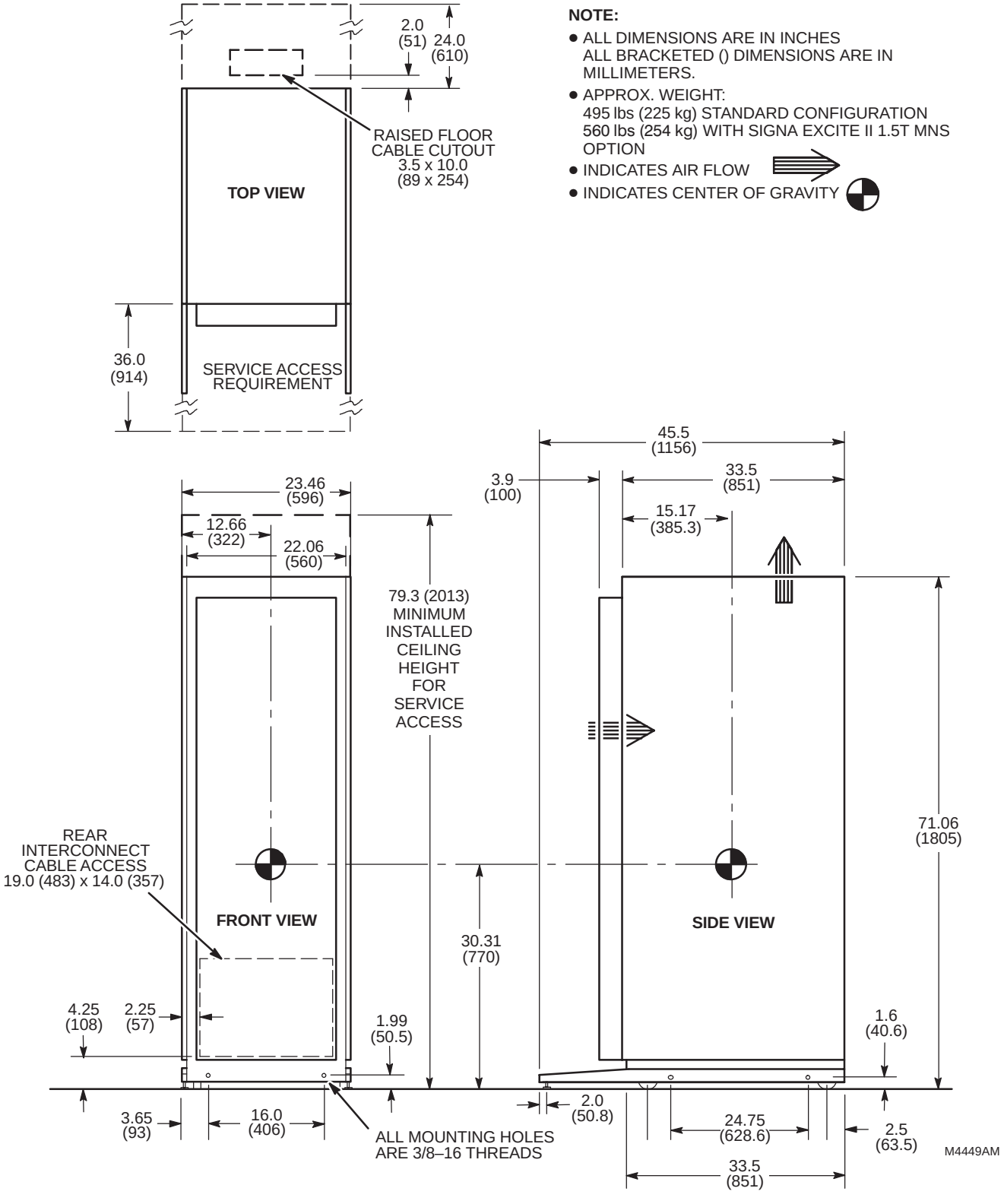
- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT: 295 lbs (134 kg) WEIGHT INCLUDES COOLING FLUID
- INDICATES AIR FLOW
- INADEQUATE VENTILATION WILL CAUSE A REDUCTION IN COOLING CAPACITY AND, IN EXTREME CASES, COMPRESSOR FAILURE. SERVICING THIS UNIT MAY REQUIRE MOVEMENT OF CABINET WITHIN AIR FLOW CLEARANCE AREA.
- INDICATES CENTER OF GRAVITY



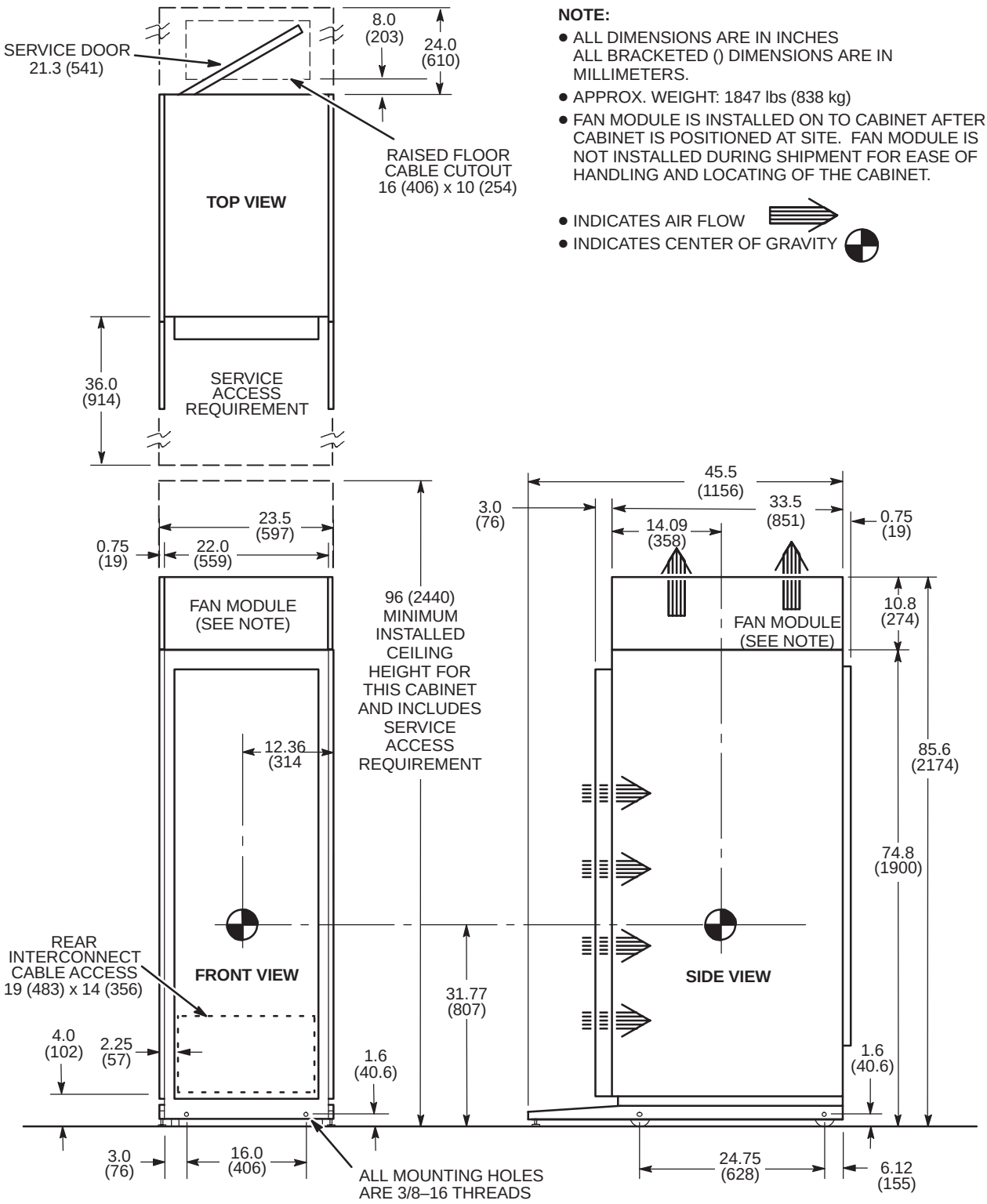
WATER CHILLER (WC1) FOR GRADIENT COIL COOLING WATER
ILLUSTRATION 3–15



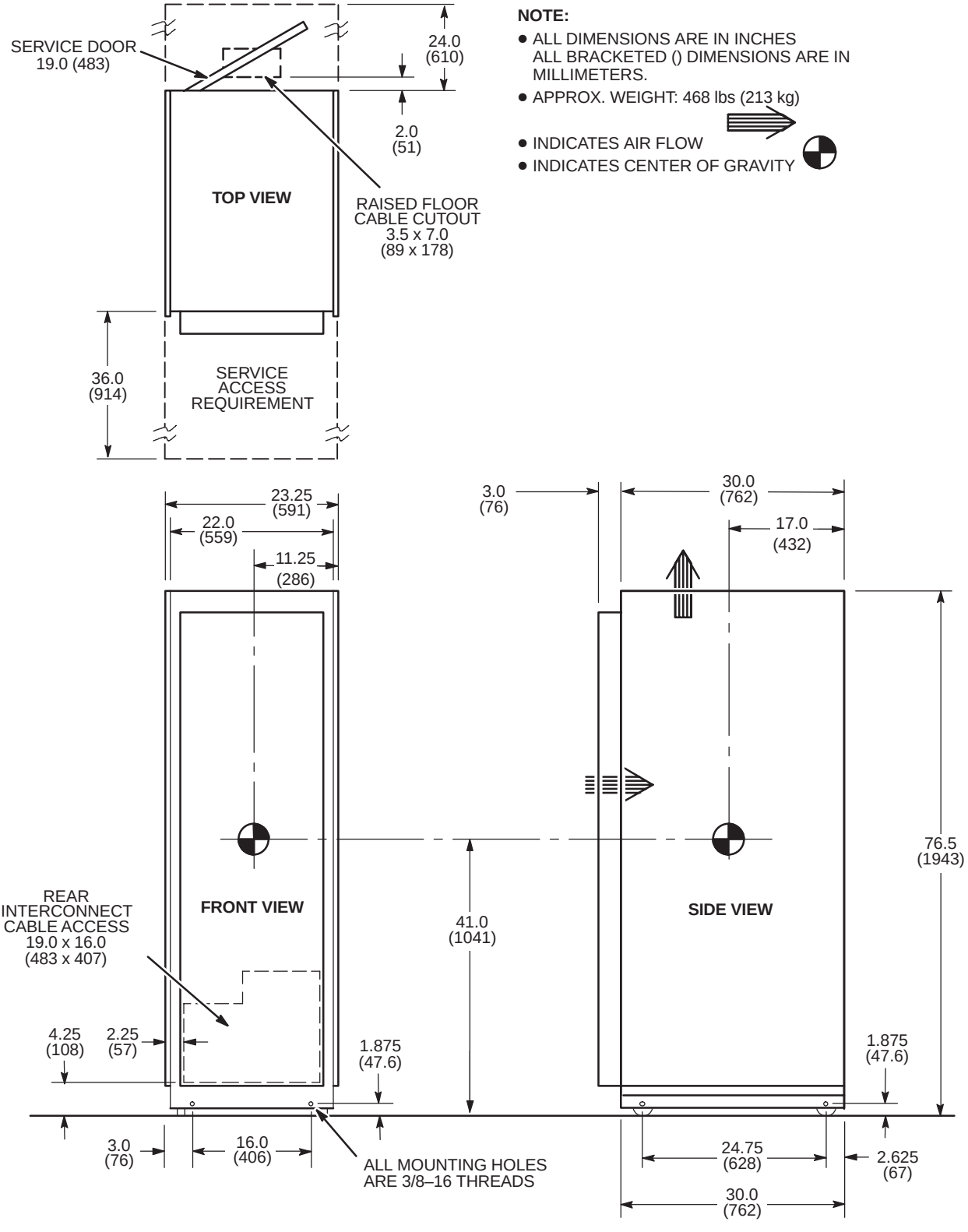
BLOWER BOX (MG6)
ILLUSTRATION 3–16



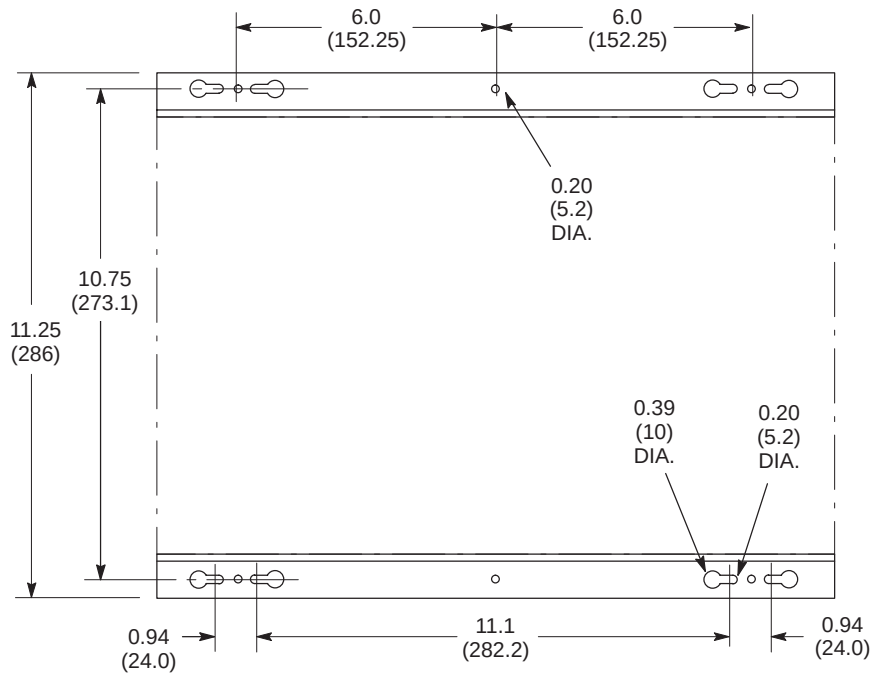
1.5T SRFD II CABINET (MR1)
ILLUSTRATION 3 – 17



ACGD/PDU CABINET (MR3)
ILLUSTRATION 3–18



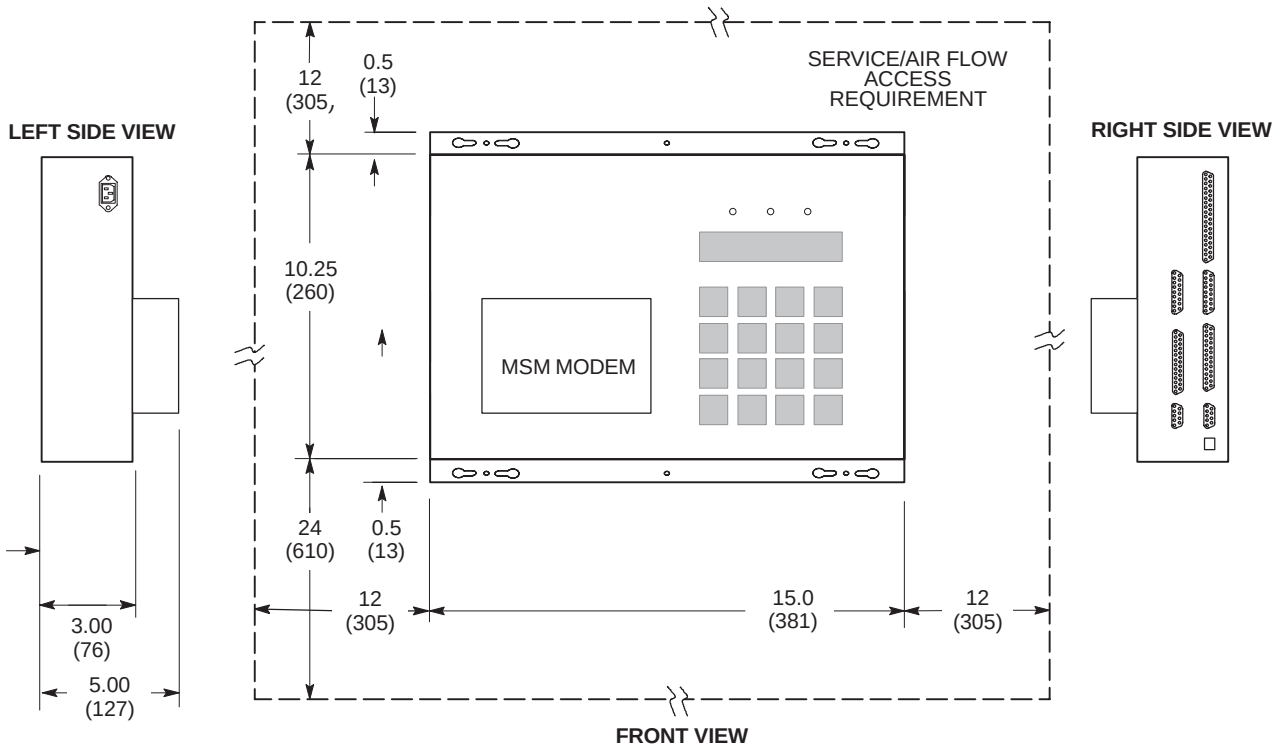
EXCITE SYSTEM CABINET (MR2)
ILLUSTRATION 3–19



MOUNTING PATTERN

NOTE:

- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT: 22 lbs (10 kg)

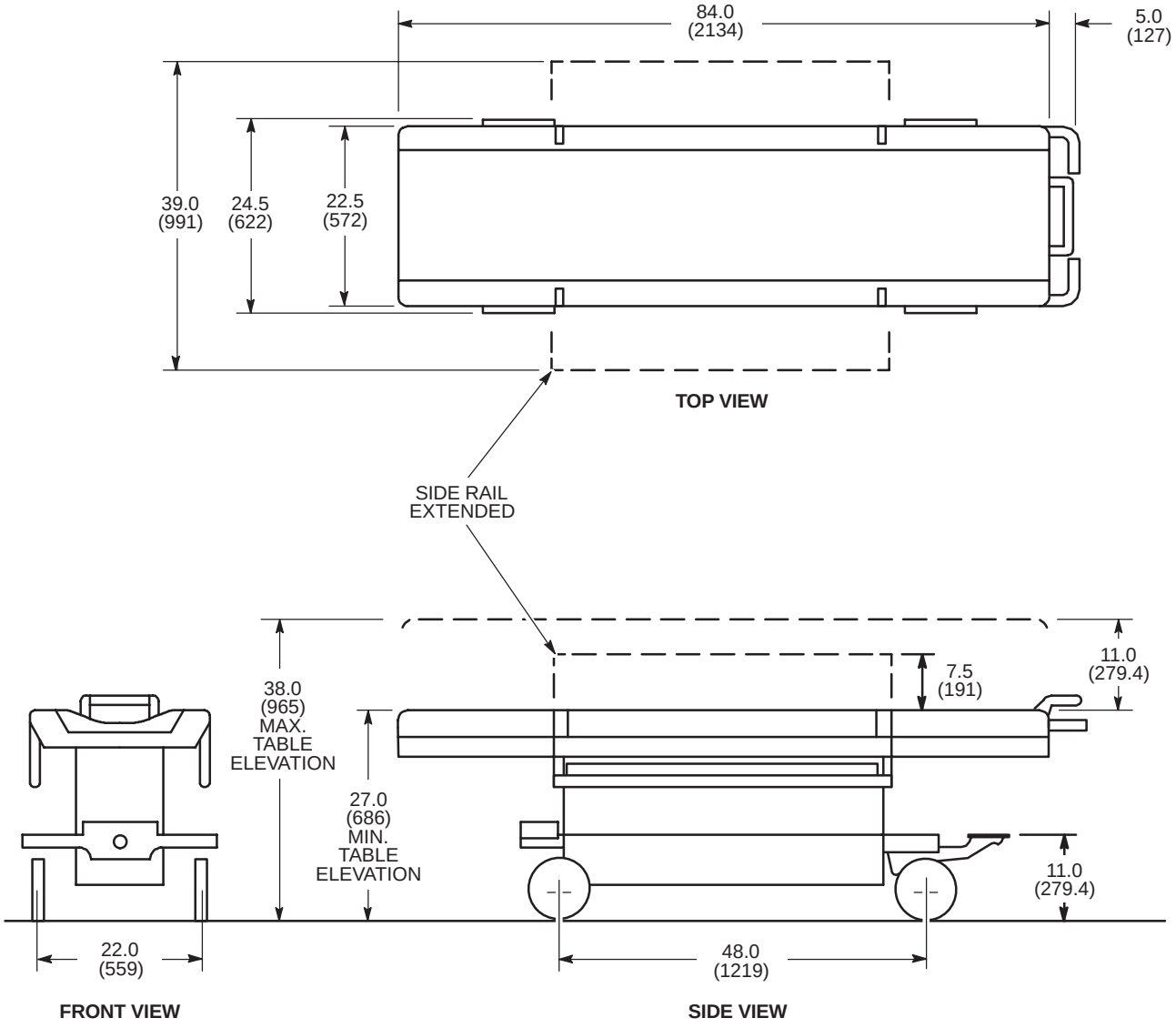


FRONT VIEW

MAGNET MONITOR (MSM)
ILLUSTRATION 3–20

NOTE:

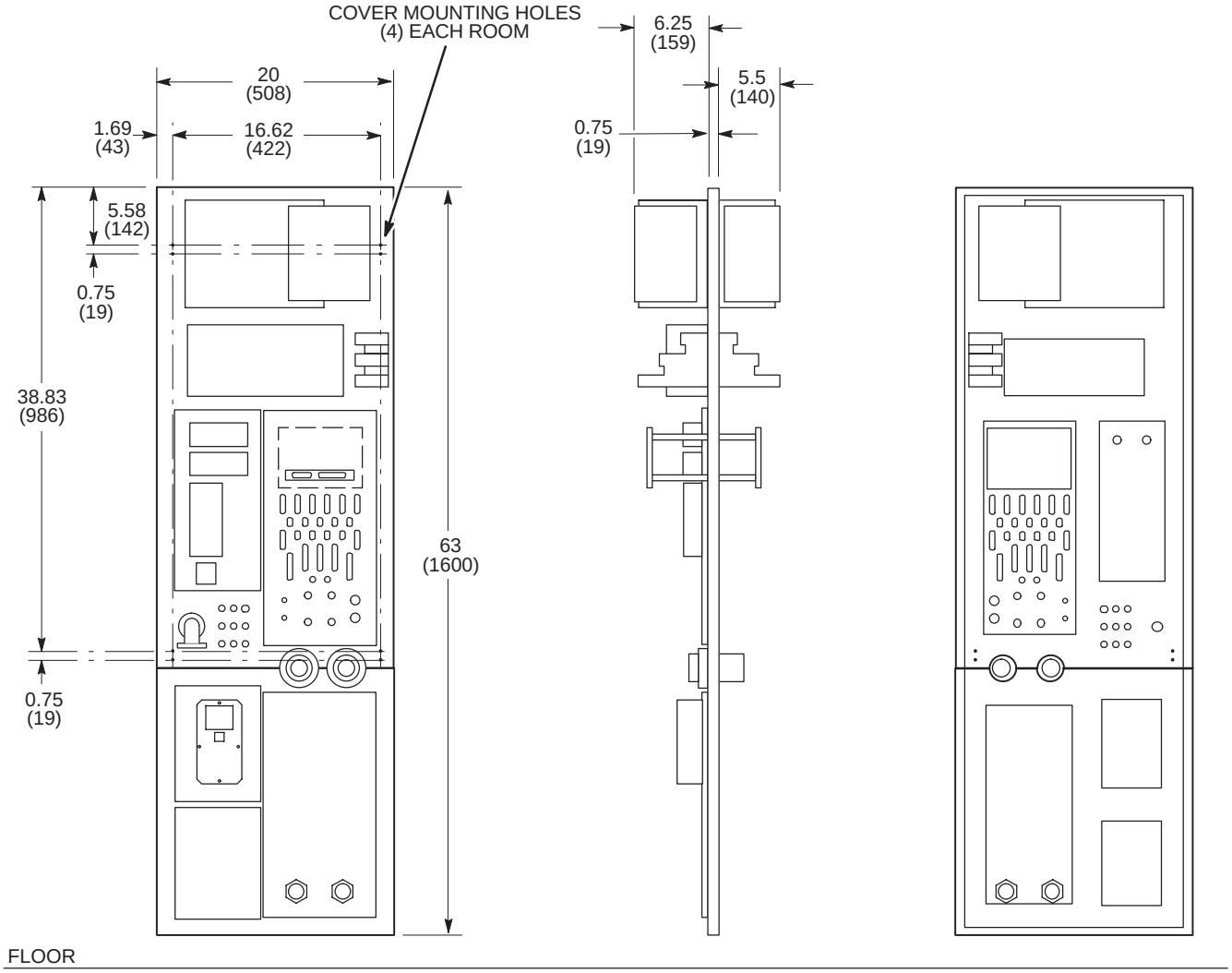
- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT: 280 lbs (127 kg) 630 lbs (286 kg) WITH 350 lbs (159 kg) PATIENT



PATIENT TRANSPORT TABLE (PT1)
ILLUSTRATION 3–21

NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT: 52 lbs (23.6 kg)



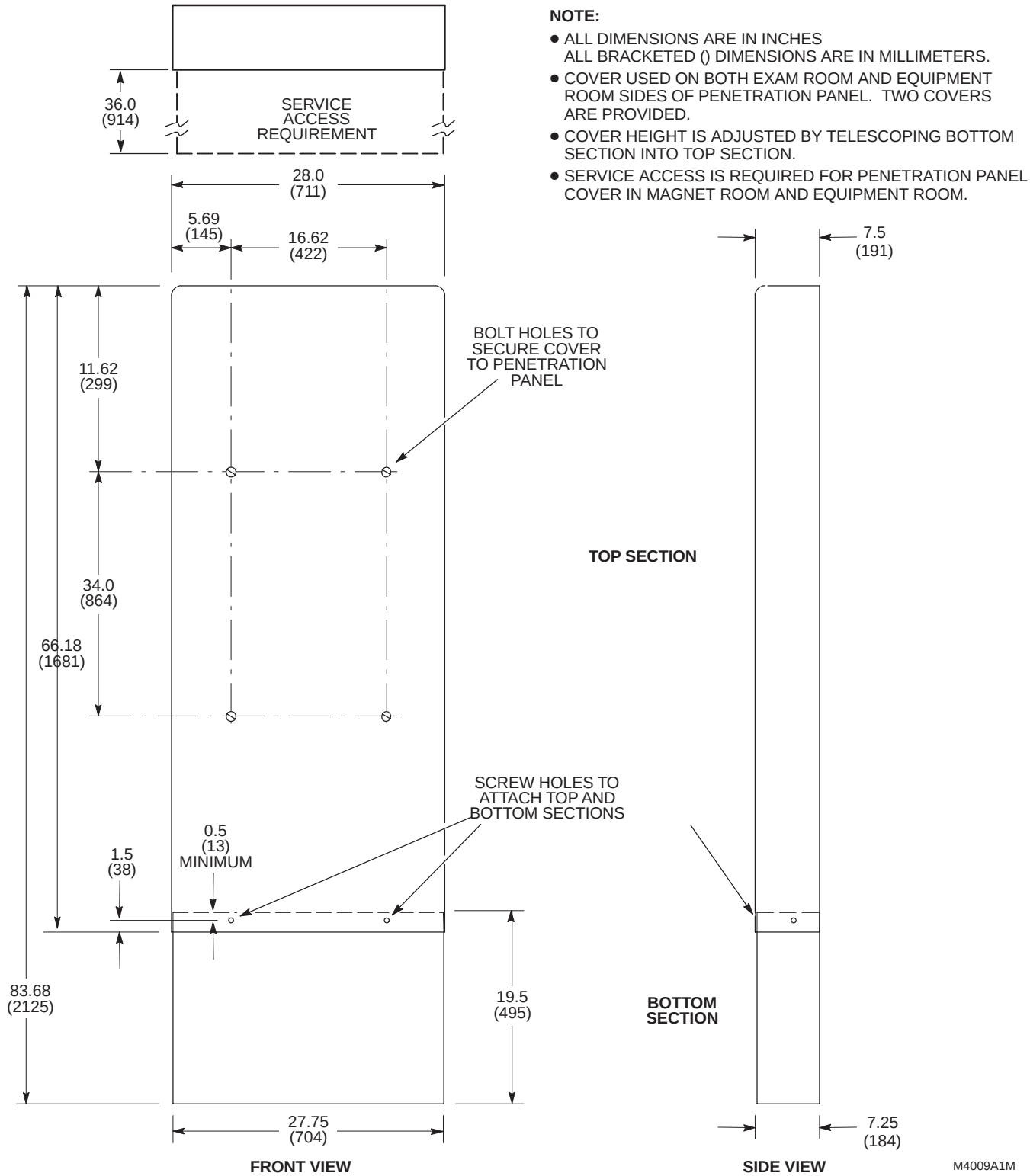
EQUIPMENT ROOM SIDE **MAGNET ROOM SIDE**

M4494A

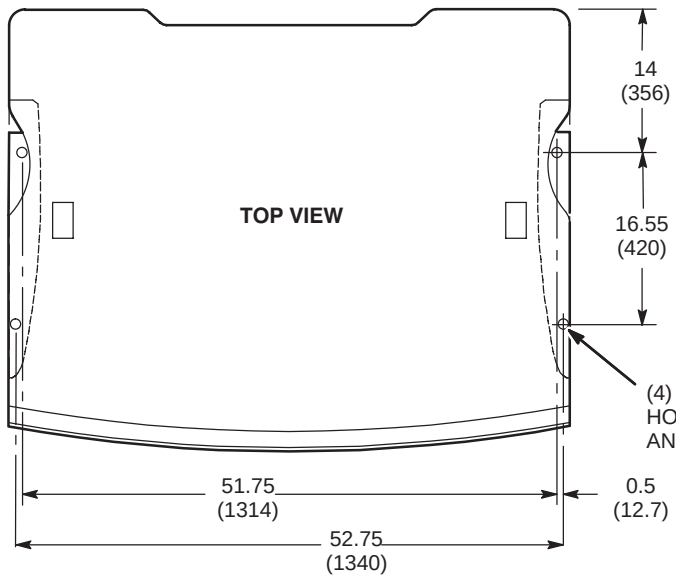
PENETRATION PANEL (PP1)
ILLUSTRATION 3–22

NOTE:

- ALL DIMENSIONS ARE IN INCHES
  ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- COVER USED ON BOTH EXAM ROOM AND EQUIPMENT ROOM SIDES OF PENETRATION PANEL. TWO COVERS ARE PROVIDED.
- COVER HEIGHT IS ADJUSTED BY TELESCOPING BOTTOM SECTION INTO TOP SECTION.
- SERVICE ACCESS IS REQUIRED FOR PENETRATION PANEL COVER IN MAGNET ROOM AND EQUIPMENT ROOM.

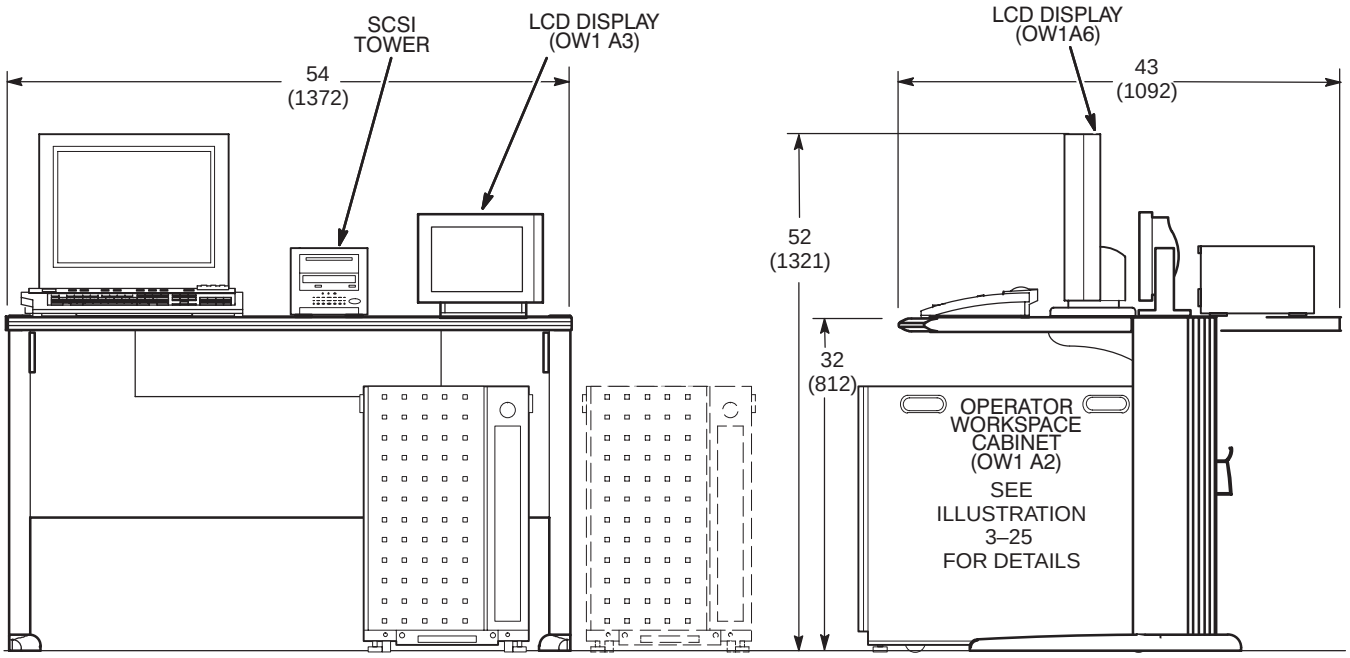


PENETRATION PANEL COVER
ILLUSTRATION 3–23

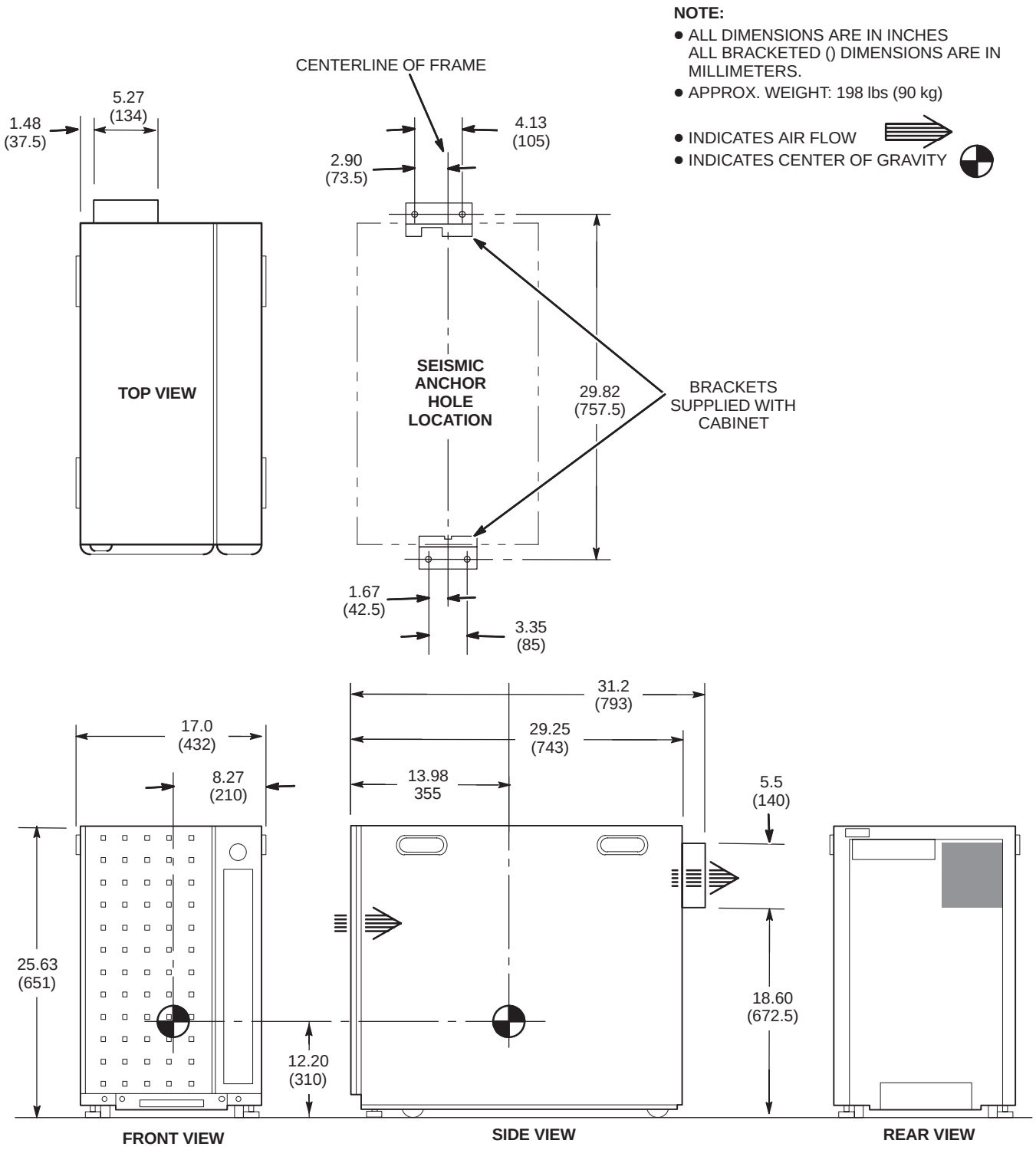


NOTE:

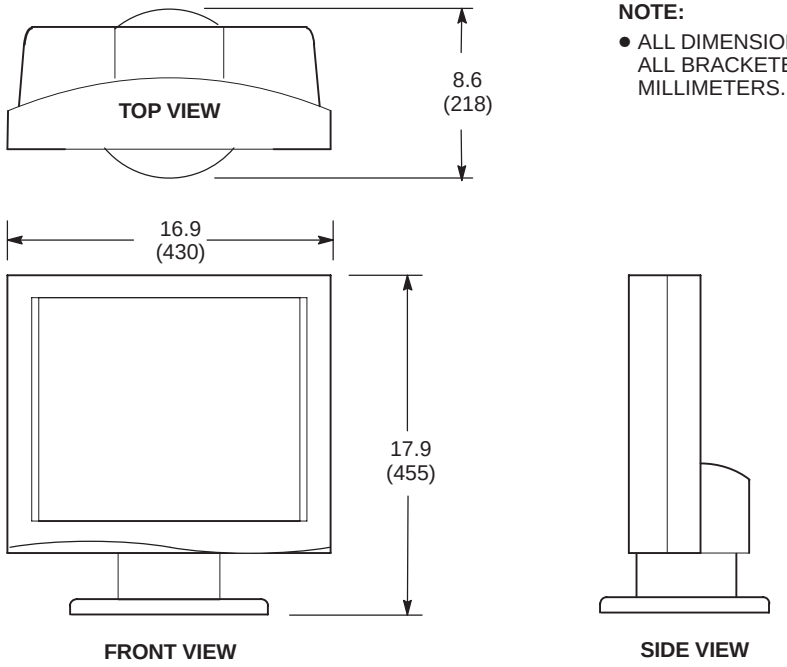
- ALL DIMENSIONS ARE IN INCHES.
  ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.



OPERATOR WORKSPACE (OW1)
ILLUSTRATION 3–24

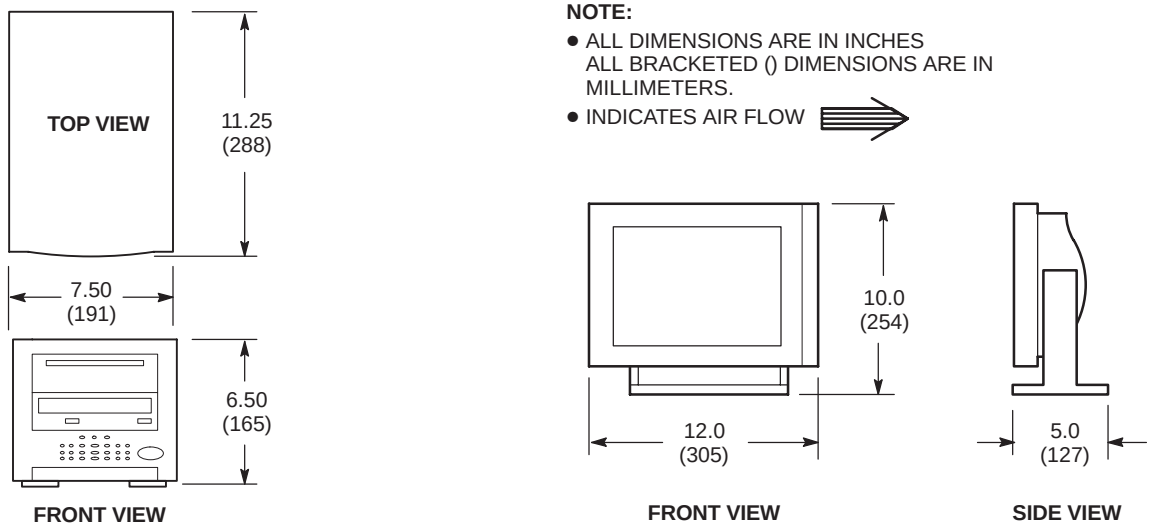


GOC COMPUTER CABINET (OW1 A2)
ILLUSTRATION 3–25



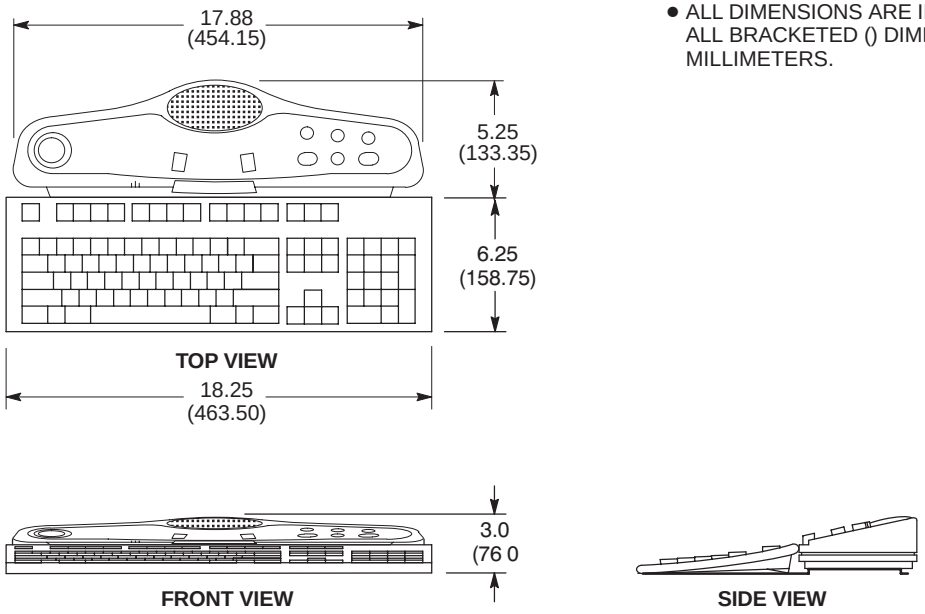
NOTE:
- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.

OPERATOR WORKSPACE COMPONENTS POSITIONED ON TABLE TOP – HOST LCD DISPLAY
ILLUSTRATION 3–26



NOTE:
- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- INDICATES AIR FLOW

OPERATOR WORKSPACE COMPONENTS POSITIONED ON TABLE TOP – SCSI TOWER & LCD DISPLAY
ILLUSTRATION 3–27



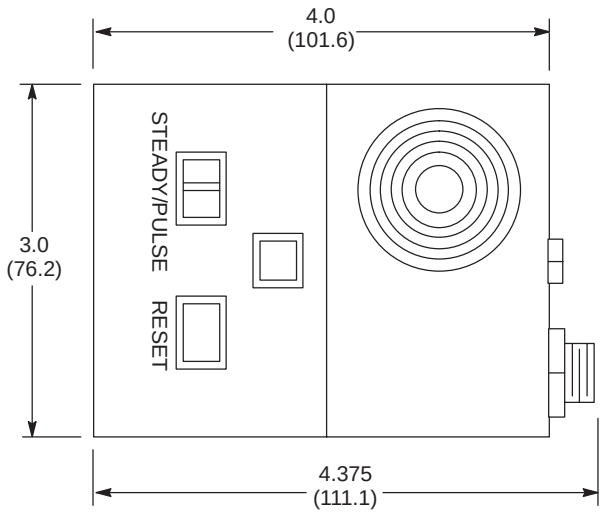
NOTE:

- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.

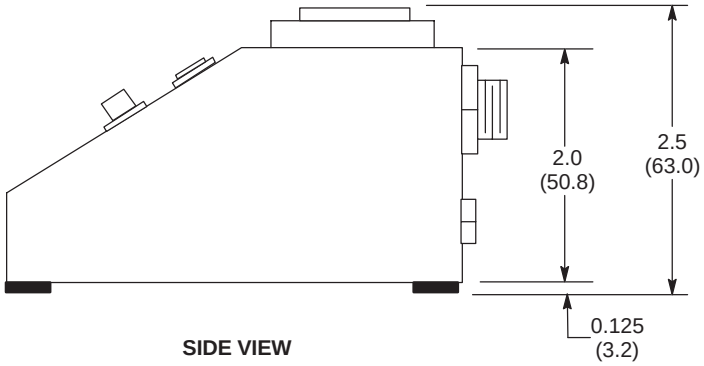
OPERATOR WORKSPACE COMPONENTS POSITIONED ON TABLE TOP – KEYBOARD
ILLUSTRATION 3–28

NOTE:

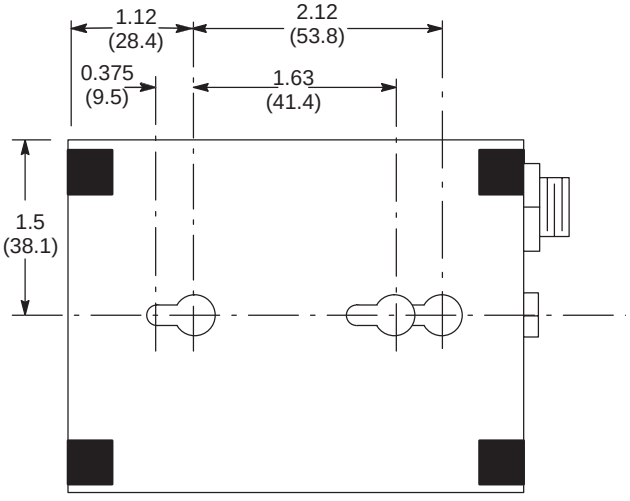
- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT: 0.5 lbs (0.2 kg)



TOP VIEW



SIDE VIEW



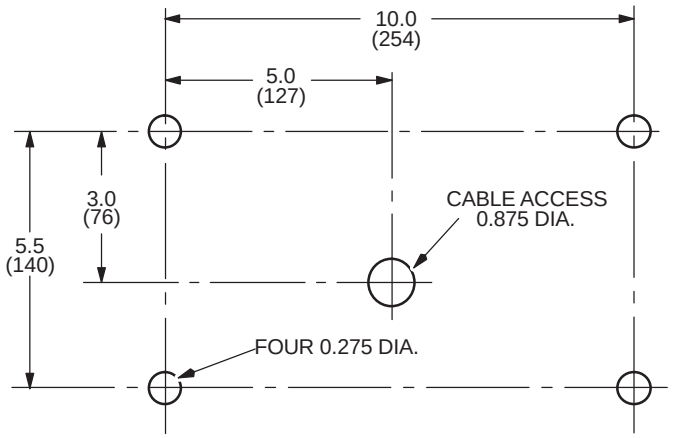
MOUNTING PATTERN

M4263A1

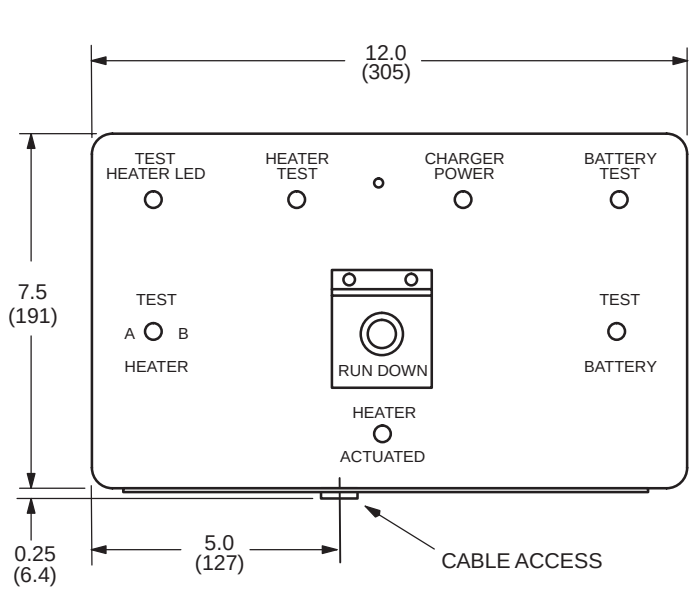
PNEUMATIC PATIENT ALERT CONTROL BOX (PA1)
ILLUSTRATION 3–29

NOTE:

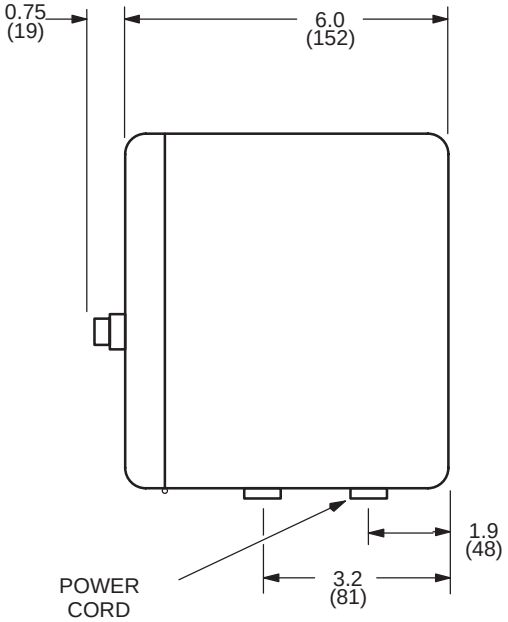
- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT: 8.8 lbs. (4kg)



MOUNTING PATTERN



FRONT VIEW



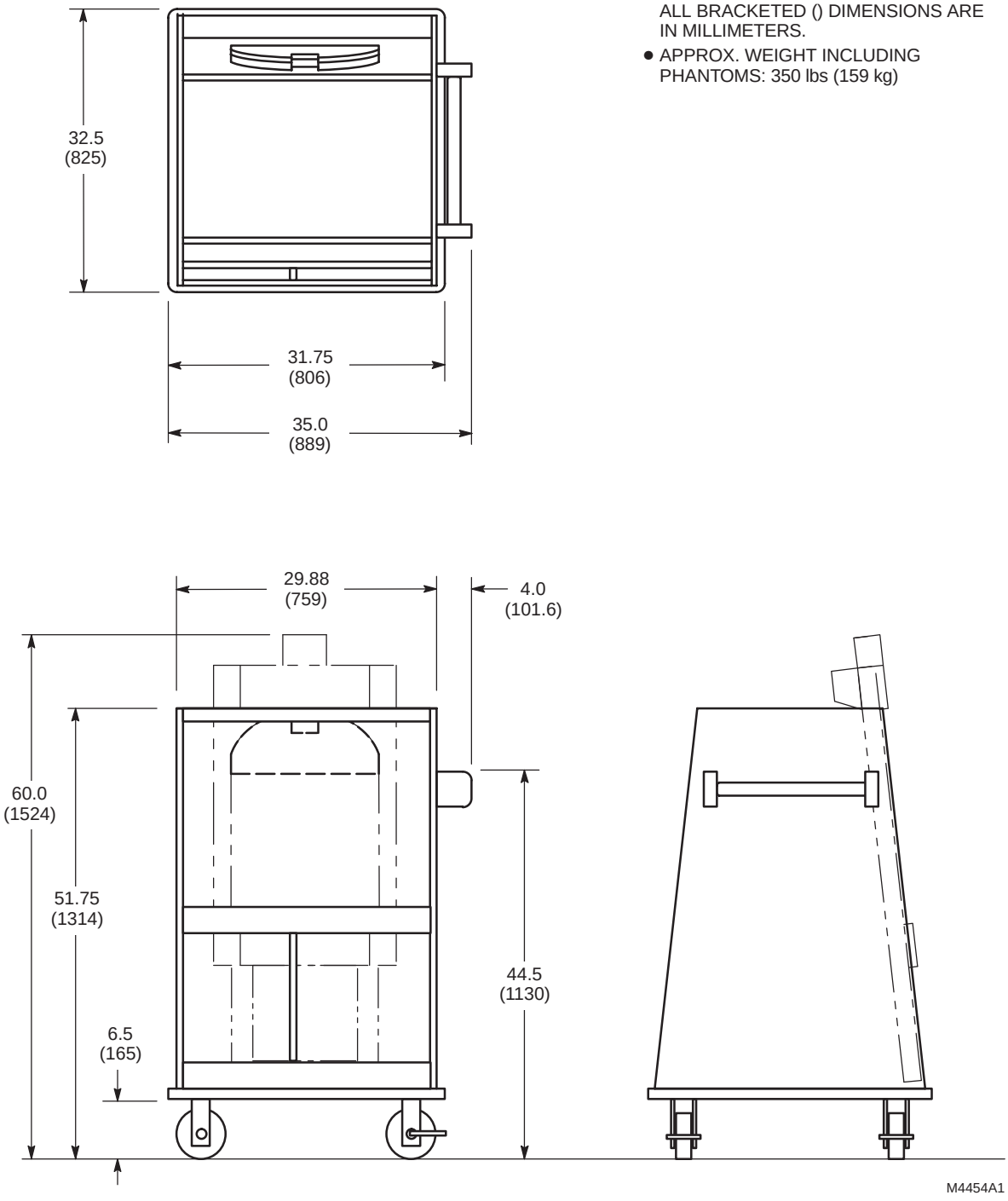
SIDE VIEW

M1517A5

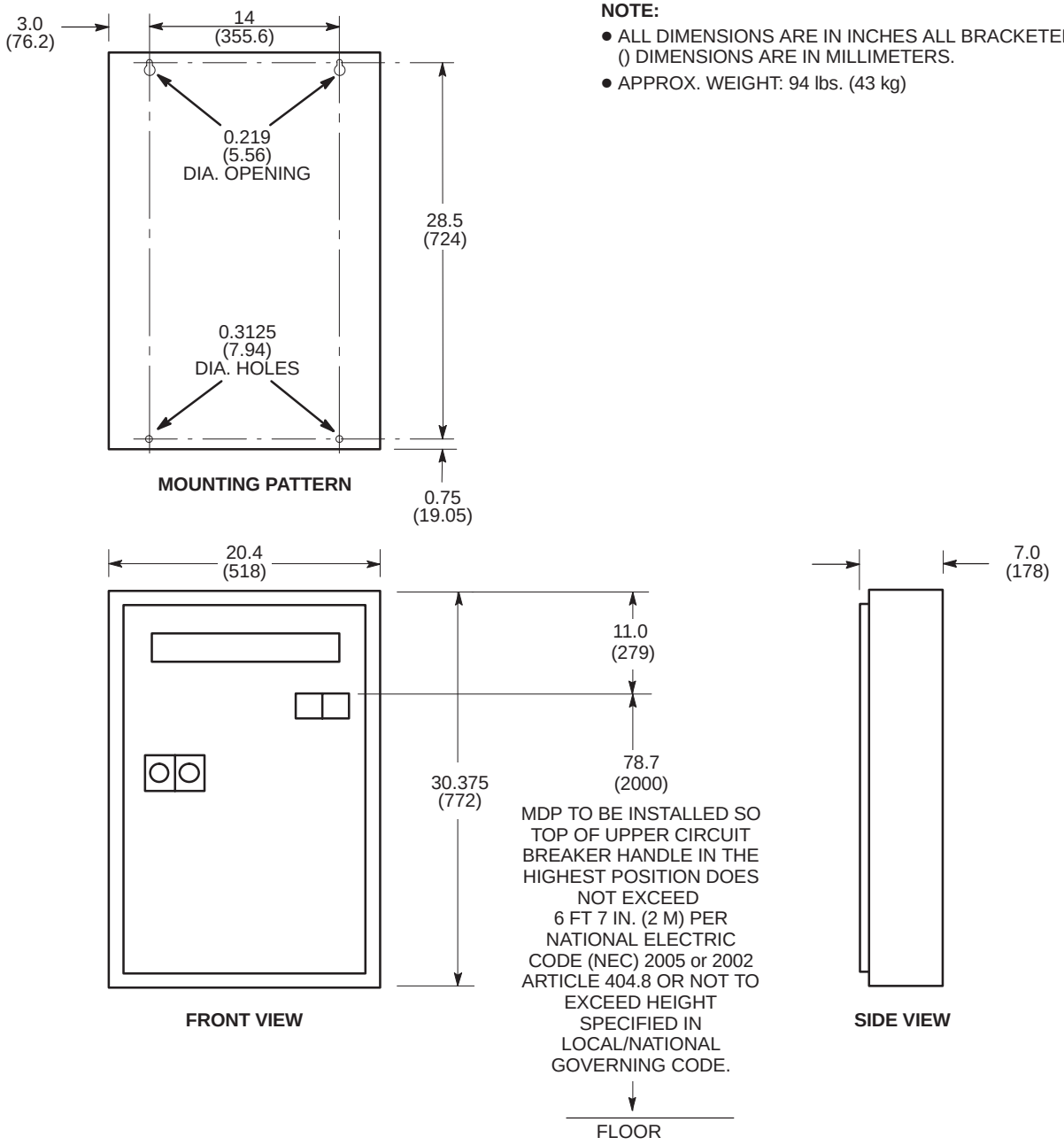
MAGNET RUNDOWN UNIT (MS4)
ILLUSTRATION 3–30

NOTE:

- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT INCLUDING PHANTOMS: 350 lbs (159 kg)



SPT PHANTOM SET SHIPPING/STORAGE CART
ILLUSTRATION 3–31



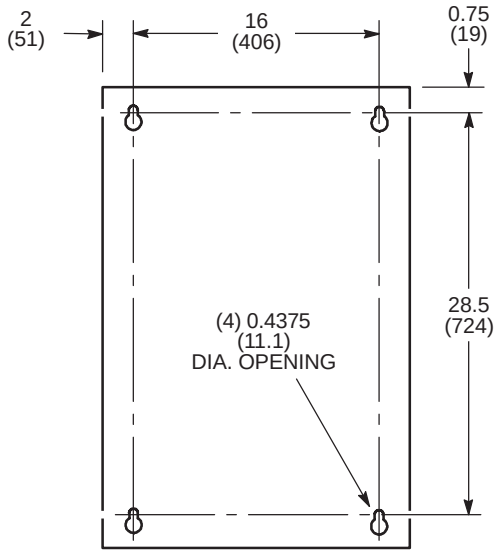
NOTE:

- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT: 94 lbs. (43 kg)

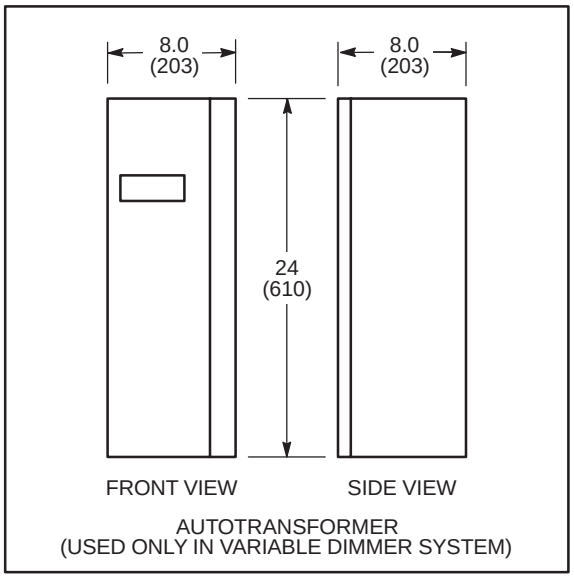
MAIN DISCONNECT CONTROL E4503AT – OPTIONAL
ILLUSTRATION 3–32

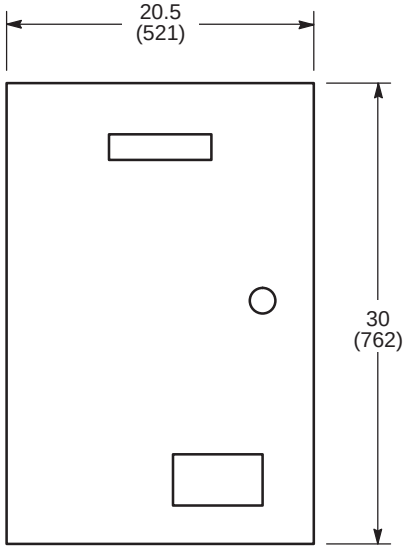
NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHTS:
  CONTROL PANEL: 155 lbs (70 kg)
  AUTOTRANSFORMER: 60 lbs (27 kg)

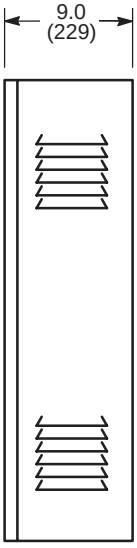


MOUNTING PATTERN
(CONTROL PANEL)





FRONT VIEW
(CONTROL PANEL)



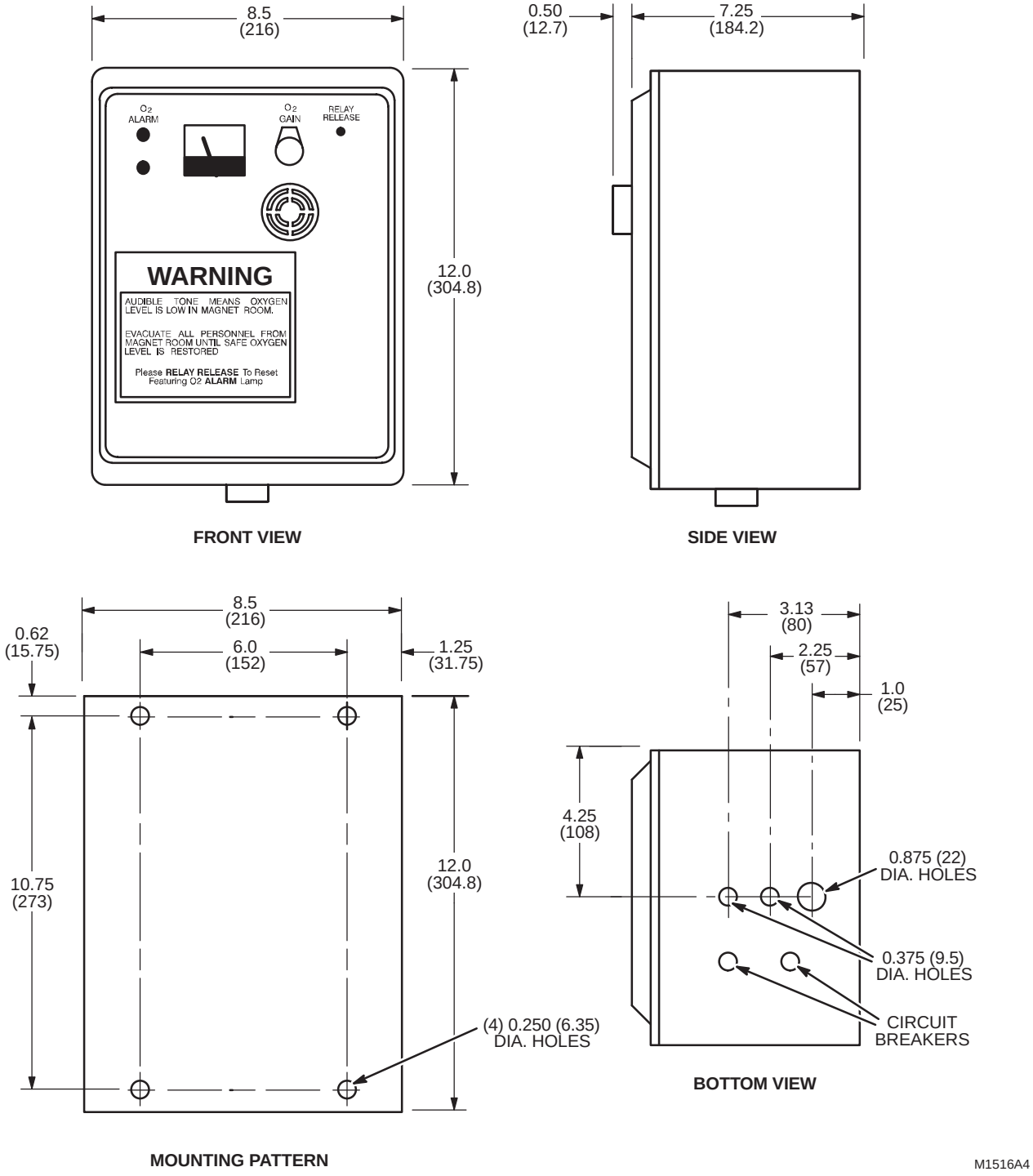
SIDE VIEW
(CONTROL PANEL)

M1519A3

DC LIGHTING CONTROLLER – OPTIONAL
ILLUSTRATION 3–33

NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT: 9 lbs (4.1 kg)

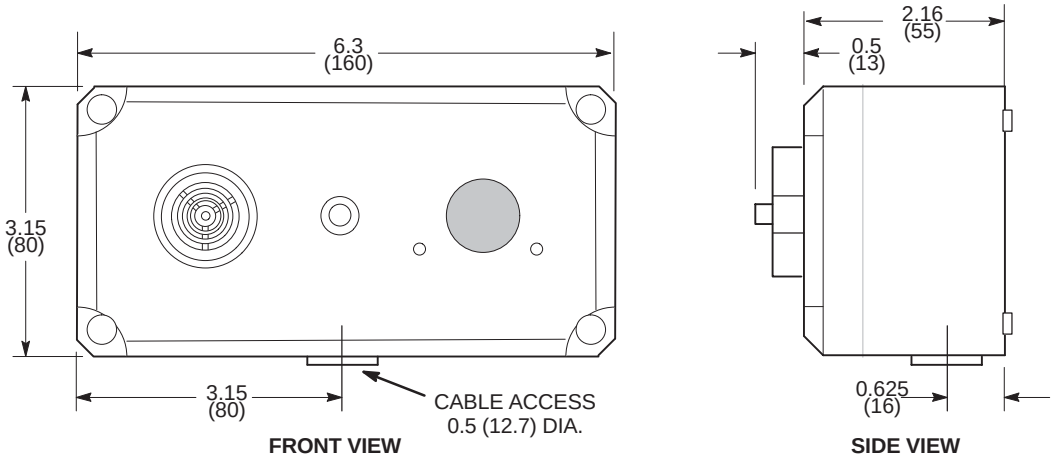


OXYGEN MONITOR (OM1) – OPTIONAL
ILLUSTRATION 3–34

MOUNTING PATTERN

NOTE:

- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT OF MODULE: 1.5 lbs (0.68 kg)

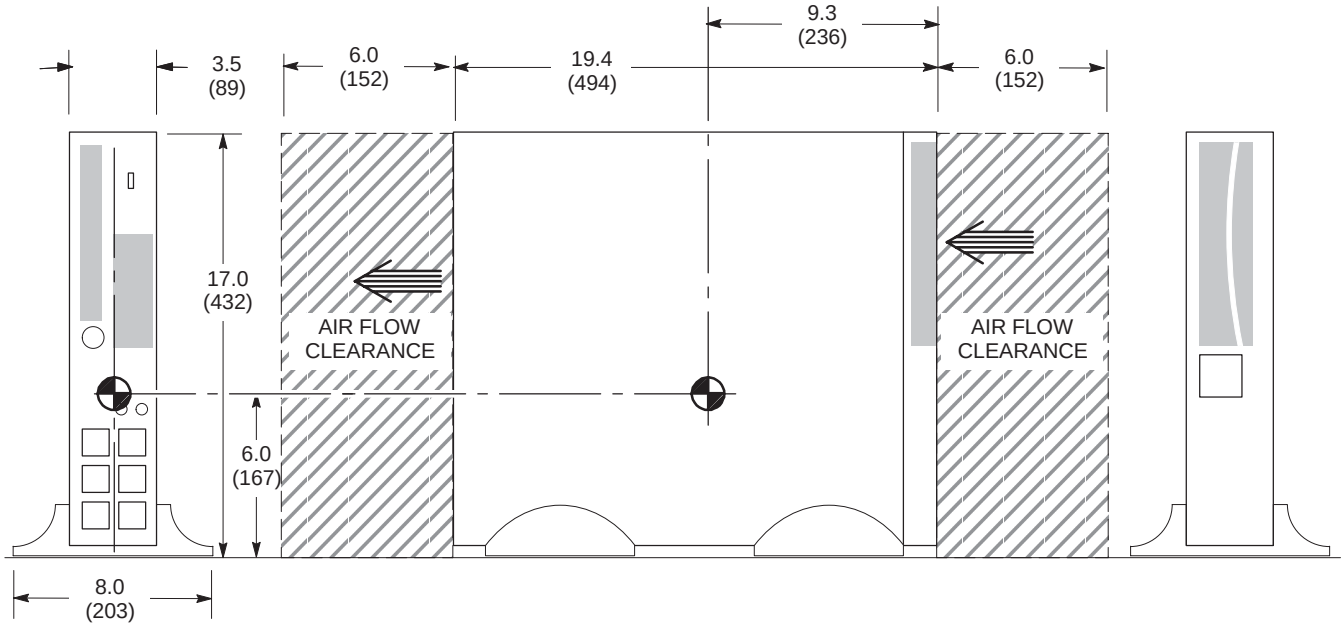


FRONT VIEW **SIDE VIEW** M3346A1M

REMOTE OXYGEN SENSOR MODULE (OM3) – OPTIONAL
ILLUSTRATION 3–35

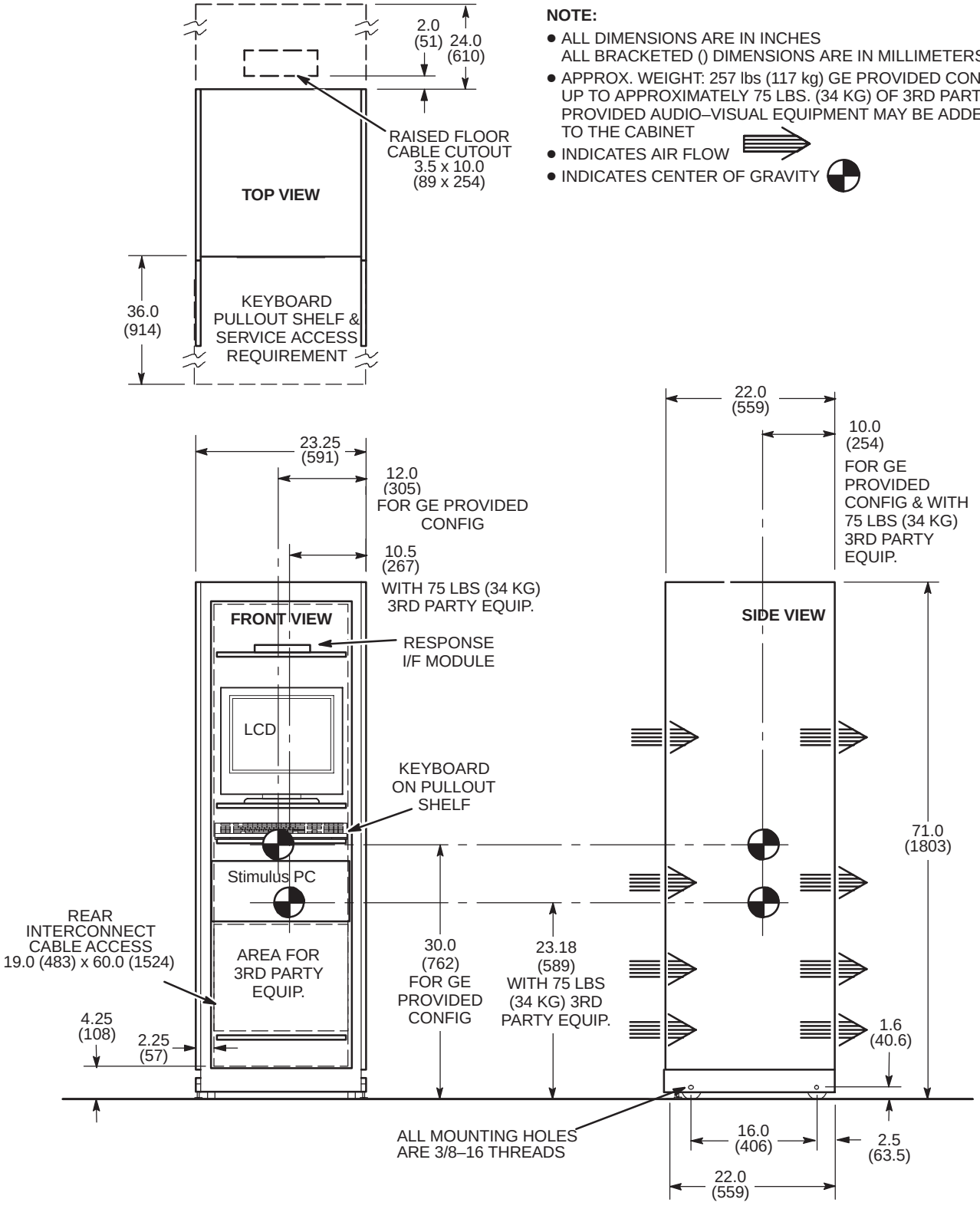
NOTE:

- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT: 50 lbs (23 kg)
- INDICATES AIR FLOW
- INDICATES CENTER OF GRAVITY

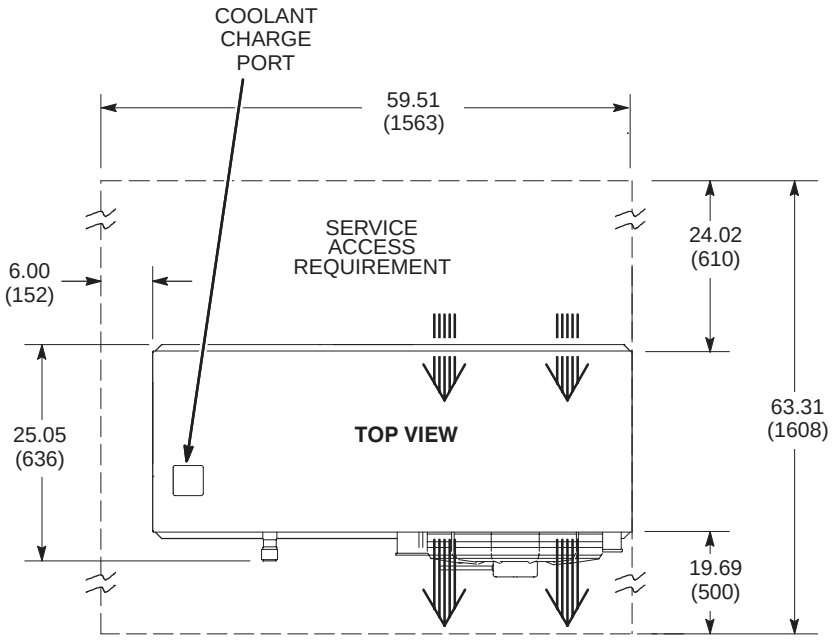


REAR VIEW **SIDE VIEW** **FRONT VIEW**

UPS FOR MAGNET MONITOR – STANDARD FOR TRUE MOBILE
ILLUSTRATION 3–36

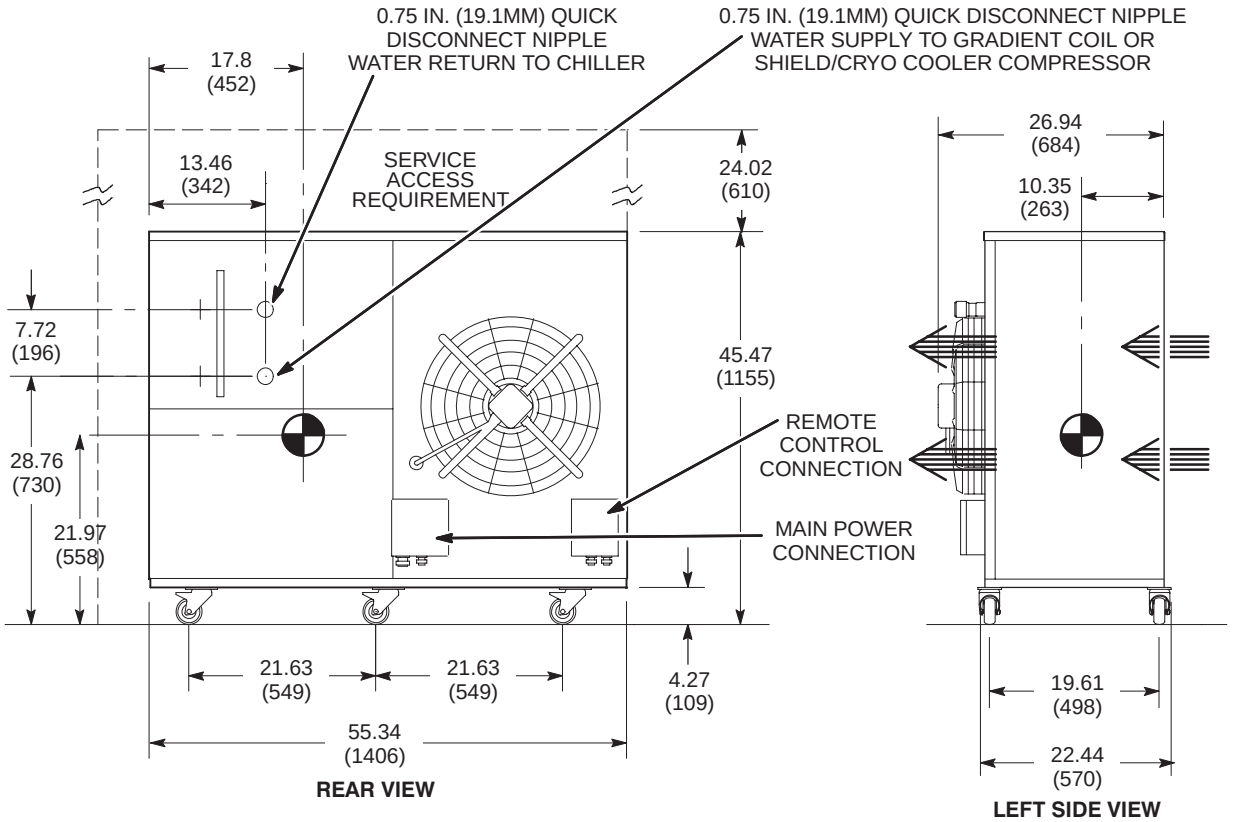


BRAINWAVEHW LITE CABINET – BrainWaveHW Lite OPTION
ILLUSTRATION 3–37



NOTE:

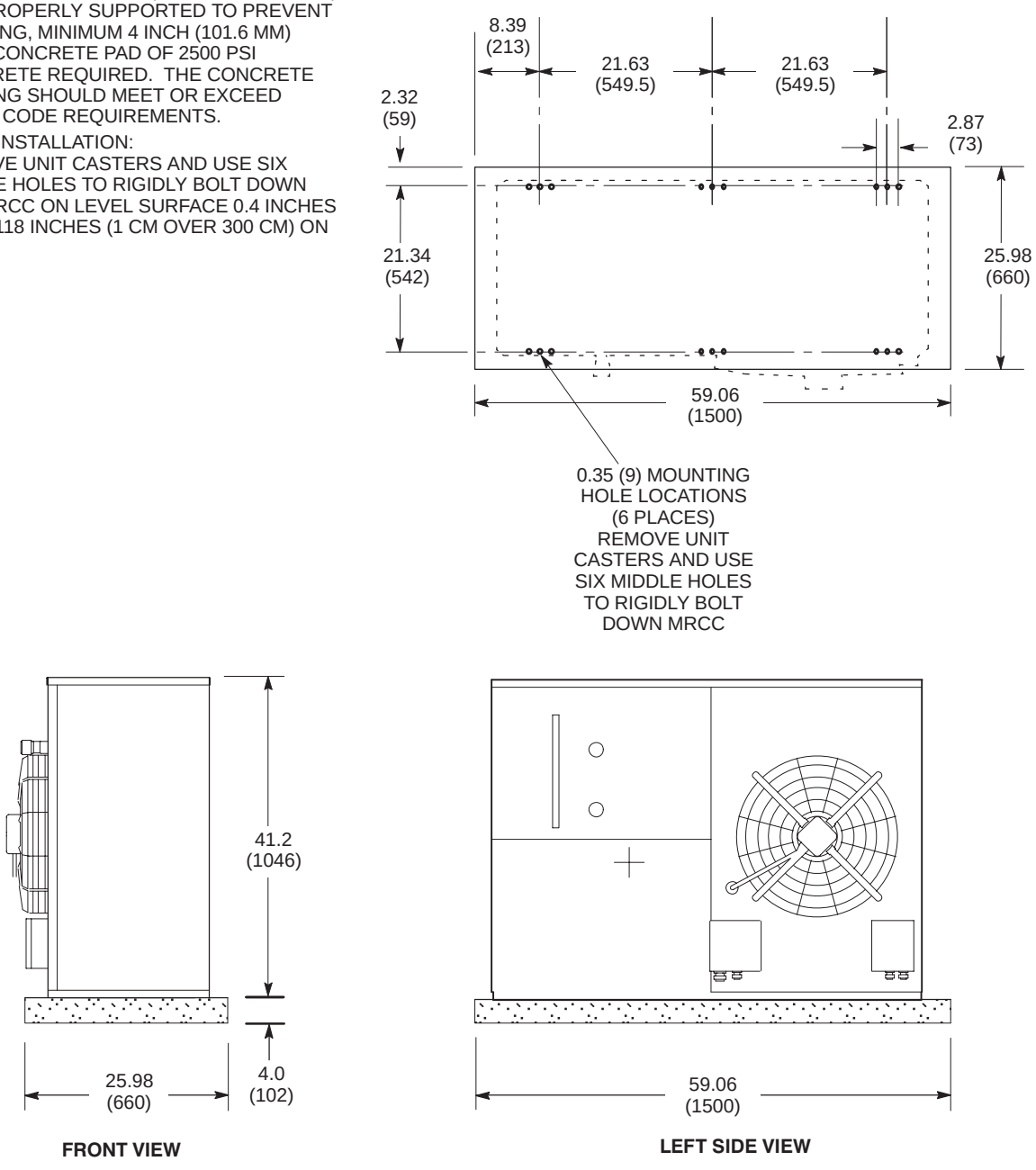
- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT: 685 lbs (310 kg) WET WEIGHT INCLUDES COOLING FLUID
- INDICATES AIR FLOW
- INDICATES CENTER OF GRAVITY
- SEE ILLUSTRATION 3–39 FOR MOUNTING INFORMATION
- IMPORTANT: REFER TO SECTION 8–3–2 MRCC ACCESS & AIR CONSIDERATIONS FOR AIR FLOW IMPORTANT NOTICES



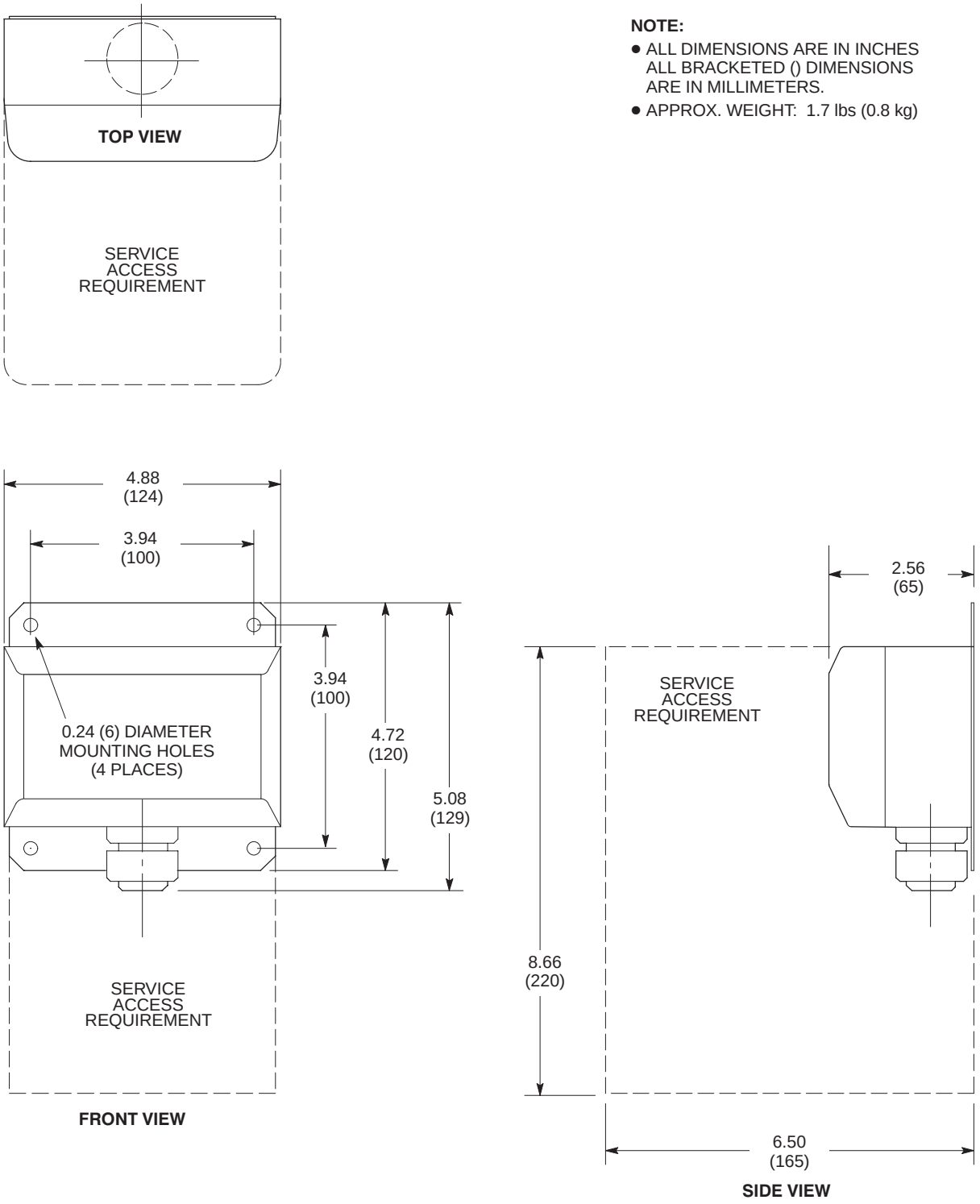
MR COMMON CHILLER (MRCC) – OPTION FOR SHIELD/CRYO COOLER COMPRESSOR WATER COOLING
ILLUSTRATION 3–38

NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- GROUND INSTALLATION:
  REMOVE UNIT CASTERS AND USE SIX MIDDLE HOLES TO RIGIDLY BOLT DOWN ON CONCRETE PAD. CONCRETE PAD MUST HAVE LEVEL SURFACE (1 CM OVER 300 CM) AND PROPERLY SUPPORTED TO PREVENT SETTLING, MINIMUM 4 INCH (101.6 MM) DEEP CONCRETE PAD OF 2500 PSI CONCRETE REQUIRED. THE CONCRETE FOOTING SHOULD MEET OR EXCEED LOCAL CODE REQUIREMENTS.
- ROOF INSTALLATION:
  REMOVE UNIT CASTERS AND USE SIX MIDDLE HOLES TO RIGIDLY BOLT DOWN THE MRCC ON LEVEL SURFACE 0.4 INCHES OVER 118 INCHES (1 CM OVER 300 CM) ON ROOF.



MRCC OUTDOOR MOUNTING
ILLUSTRATION 3–39



NOTE:

- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- APPROX. WEIGHT: 1.7 lbs (0.8 kg)

REMOTE CONTROL PANEL (RCP) FOR MRCC
ILLUSTRATION 3–40

Chapter 4 – Magnetic Field Considerations

1 Introduction

The static magnetic field is three–dimensional and extends into space above and below the magnet as well as to the surrounding space on the same level. Objects within this three–dimensional space can be affected by the magnetic field or can affect the magnetic field, refer to Chapter 3 Section 2 Proximity Limits. Therefore all ferromagnetic material within this three–dimensional magnetic field must be thoroughly examined to ensure it is not significantly affected by nor affects the magnetic field.

2 Homogeneity Requirements

Structural steel within the static magnetic field of an unshielded magnet has a definite impact on the homogeneity or uniformity of the field. The magnet's field homogeneity is an important criteria that impacts image quality of the magnet. Homogeneity requirements for imaging are just as stringent as the homogeneity requirements for chemical shift analysis (spectroscopy).

3 Structural Steel Evaluation Of Proposed Sites

Notice!

If a site has an existing magnetic shield then the existing shield must be evaluated by the GE Healthcare MR Siting And Shielding Group.

Structural steel near the magnet (especially unshielded and actively shielded magnets) causes perturbations in the magnetic field within the imaging region of the magnet. This may degrade the homogeneity of the magnet and thus system performance. An evaluation of the effects of structural steel on the magnet is required in some instances, refer to Chapter 5 Section 15–1 Magnet Room Floors Magnetic Properties.

The customer must provide information indicating mass and location of all iron and steel within an 8 feet (2.5 meter) radius of the 1.5T (Actively Shielded) magnet isocenter. This 8 feet (2.5 meter) radius is shown as the shaded region in Illustrations 4–1 through 4–3. This includes iron below the magnet such as sewer pipes, floor beams and any steel rebar in the concrete floor or structural members. Any structural steel required for the installation of the magnet at the particular site (i.e. floor reinforcement) must also be indicated.

If the steel in close proximity to the magnet exceeds the limits found in Chapter 5 Section 15–1 Magnet Room Floors Magnetic Properties then one of the following actions must be taken:

- Choose an alternate site.
- Redesign steel structure.
- Request a steel analysis by the MR Siting & Shielding group to determine if there are options to address effects of nearby structural steel.

4 Magnetic Shielding

Notice!

If a site has an existing magnetic shield and an upgrade to the LCC magnet is being performed, the existing shield must be evaluated by the GE Healthcare MR Siting And Shielding Group.

Magnetic shielding is used to reduce the fringe field around the magnet.

Room magnetic shielding generally consists of iron plates in the room walls, floor, and ceiling. Special consideration should be given when selecting a magnet site location due to the expense and effort required to provide magnetic shielding.

Designing a magnetic shield requires a comprehensive computer analysis which predicts the effect the shield will have on the magnetic field as well as the effect of the shield on the homogeneity of the magnet. The structural capacity of the site and space availability are important factors in the design of the shield. The GE Healthcare MR Siting & Shielding Group has the capability to design magnetic shields which meet a broad range of site requirements.

5 Magnetic Field

Illustrations 4–1 through 4–3 are the fringe field plots for the 1.5T Active Shield magnet. These plots illustrate the three–dimensional area of magnetic field without the influence of any nearby ferrous objects or the earth's ambient magnetic field. Actual magnetic field intensity at given locations will vary from these plots due to the following effects:

- Ferrous materials used in building construction which will become permanently magnetized when in close proximity to the MR generated magnetic field.
- Earth's magnetic field – about 0.5 gauss in strength and unidirectional.

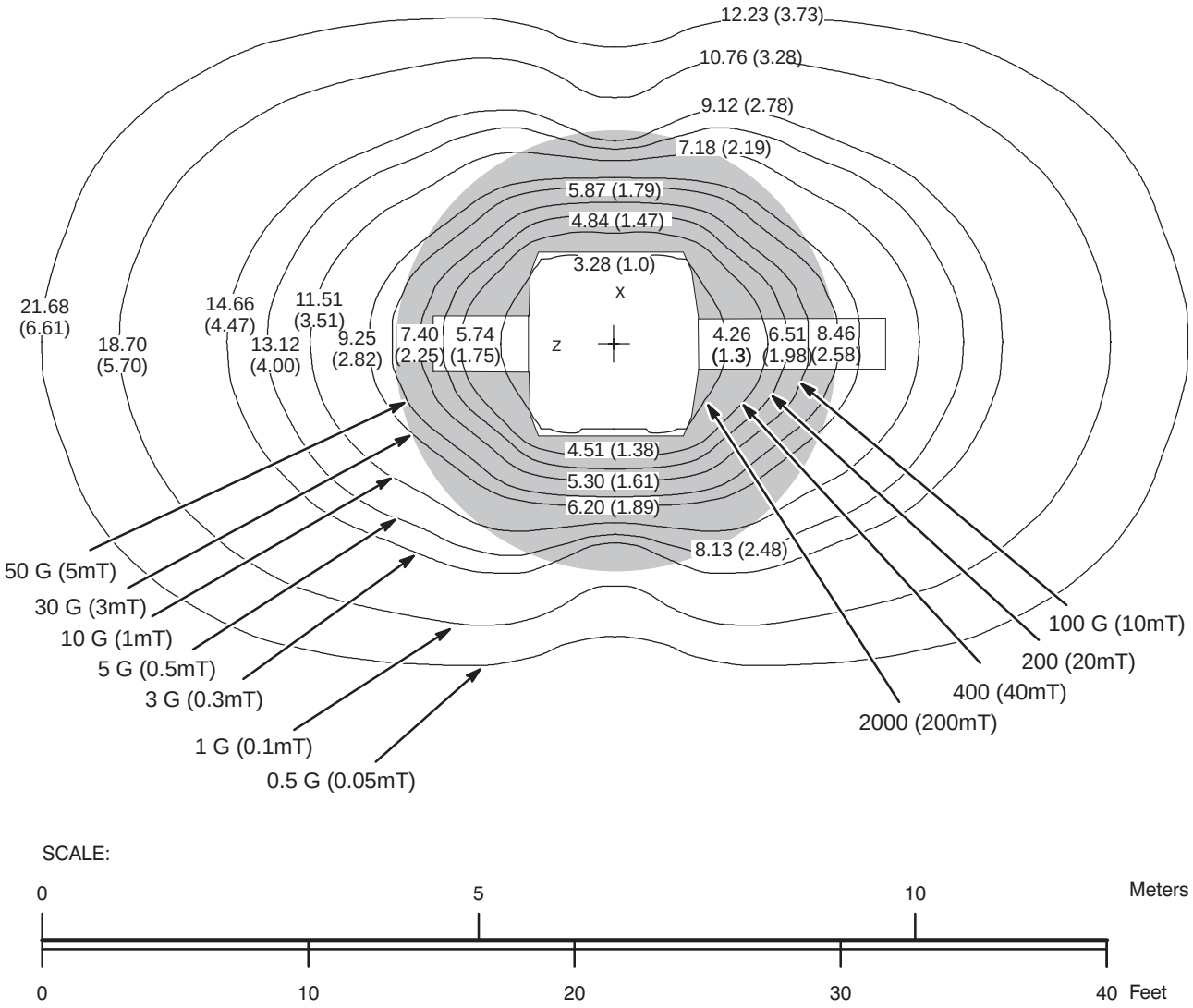
Therefore, these plots are only approximations of actual field intensities found at points surrounding the magnet. These plots should be used as an aid in reviewing the location of MR and hospital equipment and services (i.e. elevators, vehicular traffic, computer monitors, etc.). Refer to Chapter 3 Section 2 Proximity Limits for the sensitivities of various equipment within the magnetic field.

6 Exclusion Zone

The five gauss exclusion zone for cardiac pacemakers, neurostimulators, and other biostimulation devices is shown in Illustration 4–1 through 4–3. It should be noted the vertical views for the various magnetic field plots show 12 ft (3.66 m) between floors for reference. If the distance between floors is other than 12 ft (3.66 m), appropriate corrections must be made.

The interaction of the main magnet coils and the cancellation coils results in the effective shielding for the active shield magnet. Magnet quenches can actually cause a very short magnetic field transient resulting in the 5 gauss (0.5mT) field expanding for 2 seconds or less as noted in Illustrations 4–1 through 4–3.

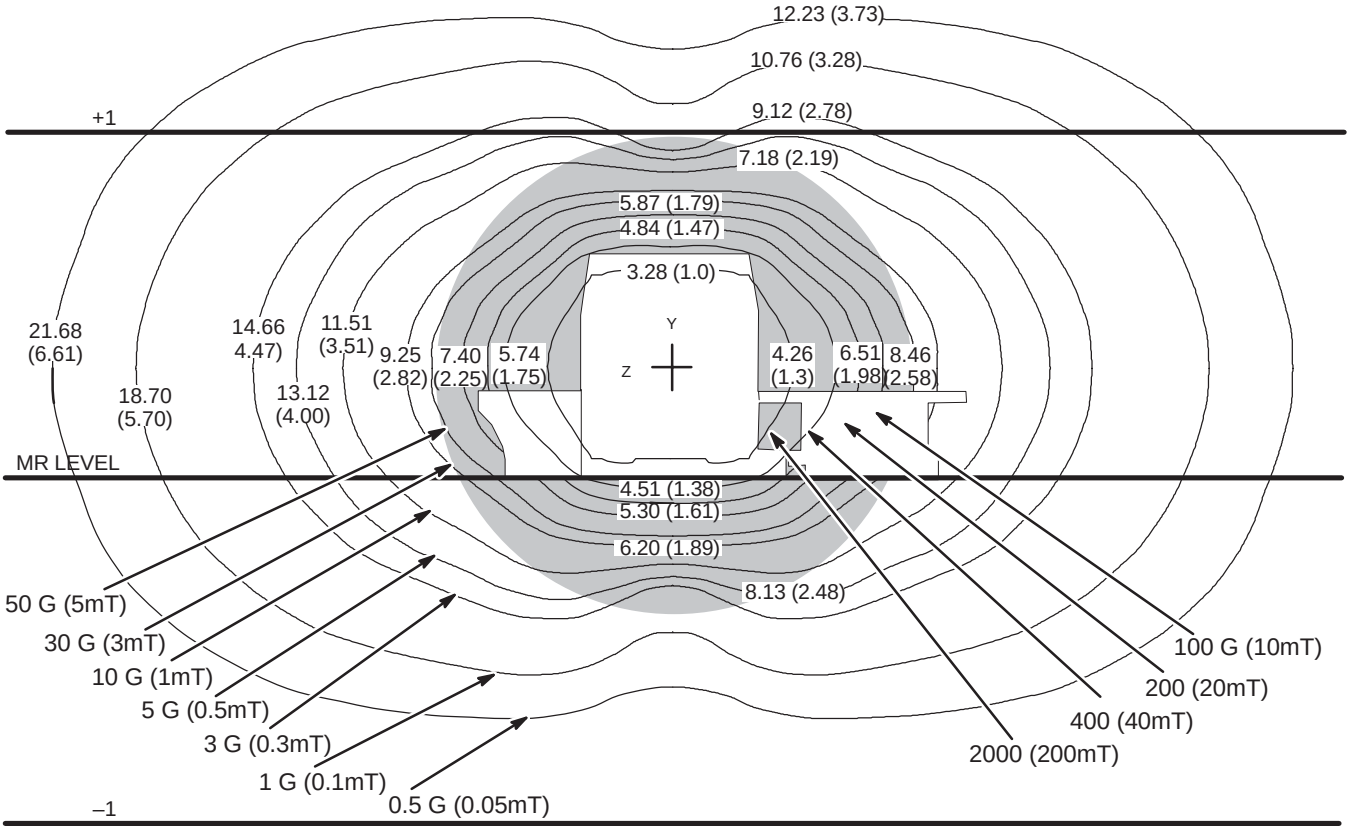
It is recommended every site consider the event of a quench and plan accordingly (such as placing 5 gauss (0.5mT) warning signs at the expanded locations).

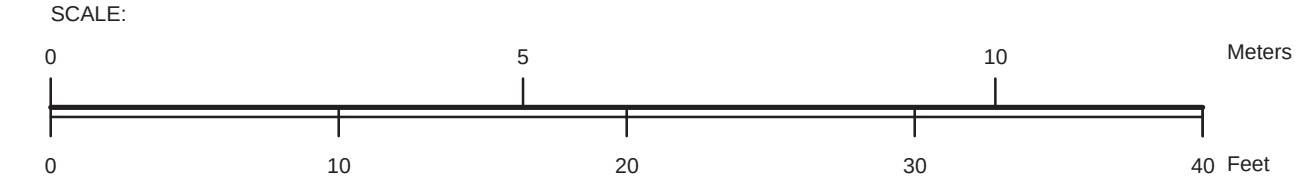


NOTE:

- MEASURED MAGNETIC FLUX DENSITY WILL VARY FROM PLOT DUE TO FACTORS SUCH AS CONCENTRATING EFFECTS OF NEARBY FERROUS OBJECTS AND AMBIENT FIELDS, INCLUDING EARTH'S MAGNETIC FIELD.
- POTENTIAL EXISTS UNDER FAULT CONDITIONS THAT THE 5 GAUSS LINE MAY EXPAND TO 16.40 ft (5.0 m) RADIALLY AND 22.96 ft (7.0 m) AXIALLY FOR 2 SECONDS OR LESS.

1.5 TESLA LCC (ACTIVE SHIELD) MAGNETIC ISOGAUSS LINE PLOT
TOP VIEW
ILLUSTRATION 4–1





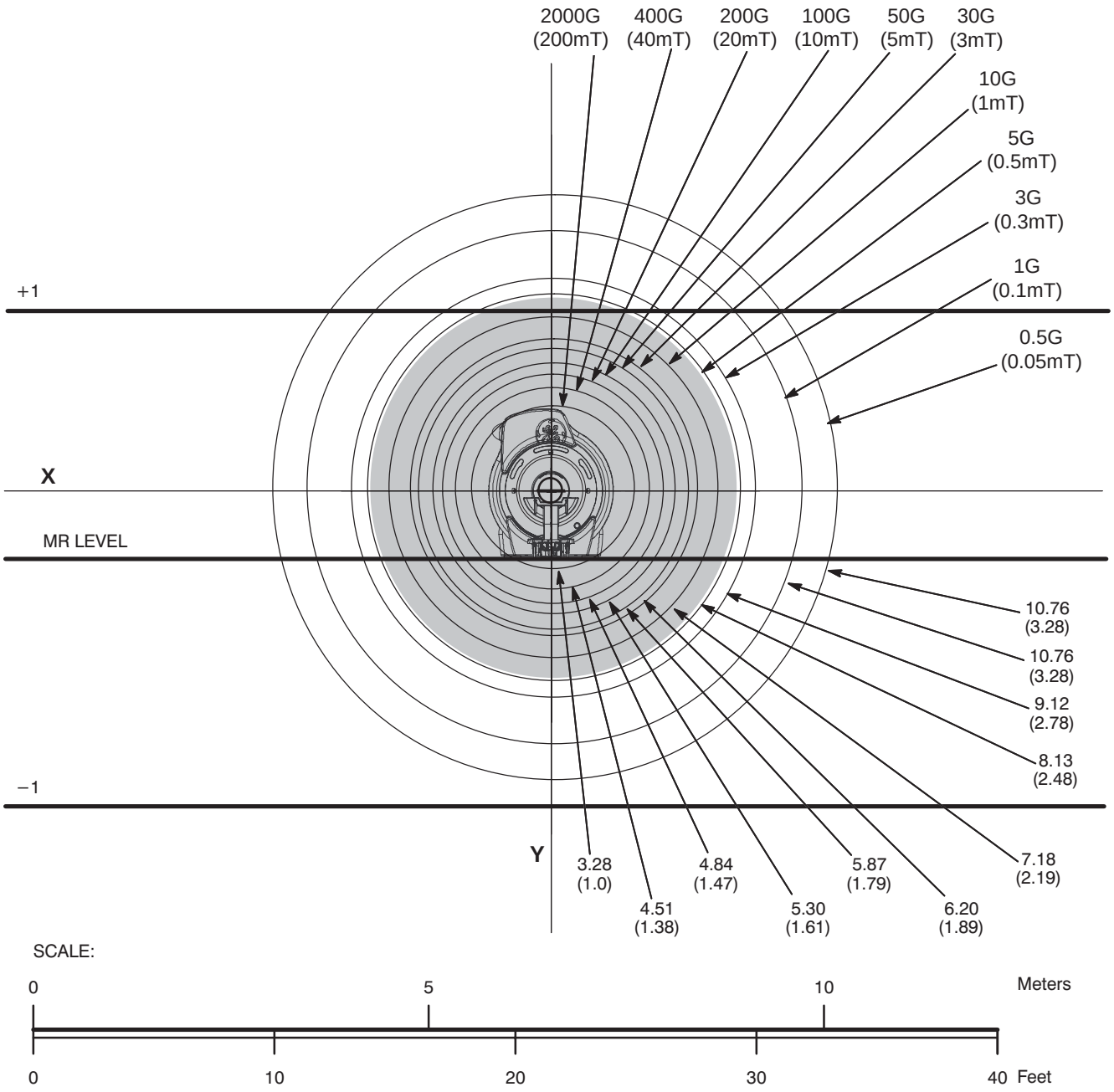
NOTE:

D 12 ft (3.66 m) BETWEEN FLOORS.

D MEASURED MAGNETIC FLUX DENSITY WILL VARY FROM PLOT DUE TO FACTORS SUCH AS CONCENTRATING EFFECTS OF NEARBY FERROUS OBJECTS AND AMBIENT FIELDS, INCLUDING EARTH'S MAGNETIC FIELD.

D POTENTIAL EXISTS UNDER FAULT CONDITIONS THAT THE 5 GAUSS LINE MAY EXPAND TO 16.40 ft (5.0 m) RADIALLY AND 22.96 ft (7.0 m) AXIALLY FOR 2 SECONDS OR LESS.

1.5 TESLA LCC (ACTIVE SHIELD) MAGNETIC ISOGAUSS LINE PLOT
SIDE VIEW
ILLUSTRATION 4–2



NOTE:

- MEASURED MAGNETIC FLUX DENSITY WILL VARY FROM PLOT DUE TO FACTORS SUCH AS CONCENTRATING EFFECTS OF NEARBY FERROUS OBJECTS AND AMBIENT FIELDS, INCLUDING EARTH'S MAGNETIC FIELD.
- POTENTIAL EXISTS UNDER FAULT CONDITIONS THAT THE 5 GAUSS LINE MAY EXPAND TO 16.40 ft (5.0 m) RADIALLY AND 22.96 ft (7.0 m) AXIALLY FOR 2 SECONDS OR LESS.

1.5 TESLA LCC (ACTIVE SHIELD) MAGNETIC ISOGAUSS LINE PLOT
FRONT VIEW
ILLUSTRATION 4–3

Chapter 5 – Site Environment

1 Introduction

The rating and duty cycles of all subsystems are applicable only if the room environment is maintained as specified in the following sections.

CAUTION

The environment must be constantly maintained (i.e. holidays, weekends, etc.) to prevent exceeding the temperature and humidity specifications. Subjecting the equipment to consistent excessive temperatures and humidity above specifications may shorten the life of the internal electrical components.

2 IEC EMC Compliance

Per IEC 60601–1–2 Edition 2 Medical Electrical Equipment needs special precautions regarding Electro Magnetic Compatibility (EMC) and needs to be installed and put into service according to the EMC information provided in the following tables. Tables 5–1, 5–2, and 5–3 provide details about the level of testing performed by the manufacturer, and provide information about potential interactions between devices.

Portable and mobile RF communications equipment can affect Medical Electrical Equipment.

Table 5–1
Guidance And Manufacturer's Declaration – Electromagnetic Emissions

The Signa MR System is intended for use in the electromagnetic environment specified below. The customer or the user of the Signa MR System should assure that it is used in such an environment.			
EMISSIONS	**TYPE OF TEST**	**COMPLIANCE LEVEL**	**ELECTROMAGNETIC ENVIRONMENT – GUIDANCE**
CISPR 11	Conducted Emissions	Class A Group 2	The MR system must emit electromagnetic energy in order to perform its intended function. Nearby electronic equipment may be affected.
	Radiated Emissions	Class A Group 2	The MR system must emit electromagnetic energy in order to perform its intended function. Nearby electronic equipment may be affected.
IEC 61000–3–2	Emissions: Harmonic disturbance <16A	Not Applicable	System is permanently connected to a supply line with >16A current draw.
IEC 61000–3–3	Emissions: Harmonic disturbance <16A	Not Applicable	System is permanently connected to a supply line with >16A current draw.
IEC 61000–4–3	E–Field RF Immunity	80–2500 MHz, 5 V/m with AM 80% @ 1kHz or 2 Hz	

2 IEC EMC Compliance (Continued)

Table 5–2
Guidance And Manufacturer's Declaration – Electromagnetic Immunity

The Signa MR System is intended for use in the electromagnetic environment specified below. The customer or the user of the Signa MR System should assure that it is used in such an environment.			
EMISSIONS	**IEC 60601 TEST LEVEL**	**COMPLIANCE LEVEL**	**ELECTROMAGNETIC ENVIRONMENT – GUIDANCE**
IEC 61000–4–2	±8 kV air	Air 2, 4, 6, 8, 10kVolts	Floors should be wood, concrete, or ceramic tile. If floors are covered with a synthetic material, the relative humidity should be at least 30%.
	±6 kV contact	Contact 2, 4, 6, 8kVolts	
		Coupling Plane2, 4, 6, 8kVolts	
IEC 61000–4–4	±2 kV for powersupply lines	Power Lines 3kVolts	Power quality should be that of a typical commercial or hospital environment.
	±1 kV for input/output lines	Interconnect Cables 1.5kVolts	
IEC 61000–4–5	±2 kV common mode	Common Mode ±2 kVolts	Power quality should be that of a typical commercial or hospital environment.
	±1 kV differential mode	Differential ±1 kVolts	
IEC 61000–4–8	3 A/m	4.5A/m at 50 Hz. and 60 Hz.	
IEC 61000–4–11	<5 % UT (>95 % dip in UT) for 5 sec	5 sec @ >–95%, Each phase individually	Power quality should be that of a typical commercial or hospital environment.
Conducted RFIEC 61000–4–6	V1 = 3 Vrms 150 kHz to 80 MHz	0.15–80 MHz @5 VRMS with AM 80% @ 1kHz 1% Frequency steps	Portable and mobile RF communications equipment should be used no closer to any part of the Signa MR System, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. **Recommend separation distance** $d = [3.5 \div V_1]\sqrt{P}$ 150 KHz to 80 MHz $d = [3.5 \div E_1]\sqrt{P}$ 80 MHz to 800 MHz $d = [7 \div E_1]\sqrt{P}$ 800 MHz to 2.5 GHz where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey, [a] should be less than the compliance level in each frequencyrange.[b] Interference may occur in the vicinity of equipment marked with the following symbol: 
Radiated RFIEC 61000–4–3	E1 = 3 V/m 80 MHz to 2,5 GHz	80–2500 MHz, 5 V/m with AM 80% @ 1kHz or 2 Hz	

Note 1 At 80 MHz and 800 MHz, the higher frequency range applies.

2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the Signa MR System issued exceeds the applicable RF compliance level above, the Signa MR System should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the Signa MR System.

[b] Over the frequency range 150 kHz to 80 MHz, field strengths should be less than [V1] V/m.

2 IEC EMC Compliance (Continued)

Table 5–3
Recommended Separation Distances

The Signa MR System is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the Signa MR System can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the Signa MR System as recommended below, according to the maximum output power of the communications equipment.

Immunity test	**Recommended Separation Distances Between Portable And Mobile RF Communications Equipment And The Signa MR System: Separation distance according to frequency of transmitter m**		
Rated maximum output power of transmitter (Watts)	$d = [3.5 \div V_1]\sqrt{P}$ 150 KHz to 80 MHz	$d = [3.5 \div E_1]\sqrt{P}$ 80 MHz to 800 MHz	$d = [7 \div E_1]\sqrt{P}$ 800 MHz to 2.5 GHz
10 mW	0.12 m	0.12 m	0.23m
100 mW	0.36m	0.36m	0.74m
1	1.16m	1.16m	2.33m
10	3.68m	3.68m	7.38m
100	11.66m	11.66m	23.33m

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in metres (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

Note 1 At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

3 Temperature And Humidity Specifications

3–1 System Suite

Notice!

If these temperature and humidity specifications are not strictly adhered to, failures of the ACGD modules of the ACGD/PDU Cabinet may occur.

Use the specifications listed in Table 5–1 for designing your HVAC (heating, ventilation, and air conditioning) system. Proper insulation and moisture barrier should be installed within the environmental controlled space (e.g. area above drop ceiling) for humidity, condensation, and temperature control.

To help prevent a patient from feeling uncomfortably warm during a scan, make sure the magnet room temperature does not exceed 69.8°F (21°C) maximum.

TABLE 5–1
TEMPERATURE AND HUMIDITY SPECIFICATIONS

AREA	TEMPERATURE RANGE °F (°C)	TEMPERATURE CHANGE °F/Hr (°C/Hr)	HUMIDITY (%)	HUMIDITY CHANGE (%/Hr)	MAX. ROOM GRADIENT °F (°C)
Equipment Room at Inlet to Equipment	59–89.6* (15–32)*	5 (3)	30–75*	5	5 (3)**
Magnet Room	59–69.8 (15–21)	5 (3)	30–60*	5	5 (3)
Operator's Control Room	59–89.6* (15–32)*	5 (3)	30–75*	5	5 (3)

Note * Non–condensing humidity with 50% nominal at 65°F (18.3°C).
** Room temperature gradient specification applies from floor to height of top discharge of equipment cabinets.

3–2 MRCC Option Outdoor Operating Environment

The MR Common Chiller (MRCC) is designed to be located external to the building and operate in environments meeting the following specifications.

Operating Ambient Temperature: –22°F (–30°C) to 110°F (43°C)

Operating Humidity: 5–100%

4 Air Cooling Requirements

Table 5–2 contains the heat output of the equipment listed in the typical site location. These values do not include people, lights and non–MR equipment. Actual site average values will vary depending on system use (ie. protocols used, patient load, etc.). Note any variations of equipment location for your site when calculating your cooling requirements for each room.

Requirements

Physical placement of the air conditioning equipment (compressor, etc.) is an important factor due to the homogeneous field requirements of the magnet. Therefore, it is important this equipment be located outside the 10 gauss line. Refer to Chapter 4 Magnetic Field Considerations for plot of gauss lines.

The Magnet Room must be an individual temperature zone controlled by a separate thermostat to allow for adjustments to meet room temperature specification as listed in Section 3 Temperature And Humidity Specifications. It is recommended that cool inlet air be directed towards the Enclosure Rear Pedestal, location of coil/bore cooling fans intake.

Recommendations

A dedicated air conditioner with a dual compressor is preferred to avert shutdowns during repair of the primary air conditioner. Due to the large variation in heat loads, the compressors should be equipped with unloaders or hot gas bypass to prevent moisture stripping of the evaporator coils.

It is recommended that a temperature and humidity recorder be used during preinstallation and during actual installation and placed near the Gradient Cabinet air inlets to establish the true criteria. Refer to cooling table calculator in this section for each room's cooling requirements.

GE recommends the use of a 12 inch high raised flooring system for the equipment room (10 inch minimum clearance from floor slab to underside of access flooring). Care must be taken in locating the air conditioning supply vents in the floor. The air conditioning supply vents should be located directly in front of the cabinet inlets.

TABLE 5–2
MAXIMUM MR AIR COOLING TABLE

MR COMPONENT	MAGNET ROOM *See Note 1 below*		EQUIPMENT ROOM *See Note 2 below*		OPERATOR/CONTROL AREA	
	BTU/HR	WATT	BTU/HR	WATT	BTU/HR	WATT
RF/Gradient Body Coil Assembly, Magnet Enclosure Equipment	12,285	3600				
Patient Blower Box	3415	1000				
Standard SRFD II Cabinet (without MNS Option)			18,423	5400		
SRFD II Cabinet with MNS Option*			23,540	6900		
ACGD/PDU Cabinet			34,120	10,000		
EXCITE System Cabinet			6140	1800		
Water Chiller for Gradient Coil (See Note 3)			14,000	4100		
Magnet Monitor			205	60		
Shield/Cryo Cooler Compressor			Heat dissipation to air negligible See Note 3			
Operator Workspace (See Note 4) with LCD Color Monitor					4950	1450
Main Disconnect Panel (See Note 5)			900	264		
MRCC* option for providing Shield/Cryo Cooler Compressor water cooling (See Note 3)			52,550	15,400		
*BrainWaveHW Lite Cabinet (see Note 6)			2337	685		

Note * Optional equipment.

† Maximum heat output is defined for temperature and humidity as defined in Table 5–1.

1 Magnet Room must be an individual temperature zone controlled by a separate thermostat to allow for adjustments to meet room specifications as listed in Section 3 Temperature And Humidity Specifications. It is recommended that cool inlet air be directed towards the Blower Box intake which contain a patient cooling fan.

2 FOR EQUIPMENT ROOM ONLY: Although the air cooling load averaged over a 12 hour working day is approximately 1/2 of the maximum value, the Equipment Room HVAC system must be sized such that Maximum Room Gradient, Temperature Range, Temperature Change per Hour, and Humidity specifications per Section 3 Temperature and Humidity Specifications are not exceeded at any point during the working day. Actual heat output is site specific and dependent on the specific MR system configuration and customer usage of the MR system and options.

3 The MR System requires water cooling for the Gradient Coil and the Shield/Cryo Cooler Compressor.
– Gradient Coil water cooling must be supplied by Water Chiller for Gradient Coil supplied with the MR system to prevent contamination/damageto the coil and for proper image quality.
– The Shield/Cryo Cooler Compressor water cooling can be provided by an optional MRCC or by customer provided facility water cooling.

4 Operator Workspace equipment includes the following: LCD Color Monitor, GOC Computer Cabinet, Workspace Cabinet, Mouse and Mouse Pad, LCD Panel, and Keyboard.

5 Values are for GE pre–engineered Main Disconnect Panel. Heat output may be different if customer supplied control is used.

6 Addition of 3rd party provided audio–visual equipment to the BrainWaveHW Lite Cabinet may increase cabinet heat maximum output to 2781 BTU/Hr (815 Watts) .

5 Water Cooling Requirements

5–1 Gradient Coil Water Cooling

The BRM Gradient Coil is air and water cooled. A water–to–air Water Chiller (WC1) is provided with the fixed site system. De–ionized water and anti–freeze mixture is supplied with the Gradient Coil for use in the closed loop system.

Note

The Water Chiller is a dedicated closed loop unit for Gradient Coil water cooling **only** and not to be shared with other equipment.

Note

The Gradient Coil has GE provided flexible hose (0.5 in. (12.7 mm) inside diameter) and adjustable compression clamps for connections. Refer to Chapter 7 Interconnect Data for flexible hose routing information.

For Mobile systems (True Mobile, Transportable, Relocatable), the BRM Gradient Coil water cooling will be provided by the Water–to–Water Heat Exchanger, the Van chilled water system will provide chilled water for the Heat Exchanger operation.

5–2 Gradient Coil Temporary Backup Water Cooling

There are no options available to support temporary backup water cooling for the BRM Gradient Coil.

Notice!

Water cooling must be provided by the system cooling equipment (WC1 unit) ordered with the system to prevent contamination/damage to the coil and for proper image quality.

5–3 Shield/Cryo Cooler Temporary Backup Water Cooling

Customer provided temporary backup water cooling is recommended for the Shield/Cryo Cooler Compressor Cabinet (MS5). The backup cooling design can utilize open loop city water only as temporary backup during loss of the closed loop water cooling from a MRCC or customer provided water cooling to the Shield/Cryo Cooler Compressor. Long term open loop systems will not allow a chemical equilibrium to be established resulting in continual build up or etching that can take place which will eventually contribute to failure. Water system capacity must be selected to make sure adequate reserve for overcoming all pressure drops and still maintain the required flow rate for the Shield/Cryo Cooler Compressor Cabinet, for water cooling specifications refer to Section 5–4 Shield/Cryo Cooler Compressor Requirements For Site Provided Water Cooling.

Note

These water cooling specifications are the requirements at the equipment. The backup cooling system design must have allowances for pressure/temperature changes dues to distance located from the Shield/Cryo Cooler Compressor.

CAUTION

Switching the Shield/Cryo Cooler Compressor inlet/outlet cooling from the MRCC to a temporary water backup supply will result in approximately 1.5 gallons (5.5 liters) of 50% mixture of Dowfrost HD and de–ionized water being discharged. This discharge may have site impacts due to local regulatory codes. Make sure to understand and follow local regulatory requirements when designing and implementing a temporary backup water system. The design of the change over equipment from MRCC to city water and vise–a–versa must not allow contamination of the closed loop system in the MRCC.

Notice!

Continuous water cooling is critical for the Shield/Cryo Cooler Compressor and therefore MUST be available 24 hours per day / 7 days per week to maximize proper uninterrupted magnet operation. Water cooling is required immediately upon magnet arrival, temporary water cooling must be provided if permanent site water cooling is not available.

Note

Connections to the Shield/Cryo Cooler Compressor requires 0.5 in. (12.7 mm) inside diameter flexible hose and 1.0 in. (25.4 mm) adjustable compression clamps.

5–4 Shield/Cryo Cooler Requirements For Site Provided Water Cooling

Note

The MR Common Chiller (MRCC) Option is a single–loop 10KW 50/60 Hz water chiller that can be ordered and installed to provide water cooling for the Shield/Cryo Cooler Compressor.

The Shield/Cryo Cooler Compressor is water cooled. All water cooling systems must be closed loop design. Customer's water cooling design can utilize open loop city water, with required filtering, only as temporary backup during loss of closed loop water cooling system. Open loop systems will not allow a chemical equilibrium to be established resulting in continual build up or etching to take place which will eventually contribute to failure. Water system capacity must be selected to insure adequate reserve for overcoming all pressure drops and still maintain the required flow rate for the Shield/Cryo Compressor.

Note

Continuous water cooling is critical for the Shield/Cryo Cooler Compressor and therefore MUST be available 24 hours per day / 7 days per week / 365 days per year to maximize proper uninterrupted magnet operation. Water cooling is required immediately upon magnet arrival, temporary water cooling must be provided if permanent site water cooling is not available.

The Shield/Cryo Cooler Compressor closed loop system may be shared with other equipment in the MR suite. The number of sharing systems should be kept to as low as possible in order to minimize contamination and reliability problems. Flow gauges and valves are recommended at all branch lines to control distribution and allow servicing of equipment.

Refer to Tables 5–3 and 5–4 for water cooling specifications.

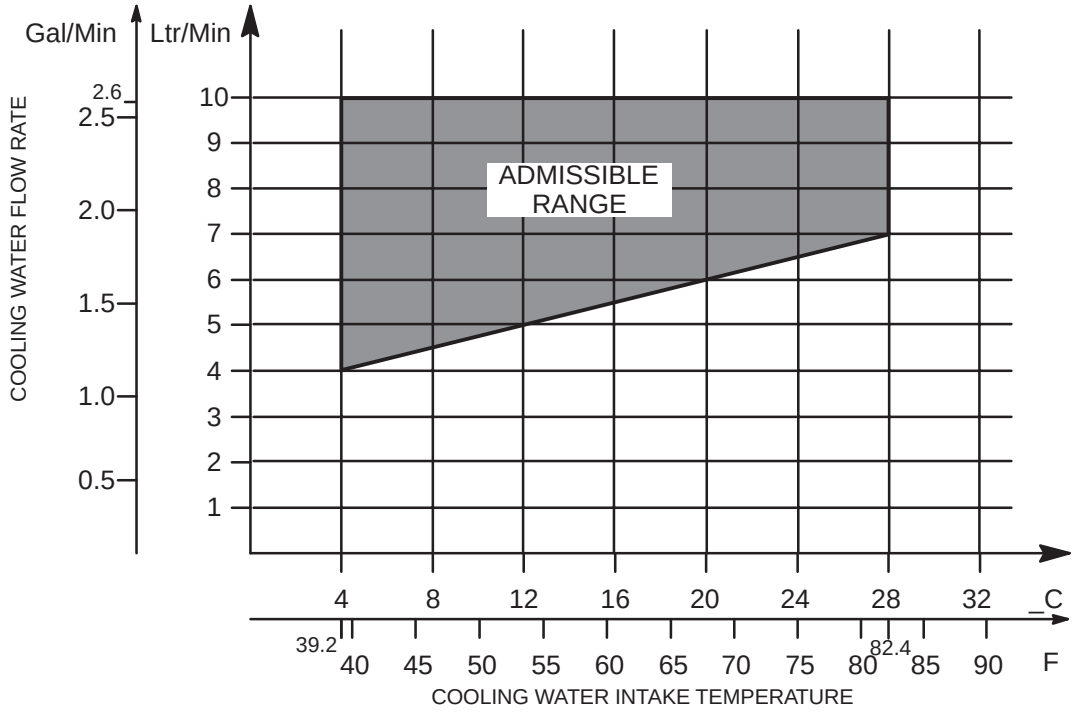
Note

The **Shield/Cryo Cooler Compressor** requires customer supplied flexible hose for mating with water cooling system. Connections to the Shield/Cryo Cooler Compressor requires 0.5 in. (12.7 mm) inside diameter flexible hose and 1.0 in. (25.4 mm) adjustable compression clamps.

5–4 Shield/Cryo Cooler Requirements For Site Provided Water Cooling (Continued)

TABLE 5–3
LCC MAGNET SHIELD/CRYO COOLER COMPRESSOR WATER QUALITY REQUIREMENTS

PARAMETER	REQUIREMENT	NOTES
pH level	6.5–8.2	GE recommends the use of de–ionized water to ensure longest life with fewest problems.
Hardness	less than 200 ppm of calcium carbonate	Hard water will produce calcium deposits in the Gradient Coil and Shield/Cryo Cooler Compressor resulting in decrease of cooling efficiency.
Suspended matter	less than 10 mg per liter, less than 150 micron particle size	To meet the specification for suspended matter it is necessary to install a 100–150 micron filter. Install Shield/Cryo Cooler Compressor Cabinet filter at cabinet inlet.
Anti–freeze	Preferred minimum 25% by Volume **Maximum 50%** by volume	Use stabilized product to reduce corrosion and organic growth. Preferred minimum value to minimize organic growth.



SHIELD/CRYO COOLER COMPRESSOR COOLING WATER REQUIREMENT
ILLUSTRATION 5–1

5–4 Shield/Cryo Cooler Requirements For Site Provided Water Cooling (Continued)

TABLE 5–4
LCC MAGNET SHIELD/CRYO COOLER COMPRESSOR WATER COOLING SPECIFICATIONS

EQUIPMENT	INLET TEMPERATURE RANGE °F (°C)	INLET PRESSURE psi (KPa)	RECOMMENDED FLOW RATE gal/min (liter/min)	PRESSURE DROP psi (bar) [KPa]	TEMPERATURE RISE Δ°F (Δ°C) See Notes 1, 4, 6, 8	TYPICAL HEAT OUTPUT BTU/Hr (Watts) See Notes 8	MAXIMUM HEAT OUTPUT BTU/Hr (Watts) See Notes 8
Shield/Cryo Cooler Compressor **	39.2 – 82.4 (4 – 28) See Note 9	Minimum 29 (200) Maximum 100 (690)	Minimum 1.1 (4) See Notes 2, 3, 4, 5, 6, & 9	7.5 (0.5) [52] at minimum flow rate See Notes 1, 2, 7, & 9	at minimum flow rate 48.4 (26.9) for 60 Hz operation 39.4 (21.9) for 50 Hz operation	25,590 (7500) for 60 Hz operation 20,728 (6100) for 50 Hz operation	28,320* (8300) for 60 Hz operation 23222* (6700) for 50 Hz operation
			Maximum 2.6 (10) See Notes 2, 3, 4, 5, 6, & 9	47 (3.2) [324] at maximum flow rate See Notes 1, 2, 7, & 9	at maximum flow rate 19.4 (10.8) for 60 Hz operation 15.7 (8.7) for 50 Hz operation		

Note: * Ensure water cooling system capacity is capable of dissipating maximum heat output.

** These water cooling specifications are the requirements at the equipment. The cooling system design must have allowances for pressure/temperature changes due to distance the chiller is located from the equipment.

1 Pressure drop and water temperature rise across equipment is given for minimum and maximum recommended flow rates as indicated. Pressure drop is measured between coolant inlet and outlet at Shield/Cryo Cooler Compressor unit.

2 Water Flowmeter Kit (46–294052G1) is available to check/monitor flow rate for Shield/Cryo Cooler Compressor. Add 2 psi to total system pressure drop if flowmeter is permanently installed in system.

3 Recommend a flowmeter be permanently installed in system, include flowmeter drop in total system pressure drop.

4 Shield/Cryo Cooler Compressor water flow rate is based on inlet water temperature of 82.4°F (28°C), lower temperature permits lower flow. See Illustration 5–1 for graphic water temperature and flow rate admissible range.

5 Minimum flow rate is for clean water (i.e. without antifreeze), maximum flow rate is for any mixture of water/antifreeze.

6 Water flow rate and temperature rise value are based on water. Laboratory grade Ethylene Glycol or Propylene Glycol anti–freeze may be used (do not mix Ethylene Glycol with Propylene Glycol). Preferred concentration is 65% water and 35% Ethylene Glycol to minimize organic growth. Concentration of 50/50 is acceptable with a derate of 0.8 in specific heat calculations and a 20% increase in flow with a resultant internal pressure increase of 40%.

7 Pressure drop values based on new system, may rise due to calcification.

8 Shield/Cryo Cooler Compressor temperature rise, typical and maximum heat output are reduced by 18% at 50 Hz operation.

9 Water Cooling Circuit typical values:
– water inlet flow 1.8 to 2.1 gal/minute (7 to 8 liter/minute)
– water inlet temperature 53.6 to 59°F (12 to 15°C)
There is a risk of damaging the Shield/Cryo Cooler Compressor with water inlet low temperature and low flow range.

6 Altitude

100 ft (30.5 m) below sea level to 8,000 ft (2438 m) above sea level.

7 Lighting

Direct Current (DC) lighting is recommended in the Magnet Room. Alternating Current (AC) lighting, other than fluorescent, may be used but the magnetic field of the system will significantly reduce the operating life of incandescent bulbs in AC lighting. Some customers have reported AC light bulb failure with 10 hours of operation. An optional DC LIghting product is available which provides for two circuits of DC power and adjustable light levels in the Magnet Room. Refer to Table 5–5 for additional lighting requirements.

Notice!

Fluorescent lighting is not allowed in the Magnet Room due to the RF noise generated by the fluorescent light tubes. Lighting fixtures selection and installation must comply with Table 5–5 requirements to minimize the possibilities of electrical discharge.

7 Lighting (Continued)

TABLE 5–5
MAGNET ROOM LIGHTING REQUIREMENTS/RECOMMENDATIONS

LIGHTING TYPE	REQUIREMENTS	RECOMMENDATIONS

Direct Current (DC)	• Illumination of 300 lux around the front of the magnet for patient access.
	• Need to provide 300 lux above the magnet service work (non–magnetic, portable lighting is acceptable).
	• The alternating current (AC) ripple from the DC power should be no greater than 5%.
	• Dimmers (i.e. SCR, rheostats, etc.) in the Magnet Room are not acceptable as these devices may produce electrical discharge (RF noise) that can have the potential to adversely affect image quality. If a low and high light level is desired, the different levels must be selectable by a discrete switch or variable lighting level DC Lighting Controller.
	• Light fixtures must have a ground wire from its power source and be grounded to the RF Shielded Room at the RF Common Ground Stud as shown in illustration in Chapter 6 Section 4–2 System Ground.
	• Light Emitting Diode (LED) lighting, if used, must meet the following:
	  • Power source must be located external to the Magnet Room RF Shield
	  • All wiring, filters, and ground requirement must be met, refer to Chapter 6, Section 4–2 System Ground subsection.
		• Direct Current (DC) lighting is recommended in the Magnet Room to minimize light bulb life issues.
		• Short filament length is recommended, linear lamps are not recommended because of the filament length and high incidence of filament failure.
		• Track lighting fixtures are not recommended in the Magnet Room to minimize the possibilities of electrical discharge (RF noise) that can have the potential to adversely affect image quality.
		• Battery chargers (e.g. emergency lighting) are recommended to be located outside the Magnet Room to minimize the possibilities of electrical discharge (RF noise) that can have the potential to adversely affect image quality.

Alternating Current (AC)	• Illumination of 300 lux around the front of the magnet for patient access.
	• Need to provide 300 lux above the magnet service work (non–magnetic, portable lighting is acceptable).
	• Fluorescent lighting is not allowed in the Magnet Room due to the RF noise generated by the fluorescent light tubes.
	• Electrical lines for AC lighting must meet filtering and grounding requirements in Chapter 8 Section 4 Electrical.
	• Dimmers (i.e. SCR, rheostats, etc.) in the Magnet Room are not acceptable not acceptable as these devices may produce electrical discharge (RF noise) that can have the potential to adversely affect image quality. If a low and high light level is desired, the different levels must be selectable by a discrete switch or variable lighting level DC Lighting Controller.
	• Light fixtures must have a ground wire from its power source and be grounded to the RF Shielded Room at the RF Common Ground Stud as shown in illustration in Chapter 6 Section 4–2 System Ground.
	• Light Emitting Diode (LED) lighting, if used, must meet the following:
	  • Power source must be located external to the Magnet Room RF Shield
	  • All wiring, filters, and ground requirement must be met, refer to Chapter 6, Section 4–2 System Ground subsection.
		• Short filament length is recommended, linear lamps are not recommended because of the filament length and high incidence of filament failure.
		• Track lighting fixtures are not recommended in the Magnet Room to minimize the possibilities of electrical discharge (RF noise) that can have the potential to adversely affect image quality.
		• Battery chargers (e.g. emergency lighting) are recommended to be located outside the Magnet Room to minimize the possibilities of electrical discharge (RF noise) that can have the potential to adversely affect image quality.

8 Acoustics

8–1 Introduction

The following acoustic information is provided for site planning and architectural design activities to address acoustics to meet local regulations and customer requirements. For more information about recommended safety procedures regarding patient exposure to MR–generated acoustic levels, see the MR Safety Guide included with the system Users Manual.

8–2 Acoustics Background

A typical MR suite has two types of acoustic noise issues. The first is the acoustics of the room where patients and technicians are impacted by the noise of the MR system as the gradients are pulsed. The second is noise transmitted to other spaces via airborne and structure borne paths.

8–2–1 Airborne

The airborne transmission path entails the excitation of air within the magnet room; the resonator module consisting of the magnet, RF coil, and gradient coil generates acoustic noise similar to an intense loud speaker. The airborne noise passes through walls via any openings, i.e. small holes, cracks, HVAC ducts, and waveguides, into surrounding spaces within and possibly beyond the confinements of the building. Acoustic energy can transmit across distances of significant length.

Examples of airborne acoustics issues may include the following (not limited to only these):

- MR Operator exposure at Operator Workstation (i.e. Operator viewing in–line with the patient inside the magnet may require a higher acoustic attenuation window)
- Image reading rooms adjacent to Magnet Room, may be separated by hallways
- Secretarial, offices, meeting rooms, patient rooms (ICU, exam, primary care, etc.)
- Adjacent residential areas/spaces
- In–house library facilities

8–2–2 Structureborne

The structureborne transmission path is the result of mechanical excitation of the floor/building structure causing the building to vibrate. The vibration of the surfaces at surrounding spaces then radiates as acoustic noise. Acoustic energy can transmit across distances of significant length.

Note

Less than 5% of installed base sites have experienced structureborne acoustic issues.

Examples of structureborne acoustics issues may include the following (not limited to only these):

- Areas directly above or below the Magnet Room, may not always be an issue
- Image reading rooms adjacent to Magnet Room, may be separated by hallways
- Secretarial, offices, meeting rooms, patient rooms (ICU, exam, primary care, etc.)
- Adjacent residential areas/spaces
- In–house library facilities

8–3 System Acoustic Noise Levels

Any GE factory–installed protocol can be modified by operators, which can increase or decrease acoustic SPL (Sound Pressure Level); or operators may create their own protocol which could produce a higher or lower acoustic SPL as stated under Operating Conditions Condition 1 below. Typical scans generate acoustic levels as stated under Operating Conditions, Condition 2 below. In addition, the exposure times are completely under operator control. Consequently, hearing protection is required for all people in the Magnet Room during scans to prevent hearing impairment, acoustic levels may exceed 99dBA. Again, for more information about recommended safety procedures regarding patient exposure to MR–generated acoustic noise, see the MR system Operator Manual.

8–3–1 Ambient Conditions

To reduce any background noise due to cabinet blowers, etc., acoustical ceilings, walls, and floors are recommended. The following are typical noise level readings:

- Operator Area . . . . . 55 dBA
- Equipment Room . . . . . 75 dBA
- MRCC (MR Common Chiller) Option . . . . . 75 dBA

8–3–2 Operating Conditions

Condition 1

MR scanners under “worst–case” operating conditions, could generate acoustic levels (as measured at the magnet isocenter) as follows:

- Average SPL 118 dBA SPL= Sound Pressure Level
- Peak 128 dB
- Frequency Range 20 to 20k Hz

Condition 2

MR scanners for many typical clinical scanning scenarios though, generate acoustic levels (as measured at the magnet isocenter) somewhat lower as follows:

- Average SPL 95 to 110 dBA
- Peak 110 to 120 dB
- Frequency Range 20 to 20k Hz

As recent history has shown an evolution towards more powerful (and hence louder) gradient subsystems, architects should consider the acoustic levels stated in the “worst case” Condition 1, mentioned above. Note that high–field Signa systems have the ability to run scanning protocols which can generate acoustic levels over the entire human perceptible frequency range (20 to 20k Hz), therefore attenuation over this entire range must be considered for site design.

8–4 Acoustic Design Guidelines

8–4–1 Magnet Room

Noise generated by the MR system is inherent to the operation of the system, refer to Section 8–3 System Acoustic Noise Levels. The sound quality (human perception) within the Magnet Room can be modified by including sound absorbing materials to make the room sound more subdued and less harsh. The measured sound levels via a sound level meter will not change. However, the measured sound levels can be reduced only when the sound level generated by the MR System is reduced.

Sound quality improvements can be achieved by the following:

- Use ceiling tiles with fiberglass panels having a 2 inch (51mm) thickness set into the standard T–bar grid system.
- Adding fiberglass panels to the side walls covering approximately 20% of the side wall surface area. The panels should focus on covering the top half of the side walls. Panels could take many different and decorative shapes to improve the sterile look of the rooms. Typically panels might be on the order of 4ft x 6ft (1.2m x 1.8m) with a thickness of 4 inches (102mm) or equivalent. Panels shape could vary to produce mosaic effects to meet the customer preference. Any decorative materials used to cover the wall panels must be porous so that sound waves can pass through with ease. In principle, a person should be able to breath through the material with ease. Fire retardant cloth should be used. The NRC (Noise Reduction Coefficient) of the panels should be 0.95 or better when mounted against a hard surface such as drywall or concrete.

8–4–2 Inter–Spacial Areas

Acoustic Noise Control to mitigate noise from being transmitted to other spaces often amounts to paying attention to small details while working with ordinary construction materials. The key objectives are to eliminate all cracks and gaps in the wall construction while making sure that the doors, walls, floor, and ceiling have adequate transmission loss via mass or special double wall construction along with good fitting massive doors.

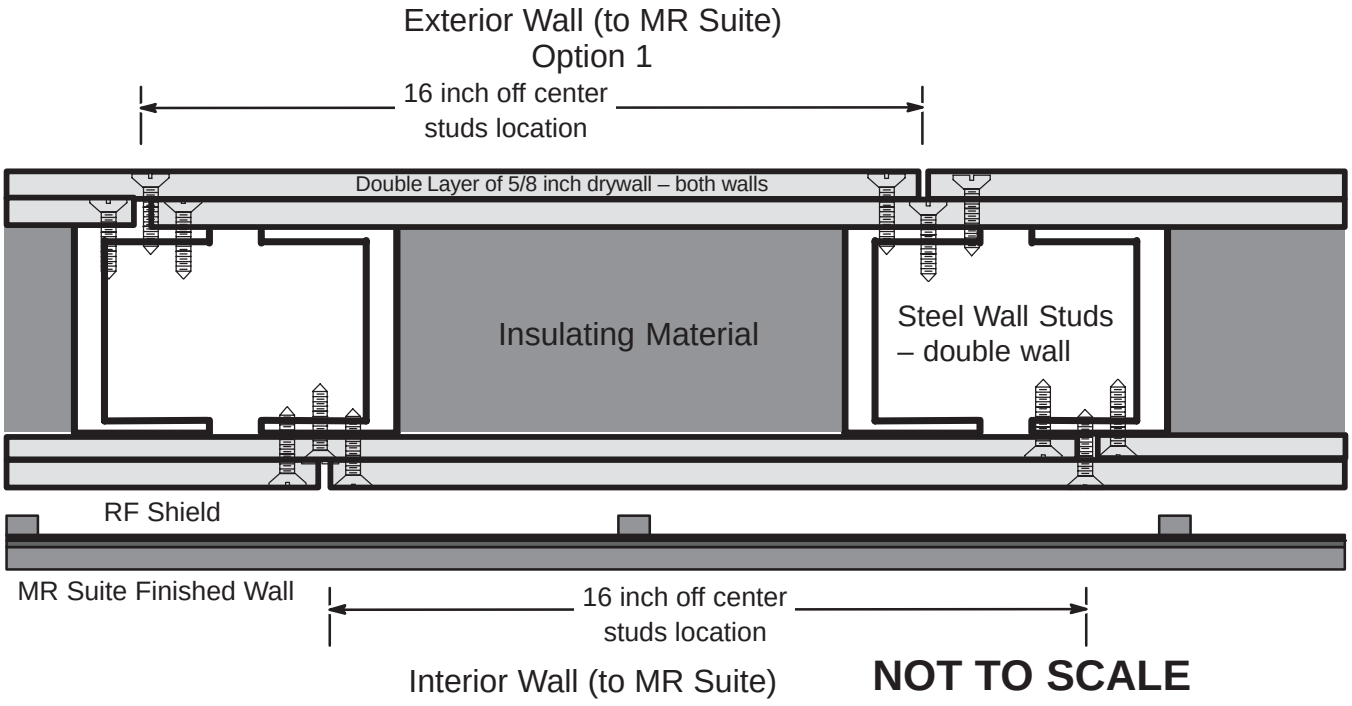
The entire Magnet must be surrounded by walls with substantial mass and/or double wall construction so that noise is contained in the room and not allowed to pass through into nearby spaces. Wall junctions must be sealed with acoustical sealant so that noise waves to do not escape from the room. In principle, if the room were filled with smoke and under a positive pressure, no smoke would leak from the room.

Wall Construction

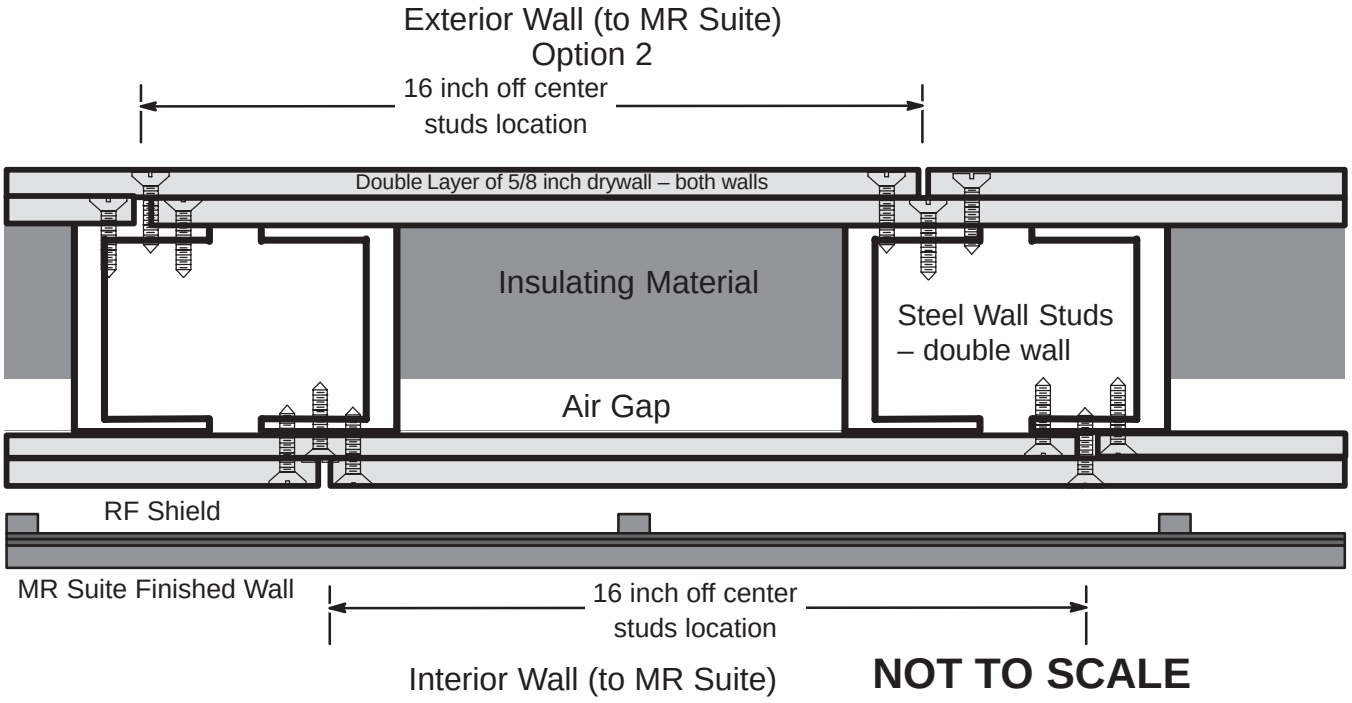
Wall Construction will entail ordinary building materials in a careful configuration.

- The preferred wall would have an ASTM STC 50 construction which entails the use of standard wall construction of steel studs (typically 3–5/8 inch (92 mm)) with 2 layers of Type X drywall (typically 5/8 (16 mm)) on each side totaling 4 layers and fiberglass batt in the stud cavity. All drywall must be overlapped by 6 inches (152 mm) or more. Beads of (USG) Acoustical Caulking (non–hardening) would be used around the entire perimeter of the drywall. Any form of wall penetration should be avoided. Any necessary wall penetrations must be sealed using combination of Acoustical Caulking (non–hardening) and fiberglass batt material. See examples of wall construction shown in Illustrations 5–2 and 5–3.
- The top of the wall must join the ceiling/floor above so that no cracks or gaps occur. If metal pan is used on the ceiling/floor (above), then flute seals would be used to seal the gaps between the drywall and the pan. Alternately drywall can be cut out to fit into the flutes. Acoustical caulking (non–hardening) will be used to seal the remaining cracks and gaps.

8–4–2 Inter–Spacial Areas (Continued)



EXAMPLE OF WALL CONSTRUCTION FOR AIRBORNE NOISE CONTROL – OPTION 1
ILLUSTRATION 5–2



EXAMPLE OF WALL CONSTRUCTION FOR AIRBORNE NOISE CONTROL – OPTION 2
ILLUSTRATION 5–3

8–4–2 Inter–Spacial Areas (Continued)

High Bay RF Room

A high bay RF Room is a self contained RF Room which has open air space between the RF Room ceiling and the building floor above. The air space is an acoustic transmission path. Acoustic energy must be reduced to minimize this transmission of energy through this path.

In cases where the Magnet is to be installed in a high bay, it may be most effective to enclose the RF Room with its own drywall and steel stud room. The key difference being a ceiling assembly that mimics the sidewall construction to contain noise.

- Normal high STC stud walls from above would be used to support a ceiling assembly constructed of structural C channel with two layers of drywall on each side (total of 4 layers) with fiberglass batt in the cavity.
- Penetrations should be avoided via the use of surface mounted lights. HVAC and ducts passing through the ceiling, party wall or side walls would require acoustic noise attenuation in the form of inline silencers. Gaps and cracks would be sealed between the ceiling, party wall or vertical side walls and the cryogen vent plumbing. In essence the Magnet would be enclosed in a drywall “doghouse”.

Miscellaneous Plumbing, RF Windows and RF Doors

Other construction details are equally important to mitigate noise transmission to meet the intended goal.

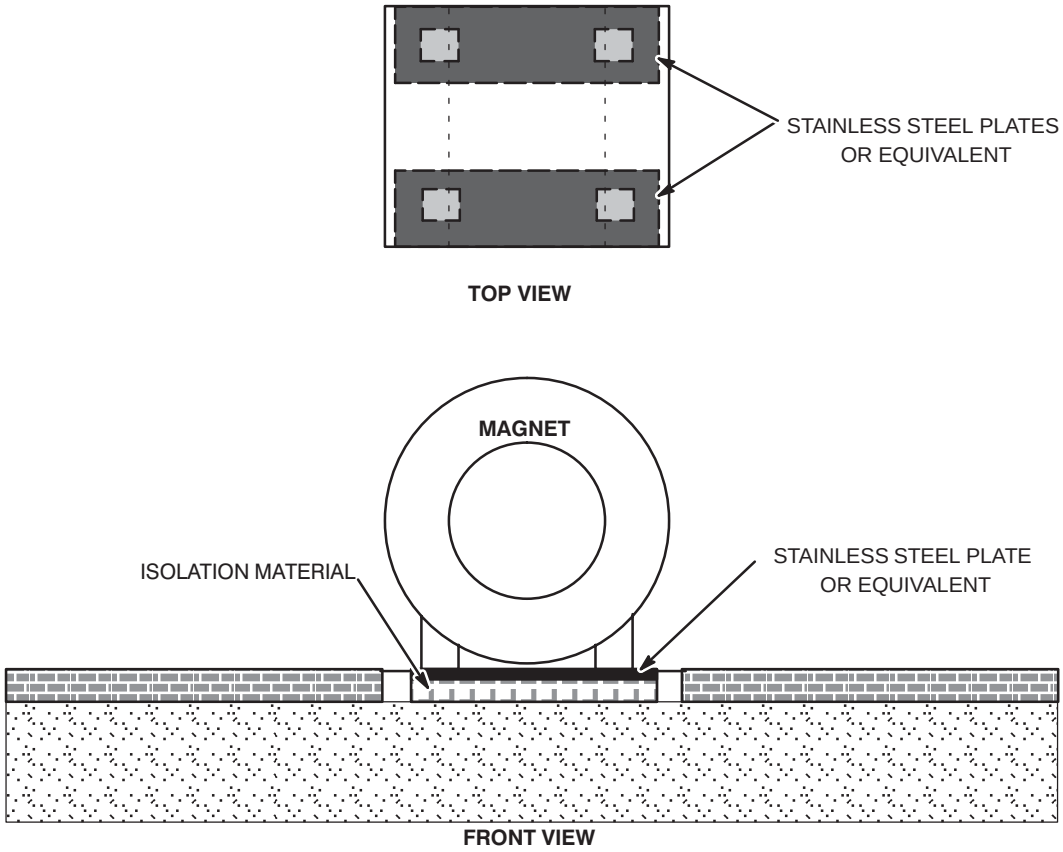
- Pipes (gas or water) and electrical conduit or Magnet Room signal cables must be sealed where they penetrate the walls or ceiling. A heavy mastic material such as Duxseal™ is appropriate.
- RF windows should be purchased as window/frame units with an STC rating obtained from laboratory testing per ASTM standards. STC 50 to 60 windows are needed. The installation must include proper sealing to avoid sound leaks.
- RF doors should be selected to provide an STC 50 to 60 to quell the noise. Contact RF Shield Room supplier for selection of RF doors that meet the local acoustic codes and site acoustic requirements. RF door seals must be selected to prevent small gaps around the door perimeter and at the door threshold. RF door seals would either require periodic replacement or a door seal that would last the life of the Magnet Room.

8–4–3 Structureborne Vibration Control

Upper floor MR installations represent the largest population of sites which may experience structureborne acoustic issues.

The GE VibroAcoustic Damping Option provides a method to reduce the probability of acoustic structureborne transmission throughout the customer facility. See Illustration 5–4 for an overview of the VibroAcoustic damping mats concept. The Magnet Room floor requirements are defined in Chapter 8, Section 6–5 Magnet Room Floors.

8–4–3 Structureborne Vibration Control (Continued)



OVERVIEW STRUCTUREBORNE VIBRATION CONTROL SOLUTION CONCEPT
ILLUSTRATION 5–4

8–4–4 VibroAcoustic Damping Option

GE customers may purchase the VibroAcoustic Damping Option to address site vibration which may contribute to potential structureborne acoustic issues. Amount of vibration attenuation provided by the VibroAcoustic Damping Option will be site dependent.

When this option is planned for the Magnet Room floor area directly beneath the Magnet needs to be properly prepared to ensure the Magnet isocenter to top of finished floor requirement is met, refer to Chapter 8 Section 6–5 Magnet Room Floors.

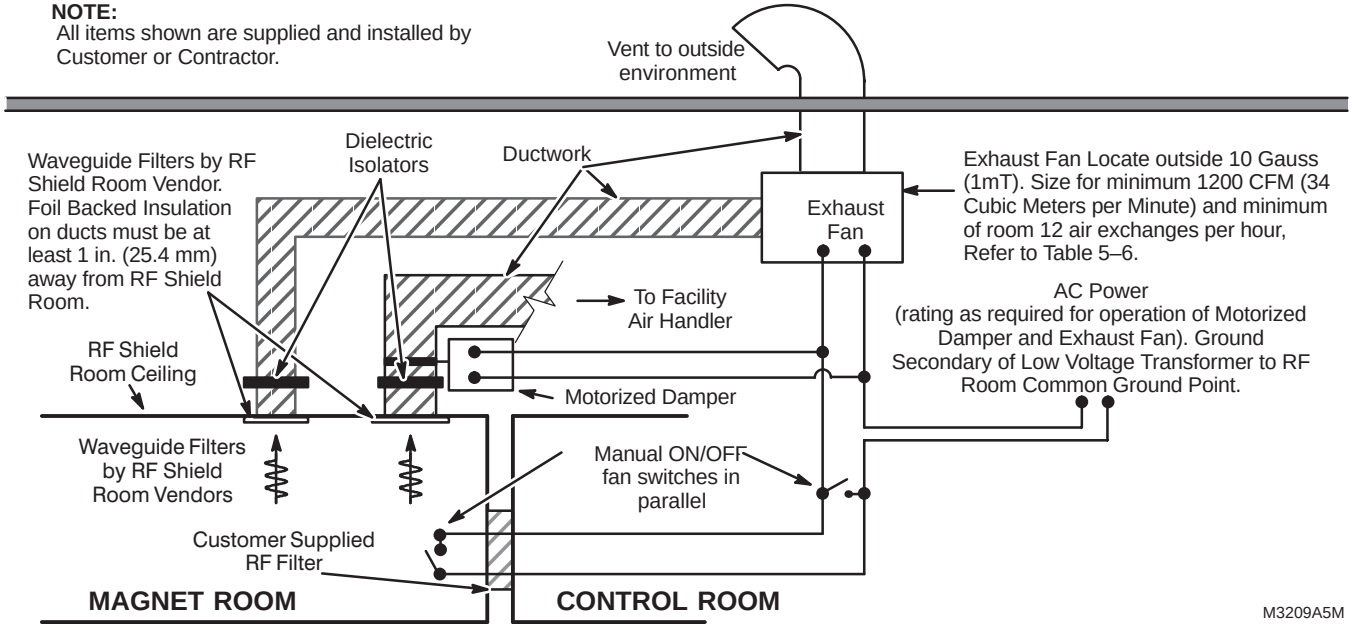
9 Room Ventilation

Refer to Table 5–6 for ventilation specifications for the magnet and cryogen storage rooms. Refer to Section 13, POLLUTION, for air quality specifications.

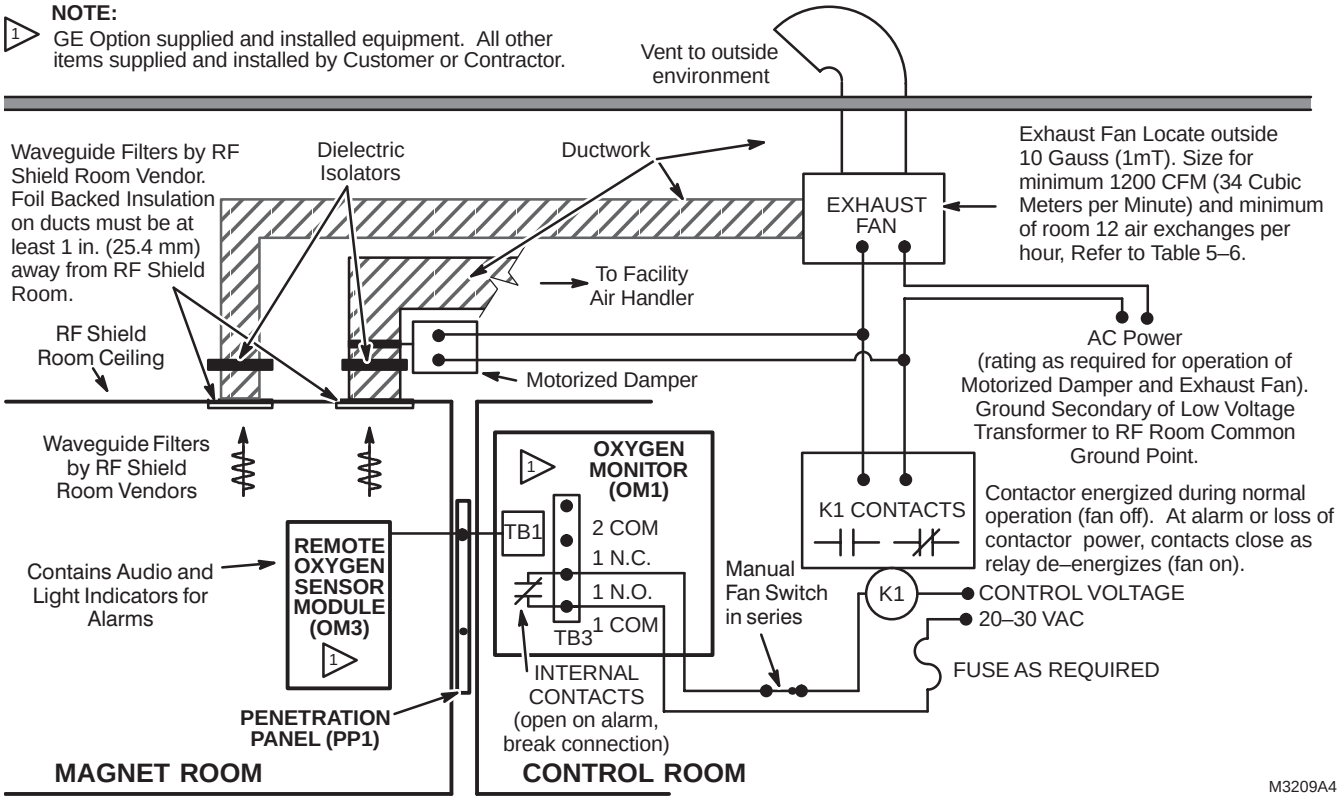
TABLE 5–6
ROOM VENTILATION REQUIREMENTS/RECOMMENDATIONS

ROOM	VENTILATION REQUIREMENTS	VENTILATION RECOMMENDATIONS
MAGNET	• Sufficient air ventilation in the magnet room must be maintained, not only for patient comfort during scans but also to maintain proper oxygen level during cryogen replenishment. • An exhaust fan to be placed above RF shielding with appropriate wave guide filtering for quick removal of helium gas if large amounts of helium disperse into magnet room. Inert gas containers, such as dewars, are not air tight. • **Magnet Room exhaust fan intake vent must be located at the highest ceiling plane near the magnet cryogen vent.** • Exhaust fan to exhaust to safe outside area and be independent of cryogenic venting. • The exhaust fan and air inlet provide for minimum of 1200 CFM (34 m^3/minute) and minimum of room 12 air exchanges per hour. • Two manual exhaust fan controls connected parallel, one to be located near the Operator Console and second control located in the Magnet Room. Refer to Illustration 5–5 for exhaust fan recommended set–up or Illustration 5–6 for recommended set–up with optional Oxygen Monitor. • Exhaust fan (customer supplied) to be installed and operating before magnet is moved into room. • **Note**: Annual customer inspection and cleaning / maintenance of the exhaust fan system (fan, inlet grill/filter, ducts, etc.) is needed to meet the minimum airflow requirement to an outside area. • Provide minimum 2 ft x 2 ft (0.61 m x 0.61 m) pressure equalizing waveguide vent in the magnet room ceiling or in the wall (with waveguide top edge located at ceiling) to prevent positive or negative pressures from interfering with opening of the magnet room door per IEC 60601–2–33 6.8.3 cc.	• Minimum 5–7% of outside makeup air to be vented into magnet room. For example, with an air input rate of 1200 cubic feet per minute (CFM) (34 cubic meters per minute), there must be a minimum of 60 CFM (1.7 cubic meters per minute) (5%) of outside makeup air.
CRYOGEN STORAGE	• Adequate ventilation to ensure acceptable oxygen level per local regulation.	

9 Room Ventilation (Continued)



EXHAUST FAN SET–UP
ILLUSTRATION 5–5



EXHAUST FAN SET–UP WITH OPTIONAL OXYGEN MONITOR
ILLUSTRATION 5–6

10 Cryogenic Venting

10–1 Cryogenic Venting Introduction

The superconducting magnet used in the MR System contains large amount of liquid helium at 4 Kelvin (K) = –452° Fahrenheit (F) or –269° Celsius (C). During a quench, the magnet quickly boils off 90% of this liquid. Consequently, a very large volume of extremely cold helium gas must be safely vented outside of the building. Failure of the cryogenic vent can result in this cold gas entering the magnet room or another portion of the building and lowering the ambient oxygen supply to an unsafe level. Therefore it is very important that designer/contractors familiar with industrial piping systems be responsible for the vent system design and installation.

When a quench occurs, the helium gas will immediately begin to warm up and expand rapidly. As the gas escapes from the magnet, the helium gas will increase in temperature from 4.5 K to approximately 30 K. As a result, the gas will expand to 10 times of its original volume. Consequently, venting systems must never decrease in size and may increase in size (diameter) as the distance from the magnet increases.

CAUTION

THE CRYOGENIC VENT INSPECTION MUST BE COMPLETED TO FINAL EXIT OUTSIDE OF THE BUILDING INCLUDING RF SHIELD PENETRATION PRIOR TO MOVING THE MAGNET INTO THE MAGNET ROOM.
IN THE SITUATION WHERE THE MAGNET DELIVERY WILL BE THROUGH A ROOF HATCH AND THE CRYOGENIC VENT WILL BE LOCATED IN THE SAME HATCH THEN THE CRYOGENIC VENT MUST BE INSTALLED AND INSPECTED TO FINAL EXIT WITHIN 24 HOURS OF THE MAGNET DELIVERY THROUGH THE HATCH.

Note

To minimize the confusion due to various domestic and foreign venting material sizing systems, the actual dimensions of the vent material are used to describe the required vent sizes in this document. Please use the locally available venting material best matching or exceeding the requirements discussed in this document.

Note

The difference in the American terminologies of pipes and tubes is disregarded in this document.

Note

The vent size is described by the inside diameter in the pressure drop tables, because the pressure drop is calculated with the inside diameter. The vent size is described by the outside diameter for the waveguide requirements, because sealing the Ventglas® and matching the outside diameters are the critical issues.

Note

Portions of this document may not be applicable to the mobile units. Cryogenic vent design for mobile units must be submitted to GE Healthcare MR Engineering for certification.

10–2 Requirements For Outside Magnet Room

The customer's vent system designer/contractor must design and install the cryogenic vent from the RF shield waveguide to the final exit on the building roof top or outside wall. Table 5–7 contains the requirements which must be strictly adhered to in order to prevent failure of the vent system during a magnet quench.

TABLE 5–7
CRYOGENIC VENTING REQUIREMENTS FOR OUTSIDE MAGNET ROOM

PARAMETER	CRYOGENIC VENTING REQUIREMENTS
VENT SIZE	• The total pressure drop of the entire cryogenic vent system must be less than 17 psi (117.2 KPa). The calculation starts at the magnet vent interface and ends at the termination point outside of the building. Use Table 5–8 to determine proper vent sizes. See Note 1. See Illustration 5–7 for a sample calculation. • The pressure drop of the RF shield waveguide must be included in the overall calculation. Make sure the RF shielded room supplier provides a straight pipe for the waveguide with an outside diameter which matches the tubing from the magnet within ± 0.125 inch (3 mm). Refer to Chapter 8 Section 2–2 Determining Cryogenic Vent Location for location of vent pipe/waveguide. • The vent route must be as direct as possible and designed with a minimum number of elbows. If elbows must be used, they must be standard or long sweep types with K factors as shown in the footnotes of Table 5–8. Use of elbows with higher K factors will result in higher pressure drops than those shown in Table 5–8. Refer to Chapter 8 Section 2–2 Determining Cryogenic Vent Location for routing of vent pipe.
VENT CONSTRUC-TION	• Expansion/contraction joints must be provided to account for dimensional changes that will occur during a magnet quench when the vent temperature decreases from ambient to 4.5 K (–451° F or –268° C). • At the waveguide, non–metallic isolation joint must be provided to ensure the integrity of the magnet room RF shield. The joint gap must be 1.0 ± 0.25 inch (25 ± 6 mm). • All components must be able to withstand the minimum static pressure as calculated form Table 5–8 and a helium flow reaction force at temperatures from 4.5 K (–451° F or –268° C) and above. • Electro–mechanical fire dampers must not be used in the design of the vent system. Fusible link fire dampers are acceptable and require routine inspection and maintenance. • Appropriate protection must be provided for any portion of the cryogenic vent system which may drip condensation on personnel or ceiling components. • Access must be available for any portions of the cryogenic vent system made of non–metallic materials which require routine inspection and maintenance by the customer.
VENT SUPPORT	• All portions of the cryogenic vent system must be adequately supported. The vent support assemblies must be capable of supporting the weight of the vent system and the helium flow reaction force of 1850 lbs (8229 N) for 1.5T magnet at the vent elbows. • Non–metallic (ie. Ventglas) joints **must not** be used as the support for the vent system.
(Continued)	

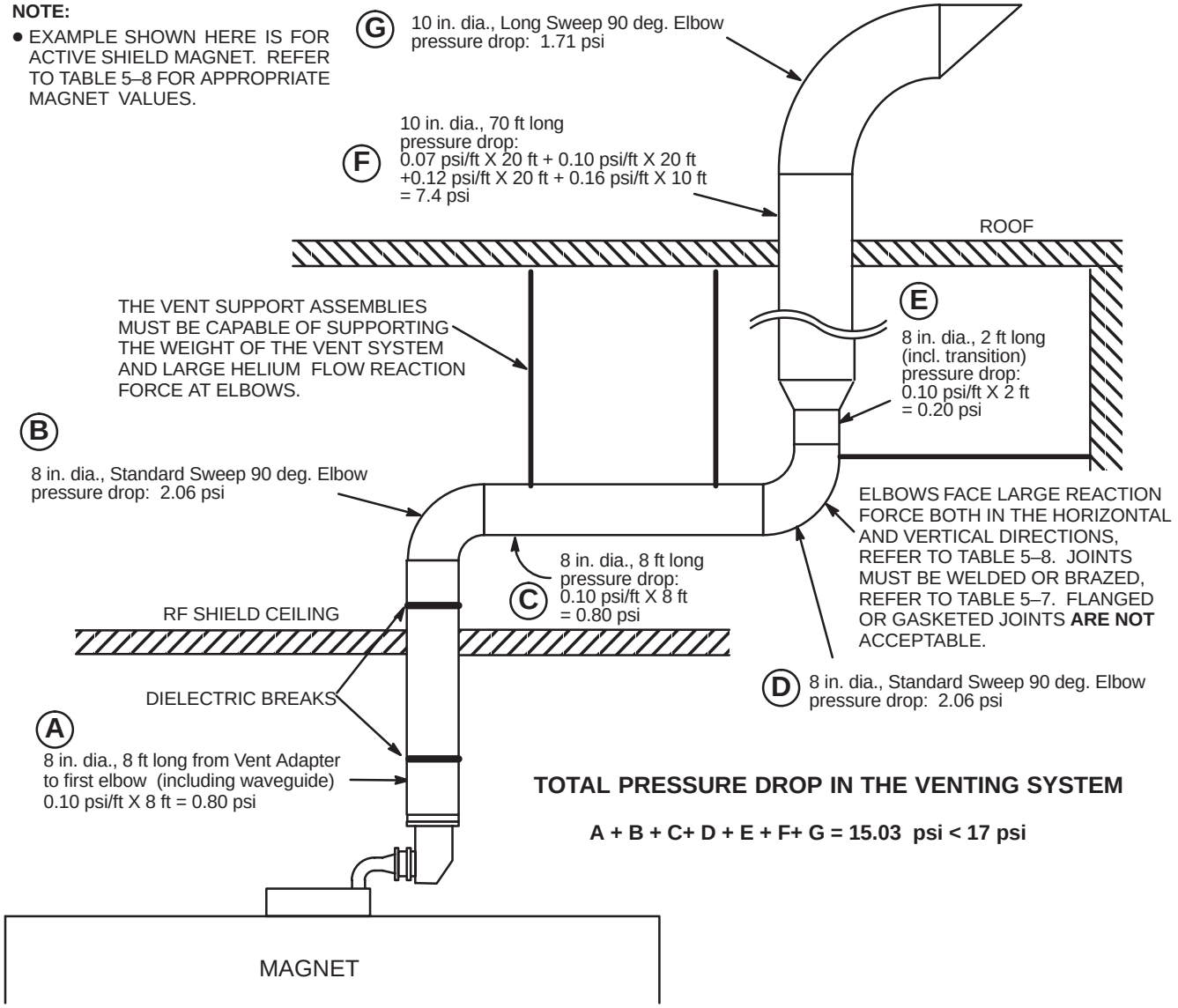
TABLE 5–7 (Continued)
CRYOGENIC VENTING REQUIREMENTS FOR OUTSIDE MAGNET ROOM

PARAMETER	CRYOGENIC VENTING REQUIREMENTS

VENT EXIT AND TERMINATION	**WARNING!**
	• The exit location of the cryogenic vent system must be chosen to prevent the extremely cold exhaust gas from injuring anyone, including maintenance personnel. Exhaust opening access must be limited by warning signs or other barriers within a distance 20 feet (6.1 meters) long by 15 feet (4.6 meters) wide for 1.5T LCC magnets.
	• During a quench the venting of cryogenic gas can lead to the formation of liquified air. The liquified air is at temperatures that can cause harm. Any personnel, building components, or objects (movable or stationary) must be protected from contact with liquified air.
	• The exhaust vent must be directed in a manner to prevent the cold gas from injuring personnel or damaging any building components. It must also be directed away from air intake vents.
	• The exit must not allow vented gas or expelled particles to contact any personnel, building components, or objects (movable or stationary).
	• For a roof top exit:
	  ◦ GE recommends that the exhaust flow be directed horizontally using a 90° elbow having minimal pressure drop and the outlet covered with a 0.5 inch (12.7 mm) mesh screen to prevent the entry of foreign material. See Illustration 5–8. Other low pressure drop, high flow rate roof caps are acceptable.
	  ◦ The bottom of the 90° elbow must be at least 3 feet (0.9 meters) above the roof deck. This dimension must be higher if the location of the vent exhaust is susceptible to being blocked by drifting material (i.e. snow, leaves, sand, etc.).
	• For a side wall exit:
	  ◦ GE recommends that the exhaust flow be directed vertically using a 45° deflector designed to withstand the helium flow reaction force (listed in Vent Construction row of this table) with no restriction of the gas flow. See Illustration 5–9.
	  ◦ Exit must be a minimum of 12 feet (3.66 meters) above the ground.
	  ◦ Exit of vent must prevent ingress of weather elements (i.e. rain, snow, hail, sand, etc.) and foreign material debris (i.e. leaves, bird nests, etc.)

Note: 1 The customer's designer is responsible for selecting materials and hardware capable of safely handling the pressures and cold temperature generated within the vent at each MRI site.	

10–2 Requirements For Outside Magnet Room (Continued)



SAMPLE PRESSURE DROP CALCULATION OF CRYOGENIC VENTING
ILLUSTRATION 5–7

10–2 Requirements For Outside Magnet Room (Continued)

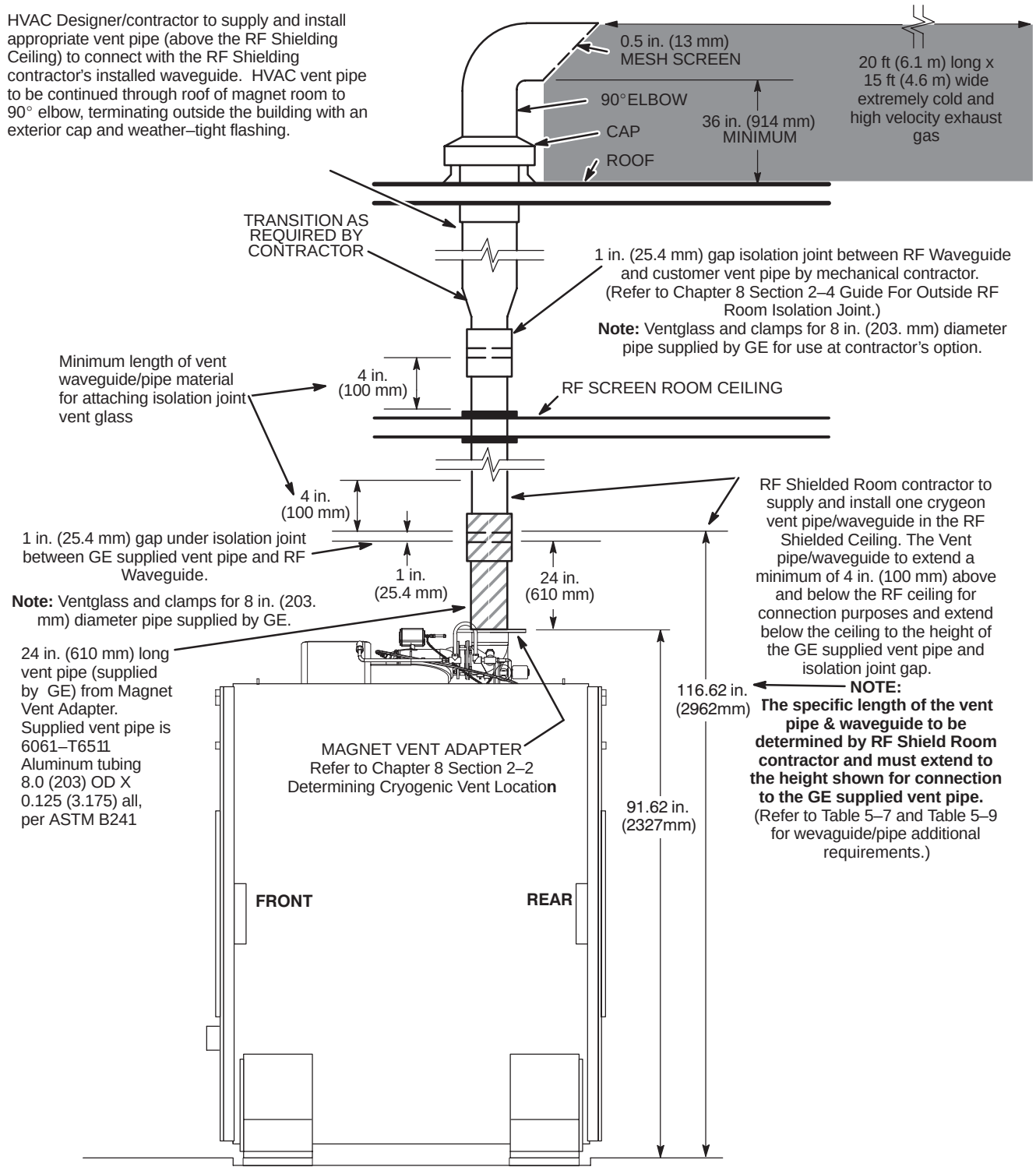
TABLE 5–8
CRYOGENIC VENT SYSTEM PRESSURE DROP MATRIX FOR 1.5 T LCC (ACTIVE SHIELD) MAGNET
(THIS TABLE MUST BE USED FOR CRYOGENIC VENT SYSTEM DESIGN)

CRYOGENIC VENT SYSTEM PRESSURE DROP MATRIX FOR A 1.5 TESLA LCC (ACTIVE SHIELD) MAGNET					PRESSURE DROP PER ELBOW USED ANYWHERE WITHIN A 20 FT VENT SEGMENT			
INSIDE DIAMETER OF VENT PIPE in. (mm)	DISTANCE OF VENT SYSTEM COMPONENT FROM MAGNET ft (m)		PRESSURE DROP FOR STRAIGHT VENT PIPE WITH SMOOTH INSIDE SURFACE psi/ft (KPa/m)		STANDARD SWEEP 45° ELBOW psi (KPa)	STANDARD SWEEP 90° ELBOW psi (KPa)	LONG SWEEP 45° ELBOW psi (KPa)	LONG SWEEP 90° ELBOW psi (KPa)
8 (203.2)	0–20	(0–6.1)	0.10	(2.26)	1.10 (7.58)	2.06 (14.20)	0.55 (3.79)	1.03 (7.10)
	20–40	(6.1–12.2)	0.21	(4.75)	2.10 (14.48)	3.70 (25.51)	1.03 (7.10)	1.85 (12.76)
	40–60	(12.2–18.3)	0.30	(6.79)	2.88 (19.86)	5.21 (35.92)	1.44 (9.93)	2.60 (17.92)
	60–80	(18.3–24.4)	0.38	(8.60)	3.70 (25.51)	6.71 (46.27)	1.85 (12.76)	3.36 (23.17)
	80–100	(24.4–30.5)	0.47	(10.63)	4.52 (31.17)	8.22 (56.68)	2.26 (15.58)	4.11 (28.34)
10 (254.0)	0–20	(0–6.1)	0.03	(0.68)	0.55 (3.79)	0.82 (5.65)	0.27 (1.86)	0.41 (2.83)
	20–40	(6.1–12.2)	0.07	(1.58)	0.82 (5.65)	1.51 (10.41)	0.41 (2.83)	0.75 (5.17)
	40–60	(12.2–18.3)	0.10	(2.26)	1.23 (8.48)	2.19 (15.10)	0.62 (4.27)	1.10 (7.58)
	60–80	(18.3–24.4)	0.12	(2.71)	1.51 (10.41)	2.74 (18.89)	0.75 (5.17)	1.37 (9.45)
	80–100	(24.4–30.5)	0.16	(3.62)	1.92 (13.24)	3.43 (23.65)	0.96 (6.62)	1.71 (11.79)
12 (304.8)	0–20	(0–6.1)	0.013	(0.29)	0.27 (1.86)	0.41 (2.83)	0.14 (0.97)	0.21 (1.45)
	20–40	(6.1–12.2)	0.027	(0.61)	0.41 (2.83)	0.82 (5.65)	0.21 (1.45)	0.41 (2.83)
	40–60	(12.2–18.3)	0.041	(0.93)	0.55 (3.79)	1.10 (7.58)	0.27 (1.86)	0.55 (3.79)
	60–80	(18.3–24.4)	0.054	(1.22)	0.69 (4.76)	1.37 (9.45)	0.34 (2.34)	0.69 (4.76)
	80–100	(24.4–30.5)	0.069	(1.56)	0.96 (6.62)	1.51 (10.41)	0.48 (3.31)	0.75 (5.17)
	100–120	(30.5–36.6)	0.08	(1.81)	1.09 (7.52)	1.77 (12.20)	0.55 (3.79)	0.88 (6.07)
	120–140	(36.6–42.7)	0.10	(2.26)	1.27 (8.76)	2.07 (14.27)	0.63 (4.34)	1.04 (7.17)
	140–160	(42.7–48.8)	0.11	(2.49)	1.43 (9.86)	2.36 (16.27)	0.72 (4.96)	1.19 (8.20)
	160–180	(48.8–54.9)	0.12	(2.71)	1.60 (11.03)	2.53 (17.44)	0.80 (5.52)	1.27 (8.76)
	180–200	(54.9–61.0)	0.17	(3.85)	1.75 (12.07)	2.93 (20.20)	0.88 (6.07)	1.47 (10.14)
14 (355.6)	0–20	(0–6.1)	0.008	(0.055)	0.20 (1.38)	0.301 (2.08)	0.102 (0.70)	0.15 (1.03)
	20–40	(6.1–12.2)	0.017	(0.12)	0.30 (2.07)	0.602 (4.15)	0.154 (1.06)	0.30 (2.07)
	40–60	(12.2–18.3)	0.026	(0.18)	0.40 (2.76)	0.808 (5.57)	0.198 (1.37)	0.40 (2.76)
	60–80	(18.3–24.4)	0.034	(0.23)	0.51 (3.52)	1.01 (6.96)	0.250 (1.72)	0.51 (3.52)
	80–100	(24.4–30.5)	0.043	(0.30)	0.71 (4.90)	1.11 (7.65)	0.353 (2.43)	0.55 (3.79)
	100–120	(30.5–36.6)	0.050	(0.34)	0.80 (5.52)	1.30 (8.96)	0.40 (2.76)	0.64 (4.41)
	120–140	(36.6–42.7)	0.063	(0.43)	0.933 (6.43)	1.52 (10.48)	0.46 (3.17)	0.76 (5.24)
	140–160	(42.7–48.8)	0.069	(0.48)	1.05 (7.24)	1.73 (11.93)	0.52 (3.59)	0.87 (6.00)
	160–180	(48.8–54.9)	0.076	(0.52)	1.18 (8.14)	1.85 (12.76)	0.59 (4.07)	0.93 (6.41)
	180–200	(54.9–61.0)	0.11	(0.76)	1.29 (8.89)	2.15 (14.82)	0.64 (4.41)	1.08 (7.45)
16 (406.4)	0–20	(0–6.1)	0.0053	(0.037)	0.153 (1.05)	0.230 (1.59)	0.078 (0.54)	0.115 (0.79)
	20–40	(6.1–12.2)	0.013	(0.09)	0.229 (1.58)	0.460 (3.17)	0.118 (0.81)	0.229 (1.58)
	40–60	(12.2–18.3)	0.020	(0.14)	0.306 (2.11)	0.618 (4.26)	0.152 (1.05)	0.306 (2.11)
	60–80	(18.3–24.4)	0.026	(0.18)	0.390 (2.69)	0.773 (5.33)	0.191 (1.32)	0.390 (2.69)
	80–100	(24.4–30.5)	0.033	(0.23)	0.543 (3.74)	0.850 (5.86)	0.270 (1.86)	0.421 (2.90)
	100–120	(30.5–36.6)	0.038	(0.26)	0.613 (4.23)	0.995 (6.86)	0.310 (2.14)	0.490 (3.38)
	120–140	(36.6–42.7)	0.048	(0.33)	0.714 (4.92)	1.16 (8.00)	0.352 (2.43)	0.581 (4.01)
	140–160	(42.7–48.8)	0.052	(0.36)	0.803 (5.54)	1.32 (9.10)	0.398 (2.74)	0.666 (4.59)
	160–180	(48.8–54.9)	0.058	(0.40)	0.903 (6.23)	1.42 (9.79)	0.451 (3.11)	0.712 (4.91)
	180–200	(54.9–61.0)	0.084	(0.56)	0.987 (6.81)	1.64 (11.31)	0.490 (3.38)	0.826 (5.70)

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

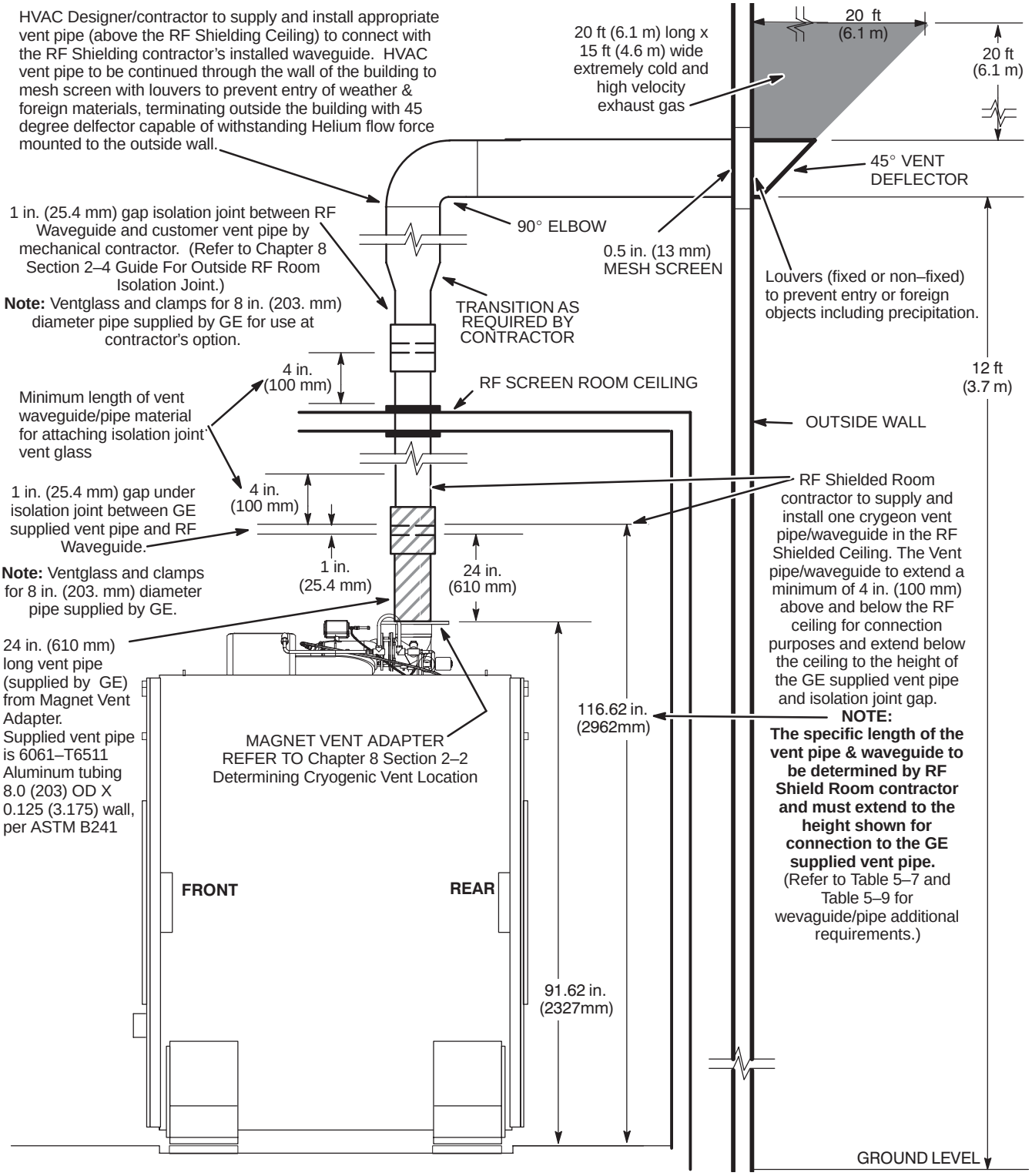
Note 2 : The table data is based on the following:
a. Initial flow conditions at magnet interface
b. Gas temperature starting at 4.5 Kelvin (–452° F or –268° C).
c. Helium gas flow rate of 2,737 cubic feet per minute (77.5 cubic meters per minute)
d. 45° standard sweep elbow K = 15 F_t
e. 90° standard sweep elbow K = 30 F_t
f. 45° long sweep elbow K = 7.5 F_t
g. 90° long sweep elbow K = 15 F_t

10–2 Requirements For Outside Magnet Room (Continued)



TYPICAL MAGNET CRYOGENIC VENT ROOF EXIT DETAIL
ILLUSTRATION 5–8

10–2 Requirements For Outside Magnet Room (Continued)



TYPICAL MAGNET CRYOGENIC VENT SIDE WALL EXIT DETAIL
ILLUSTRATION 5–9

10–3 Requirements For Inside Magnet Room

GE provides and installs a vertical 8 in. (203.2 mm) outside diameter 24 in. (610 mm) long cryogenic vent tube within the magnet room straight up from the magnet in line with the waveguide in the RF Shield. The customer is responsible to provide additional vent tube within the magnet room to meet requirements defined in Table 5–9. The Vent diameter is determined by magnet, refer to Chapter 8 Section 2–2 Determining Cryogenic Vent Location. For other vent configurations (i.e. offset ceiling exits, wall exits and geodesic domes) the customer's contractor is responsible for the design and installation of the cryogenic vent system and vent supports within the magnet room. In these cases, a complete description of the vent size, materials/properties and routing must be sent to GE Healthcare MR Siting & Shielding Group for final review. Table 5–9 contains the GE requirements for vent design within the magnet room.

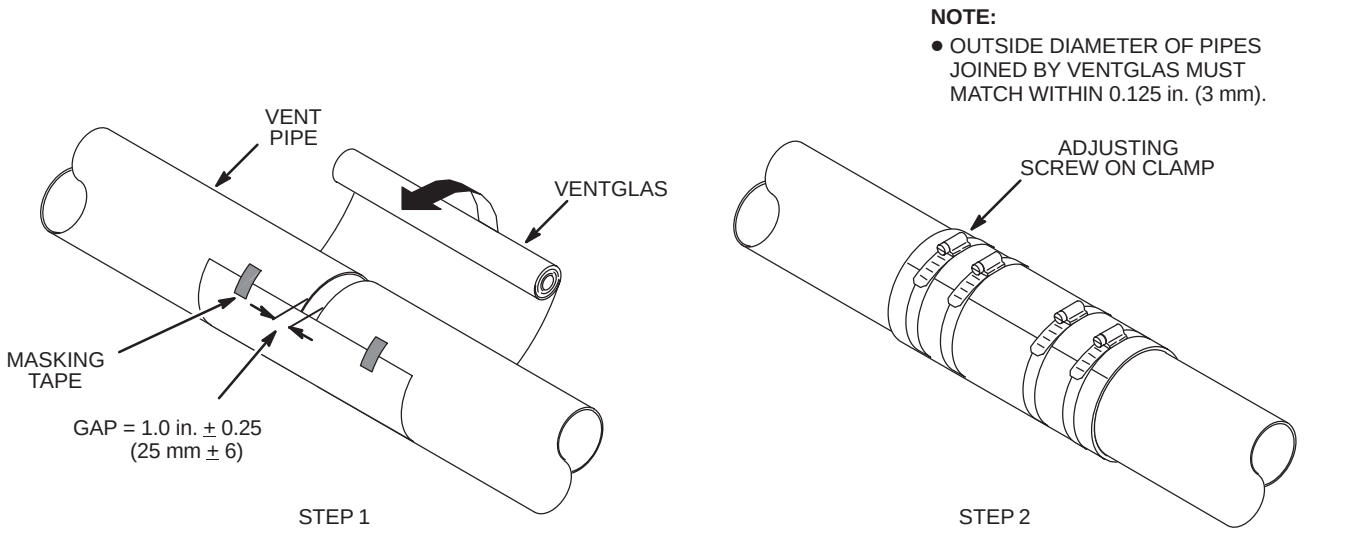
TABLE 5–9
CRYOGENIC VENTING REQUIREMENTS FOR INSIDE MAGNET ROOM

PARAMETER	CRYOGENIC VENTING REQUIREMENTS
VENT SIZE	• The total pressure drop of the entire cryogenic vent system must be less than 17 psi (117.2 KPa). The calculation starts at the magnet vent interface and ends at the termination point outside of the building. Use Table 5–8 to determine proper vent sizes. • The pressure drop of the RF shield waveguide must be included in the overall calculation. Make sure the RF shielded room supplier provides for 1.5T LCC (Active Shield) magnets 8 inch (203.2 mm) outside diameter straight pipe for the waveguide. Refer to Chapter 8 Section 2–2 Determining Cryogenic Vent Location for location of vent pipe/waveguide.
VENT MATERIAL	• The vent material must be Stainless Steel 304, Aluminium 6061–T6 or Copper type DWV, M or L. • Either tubes or pipes meeting the requirements may be used for venting. The vent pipe must be either seamless or have welded seams. Corrugated pipe **must not** be used. If necessary, bellows pipe of length less than 1 ft (30 cm) is allowed for thermal expansion joint. • For 1.5T magnets, the vent pipe must be capable of withstanding pressures up to 35 psi (241.4 KPa). • For the waveguide, the vent material must match the outside diameter of the magnet's vent. Refer to Table 5–10. • Venting wall thickness: SS 304 Minimum 0.035 in. (0.89 mm) Maximum 0.125 in. (3.18 mm) AL 6061–T6 Minimum 0.083 in. (2.11 mm) Maximum 0.125 in. (3.18 mm) CU DWV, M or L Minimum 0.083 in. (2.11 mm) Maximum 0.140 in. (3.56 mm)
VENT SUPPORT	• All portions of the cryogenic vent system must be adequately supported. The vent support assemblies must be capable of supporting the weight of the vent system. To ensure the integrity of the RF shield for the magnet room, electrically isolate any support assemblies which are used to support sections of venting between the magnet interface and the isolation joint at the waveguide. • For 1.5T magnets, the vent support assemblies must be capable of supporting the weight of the vent system and 1850 lb. (8229 N) helium flow reaction force at vent elbows. • Non–metallic (i.e. Ventglas) joint **must not** be used as the support for the vent system.
VENT CONSTRUC-TION	• One dielectric break in the vent system (ie. Ventglas) is required within the Magnet Room. A non–metallic isolation joint must be provided between the GEMS supplied 24 in. (610 mm) long vent pipe and the cryogen vent system ensure the integrity of the RF shield for the Magnet Room. • For vent systems with offsets, a thermal expansion joint may be necessary to allow for the thermal expansion and contraction of the vent system. • All joints except 1 non–metallic isolation (ie. Ventglas) must be welded or brazed. No clamped, sealed flanges permitted. • All isolation/thermal expansion joints except 1 non–metallic isolation (ie. Ventglas) must be able to withstand temperatures from 4.5 K (–451° F or 268° C) and above. For 1.5T magnets, these joints must also withstand pressures up to 35 psi (241.4 KPa). • GE requires Ventglas material to be used for 1 isolation joint, which may serve as a non–metallic thermal expansion joint. Rubber soil pipe couplings are not acceptable for this application. When using Ventglas material to join 2 pipes together make sure the gap between the pipes is 1.0 ± 0.25 inch (25.4 ± 6 mm) and use a continuous wrap technique during installation. See Illustration 5–10. Use 2 hose clamps on each side of the joint for securing the Ventglas to the vent pipe. • To prevent condensation during magnet ramping, the vent must be insulated with 1.5 inch (38 mm) thick flexible unicellular insulation. For appearances, all exposed insulation should be covered with white PVC jackets. **Note**: Access must be available to the non–metallic isolation joint located within 24 in. (610 mm) of the Magnet Vent Adapter for annual inspection and/or maintenance by the customer. **Note**: The installation of the vent pipe section between the waveguide and the supplied magnet vent pipe **must not** result in any vertical or side load to the waveguide and the magnet vent pipe.

10–3 Requirements For Inside Magnet Room (Continued)

TABLE 5–10
MAGNET TYPE MATRIX

MAGNET TYPES	**DIMENSIONS LxWxH inches (mm)**	**HELIUM VOLUME** gallons (liters)	**PEAK HELIUM FLOW DURING QUENCH** ft^3 per min (m^3 per min)	**MAGNET VENT OD** inches (mm)	**VENT LOCATION ON MAGNET** SEE SECTION 2–2
1.5T LCC Magnet	69.7x81.15x91.54 (1770x2061x2325)	520.0 (1970)	2737 (77.50)	8 (203.2) Floating Flange	Illustration 8–1



VENT GLASS CONTINUOUS WRAP
ILLUSTRATION 5–10

11 Alarm Devices, Water Sensors And Thermostats

11–1 System Cabinet

The EXCITE II System Cabinet has 104 °F (40°C) and 122 °F (50°C) temperature sensors. When the temperature in the System Cabinet reaches 40°C a Warning Message will be displayed on the Operator Workspace. When the temperature in the System Cabinet reaches 122 °F (50°C) or above a Warning Message will be displayed on the Operator Workspace and the system scanning operation will be inhibited. Normal scanning operation will be allowed when the System Cabinet temperature returns to normal. Any external alarm device for room temperature monitoring must be supplied by the customer.

11–2 Water Sensor Alarm and Floor Drain

It is recommended that customer supplied water sensor alarms and floor drain be located on floors where water cooled cabinets are positioned, especially under raised flooring.

11–3 Pneumatic Patient Alert

The Pneumatic Patient Alert Control Box provides an audible and visual alarm near the operator when the patient depresses the hand held squeeze bulb. The control box is to be mounted with consideration for ease of use by operator, remaining in sight of operator, and remaining within 5 ft. (1.5 m) of an electrical outlet. Note, an outlet on the Operator Workstation may be used. Options for control box location include mounting box vertically (on a wall or other vertical surface), horizontally (place box on a counter top, desk top, or other horizontal surface), or under a shelf within sight of operator.

12 Ambient Radio Frequency Interference (RFI)

The MR System utilizes spatially encoded radio frequency information to create the MR image. Therefore, it is sensitive to ambient RFI. To protect the MR from ambient RFI (as well as the local environment from Magnetic Resonance RF), all sites require a 100 dB RF Shield, refer to Section 8 RF Shielded Room for exact requirements. It is very unlikely that local signals will affect an MR System with a properly designed and installed RF Shield. During the site evaluation visit, GE notes the location of nearby sources of RFI and will advise if further information or on–site testing is required. Most sites do not require on–site testing. Listed in Table 5–11 are the recommended centerband and bandwidth frequencies to be used when measuring radio frequency interference. This table includes those frequency bands which are important for both proton imaging and spectroscopy.

TABLE 5–11
RADIO FREQUENCY SURVEY SPECIFICATIONS

ISOTOPE	1.5T SYSTEM	
	BANDCENTER MHz	BANDWIDTH Hz
^{1}H	63.86	916,138
^{19}F	60.12	981,882
^{31}P	25.88	390,296
^{23}Na	16.90	242,773
^{13}C	16.06	233,925

When required, RFI site surveys are to be performed by cycling through the preceding frequency bands and a broad band range of 100MHz $\pm$ 10MHz. Special emphasis, however, should be placed on the 1H band since this is used in proton imaging. The RFI site survey should be performed for a length of time necessary to determine, within a reasonable degree of certainty, that the RFI noise at the site will not exceed the 100 db attenuation provided by the RF shielded room. Note that any RFI site survey no matter how thorough, will not preclude the possibility of future or unmeasured RFI caused by new or intermittent sources.

The ambient RF noise measured should be less than 100 millivolt per meter (100 dB microvolt per meter). When a RFI site survey is required, it must be completed before the purchase and installation of the RF shielded room.

To ensure that 100 millivolt (or greater) RF noise peaks outside the bandwidths specified above do not actually extend into these bandwidths and exceed the 100 millivolt limit, adjust the resolution of the test equipment (spectrum analyzer) according to the equation:

$$BW\ (resolution) = f_0 / 50$$

where: BW = Bandwidth (resolution)
f_0 = Center frequency (for 1H: at 1.5 Tesla 63.86 MHz)

13 Pollution

The site must be clean prior to delivery of the equipment. Although individual components have filters for optimum air filtration, care should be taken to keep air pollution to a minimum.

Since static discharge can cause system failures or affect its operation, carpeting should be of the anti–static type or treated with an anti–static solution.

When cleaning tile floors, do not use steel wool which could enter cabinet enclosures and cause internal shorts.

The computer/equipment area requires that the air be filtered to remove 90 percent of all particles down to 10 microns and 80 percent of all particles from 10 to 5 microns in size.

14 Changing Magnetic Environment Specifications

Note

Refer also to Table 3–1 for additional proximity limitations.

Definition Of Moving Metal

Moving metal means metal objects that move inside of the moving metal sensitivity line during system scans. For example, cars being driven inside the moving metal sensitivity line are moving metal. However, if a car or a dumpster is within the moving metal sensitivity line and **does not** move during scans, then it is not an issue. Note, the 3 gauss line proximity limit for metal objects still applies to Active Shield magnets.

14–1 Steel Objects Categories And Requirements

Refer to Table 5–12 for 1.5T LCC Magnet moving metal requirements and see Illustrations 5–14 & 5–15.

TABLE 5–12
LCC (ACTIVE SHIELD) MAGNET MOVING METAL REQUIREMENTS

STEEL OBJECTS CATEGORY	DEFINITION OF DISTANCE LOCATION	MINIMUM DISTANCE RADIAL X AXIAL ft (m) See Note 1
Objects 100 – 400 lbs	distance from isocenter radial x axial (See Note 1)	3 Gauss line 7.87 x 13.45 (2.4 x 4.1)
CARS, MINIVANS, VANS, PICKUP TRUCKS, AMBULANCES	distance from isocenter measured to center of driving or parking lane radial x axial (See Note 1)	15.5 x 21 (4.72 x 6.40)
BUS, TRUCKS (UTILITY, DUMP, SEMI)	distance from isocenter measured to center of driving or parking lane radial x axial (See Note 1)	18.1 x 24.5 (5.52 x 7.47)
Objects > 400 lbs, ELEVATORS, TRAINS, SUBWAYS	Place a directional probe (eg. flux gate sensor) at isocenter of proposed magnet location aligned along the Z–axis. Measure p–p magnetic field change (dc).	See Illustration 5–11 and See Example in Note 2

Note 1 Radial distances are magnet X and Y axis. Axial distances are magnet Z axis.

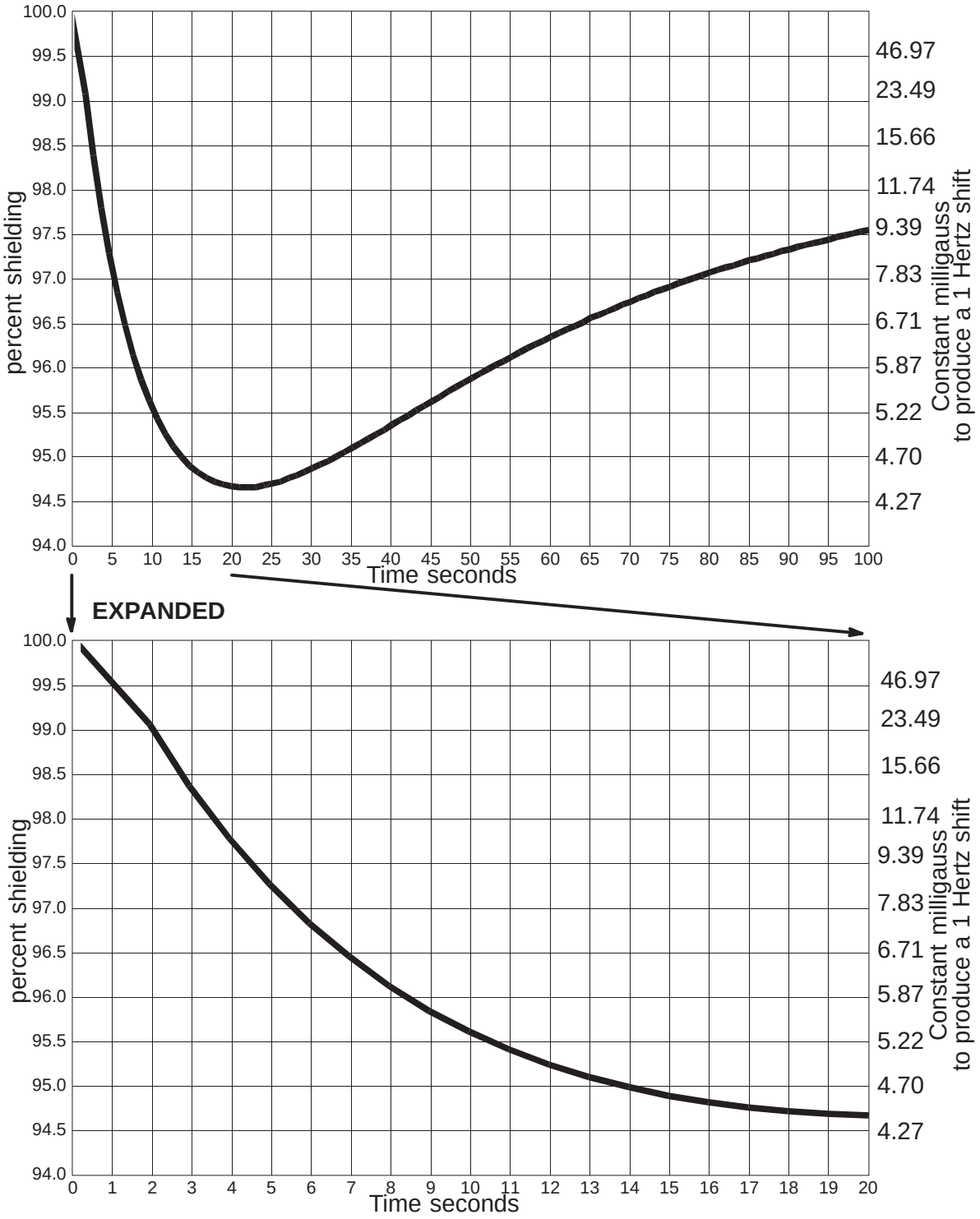
2 EXAMPLE: For Moving Metal Requirements of objects > 400 lbs category you can use the time history of the occurrence to determine what milligauss level to use.

A. If the site has elevators/counter weights near the magnet and the elevator can stop on the floors for longer than 20 seconds (which is usually the case), you need to use a shielding factor of 94.7% and a resulting peak–to–peak milligauss reading of 4.43.

B. If the site has a subway nearby and the field disturbance is less than 5 seconds, you can use a shielding factor of 97.3% and a resulting peak–to–peak milligauss reading of 8.39.

C. Therefore, be conservative and use 4.43 milligauss peak–to–peak.

14–1 Steel Objects Categories And Requirements (Continued)



ACTUAL AXIAL SHIELDING PERFORMANCE FOR LCC (ACTIVE SHIELD) MAGNET
ILLUSTRATION 5–11

14–2 Distances For AC Power Lines, Transformers And Electric Motors

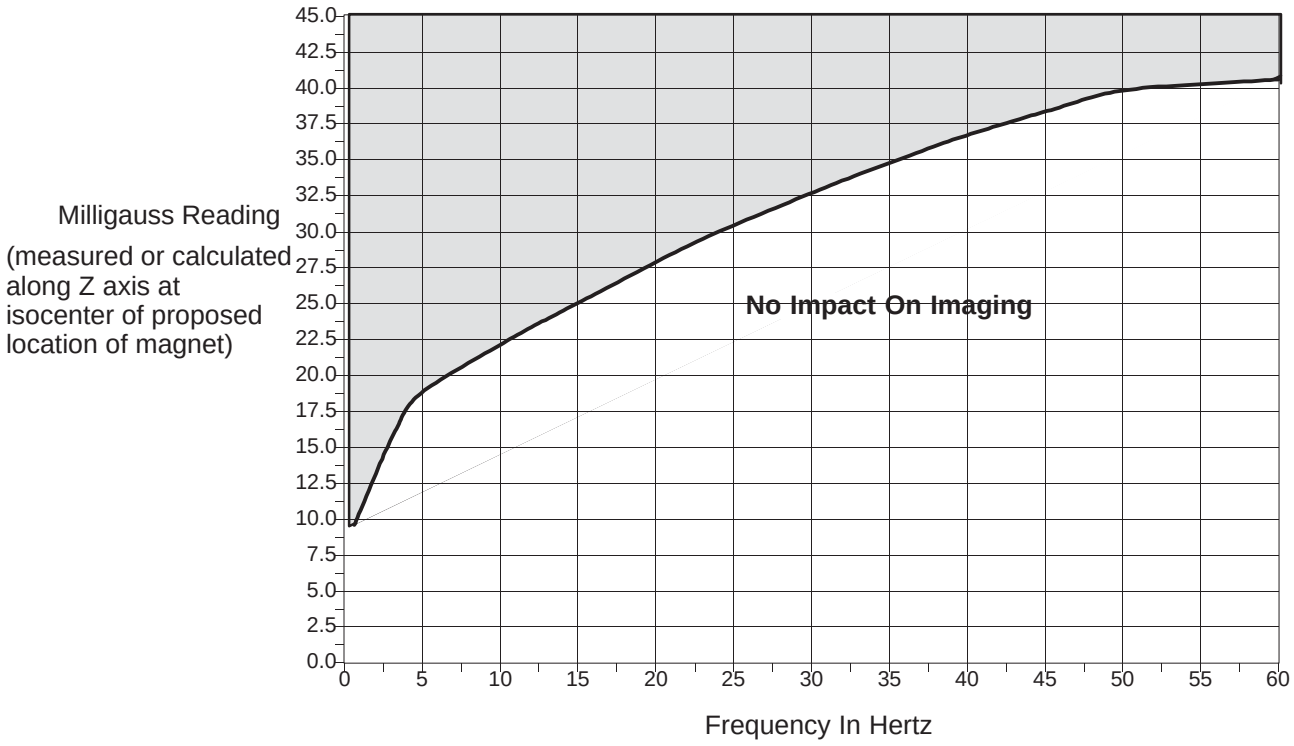
In general most AC equipment in sites is not an issue if it kept outside the 5 gauss line. If a site has large AC equipment (building mains, substations, electric trains, or subways) see Illustration 5–12 and calculate or measure the field along the Z axis at the magnet isocenter.

Electrical currents flowing in high voltage power lines, transformers, and large generators or motors near the magnet can affect the magnetic field homogeneity that is essential to the proper performance of the MR System. Although it is highly unlikely that induced magnetic fields will be a problem, possible sources of AC interference are identified by GE during the site evaluation visit. GE will analyze this information and advise if further shielding or site rearrangement are necessary.

Magnetic field interference at 50 or 60 Hz must not exceed 40 milligauss RMS at the magnet location. The following equation can be used as a general guide in determining allowable current in feeder lines at a given distance from the magnet isocenter.

$$I = \frac{20X^2}{S}$$

where: I = Maximum allowable RMS single phase current (in amps) or maximum allowable RMS line current (in amps) in three phase feeder lines
S = Separation (in meters) between single phase conductors or greatest separation between three phase conductors
X = Minimum distance (in meters) from the feeder lines to isocenter of the magnet



ALLOWABLE MILLIGAUSS VS LINE FREQUENCY FOR AC EQUIPMENT
ILLUSTRATION 5–12

See Illustration 5–13 for a sample calculation.

14–2 Distances For AC Power Lines, Transformers And Electric Motors (Continued)

This is a sample calculation to determine minimum distance from a feeder, transformer, or other AC electrical source, using the Formula found in **Section 14–2 Distances For AC Power Lines, Transformers And Electric Motors**.

$$\mathrm{I(amps)} = 20\mathrm{X}^2\mathrm{(meters)} \div \mathrm{S(meters)}$$

Note that the formula has 3 variables, if you have 2 of them, you can calculate the 3rd. In this example, we calculate the minimum distance **X** from the source, in this case a main electrical feeder carrying 450 amps of current in a 5 inch conduit.

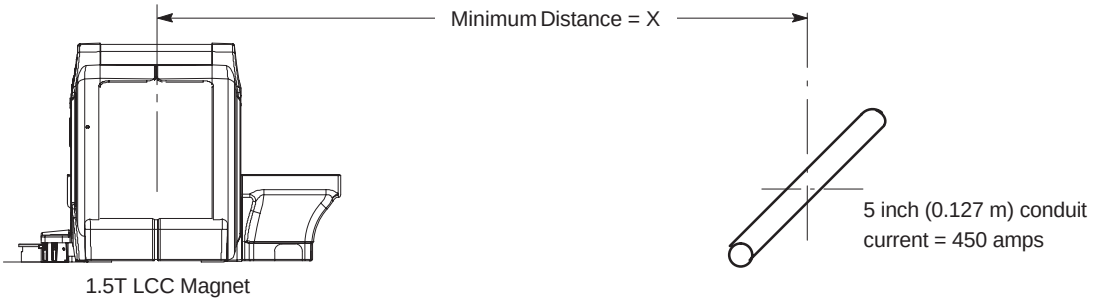
Rearranging:

$$X^2(meters) = \{I(amps) \times S(meters)\} \div 20$$

$$X = \sqrt{\left\{\frac{\{I(amps) \times S(meters)\}}{20}\right\}}$$

Note that the separation “S” is the spacing between the conductors and when all 3 conductors are run in a single conduit, “S” is simply the diamter of the conduit.

$$S = 5\ inches = 0.127\ meters$$



$$X = \sqrt{\left\{\frac{\{450(amps) \times 0.127(meters)\}}{20}\right\}}$$

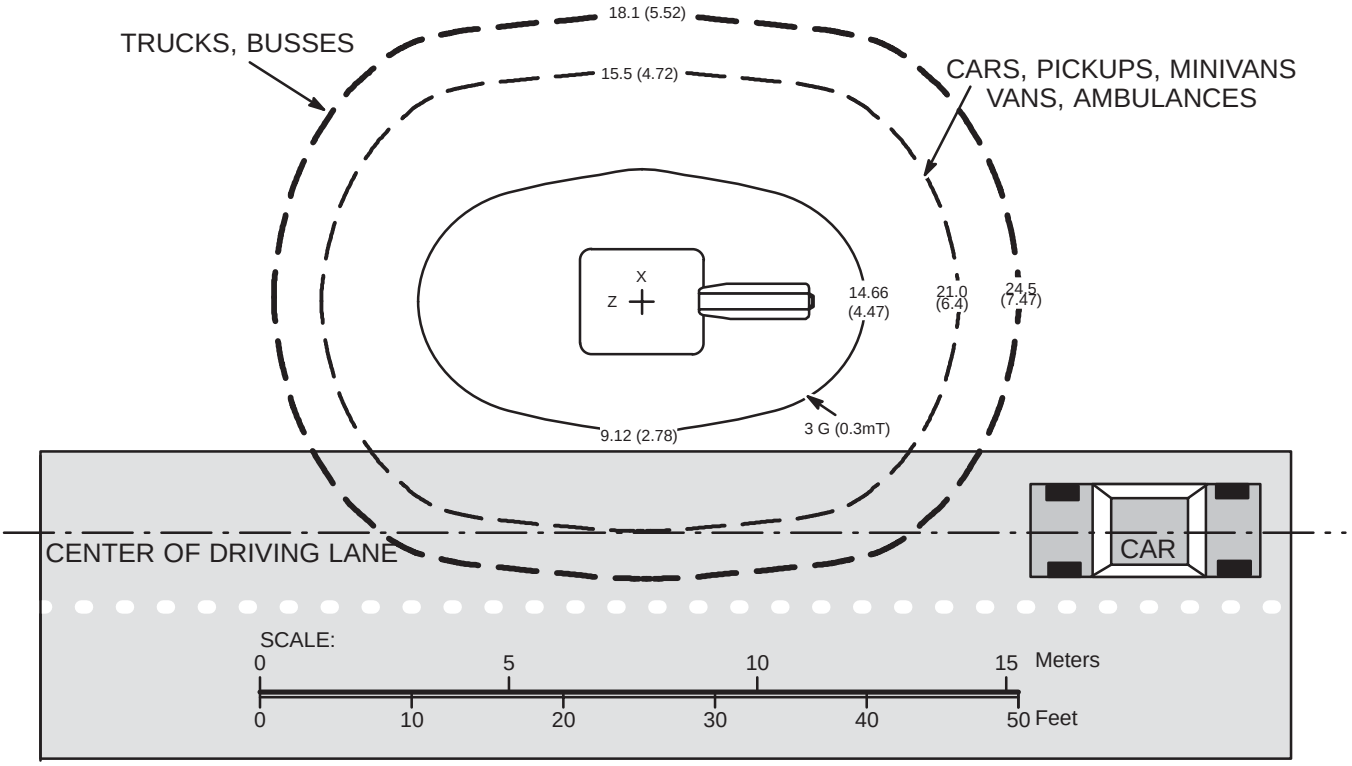
$$X = 1.69\ meters = 5.54\ feet$$

So in this example, the condiut should be 1.69 meters or 5.54 feet or farther from the magnet’s isocenter.

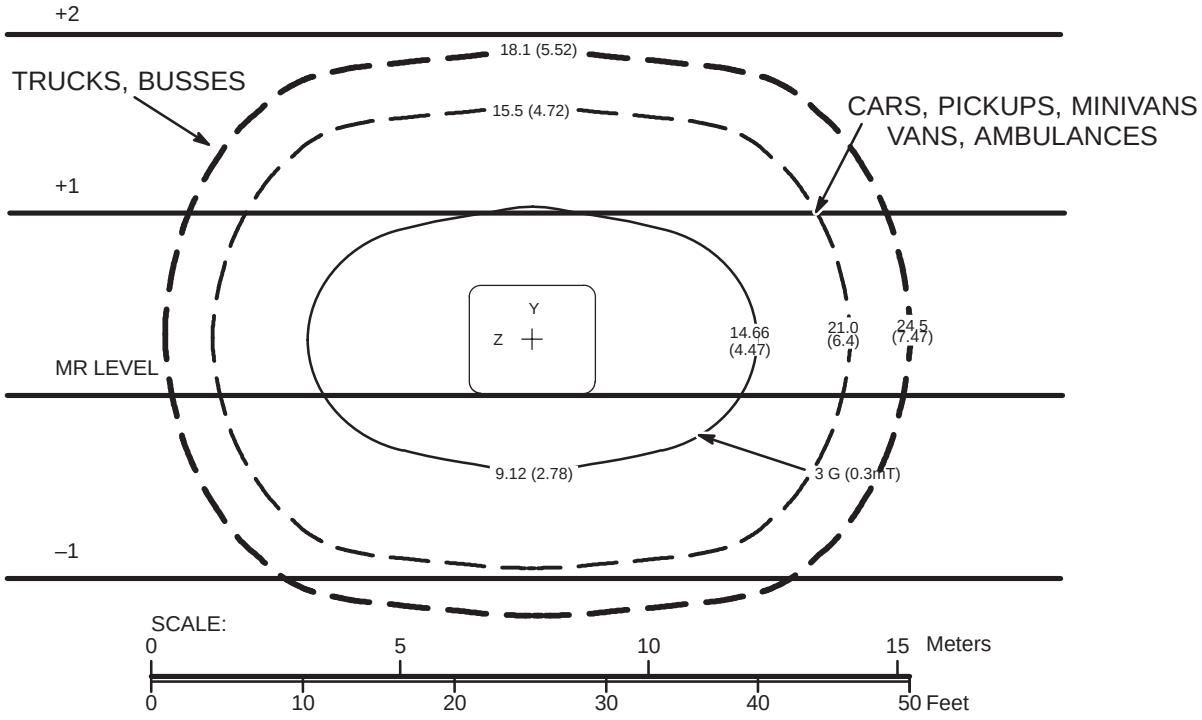
In other situations, the spacing “S” may be the spacing between HV feeders, the distance between transformer lugs, or the spacing bvetween conduits when the phase conductors are run in separate conduits.

What if it is too close? Keep in mind that if this is an existing condition, you should request an EMI study to quantify the magnitude and direction of the AC disturbances. The calculation is worse case and does not take into account the vector direction of the AC interference. The magnet is only sensitive to AC disturbances that are directed horizonally (magnet z–axis). Also the calcuation does not account for any magnetic shielding effect of steel conduit.

SAMPLE CALCULATION DETERMINE MINIMUM DISTANCE FROM AC POWER LINES, TRANSFORMERS, AND ELECTRIC MOTORS
ILLUSTRATION 5–13



1.5 TESLA LCC (ACTIVE SHIELD) MOVING METAL SENSITIVITY LINE PLOT (MR CENTER LEVEL)
ILLUSTRATION 5–14



1.5 TESLA LCC (ACTIVE SHIELD) MOVING METAL SENSITIVITY LINE PLOT (VERTICAL VIEW)
ILLUSTRATION 5–15

15 Construction Materials

The following recommendations are for maintaining field homogeneity of the magnet. All construction must comply with local and national building codes.

Note

When welding in an MR room with system equipment installed, the return path for the welding must be in very close proximity to the welding. The close proximity is needed to make sure the welding currents do not cause damage to the system. Never use the building structure as a return path for welding.

15–1 Magnet Room Floors Magnetic Properties

For the 1.5T LCC magnet, the magnet room floor should be poured slab on grade with polypropelene fiber impregnated or epoxy reinforced concrete. Non–magnetic stainless steel rebar or fiberglass rebar may also be used as a reinforcing material. Steel reinforcing rods or corrugated iron sheets should be avoided especially within the 50 gauss for the 1.5T LCC magnets. If these materials exist at the site, or if installation of these materials is contemplated, they must be taken into account in the structural steel evaluation of the site. Refer to Chapter 4 Magnetic Field Considerations for more information. If necessary, systems with the 1.5T LCC Magnet can correct for *some* steel in the floor. This includes steel rebars and other steel building components within a 10 foot by 10 foot (3.1 meter by 3.1 meter) area directly below the magnet. Table 5–13 illustrates the varying limits of mass of steel in close proximity to the magnet isocenter when using normal system shimming techniques. The data is based on a square area located directly beneath the magnet and calculating an equivalent density from the total volume of existing structural steel. In most cases, an I–Beam located directly beneath the magnet is prohibited. For the 1.5T LCC Magnets, a single I–Beam larger than W8x40 (beam 8 inches wide and 40 lbs/ft weight) or metric HE200B (200 mm wide wings steel beam and 61 kg/linear meter), should be kept a minimum of 52 inches (1321 mm) from the magnet isocenter. In any case, the values listed Table 5–13 should not be exceeded.

TABLE 5–13
STEEL MASS PROXIMITY TO MAGNET ISOCENTER

MAGNET TYPE	DISTANCE FROM MAGNET ISOCENTER in. (mm)	DISTANCE BELOW TOP SURFACE OF FLOOR in. (mm)	LIMITS OF STEEL MASS lbs/ft^2 (kg/m^2)
1.5T LCC (Active Shield) See Note 1	42 (1067)	0 (0)	0 (0)
	45 (1143)	3 (76)	2 (9.8)
	47 (1194)	5 (127)	3 (14.7)
	52 (1321)	10 (254)	8 (39.2)
	55 (1397)	13 (330)	20 (98.0)

Note 1 If non–uniform steel is present or if these mass proximity limits are exceeded for then the steel must be analyzed by the MR Siting and Shielding Team. Refer to Chapter 4 Section 1 Introduction, Chapter 4 Section 3 Structural Steel Evaluation Of Proposed Sites, and Chapter 4 Section 5 Magnetic Field.
If the MR Siting and Shielding Team analysis of the site steel determines the steel cannot be shimmed by normal methods, the customer will be required to alter the structural design using non–magnetic materials and/or more favorable geometry. If changes cannot be made, on–site factory shimming at extra cost and extended calibration cycle may be necessary. Also, the GE Field Service Engineer must arrange for delivery of the necessary shim tools and a 1000 amp Power Supply. Refer to Chapter 11 Section 4 Installation Equipment.

Steel rebar must not be positioned in such a manner as to interfere with anchor bolt locations for the Magnet Room equipment and the Magnet when the VibroAcoustic Damping Option is not used, refer to Chapter 8 Section 8 Magnet Room Equipment Mounting and Chapter 8 Section 7 Anchor Hardware Requirements For MR Equipment Inside RF Shielded Room subsections.

15–2 Walls, Ceilings, and Fixtures

All electrical and mechanical connections and fasteners including screws, nails, nuts, bolts, clips, clamps, etc. must be sufficiently tightened and secured so as not to become a potential broadband noise source, refer to Chapter 8 Section 1 RF Shielded Room Requirements for broadband noise definition. Standard steel nails, screws, and other hardware are acceptable if properly secured. Any loose steel objects can be violently accelerated into the bore of the magnet.

Careful thought should be given to the selection of light fixtures, cabinets, wall decoration, etc. to minimize this potential hazard. For safety, all removable items within the magnet room such as switch box cover plates, light fixture components, mounting screws, etc. must be non–magnetic. If you have a specific question about material, bring it to the attention of your GE Healthcare Installation Specialist.

Non–movable steel such as wall studs or HVAC components will produce negligible effect on the magnet.

15–3 Electrical Conduits

15–4 Plumbing pipes and drains

Pipes and drains within the magnet room may be iron, if desired, without significant effect on the magnet homogeneity. For safety, any removable items such as faucet handles, drain covers, etc. must be non–magnetic material such as PVC, copper, or brass. Any magnetic material inside the magnet room could inadvertently become a projectile. Refer to Section 10 Cryogenic Venting for cryogenic vent materials requirements.

16 Vibration

16–1 Definition

Improvements in MR imaging technology has increased imaging capabilities. Certain MR procedures (not all imaging techniques) require a stable environment to achieve high–resolution image quality. **Environmental site vibration has the ability to affect the magnet phase stability and ultimately image quality.** The vibration effects on image quality can be minimized early in the site planning of the MR suite.

The magnet may be sensitive to vibration in the frequency range of 0 to 50 Hz depending on the amplitude of the vibration, the imaging technique employed, and the time at which the vibration disturbance reaches the magnet (relative to the image acquisition). In the physical area surrounding the proposed MR suite, every precaution must be taken to ensure that the vibration is minimized. In the proposed magnet site location (when the site exists), the structural stability and behavioral characteristics can be assessed in the early stages of site planning. **The vibration tests outlined in Chapter 12 Section 1 MR Site Vibration Test Guidelines must be used to assess the vibration environment.**

- Sites which meet the vibration criteria may proceed with the installation planning.
- Sites which fail to meet the vibration requirements will be required to have the customer architect/project engineer provide recommendation to isolate the vibration source(s) and/or recommend structural modifications.
- Sites building a new complex to house the MR suite must use the Chapter 12 Section 1 MR Site Vibration Test Guidelines in the design of the facility.

It remains the customer's responsibility to contract a vibration consultant or qualified engineer to implement design modifications to meet the specified vibration guidelines. With the vibration consultant present, local GE Field Service, the GE Installation Specialist or a customer representative must verify the source identification; elimination or reduction of all sources can be achieved (i.e.: power down the suspected component and verify elimination using the vibration test equipment.

16–1 Definition (Continued)

To minimize potential vibration image quality issues, the magnet should be placed on a solid floor, located as far as possible from the following vibration sources:

- parking lots
- roadways
- subways
- trains
- hallways
- hospital physical plants containing pumps, motors, air handling equipment, air conditioning units, water cooling towers,
- elevators
- heliports.

Note

Please note that other items not listed could also be potential sources of vibration.

Note

Vibration isolation is highly recommended at floor connection points of the air conditioning unit(s) that will be installed for the purpose of cooling the MR Suite.

Note

Isolation of the MR magnet is not a recommended solution for reducing environmental vibration. Refer to Structureborne Vibration Control section in Section 8–4 Design Guidelines for solution guidelines. The magnet must be bolted rigid to a structure or to VibroAcoustic Damping Option mats which set on the recessed floor area for non–seismic zones. For VibroAcoustic Damping Option mounting in seismic zones refer to seismic drawings available on request from your local GE Healthcare Installation Specialist.

Vibration measurements should be made at the proposed MR site and all alternate locations. Measurements should be made using a spectrum analyzer capable of performing the test guidelines detailed in Chapter 12 Section 1 MR Site Vibration Test Guidelines.

16–2 Types of Vibration Image Quality Issues

16–2–1 Background

Vibration capable of affecting MR image quality can be classified as either steady state or transient vibration. Steady state vibration typically refers to disturbances caused by rotating machinery. Examples of machinery known to have previously generated vibration image quality problems (in a very limited number of installations) are exhaust fans, air conditioning blower units, compressors, pumps (air and water), etc. Steady state vibration may appear as transient vibration when multiple sources add to and/or subtract from the real time vibration signal due to time variant phasing of the multiple vibration sources. Transient vibrations are typically a function of the building structure and/or building foundations. Transient vibration would typically be associated with vehicular traffic, pedestrian motion, patient transport, door slamming, etc. Transient vibration would occur randomly and last for short periods of time. The transient event would typically result from a high amplitude impact followed by a low frequency sinusoidal signal that would start at a site dependent vibration amplitude and decay to a lower level.

16–2–2 Magnet Siting Requirement

Improper mechanical coupling of the magnet to the floor can in some circumstances create unique vibration characteristics. Magnets improperly mechanically shimmed/coupled to the floor may experience vibration image quality issues. The magnet will ship with a shim kit to make sure each of the magnet feet make full contact to the floor and that each foot produces an equal bearing load to the floor. Refer to Chapter 8 Section 7 Anchor Hardware Requirements For MR Equipment Inside RF Shielded Room for magnet mounting requirements.

16–3 Vibrations Specifications

Note

Refer to Chapter 12 Section 1 MR Site Vibration Test Guidelines for definition of ambient baseline.

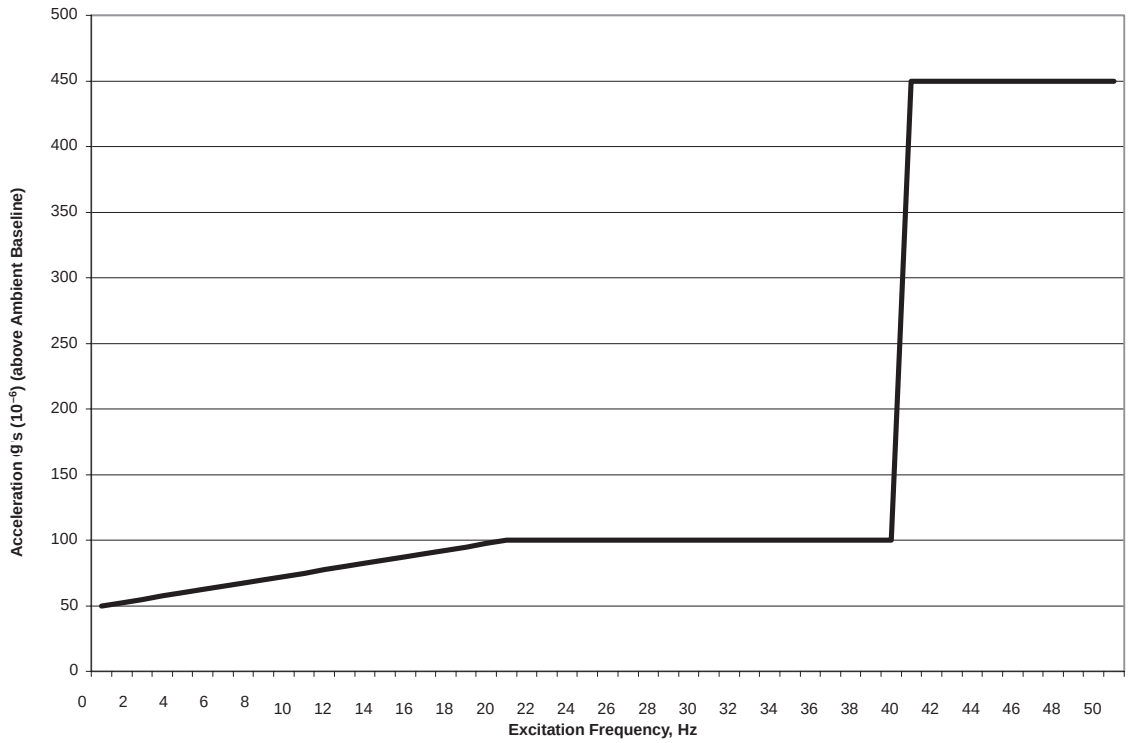
16–3–1 Steady State Vibration

The maximum steady state vibration transmitted through the floor should not exceed the following maximum single frequency components above ambient baseline listed in Table 5–14 and Illustration 5–16.

TABLE 5–14
1.5T LCC MAGNET STEADY STATE VIBRATION SPECIFICATION

Vibration Threshold	Frequency Range
5 x 10^{-5} g rms at 0 Hz ramping to 10 x 10^{-5} g rms at 20 Hz	
10 x 10^{-5} g rms	20–40 Hz
45 x 10^{-5} g rms	40–50 Hz

In order to ensure that any discrete signal represents a real mechanical vibration source, the signal must have a bandwidth that typifies dynamic system response.



LCC MAGNET STEADY STATE VIBRATION SPECIFICATIONS
ILLUSTRATION 5–16

Refer to Chapter 12 Section 1 MR Site Vibration Test Guidelines Illustration 12–2 for an example applying the steady state specifications with ambient baseline.

16–3–2 Transient Vibration

Note

Transient vibration analysis requires the elimination of all steady state vibration so as not to mask the transient signal.

Time history transient levels exceeding 500 micro–g, zero to peak must be fully analyzed to assess impact to the building structure. The building (spectral) response immediately following the 500 micro–g trigger level must not cause the site environment to exceed the Steady State Vibration levels defined in preceding subsection and Illustration 5–16. That is, the vibration consultant must measure and report the transient disturbance of concern. The consultant must determine (assess) the frequency, amplitude, and duration of the transient, then determine whether the disturbance will vibrate the building structure, MR RF Shielded Room, plus the magnet to amplitudes that would exceed the Steady State Vibration specifications, refer to preceding subsection and Illustration 5–16.

As an example; a consultant might find transient events with pulse width greater than 5 milliseconds with vibration response (decay) longer than 100 milliseconds which may suggest a need for further analysis. The vibration consultant should document in the report any transient event that may excite the building resonance (including the MR system installed weight).

Chapter 6 – Power Requirements

1 System Power Introduction

The MR system includes a Power Distribution module (PD1) in the lower portion of the ACGD/PDU Cabinet (MR3) which distributes power to most MR system components. Refer to Table 6–1 for required customer power specifics. Refer to Section 2 Critical Power Requirements for specifications of required facility input to the MR System.

THE FACILITY TRANSFORMER AND FEEDER WIRES NEED TO BE CORRECTLY SIZED FOR THE SIGNA SYSTEM POWER DEMANDS.

CUSTOMER SUPPLIED MAIN DISCONNECT PANEL DESIGN NEEDS TO HAVE CORRECTLY SIZED WIRES AND RATED COMPONENTS TO MEET THE MR SYSTEM POWER REQUIREMENTS.

IF AN UNINTERRUPTIBLE POWER SUPPLY (UPS) WILL BE PROVIDING POWER TO THE ENTIRE MR SYSTEM THEN THERE IS A NEED TO MAKE SURE THE UPS OPERATION PARAMETERS ARE COMPATIBLE WITH THE SIGNA SYSTEM WITH ACGD POWER AND REGULATION DEMANDS.

Customers should carefully consider the advantages and disadvantages of raised flooring, conduits, floor ducts, and surface raceways for running cables in accordance with local codes. If used, conduits should be large enough to pass any cable and its connector through with all other cables in the conduit.

To reduce voltage regulation problems and wiring costs, minimize the cable length between the primary power source and the Power Distribution Unit. When routing cables, keep all phase conductors and ground for a circuit in the same trough. Whenever possible, keep power cables away from signal and data cables. Use separate trough or dividers in duct.

1 System Power Introduction (Continued)

TABLE 6–1
REQUIRED CUSTOMER POWER

MR COMPONENT	VOLTAGE (VAC)	FREQUENCY	PHASE	MAX. AMPS	COMMENTS
GE Main Disconnect Panel (MDP) See Notes 1, 2, 4, & 5 See Note 6 if customer MDP	480Y/277 VAC ±10% or 400Y/230 VAC ±10%	60 Hz 50 Hz	(3+GND) See Comments	See Note 3	Recommended input configuration: 3 phase solidly Grounded WYE with Neutral and Ground (5 wire system). Note, The MR system does not require Neutral. The Neutral must be terminated prior to PDU or inside the Main Disconnect Panel and not brought to the ACGD/PDU Cabinet. Optional input configuration: 3 phase DELTA with Ground (4 wire) input, recommend corner Grounded Delta configuration.
Shield/Cryo Cooler Cabinet	460, 480 380, 400, 415	60 Hz 50 Hz	3+GND	9 KVA	Hard wired in unit and at facility power (no power connector). Shield/Cryo Cooler Compressor power and water cooling MUST be available 24 hours per day / 7 days per week to maximize proper uninterrupted magnet operation. Also see Note 2.
Magnet Rundown Unit	100–120 or 200–240	50/60 Hz	1	1.0	Hard wired in unit.
Magnet Monitor	100/120 or 200/220	50/60 Hz	1	0.75	Receptacle required, Magnet Monitor power is required to be ON 24 hours per day to minimize cryogen costs and for proper LCC Magnet performance. Also see Note 4.
Pneumatic Patient Alert Control Box	115 or 230	50/60 Hz	1	0.2	An outlet on the Operator Workspace Table equipment can be used.
Service Receptacle in Magnet Room	110–120 See Comments	50/60 Hz	1	2.0	Receptacle required for small power tools. Local voltage and portable transformers for voltages values.
InSite Modem	See Comments	See Comments	See Comments	See Comments	Insite Modem is provided by local GE Service to be compatible with local communication equipment. Power requirements to be determined locally.
* Remote Magnet Rundown Unit	100–120 or 200–240	50/60 Hz	1	1.0	Hard wired in unit.
*MR Common Chiller (MRCC)	460/480±10% 380/400±10%	60 Hz 50 Hz	3	6.2	15 amp minimum circuit required, customer supplied power wire, 6 AWG (16 mm^2) maximum wire size.
*O_2 Monitor	110–120 or 200–240	50/60 Hz	1	3.0	Hard wired in monitor

Note * Optional equipment.

1 Power phase conductors, neutral (if present), and ground conductor must be routed inside the same raceway, cable tray, trench cable or cord per National Electric Code (NEC) 2005 or 2002 Articles 250.134, 300.3, 517.13.

2 GE pre–engineered MDP (E4503AT) option controls power the MR system Power Distribution Unit and Shield/Cryo Cooler Compressor. GE MDP option does not support the MRCC option. Customer is responsible for the power requirements for MRCC (M3088TL).

3 Maximum amps dependent on voltage selected. Refer to Section 2 Critical Power Requirements for configuration.

4 Shield/Cryo Cooler Cabinet power and water cooling are required immediately upon magnet arrival. If permanent site power is not ready, temporary drop line must be made available. If site voltage is not any of the voltages listed above, customer must provide transformer and secondary circuit breaker to provide correct voltage and/or configuration.

5 The complete MR System Digital Energy SG Series UPS 100KVA (E4502FB) option requires 480 VAC, 3–phase, 4 wire + ground, 60 Hz input power.

6 If customer provided MDP has been selected then customer provided MDP MUST meet all MDP requirements, refer to Section 3–1 Main Disconnect Panel (MDP).

2 Critical Power Requirements

The facility shall provide a Main Disconnect Panel with Low Voltage Low Energy local and multi–point remote control capability in the feeder lines that supply input power to the Shield Cooler Cabinet and the Power Distribution Unit (PD1). Refer to Section 3 Power Distribution System for Main Disconnect Panel capability and set up.

Notice!

If customer provided MDP has been selected then Customer provided MDP MUST meet all MDP requirements, refer to Section 3–1 Main Disconnect Panel (MDP).

All work is to be done in accordance with national and local electrical codes.

THE FACILITY TRANSFORMER AND FEEDER WIRES NEED TO BE CORRECTLY SIZED FOR THE SIGNA SYSTEM.

IF AN UNINTERRUPTIBLE POWER SUPPLY (UPS) WILL BE PROVIDING POWER TO THE ENTIRE MR SYSTEM THEN THERE IS A NEED TO MAKE SURE THE UPS OPERATION PARAMETERS ARE COMPATIBLE WITH THE SIGNA SYSTEM POWER AND REGULATION DEMANDS.

All work is to be done in accordance with national and local electrical codes.

2 Critical Power Requirements (Continued)

Table 6–2
CRITICAL POWER REQUIREMENTS

Parameter	Requirement
Configuration	• Recommend input configuration 3 phase solidly Grounded WYE with Neutral and Ground (5 wire system). Note, Neutral must be terminated prior to or inside the Main Disconnect Panel and not brought to the ACGD/PDU Cabinet. • Optional input configuration 3 phase DELTA with Ground (4 wire) input, recommend corner Grounded Delta configuration.
Frequency	50 ± 3 Hz or 60 ± 3 Hz
Regulation	4% maximum at system maximum power demand (averaged over 5 seconds) from source to PDU (i.e. includes all feeders and transformer to utility)
Phase Balance	Difference between the highest phase line–to–line voltage and the lowest phase line–to–line voltage must not exceed 2%
Daily Voltage Variation	±10% from nominal under worst case line and load regulation
PDU Voltage	200/208/380/400/415/480 VAC ±10%
Shield/Cryo Cooler Compressor (MS5) Voltage	380/400/415 VAC 50 Hz or 460/480 VAC 60Hz
Magnet Monitor equipment Voltage	100/120 or 200/220 VAC
Voltage Transients	Phase–to–phase voltages must be within 2% of the lowest phase–to–phase voltage. Maximum allowable transient voltage above or below nominal waveshape not to exceed 200 V at a maximum duration of 1 cycle and frequency of 10 times per hour.
Facility Zero Voltage Reference Ground	• Main facility ground conductor to Main Disconnect Panel (MDP) shall be copper and the minimum as required by the local coding regulations, such as the National Electric Code (NEC) 2005 or 2002 Article 250.122. • Main facility ground wire to be insulated. • Ground impedance to earth at power source to be 2 ohms or less. • Main facility ground wire to be bonded at every distribution box in an approved grounding block.
Maximum Momentary Demand	The power demands are specified as a function of the duration of the power demand. Table 6–3 lists points on the curve. The power system feeding the Signa system must be designed to meet the specifications of less than 4% regulation when loaded at the 5.0 second allowable consumption. For short intervals the power demands can exceed the 5.0 second value and the line voltage delivered to the system will sag below the 4% regulation. The Signa system is designed to tolerate these short voltage sags.
Average (while scanning) Power Demand	57.1 KVA consisting of 48.1 KVA for PDU and 9KVA (continuous operation) for Shield/Cryo Cooler Cabinet.
Standby (no scan) Power Demand	13.4 KVA at 0.9 lagging Power Factor including 4.4 KVA for PDU and 9KVA (continuous operation) for Shield/Cryo Cooler Cabinet

2 Critical Power Requirements (Continued)

TABLE 6–3
SYSTEM WITH ACGD POWER DEMANDS DETAILS

System Equipment (See Note 1)	Power Demand
PDU draw for 5.0 seconds	~61.2 KVA
PDU draw for 1.0 seconds or less See Note 2	~65 KVA
Shield/Cryo Cooler Compressor	9 KVA
TOTAL for 5.0 seconds	~70.2 KVA
TOTAL for 1.0 seconds or less	~74 KVA

Note 1 MRCC option for Shield/Cryo Cooler Compressor water cooling or Customer provided water cooling equipment power demands are not included in the values in this table. The GE pre–engineered MDP option (E4503AT) option does not support the MRCC. Customer is responsible for the power requirements of water cooling equipment power demands.

2 The PDU draw on the line will not exceed list values. The ACGD Power Supply may provide up to 170 KVA for 0.003 seconds from supply internal capacitance but the supply will recharge capacitors at a power level less than 45 KVA.

3 Power Distribution System

3–1 Main Disconnect Panel (MDP)

Notice!

If customer provided MDP has been selected then Customer provided MDP MUST meet all MDP requirements.

WARNING!

THE CUSTOMER SUPPLIED MAIN DISCONNECT PANEL DESIGN NEEDS TO HAVE CORRECTLY SIZED WIRES AND RATED COMPONENTS TO MEET THE MR SYSTEM POWER REQUIREMENTS.

IF AN UNINTERRUPTIBLE POWER SUPPLY (UPS) WILL BE PROVIDING POWER TO THE ENTIRE MR SYSTEM THEN THERE IS A NEED TO MAKE SURE THE UPS OPERATION PARAMETERS ARE COMPATIBLE WITH THE SIGNA SYSTEM WITH ACGD POWER AND REGULATION DEMANDS.

Required Main Disconnect Panel shall consist of two three–pole, 600 VAC circuit breakers trip rated for the appropriate current. The short–circuit current interrupting rating of the breaker must be sized to accommodate fault current available.

Note

The MDP circuit breaker for lines providing power to Shield/Cryo Cooler Compressor and PDU must be capable of handling the magnetizing inrush current of the Shield/Cryo Cooler Compressor and transformer of the PDU module (PD1) in the ACGD/PDU Cabinet (MR3).

Note

The MDP circuit for the PDU shall have an undervoltage device that automatically trips the breaker when the applied coil voltage drops to a specific percent of the rated value.

Note

The MDP circuit for the Shield Cooler Compressor Cabinet shall provide auto restart upon return of normal power to maximize proper uninterrupted magnet operation and to minimize cryogen consumption of the system.

WARNING!

THE MDP CIRCUIT FOR THE SHIELD COOLER COMPRESSOR CABINET AUTO RESTART FUNCTION MUST BE CONTROLLED BY THE EMERGENCY OFF FUNCTION.

Main Disconnect Panel is to be located so the panel is visible to Power Distribution Unit (PD1) service personnel. Panel position above the floor must be per National Electric Code (NEC) 2005 or 2002 Article 404.8 or other national or local code.

A recommended method for providing a Main Disconnect Panel with multi–point remote control capability is shown in Illustration 6–1.

3–1 Main Disconnect Panel (MDP) (Continued)

Time delay fuses are recommended on the lines providing power to the protective disconnect device and must be rated according to the cable size. The circuit breaker ahead of the fuses must be capable of handling the magnetizing inrush current values of the Shield Cryo Cooler Compressor and transformer of the PDU module (PD1) in the ACGD/PDU Cabinet (MR3).

Check local and national codes to determine if an interlock to the air–conditioning unit in the Computer/Equipment Room is required in the protective disconnect set–up.

Customer supplied emergency off buttons are to be mounted in the Magnet Room near each exit at a height specified by local/national codes and connected to the protective disconnect device in order to disable the power to all MR system equipment in emergency situations. This button is to be clearly labeled “Emergency Off” and visible to personnel in the Magnet Room. It is important that the button be labeled “off” and not “stop” since there exists an “Emergency Stop” button in the Signa system which disables output power of MR system equipment to the patient area of the MR system. A second emergency off button should be mounted in the computer/equipment room near the exit door.

Customer supplied Main Disconnect Panel (MDP) must be lockable to meet OSHA requirements for power Lockout/Tagout requirements. An optional GE pre–engineered MDP is available from GE providing for the disconnect of the facility power to the PDU, including the emergency off buttons, contacts for an interlock to the air–conditioning units in the computer/equipment room, and the Shield Cooler Compressor Cabinet power circuit with auto restart and emergency off functions.

The Main Disconnect Panel must be listed and labeled by a Nationally Recognized Testing Lab (NRTL) such as Underwriters Laboratory (UL) in accordance with National Electric Code (NEC) 2005 or 2002 Article 110.2.

Note

The maximum conductor the optional GE pre–engineered MDP can accept is #3/0 AWG (95 mm^2). For feeders larger than 3/0 AWG (83 mm^2) the wires must be reduced (ie. splice, junction box, etc.) to 3/0 AWG (83 mm^2) within 10 feet (3 meters) of MDP. It is important to note the maximum cable wire from the MDP to the PDU must not be larger than 3/0 AWG (83 mm^2).

3–1 Main Disconnect Panel (MDP) (Continued)

NOTE:●RUNS 296 AND 297 ARE GE SUPPLIED CABLES. ALL OTHER WIRING IS CUSTOMER SUPPLIED. ALL EMERGENCY "OFF" BUTTONS ARE CUSTOMER SUPPLIED. **ALL OTHER WIRING IS CUSTOMER SUPPLIED.**

●CIRCUIT BREAKER IS REQUIRED FOR SHIELD COOLER COMPRESSOR CABINET.

●TWO REMOTE EMERGENCY "OFF" BUTTONS ARE SUPPLIED WITH GE MDP OPTION, **EMERGENCY OFF BUTTONS ARE CUSTOMER SUPPLIED IF GE MDP OPTION NOT USED** .

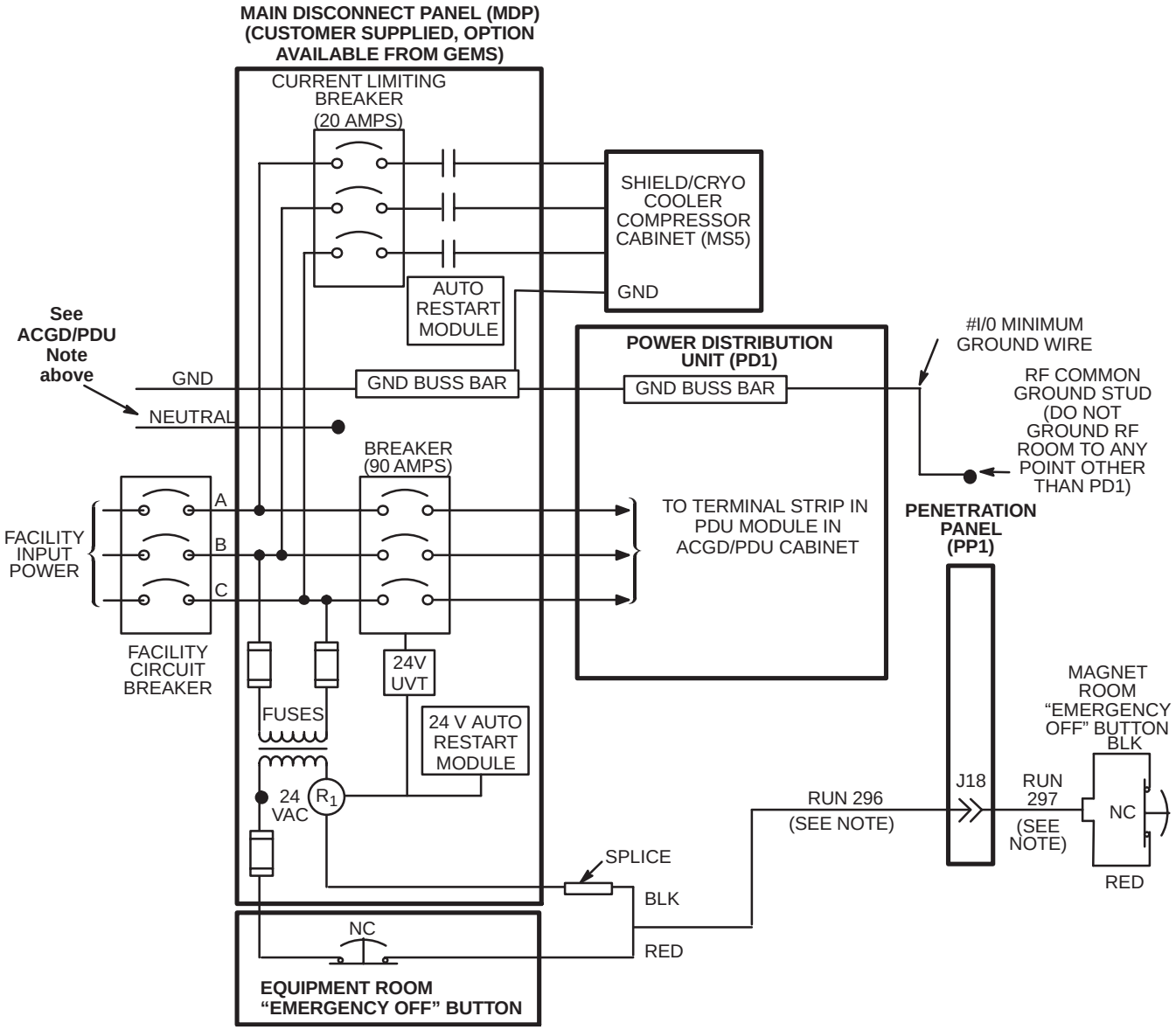
●UNDERVOLTAGE DEVICE AUTOMATICALLY TRIPS PDU BREAKER WHEN COIL VOLTAGE DROPS TO A SPECIFIC PERCENT OF RATED VALUE, UNDERVOLTAGE TRIP (UVT).

●AUTO RESTART CIRCUIT MUST START SHIELD COOLER COMPRESSOR AFTER ANY POWER OUTAGE.

●EMERGENCY OFF CIRCUIT TRIPS PDU BREAKER & LOCKS OUT SHIELD COOLER.

●PANEL MUST BE LISTED AND LABELED BY A NATIONALLY RECOGNIZED TESTING LAB (NRTL) SUCH AS UNDERWRITERS LABORATORY (UL) IN ACCORDANCE WITH NATIONAL ELECTRIC CODE (NEC) 2005 OR 2002 ARTICLE 110.2.

●IF 3 PHASE WYE WITH NEUTRAL AND GROUND (5 WIRE SYSTEM) INPUT USED THEN NEUTRAL MUST BE TERMINATED INSIDE THE MAIN DISCONNECT CONTROL AND NOT BROUGHT TO THE ACGD/PDU CABINET



PROTECTIVE DISCONNECT SET–UP
ILLUSTRATION 6–1

3–2 System Power Distribution Unit

The PDU Module in the lower portion of ACGD/PDU Cabinet has an integrated filter for a level of power conditioning. The largest allowable phase conductor the PDU will accept is 3/0 AWG (83 mm^2). Larger feeder wires can be connected to the MDP with 3/0 AWG (83 mm^2) between the MDP and PDU.

Note

The ground conductor between the MDP and PDU shall be minimum size of 1/0 AWG copper or the same size as the feeder wire, which ever is larger. Lug connector for the ground wire is to be provided by the contractor, recommended Amp Inc. number 36919 lug.

Note

The resistance between any two grounded devices in the MR system must not exceed 0.1 ohm (ie. PDU and MDP).

Note

Neutral, if present, must be terminated prior to or inside the Main Disconnect Panel and not brought to the PDU Module in the lower portion of ACGD/PDU Cabinet (MR3).

Note

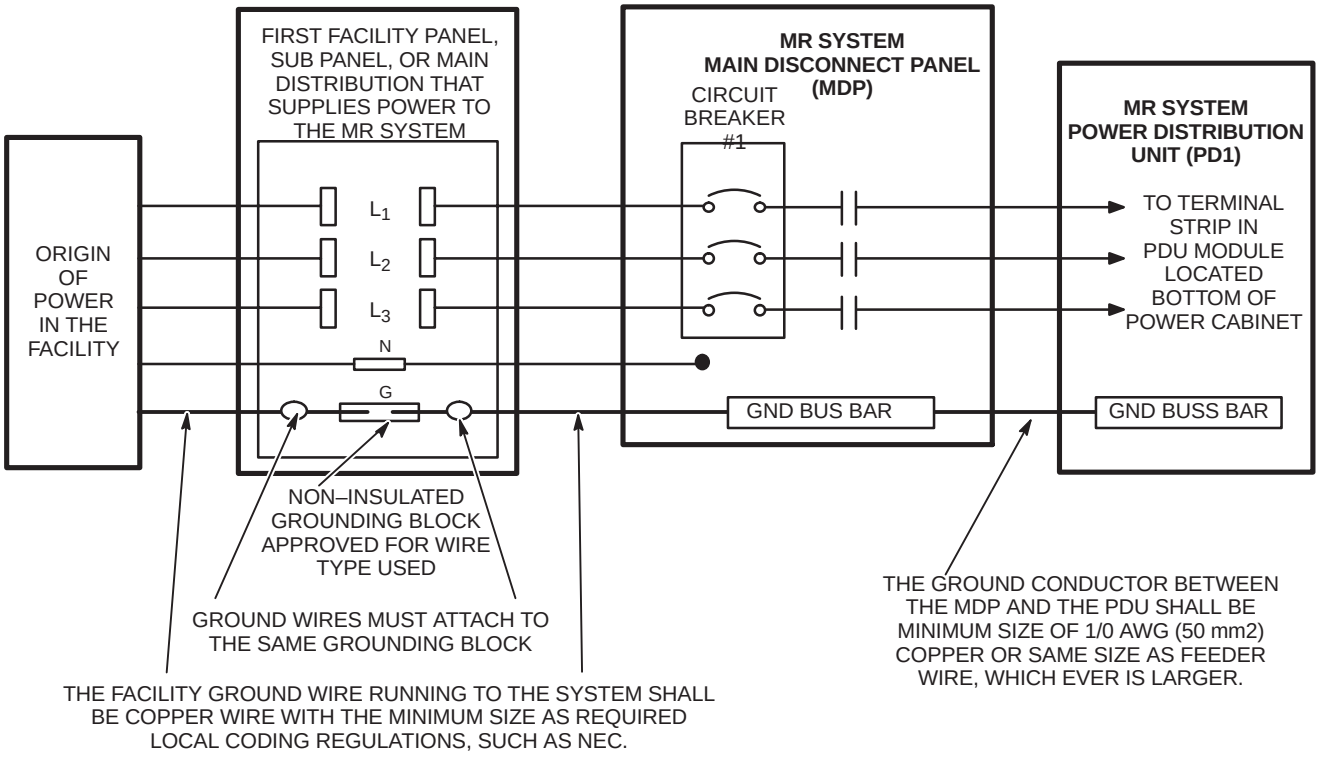
When the full MR system UPS option [Digital Energy SG Series 3 phase UPS 100KVA (E4502FB)] is installed the feeder wiring from the UPS to the PDU Module must be sized to maintain voltage regulation of <5% at 100KVA.

4 Grounding

4–1 Facility Ground

The ground for the MR system shall originate at the system power source, ie. transformer or first access point of power into a facility, and be continuous to the MR system power disconnect in the room. This ground can be spliced with "High Compression Fittings" and should be terminated at each distribution panel it passes through. When it is broken for a connection to a panel, it shall be connected into an approved non–insulated grounding block with the incoming and outgoing ground in this same grounding block, which is then connected to the steel panel, never using the steel or other material of the panel as the block. See Illustration 6–2.

The connection at the power source shall be at the grounding point of the "Neutral – Ground" if a "Wye" transformer is used, or typical grounding points of separately derived system. In the case of an external facility, it shall be bonded to the facility ground point at the service entrance.



GROUND CONNECTION AT DISTRIBUTION PANEL
ILLUSTRATION 6–2

Ground Wire

The main facility ground conductor to the MDP shall be copper wire and the minimum size as required by the local coding regulations, such as the NEC 2005 or 2002 Article 250.122. A dedicated copper ground wire the same size as the feed wires or 1/0 AWG (which ever is larger) must be run from the MR system MDP to the PDU. See Illustration 6–2. The ground wire impedance from the MR system disconnect, including the ground rod, shall not have an impedance greater than 2 ohms to earth as measured by one of the applicable techniques described in Section 4 of ANSI/IEEE Standard 142 – 1982 which can be accomplished using 3–point Fall Of Potential (3 point measurement) method or Clamp–On Ground Resistance measurement which requires a ground measurement device such as AEMC 3730.

4–2 System Ground

The MR system is designed with minimum ground loops to prevent noise currents and natural disturbances from flowing through the low–level signal reference path.

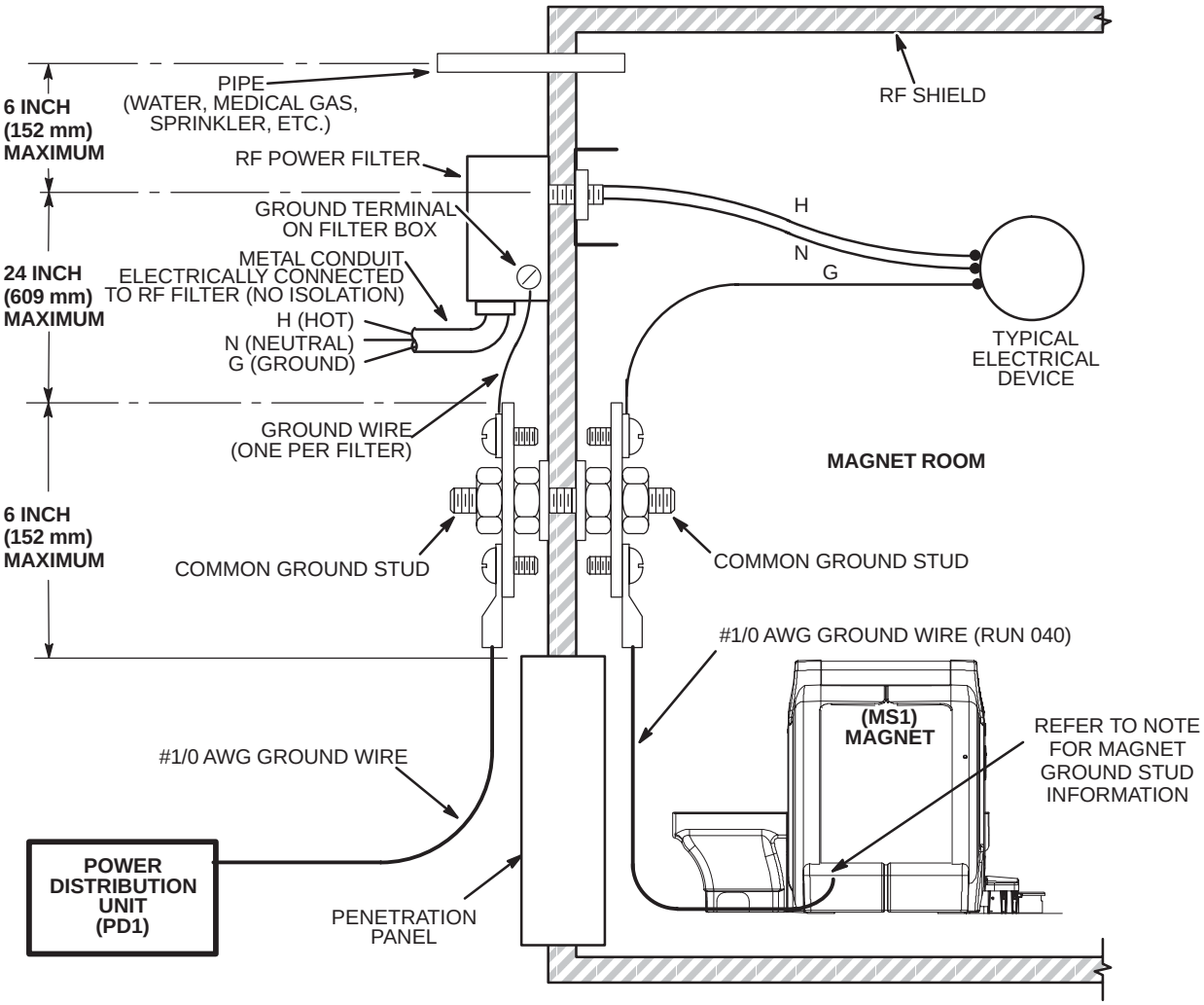
The three major grounding points in the MR system are: the system ground point (bus) in the System PDU (PD1), the enclosure ground points (ground studs located in each cabinet or enclosure), and the RF shielded room common ground point. **This RF shielded room common ground point is to be located within 6 in. (152 mm) of the GE supplied Penetration Panel.** Refer to Chapter 8 Section 4–1 Electrical Lines and Filters for a further description of the RF shielded room common ground point.

To ensure patient safety and system performance, the conditions defined in Illustration 6–3 must be met when running power lines into the Magnet Room.

Any modifications or non–MR equipment grounds added to the MR ground system must be approved by your GE Service Representative in order to ensure safety and performance.

4–2 System Ground (Continued)

NOTE:
- ALL ITEMS SHOWN ARE CUSTOMER SUPPLIED EXCEPT POWER DISTRIBUTION UNIT, MAGNET, AND ONE #1/0 AWG GROUND WIRE BETWEEN MAGNET GROUND STUD AND RF COMMON GROUND POINT.
- **RESISTANCE BETWEEN ANY TWO GROUNDED DEVICES *MUST NOT EXCEED 0.1 OHM* TO ENSURE EQUAL POTENTIAL GROUND SYSTEM WITHIN MAGNET ROOM.**
- **LOCATE FILTERS WITHIN 2 FEET (600 mm) OF RF COMMON GROUND STUD WHICH MUST BE LOCATED WITHIN 6 INCHES (152 mm) OF PENETRATION PANEL.**
- ALL EXTERNAL CONDUIT MUST BE **METAL AND ELECTRICALLY CONNECTED** TO THE RF POWER FILTERS (REGARDLESS OF FILTER VOLTAGE) PER NEC 2005 OR 2002 ARTICLE 250.110.
- RF POWER FILTERS OF 30 VOLTS OR LESS MAY BE LOCATED ANYWHERE ON THE RF SHIELD **PROVIDED THE INCOMING CONDUIT IS METALLIC** PER NEC 2005 OR 2002 ARTICLE 725.21**, THESE FILTERS MUST ALSO BE LOCATED WITHIN 24 INCHES (609 mm) OF THE RF COMMON GROUND STUD.**
- ALL CONDUITS IN THE RF ROOM MUST BE **METAL**. STEEL IS ACCEPTABLE PROVIDED IT IS ADEQUATELY ANCHORED.
- ALL ELECTRICAL DEVICES (IE. OUTLETS, LIGHT FIXTURES, ETC.) MUST HAVE A GROUND WIRE FROM ITS POWER SOURCE AND BE GROUNDED TO RF ROOM SHIELD AT THE RF COMMON GROUND STUD AS SHOWN BELOW.
- ALL METALLIC PIPES ENTERING THE RF ROOM, EXCLUDING CRYOGENIC VENT AND FLOOR DRAINS, MUST BE LOCATED WITHIN 30 INCHES (762 MM) OF THE RF COMMON GROUND.
- LCC MAGNET HAS 2 GROUND STUDS, ONE ON FRONT FOOT AND ONE ON REAR FOOT (COLDHEAD SIDE OF MAGNET). HOWEVER, THERE IS ONLY ONE #1/0 AWG GROUND WIRE TO BE CONNECTED TO ONLY ONE OF THE GROUND STUDS.



MR MAGNET ROOM GROUNDING REQUIREMENTS AND TYPICAL DIAGRAM
ILLUSTRATION 6–3

5 Ground Fault Protection

MR suites and radiology departments are considered health care facilities pursuant to National Electric Code (NEC) 2005 or 2002 Article 517.2 definitions and as such must be powered from sources that comply with the ground fault requirements of NEC 2002 Article 517.17. NEC 2005 Article 517.17(B) or NEC 2002 Article 517.17(A) states “Where ground fault is required for the operation of the service disconnecting means or feeder disconnecting means as specified in NEC 230.95 or 215.10, an additional step of ground fault protection shall be provided in the next level of feeder disconnecting means downstream towards the load.”

NEC 2005 or 2002 Article 230.95 or 215.10 requires ground fault protection on service disconnecting means rated 1000 Amps or more on solidly grounded WYE services over 150 volts to ground but not over 600 volts phase to phase.

The two or more levels of ground fault shall be coordinated to provide selectivity between each level of ground fault such that a ground fault on the load side of the feeder would cause the feeder and not the service disconnect to open on a ground fault. Six cycles of separation between the different levels of ground fault tripping is required for the system to be considered selective in accordance with NEC 2005 Article 517.17(C) or NEC 2002 Article 517.17(B).

Check national and local electrical codes.

6 Power Source Monitoring

The facility input power for the proposed system should be checked using a power line disturbance monitor for average line voltage, surges–sags, impulses, and frequency. Some of the recommended line analyzers which are designed for unattended monitoring are the Dranetz Models 656A or 658 and RPM Models 1651, 1656, or 1658.

Analysis should span a period to include two weekends so as to cover several days of normal use. The possibility of “brown–out” conditions which may be experienced in summer must be considered. Any existing power problems with large power consuming systems (x–ray units, CT scanners, etc.) or other computer installations at the proposed site should be reviewed as they may affect the MR system. Results of this analysis should be reviewed with your GE representative to determine if line conditioning is needed.

7 Emergency Power

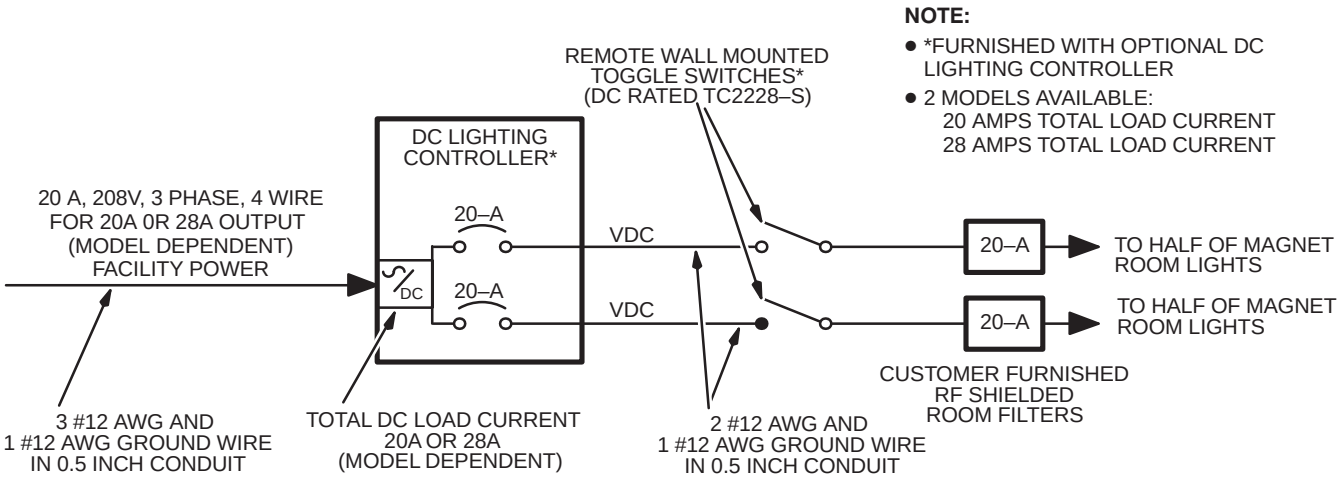
Primary power should be distributed from the customer’s emergency life–safety power branch to an emergency lighting source in the Magnet Room. All input power lines must be filtered upon entrance into the RF shielded room (Magnet Room) and grounded according to the requirements listed in Section 4–2 System Ground. Always check national and local codes for other emergency power requirements.

8 DC Lighting Controller (Facility Option)

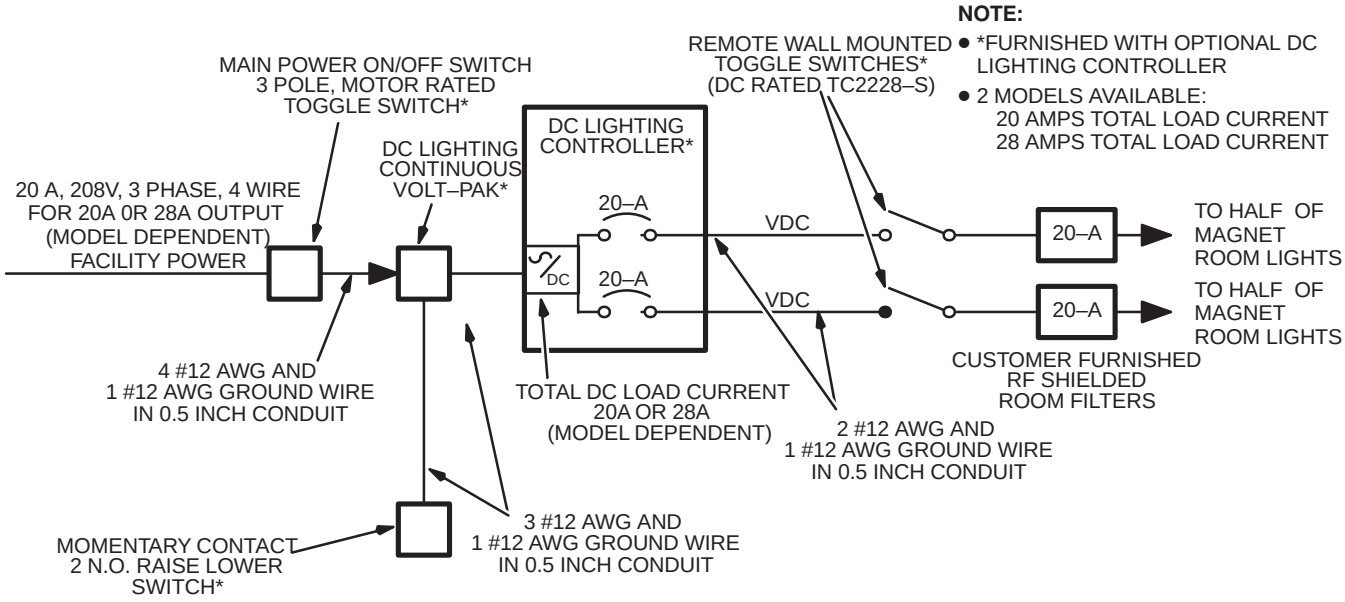
Direct current (DC) powered lighting is recommended in the Magnet Room per Chapter 5 Section 7 Lighting. A constant lighting level DC light controller is available from GE as well as a variable DC lighting controller system. The wiring diagrams for these units are shown in Illustrations 6–4 and 6–5. The input power, interconnect cabling, RF shielded room filters, lighting fixtures, and conduit are customer furnished.

The DC lighting systems output is rated nominally 115 VDC. Determining whether the 20 or 28 Amp system is required can be calculated by: $I = TotalLampWattage \div 115V$. If I is equal to or less than 20 then a 20 Amp system can be used. If I is greater than 20 but equal to or less than 28 then use the 28 Amp rated system.

8 DC Lighting Controller (Facility Option) (Continued)



DC LIGHTING CONTROLLER (Facility Option) WIRING DIAGRAM
ILLUSTRATION 6–4



VARIABLE DC LIGHTING CONTROLLER (Facility Option) WIRING DIAGRAM
ILLUSTRATION 6–5

Chapter 7 – Interconnect Data

1 Introduction

Installation must be in accordance with local and national code.

This chapter addresses cable interconnections and customer supplied components for the system. It's subsections are broken down as follows:

- 1 Introduction
  - overall system interconnects, component designations
- 2 Power Interconnects
  - cable connections to the Power Distribution Unit, subsystem power distribution
- 3 Emergency Off Wiring
  - wiring to main disconnect for emergency off
- 4 System Interconnects
  - Cable Group Lengths Provided
  - Location 1 – Interconnects Within Magnet Room details
  - Location 2 – Interconnects Between PP1 & Components In Equipment Room details
  - Location 1 / Location 2 – Interconnects Shared Between Magnet Room & Equipment Room Through PP1 details
  - Location 3 – Interconnects Between Components Within Equipment Room details
  - Location 4 – Interconnects Between OW & PP1 details
  - Location 5 – Interconnects Between OW & Components In Equipment Room details
  - Customer Supplied Interconnects
  - Cable Group & Location Cross Reference
- 5 Contractor Furnished Components
  - miscellaneous components typically provided by a contractor
- 6 Spectroscopy Interconnects
  - cable connections for the 1.5T spectroscopy option
- 7 Oxygen Monitor Option Interconnects
  - cable connections for the optional Oxygen Monitor
- 8 MRCC Additional Interconnects
  - additional system cable interconnects for each of the MRCC configurations
- 9 BrainWaveHW Lite Option Interconnects
  - cable connections for the BrainWaveHW Lite option

1–1 Component Designators

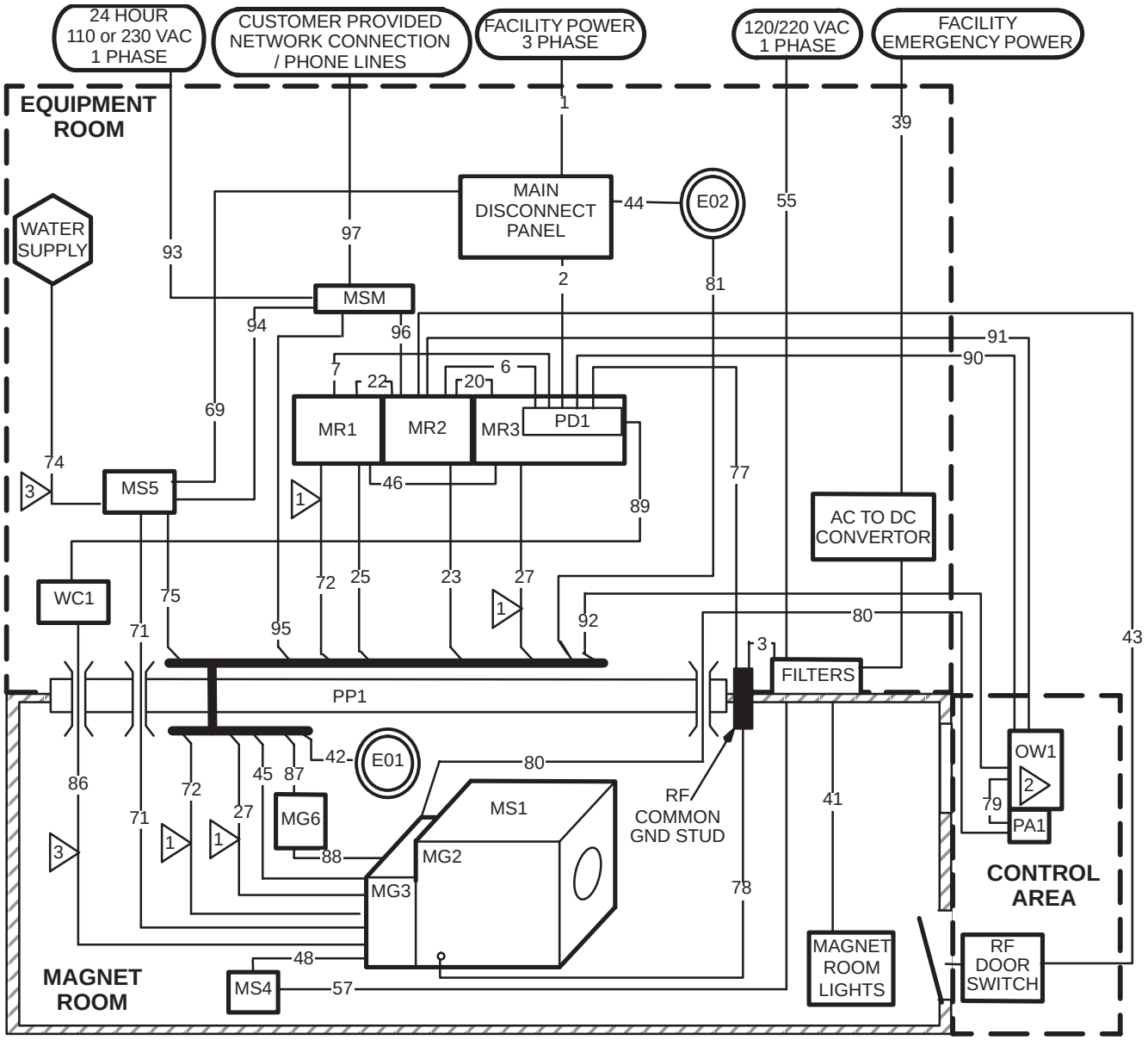
GE uses a Component Designator System as a means of identifying system components in a consistent manner. All subsystem cabinets and other components are referred to by their component designators in the diagrams and tables of this section. For example, the System Cabinet is referred to as MR2. Refer to Table 7–1 for all component designators.

TABLE 7–1
COMPONENT DESIGNATION

BASIC SYSTEM OR OPTION	COMPONENT DESIGNATOR	DESCRIPTION
Basic System	EO1/EO2	Emergency Off Buttons
	MDP	Main Disconnect Panel
	MG2	Magnet Enclosure
	MG3	Magnet Rear Pedestal
	MG6	Blower Box
	MR1	1.5T SRFD II Cabinet
	MR2	System Control Cabinet
	MR3	ACGD/PDU Cabinet has PD1 in lower portion cabinet
	MS1	Superconducting Magnet
	MS4	Magnet Rundown Unit (MRU)
	MS5	Shield/Cryo Cooler Compressor Cabinet
	MSM	Magnet Monitor
	OW1	Operator Workspace
	PD1	Power Distribution Unit (PDU) is a module in lower portion of ACGD/PDU Cabinet
	PA1	Pneumatic Patient Alert Control Box
	PP1	Penetration Panel
	PT1	Patient Transport Table
	WC1	Water Chiller for Gradient Coil
System Options	BW	BrainWaveHW Lite Cabinet
	MS10	Remote MRU
	MNS	MNS Cabinet
	MRCC	MR Common Chiller
	OM1	Oxygen Monitor
	OM3	Remote Oxygen Sensor Module

1–2 Group Interconnects

Illustration 7–1 shows the Group Interconnect Diagram for Signa EXCITE II MR/i1.5T systems. Each group contains one or more cables. This diagram should be referred to when using the tables in this section.



1 MUST BE CUT AND CONNECTED TO PP1 AT SITE.
NOTE: IMPEDANCE IS NOT CRITICAL SO EXCESS CABLE SHOULD BE CUT OFF.

2 OPERATOR WORKSPACE (OW1) SUBSYSTEM EQUIPMENT IS PROVIDED WITH MAXIMUM LENGTH CABLES POSSIBLE. SEVERAL OW ASSEMBLIES ARE MOUNTED TO OW TABLE & OW INTERCONNECTS ARE ROUTED THROUGH TABLE CABLE TRAY. FOR REFERENCE USE ONLY THE OW1 RUN NUMBERS FOR LINUX PC ARE 1059, 1060, 1061, 1062, 1063, 1064, 1065, 1066, 1067, 1068, 1069, 1070, 1071, 1074, 1075.

3 THIS GROUP CONTAINS WATER LINES WHICH SHALL BE ROUTED SEPARATE FROM ELECTRICAL LINES (I.E. POWER & SIGNAL).

SIGNA EXCITE II MR/*i* 1.5T SYSTEM GROUP INTERCONNECT DIAGRAM
ILLUSTRATION 7–1

1–3 Definition of Terms

The definition of terms used in the interconnects details tables throughout this section are:

- Location of interconnects is defined as the following:

  L1 Between Penetration Panel (PP1) and components in Magnet Room and Within Magnet Room between components

  L2 Between Penetration Panel (PP1) and components in Equipment Room

  L1/L2 Between Magnet Room and Equipment Room components, includes interconnects routed through PP1 waveguides and interconnects which length provided is cut at site and shared between Magnet and Equipment Rooms

  L3 Between components within Equipment Room

  L4 Between Operator Workspace (OW) and PP1

  L5 Between OW and components in Equipment Room

  For Signa 1.5T MR/i With EXCITE II fixed site Table 7–2 lists the relative length for each location.

TABLE 7–2
SIGNA 1.5T EXCITE II MR/*i* INTERCONNECTS LOCATION & RELATIVE LENGTH PROVIDED

INTERCONNECTS		RELATIVE LENGTH PROVIDED BY EACH CATALOG See Note 1		
LOCATION	**DESCRIPTION**	**M3143PD**	**M3144PD**	**M3145PD**
L1	Interconnects between Penetration Panel (PP1) and components in Magnet Room and Within Magnet Room between components	short	short	long
L2	Interconnects between Penetration Panel (PP1) and components in Equipment Room	short	long	short
L1/L2	Interconnects between Magnet Room and Equipment Room components, includes interconnects routed through PP1 waveguides and interconnects which length provided is cut at site and shared between Magnet and Equipment Rooms	short	long	medium
L3	Interconnects between components within Equipment Room	same length for all catalogs		
L4	Interconnects between Operator Workspace (OW) and Penetration Panel	same length for all catalogs		
L5	Interconnects between Operator Workspace (OW) and components in Equipment Room	same length for all catalogs		
Note 1 Refer to Section 4–2 Cable Groups Length Provided for cable groups specific length provided by each catalog.				

- Usable Length: amount of cable/wire/hose/etc. available for site routing point to point of the FROM and TO equipment. The interconnect cable/wire/hose total length MINUS any required takeup at or within both the FROM and TO equipment determines the usable length.

1–3 Definition of Terms (Continued)

- Group Number: identifying number referenced to bundles (i.e. groups) of cables as shown in Illustrations 6–1
- Area: cross–sectional area of the combined cables in a group

Note

The group area was found by adding up the circular cross–sectional areas of all individual cables within a group. It does not take any fill factors or space between cables into account. Adhere to applicable electrical codes for fill factors.

- Between Units (From/To): component designators as found in interconnects list tables throughout this section
- Run Number: unique number assigned to each GE–supplied cable

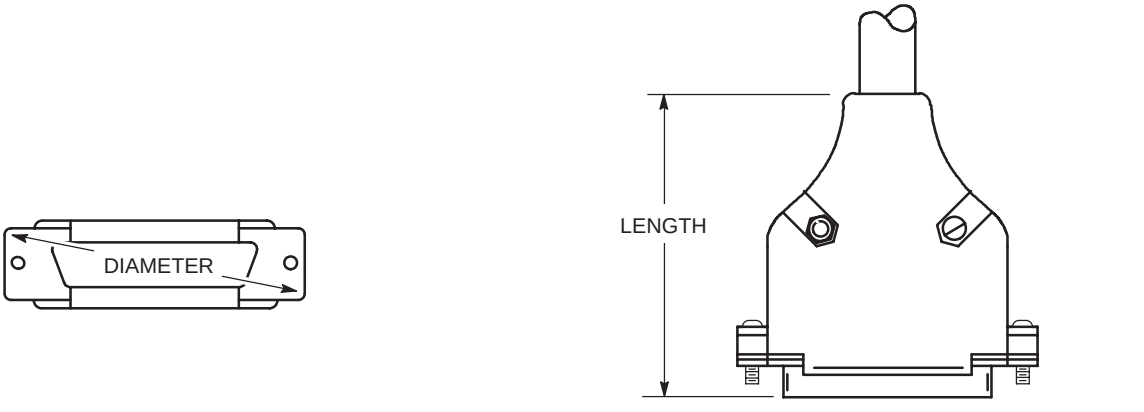
Note

The run number must be used when making special cable orders.

- Cable Diameter: diameter of an individual cable
- Plug Pulling Diameter x Length: cable plug dimensions as shown in Illustration 6–6

Note

In some cases, a cable has more than one connector on an end. These cables will have the number of connectors following the english dimensions of the plug pulling diameter times length (e.g. '2.0x3.25 –x2' means there are 2 connectors with dimensions of 2.0 in. diameter and 3.25 in. length). Of course, the same number of connectors apply to the metric dimensions as well.



SUBMINIATURE–D CONNECTOR PLUG PULLING DIMENSIONS
ILLUSTRATION 6–6

2 Power Interconnects

The interconnects for the MDP include:

- Facility Main power; refer to Chapter 6 – Power Requirements for detailed information on main power connections.
- Main power between the system Main Disconnect Panel (MDP) and Power Distribution Unit (PD1).

Note

The PDU is a module (PD1) in the lower portion of the ACGD/PDU Cabinet (MR3).

- Emergency off wiring; refer to Section 3 Emergency Off Wiring for information on the emergency off circuit interfacing.
- Shield/Cryo Cooler Compressor Cabinet (MS5)

The interconnects for the PD1 include:

- Power cables GE–supplied subsystems for Operator Workspace, System Cabinet, Water Chiller for Gradient Coil.
- 3 auxiliary ground cables to the PD1.
- 2 control cables to the PD1

Conduit or pipe is not recommended for cable runs since the system uses many prefabricated cables with large connectors. Power cables may be pulled by the lug terminal ends so the connector pulling dimensions on the plug ends will not be a factor for power cables.

Note

The power cables will probably need to be terminated at PD1 located in the lower portion of the ACGD/PDU Cabinet if conduit is used.

Unless otherwise specified, cables and components listed in the following sub–sections are supplied by GE.

3 Emergency Off Wiring

3–1 Introduction

This section addresses wiring for the Emergency Off circuit (also known as protective disconnect circuit). Refer to Chapter 6 Section 3 Power Distribution System for information on the recommended protective disconnect device and emergency off button locations and mounting.

The emergency off wiring for the MR system is unique because the wiring into the magnet room must be RF tight.

3–2 Protective Disconnect Device Connections

A typical emergency off circuit is shown in Chapter 6 Section 3 Power Distribution System Illustration 6–1**.** GE recommends the normally closed series loop shown. The GE available option MDP provides 2 emergency off buttons.

Note

The actual number of emergency off switches may vary from what is shown in Illustration 6–1.

3–3 Magnet Room Wiring

GE provides two cables for routing the emergency off circuit through the Penetration Panel and into the magnet room (Runs 296 and 297). Alternate wiring may be used by the customer; however, the use of these cables ensures that the emergency off wiring will be RF tight.

In Illustration 6–1 black and red wires are used for connections on the ends of Runs 295 and 297. Actually any pair of wires on these runs could be used so long as both ends are consistent with one another. (Runs 296 and 297 are actually nine wire cables.)

4 System Interconnects

4–1 System Interconnects General Information

The MR system uses many prefabricated interconnects with large connectors which greatly simplifies system installation. Due to variability of site physical layouts the GE provided interconnects length may result in excess length which must be properly managed in the site to minimize adverse impacts on system performance. There are several catalogs available to allow for the maximum variability of physical site layouts which the provided interconnects can accommodate while minimizing the excess interconnects length.

The following sections contain details of cable group lengths provided by specific system configuration catalogs.

4–2 Cable Groups Length Provided

Table 7–3 lists the specific usable length provided for each interconnect Group to determine the 1.5T Signa EXCITE II MR/i cable catalog which will best meet the specific site layout needs.

TABLE 7–3
1.5T SIGNA EXCITE II MR/i CABLE GROUPS LENGTH PROVIDED BY FIXED SITE CABLE COLLECTOR CATALOGS

LOCATION	GROUP	BETWEEN UNITS		USABLE LENGTH		
		FROM	TO	M3143PD FT (M)	M3144PD FT (M)	M3145PD FT (M)
L1	42	PP1	EO1	68 (20.73) Usable length allows EO1 takeup of 15 ft (4.57 m) Refer to Section 3 Emergency Off Wiring for additional information.		
	45	PP1	MG2/3	19 (5.79)	19 (5.79)	40 (12.2)
				See Note 1 & 2		
	48	MS4	MS1	81 (24.7) **See Note 2**		
	78	RF Common Ground Stud	MS1	19 (5.79)	19 (5.79)	40 (12.2)
				minus takeup at RF Common Ground Stud		
	87	PP1	MG6	16 (4.88)	16 (4.88)	37 (11.3)
	88	MG6	MG3	16 (4.88) allows 2 ft (0.61 m) takeup at MG6 **See Note 3**		
L2	23	MR2	PP1	25 (7.62)	55 (16.8)	25 (7.62)
	25	MR1	PP1	21 (6.40)	55 (16.8)	21 (6.40)
	75	MS5	PP1	42 (12.80) **See Note 2**		
	81	EO2	PP1	30 (9.14)	50 (15.24)	30 (9.14)
	95	MSM	PP1	67 (20.42) usable length allows 8 ft (2.44 m) takeup at MSM1 **See Note 1**		

Note 1 1.5T LCC Magnet Catalog (M1060LA) provides Magnet Monitor interconnects included in this Group.

2 Shield/Cryo Cooler Compressor Catalog (M1060JW) provides Compressor to Magnet interconnects included in this Group.

3 Site Collector Catalog (M3043PD) provides Group 88 interconnect.

Continued)

4–2 Cable Groups Length Provided (Continued)

TABLE 7–3 (Continued)
1.5T SIGNA EXCITE II MR/i CABLE GROUPS LENGTH PROVIDED BY FIXED SITE CABLE COLLECTOR CATALOGS

LOCATION	GROUP	BETWEEN UNITS		USABLE LENGTH		
		FROM	TO	M3143PD FT (M)	M3144PD FT (M)	M3145PD FT (M)
L1/L2	27	MR3	MG2/MG3	38 (11.58)	74 (22.56)	59 (17.98)
				Runs in this Group are cut to length and connected via PP1 at site. Usable length provided is for routing in **both** the Equipment Room and Magnet Room. These cables have a minimum bend radius of 8 in. (203 mm).		
	71	MS5	MS1	42 (12.80) Runs are routed through waveguides in PP1. **See Note 2**		
	72	MR1	MG2/3	46 (14.0)	88 (26.8)	68 (20.7)
				These runs are RF Transmit Cables, must be cut to length and connected via PP1 at site. Usable length provided for routing in Equipment Room and Magnet Room.		
	86	WC1	MG2	80 (24.4) Flexible water tubing are routed through waveguides in PP1.		
L3	6	PD1	MR2	16 (4.88)		
	7	PD1	MR1	16 (4.88)		
	20	MR2	MR3	16 (4.88)		
	22	MR2	MR1	16 (4.88)		
	46	MR1	MR3	16 (4.88)		
	69	MDP	MS5	29.8 (9.1) **minus** takeup at MDP		
	89	PD1	WC1	33 (10.0)		
	94	MSM	MS5	49 (14.94) usable length allows 8 ft (2.44 m) takeup at MSM1 **See Note 1**		
	96	MSM	MR2	50 (15.24) usable length allows 8 ft (2.44 m) takeup at MSM1 **See Note 1**		

Note 1 1.5T LCC Magnet Catalog (M1060LA) provides Magnet Monitor interconnects included in this Group.

2 Shield/Cryo Cooler Compressor Catalog (M1060JW) provides Compressor to Magnet interconnects included in this Group.

Continued)

4–2 Cable Groups Length Provided (Continued)

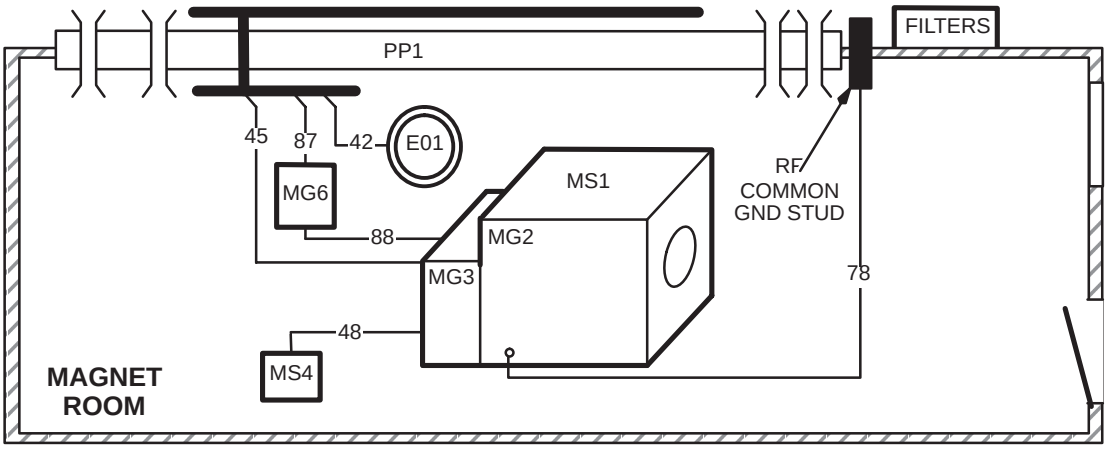
7TABLE 7–3 (Continued)
1.5T SIGNA EXCITE II MR/i CABLE GROUPS LENGTH PROVIDED BY FIXED SITE CABLE COLLECTOR CATALOGS

LOCATION	GROUP	BETWEEN UNITS		USABLE LENGTH		
		FROM	TO	M3143PD FT (M)	M3144PD FT (M)	M3145PD FT (M)
L4	79	OW1	PA1	5 (1.5) **minus** takeup at PA1		
	80	PA1	MG2	72 (21.95) allows 5 ft (1.5 m) takeup at PA1 **See Note 4** Pneumatic tubing is continuously routed from PA1 through PP1 and MG3 to MG2		
	92	PP1	OW1	80 (24.4)		
L5	43	MR2	RF Door Switch	83 (25.3) allows 15 ft takeup at RF Door Switch		
	90	PD1	OW1	80 (24.4)		
	91	MR2	OW1	80 (24.4)		

Note 4 If installation requires greater than 97 feet (29.6 meters) of pneumatic tubing between the squeeze bulb, located on the front of the Magnet Enclosure, and the Patient Alert Control Box (PA1), located near the Operator Workspace, an Extender Kit (46–317758P2) must be ordered. The Extender Kit consists of a small Extender Box (to be mounted in Equipment Room) and 95 feet (29.0 meter) of pneumatic tubing.

4–3 L1 Interconnects

Illustration 7–2 shows the cable Groups which are included in Location 1 interconnects within the Magnet Room. Table 7–4 contains details of the specific interconnects for each Group. Conduit or pipe is not recommended for cable runs since the system uses many prefabricated cables with large connectors. Unless otherwise specified, cables and components listed in Table 7–4 are supplied by GE.



SYSTEM L1 INTERCONNECTS DIAGRAM
ILLUSTRATION 7–2

4–3 L1 Interconnects (Continued)

TABLE 7–4
L1 CABLE GROUPS INTERCONNECTS DETAILS

GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
42	0.096 (61.94)	PP1	E01	297	0.35 (8.9)	1.30x2.00 (33.5x50.8)	Hard Wired	Refer to Section 3 Emergency Off Wiring.
45	3.337 (2153)	PP1	MG2/3	262	0.212 (5.38)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				282	0.464 (11.8)	2.30x2.00 (57.2x50.8	2.30x2.00 (57.2x50.8	
				300	0.44 (11.18)	2.30x2.00 (57.2x50.8)	Ring Terminals	
				318	0.35 (8.9)	1.30x2.00 (33.5x50.8)	1.30x2.00 (33.5x50.8)	
				385	0.525 (13.3)	2.80x2.00 (70.4x50.8)	2.80x2.00 (70.4x50.8)	
				387	0.415 (10.5)	2.30x2.00 (57.2x50.8)	2.30x2.00 (57.2x50.8)	
				491	0.24 (6.1)	0.55x1.10 (14.0x27.9)	0.55x1.10 (14.0x27.9)	
				492	0.36 (9.1)	0.55x1.10 (14.0x27.9)	0.55x1.10 (14.0x27.9)	
				493	0.24 (6.1)	0.55x1.10 (14.0x27.9)	0.55x1.10 (14.0x27.9)	
				494	0.24 (6.1)	0.55x1.10 (14.0x27.9)	0.55x1.10 (14.0x27.9)	
				624	0.26 (6.6)	Ring Terminals	1.00x1.38 (25.4x35.1)	
				711/ 712	1.04 (26.4)	1.04x2.00 (26.4x50.8)	1.04x2.00 (26.4x50.8)	Run 711/712 is flexible conduit containing fiber optic cables with a minimum bend radius of 2 in. (51 mm).
				715	0.525 (13.3)	2.80x2.00 (70.4x50.8)	2.80x2.00 (70.4x50.8)	
				716	0.34 (8.64)	1.60x2.00 (40.6x50.8)	1.60x2.00 (40.6x50.8)	

(Continued)

4–3 L1 Interconnects (Continued)

TABLE 7–4 (Continued)
L1 CABLE GROUPS INTERCONNECTS DETAILS

GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
45 (continue)	See preceding page	PP1	MG2/3	778	0.212 (5.38)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				779	0.212 (5.38)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				780	0.212 (5.38)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				781	0.212 (5.38)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				782	0.212 (5.38)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				828	0.31 (7.75)	2.30x2.00 (57.2x50.8	2.30x2.00 (57.2x50.8	Run 828 provided by M1060LA & M1860LA.
				829	0.30 (7.62)	1.30x2.00 (33.5x50.8)	1.30x2.00 (33.5x50.8)	Run 829 provided by M1060LA & M1860LA.
				1036	0.24 (6.1)	0.55x1.10 (14.0x27.9)	0.55x1.10 (14.0x27.9)	
				1037	0.23 (5.94)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1038	0.23 (5.94)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1039	0.23 (5.94)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1040	0.23 (5.94)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1041	0.45 (11.4)	1.60x2.00 (40.6x50.8)	1.60x2.00 (40.6x50.8)	
				1042	0.45 (11.4)	1.60x2.00 (40.6x50.8)	1.60x2.00 (40.6x50.8)	
				1057	0.44 (11.18)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	

(Continued)

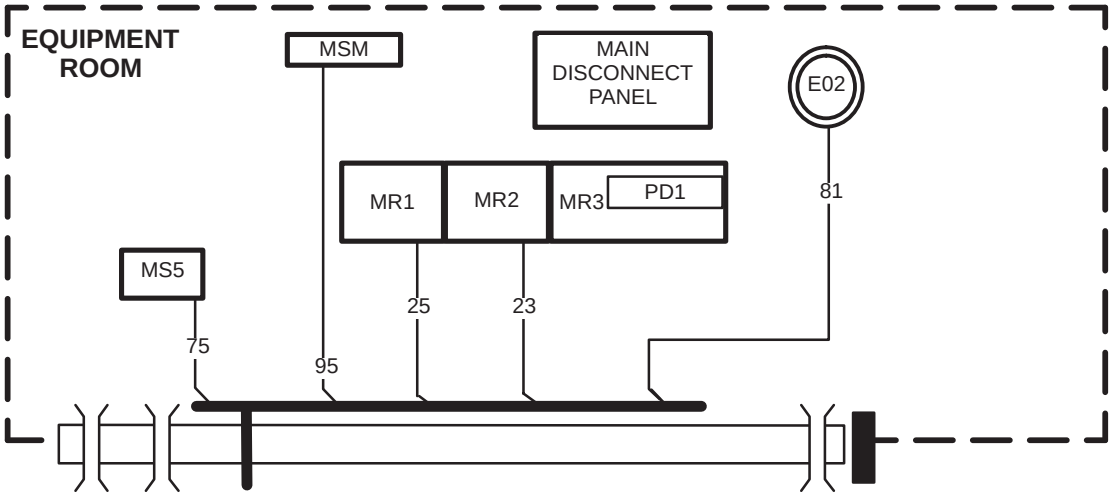
4–3 L1 Interconnects (Continued)

TABLE 7–4 (Continued)
L1 CABLE GROUPS INTERCONNECTS DETAILS

GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
48	0.071 (45.6)	MS4	MS1	606	0.30 (7.6)	0.65x1.85 (16.5x47.0)	0.65x1.85 (16.5x47.0)	
78	0.338 (218)	RF COM-MON GND STUD	MS1 GND STUD	040	0.464 (11.79)	Hard Wired	Ring Terminal	1 ground wire.
87	0.673 (228)	PP1	MG6	045	0.195 (4.95)	Ring Terminal	Ring Terminal	The usable length is based on MG6 being mounted on floor and floor routing of cables.
				784	0.64 (16.3)	Ring Terminals	2.28x3.85 (57.9x97.8)	
				786	0.64 (16.3)	Ring Terminals	2.28x3.85 (57.9x97.8)	
88	49.09 (29,952)	MG6	MG2/3	—	6.5 (165.1)	Flexible vinyl hose	Flexible vinyl hose	The flexible vinyl hoses are cut to length during installation. Site Collector Catalog provides Group 88 interconnect.
				—	4.5 (104.3)	Flexible vinyl hose	Flexible vinyl hose	

4–4 L2 Interconnects

Illustration 7–3 shows the cable Groups which are included in Location 2 between Penetration Panel (PP1) and components in Equipment Room. Table 7–5 contains information on interconnects between Penetration Panel (PP1) and components in Equipment Room (Location L2). Conduit or pipe is not recommended for cable runs since the system uses many prefabricated cables with large connectors. Unless otherwise specified, cables and components listed in Table 7–5 are supplied by GE.



SYSTEM L2 INTERCONNECTS DIAGRAM
ILLUSTRATION 7–3

4–4 L2 Interconnects (Continued)

TABLE 7–5
L2 CABLE GROUPS INTERCONNECTS DETAILS

GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
23	1.58 (1021)	MR2	PP1	231	0.212 (5.84)	0.57x2.00 (14.5x50.8)	0.57x2.00 (14.5x50.8)	**RF Receive Cable**
				488	0.24 (6.1)	0.55x1.10 (14.0x27.9)	0.55x1.10 (14.0x27.9)	**RF Receive Cable**
				489	0.24 (6.1)	0.55x1.10 (14.0x27.9)	0.55x1.10 (14.0x27.9)	**RF Receive Cable**
				490	0.24 (6.1)	0.55x1.10 (14.0x27.9)	0.55x1.10 (14.0x27.9)	**RF Receive Cable**
				499	0.234 (5.94)	0.57x2.00 (14.5x50.8)	0.57x2.00 (14.5x50.8)	**RF Receive Cable**
				1025	0.234 (5.94)	0.57x2.00 (14.5x50.8)	0.57x2.00 (14.5x50.8)	**RF Receive Cable**
				1026	0.234 (5.94)	0.57x2.00 (14.5x50.8)	0.57x2.00 (14.5x50.8)	**RF Receive Cable**
				1027	0.234 (5.94)	0.57x2.00 (14.5x50.8)	0.57x2.00 (14.5x50.8)	**RF Receive Cable**
				1028	0.234 (5.94)	0.57x2.00 (14.5x50.8)	0.57x2.00 (14.5x50.8)	**RF Receive Cable**
				1029	0.34 (8.6)	1.6x2.00 (40.6x50.8)	1.6x2.00 (40.6x50.8)	
				1030	0.525 (13.3)	2.8x2.00 (71.1x50.8)	2.8x2.00 (71.1x50.8)	
				1045	1.04 (26.4)	1.04x2.00 (26.4x50.8)	1.04x2.00 (26.4x50.8)	Run 1045 is a flexible conduit containing fiber optic cables with a minimum bend of 2 in. (50 mm).
				1053	0.23 (5.94)	0.57x1.125 (14.5x28.57)	0.57x1.125 (14.5x28.57)	

(Continued)

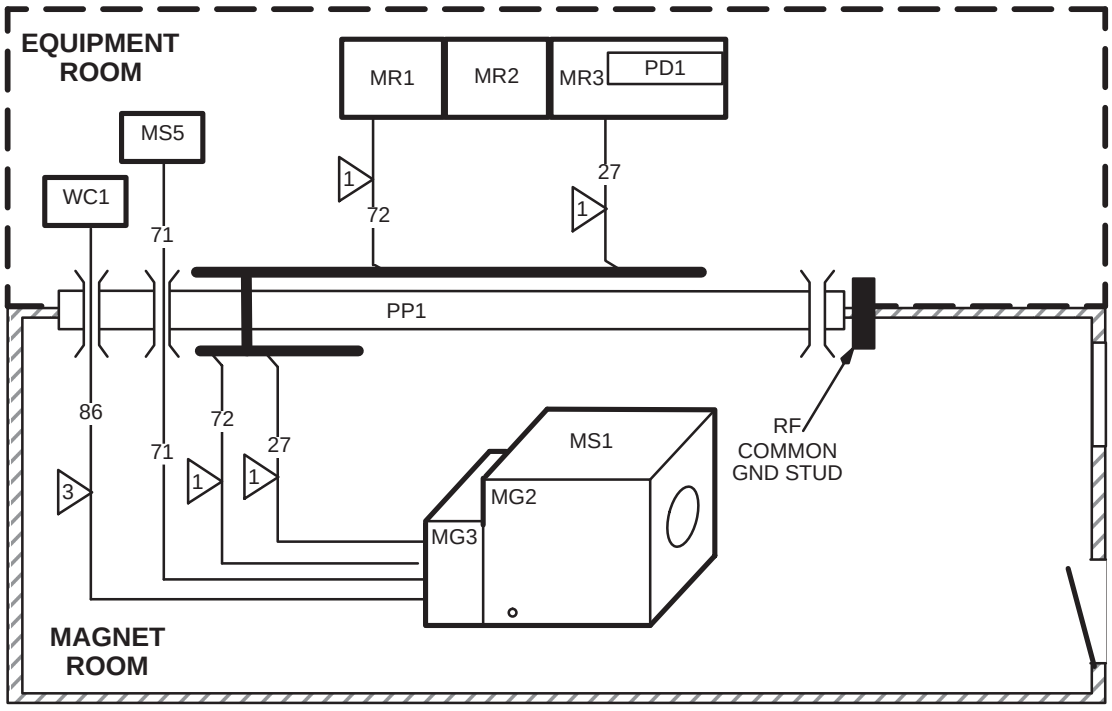
4–4 L2 Interconnects (Continued)

TABLE 7–5 (Continued)
L2 CABLE GROUPS INTERCONNECTS DETAILS

GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
25	1.661 (1073)	MR1	PP1	044	0.20 (5.1)	Ring Terminal	Ring Terminal	Ground cable
				768	0.525 (13.3)	2.80x2.00 (70.4x50.8)	2.80x2.00 (70.4x50.8)	
				769	0.44 (11.2)	2.30x2.00 (57.2x50.8)	2.30x2.00 (57.2x50.8)	
				770	0.31 (7.9)	1.30x2.00 (33.5x50.8)	1.30x2.00 (33.5x50.8)	
				771	0.415 (10.5)	2.30x2.00 (57.2x50.8)	2.30x2.00 (57.2x50.8)	
				772	0.525 (13.3)	2.80x2.00 (70.4x50.8)	2.80x2.00 (70.4x50.8)	
				773	0.34 (8.64)	2.30x2.00 (57.2x50.8)	2.30x2.00 (57.2x50.8)	
				775	0.212 (5.4)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				776	0.212 (5.4)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				777	0.212 (5.4)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				783	0.64 (16.3)	1.60x2.00 (40.6x50.8)	Ring Terminals	
				785	0.64 (16.3)	1.60x2.00 (40.6x50.8)	Ring Terminals	
75	0.035 (22)	MS5	PP1	623	0.21 (5.28)	1.00x1.38 (25.4x35.1)	Ring Terminals	
81	0.460 (297.3)	EO2	PP1	296	0.35 (8.9)	Hard Wired	1.30x2.00 (33.5x50.8)	Refer to Chapter 6 Section 3 Power Distribution System
95	0.22 (144)	MSM	PP1	824	0.44 (11.2)	2.30x2.00 (57.2x50.8)	2.30x2.00 (57.2x50.8)	Run 824 provided by M1060LA
				825	0.30 (7.62)	1.30x2.00 (33.5x50.8)	1.30x2.00 (33.5x50.8)	Run 825 provided by M1060LA

4–5 L1 / L2 Interconnects

Illustration 7–4 shows the cable Groups which are included in shared between Location 1 / Location 2 the Magnet Room and Equipment Room routing through the Penetration Panel (PP1). Table 7–6 contains information on interconnects which the length is shared between the Magnet Room and Equipment Room (Location L1/L2) routing through the Penetration Panel (PP1). Conduit or pipe is not recommended for cable runs since the system uses many prefabricated cables with large connectors. Unless otherwise specified, cables and components listed in Table 7–6 are supplied by GE.



1 MUST BE CUT AND CONNECTED TO PP1 AT SITE.
NOTE: IMPEDANCE IS NOT CRITICAL SO EXCESS CABLE SHOULD BE CUT OFF.

3 THIS GROUP CONTAINS WATER LINES WHICH SHALL BE ROUTED SEPARATE FROM ELECTRICAL LINES (I.E. POWER & SIGNAL).

SYSTEM L1/L2 INTERCONNECTS DIAGRAM
ILLUSTRATION 7–4

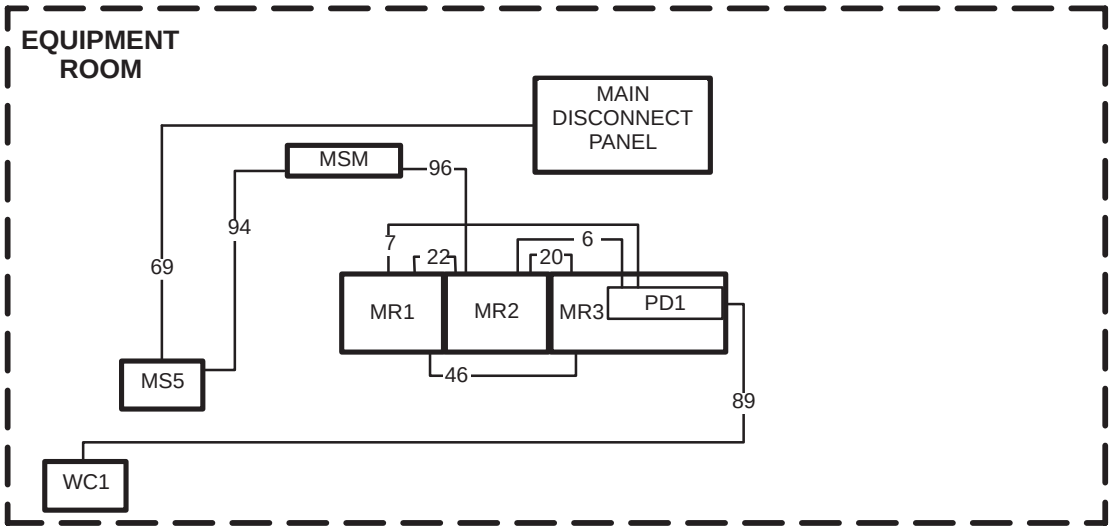
4–5 L1 / L2 Interconnects (Continued)

TABLE 7–6
L1/L2 SHARED CABLE GROUPS INTERCONNECTS DETAILS

GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
27	3.450 (740.2)	MR3	MG2/ MG3	762 763 764	1.21 (30.7) 1.21 (30.7) 1.21 (30.7)	Hard wired Hard Wired Hard Wired	Ring Terminals Ring Terminals Ring Terminals	Runs in this Group are cut to length and connected via PP1 at site. Usable length provided is for routing in **both** the Equipment Room and Magnet Room. These cables have a minimum bend radius of 8 in. (203 mm).
71	4.28 (2758)	MS5	MS1	621 622	1.65 (41.9) 1.65 (41.9)	2.00x3.75 (50.8x95.3) 2.00x3.75 (50.8x95.3)	2.00x3.75 (50.8x95.3) 2.00x3.75 (50.8x95.3)	Runs 621 and 622 are continuous helium lines routed through PP1. Bend radius of Runs 621 and 622 is 8 in. (203.2 mm). Cable diameter includes foam insulation installed on lines.
72 for M3143PD **M3145PD**	0.87 (560)	MR1	MG2/3	235 & 257 236 & 258	0.87 (22.1) 0.59 (15.0)	1.36x2.12 (34.5x53.9) 1.5x2.50 (38.1x63.5)	1.36x2.12 (34.5x53.9) 1.5x2.50 (38.1x63.5)	**These runs are RF Transmit Cables.** Runs 235/257 and 236/258 must be cut to length and connected via PP1 at site. Usable length provided is for routing in **both** Equipment Room and Magnet Room.
72 for M3144PD	1.27 (820)	MR1	MG2/3	235 & 257 236 & 258	1.10 (27.9) 0.64 (16.3)	1.40x3.40 (35.6x86.4) 0.90x2.50 (22.9x63.5)	1.40x3.40 (35.6x86.4) 0.90x2.50 (22.9x63.5)	**These runs are RF Transmit Heliax.** Runs 235/257 and 236/258 must be cut to length and connected via PP1 at site. Usable length provided is for routing in **both** Equipment Room and Magnet Room.
86 **SEE NOTE 1**	0.884 (573)	WC1	MG2	536 537	0.75 (19.1) 0.75 (19.1)	Flexible Tubing Flexible Tubing	Flexible Tubing Flexible Tubing	Runs 536 and 537 are routed through waveguides in PP1.
Note 1 This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).								

4–6 L3 Interconnects

Illustration 7–5 shows the cable Groups which are included in Location 3 between between components within Equipment Room. Table 7–7 contains information on interconnects between components within Equipment Room (Location L3). Conduit or pipe is not recommended for cable runs since the system uses many prefabricated cables with large connectors. Unless otherwise specified, cables and components listed in Table 7–7 are supplied by GE.



SYSTEM L3 INTERCONNECTS DIAGRAM
ILLUSTRATION 7–5

TABLE 7–7
L3 CABLE GROUPS INTERCONNECTS DETAILS

GROUP NUMBER	GROUP AREA in.²(mm²)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
6	0.803 (518)	PD1 **See Note 1**	MR2	037	0.188 (4.78)	Hard Wired	Hard Wired	#10 AWG / 1 wire Ground cable
				971	0.375 (9.50)	1.60x2.00 (41.1x50.8)	1.60x2.00 (41.1x50.8)	
				968	0.92 (23.37)	Hard Wired	Hard Wired	#8 AWG / 5 wire Power cable
Note 1 The PDU is a module (PD1) in the lower portion of the ACGD/PDU Cabinet (MR3).								
(Continued)								

4–6 L3 Interconnects (Continued)

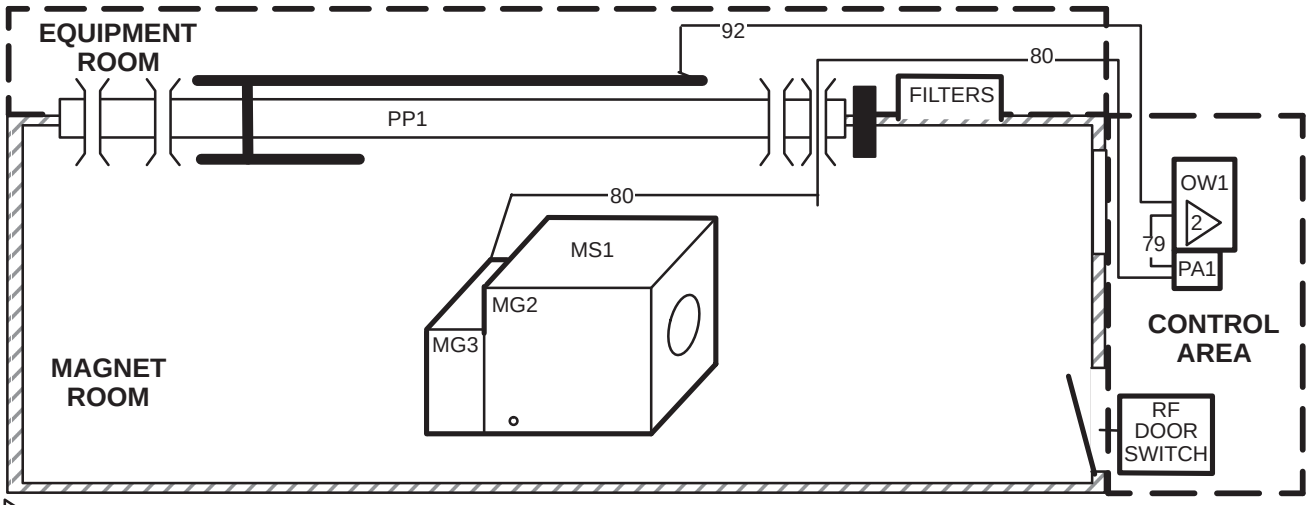
TABLE 7–7 (Continued)
L3 CABLE GROUPS INTERCONNECTS DETAILS

GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
7	1.36 (878)	PD1 **See Note 1**	MR1	038	0.188 (4.78)	Hard Wired	Hard Wired	#10 AWG / 1 wire Ground cable
				966	0.92 (23.37)	Hard Wired	Hard Wired	#8 AWG / 5 wire Power cable
				967	0.92 (23.37)	Hard Wired	Hard Wired	#8 AWG / 5 wire Power cable
20	0.78 (506)	MR2	MR3	1034	1.04 (26.4)	1.04x2.00 (26.4x50.8)	1.04x2.00 (26.4x50.8)	Run 1034 is flexible conduit containing fiber optic cable(s) with a minimum bend of 2 in. (50 mm).
22	0.83 (537)	MR2	MR1	229	0.23 (5.84)	0.57x2.00 (14.5x50.8)	0.57x2.00 (14.5x50.8)	
				702	0.35 (8.90)	1.30x2.00 (33.5x50.8)	1.30x2.00 (33.5x50.8)	
				774	0.44 (11.2)	2.30x2.00 (58.4x50.8)	2.30x2.00 (58.4x50.8)	
				1033	0.83 (21.1)	0.83x2.00 (21.1x50.8)	0.83x2.00 (21.1x50.8)	Run 1033 is flexible conduit containing fiber optic cable(s) with a minimum bend of 2 in. (51 mm).
46	0.541 (349)	MR1	MR3	709	0.83 (21.1)	0.83x2.00 (21.1x50.8)	0.83x2.00 (21.1x50.8)	Run 709 is flexible conduit containing fiber optic cables.
69	1.31 (842)	MDP	MS5	—	1.29 (32.75)	Hard Wired	Hard Wired	Both ends have liquid tight connector which wires pass through for hard wire connections.
89	0.35 (222)	PD1 **See Note 1**	WC1	970	0.635 (16.1)	Hard Wired	1.78x2.60 (45.2x66.0)	#10 AWG / 3 wire Power cable
94	0.09 (58.6)	MSM	MS5	826	0.34 (8.64)	1.60x2.00 (40.6x50.8)	1.60x2.00 (40.6x50.8)	Run 826 provided by M1060LA & M1860LA.
96	0.09 (58.6)	MSM1	MR2	823	0.34 (8.64)	1.60x2.00 (40.6x50.8)	1.60x2.00 (40.6x50.8)	Run 823 provided by M1060LA & M1860LA.

Note 1 The PDU is a module (PD1) in the lower portion of the ACGD/PDU Cabinet (MR3).

4–7 L4 Interconnects

Illustration 7–6 shows the cable Groups which are included in Location 3 between the Operator Workspace (OW) and Penetration Panel (PP1). Table 7–8 contains information on interconnects between the Operator Workspace (OW) and PP1 (Location L4). Conduit or pipe is not recommended for cable runs since the system uses many prefabricated cables with large connectors. Unless otherwise specified, cables and components listed in Table 7–8 are supplied by GE.



2 OPERATOR WORKSPACE (OW1) SUBSYSTEM EQUIPMENT IS PROVIDED WITH MAXIMUM LENGTH CABLES POSSIBLE. OW INTERCONNECTS ARE ROUTED THROUGH TABLE CABLE TRAY & FOR OCTANE COMPUTER SEVERAL OW ASSEMBLIES ARE MOUNTED TO OW TABLE. FOR REFERENCE USE ONLY THE OW1 RUN NUMBERS FOR LINUX PC ARE 1059, 1060, 1061, 1062, 1063, 1064, 1065, 1066, 1067, 1068, 1069, 1070, 1071, 1074, 1075 AND FOR OCTANE COMPUTER ARE 049, 792, 793, 794, 795, 796, 797, 798, 799, 806, & 807.

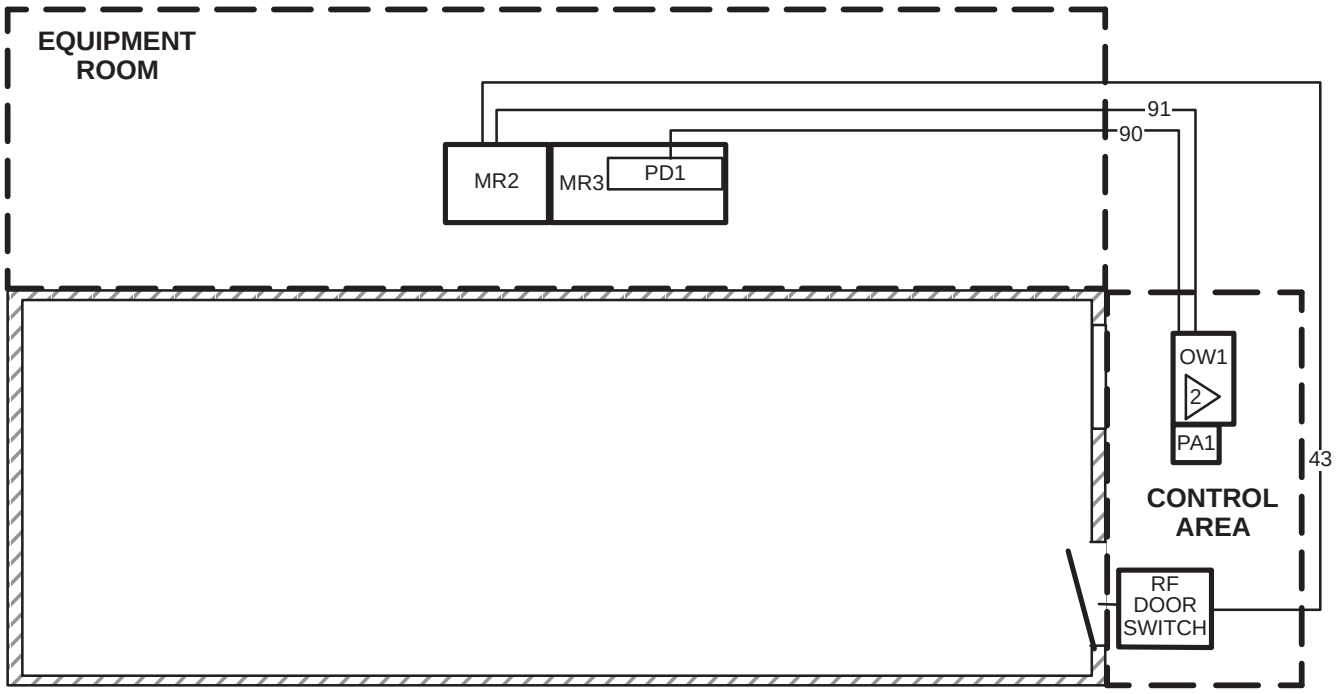
SYSTEM L4 INTERCONNECTS DIAGRAM
ILLUSTRATION 7–6

TABLE 7–8
L4 CABLE GROUPS INTERCONNECTS DETAILS

GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
79	0.013 (8.0)	OW1	PA1	—	0.13 (3.2)	3.00x3.00 (76.2x76.2)	0.38x1.75 (9.6x44.5)	
80	0.049 (32.1)	PA1	MG2	—	0.25 (6.4)	pneumatic tubing	pneumatic tubing	This pneumatic tubing is continuously routed from PA1 through PP1 and MG3 to MG2.
92	0.152 (99)	PP1	OW1	1085	0.44 (11.2)	2.30x2.00 (57.2x50.8)	2.30x2.00 (57.2x50.8)	

4–8 L5 Interconnects

Illustration 7–7 shows the cable Groups which are included in Location 3 between the Operator Workspace (OW) and components in Equipment Room. Table 7–9 contains information on interconnects between the OW and components in Equipment Room (Location L5). Conduit or pipe is not recommended for cable runs since the system uses many prefabricated cables with large connectors. Unless otherwise specified, cables and components listed in Table 7–9 are supplied by GE.



2 OPERATOR WORKSPACE (OW1) SUBSYSTEM EQUIPMENT IS PROVIDED WITH MAXIMUM LENGTH CABLES POSSIBLE. OW INTERCONNECTS ARE ROUTED THROUGH TABLE CABLE TRAY & FOR OCTANE COMPUTER SEVERAL OW ASSEMBLIES ARE MOUNTED TO OW TABLE. FOR REFERENCE USE ONLY THE OW1 RUN NUMBERS FOR LINUX PC ARE 1059, 1060, 1061, 1062, 1063, 1064, 1065, 1066, 1067, 1068, 1069, 1070, 1071, 1074, 1075 AND FOR OCTANE COMPUTER ARE 049, 792, 793, 794, 795, 796, 797, 798, 799, 806, & 807.

SYSTEM L5 INTERCONNECTS DIAGRAM
ILLUSTRATION 7–7

4–8 L5 Interconnects (Continued)

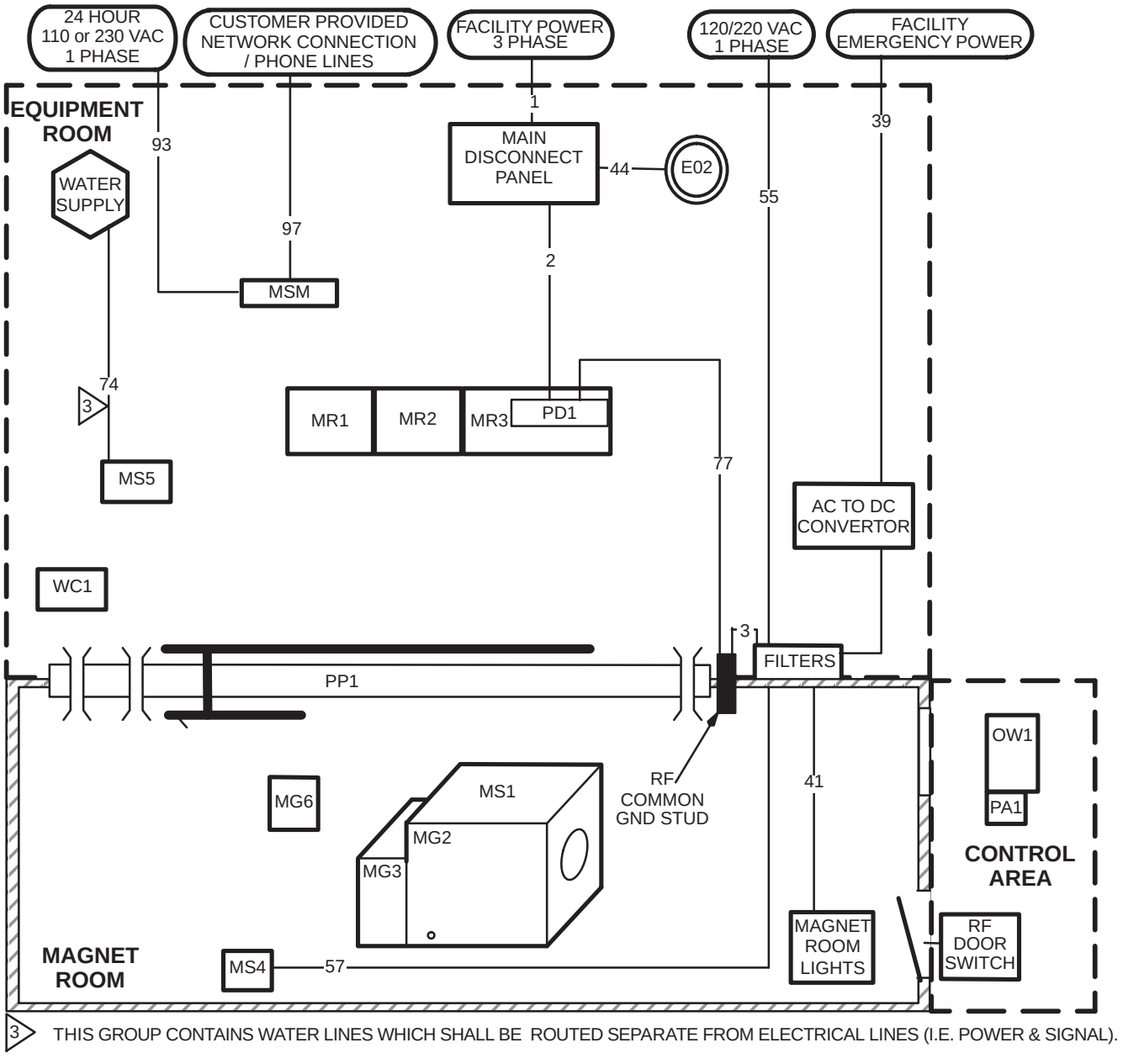
TABLE 7–9
L5 CABLE GROUPS INTERCONNECTS DETAILS

GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
43	0.096 (61.94)	MR2	RF Door Switch	701	0.35 (8.9)	1.30x2.00 (33.5x50.8)	Hard Wired	RF Door Switch provided by RF Screen Room vendor. Usable length allows RF Door Switch takeup of 15 ft (4.57 m).
90	0.385 (248)	PD1 **See Note 1**	OW1	1081†	0.70 (17.78)	Hard Wired	Hard Wired	#10 AWG / 4 wire power cable
91	0.210 (133)	MR2	OW1	1082	0.25 (6.35)	0.50x0.75 (12.7x19.1)	0.50x0.75 (12.7x19.1)	
				1083	0.33 (8.3)	1.75x2.00 (44.5x50.8)	1.75x2.00 (44.5x50.8)	
				1084	0.31 (7.75)	1.30x2.00 (33.5x50.8)	1.30x2.00 (33.5x50.8)	

Note 1 The PDU is a module (PD1) in the lower portion of the ACGD/PDU Cabinet (MR3).

4–9 Customer Supplied Interconnects

Illustration 7–7 shows the cable Groups which are customer supplied. Table 7–10 contains the list of customer supplied interconnects for the MR system and references to location of detail information for the specific interconnects.



SYSTEM CUSTOMER SUPPLIED INTERCONNECTS DIAGRAM
ILLUSTRATION 7–8

4–9 Customer Supplied (Continued)

TABLE 7–10
CUSTOMER SUPPLIED INTERCONNECTS

GROUP NUMBER	GROUP AREA in.^{2} mm^2)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
1	—	Facility Power	MDP	—	—	—	—	Customer supplied, See Note 1**.**
2	—	MDP	PD1 **See Note 2**	—	—	—	—	Customer supplied. Refer to Chapter 6 Section 3–2 Power Distribution System Unit for wire size information.
3	—	Facility Emerg Power Filter	PP1	—	—	—	—	Customer supplied Ground.
39	—	Facility Emerg Power	Filter	—	—	—	—	Refer to Chapter 6 Section 8 for DC Lighting Controller cabling.
41	—	Filter	Magnet Room Lights	—	—	—	—	Refer to Chapter 6 Sections 7 Emergency Power and 8 DC Lighting Controller (Facility Option).
44	—	MDP	EO2	—	—	—	—	Customer supplied Refer to Section 3 Emergency Off Wiring.
55	—	Facility Power	Filter	—	—	—	—	Customer supplied Magnet Room power (refer to Chapter 6 Section 1 System Power Introduction and Chapter 8 Section 4 Electrical).
57	—	Filter	MS4	—	—	—	—	Customer supplied (refer to Chapter 6 Section 1 System Power Introduction).
74 **See Note 3**	—	Water	MS5	—	—	—	—	Customer Furnished water lines (refer to Chapter 5 Sections 5 Water Cooling Requirements and Chapter 6 Sections 1 System Power Introduction).
77	—	PD1 **See Note 2**	RF COM-MON GND STUD	—	—	Ring Terminal	Ring Terminal	Customer supplied ground cable, refer to Chapter 6 Section 4–2 System Ground.
93	— —	24 Hour Facility Power	MSM	—	—	1.2x3.00 (30.5x76.2)	1.2x3.00 (30.5x76.2)	MSM has a 6 ft (1.8 m) power cord.
97	—	Net-work &/or Phone Line Con-nection	MSM1 or MSM4 (Op-tion)	—	—	—	–	Refer to Chapter 3 Section 9–7 System Monitoring & Support Connectivity Requirements for additional customer network and/or phone line information.

Note 1 If low Voltage Step–Up Transformer Option (R4500AW or R4500BE) is used then customer supplied interconnects are required between facility power, transformer and MDP.

2 The PDU is a module (PD1) in the lower portion of the ACGD/PDU Cabinet (MR1).

3 This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).

4–10 Cable Group and Location Cross Reference

Cable groups shown in Illustration 7–1 are listed in Table 7–11 which contains the Location for each Group and a reference to the subsection or table which has the group content details and the usable length provided by the listed Site Collector catalogs.

TABLE 7–11
LOCATION & CABLE GROUP CROSS REFERENCE TO RUNS DETAILS

CABLE GROUP #	BETWEEN UNITS		LOCATION	SECTION OR TABLE WITH GROUP CONTENT DETAILS
	FROM	TO	See Note 1 for definition of L numbers	
1	Facility Power	MDP	Customer Supplied	Section 4–9 Table 7–10
2	MDP	PD1	Customer Supplied	Section 4–9 Table 7–10
3	Facility Emerg Power Filter	PP1	Customer Supplied	Section 4–9 Table 7–10
4 to 5	—	—	Group Not Used	—
6	PD1	MR2	L3	Section 4–6 Table 7–7
7	PD1	MR1	L3	Section 4–6 Table 7–7
8 to 14	—	—	Group Not Used	—
15 **See Note 2**	MS5	MRCC	L3	Refer to Section 8–1 System Interconnects For MRCC Unit Located Outdoors or Section 8–2 System Interconnects For MRCC Unit Located Indoors.
16	Facility Power	MRCC Unit #1	Customer Supplied	Refer to Section 8–1 System Interconnects For MRCC Unit Located Outdoors, Section 8–2 System Interconnects For MRCC Unit Located Indoors.
17 to 19	—	—	Group Not Used	—
20	MR2	MR3	L3	Section 4–6 Table 7–7
21	—	—	Group Not Used	—
22	MR2	MR1	L3	Section 4–6 Table 7–7
23	MR2	PP1	L2	Section 4–4 Table 7–5
24	—	—	Group Not Used	—
25	MR1	PP1	L2	Section 4–4 Table 7–5
26	—	—	Group Not Used	—
27	MR3	MG2	L1/L2	Section 4–5 Table 7–6
28 to 38	—	–	Group Not Used	—
39	Facility Emerg Power	Filter	Customer Supplied	Refer to Chapter 6 Section 8 DC Lighting Controller (Facility Option) for DC Lighting Controller cabling.

Note 1 Interconnects LOCATION is defined as the following:

L1	Within Magnet Room between components
L2	Between Penetration Panel (PP1) and components in Equipment Room
L1/L2	Between Magnet Room and Equipment Room components through PP1
L3	Between components within Equipment Room
L4	Between Operator Workspace (OW) and PP1
L5	Between OW and components in Equipment Room

2 This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).

(Continued)

4–10 Cable Group and Location Cross Reference (Continued)

TABLE 7–11 (Continued)
LOCATION & CABLE GROUP CROSS REFERENCE TO RUNS DETAILS

CABLE GROUP #	BETWEEN UNITS		LOCATION	SECTION OR TABLE WITH GROUP CONTENT DETAILS
	FROM	TO	See Note 1 for definition of L numbers	
40	—	—	Group Not Used	—
41	Filter	Magnet Room Lights	Customer Supplied	Refer to Chapter 6 Sections 7 Emergency Power and 8 DC Lighting Controller (Facility Option).
42	PP1	EO1	L1	Section 4–3 Table 7–4
43	MR2	RF Door Switch	L5	Section 4–8 Table 7–9
44	MDP	E02	Customer Supplied	Section 4–9 Table 7–10
45	PP1	MG2/3	L1	Section 4–3 Table 7–4
46	MR1	MR3	L3	Section 4–6 Table 7–7
47	—	—	Group Not Used	—
48	MS4	MS1	L1	Section 4–3 Table 7–4
49	—	—	Group Not Used	—
50	MRCC Unit located Outdoors	See Section reference at right	Customer Supplied	Refer to Section 8–1 System Interconnects For MRCC Units Located Outdoors.
51	—	—	Group Not Used	—
52	MRCC Unit	See Section reference at right	L3	Refer to Section 8–1 System Interconnects For MRCC Unit Located Outdoors or Section 8–2 System Interconnects For MRCC Unit Located Indoors
53 to 54	—	—	Group Not Used	—
55	Facility Power	Filter	Customer Supplied	Section 4–9 Table 7–10
56	—	—	Group Not Used	—
57	Filter	MS4	Customer Supplied	Section 4–9 Table 7–10
58 to 68	—	—	Group Not Used	—
69	MDP	MS5	L3	Section 4–6 Table 7–7
70	—	—	Group Not Used	—
71	MS5	MS1	L1/L2	Section 4–5 Table 7–6
72	MR1	MG2/3	L1/L2	Section 4–5 Table 7–6
73	—	—	Group Not Used	—
74 **See Note 2**	Water	MS5	Customer Supplied	Section 4–9 Table 7–10

Note 1 Interconnects LOCATION is defined as the following:

L1	Within Magnet Room between components
L2	Between Penetration Panel (PP1) and components in Equipment Room
L1/L2	Between Magnet Room and Equipment Room components through PP1
L3	Between components within Equipment Room
L4	Between Operator Workspace (OW) and PP1
L5	Between OW and components in Equipment Room

2 This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).

(Continued)

4–10 Cable Group and Location Cross Reference (Continued)

TABLE 7–11 (Continued)
LOCATION & CABLE GROUP CROSS REFERENCE TO RUNS DETAILS

CABLE GROUP #	BETWEEN UNITS		LOCATION See Note 1 for definition of L numbers	SECTION OR TABLE WITH GROUP CONTENT DETAILS
	FROM	TO		
75	MS5	PP1	L2	Section 4–4 Table 7–5
76	—	—	Group Not Used	—
77	PD1	RF COMMON GROUND STUD	Customer Supplied	Section 4–9 Table 7–10
78	RF COMMON GROUND STUD	MS1 GROUND STUD	L1	Section 4–3 Table 7–4
79	OW1	PA1	L4	Section 4–7 Table 7–8
80	PA1	MG2	L4	Section 4–7 Table 7–8
81	EO2	PP1	L2	Section 4–4 Table 7–5
82 to 85	—	—	Group Not Used	—
86 **See Note 2**	WC1	MG2	L1/L2	Section 4–5 Table 7–6
87	PP1	MG6	L1	Section 4–3 Table 7–4
88	MG6	MG2/3	L1	Section 4–3 Table 7–4
89	PD1	WC1	L3	Section 4–6 Table 7–7
90	PD1	OW1	L5	Section 4–8 Table 7–9
91	MR2	OW1	L5	Section 4–8 Table 7–9
92	PP1	OW1	L4	Section 4–7 Table 7–8
93	24 Hour Facility Power	MSM	Customer Supplied	Section 4–9 Table 7–10
94	MSM	MS5	L3	Section 4–6 Table 7–7
95	MSM	PP1	L2	Section 4–4 Table 7–5
96	MSM	MR2	L3	Section 4–6 Table 7–7
97	Network or Phone Line Connection	MSM1 or MSM4 (Option)	Customer Supplied	Section 4–9 Table 7–10

Note 1 Interconnects LOCATION is defined as the following:

L1	Within Magnet Room between components
L2	Between Penetration Panel (PP1) and components in Equipment Room
L1/L2	Between Magnet Room and Equipment Room components through PP1
L3	Between components within Equipment Room
L4	Between Operator Workspace (OW) and PP1
L5	Between OW and components in Equipment Room

2 This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).

5 Contractor Furnished Components

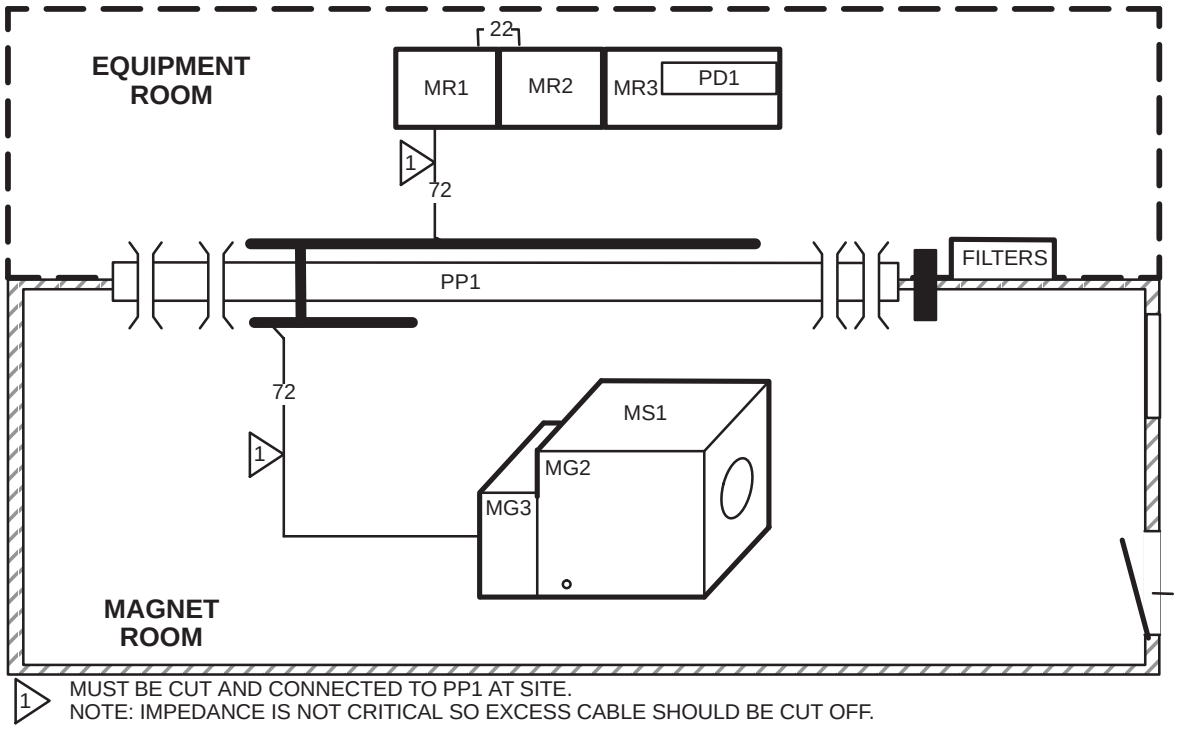
Table 7–12 lists contractor furnished components and details for connections to the system.

TABLE 7–12
CONTRACTOR FURNISHED COMPONENTS

ASSOCIATED EQUIPMENT	MATERIAL/LABOR PROVIDED BY CUSTOMER CONTRACTOR
SYSTEM EMERGENCY OFF BUTTONS	Provide and install flush mounted wall switch box for single push button stations. Push button stations to have one normally closed contact rated for 24 volts. Provide red emergency off push button switch with a guard to prevent inadvertent actuation. Also provide nameplate "**SYSTEM EMERGENCY OFF**". Locate 60 in. (1524 mm) from floor near each exit in the magnet and equipment rooms. (See Section 3 Emergency Off Wiring and Chapter 6 Section 3 Power Distribution System.) **Note:** DO NOT label buttons "Emergency Stop" — they are not the same.
POWER IN MAGNET ROOM	Provide and install power and wall duct for magnet rundown unit. (See Chapter 6 Section 1 System Power Introduction for power specifications.)
SYSTEM GROUND	Provide ground cable between RF shielded room common ground point and Power Distribution Unit (PD1). (See Chapter 6 Section 4 Grounding for cable specifications.)
EQUIPMENT POWER • Magnet Rundown Unit • Pneumatic Patient Alert Control Box** • Service Outlet in Magnet Room • * MR Common Chiller (MRCC) • * Oxygen Monitor	Provide and install power, duct work, receptacle, and coverplate for each item listed. (See Chapter 6 Section 1 System Power Introduction for power specifications.)
SHIELD COOLER POWER	Provide and install conduit, transformer, and second circuit breaker for 3 phase 480/277 VAC 60 Hz or 380/220 VAC 50 Hz and with auto restart and emergency off functions as defined in Section 3–1 Main Disconnect Panel (MDP). Power required at time of magnet delivery. (See Chapter 6 Section 1 System Power Introduction for power specifications.)
MAIN DISCONNECT PANEL	Provide and install Main Disconnect Panel with Low Voltage Low Energy local and multi–point remote control capability (Three–pole, 600 VAC circuit breaker trip rated appropriately.) (See Section 3 Emergency Off Wiring and Chapter 6 Section 3 Power Distribution System.)
PLUMBING	Provide and install all water cooling equipment, see Chapter 5 Site Environment for customer supplied components & requirements.
CRYOGENIC VENTING	Provide and install cryogenic vent system. (See Chapter 5 Section 10 Cryogenic Venting for vent specifications.)
ROOM VENTILATION	Provide and install all room ventilation equipment (e.g. Magnet Room exhaust fan) Chapter 5 Section 9 Room Ventilation for room ventilation specifications.
PENETRATION PANEL MOUNTING HARDWARE	RF shielded room vendor to provide appropriate mounting hardware for GE supplied penetration panel. (See Chapter 8 Section 5 RF Penetration Panel.)
RF DOOR SWITCH AND CABLING	RF shielded room vendor to provide and install RF door switches on all RF shielded room doors. All switches must be wired in series. GE supplies a 100 ft (30.5 m) cable from System Cabinet which is terminated with 2 leads. These leads are connected to the set of switches. Switches must be in the open position when RF door is open but closed when door is closed. (See Chapter 8 RF Shielded Room.)
Note * Optional Equipment. ** The Pneumatic Patient Alert Control Box can be powered from an outlet on the Operator Workspace.	

6 Spectroscopy Additional Interconnects

Illustration 7–9 shows the 1.5T Signa EXCITE II 1.5T MR/*i* system interconnect groups which have additional interconnects for MNS option. Table 7–13 contains cable length for the system additional interconnects provided by the MNS Option catalog. Tables 7–14, 7–14, and 7–15 contain the cable data for the additional interconnects.



1.5T SIGNA EXCITE II MR/*i* MNS OPTION GROUP ADDITIONAL INTERCONNECTS DIAGRAM
ILLUSTRATION 7–9

TABLE 7–13
1.5T SIGNA EXCITE II MR/*i* MNS OPTION CATALOG PROVIDED FOR ADDITIONAL INTERCONNECTS CABLE LENGTH

LOCATION	GROUP	BETWEEN UNITS		USABLE LENGTH
		FROM	TO	M3333TJ FT (M)
L1/L2	72	MR1	MG2/3	88 (26.8) **These runs are RF Transmit Cables,** must be cut to length and connected via PP1 at site. Usable length provided for routing in Equipment Room and Magnet Room.
L3	22	MR2	MR1	23 (7.01)

6 Spectroscopy Additional Interconnects (Continued)

TABLE 7–14
L1/L2 CABLE GROUPS MNS ADDITIONAL INTERCONNECTS DETAILS

GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
72*	0.273 (109)	MR1	MG2/3	1146/ 1147	0.59 (14.99)	1.44x0.87 (36.6x22.1)	1.44x0.87 (36.6x22.1)	**RF Transmit**
Note *	Group Area listed is for the additional cables shown in table ONLY. Refer to Section 4–5 Location 1 / Location 2 – Interconnects Shared Between Magnet Room & Equipment Room Through PP1 Group standard system cables information.							

TABLE 7–15
L3 CABLE GROUPS MNS ADDITIONAL INTERCONNECTS DETAILS

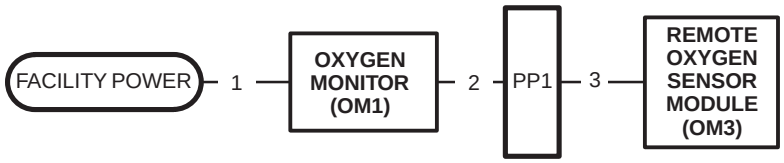
GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO			FROM	TO	
22*	0.273 (109)	MR1	MG2/3	1158	0.59 (14.99)	1.44x0.87 (36.6x22.1)	1.44x0.87 (36.6x22.1)	**RF Transmit**
Note *	Group Area listed is for the additional cables shown in table ONLY. Refer to Section 4–6 Location 3 – Interconnects Between Components Within Equipment Room Groups 7 and 22 system standard cables information.							

7 Oxygen Monitor Option Interconnects

The Oxygen Monitor option consists of the following items:

- Oxygen Monitor
- Remote Oxygen Sensor Module
- Interconnect cables

Illustration 7–10 shows the Interconnect Diagram. Table 7–16 contains the cable data.



OXYGEN MONITOR INTERCONNECT DIAGRAM
ILLUSTRATION 7–10

TABLE 7–16
OXYGEN MONITOR INTERCONNECT LIST

GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		USABLE LENGTH ft (m)	RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO				FROM	TO	
1	—	Facility Power	OM1	—	—	—	—	—	Customer Furnished recommended power source for OM1 (refer to Section 1).
2	0.096 (61.94)	OM1	PP1	94 (28.7) **minus** takeup at OM1	457	0.35 (8.9)	Hard Wired	1.30x2.00 (33.5x50.8)	
3	0.096 (61.94)	PP1	OM3	84 (25.6) **minus** takeup at OM3	458	0.35 (8.9)	1.30x2.00 (33.5x50.8)	Hard Wired	

8 MRCC Option Additional Interconnects

The following sections show the system interconnects required for the MR Common Chiller (MRCC) option configurations in addition to the interconnects in Section 4 System Interconnects.

8–1 System Interconnects For MRCC Unit Located Outdoors

Note

Refer to Chapter 3 Section 8–3 MRCC Siting Considerations Table 3–7 for listing of responsibility for the specific installation tasks. Also refer to *AirSys Group User Manual: MEDICOOL 10.0 P6 R407C 10K Watt Gradient/Coldhead Compressor Water Chiller* for additional information and details.

The site design for the Outdoor installation of the MRCC unit must meet the following requirements for vertical separation and water lines/hose lengths limitations. **Installation of the MRCC outdoor must be in accordance with local and national codes**.

8–1–1 Vertical Separation Requirements

- Maximum vertical separation from the Shield/Cryo Cooler Compressor is not to exceed 98 ft (30 m) with the MRCC above the MR system or 10 ft (3.1 m) with the MRCC below the MR system.

8–1–2 MRCC to Shield/Cryo Cooler Compressor: Water Cooling Lines & Hoses Requirements

Customer must provide water supply and return lines between the Outdoor MRCC and the AirSys supplied hoses for the Shield/Cryo Cooler Compressor.

- AirSys provides two 0.75 in. (19 mm) quick disconnect fittings at the MRCC for the Shield/Cryo Cooler Compressor water cooling lines connections, refer to Illustration 3–38 for location of fittings on MRCC.
- AirSys provides 3.2 ft (1 m) section of 0.5 in. (12.7 mm) ID rubber hose with 0.5 in. to 0.75 in. (12.7 mm to 19.1 mm) hose adapter fitting to allow the 0.75 in. (19.1mm) hose to be connected to the 0.5 in. (12.7 mm) fittings on the Shield/Cryo Cooler Compressor Cabinet.
- AirSys provides two 0.75 inch (19.1 mm) ID rubber hoses of 100 ft (30.5 m) total length to connect from Customer provided copper line hose barbs with ball valves to Shield/Cryo Cooler Compressor Cabinet. Site layout for the Shield/Cryo Cooler Compressor water cooling lines and hoses must meet the following:
  - Total line length from the MRCC located outdoor to the Shield/Cryo Cooler Compressor connection MUST NOT EXCEED 200 ft (61 m). AirSys supplied rubber hoses for Shield/Cryo Cooler Compressor is a maximum length of 100 ft (30.5 m) total length.
  - If the 0.75 in. (19 mm) copper lines exceed 100 ft (30.5 m) then the rubber hose length must be reduced 1 ft (0.3 m) for every 1 ft (0.3 m) of copper line that exceeds 100 ft (30.5 m).
  - Outdoor installation copper lines must be thermally insulated.

8–1–3 RCP Data Cables Requirements

AirSys provide one data cable that connect between the RCP and the MRCC. This cable is 100 ft (30.5 m) total length. Usable length is dependent on MRCC and RCP placement [total length minus height of connection at MRCC located outdoor and height of connection at RCP, no cable takeup inside of MRCC or RCP].

Note

Contact AirSys to determine if additional length cable are possible based on specific site design.

8–1 System Interconnects For MRCC Unit Located Outdoors (Continued)

8–1–4 Power Wiring Requirements

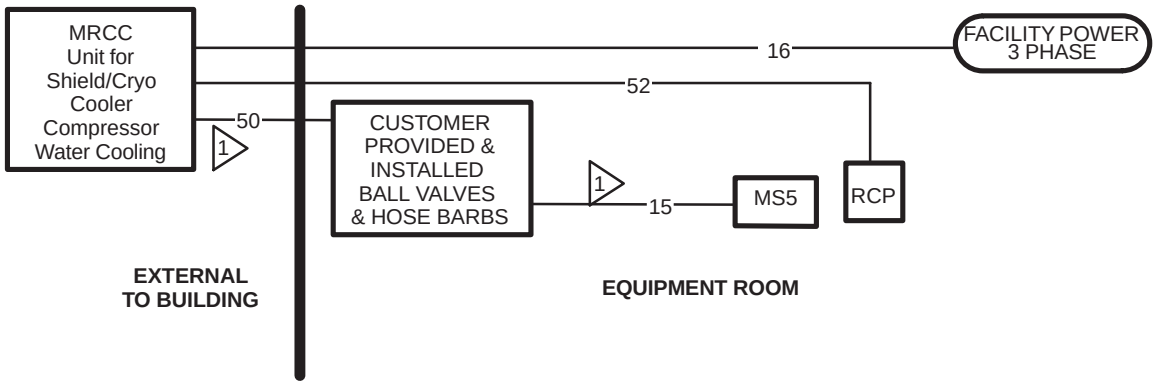
Power wiring between the MRCC and the facility power is customer supplied. The MRCC maximum wire size is 6 AWG (16 mm^2).

8–1–5 System Additional Interconnects

Illustration 7–11 shows the additional system Group Interconnect Diagram for the MRCC unit located outdoor. Each group contains one or more cables, refer to Tables 7–17 and 7–18 for specifics.

NOTE:

- ONLY INTERCONNECTS SPECIFIC TO MRCC SUBSYSTEM EQUIPMENT SHOWN HERE. REFER TO **Section 4 SYSTEM INTERCONNECTS** FOR OTHER SYSTEM INTERCONNECTS.



1 THIS GROUP CONTAINS WATER LINES WHICH SHALL BE ROUTED SEPARATE FROM ELECTRICAL LINES (I.E. POWER & SIGNAL).

MRCC UNIT LOCATED OUTDOOR & RCP SUBSYSTEM GROUP INTERCONNECT DIAGRAM
ILLUSTRATION 7–11

8–1–5 System Additional Interconnects (Continued)

TABLE 7–17
MRCC UNIT LOCATED OUTDOOR & RCP SUBSYSTEM ADDITIONAL SYSTEM INTERCONNECT LIST
CUSTOMER SUPPLIED

GROUP NUMBER	GROUP AREA in.²(mm²)	BETWEEN UNITS		USABLE LENGTH ft (m)	RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO				FROM	TO	
16	—	Facility Power	MRCC Unit	—	—	—	—	—	Customer supplied wiring, refer to Section 8–1–4 Power Wiring Requirements
50 **SEE NOTE 1**	—	MRCC outdoor	Customer ball valves & hose barbs for Gradient Coil	**See row Notes**	— —	— —	copper supply line copper return line	copper supply line copper return line	• Customer to provide & install 0.75 (19 mm) ID copper lines for Gradient Coil water cooling supply & return with • Customer to provide & install in Equipment Room in end of each copper line a 0.75 in. (19 mm) ball valve & 0.75 in. (19 mm) hose barb. • Group 50 and 15 MUST NOT EXCEED limitations specified in Section 8–1–2 MRCC to Shield/Cryo Cooler Compressor: Water Cooling Lines & Hoses Requirements
Note 1	This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).								

TABLE 7–18
MRCC UNIT LOCATED OUTDOOR & RCP SUBSYSTEMS ADDITIONAL SYSTEM INTERCONNECT LIST
L3 – INTERCONNECTS BETWEEN COMPONENTS WITHIN EQUIPMENT ROOM

GROUP NUMBER	GROUP AREA in.²(mm²)	BETWEEN UNITS		USABLE LENGTH ft (m)	RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO				FROM	TO	
15 **See Note 1**	1.571 (1013)	Customer provided ball valves & hose barbs for Shield/Cryo Cooler	MS5	**See row NOTES**	— —	1.0 (25.4) 1.0 (25.4)	Flexible Tubing Flexible Tubing	Flexible Tubing Flexible Tubing	Group 50 and 15 MUST NOT EXCEED limitations specified in Section 8–1–2 MRCC to Shield/Cryo Cooler Compressor: Water Cooling Lines & Hoses Requirements
52	0.110 (71)	MRCC Unit outdoor	RCP	92 (28.0) **See row NOTES**	—	0.375 (9.5)	Hard Wired	Hard Wired	Usable length allows the RCP to be mounted 5 ft (1.5 m) above the floor.
Note 1	This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).								

8–2 System Interconnects For MRCC Unit Located Indoors

Note

Refer to Chapter 3 Section 8–3 MRCC Siting Considerations Table 3–7 for listing of responsibility for the specific installation tasks. Also refer to *AirSys Group User Manual: MEDICOOL 10.0 P6 R407C 10K Watt Gradient/Coldhead Compressor Water Chiller* for additional information and details.

The site design for the Indoor installation of MRCC unit must meet the following requirements for vertical separation and water lines/hose lengths limitations. Installation of the MRCC indoor must be in accordance with local and national codes.

8–2–1 Vertical Separation Requirements

Maximum vertical separation from the Shield/Cryo Cooler Compressor is not to exceed 98 ft (30 m) with the MRCC above the MR system or 10 ft (3.1 m) with the MRCC below the MR system.

8–2–2 MRCC to Shield/Cryo Cooler Compressor: Water Cooling Lines & Hoses Requirements

Customer must provide water supply and return lines between the Outdoor MRCC and the AirSys supplied hoses for the Shield/Cryo Cooler Compressor.

- AirSys provides two 0.75 in. (19 mm) quick disconnect fittings at the MRCC for the Shield/Cryo Cooler Compressor water cooling lines connections, refer to Illustration 3–38 for location of fittings on MRCC.
- AirSys provides 3.2 ft (1 m) section of 0.5 in. (12.7 mm) ID rubber hose with 0.5 in. to 0.75 in. (12.7 mm to 19.1 mm) hose adapter fitting to allow the 0.75 in. (19.1mm) hose to be connected to the 0.5 in. (12.7 mm) fittings on the Shield/Cryo Cooler Compressor Cabinet.
- AirSys provides two 0.75 inch (19.1 mm) ID rubber hoses of 100 ft (30.5 m) total length to connect from from quick disconnect fittings at the MRCC to Shield/Cryo Cooler Compressor Cabinet.

8–2–3 RCP Data Cables Requirements

AirSys provide one data cable that connect between the RCP and the MRCC. This cable is 100 ft (30.5 m) total length. Usable length is dependent on MRCC and RCP placement [total length minus height of connection at MRCC located outdoor and height of connection at RCP, no cable takeup inside of MRCC or RCP].

Note

Contact AirSys to determine if additional length cable are possible based on specific site design.

8–2–4 Power Wiring Requirements

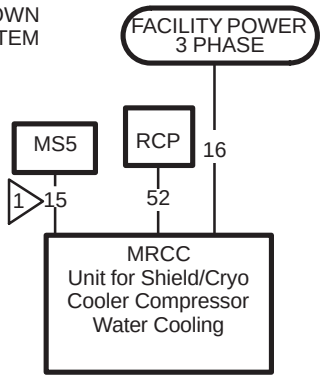
Power wiring between the MRCC and the facility power is customer supplied. The MRCC maximum wire size is 6 AWG (16 mm^2).

8–2–5 System Additional Interconnects

Illustration 7–12 shows the additional system Group Interconnect Diagram for the MRCC units located indoor. Each group contains one or more cables, refer to Tables 7–19 through 7–20 for specifics.

NOTE:

- ONLY INTERCONNECTS SPECIFIC TO MRCC SUBSYSTEM EQUIPMENT SHOWN HERE. REFER TO **Section 4 SYSTEM INTERCONNECTS** FOR OTHER SYSTEM INTERCONNECTS.



1 THIS GROUP CONTAINS WATER LINES WHICH SHALL BE ROUTED SEPARATE FROM ELECTRICAL LINES (I.E. POWER & SIGNAL).

TWO MRCC UNITS LOCATED INDOOR & RCP SUBSYSTEMS GROUP INTERCONNECT DIAGRAM
ILLUSTRATION 7–12

TABLE 7–19
MRCC UNIT LOCATED INDOOR & RCP SUBSYSTEMS ADDITIONAL SYSTEM INTERCONNECT LIST
CUSTOMER SUPPLIED

GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		USABLE LENGTH ft (m)	RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO				FROM	TO	
16	—	Facility Power	MRCC Unit	—	—	—	—	—	Customer supplied wiring, refer to Section 8–2–4 Power Wiring Requirements

8–2 System Additional Interconnects (Continued)

TABLE 7–20
MRCC UNIT LOCATED INDOOR & RCP SUBSYSTEMS ADDITIONAL SYSTEM INTERCONNECT LIST
L3 – INTERCONNECTS BETWEEN COMPONENTS WITHIN EQUIPMENT ROOM

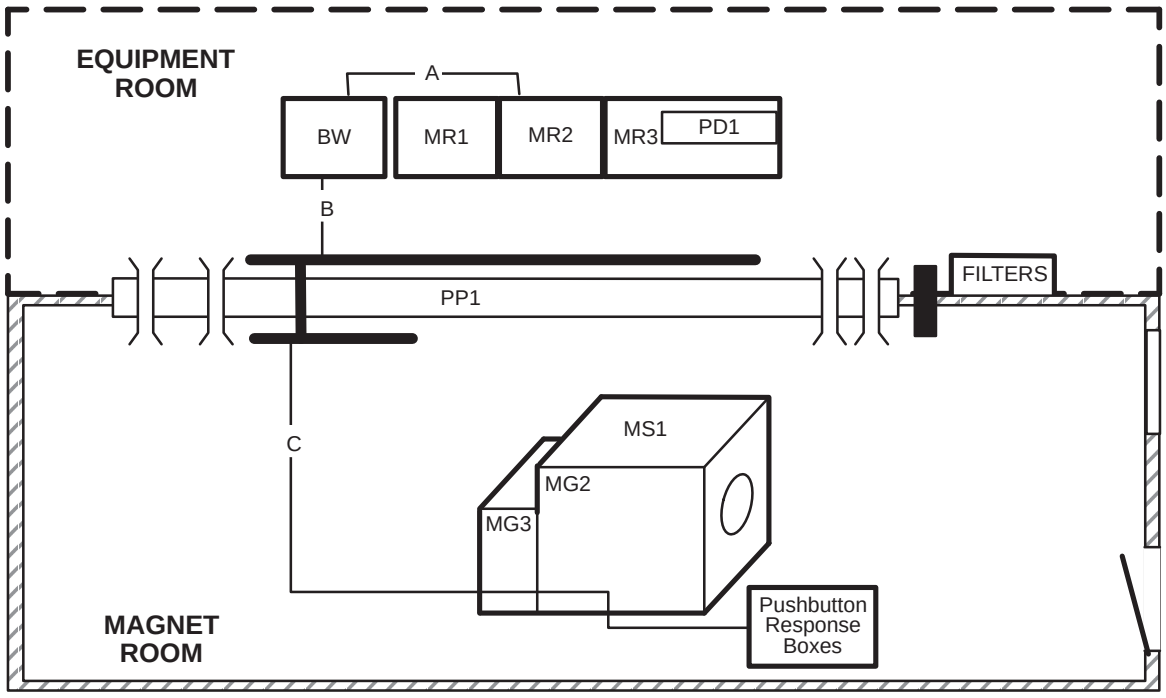
GROUP NUMBER	GROUP AREA in.^{2}(mm^2)	BETWEEN UNITS		USABLE LENGTH ft (m)	RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO				FROM	TO	
15 **See Note 1**	1.571 (1013)	MRCC Unit	MS5	See row NOTES	— —	1.0 (25.4) 1.0 (25.4)	Flexible Tubing Flexible Tubing	Flexible Tubing Flexible Tubing	Group MUST NOT EXCEED limitations specified in Section 8–2–2 MRCC to Shield/Cryo Cooler Compressor: Water Cooling Lines & Hoses Requirements
52	0.110 (71)	MRCC Unit	RCP	92 (28.0) See row NOTES	—	0.375 (9.5)	Hard Wired	Hard Wired	Usable length allows the RCP to be mounted 5 ft (1.5 m) above the floor.
Note 1 This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).									

9 BrainWaveHW Lite Option Interconnects

The BrainWaveHW Lite option consists of the following items:

- BrainWaveHW Lite Cabinet
- Push button Response Boxes
- Interconnect cables

Illustration 7–10 shows the Interconnect Diagram. Table 7–16 contains the cable data.



BrainWaveHW Lite OPTION GROUP INTERCONNECT DIAGRAM
ILLUSTRATION 7–13

9 BrainWaveHW Lite Option Interconnects (Continued)

TABLE 7–21
BrainWaveHW Lite OPTION INTERCONNECT LIST

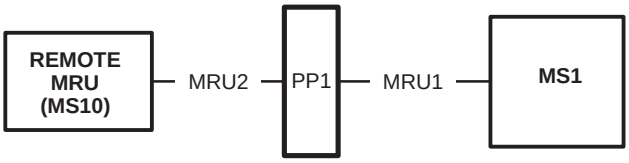
GROUP NUMBER	GROUP AREA in.²(mm²)	BETWEEN UNITS		USABLE LENGTH ft (m)	RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO				FROM	TO	
A	0.243 (158)	BW	MR2	10 (3.0)	520423	0.38 (9.7)	1.45x2.5 (36.8x63.5)	1.45x2.5 (36.8x63.5)	Trigger Extension Cable
					560202	0.32 (8.1)	1.28x3.0 (32.5x76.2)	Hardwired	AC Power
					758616	0.25 (6.4)	0.50x0.88 (12.7x22.3)	0.50x0.88 (12.7x22.3)	Network Cable
B	0.113 (74)	BW	PP1	60 (18.3)	979153	0.38 (9.7)	0.72x2.43 (18.3x61.7)	1.26x1.75 (32.0x44.5)	DC Power – Response
C	0.113 (74)	PP1	Push button Response Boxes	53 (16.2)	979152	0.38 (9.7)	1.26x1.75 (32.0x44.5)	0.72x2.43 (18.3x61.7)	DC power – Response This run contains a connector at MG2 with a separate cable routed out to the Push button Response Boxes.

10 Remote MRU Option Interconnects

The Remote MRU option consists of the following items:

- Secondary MRU
- Remote MRU Connector Box (to be mounted inside the Magnet Enclosure)
- Interconnect cables

Illustration 7–14 shows the Interconnect Diagram. Table 7–22 contains the cable data.



DISTANT REMOTE CONSOLE CABLING
ILLUSTRATION 7–14

TABLE 7–22
OXYGEN MONITOR INTERCONNECT LIST

GROUP NUMBER	GROUP AREA in.²(mm²)	BETWEEN UNITS		USABLE LENGTH ft (m)	RUN NUMBER	CABLE DIAMETER in. (mm)	PLUG PULLING DIAMETER X LENGTH in. (mm)		NOTES
		FROM	TO				FROM	TO	
MRU1	0.071 (45.6)	PP1	MS1	81.0 (24.69)	1265	0.30 (7.6)	1.30x2.00 (33.5x50.8)	0.787x2.33 (20.0x59.2)	
MRU2	0.071 (45.6)	MS10	PP1	88.0 (26.82)	1266	0.30 (7.6)	0.787x2.33 (20.0x59.2)	1.30x2.00 (33.5x50.8)	

Chapter 8 – RF Shielded Room

1 RF Shielded Room Requirements

Improvements in MR imaging technology have increased imaging capabilities. MR procedures require a stable RF environment to achieve high resolution image quality. RF sources both inside and outside the Magnet Room have the potential to adversely affect image quality. Therefore the Magnet Room must be properly RF shielded to prevent external RF sources from entering the room. In addition, the selection of materials and construction methods of the RF Shield must be designed and installed to minimize the generation of adverse signals within the RF Shield and Magnet Room.

1–1 RF Shielding Background

RF sources which can adversely affect image quality may be generated by discrete frequency or broadband noise (RF) sources.

1–1–1 Discrete Frequency

Discrete RF interferences are narrowband and are fixed frequency in nature. The Magnet Room must be RF shielded from RF sources so external RF energy do not degrade the MR system RF receivers at the system imaging frequencies, refer to Chapter 5 Section 12 Ambient Radio Frequency Interference (RFI). Some potential sources for discrete frequency signals are radio station transmitters, mobile or hand–held RF transmitting devices, etc.

1–1–2 Broadband RF Noise

Broadband RF noise is a single transient or continuous series of transient disturbances caused by an electrical discharge, refer to Chapter 5 Section 12 Ambient Radio Frequency Interference (RFI). Low humidity environmental conditions will have higher probability of electrical discharge, refer to Chapter 5 Section 3 Temperature And Humidity Specifications. Electrical discharge can occur due to electrical arcing (micro arcing) or merely a static discharge. Some sources capable of producing electrical discharge and have the potential to adversely affect image quality include:

- loose hardware/fasteners vibration or movement (electrical continuity must always be maintained)
- flooring material including raised access flooring (panels & support hardware) and carpeting
- electrical fixtures
  - lighting fixtures
  - track lighting
  - emergency lighting
  - battery chargers
  - outlets
- ducting for HVAC and cable routing
- RF Shield seals (walls, doors, windows, etc.).

1–2 RF Shielded Room Requirements

The Magnet Room RF Shield must meet the requirements defined in Table 8–1 for the system to produce high quality MR images.

Note

The RF Attenuation and Ground Isolation are intended to control discrete RF signals and RF interference sources. The remaining parameters contained in Table 8–1 are intended to minimize potential broadband noise sources.

TABLE 8–1
RF SHIELDED ROOM REQUIREMENTS

PARAMETER See Note *	**REQUIREMENTS See Note ***
RF Attenuation	• 100dB (100MHz ± 10MHz) planewave, refer to Chapter 12 Section 2 RF Shielded Enclosure Test Guideline, Frequency Range subsection.
Ground	• Ground Isolation: 1,000 ohms or greater • Primary Ground: All RF Shield components (walls, floor, ceiling, etc) must be electrically bonded together to form one common ground plane which is connected to the Facility Grounding Conductor. – The RF Shield must be grounded back to the facility ground via the Common Ground Stud connection to the MR system PDU. **Note:** Introduction of facility power into the RF Shielded Room must not compromise the RF Shield Primary Ground. • Secondary Ground (Other grounds that connect the outside of the RF Shield Room to earth grounds are called secondary grounds.): Secondary grounds must not compromise Ground Isolation of 1,000 ohms or greater. • Refer to Section 7 Anchor Specification For MR Equipment Inside RF Shielded Room for additional information on electrical isolation requirement.
(Continued)	

1–2 RF Shielded Room Requirements (Continued)

TABLE 8–1 (Continued)
RF SHIELDED ROOM REQUIREMENTS

PARAMETER See Note *	REQUIREMENTS See Note *
Materials	• The choice of RF Shield material including fasteners is the responsibility of the customer's architect and RF vendor. • The choice of material must not affect magnet homogeneity (i.e. copper, brass or treated aluminum are non–magnetic and will not affect Magnet homogeneity). **Note:** Any steel RF Shield will affect the magnet's homogeneity and must be reviewed by GE Healthcare MR Siting and Shielding Group. • The floor under the Magnet in a 10 ft x 10 ft (3.048 m x 3.048 m) area must not be fabricated from magnetic materials, refer to Chapter 5 Section 15–1 Magnet Room Floors Magnetic Properties. • The Magnet Room floor materials must meet the requirements in Section 6–5 Magnet Room Floors. • The door or any other moving or non–rigid parts must not be fabricated from magnetic materials. • The RF Shield integrity (attenuation) must not be compromised by corrosion for the anticipated duration of usage for MR imaging. The following items are critical: – Avoid direct contact of materials of different solution potential (e.g. dissimilar metals galvanic corrosion) when selecting fasteners to secure the RF screen material to the RF supporting structure. – Ensure the RF shield seams/joints have overlaps that are properly dressed selecting proper material to avoid galvanic corrosion. – Introduce sacrificial anodes to prevent corrosion of critical RF shield components. **Note:** Typically the RF Shield surrounds the Magnet Room finished walls, ceiling, and floor. Therefore the RF Shield may not be in a temperature and humidify controlled environment. • It is highly recommended the RF Shield vendor use a water seal / thin coat of lacquer to protect any exposed RF shield material from condensation produced when servicing the Magnet cryogens or from cleaning liquids. • RF Screen Room including all openings (i.e. windows, doors, vents, etc.) need acoustic properties to meet local regulations and customer requirements. **Note:** RF Screen Room doors with <55db acoustic attenuation have caused customer acoustics issues. Refer to Chapter 5 Section 8 Acoustics for additional information.
(Continued)	

1–2 RF Shielded Room Requirements (Continued)

TABLE 8–1 (Continued)
RF SHIELDED ROOM REQUIREMENTS

PARAMETER See Note *	**REQUIREMENTS See Note ***
Construction	• The design of the shield support system is the responsibility of the customer's architect and RF vendor. • RF Shield construction methods must not compromise RF Shield integrity (attenuation) for the anticipated duration of usage for MR imaging. – When RF shield seams/joints are sealed with solder: all solder drips, cold solder joints, and cracked solder joints must be cleaned and repaired. – RF Shield movement can cause micro electrical arcs (static discharge or broadband RF noise) that will cause MR image artifact known as White Pixel. – Physical fluctuation of the RF Shield material can result in RF leaks due to seam openings, cracks, enlarged holes at fasteners. Physical fluctuation of the RF Shield can be generated by cyclic air pressure changes and door closures/openings. – All electrical and mechanical connections and fasteners including screws, nails, nuts, bolts, clips, clamps, etc. must be sufficiently tightened and secured so as not to become a potential broadband noise source, refer to Section 1–1–2 broadband noise for definition. – Self–tapping screws and pop rivets tend to loosen as force or vibration is applied. Therefore self–tapping screws or pop rivets are not to be used within 2 feet (0.61 m) of the Gradient Cables inside the RF Shield due to the potential of screws and metal interaction becoming a source of broadband noise. – Site constructed or purpose built interconnect raceways must meet all construction and material requirements contained in this table to avoid the potential of becoming a broadband noise source. **Note:** Electrical and mechanical connections/fasteners and access flooring removable panels are known sources of RF broadband noise. The use of non–magnetic metal material (e.g. aluminum) must have individual or potentially loose parts (i.e. nuts, panel to panel joints, panel to standoffs or supports, etc.) electrically isolated or fully grounded. • The Magnet Room floor design and construction must meet the requirements in Section 6–5 Magnet Room Floors. • It is the customer's responsibility to coordinate mounting methods for equipment in the Magnet Room with the RF Shielded Room vendor to prevent RF leaks and secondary grounding problems. For additional information refer to Section 7–1 Anchor Hardware For MR Equipment Inside RF Shield, Section 7–2 Physical Characteristics, Section 7–3 Anchor Location and Installation, Section 7–4 Clamping Force (Tension) And Pull Test, Section 7–5 RF Shield Integrity, Section 7–6 Electrical Isolation, and Section 8 Magnet Room Equipment Mounting. **CAUTION** **For safety reasons, magnetic material must be secured to ensure magnetic components do not become projectiles. Methods of securement must not loosen due to repeated use, some options include (but not limited to) redundant restrains straps or anchors/bolts with locking nuts.**
Testing	• The customer's architect and RF vendor are responsible for conducting testing to verify compliance with the requirements for RF attenuation and ground isolation. • The RF shielded room verification test is to be performed in the presence of a GE representative. • The FINAL RF Shielded room acceptance test shall be performed in accordance with Chapter 12 Section 2 RF Shielded Enclosure Test Guideline.
Maintenance	• The customer is responsible for maintaining the RF Shield service life integrity for the anticipated duration of usage for MR imaging per the RF vendor's recommended maintenance. • The customer is responsible to notify the GE Service Representative of any RF shielded Room maintenance issues since there may be system performance impacts.
Note * The RF Shielded Room design, materials, construction, and installation shall be such to meet the requirements for the anticipated duration of usage for MR imaging.	

2 Vents

2–1 Cryogenic

Due to normal boil–off of liquid helium and the possibility of a quench with superconducting magnets, outside cryogenic venting is required. RF shielded room contractor is to provide one straight pipe with maximum 0.125 in. (3.175 mm) wall thickness for the cryogenic vent pipe/waveguide. The vent pipe/waveguide is to be made of non–magnetic material which is grounded to the RF room and electrically isolated from any other grounds. The vent pipe/waveguide must extend inside and outside of the RF shielded room to allow for non–metallic isolation joint connections. The HVAC (heating, ventilation, and air conditioning) contractor is to make cryogenic vent connections to vent pipe/waveguide outside of the RF shield and GE will make the normal connection in the Magnet Room. Refer to Section 10–3, Requirements For Inside Magnet Room, for exceptions.

2–2 Determining Cryogenic Vent Location

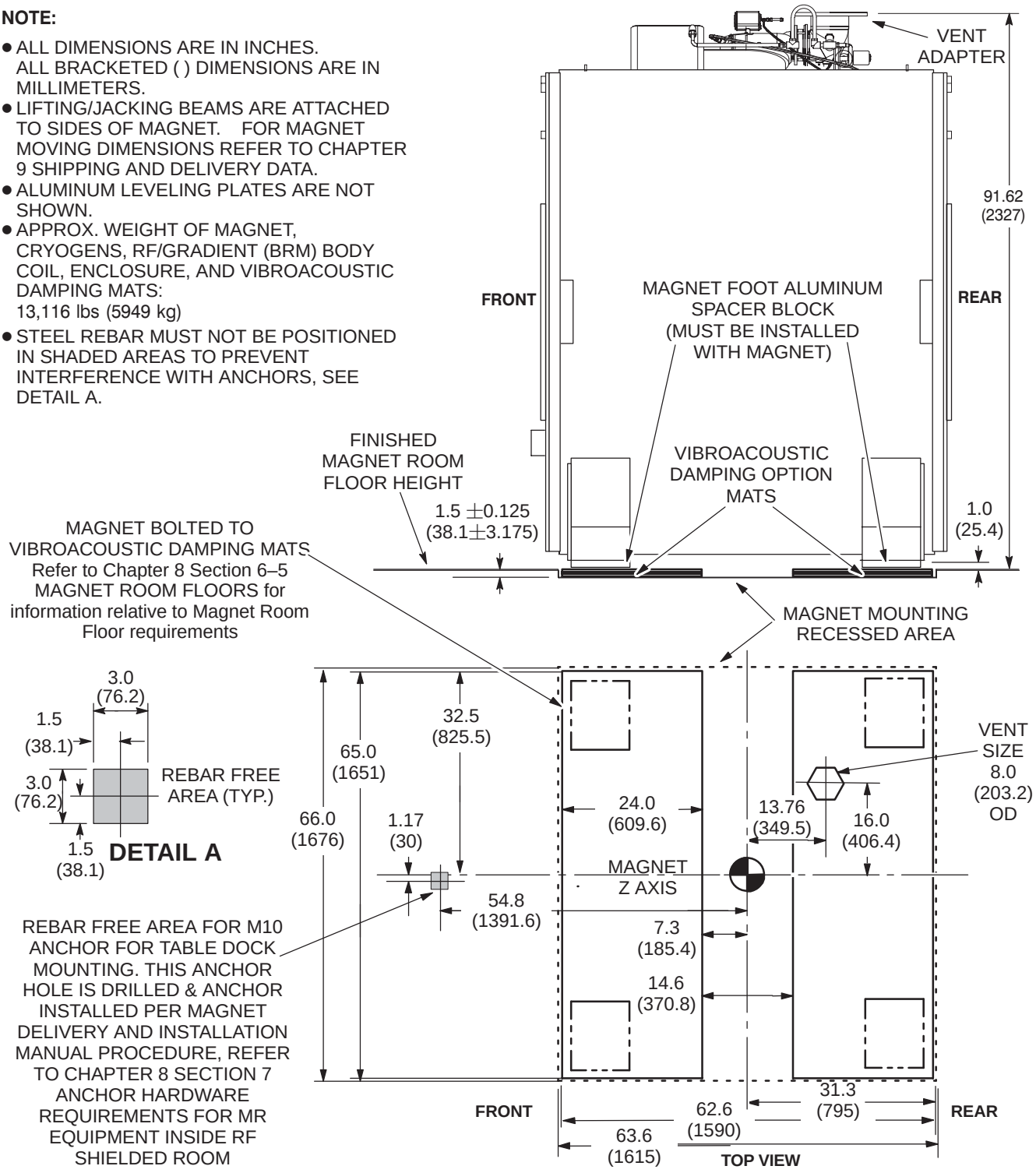
Shown in Illustration 8–1 and 8–2 is the LCC magnet vent location. It is important that the 0.25 in. (6.35 mm) tolerance for vent opening be met. Included with the 1.5T LCC (Active Shield) magnets is a vertical helium vent tube made with tubing of 6061–T6511 aluminum tubing 8 in. (203.2 mm) OD x 0.125 in. (3.175 mm) wall, per ASTM B241. A typical route for this vent tube is shown in Illustration 8–3. However, if the tolerances shown in Illustration 8–1 can not be met, the customer's contractor is responsible for the design and installation of a cryogenic vent system which meets the requirements in Chapter 5 Section 10 Cryogenic Venting.

GE provides a Floating Flange Vent Adaptor Kit with all of the 1.5T LCC Active Shield magnet. The kit increases the vent adapter radial adjustability in any direction to one inch (25.4 mm). The adjustability helps absorb some mismatch (1 inch (25.4 mm) in any horizontal direction) of the locations of the Vent Pipe from the magnet and the Ceiling Vent Pipe, installed by the RF Room contractor. See Illustration 8–4. The GE provided Vent Pipe is 24 inches (610 mm) long with a wall thickness of 0.125 inch (3.175 mm) and may be cut short to create 1 $\pm$ 0.25 inch (25 $\pm$ 6 mm) gap between the Vent Pipe and the Ceiling Waveguide for dielectric isolation to ensure the integrity of the RF shield room.

2–2 Determining Cryogenic Vent Location (Continued)

NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- LIFTING/JACKING BEAMS ARE ATTACHED TO SIDES OF MAGNET. FOR MAGNET MOVING DIMENSIONS REFER TO CHAPTER 9 SHIPPING AND DELIVERY DATA.
- ALUMINUM LEVELING PLATES ARE NOT SHOWN.
- APPROX. WEIGHT OF MAGNET, CRYOGENS, RF/GRADIENT (BRM) BODY COIL, ENCLOSURE, AND VIBROACOUSTIC DAMPING MATS: 13,116 lbs (5949 kg)
- STEEL REBAR MUST NOT BE POSITIONED IN SHADED AREAS TO PREVENT INTERFERENCE WITH ANCHORS, SEE DETAIL A.

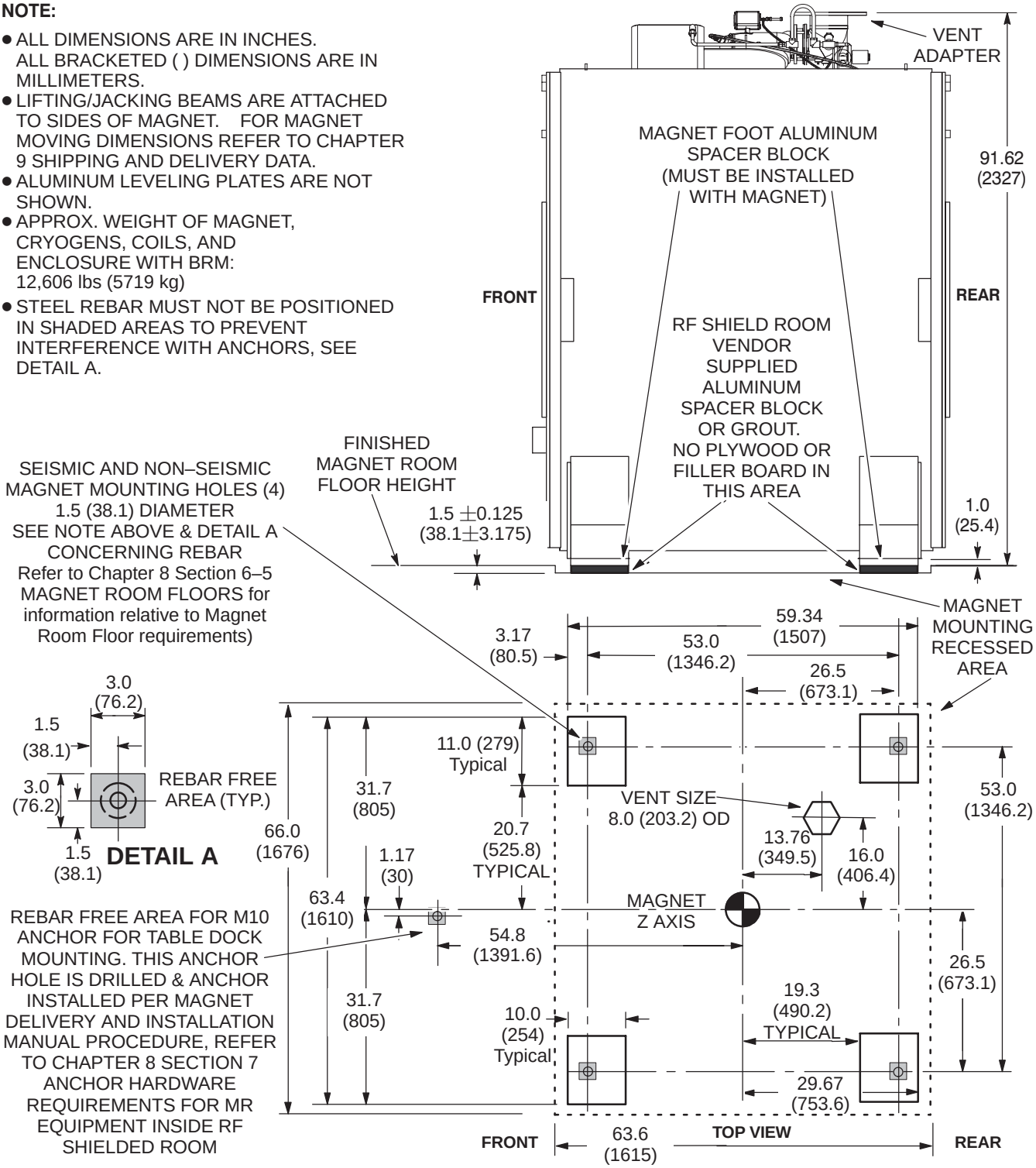


LCC MAGNET CRYOGENIC MOUNTING & VENT LOCATION WITH VIBROACOUSTIC DAMPING OPTION
ILLUSTRATION 8–1

2–2 Determining Cryogenic Vent Location (Continued)

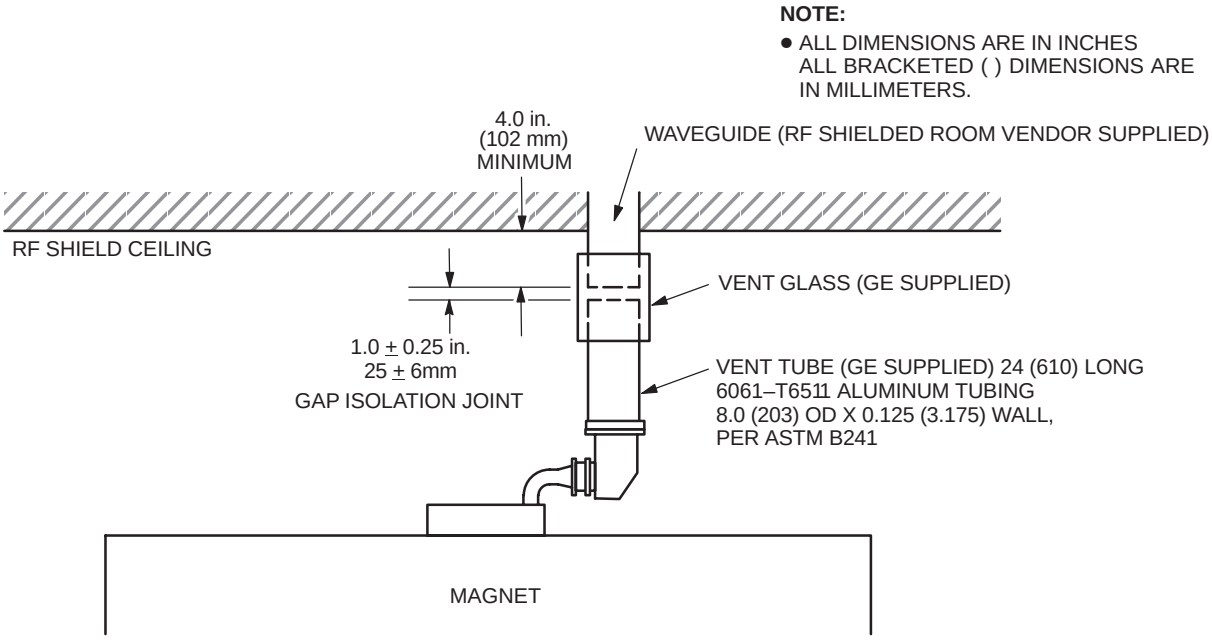
NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- LIFTING/JACKING BEAMS ARE ATTACHED TO SIDES OF MAGNET. FOR MAGNET MOVING DIMENSIONS REFER TO CHAPTER 9 SHIPPING AND DELIVERY DATA.
- ALUMINUM LEVELING PLATES ARE NOT SHOWN.
- APPROX. WEIGHT OF MAGNET, CRYOGENS, COILS, AND ENCLOSURE WITH BRM: 12,606 lbs (5719 kg)
- STEEL REBAR MUST NOT BE POSITIONED IN SHADED AREAS TO PREVENT INTERFERENCE WITH ANCHORS, SEE DETAIL A.

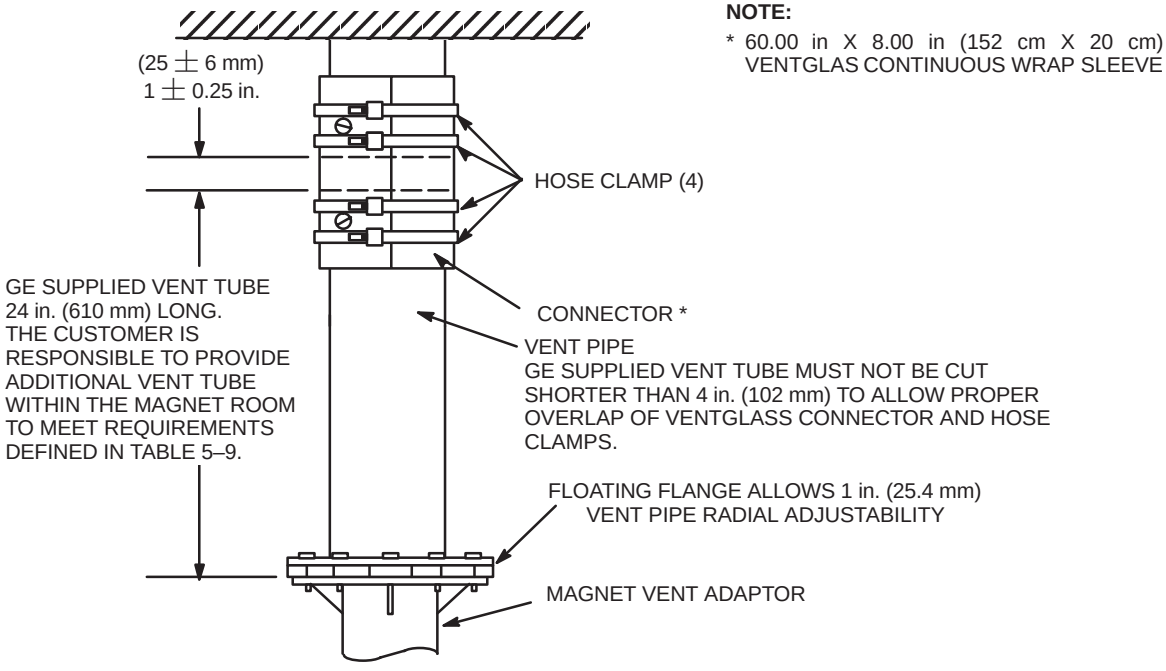


LCC MAGNET CRYOGENIC MOUNTING & VENT LOCATION WITHOUT VIBROACOUSTIC DAMPING OPTION
ILLUSTRATION 8–2

2–2 Determining Cryogenic Vent Location (Continued)



CRYOGENIC VENT ROUTING
ILLUSTRATION 8–3



FLOATING FLANGE
ILLUSTRATION 8–4

2–3 Waveguide

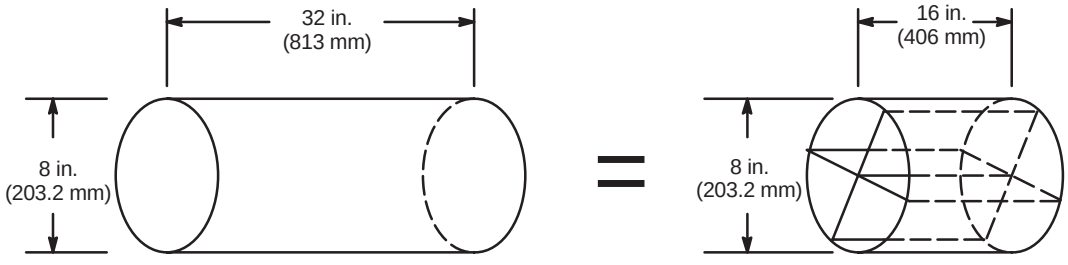
RF shield room contractor/designer is responsible for choosing and installing a RF shield waveguide . The generally accepted length of the waveguide is four times the outside diameter of the tube. Therefore, an 8 in. (200 mm) OD waveguide should be 32 in. (800 mm) long. Refer to Table 8–2 for list of GE requirements for the waveguide.

TABLE 8–2
WAVEGUIDE REQUIREMENTS

PARAMETER	REQUIREMENTS
WAVEGUIDE SIZE	• If the provided GE vent tube is to be connected directly to the waveguide via the GE Ventglas method, the outside diameter of the waveguide must match the outside diameter of the GE vent tube within ± 0.125 in. (3 mm). Larger mismatches in diameters will result in unacceptable leakage during a quench. • The generally accepted length of the waveguide is four times the inside diameter of the tube. Therefore, an 8 in. (203.2 mm) OD waveguide should be 32 in. (813 mm) long.
WAVEGUIDE MATERIAL	• The Waveguide must be constructed from one of the GE accepted materials (i.e. stainless steel, aluminium or copper). Typically, the waveguide is made from the same material as the RF shielded enclosure to avoid dissimilar metal interfaces (i.e. galvanic reaction).
WAVEGUIDE CONSTRUCTION	• The waveguide does not have to be positioned equally on either side of the RF ceiling (or wall). For example, 6 in. (152.4 mm) of a 32 in. (813 mm) long waveguide may hang down below the RF ceiling with the remaining 26 in. (660 mm) extending above. • If a 90 degree elbow is required to avoid ceiling structures, the elbow can be a part of the waveguide and contribute to its overall length. Waveguides do not have to be completely straight. • If a full length waveguide is not possible due to structural interferences, a shorter waveguide can be fabricated by dividing the inside volume into no more than four chambers. For example, if an 8 in. (203.2 mm) OD waveguide is divided into four equal chambers, as shown in Illustration 8–5, the length of the waveguide may be decreased from 32 in. (813 mm) to 16 in. (406 mm). If this technique is used, 1 psig must be added to the pressure drop calculation to account for the pressure drop of the four chambered waveguide. (Chapter 5 Section 10 Cryogenic Venting) • Flat, honeycomb type waveguide is not acceptable.

NOTE:

- 1 psig MUST BE ADDED TO THE PRESSURE DROP CALCULATION TO ACCOUNT FOR THE PRESSURE DROP OF THE FOUR CHAMBERED WAVEGUIDE.
- IN A CASE OF WAVEGUIDE LENGTH RESTRICTION, A HALF LENGTH WAVEGUIDE WITH FOUR CHAMBERS MAY BE USED.



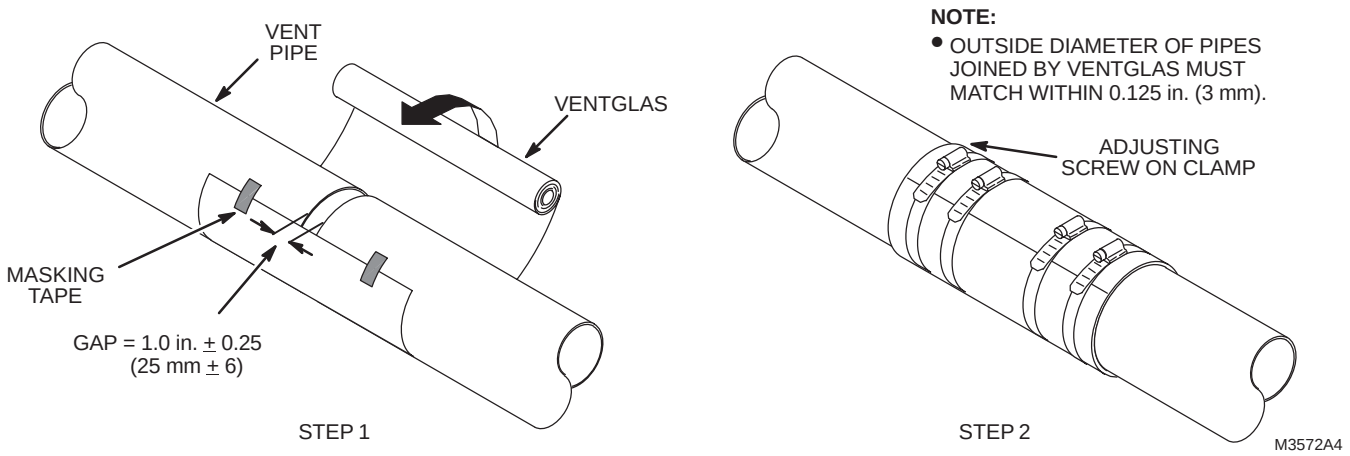
4 CHAMBER WAVEGUIDE
ILLUSTRATION 8–5

2–4 Guide For Outside RF Room Isolation Joint

The RF shielded room contractor/designer is responsible for choosing and installing an isolation joint outside of the RF shielded room as shown in Chapter 5 Section 10–2 Requirements For Outside Magnet Room. This isolation joint is required to maintain the single point ground concept for the RF shielded room. Table 8–3 contains suggestions for the RF room isolation joint.

TABLE 8–3
OUTSIDE RF ROOM ISOLATION JOINT SUGGESTIONS

PARAMETER	ISOLATION JOINT SUGGESTIONS
ISOLATION JOINT MATERIAL	• PVC, rubber or soil pipes **must not** be used to construct the isolation joint. • Ventglas and Lorenz clamp are two GE recommended methods of achieving the isolation.
ISOLATION JOINT CONSTRUCTION	• Ventglas: If the connection diameter is 8 in. (203 mm), a Ventglas connection method as shown in Illustration 8–6 is recommended. • Lorenz clamp: If the connection diameter is 8 in. (203 mm), a Lorenz clamp connection as shown in Illustration 8–7 is recommended. • The mating diameters must match within ± 0.125 in. (3 mm). • The Ventglas **must not** be used for structural support.
INFORMATION	• Ventglas information may be obtained from: Industrial Machine & Fabricating Inc. 2808 E Sammys Lane Florence, SC 29506–3841 USA (843) 667–4582 e–mail address indmachfab@aol.com Vent Fabrics Inc. 5520 N Lynch Avenue Chicago, IL 60630–1418 USA (800) 621–1207 or (773) 775–4477 web site address www.ventfabrics.com • Lorenz clamp information may be obtained from: Lorenz and Son Mfg. Co. LTD. P.O. Box 1002 Cobourg, Ontario, Canada K9A4W4 (905) 372–2240, fax (905) 372–4456

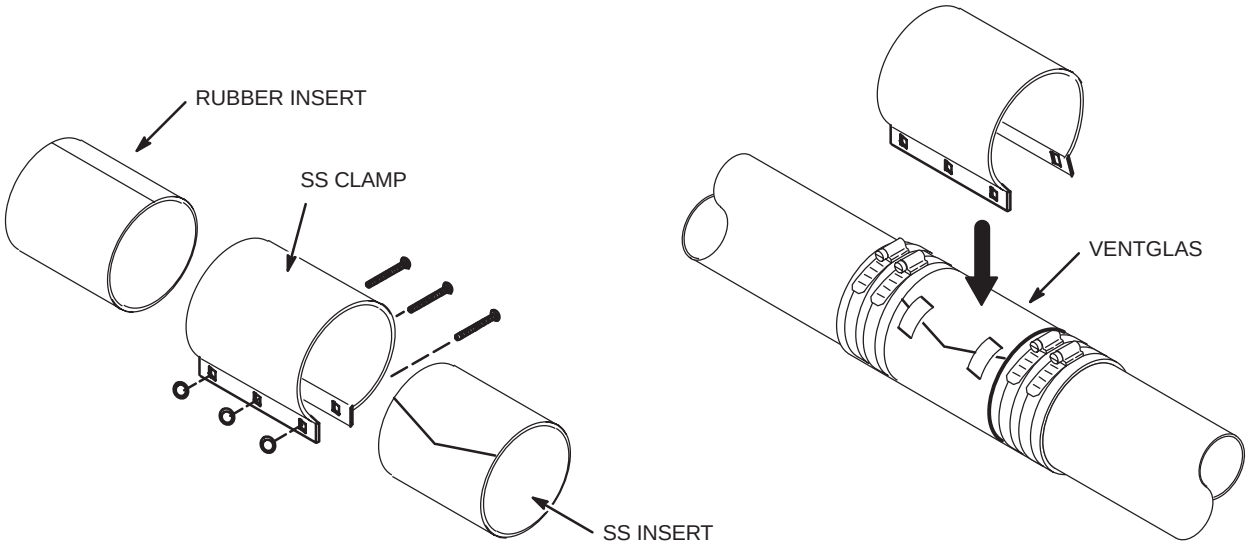


VENT GLASS CONTINUOUS WRAP
ILLUSTRATION 8–6

2–4 Guide For Outside RF Room Isolation Joint (Continued)

NOTE:

- LORENZ CLAMP IS ATTACHED OVER THE VENT GLASS FOR ADDED REINFORCEMENT.
- SS = STAINLESS STEEL



LORENZ CLAMP
ILLUSTRATION 8–7

2–5 HVAC

RF shielded room contractor is to install HVAC waveguides (open pipes or honeycomb–type) which penetrate room and to ensure waveguides are non–magnetic and electrically isolated. HVAC contractor is to determine size and number of vents, consistent with local codes.

Honeycomb–type must be accessible for annual customer inspection and cleaning / maintenance.

An exhaust fan placed outside the RF shielding with appropriate wave guide filtering is required for quick removal of helium gas in the event large amounts of helium disperse into the Magnet Room. The exhaust fan can be connected to the output relay of the optional oxygen monitor. The fan will then be activated in the event the room oxygen level is less than 18%. Refer to Section 9, ROOM VENTILATION, for other exhaust fan requirements.

3 Plumbing

All metallic pipes entering the RF Room, excluding cryogenic vent and floor drains, must be located within 30 inches (762 mm) of the RF common ground.

Notice!

Mounting and support of all metallic pipes must comply with Section 1 RF Shielded Room Requirements requirements to minimize the possibilities of electrical discharge which can cause RF broadband noise.

Note

When welding in an MR room with system equipment installed, the return path for the welding must be in very close proximity to the welding. The close proximity is needed to make sure the welding currents do not cause damage to the system. Never use the building structure as a return path for welding.

3–1 Water

All pipe waveguides must meet the 100 dB requirements. If a floor drain is to be installed in the Magnet Room, it must be electrically isolated and meet the 100 dB requirements. All plumbing must be consistent with local codes.

3–2 Medical Gases

The customer should consider if medical gases are to be piped into the Magnet Room along with suction service for patient life support. Remember, all non–electrical entries into the Magnet Room must use appropriate waveguide. Special precaution must be taken to ensure that ferromagnetic medical gas cylinders are not brought into the Magnet Room.

3–3 Sprinklers

If using sprinklers in the Magnet Room, dry pipe systems have the advantage of reducing ground problems. However, all decisions regarding fire protection systems are the customer's responsibility. If wet–type sprinkler system is used, pipe penetration should be limited to one location.

4 Electrical

4–1 Electrical Lines and Filters

The entry of any electrical lines into the RF shielded room must be filtered to ensure that the RF shielded room meets the minimum attenuation levels. The RF shielded room vendor must supply filters for all penetrations of the RF shielding excluding the lines entering through the GE supplied RF penetration panel. All filters (for electrical lines) must be located outside the 200 gauss line.

Note

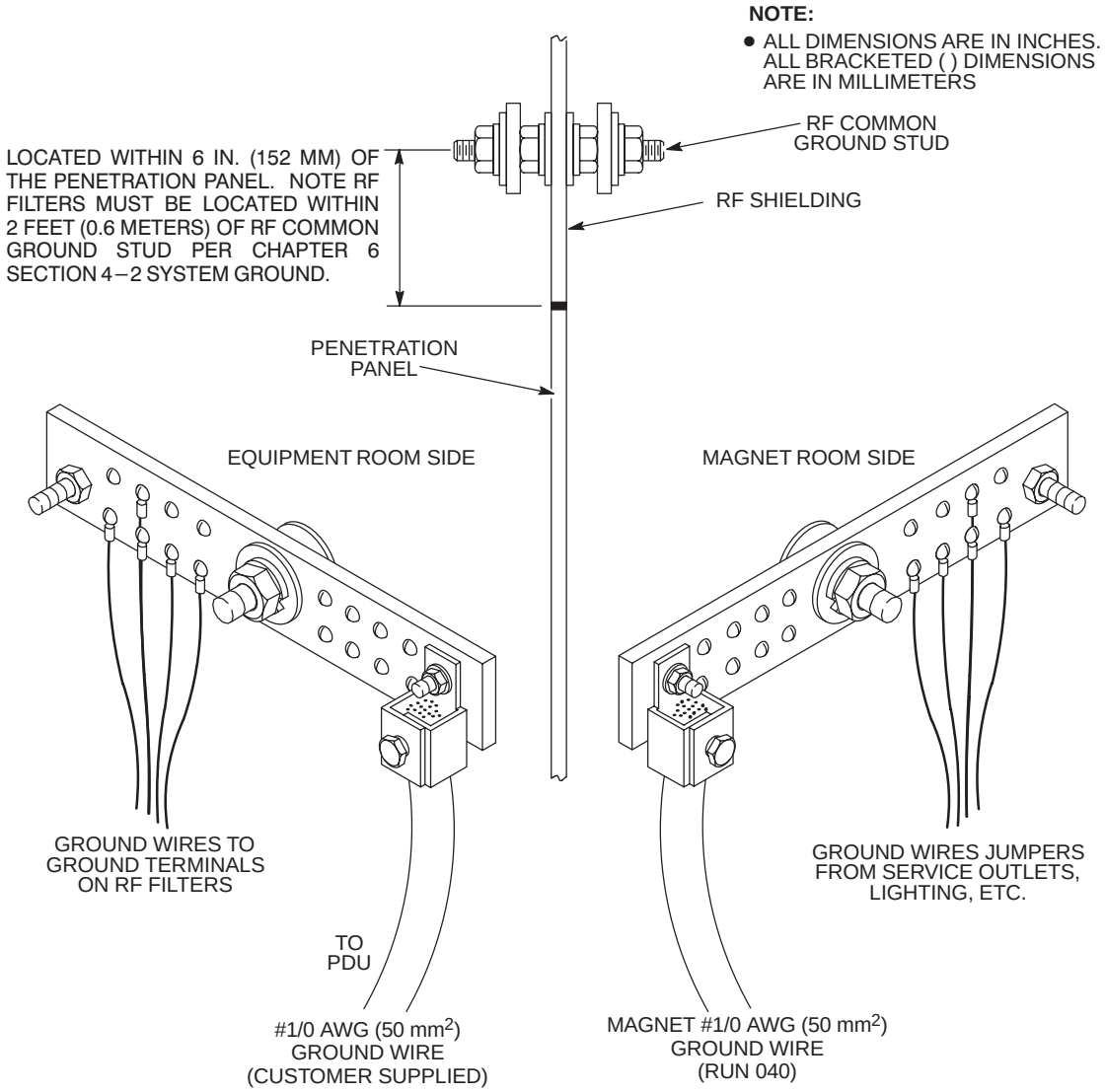
All electrical lines and filters must comply with Section 1 RF Shielded Room Requirements requirements to minimize the possibilities of electrical discharge can cause RF broadband noise.

RF shielded room vendor should review with the electrical contractor the number of incoming power lines to the Magnet Room in determining the number of filters needed for electrical requirements.

Grounding from customer supplied power filters to the RF shield common ground stud. See Chapter 6 Section 4 Grounding for power and grounding requirements of all incoming power lines to the RF shielded room.

Common ground connection for shielded room must be located within 6 in. (152 mm) of the RF shielded room Penetration Panel with RF filters located within 2 feet (0.6 meters) of the RF common ground. RF shielded room vendor to provide this common ground connection on both sides of shielded room by means of a stud extending through the shielded room (see Illustration 8–8). RF Common ground stud must be accessible for servicing purposes on both sides of shield room. For aesthetic purposes, it is recommended that the stud be positioned above the Penetration Panel so it is concealed behind the penetration panel cover (see Illustration 8–11).

4–1 Electrical Lines and Filters (Continued)



RF COMMON GROUND PENETRATION STUD
ILLUSTRATION 8–8

4–2 Room Lighting

Notice!

Installation and selection of lighting fixtures must comply with requirements in Section 1 RF Shielded Room Requirements to minimize the possibilities of electrical discharge which can cause RF broadband noise.

Florescent lighting is not allowed in the Magnet Room due to the RF noise generated by the florescent light tubes. Dimmer switches must not be used; however, a selectable switch may be used to change the light intensity.

For additional Magnet Room lighting information refer to Chapter 5 Section 7 Lighting, Chapter 6 Section 4 Grounding, Chapter 6 Section 7 Emergency Power, Chapter 6 Section 8 DC Lighting Controller (Facility Option), and Chapter 7 Section 4–9 Customer Supplied Interconnects.

5 RF Penetration Panel

Illustrations 8–9 and 8–10 show two different methods for mounting the GE MR Penetration Panel. Either method may be used depending on RF shielded room wall thickness. Ensure if the mounting method in Illustration 8–9 is used then the RF wall thickness is 0.75 in. (19 mm) $\pm$ 0.0625 in. (1.6 mm). Check with RF shielded room vendor to determine appropriate mounting method. The Penetration Panel must be covered on both sides for safety. If GE supplied adjustable covers are not used, customer must furnish covers or enclosures with key or tool required for opening to limit access to the panel.

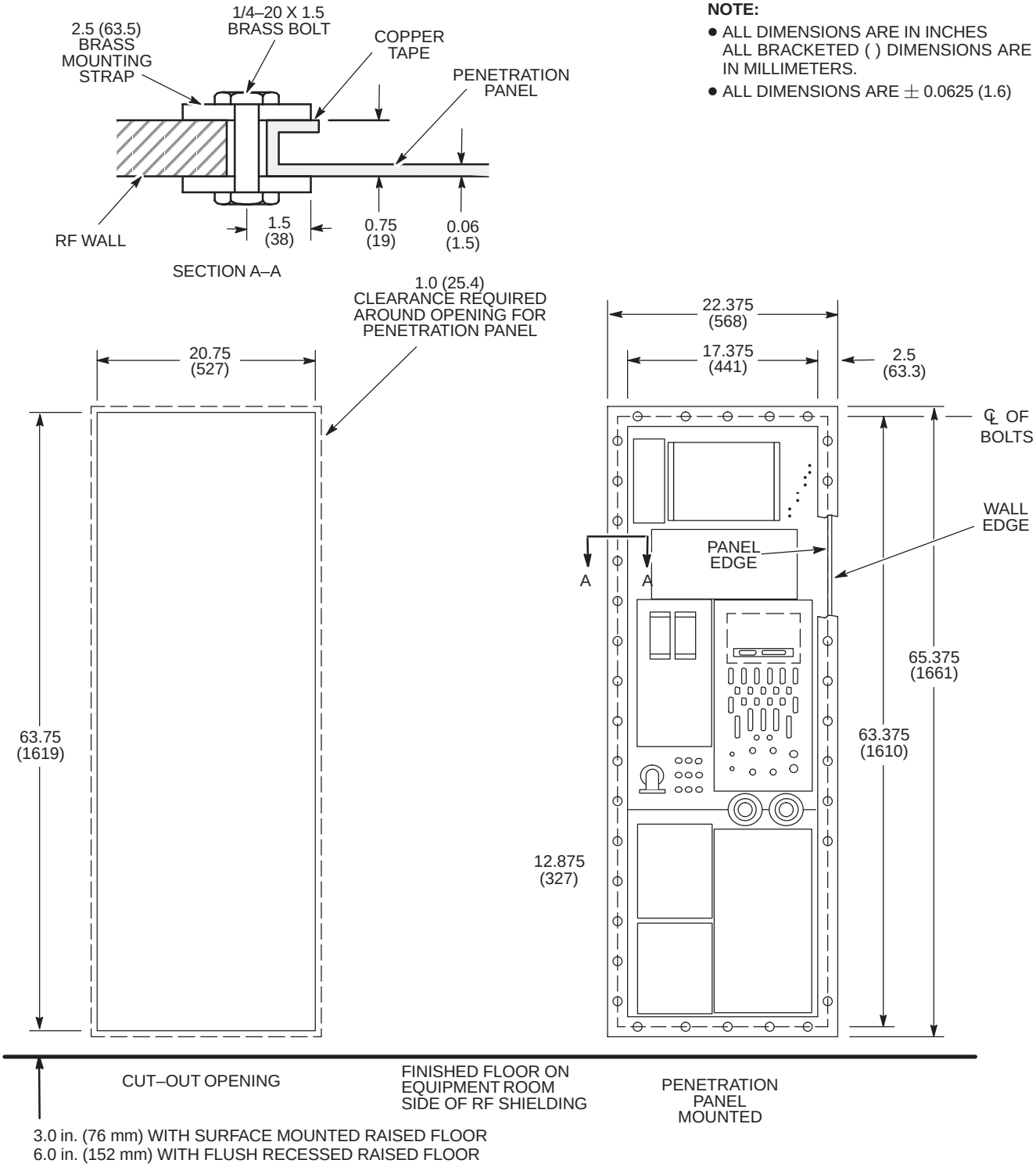
Notice!

Penetration Panel electrical and mechanical connections, mounting hardware, and installation must comply with requirements in Section 1 RF Shielded Room Requirements to minimize the possibilities of electrical discharge can cause RF broadband noise.

The Penetration Panel is to be mounted above the finished floor on the Equipment Room side of the RF shielded room. GE supplies only the Penetration Panel as shown in Illustrations 8–9 and 8–10. The mounting and clearance dimensions for the Penetration Panel covering are shown in Penetration Panel/Covering Mounting Requirements Illustration 8–11.

RF shielded room vendor must provide the opening in the RF shielding and appropriate mounting hardware for the GE penetration panel. The RF shielded room acceptance test must be performed after the opening is cut in the RF shielding for the GE penetration panel. This acceptance test must be conducted with vendor supplied blank panel and the same mounting hardware to be used with the GE penetration panel. It is the facility's responsibility to ensure that the RF shielded room vendor testing meets the attenuation specifications listed in Section 1 RF Shielded Room Requirements.

5 RF Penetration Panel (Continued)

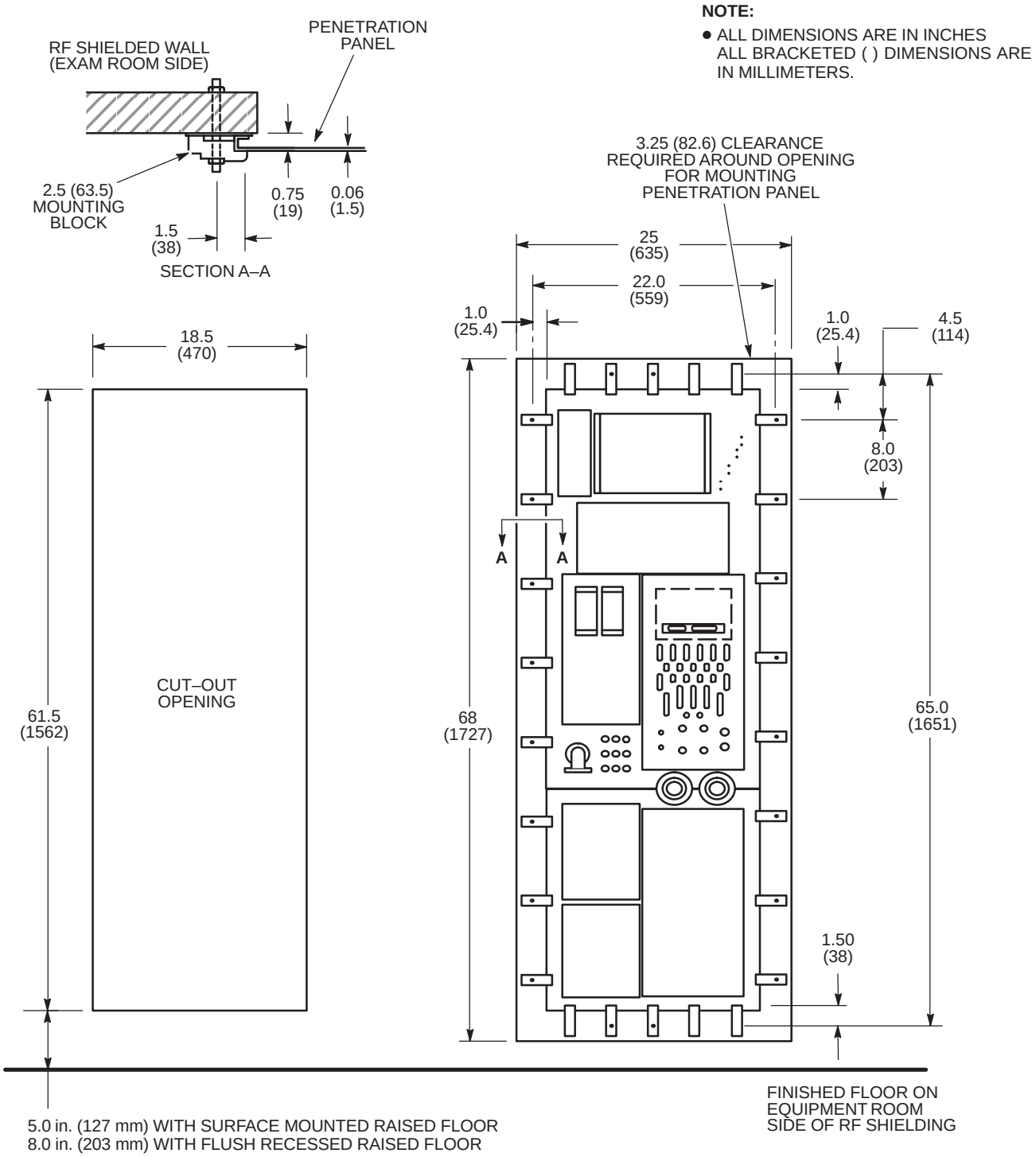


NOTE:

- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- ALL DIMENSIONS ARE ± 0.0625 (1.6)

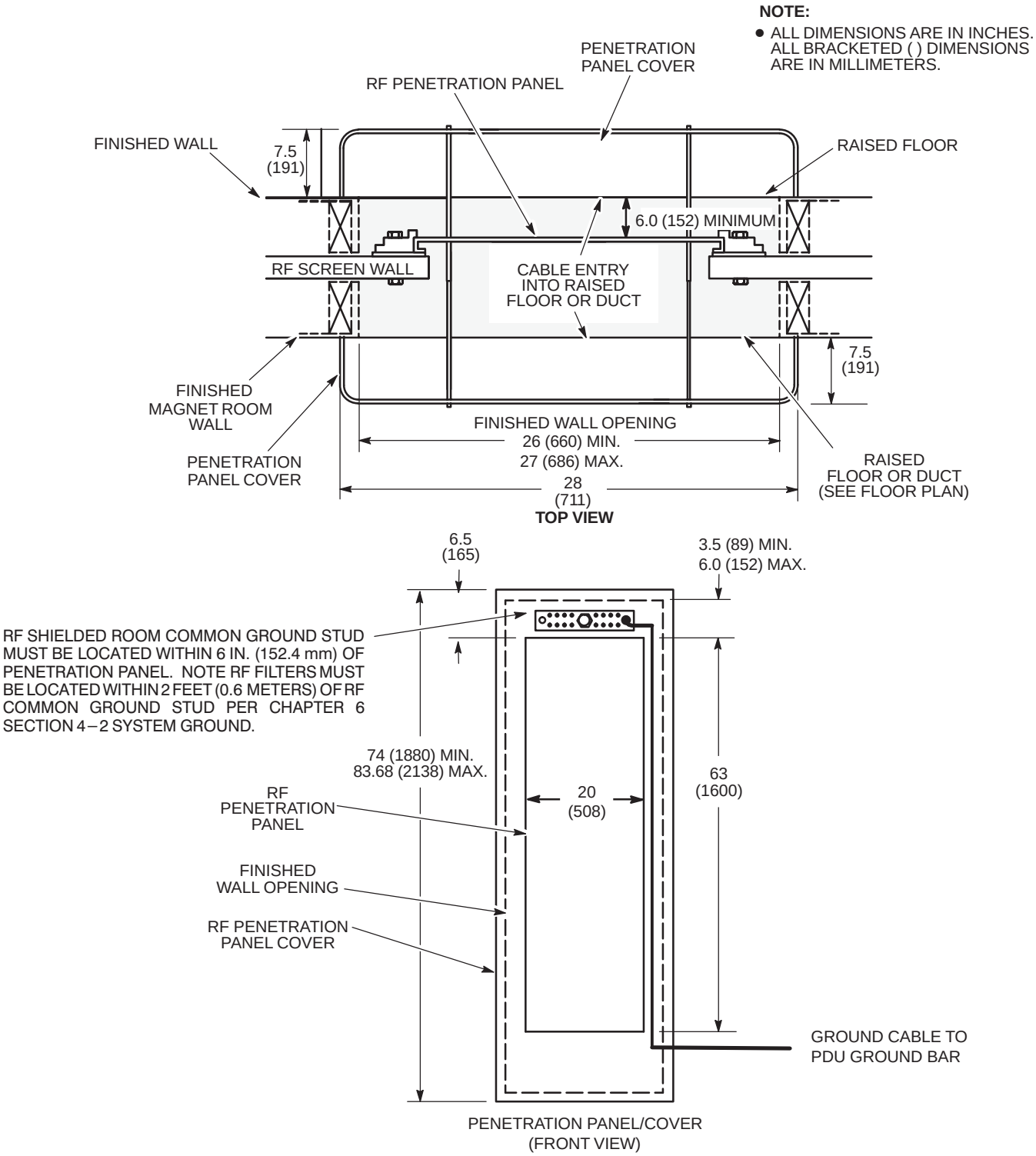
PENETRATION PANEL CUT OUT FOR 0.75 INCH (19 MM) THICK RF WALL
ILLUSTRATION 8–9

5 RF Penetration Panel (Continued)



PENETRATION PANEL CUT OUT FOR RF WALL THICKNESS VARYING FROM SMALL TO LARGE
ILLUSTRATION 8–10

5 RF Penetration Panel (Continued)



PENETRATION PANEL/COVERING MOUNTING REQUIREMENTS
ILLUSTRATION 8–11

6 Physical Considerations

6–1 Introduction

The RF shielded room can be either a free standing shielded structure or a shielded room within an existing room. All styles of RF Shielded Rooms must be electrically isolated from earth ground complying with requirements in Section 1 RF Shielded Room Requirements.

Note

All physical considerations must comply with requirements in Section 1 RF Shielded Room Requirements to minimize the possibilities of electrical discharge that can cause RF broadband noise.

6–2 Doors and Other Openings

Shielded room doors are a major source of RFI leaks and must comply with requirements in Section 1 RF Shielded Room Requirements.

The main door requires a minimum finished opening of 43 in. (1092 mm) to allow for helium dewars and patient tables to pass through the opening. However, a 48 in. (1219 mm) wide door is recommended for easy maneuvering of the Patient Table. Maximum door sill height is 1 in. (25 mm) with a 10 degree maximum threshold inclination.

The magnet delivery into the Magnet/RF Shielded Room requires an access opening into the room which meets the following:

- Wall or ceiling opening to allow sufficient clearance of magnet with rigging equipment, refer to Chapter 9 Section 2 Magnet Shipping Considerations for magnet shipping dimensions and consult with customer provided/arranged riggers to determine clearances required for their equipment.

Note

Consideration for clear opening dimensions is especially important for sites requiring magnetic shielding.

Note

A typical 9 ft wide by 10 ft high removable wall panel or 9 ft by 10 ft ceiling hatch may require a larger opening in the RF Shield wall or ceiling to accommodate panel or hatch mounting hardware.

- Removable panels/hatch mounting and installation must comply with requirements in Section 1 RF Shielded Room Requirements for RF Shield integrity and to minimize the possibilities of electrical discharge can cause RF broadband noise.

- Future access may be required for magnet entrance/exit so there should be contingency plans for such situations.

6–3 Ceiling Height

Table 8–4 lists the Magnet Room absolute minimum ceiling height required for servicing the listed magnets. This height is required for the area directly above the magnet. GE Healthcare, Design Center group must be notified of any ceiling dimensions less than ceiling heights stated in Table 8–4 and shown in Illustration 8–12. The Design Center group can be reached at (262) 548–4500.

TABLE 8–4
MAGNET SERVICING CEILING HEIGHT REQUIREMENTS

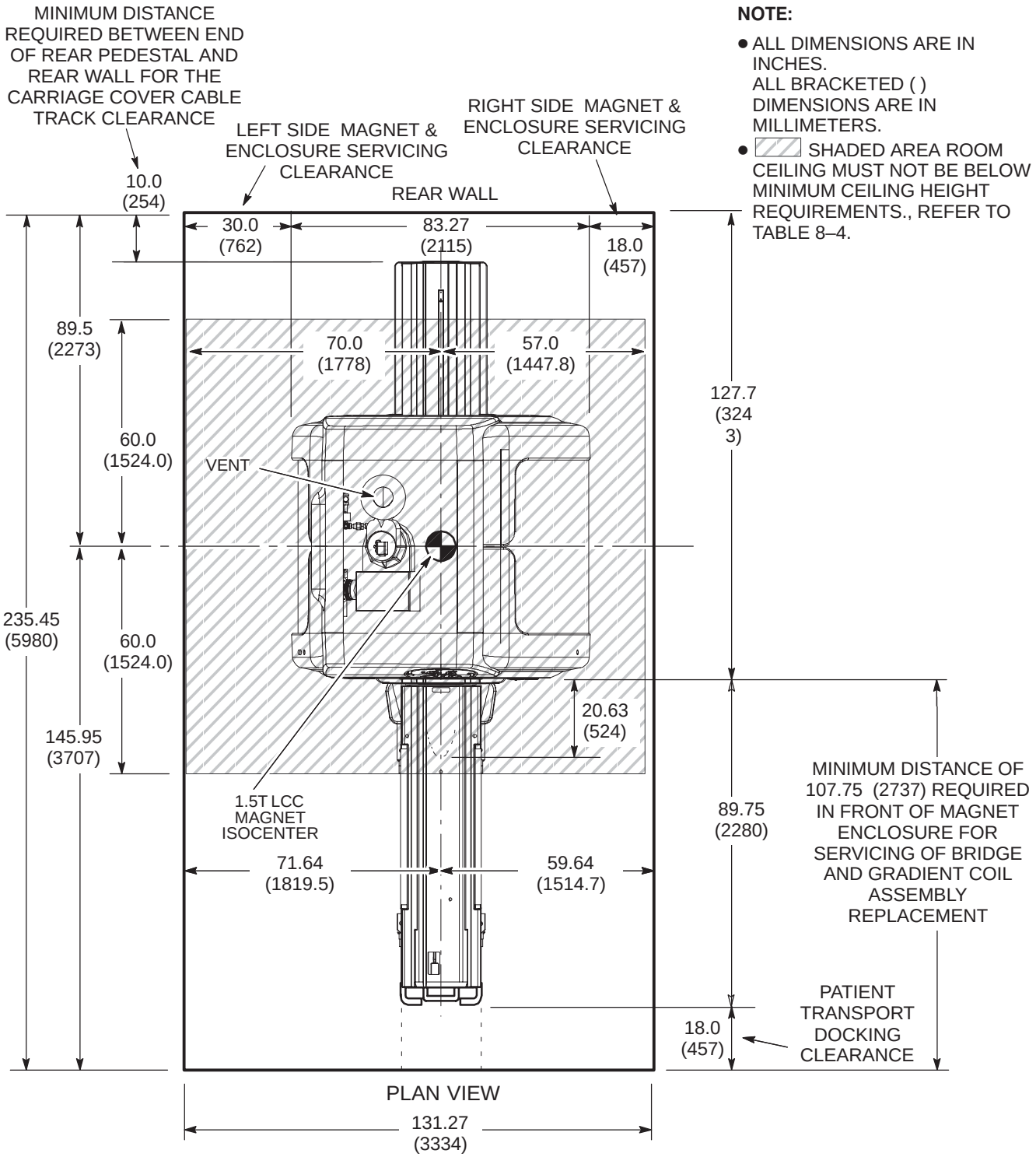
MAGNET TYPE	ABSOLUTE MINIMUM CEILING HEIGHT IN. (MM) See Notes 1 & 2	COMMENTS
1.5T LCC	105 (2667)	Magnet servicing is performed from a platform ladder which is positioned at the Coldhead side of the Magnet. Ceiling height allows for clearance for fill line stinger insertion.
1.5T LCC with Low Ceiling Height Siting Option (M1060SR) installed	98.5 (2500)	Magnet servicing is performed from a platform ladder which is positioned at the Coldhead side of the Magnet. Ceiling height allows for clearance for insertion of fill line with 7 inch (178 mm) stinger adapter.

Note * Magnet servicing is performed on a platform mounted on top of the Magnet. Ceiling height includes 39 inches (991 mm) of clearance for Service Personnel.

1 Absolute minimum ceiling height values are from magnet room finished floor to fixed ceiling.

2 Cryogen vent routing must be considered when using minimum ceiling height.

6–3 Ceiling Height (Continued)



MINIMUM CEILING HEIGHT 1.5T LCC (ACTIVE SHIELD) MAGNET
ILLUSTRATION 8–12

6–3 Ceiling Height (Continued)

Use of a standard valved helium transfill line and a 250 liter dewar (not more than 70 in. (1778 mm) high) requires a ceiling height of 135.5 in. (3442 mm) for inserting transfill line into the dewar. Note that this need only be a 24 in. (610 mm) square ceiling recess located either in the Magnet Room or in an accessible area near the Magnet Room where the transfill line can be inserted into the dewar. A 500 liter dewar (not more than 73 in. (1854 mm) high) requires a ceiling height of 138 in. (3505 mm) for the same process.

If the helium transfill requirements cannot be satisfied in or near the Magnet Room, consider a location outside the building or on a loading dock. The standard valved transfill line, after insertion into either a 500 or 250 liter dewar, will fit through 79 in. (2007 mm) high doorways and hallways. Provide free access from the dewar location to the magnet. If elevators are to be used along cryogen delivery route, verify that elevator dimensions and weight capacity is sufficient to handle the cryogen dewars. Also, elevator must be dedicated with restricted access during cryogen transport (will not allow stops between initial start and final floor destination).

6–4 Walls

It is recommended that walls be covered to protect RF material and to add to the aesthetics of the room for patient comfort. Fire retarding material must be used per building codes. Consult RF Shield Room vendor for RF shielding service requirements prior to covering RF walls. Removable wall covering may be needed if periodic RF shield servicing is required to maintain RF integrity. For wall designs impacts to sound quality improvements within the Magnet Room and to address airbourne acoustics to areas outside the Magnet Room refer to Chapter 5 Section 8 Acoustics.

Note

Walls materials and installation including all electrical and mechanical connections, mounting hardware, and installation must comply with requirements in Section 1 RF Shielded Room Requirements to minimize the possibilities of electrical discharge can cause RF broadband noise.

The recommended patient viewing window dimensions are 48 in. wide by 42 in. high (1219 mm x 1067 mm). The location of the window is dependent on the position of the Operator Workspace. Refer to Chapter 5 Section 8 Acoustics for potential acoustic impact of window location.

Note

The operator at the Operator Workspace must be able to view the patient during a scan.

6–5 Magnet Room Floors

Refer to Table 8–5 for Magnet Room floors requirements and recommendations. Flooring consists of all materials above the structural floor support including subflooring and magnet support/mounting.

TABLE 8–5
MAGNET ROOM FLOOR REQUIREMENTS/RECOMMENDATIONS

AREA	REQUIREMENTS	RECOMMENDATIONS
Floor Design	• Magnet Room floor site steel and iron materials must comply with the requirements in Chapter 5 Section 15–1 Magnet Room Floors Magnetic Properties. • Flooring materials must support the MR system equipment weight, refer to Chapter 3 Section 11 Floor Loading and Weights. • Floors must support the equipment and any transport device needed to move the equipment. • Flooring throughout the system including Magnet Room must be in accordance with local and national codes. • Floor design must consider the MR system interconnect cables are FT4 or equivalent rated, not plenum rated. • The floor design must make sure the dimension of 42.125 in. +0.25 in. (1070 mm +6.35 mm) is maintained from the top of the finished floor to the center of the magnet opening, refer to Chapter 3 Section 3–10 Magnet and Enclosure Magnet Enclosure Front And Rear Views illustration. This will allow the Patient Transport to properly dock to the enclosure. • Electrically conductive materials (access flooring) utilized must comply with requirements in Section 1 RF Shielded Room Requirements to minimize the possibilities of electrical discharge which can cause RF broadband noise. **Notice!** **Access flooring removable panels are known sources of RF broadband noise. The use of non–magnetic metal material (e.g. aluminum) must have individual or potentially loose parts (i.e. nuts, panel to panel joints, panel to standoffs or supports, etc.) electrically isolated or fully grounded.**	

Floor Levelness	• Magnet Room floor levelness must meet the following:
	  • Floor levelness must not be greater than 0.3125 in. (8 mm) between high and low spots over any 120 in. (3048 mm) distance within the area of the Magnet Enclosure and the area in front of the Enclosure for accurate Patient Table docking, see shaded area shown in Illustration 8–13.
	  • The Magnet mounting area (shown in Illustration 8–13) must be recessed 1.5±0.125 (38.1±3.175) relative to the Magnet Room finished flooring.
	  • The levelness requirement applies to the finished Magnet Room floor and the recessed Magnet mounting area floor.
	  • The finished Magnet Room floor plane and the recessed Magnet mounting area plane must be parallel within 0.125 in. (3 mm) with respect to each other.	

(Continued)

6–5 Magnet Room Floors (Continued)

TABLE 8–5
MAGNET ROOM FLOOR REQUIREMENTS/RECOMMENDATIONS (Continued)

AREA	REQUIREMENTS	RECOMMENDATIONS
Floor Construction	• Flooring throughout the system including Magnet Room must be in accordance with local and national codes. • Floor construction must consider the MR system interconnect cables are FT4 or equivalent rated, not plenum rated. • Only non–magnetic metal material (e.g. aluminum) can be used when routing cables in the Magnet Room. • When the VibroAcoustic Damping Option is not installed then the Magnet feet must be set on and anchored to a non–compressible material (i.e. grout, concrete, or aluminum). Refer to Illustration 8–15. Plywood, filler board or other compressible material are not allowed under the magnet feet. **Note** When the VibroAcoustic Damping Option is not installed the Magnet feet must set on and be anchored to a non–compressible material to comply with specifications in Chapter 5 Section 16 Vibration. • The Rear Pedestal leveling feet must be positioned on solid floor or must reside on only 1 section of structural floor or removable access flooring capable of supporting 550 lbs (250 kg) distributed across the 4 feet (1.2 meter). This weight value includes patient and Rear Pedestal weight. **Notice!** **No cut, partial or shared removable access flooring panels are allowed to span across any of the four leveling feet of the Rear Pedestal.** • Flooring and subflooring must be compliant with requirements in Section 1–2 RF Shielding Requirements and Section 7–2 Physical Considerations. • The Magnet Room floor must be designed to support Gradient Coil replacement. Refer to Chapter 3 Section 5–1 Minimum Delivery Route Sizes and Capacity for weight and dimensions of the Gradient Coil on cradle/cart utilized for replacement. • Blower Box mounting must meet the requirements stated in Chapter 3 Section 9–1 Blower Box (MG6).	• It is highly recommended the RF Shield vendor use a water seal / thin coat of lacquer to protect any exposed RF shield material from condensation produced when servicing the Magnet cryogens or from cleaning liquids.

(Continued)

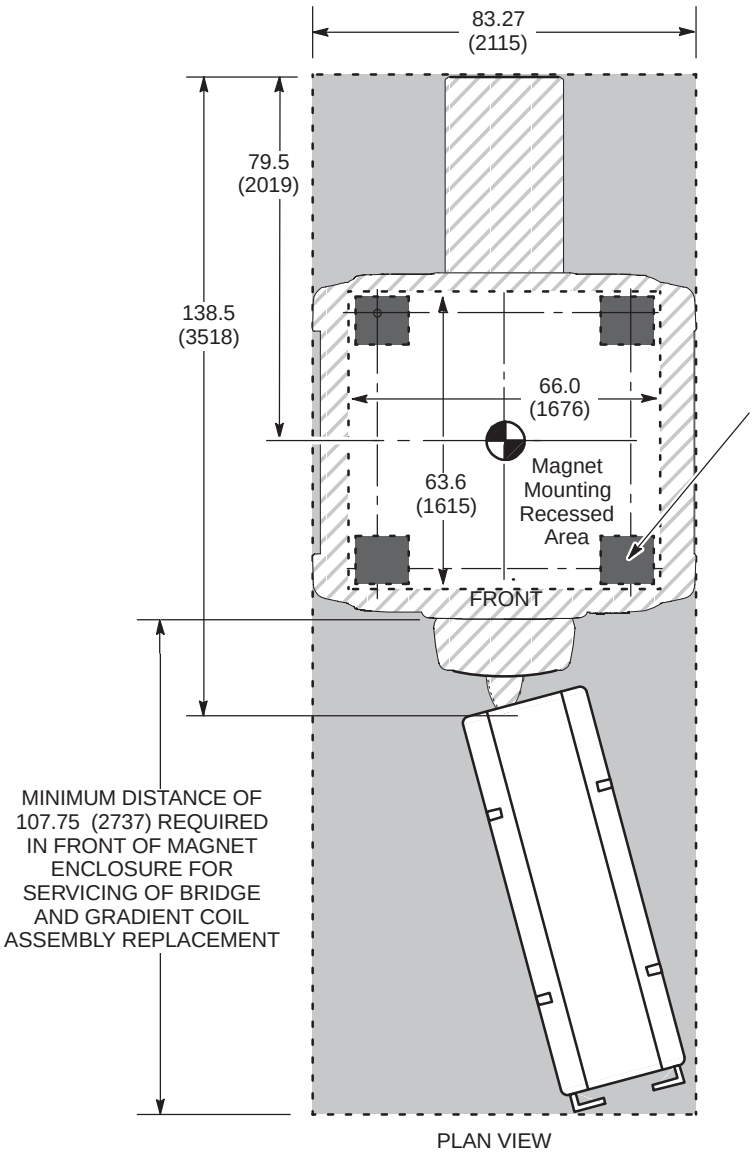
6–5 Magnet Room Floors (Continued)

TABLE 8–5
MAGNET ROOM FLOOR REQUIREMENTS/RECOMMENDATIONS (Continued)

AREA	REQUIREMENTS	RECOMMENDATIONS

Finished Flooring	• Magnet Room finished flooring must comply with the following:
	  • The surface resistance of the flooring is to be between 10E6 ohms and 10E9 ohms with grounding device fastened and secured to the RF Shield Common Ground Stud. Flooring grounding device and fasten/securing equipment are customer/contractor supplied.
	  • Installation of flooring grounding device and connection to the RF Common Ground Stud must be in compliance with local and national codes.
	  • No carpet, antistatic wax or spray on treatment solution allowed.
	• The floor design must make sure the dimension of 42.125 in. ±0.25 in. (1070 mm ±6.35 mm) is maintained from the top of the finished floor to the center of the magnet opening, refer to Illustration 3–10. This will allow the Patient Transport to properly dock to the enclosure.
	• The finished floor needs to be water resistant and protect the RF/Magnetic Shield and subfloor from possible water damage.
	• Only non–magnetic metal material (e.g. aluminum) can be used when routing cables in the Magnet Room.
	Notice!
	Access flooring removable panels are known sources of RF broadband noise. The use of non–magnetic metal material (e.g. aluminum) must have individual or potentially loose parts (i.e. nuts, panel to panel joints, panel to standoffs or supports, etc.) electrically isolated or fully grounded.
	• Electrically conductive materials utilized must comply with the requirements in Section Section 1 RF Shielded Room Requirements to minimize the possibilities of electrical discharge which can cause RF broadband noise.
		• The finished floor should also be easily replaceable to repair tiles/areas that are damaged from occasional cryogen spillage.

6–5 Magnet Room Floors (Continued)



PLAN VIEW

MAGNET FLOOR LEVELNESS AREA
ILLUSTRATION 8–13

NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- ROOM FLOOR MUST BE CLEAR AND LEVEL FLOOR TO THE ROOM DOOR TO ALLOW FOR PATIENT TABLE MOVEMENT.
- MAGNET MOUNTING AREA (SHOWN IN WHITE) MUST BE RECESSED 1.5±0.125 (38.1±3.175) RELATIVE TO THE MAGNET ROOM FINISHED FLOORING.
- RECESSED MAGNET MOUNTING AREA IS REQUIRED WITH OR WITHOUT THE INSTALLATION OF VIBROACOUSTIC DAMPING OPTION

Magnet installed without VibroAcoustic Damping Option: For details of non–compressible material under Magnet feet requirement refer to Illustration 8–15.

For location & dimensions of Magnet feet refer to Illustration 3–13 .

7 Anchor Hardware Requirements For MR Equipment Inside RF Shielded Room

7–1 Anchor Hardware For MR Equipment Inside RF Shield

An RF Shielded Room is required per Section 1 RF Shielded Room Requirements. The mounting of MR equipment located inside the RF Shield must comply with the RF Shield requirements.

Anchors are installed into the Magnet Room floor to provide a connection point to securely mount equipment. Improper installation of anchors can introduce RF issues (discrete and/or broadband) as well as secondary ground issues. Refer to Section 1 RF Shielded Room Requirements for potential RF issues and for RF Shielded Room requirements.

When the anchors penetrate the RF shield then the installation of the anchors must meet the requirements of Table 8–1. Refer to Section 7–5 RF Shield Integrity and Section 7–6 Electrical Isolation for additional information.

Notice!

Customers choosing to install the Magnet using the VibroAcoustic Damping Option (M1060MA) are not required to set anchors into the structural floor directly under the magnet feet. However, other system equipment anchors defined in the following sections are still required.

7–1–1 Customer Responsibilities

The Customer is responsible for the following tasks:

- Contract with RF Shield Room vendor, structural engineer, and architect to design the equipment anchor hardware to meet the GE specifications, refer to Section 1 RF Shielded Room Requirements, Section 7–2 Physical Characteristics, and Section 7–3 Anchor Location and Installation.

Note

The need for Blower Box anchors must be planned in advance to allow the RF Shield vendor to include the cost in their bid.

- Obtain any and all approvals necessary for the construction of equipment support and seismic anchoring. The customer needs to obtain a copy of building inspector’s (inspection) report and approval of the anchor method, maintain these documents with the site documentation.

- Coordinate equipment anchor methods and anchor location with the contracted RF Shield Room vendor, structural engineer, and architect to prevent RF leaks and secondary grounding problems.

7–1–2 RF Shield Room Vendor Responsibilities

The RF Shield Room vendor is responsible for the following tasks:

- Design the equipment anchor hardware to meet the GE specifications, refer to Section 1 RF Shielded Room Requirements, Section 7–2 Physical Characteristics, and Section 7–3 Anchor Location and Installation.
- Procurement of commercially available anchors, bolts/removeable rods, and fastening hardware required for equipment listed in Section 7–2 Physical Characteristics.

Notice!

The RF Shield Room vendor MUST supply torque specifications for all procured two part type anchors, BOLTS / REMOVABLE RODS, and fastening hardware to meet the clamping force specified each piece of equipment listed in Section 7–2 Physical Characteristics.

- Define the anchor torque/method required to achieve the specified clamping force (tension), refer to Section 7–2 Physical Characteristics. The torque requirement to be provided to the customer for use during Magnet installation.
- Layout and installation of the equipment anchors (create own template from GE supplied information) Coordination with Building Contractor/Architect may be necessary to prevent interference with rebar or structural steel that would cause a secondary ground path through the anchor.
  - Coordinate with GE Service to locate magnet isocenter and equipment mounting. RF Shield Room vendor must be present when GE Service identifies magnet isocenter location (to maximize the accuracy of the location).
  - Coordinate with GE Service to make sure site requires Magnet anchor bolts (i.e. VibroAcoustic Damping Option (M1060MA) not planned to be installed).
  - If VibroAcoustic Damping Option (M1060MA) not planned to be installed then anchors for Magnet shall be installed prior to magnet installation to allow time to address any issues that may arise.
  - Anchors for Magnet shall be installed prior to magnet installation to allow time to address any issues that may arise.
  - Dock Assembly Anchor shall be installed at the anchor location determined by GE Service using the Dock Assembly aligned to the Magnet.
  - If the Blower Box is secured to the finished floor and the anchor hardware penetrates the RF shield then the RF Shield Vendor must install the anchors prior to system equipment delivery.
- Perform pull test on all anchors to confirm the specified clamping force (tension) can be meet, refer to Section 7–4 Clamping Force (Tension) And Pull Test. A copy of the test results must be provided to the customer (customer to maintain copy with the site documentation).
- Perform ground impedance (electrical isolation) test on installed anchors, refer to Section 7–6 Electrical Isolation.
- Perform RF integrity test per Chapter 12 Section 2 RF Shielded Enclosure Test Guideline.
- Provide copy of ground impedance and RF room integrity tests to the customer to be maintained with the site documentation.

7–1–3 GE Healthcare Responsibilities

GE Healthcare is responsible for the following tasks:

- GE Installation Specialist to provide equipment dimensions drawings showing equipment mounting locations to the RF Shield Room vendor and review the anchor method prior to anchor installation.
- GE Service to assist RF Shield Room vendor by locating magnet isocenter during layout of equipment anchors. RF Shield Room vendor to be present when GE Service identifies magnet isocenter location to maximize the accuracy of the location.
- GE Service to inspect and verify the anchor location is correct and obtain the anchoring hardware from the RF Shield Room vendor prior to equipment delivery.
- GE Service to carefully inspect the RF seal (electrical connectivity) of the anchor and bolts/removable rods to the RF Shield (i.e. the fibrous washer or equivalent device is in place).
- GE Service to work with riggers to secure Magnet to anchors at time of delivery and installation.
- The Dock Assembly anchor location is determined by GE Service using the Dock Assembly aligned to the Magnet. (RF Shield Room Vendor is responsible for installing the two part anchor.)

Refer to Table 8–6 for equipment type and seismic anchor characteristics.

7–2 Physical Characteristics

Note

The LCC Magnet installed with the VibroAcoustic Damping Option (M1060MA) has the VibroAcoustic Damping mats resting directly on the recessed Magnet mounting area floor. The LCC Magnet is leveled and bolted to the VibroAcoustic mats stainless steel top plate. The VibroAcoustic mats do not require anchors into the Magnet Room floor In non–seismic areas.

7–2–1 Anchor Requirements and Material Properties

Anchor hardware must meet the following requirements:

- Two part type anchor assembly (female and male)
  - The female anchor can be expansion or epoxy type (must be compliant with local and national code and regulation)
  - The male anchor can be either a bolt or threaded rod with appropriate sized nut (rod must be completely removable, not epoxyed or cemented in place)

Note

All anchors must be the two part type that meet the design requirements to allow for future serviceability. **No exceptions allowed!**

- Able to achieve clamping force (tension) requirement for the equipment to be anchored, refer to Table 8–6
- Non–magnetic and electrically conductive (to allow it to be electrically connected to the Room's RF Shield at the point of penetration)
- Compatible with the material properties of the RF Shield and not produce galvanic corrosion due to dis–similar metals
- Be completely removable for Service activities and equipment installation
- Be commercially procured
- Is approved by the local building inspector.

7–2–2 Design of Anchor Assembly

The following factors contribute to the anchor selection:

- Embedment depth (affects the length of the bolt/removable rod) and properties of material in which the anchor will be embedded
- Floor thickness including RF Shield floor and Magnet Room finished floor
- Equipment base thickness and any spacers required under the base
- Equipment base clearance for protrusion of bolt/rod inside the base
- Anchor diameter:
  - Magnet anchor bolt/removable rod diameter: minimum 0.625 in. (M16) and maximum 1.25 in. (M32)
  - Dock and Blower Box: refer to Table 8–6
- Size of the hole in the equipment base (affects the diameter of the bolt/removable rod)
- Clamping force (tension) requirement for the equipment, refer to Table 8–6
- Seismic codes (affect the length and diameter of the bolt/removable rod and anchor size)

Refer to Table 8–7 for Equipment Characteristics.

TABLE 8–6
EQUIPMENT CLAMPING FORCE (TENSION) REQUIREMENTS

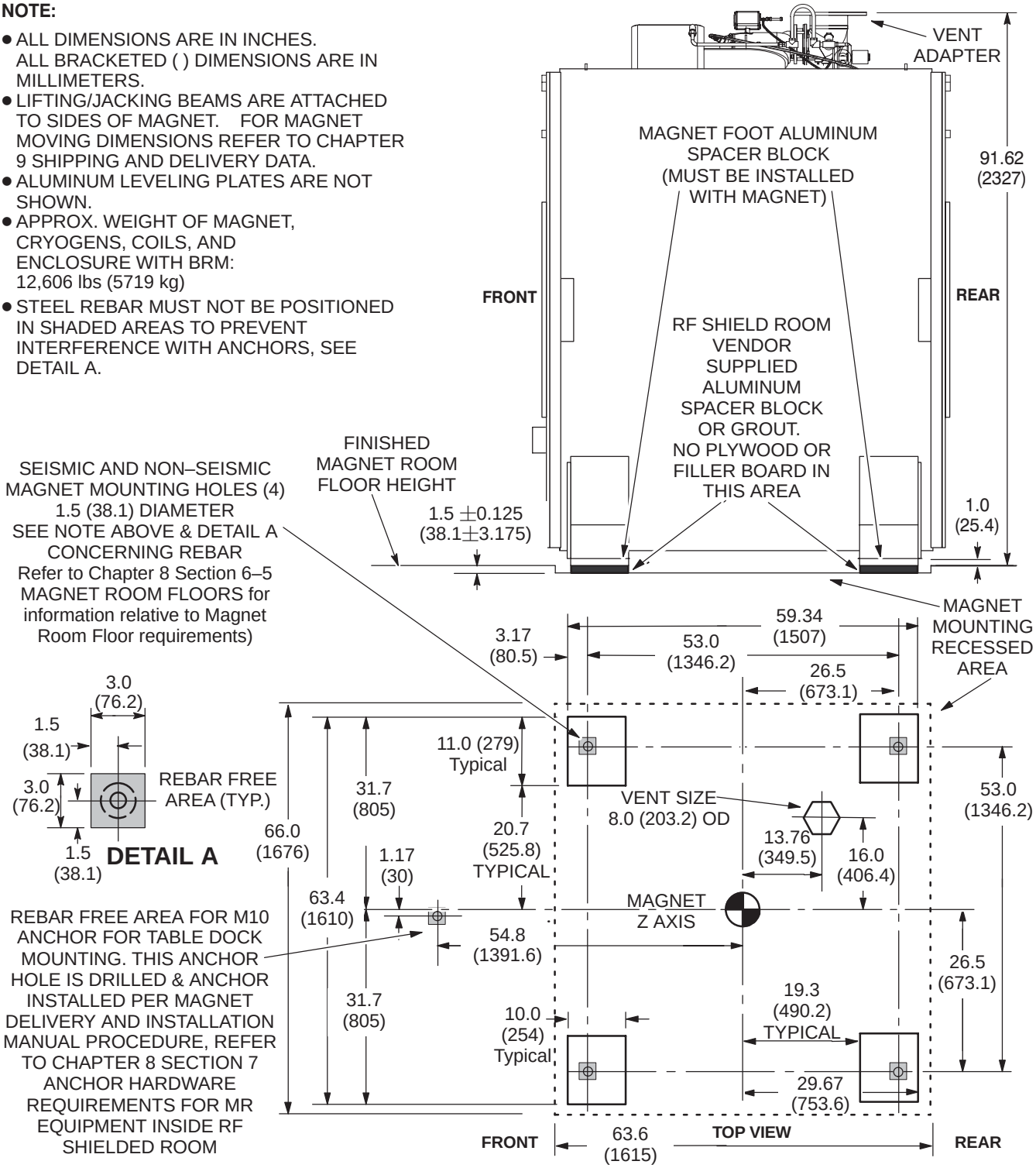
EQUIPMENT TYPE	CLAMPING FORCE (TENSION) TO THE FLOOR APPLIED TO EACH ANCHOR lbs (N) See Note 1
1.5T LCC (Active Shield) Magnet (See Notes 2 and 3)	2,500 ± 200 (11,100 ± 900)
Dock Assembly for LCC (Active Shield) Magnet	600 ± 100 (2700 ± 450)
Blower Box (See Note 4)	100 ± 10 (450 ± 45)

Note
1. The RF Screen Room Vendor must perform a pull test on each anchor, equal to the clamping force (tension) required for the equipment, prior to equipment delivery. A copy of the pull test results, anchor ground impedance measurements and building inspection certification must be given to given to the customer to be maintained with the site documentation.
2. Compressible material must not be present in the recessed area under the magnet feet, refer to Illustration 8–14 and Illustration 8–15. The clamping force (tension) must be maintained for the equipment over the life of the product.
3. All four feet of the magnet must be anchored to the floor. The anchor hole openings in the magnet base are to be used to anchor the magnet.
4. The Blower Box must be securely mounted to the solid floor in the Magnet Room or a support shelf on the Magnet Room wall or ceiling with support provided under the Blower Box. The Blower Box **must not** be on a raised floor section within the Magnet Room. If the Blower Box is secured to the finished floor and the anchor hardware penetrates the RF shield then the RF Shield Vendor must install the anchors prior to system equipment delivery. The need for Blower Box anchors must be planned in advance to allow the RF Shield vendor to include the cost in their bid.

7–2–2 Design of Anchor Assembly (Continued)

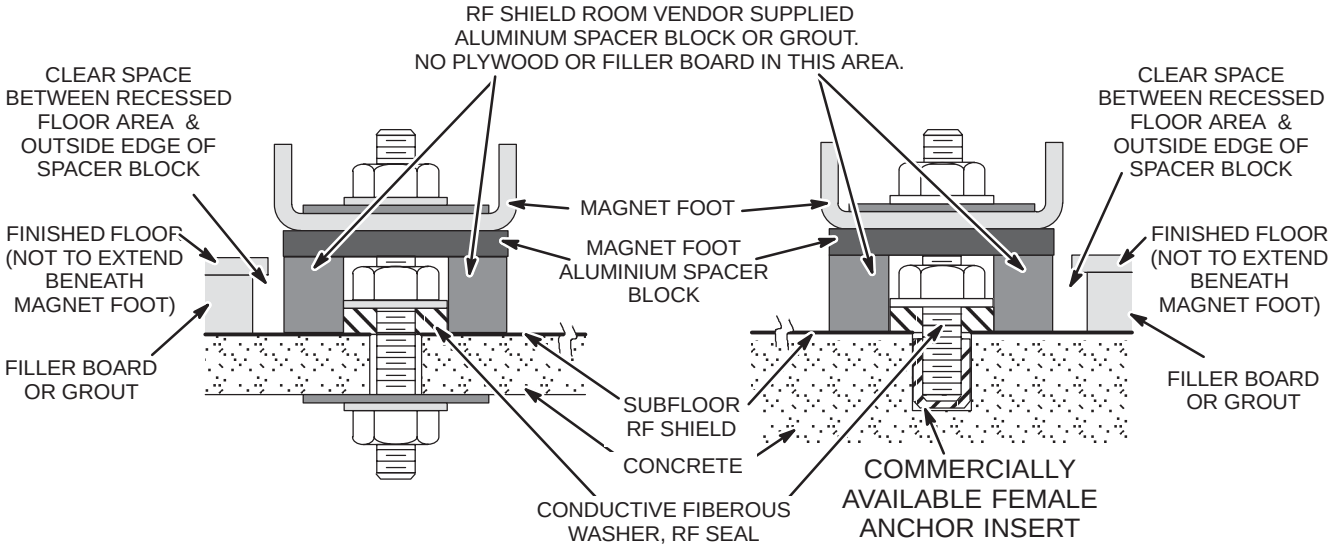
NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- LIFTING/JACKING BEAMS ARE ATTACHED TO SIDES OF MAGNET. FOR MAGNET MOVING DIMENSIONS REFER TO CHAPTER 9 SHIPPING AND DELIVERY DATA.
- ALUMINUM LEVELING PLATES ARE NOT SHOWN.
- APPROX. WEIGHT OF MAGNET, CRYOGENS, COILS, AND ENCLOSURE WITH BRM: 12,606 lbs (5719 kg)
- STEEL REBAR MUST NOT BE POSITIONED IN SHADED AREAS TO PREVENT INTERFERENCE WITH ANCHORS, SEE DETAIL A.



LCC MAGNET LOAD PATTERN WITHOUT VIBROACOUSTIC DAMPING OPTION
ILLUSTRATION 8–14

7–2–2 Design of Anchor Assembly (Continued)



Note: For sites with RF Shield on top of subfloor, the RF Shield needs to be recessed to the concrete level to provide a proper RF Seal.

RF SHIELD ROOM ANCHOR DETAILS
ILLUSTRATION 8–15

Note

When the Magnet is installed with the VibroAcoustic Damping Option then the Magnet is bolted to the VibroAcoustic Damping Option mats which set on the recessed floor area for non–seismic zones. For VibroAcoustic Damping Option mounting in seismic zones refer to seismic drawings available on request from your local GE Healthcare Installation Specialist.

7–2–2 Design of Anchor Assembly (Continued)

TABLE 8–7
EQUIPMENT CHARACTERISTICS – See Note 1

EQUIPMENT TYPE	EQUIPMENT MOUNTING BASE THICKNESS in. (mm)	CLEARANCE HOLE IN EQUIPMENT BASE in. (mm)	MAXIMUM CLEARANCE ABOVE EQUIPMENT BASE in. (mm) See Note 2	SEISMIC REQUIREMENT PRE–APPROVED BY OSHPD FOR BOLT OR REMOVABLE ROD DIAMETER in. (mm) See Note 3	EQUIPMENT MOUNTING ILLUSTRATION
1.5T LCC Magnet without VibroAcoustic Damping Option See Note 4	1.75 (44) See Note 5	1.5 (38)	2.5 (64)	1.0 (M24)	8–14 & 8–15
Dock Assembly for LCC Magnet	0.75 (20)	0.43 (11)	2.0 (50)	Pre–approval not required. Select anchor to clamping force (tension).	8–14
Blower Box See Note 6	0.25 (6)	0.25 (6)	0.5 (13)	Pre–approval not required. Select anchor to clamping force (tension).	3–16

Note 1 All equipment mounting methods and installation must meet requirements in Section 1–2 RF Shielded Room Requirements.

2 Maximum Clearance Above Equipment Base is the dimension for protrusion of the bolt or removable rod inside the equipment base including clearance for tools to tighten hardware to meet specifications in Table 8–6.

3 In California, USA all anchor hardware designs must be submitted to the Office of Statewide Health Planning and Development (OSHPD) for pre–approval. For all other states, providences or countries, plans must be submitted to the local planning authority (where seismic codes apply).

4 When the VibroAcoustic Damping Option is not installed then all four feet of the Magnet must be anchored to the floor. The anchor hole openings in the Magnet base are to be used to anchor the Magnet.

5 Magnet mounting base thickness includes the 1 inch (25 mm) foot block required to maintain the Magnet Center Line Height dimension as defined in Illustration 3–10.

6 The Blower Box must be securely mounted to the solid floor in the Magnet Room, or a support shelf on the Magnet Room wall or ceiling with support provided under the Blower Box. The Blower Box **must not** be on a raised floor section within the Magnet Room. If the Blower Box is secured to the finished floor and the anchor hardware penetrates the RF shield then the RF Shield Vendor must install the anchors prior to system equipment delivery. The need for Blower Box anchors must be planned in advance to allow the RF Shield vendor to include the cost in their bid.

7–3 Anchor Location and Installation

Notice!

Anchor hardware must avoid direct contact with rebar or wire mesh located in the building or Magnet Room floor to avoid secondary ground planes and/or RF issues (discrete and/or broadband), refer to Table 8–1 Grounding.

The exact location for installing the Magnet anchors is determined by dimensional footprint drawings for the MR equipment to be installed. The Design Center group at GE Healthcare will provide to the RF Shield Room Vendor the dimensional drawing showing all anchor locations. The drawing can be issued in either hard copy or electronic format. The RF Shield Room Vendor is responsible for supplying their own template to precisely mark the Magnet anchor locations within the room.

Dock Assembly Anchor shall be installed at the anchor location determined by GE Service using the Dock Assembly aligned to the Magnet. RF Shield Room Vendor is responsible for installing the two part anchor.

Coordination between the RF Shield Room Vendor and Building Contractor/Architect may be necessary to mark the location of the Magnet anchors to prevent interference with rebar or structural steel. A re–arrangement of the room may be necessary to ensure ground isolation, refer to Table 8–1 Grounding.

Refer to Table 8–7 equipment dimensional illustration references.

7–4 Clamping Force (Tension) And Pull Test

1. Anchors which meet requirements in Section 7–2 Physical Characteristics must be installed per Section 7–3 Anchor Location and Installation.

2. Each anchor must meet the clamping force (tension) requirement defined in Section 7–2 Physical Characteristics.

Note

The equipment must be clamped directly to the floor and the entire equipment base must maintain full contact to the floor per Section 7–2 Physical Characteristics requirements.

3. A pull test equal to the clamping force (tension) must be performed by the RF Shield Room Vendor prior to the equipment installation. The test results indicating the torque required to achieve the specified clamping force (tension) must be recorded by RF Shield Room Vendor and the customer to maintain a copy of this report with the site documentation.

7–5 RF Shield Integrity

The anchor assembly must maintain RF shield integrity. This is accomplished by electrically sealing the anchor assembly at the penetration point on the RF shield. The method by which the electrical contact is made must take into account any stretch in the bolt/removable rod resulting from the applied clamping force (tension). A fibrous washer or equivalent will provide a proper RF seal where a solid flat washer could produce an RF leak and introduce artifacts into the MR images. The RF room test should result in a specific attenuation at the operating frequency of the system under the following conditions:

1. Blank Penetration Panel installed
2. Anchor hardware installed
3. Electrical connection made between the anchor assembly and the RF shield.

Refer to Chapter 12 Section 2 RF Shielded Enclosure Test Guideline.

7–6 Electrical Isolation

The anchor hardware must not provide a secondary ground path for the RF Shield Room, refer to Table 8–8 for anchor hardware electrical isolation requirements and recommendations.

TABLE 8–8
ANCHOR HARDWARE ELECTRICAL ISOLATION REQUIREMENTS/RECOMMENDATIONS

REQUIREMENTS	RECOMMENDATIONS
• Ground Isolation: 1,000 ohms or greater (refer to Table 8–1) • Secondary Ground (Other grounds that connect the outside of the RF Shield Room to earth grounds are called secondary grounds.): Secondary grounds must not compromise Ground Isolation of 1,000 ohms or greater. (Refer to Table 8–1) **Note:** If the result is less than 100 ohms then it is very likely the anchor has made contact to steel rebar or wire mesh. In this case the steel in the floor will need to be removed or the anchors will need to be relocated. In either case GE Healthcare must be notified and a retest performed after the corrective action is taken. • The electrical isolation test results must be recorded by RF Shield Room Vendor and the information forwarded to the customer to be maintained with the site documentation.	• Electrical isolation test of each anchor and bolt/removable rod should be performed prior to Magnet placement.

7–7 Example – Select Magnet Anchor Size

The following is an example of to illustration the selecting of proper anchor to install an LCC Magnet into a building structure with 2000 psi (13.8 MPa) concrete. For this example the area is not under seismic requirements.

1. Determine magnet clamping force (tension) by referring to requirements in Table 8–6.

   2500 lbs + 200 lbs = 2700 lbs 11,100 N + 900 N = 12,000 N

2. Refer to Tables 8–9 or 8–10 (examples of anchor vendor catalogs) to select anchor diameter and embedment which meets the clamping force (tension) determined in Step 1.

   Diameter : Min. 0.625 inch Max. 1.25 inch Diameter : Min. M16 Max. M32
   For 8 inch embedment select 3/4 inch diameter For 130 mm embedment select M20 diameter
   For 4.5 inch embedment select 1 inch diameter For 114 mm embedment select M24 diameter

3. The vendor instructions and torque to the maximum recommended level for the anchor selected in Step 2 must be provided to the RF Shield Room vendor for proper installation of the anchor and equipment.

7–7 Example – Select Magnet Anchor Size (Continued)

TABLE 8–9
EXAMPLE OF ENGLISH UNITS STAINLESS STEEL ANCHOR ALLOWABLE LOADS IN CONCRETE

ANCHOR DIAMETER in. (mm) See Note 1	EMBEDMENT DEPTH in. (mm)	2000 psi (13.8 MPa)		3000 psi (20.7 MPa)		4000 psi (27.6 MPa)		6000 psi (41.4 MPa)	
		TENSION lb (kN)	SHEAR lb (kN)	TENSION lb (kN)	SHEAR lb (kN)	TENSION lb (kN)	SHEAR lb (kN)	TENSION lb (kN)	SHEAR lb (kN)
5/8 (15.9)	2 3/4 (70)	1250 (5.6)	2800 (12.5)	1600 (7.1)	3070 (13.7)	1810 (8.1)	3330 (14.8)	1920 (8.5)	3330 (12.5)
	4 (102)	1870 (8.3)	3330 (14.8)	2400 (10.7)	3330 (14.8)	2930 (13.0)	3330 (14.8)	3200 (14.2)	3330 (12.5)
	7 (178)	2500 (11.2)	3330 (14.8)	3010 (13.4)	3330 (14.8)	3650 (16.2)	3330 (14.8)	3650 (16.2)	3330 (12.5)
3/4 (19.1)	3 1/4 (83)	1550 (6.9)	2880 (12.8)	1950 (8.7)	3310 (14.7)	2350 (10.5)	3730 (16.6)	2610 (11.6)	4800 (21.4)
	4 3/4 (121)	2510 (11.2)	4510 (20.1)	3250 (14.5)	4650 (20.7)	3870 (17.2)	4800 (21.4)	4670 (20.8)	4800 (21.4)
	8 (203)	2930 (13.0)	4800 (21.4)	3870 (17.2)	4800 (21.4)	4530 (20.2)	4800 (21.4)	5120 (22.8)	4800 (21.4)
1 (25.4)	4 1/2 (114)	3120 (13.9)	6080 (27.0)	3870 (17.2)	6770 (30.1)	4610 (20.5)	7470 (33.2)	4800 (21.4)	7470 (33.2)
	6 (152)	4400 (19.6)	7470 (33.2)	6400 (28.5)	7470 (33.2)	7200 (32.0)	7470 (33.2)	7330 (32.6)	7470 (33.2)
	9 (229)	5600 (24.9)	7470 (33.2)	8000 (35.59)	7470 (33.2)	9390 (41.77)	7470 (33.2)	9390 (41.8)	7470 (33.2)

Note 1 All shaded values fail to meet the clamping force (tension), therefore are not acceptable anchors.

TABLE 8–10
EXAMPLE OF METRIC STAINLESS STEEL ANCHOR ALLOWABLE LOADS IN CONCRETE

ANCHOR DIAMETER See Note 1	EMBEDMENT DEPTH mm (in.)	13.8 MPa (2000 psi)		20.7 MPa (3000 psi)		27.6 MPa (4000 psi)		41.4 MPa (6000 psi)	
		TENSION kN (lb)	SHEAR kN (lb)	TENSION kN (lb)	SHEAR kN (lb)	TENSION kN (lb)	SHEAR kN (lb)	TENSION kN (lb)	SHEAR kN (lb)
M16	105 (4 1/8)	11.2 (2500)	25.1 (5650)	20.9 (4705)	39.9 (8965)	24.2 (5450)	10125 (45.0)	6900 (30.7)	10550 (46.9)
M20	130 (5 1/8)	25.1 (5650)	52.9 (11900)	30.7 (6910)	58.7 (13195)	36.4 (8175)	14490 (64.5)	10005 (44.5)	14490 (64.5)
M24	155 (6 1/8)	30.0 (6735)	61.2 (13760)	36.9 (8300)	70.5 (15855)	43.9 (9860)	29.8 (17950)	57.7 (12980)	95.6 (21490)

Note 1 All shaded values fail to meet the clamping force (tension), therefore are not acceptable anchors.

8 Magnet Room Equipment Mounting

8–1 Magnet Rundown Unit (MS4)

The magnet rundown unit should be mounted 60 in. (1524 mm) above the Magnet Room floor near the front of the magnet enclosure but outside the 200 gauss zone.

8–2 Emergency Off buttons

Customer supplied emergency off buttons to be located near each room exit including magnet and equipment rooms. These buttons must be clearly labeled, “Emergency Off”. Refer to Chapter 6 Section 3–1 Main Disconnect Panel (MDP) for emergency off power requirements.

8–3 Remote Oxygen Sensor Module (OM3) – Optional

The Remote Oxygen Sensor Module (if option ordered) must be mounted approximately 60 in. (1524 mm) above the Magnet Room floor near the front of the magnet enclosure.

9 RF Door Switch

RF shielded room vendor must supply and install RF door switches on all RF shielded doors. These switches must be wired in series and a GE supplied cable (two loose lead conductors) will attach to one door switch. RF switches must be rated for 24 volts at 750 milliamperes maximum and the switches must be in the open position when the doors are open (switch contacts close when the doors are completely closed).

10 Emergecny Exit

Emergency exiting from the Magnet Room is to be specified by the customer’s architect and contractor. Such measures as an out swinging door, emergency door latch release, easily removed window, or other measures must be designed into the room. Emergency exit instructions must be permanently and prominently mounted near the door and/or window.

11 Room Ventilation Switch

Placement of the room ventilation switch should be near the Magnet Room door and is the responsibility of the architect and mechanical contractor.

Chapter 9 – Shipping And Delivery Data

1 Shipment

Domestic transportation for the MR system, excluding the magnet, will be via an air–ride moving van. The magnet will be shipped on an air–ride flat–bed truck. Export transportation for the MR system overseas will be via air shipment in a pressurized cargo hold. See Table 9–2 for the shipping weights and dimensions of the major MR system components. Actual shipping may vary, international shipment may require equipment to be crated. Refer to Table 9–1 for transportation environmental conditions.

TABLE 9–1
TRANSPORTATION & STORAGE ENVIRONMENTAL CONDITIONS

TEMPERATURE RANGE °F (°C)	TEMPERATURE CHANGE °F/Hr (°C/Hr)	RELATIVE HUMIDITY %	HUMIDITY CHANGE (%/Hr)	ATMOSPHERIC PRESSURE hPa
–30 to 140 (–34 to 60)	176 (80)	0–90 non–condensing	30	1012 to 525

The GE magnet utilizes a Shield/Cryo Cooler System to maintain a reduced helium boil–off. However, the Shield Cooler System is not operational during transportation. Therefore the magnet will require liquid helium replenishment if transportation time exceeds two weeks. Contact GE Service for magnet servicing.

The LCC Magnet is filled with liquid helium at initial shipment but can be allowed to warm up during transportation without damage to the support structure.

If the system is stored before installation, it must be stored in a warehouse protected from weather and meet the environmental conditions in Table 9–1. The storage temperature should be between –30 and 140 degrees F (–34 and 60 degrees C) and the relative humidity between 0 and 90% (non–condensing).

There are two scenarios for storing the magnet. One is to maintain the magnet cold temperature by connecting and operating the Shield/Cryo Cooler System. Periodic replenishment of liquid helium may be required depending on the storage time. The other scenario is to store the magnet without maintaining the cold temperature. The LCC magnet can be moved cold or warm, refer to *Direction 2226318, 1.5T & 1.0T LCC Magnet Signa MR/i Delivery and Installation* for magnet moving requirements and details. Contact GE Service for necessary servicing before moving the magnet.

1 Shipment (Continued)

TABLE 9–2
SHIPPING DATA

MR COMPONENT	APPROXIMATE W x D x H	APPROXIMATE WEIGHT	METHOD OF SHIPMENT
1.5T LCC Magnet with cryogens, partial Wide Open Enclosure installed	93 x 144 x 107 (2362 x 3658 x 2718)	See Note 1	crate/skid
Magnet Accessory Equipment	48 x 48 x 28 (1219 x 1219 x 711)	400 (182)	crate
Shield/Cryo Cooler Compressor Cabinet	26 x 28 x 42 (660 x 711 x 1067)	240 (109)	skid with box cover
Bridge	24 x 161 x 10 (610 x 4090 x 254)	125 (57)	box
Rear Pedestal Assembly	24 x 48 x 36 (610 x 1219 x 914)	40 (18)	box
Enclosure Top	48 x 36 x 36 (1219 x 914 x 914)	30 (14)	box
Enclosure Skirts	40 x 24 x 24 (1016 x 610 x 610)	30 (14)	box
Fixed Site Water Chiller for Gradient Coil Cooling	29 x 42 x 33 (737 x 1067 x 838)	320 (154) dry weight	crate
Patient Table	95 x 36 x 50 (2413 x 914 x 1270)	670 (305)	pallet
1.5T standard SRFD II Cabinet	24 x 38 x 72 (610 x 965 x 1829)	500 (225)	on cabinet casters, wrapped with plastic
1.5T SRFD II Cabinet with MNS Option	24 x 38 x 72 (610 x 965 x 1829)	565 (256)	on cabinet casters, wrapped with plastic
ACGD/PDU Cabinet without Fan Module installed	24 x 37 x 75 (610 x 940 x 1905)	1810 (823)	on cabinet casters, wrapped with plastic
Fan Module for ACGD/PDU Cabinet	28 x 38 15 (711 x 965 x 381)	160 (73)	on pallet
System Control Cabinet	24 x 33 x 78 (610 x 838 x 1981)	500 (227)	on cabinet casters, wrapped with plastic
EXCITE System Control Cabinet	24 x 33 x 78 (610 x 838 x 1981)	475 (215)	on cabinet casters, wrapped with plastic
SPT Phantom Set	34 x 32.5 x 60 (864 x 826 x 1524)	350 (159)	on cart casters with box cover
Operator Workspace Cabinet	25 x 38 x 34 (635 x 965 x 864)	200 (91)	skid
GOC Computer Cabinet	24 x 35 x 31 (600 x 900 x 780)	243 (110)	wood pallet with cardboard cover
Operator Workspace LCD Color Monitor	27 x 33 x 27 (686 x 838 x 686)	125 (57)	skid
Operator Workspace equipment	32 x 32 x 23 (813 x 813 x 584)	100 (45)	box
Operator Workspace Table	45 x 54 x 37 (1143 x 1372 x 940)	180 (82)	box
BrainWaveHW Lite Cabinet * (GE provided equipment configuration)	24 x 23 x 72 (610 x 584 x 320)	245 (111)	on cabinet casters, wrapped with plastic
MRCC * Outdoor/Indoor Air Cooled:			
MRCC unit	63.8 x 34.3 x 59.1 (1620 x 870 x 1500)	750 (340)	crate
Ship loose items	31.5 x 31.5 x 36 (800 x 800 x 920)	394 (178.5)	box

Note * Optional Equipment

1 Approximate magnet shipping weight (includes packaging material) and weight of magnet with cryogens, RF/Gradient BRM coil, Enclosure parts installed on magnet, lifting beams, crate, and skid (i.e. minus packaging material): 13,900 lbs (6320 kg) International shipments must add shipping crate/pallet of 2,200 lbs (998 kg).

2 Magnet Shipping Considerations

For domestic, the magnet is shipped covered with plastic (no shipping pallet). For export, the magnet is crated for shipment on a special shipping pallet. Refer to Table 9–2 for the weight and dimensions of the magnet in its cold ship configuration (i.e. with liquid cryogens in vessel within the cryostat) and with the RF/Gradient Coil inside the magnet bore.

The magnet moving dimensions are shown in Illustration 9–1.

Consideration must be given to the delivery route of the magnet to ensure that the floor can support the magnet and any rigging equipment required to move it. A structural analysis should be performed by a professional structural engineer. The magnet must not be tilted more than 30° in any direction when being moved into position.

The customer is to provide and arrange for riggers to move the magnet from the delivery truck to the final site location. Contact local GE Service for a list of recommended rigger companies. The customer's riggers should have an adequate amount of liability insurance to cover any damage to property or MR system that may occur during delivery of the magnet. The GE sales representative or installation specialist can provide customer riggers with the replacement value of the MR system for insurance purpose.

The magnet is shipped with liquid helium in the vessel within the cryostat. Thus, when these magnets arrive at site, a cryogen delivery route must be available for moving cryogen dewars to the magnet for periodic replenishment of liquid helium. Power and cooling water for the shield cooler cabinet must be available when the magnet is delivered to minimize cryogens usage. See Chapter 5 Section 5 Water Cooling Requirements and Chapter 6 Power Requirements for specifications.

Means must be provided for venting of the cryogenic gases, refer to specifications in Chapter 5 Section 10 Cryogenic Venting.

NOTE:

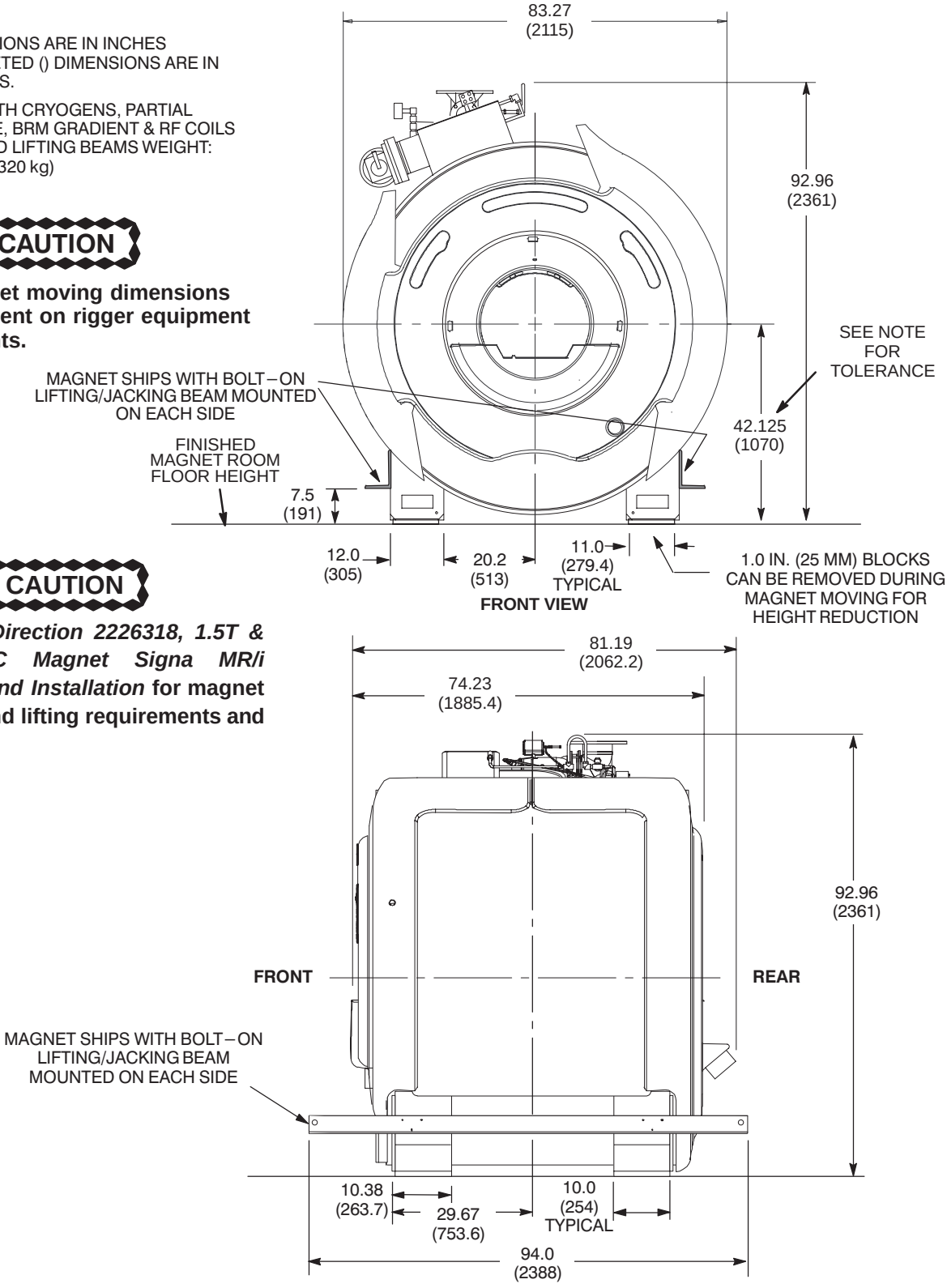
- ALL DIMENSIONS ARE IN INCHES ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
- MAGNET WITH CRYOGENS, PARTIAL ENCLOSURE, BRM GRADIENT & RF COILS IN BORE AND LIFTING BEAMS WEIGHT: 11,700 lbs (5320 kg)

CAUTION

Final magnet moving dimensions are dependent on rigger equipment requirements.

CAUTION

Refer to *Direction 2226318, 1.5T & 1.0T LCC Magnet Signa MR/i Delivery and Installation* for magnet moving and lifting requirements and details.



1.5T LCC (ACTIVE SHIELD) MAGNET MOVING DIMENSIONS
ILLUSTRATION 9–1

Chapter 10 – Pre–Installation Checklist

1 Introduction

“Preinstallation” refers to work necessary to plan and prepare a site for delivery and installation of equipment. Delay, confusion, and waste of manpower can be avoided by completing preinstallation work. It is recommended to have GE Service Representative make on–site inspections during construction.

The purpose of this section is to outline key areas of concern in the preparation of a customer’s site for magnetic resonance. It is intended as a guide for GE‘s Installation Specialists and/or Installation Leaders when making on–site inspections during the construction phase of an MR project. Note that these inspections by GE are intended to aid the overall site preparation process. They do not relieve the customer and project architect from responsibility for the design, engineering, and coordination efforts necessary to ensure a successful MR project.

During the course of the site preparation process, GE‘s Installation Specialists and/or Installation Leaders may observe that the Requested On–Site Date (ROSD) for the MR equipment is not realistic. If this is the case, appropriate actions must be taken by the GE Field Sales/Service Team to adjust the ROSD accordingly.

All work must be in compliance with national and local safety codes.

2 General Pre–Installation Reminders

☐ 1. The customer's architect has fully reviewed final site construction drawings using the guidelines provided by GE Healthcare Design Center.

☐ 2. **CTIQ#1 Vibration:** The vibration study has been completed and sources identified been addressed to comply with the specification. (It is the customer's responsibility to contract a vibration consultant or qualified engineer to implement design modifications to meet the specified limits.) Refer to Chapter 5 Section 16 Vibration.

☐ 3. **CTIQ#2 Magnetic Field:** The customer has confirmed that the site design contains the magnetic field and site design complies with the moving metal requirements. Refer to:
- Chapter 3 Section 2 Proximity Limits
- For magnetic field containment refer to Chapter 4 Magnetic Field Considerations
- Chapter 5 Section 14 Changing Magnetic Environment Specifications.

☐ 4. **CTIQ#3 Structural Steel:** Site steel and iron materials comply with the requirements. Refer to:
- Chapter 4 Section 3 Structural Steel Evaluation Of Proposed Sites
- Chapter 5 Section 15–1 Magnet Room Floors Magnetic Properties.

☐ 5. **CTIQ#4 Magnet Room Floor and Recessed Magnet Mounting Area:** The Magnet Room floor and recessed Magnet mounting area has been properly design/constructed (location, size, levelness, etc.) relative to the cryogenic vent location, finished floor to center of Magnet opening dimension, Rear Pedestal support, flooring and subflooring materials and construction. Refer to Chapter 8 Section 2–2 Determining Cryogenic Vent Location and Section 6–5 Floors.

☐ 6. **CTIQ#5 Acoustics:** The site has been designed and constructed to contain the MR System acoustic levels to meet local regulations and customer requirements. Refer to Chapter 5 Section 8–3 System Acoustic Noise Levels and Section 8–4 Acoustic Design Guidelines.

☐ 7. **CTIQ#6 Power Quality:** The site power plan meets the power quality requirements. Refer to Chapter 6 Section 1 System Power Introduction and Section 2 Critical Power Requirements.

☐ 8. **CTIQ#7 Lighting:** The Magnet Room lighting design and installation complies with the requirements so as to not generate RF Noise which would be detrimental to the ability of the MR System to produce images of good quality. Refer to Chapter 5 Section 7 Lighting.

☐ 9. **CTIQ#8 Multiple MR System Site:** The site design complies with the requirements for sites with more than one magnet in the magnetic field area or the Equipment Room is shared by more than one MR system of the same field strength. Refer to Chapter 3 Section 4–1 Two Magnet Site Layout and Section 4–2 Equipment Room Shared By Multiple MR Systems**.**

3 Safety

WARNING!

GASEOUS HELIUM IS AN INVISIBLE, ODORLESS GAS THAT CAN CAUSE ASPHYXIATION WHEN DEPLETING THE AMBIENT OXYGEN SUPPLY. HELIUM GAS IS LIGHTER THAN AIR AND WILL RISE TO THE CEILING.
THE MAGNET WILL BE EXHAUSTING HELIUM GAS DURING THIS TIME.
THE FOLLOWING SAFETY ITEMS MUST BE ADHERED TO PRIOR TO MOVING THE MAGNET FROM THE TRUCK INTO THE ROOM.

☐ 1. **CTIQ#9 Cryogenic Vent:** The cryogenic vent has been installed completely from the Magnet Room RF shield waveguide to the final exit and has been inspected to the final exit outside of the building. The customer needs to maintain a copy of the Vent Inspection Report with the site documentation. Refer to Chapter 5 Section 10 Cryogenic Venting:
- Section 10–1 Cryogenic Venting Introduction
- Section 10–2 Requirements For Outside Magnet Room
- Section 10–3 Requirements For Inside Magnet Room

☐ 2. **CTIQ#10 Broadband Network Connection & Telephone:** Functioning Broadband (network) connections and telephone are available at the site for the duration of the installation and system operation. Broadband is needed for Magnet Monitor and MR System computer access. Telephone is needed to dial out in case of an emergency. Refer to Chapter 3 Section 9–7 System Monitoring & Support Connectivity Requirements.

☐ 3. **CTIQ#11 Room Ventilation & Air Conditioning:** All of the required Magnet Room ventilation items have been installed and tested to make sure sufficient ventilation is available. The exhaust fan and fan controls are installed and functional. The customer needs to maintain a copy of the Exhaust Fan System test reports with the site documentation. Refer to Chapter 5 Section 9 Room Ventilation.

☐ 4. Plans have been made to connect the cryogenic vent to the magnet after magnet installation in the room. Refer to Chapter 5: Section 10–1 Cryogenic Venting Introduction, Section 10–2 Requirements For Outside Magnet Room, and Section 10–3 Requirements For Inside Magnet Room.

4 Required Before Magnet Delivery And Move Into Room

The following items must be completed prior to magnet delivery. A site inspection by GE Service Representative must be completed prior to magnet delivery to ensure site readiness.

☐ 1. **CTIQ#11 Room Ventilation & Air Conditioning:** Heating, Ventilating & Air Conditioning (HVAC) is installed, functional and available 24 hour/day, 7 days/week for Magnet Room and Equipment Room. Refer to Chapter 5 Section 3 Temperature and Humidity Specifications and Section 4 Air Cooling Requirements**.**

☐ 2. **CTIQ#12 Water Cooling:** CTIQ#12 Water Cooling: Water cooling is available 24 hour/day, 7 days/week (if the MR system configuration is utilizing facility water cooling for the Shield/Cryo Cooler cabinet.) Refer to Chapter 5 Section 5–4 Shield/Cryo Cooler Compressor Requirements For Site Provided Water Cooling.

☐ 3. **CTIQ#13 Magnet Room Equipment Anchors Pull Test:** All Magnet Room equipment anchors (i.e. Magnet if required, Blower Box, etc.) have had pull tests performed, meet requirements and the installation torque value defined. Test results have been recorded by the RF Shield Room Vendor. The customer needs to maintain a copy of the pull tests results with the site documentation. Refer to Chapter 8 Section 7–4 Clamping Force (Tension) And Pull Test.

☐ 4. **CTIQ#14 Magnet Room Equipment Anchors Electrical Isolation:** All Magnet Room equipment anchors (i.e. Magnet if required, Blower Box, etc.) have had ground impedance test been performed and meet requirements. Test results recorded by RF Shield Room Vendor and information forwarded to the customer to be maintained with the site documentation. Refer to Chapter 8 Section 7–6 Electrical Isolation.

☐ 5. **CTIQ#15 Main Disconnect Panel (MDP):** The site power meets the power quality requirements. The Main Disconnect Panel (MDP) has been installed, electrician wiring complete, and the MDP is operational with power available 24 hour/day, 7 days/week for powering the Shield/Cryo Cooler Compressor cabinet, Magnet Monitor equipment, and Coldhead Compressor Chiller (MRCC) if providing water cooling for the Shield/Cryo Cooler Compressor cabinet. Refer to Chapter 6 Section 1 System Power Introduction and Chapter 6 Section 2 Critical Power Requirements**.**

☐ 6. A clear route to the Magnet Room has been defined for Magnet installation and cryogen servicing of the Magnet. Refer to Chapter 3 Section 5–1 Minimum Delivery Route Sizes and Capacity.

☐ 7. Arrangements have been made for the use of special rigging equipment for moving the Magnet into the Magnet Room. Refer to Chapter 9 Section 2 Magnet Shipping Considerations.

☐ 8. Work in the Magnet Room has been completed or suspended, the Magnet Room closed off to provide a dust–free, closed environment and all equipment has been removed from the Magnet Room to allow space for the Magnet with rigging equipment and cryogen servicing if needed. Refer to Chapter 9 Section 2 Magnet Shipping Considerations.

5 Required Before System Delivery And Install

The following items must be completed prior to system delivery. A site inspection by GE Service Representative must be completed prior to system delivery to ensure site readiness.

☐ 1. **CTIQ#16 Dust–Free Environment:** All of the areas in the MR System Magnet Room, Equipment Room, and Control Room are complete, so a dust–free environment is available for the installation of the equipment. Refer to Chapter 5 Section 13 Pollution**.**

☐ 2. **CTIQ#17 Environmental Controls:** Environmental systems and controls are functioning to provide the required site environment for all MR System equipment. Refer to Chapter 5 following sections:
- Section 3 Temperature and Humidity Specifications
- Section 4 Air Cooling Requirements
- Water Cooling Requirements
  - Section 5–1 Gradient Coil Water Cooling
  - Section 5–2 Gradient Coil Temporary Backup Water Cooling
  - Section 5–3 Shield/Cryo Cooler Temporary Backup Water Cooling
  - Section 5–4 Shield/Cryo Cooler Requirements For Site Provided Water Cooling

☐ 3. The MR System interconnects routing design/method equipment has been installed and ready for interconnects installation. Refer to Chapter 3 Section 6 MR System Interconnects Routing.

☐ 4. Delivery route has been defined for equipment including plans for protecting flooring for heavy equipment and carts. Refer to Chapter 3 Section 5–1 Minimum Delivery Route Sizes and Capacity.

☐ 5. Power Distribution Unit power is available for connection to the Main Disconnect Panel. Refer to Chapter 6 Section 3–1 Main Disconnect Panel (MDP) and Section 3–2 System Power Distribution Unit.

6 Required Before Magnet Ramp–Up

WARNING!

GASEOUS HELIUM IS AN INVISIBLE, ODORLESS GAS THAT CAN CAUSE ASPHYXIATION WHEN DEPLETING THE AMBIENT OXYGEN SUPPLY. HELIUM GAS IS LIGHTER THAN AIR AND WILL RISE TO THE CEILING.
THE MAGNET WILL BE EXHAUSTING HELIUM GAS DURING THIS TIME.
MAGNET MUST BE CONNECTED TO CRYOGENIC VENT COMPLETED TO FINAL EXIT OUTSIDE OF THE BUILDING BEFORE STARTING MAGNET RAMP–UP.

☐ 1. **CTIQ#18 RF Shielding:** The Magnet Room has been tested to ensure that the RF shielding meets the attenuation and electrical isolation requirements. Refer to Chapter 8 Section 1–2 RF Shielded Room Requirements. The customer needs to maintain a copy of the RF Shielded Room vendor test reports with the site documentation.

☐ 2. The Magnet Room has been completely closed (removeable section closed and sealed) and all ferrous objects have been removed from the Magnet Room.

☐ 3. Adequate signs (Safety and Exclusion Zones) been posted to warn personnel about dangers of magnetic field. Refer to Chapter 4 Section 6 Exclusion Zone.

☐ 4. Facility personnel, local fire department(s), and police department(s) have been informed of unique characteristics (e.g. strong magnetic field, cryogens, etc.) of normal magnet safety procedures and correct precautions to take in event of emergencies. Refer to Direction 2381696 MR Safety Guide provided with the MR System Operators manuals.

☐ 5. Power has been connected from the Main Disconnect Panel to Power Distribution Unit. Refer to Chapter 6 Section 3–1 Main Disconnect Panel (MDP) and Section 3–2 System Power Distribution Unit.

☐ 6. The Penetration Panel has been installed. Refer to Section 8 Section 5 RF Penetration Panel.

☐ 7. Precautions have been taken to prevent movement of large metal objects within the Moving Metal Sensitivity Line and all contractor equipment that could affect shimming has been removed from within the Moving Metal Sensitivity Line. Refer to Chapter 5 Section 14 Changing Magnetic Environment Specifications**.**

7 Typical MR Installation Project Schedule

The MR Project schedule shown below depicts a typical MR 1.5T installation. The purpose of this project schedule is to provide a guide for your MR project in regards to tasks which need to be completed, duration of each task and who is primarily responsible for completion of the task. This project schedule starts at magnet delivery which occurs when your site construction is completed, except for magnet room opening. Your GE Installation Specialist can provide more detailed information if needed.

TYPICAL MR INSTALLATION PROJECT SCHEDULE

Typical MR Installation Schedule	Duration	Responsibility	Week 1					Week 2					Week 3					Week 4				
			M	T	W	T	F	M	T	W	T	F	M	T	W	T	F	M	T	W	T	F
Magnet delivered	.5 day	GE																				
Magnet mechanical / electrical	.5 day	GE																				
Magnet room closure	3 days	Contractor																				
Shielding is completed and tested		Contractor																				
Complete magnet room opening		Contractor																				
Flooring completed		Contractor																				
MR system delivered	.5 day	GE																				
Mechanical Installation of system	3 days	GE																				
Calibration of system	12 days	GE																				
MR system available to customer																						

Chapter 11 – Tools And Test Equiment

1 Moving Metal Measurement Equipment

TABLE 10–1
MOVING METAL MEASUREMENT EQUIPMENT

ITEM	GE PART NUMBER	DESCRIPTION
1	——	Magnetometer sensitive to 50 μ gauss Flux gate or equivalent Example: Barrington Instruments Ltd. Model Mag–03MC 500 μT

2 Rigger/Customer Supplied Equipment

Note

Table 10–2 contains an overview of equipment for initial planning purposes, refer to *Direction 2226318, 1.5T & 1.0T LCC Magnet Signa MR/i Delivery and Installation Manual* for details of equipment and requirements.

TABLE 10–2
RIGGER/CUSTOMER SUPPLIED EQUIPMENT

SUPPLIED BY	ITEM	DESCRIPTION
Rigger	1	Crane for removing magnet crate from delivery truck: 12 ton (10,909 kg)
	2	Motorized tow vehicle for pushing/pulling magnet when it is on dollies (e.g. an electric fork lift).
	3	Steel floor plates (8) to cover floors while transporting magnet, 36 in. x 12 in. x 0.25 in. (914 mm x 305 mm x 6.4 mm).
	4	Wood blocks, assorted sizes.
	5	Jacks and accessories for lifting magnet: 20,000 lbs (9091 kg) total capacity
	6	Spreader Beam
	7	For LCC magnet: Lifting straps which meet specifications in *Direction 2226318, 1.5T & 1.0T LCC Magnet Signa MR/i Delivery/Installation Manual*
Customer	8	Equipment for off loading electronics and other miscellaneous components. (e.g. fork lift, hand trucks, straps, etc.)
	9	Panel lifters for computer flooring: Smooth floor Indicon Industries PL2DC; Standard carpeted floor Indicon Industries PL30P; Level loop carpet floor Indicon Industries SCLV1.
Customer/ Contractor	10	Resistance meter: • Megger Insulation Tester **– PREFERRED TEST UNIT** • Analog d'Arsonval Meter (meter must have test source >9 VDC per specification in Chapter 12 Section 2–6 Enclosure Power Reference Isolation)

3 Cryogenic Equipment

TABLE 10–3
CRYOGENIC EQUIPMENT

ITEM	GE PART NUMBER	DESCRIPTION
1	46–306734G1	Low Pressure Regulator Kit (Non–magnetic gas cylinder regulator / hose assembly consisting of regulator, hose, and case) (See Note 2)
2	——	Liquid helium in non–magnetic dewars is needed for refilling the magnet (See Note 2). Refer to appropriate magnet manual for helium volume.
3	46–306717G1	Non–magnetic gaseous helium cylinder cart (See Note 2)
4	46–294705G1	Universal Fill Line Kit (See Note 2)
5	46–294511P1	250 Liter Dewar Stinger (See Note 2)
6	46–294511P2	500 Liter Dewar Stinger (See Note 2)
7	46–294512P1 (12 ft) 46–294512P2 (8 ft)	Transfer Line (See Note 2)
8	46–282336P2	Dewar stinger assembly (High Efficiency) (See Note 2)
9	46–306812G1	Dewar tube ”Thumper” tool (See Note 2)
10	2253802	Burst Disk and Gasket Assembly for LCC Magnet Helium Vessel (See Note 1)
11	46–271136G1	Dewar Adapting Kit including O–ring Kit for Dewar Adapting kit (46–271135P9) (See Note 2)
12	46–271137G1	Cryogen Safety Shield Kit (Includes gloves, face shield, and safety glasses.) (See Note 2)
13	46–294804G1	Non–magnetic Aeroquip wrench Set (See Note 2) includes the following: • 46–294800G1 case for bronze wrench kit • 46–294805P1 bronze 1 $^{5}/_{8}$ in. open end wrench • 46–294805P2 bronze 1 $^{3}/_{8}$ in. open end wrench • 46–294805P3 bronze 1 $^{3}/_{16}$ in. open end wrench • 46–294805P4 bronze 1 $^{1}/_{8}$ in. open end wrench • 46–294805P5 bronze 1 in. open end wrench
14	46–281088G3	Shield Cooler Installation / Maintenance Kit (See Note 2)
15	46–265273G1	Liquid Helium Level Meter Kit (See Note 2)
16	46–306781G1	Helium Mechanical Gas Flowmeter (See Note 2)
17	46–301477G1	Cryogenic Thermometer, Lakeshore 208 Cryogenic Thermometer Kit or alternate Diode Temperature current source 46–317543G1 (See Note 2)
18	46–252210P1	3 Inch Valve Operator (vacuum break tool) (See Note 1)
19	46–294872G2	SAV–CON / Instrumentation Lead Service Kit (See Note 2)
20	46–318784G2	Shield Cooler Test Kit (See Note 2)
21	46–318696G1	Water Tee for Shield Cooler Water Samples access (See Note 2)
22	46–294052G1	Water Flow Meter Kit (for checking flow of water to Shield Cooler Compressor) (See Note 2)
23	2171219	RUO Temperature Monitor for LCC 1.5T & 1.0T Magnet (See Note 2)
24	46–252805P2 (10 ft) 46–252805P3 (15 ft)	Nitrogen Transfill line (only needed if magnet is warmer than nitrogen temperature)
25	46–260201P1	N2 Precool Syphon (only needed if magnet is warmer than nitrogen temperature)

Note 1 Supplied as part of Signa.

2 Supplied by GE until turnover of system to customer, then available as part of a GE Cryogen and/or Service Contract.

4 Installation Equipment

TABLE 10–4
INSTALLATION EQUIPMENT

ITEM	GE PART NUMBER	DESCRIPTION
1	——	Ramp for removing cabinets from pallets for International shipments (See Note 1)
2	——	Wrecking bar
3	——	Claw hammer, 3/4 lb
4	46–271138G1	Restricted Access Control Kit. Contains two plastic warning signs for posting at site during installation and service activity.
5	46–294060G4	Mapping Fixture for field plotting equipment for Cx/LCC magnet Typically not needed to map Cx/LCC Magnet depending on proximity of steel at site, refer to Chapter 5 Section 15–1 Magnet Room Floors Magnetic Properties.
6	2163971	Field Mapping Fixture Upgrade Kit to make kit compatible with Cx/LCC Magnets Used to upgrade 46–294060G3 to 46–294060G4
7	——	Magnet Log Book
8	——	Installation log book
9	——	4 foot or equivalent carpenter level
10	2230707	For LCC Magnet: Aluminum platform ladder, 47.5 inches (1206.5mm) (See Note 1)
11	2134776	Gradient Cable Crimper/Stripper Kit (Note 2) consisting of: • 2134586 Cable stripping tool • 2134586–2 Stripping tool replacement blade • 2134587 Cable slicer • 46–282853P1 Ratcheting crimper • 2135839 1/2 inch terminals • 2135839–2 3/8 inch terminals
12	46–301450G1	Fiber optic connector repair kit (See Note 2)
13	46–260776G3	Magnet Service Tool 750 Amp Power Supply Cabinet dimensions W x D x H is 24.5 in. x 31.5 in. x 35.75 in. (622 mm x 801 mm x 908 mm) and weight of 375 lbs (170 kg).
14	46–260776G4	Magnet Service Tool 1000 Amp Power Supply Cabinet dimensions W x D x H is 24.5 in. x 31.5 in. x 35.75 in. (622 mm x 801 mm x 908 mm) and weight of 375 lbs (170 kg).
15	46–260777G3	Shim Service Tool Power Supply Cabinet dimensions W x D x H is 24.5 in. x 31.5 in. x 35.75 in. (622 mm x 801 mm x 908 mm) and weight of 290 lbs (132 kg).
16	46–306763G1	Subminiature–D Connector Removal/Re–termination Repair Kit for Robinson–Nugent Sub–D connectors
17	46–251865G2	Field Plotting Kit – Metro Lab Teslameter

Note 1 Supplied as part of Signa.
2 Supplied by GE until turnover of system to customer, then available as part of a GE Cryogen and/or Service Contract.

(Continued)

4 Installation Equipment (Continued)

TABLE 10–4 (Continued)
INSTALLATION EQUIPMENT

ITEM	GE PART NUMBER	DESCRIPTION
18	46–260703G3	Magnet Ramping Equipment Kit
19	46–318833G1	Ramp Cable Holder
20	46–294998G1	Ramping Supply and Equipment kit includes the following: • 46–260703G3 Magnet Ramping Equipment Kit (see Item 18) • 46–260776G3 Magnet Service Tool Power Supply Cabinet (see Item 13)
21	46–320273G3 or G4	Non–Magnetic Tool Kit – Universal (See Note 2) Both metric and inch Non–Magnetic Tool Kits needed. May substitute both of the following kits: • 46–320273G1 Non–Magnetic Tool Kit – Metric • 46–320273G2 Non–Magnetic Tool Kit – Inch
Note 1 Supplied as part of Signa. 2 Supplied by GE until turnover of system to customer, then available as part of a GE Cryogen and/or Service Contract.		

5 Test Equipment

TABLE 10–5
TEST EQUIPMENT

ITEM	GE PART NUMBER	DESCRIPTION
1	2284754	Textronic TDS3012 digital scope
2	2284763	Fluke FLK196M scopemeter for medical applications
3	46–194427P226	Dual trace oscilloscope, 100 MHz bandwidth, 2 channel, digital storage, Textronic 2232
4	46–194427P222	Dual trace oscilloscope, 350 MHz bandwidth, 4 channel, Textronic 2465
5	46–194427P284	Battery operated digital multi–meter, Fluke 87, 4.5 digits with frequency counter and capacitance
6	46–208572P9	Clamp–on Ammeter, 1–200A, AC/DC
7	46–317724P14	Attenuator/ load, 200 Watt, 30 dB attenuator
8	46–317724G2	RF Power Measurement Kit with Attenuator/ load, 200 Watt, 30 dB attenuator 46–317724P14
9	2218826	RPM 1650 Power Analyzer Kit
10	46-328143G3	Dranetz 626 analyzer kit with 1 and 3 phase modules
11	Catalog E6320DA or 46–194427P144	Densitometer
12	46–306801G1	Bell Gauss Meter Kit
13	46–194427P248	Microguard or ECOS leakage tester
14	46–306797G1	Fogg (ECG) Simulator and Memory Module
15	46–320433P1	Infrared Scanner 0 – 100° C
16	46–317830G1	Fiber Optic Light Meter Kit
17	46–294047G1	Shield Cooler Vacuum Pump Kit
18	46–251867G1	Main Vacuum Pump Down Kit
19	46–1944278P448	AEMC Clamp–On Ground Rod Impedance Meter

6 Calibration Tools/Fixtures

TABLE 10–6
CALIBRATION TOOLS/FIXTURES

ITEM	GE PART NUMBER	DESCRIPTION
1	46–307500G1	Longitudinal Drive Force Gauge
2	2133388–6	System Performance Test (SPT) Phantom Set for Systems with Cx/LCC (Active Shield) systems (See Note 1) consisting of the following: • 2125247–10 Nesting Plate • 2125245 Large Volume Shim Phantom Assembly • 2125244 Short Loader Assembly • 2131027–2 Daily Quality Assurance (DQA III) Phantom • 2134213 SPT Shipping/Storage Cart (Not used for Mobile Systems) • 2170481 EPI Foam Positioner • 2141454 Quick Shim Positioner
3	46–287900G3	Head TLT Sphere (46–265826G6), one 100 mm NIckel Chloride sphere (46–317586G1), and Loader (46–287899G1) See Note 1
4	46–255816G1	RF Test Cables Kit
5	46–265434G1	Magnet Rundown Unit Test Box
6	46–307164G4	1.5T / 1.0T GRAFIDY II Kit
7	46–328021G1	Enmet Oxygen Monitor Calibration consisting of the following: • 1800 PSI cylinder of 20.9% Oxygen in Nitrogen • 1800 PSI cylinder of 17% Oxygen in Nitrogen • Regulators with calibration adapter For use with portable or permanent Oxygen Monitor.
8	2106236	Portable Oxygen Monitor (Connecticut Analytical)
9	2107184	Permanent Oxygen Monitor (Enmet)
10	46–301549G1	TPS RF Test Cable/Adapter Kit
11	46–301927G1	TPS RF Service Interface Kit (See Note 2)
12	46–306712G1	Torque driver kit
13	46–306864G1	Magnet Helium Resistance Box Kit
14	2101360	Power Supply Calibration Kit
15	46–265826G3	Head Signal–to–noise (SNR) sphere (See Note 3)
16	46–265635G4	Body Signal–to–noise (SNR) sphere (See Note 3)
17	46–265635G2	Body T2 sphere (See Note 3)
18	46–328480G1	100 mm Nickel Chloride sphere (46–317586G1) and Universal Phantom Holder (46–328383P1) See Note 2

Note 1 Supplied as part of Signa.
2 Supplied by GE until turnover of system to customer, then available as part of a GE Service Contract.
3 Customer may purchase these items.

7 Tool Kit

TABLE 10–7
TOOL KIT

ITEM	GE PART NUMBER	DESCRIPTION
1	——	Extension cords, with ground conductor
2	——	Power strip, grounded type, with minimum of five outlets
3	——	Soldering iron, pencil type with solder
4	——	Solder sucker
5	——	Assortment of Brady Quick labels
6	——	Micro clip leads
7	——	14 pin and 16 pin DIP clips
8	46–258218P3	Vinyl electrical tape
9	46–258218P4	Copper tape, 3 in. wide
10	46–258218P5	Copper tape, 2 in. wide
11	46–258218P6	Copper tape, 1 in. wide
12	——	Alcohol cleaning solution
13	——	Plastic or aluminum flashlight
14	——	Plastic or aluminum pen light
15	AMP No. 458994–1	Pin extractor, Universal Mate'n'Lock
16	AMP No. 305183–R	Pin extractor, M–series
17	46–237072P1	Pin extractor, Sub–D
18	46–307307G1	Crimping tool for coax cable and BNC connectors Inserts for RG8, 9, 11, 214 46–255841P103 RG58, 223 46–255841P100 RG59 46–255841P101 RG174 46–255841P102 Die Removal Tool 46–255841P201
19	——	Assorted crimp tools.
20	——	Non–magnetic level
21	——	Non–magnetic tape rule, 12 ft
22	——	Assorted drill bits
23	——	Inspection mirror
24	——	Tap set, standard, and tap handle, T–type
25	——	6 in. rule, standard and metric markings
26	——	Alignment tool (tweaker)
27	——	Hex/alignment tool
28	——	Hemostat, 5 in., curved
29	46–198094P1	Wrist grounding strap

(Continued)

7 Tool Kit (Continued)

TABLE 10–7 (Continued)
TOOL KIT

ITEM	GE PART NUMBER	DESCRIPTION
30	Xcelite 110CG	Diagonal Cutting Pliers, 4–1/2 in.
31	——	Screw Starter, aluminum or plastic shaft
32	——	Hobby and utility knives
33	——	Spring scales, 0–10 lbs and 0–50 lbs
34	46–313413P1	Extractor for 20 – 100 pin PLCC Chips

Chapter 12 – Appendixes

1 MR Site Vibration Test Guidelines

1–1 Test Measurements

- Vibration measurements are in the range of 10^{-6} g. Test equipment must have the required sensitivity to these levels.
- Instrumentation is recommended to have a low tolerance to temperature effects as many times the low frequency thermal drift may influence the measurements.
- It is highly recommended all measured data is real time data acquisition. Recording of vibration data will not allow for a proper site survey, specifically when studying transient vibration and when searching for specific vibration sources.
- All analyses are to be narrowband Fast Fourier Transforms (FFT's) over the frequency bands listed in Table 12–1.

TABLE 12–1
FREQUENCY BANDS FOR FFT'S

FREQUENCY BAND	FREQUENCY RESOLUTION
0.2 to 50 Hz	Δf= 0.125 Hz

- Time histories of the vibration must be recorded as acceleration levels vs. time. The resolution of the time history must be adjusted to clearly capture the transient event. The analyzer set–up will be site dependent and, in special cases, vibration response dependent. It is the responsibility of the vibration consultant to study the transient environment, capture data to confirm transient activity exceeds the trigger level, then expand the time history data to exhibit the structural response.

1–2 Equipment (Spectral Analyzer) Set–Up

- Frequency average a minimum of 20 linear averages Do not use peak hold or 1/3 octave analysis.
- Average and store a minimum of 10 plots to support the site vibrations consistency.
- Hanning window must be applied to the entire spectra

Spectrum analyzers capable of these measurements are readily available for purchase or rental. Models such as the HP 3560A, Nicolet Phaszer, B&K Pulse, and HP 35670 are all capable of making the site vibration measurements. Accelerometers must have the capability to measure from 0.2 Hz beyond 50 Hz. Time histories can be recorded using any of the analyzers listed above. Please note that the equipment mentioned are for example only. It is the responsibility of the Engineering test firm to provide equipment that will allow measurements compliant with this guideline.

1–3 Data Collection

1–3–1 Ambient Baseline Condition

All of the measurements defined in Section 1–1 and 1–2 must be made in a ‘quiet’ site environment. That is, in areas where excessive traffic, subway trains, etc. exists, a vibration measurement must also be made during periods without traffic or during periods of light traffic. Measurements must define the lowest levels of vibration possible at the site.

The source of any steady state vibration whose levels exceed the specifications in Chapter 5 Section 16–3 Specifications For 1.5T LCC (Active Shield) Magnets must be identified as to the source of the vibration disturbance. A second measurement should be made with all of the identified contributors powered down if possible. In situations where it is not possible to power down equipment, vibration data must be collected to identify specific source of the vibration concern. The majority of steady state vibration problems can be negated by isolating the vibration source.

1–3–2 Normal Condition

All of the vibration measurements listed above must be repeated during periods of ’normal’ environmental conditions including the FFT’s and time histories. The transient measurements must be provided to define the dynamic disturbances the MR system might be exposed to. Transient analysis is required for a true assessment of the site.

Special attention must be paid to the site assessment during the entire analysis. Since transient vibration is not easily addressed once the MR suite is fully constructed, the test consultant must fully understand the needs for this analysis. The source of any transient must be identified and supported with vibration plots. If the source of any transient is not able to be located, it is recommended that the customer should have an alternate location identified and vibration studied.

Transient vibration can be difficult to assess if the details of the transient vibration is not understood. The **0.0005g, zero to peak trigger level** is a starting point to begin understanding the vibration stability. The transient vibration peak amplitude, structural (time variant) response, decay rate and an estimate of the number of events per unit time would constitute a complete transient analysis. All transient failures must be supported by time history plots. The plots must clearly show the structural response, the frequency of the signature and the decay rate. From this data, GE can help determine compliance to the vibration guidelines.

Test consultant must prove design recommendations for all sites/building structures which are found to exceed the specifications in Chapter 5 Section 16–3 Specifications For 1.5T LCC (Active Shield) Magnets.

1–4 Presentation/Interpretation Of Results

The recommended format for site vibration data collection, presentation, and analysis is illustrated in the examples shown in Illustrations 12–1 through 12–4. Presentation of the data in any other format (linear units only) may result in an incorrect interpretation and diagnosis of the site. Additional data collection or presentation methods is at the option of the vibration testing service.

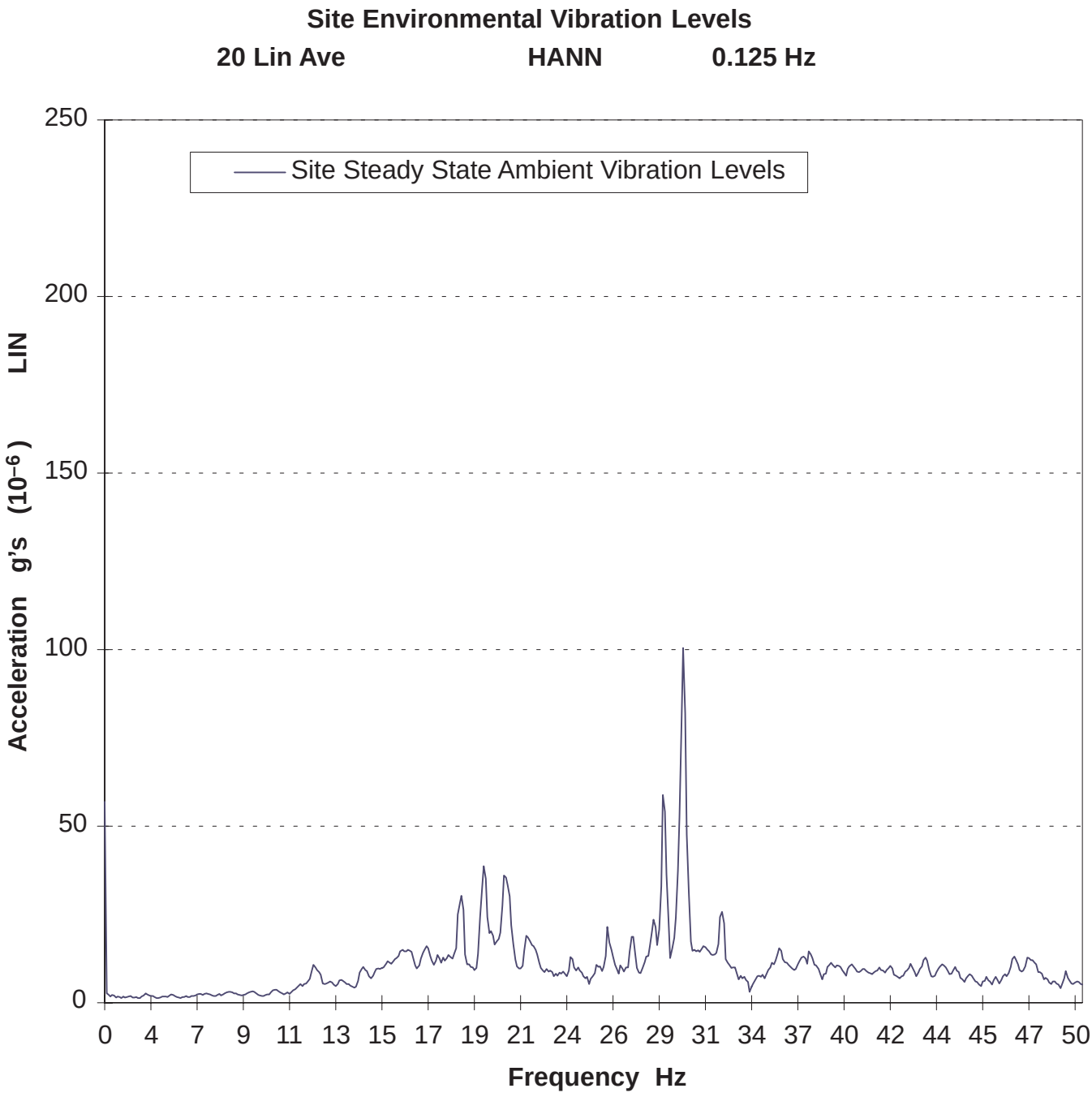
It is the responsibility of the customer's vibration testing service to interpret the results and determine if that site meets GE's specifications. Illustrations 12–1 and 12–2 are examples provided to assist a test consultant in the use of GE Steady State specifications (vibration specifications above ambient baseline). If the vibration levels are too high, additional data acquisition may be necessary to:

- determine the source of the vibration
- propose a solution to the problem
- find an alternate site location.

Illustrations 12–3 and 12–4 are examples provided to assist a test consultant in the use of GE Transient specifications. The **0.0005g, zero to peak trigger level** identifies data collection to begin assessment of the site vibration analysis. The response of the transient must be assessed relative to the Steady State vibration specifications in Chapter 5 Section 16–3 Specifications For 1.5T LCC (Active Shield) Magnets**.**

Any questions regarding test equipment requirements, test parameters, or general questions should be discussed with your GE Installation Specialist.

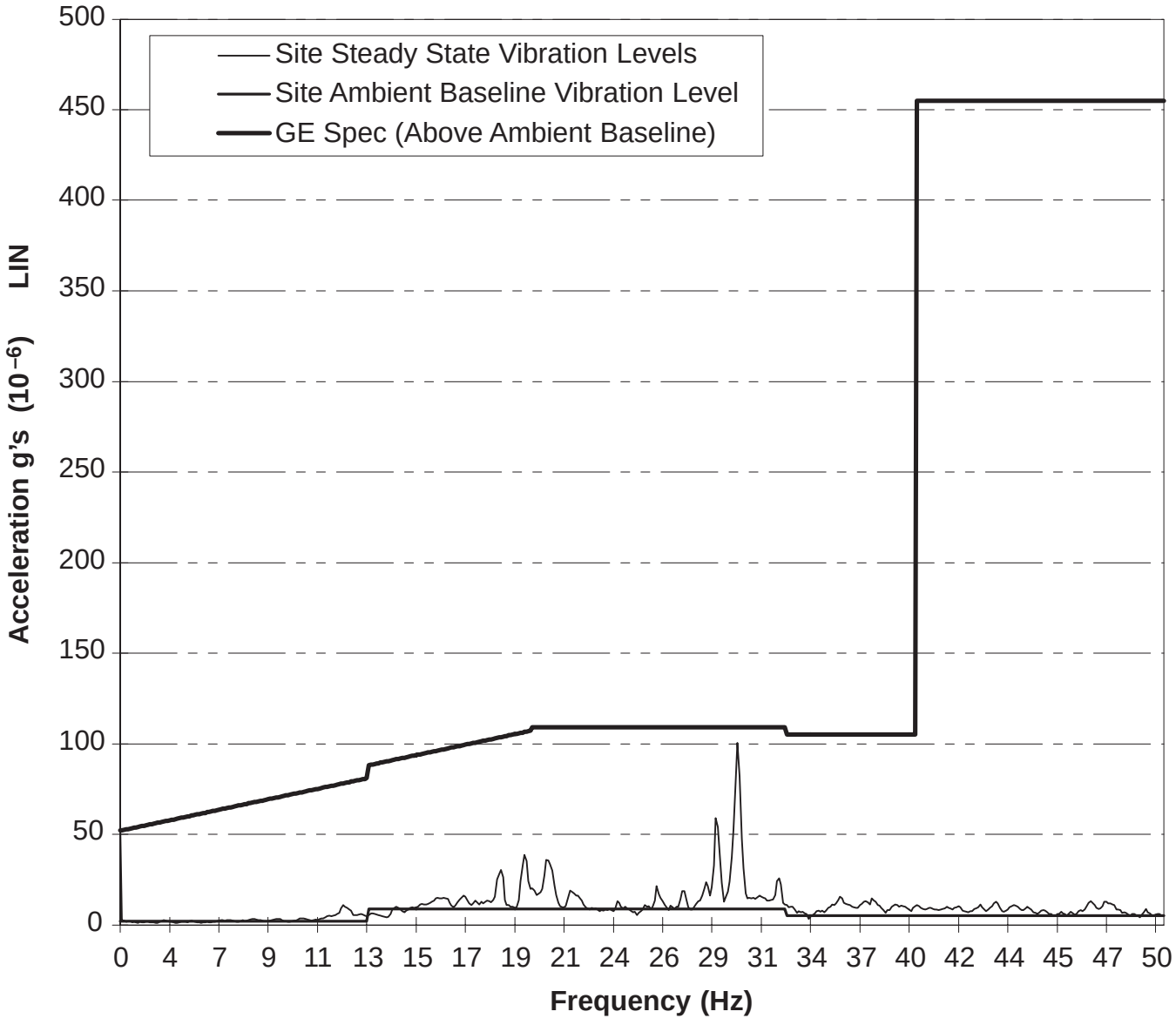
1–4 Presentation/Interpretation Of Results (Continued)



EXAMPLE SITE ENVIRONMENTAL VIBRATION
ILLUSTRATION 12–1

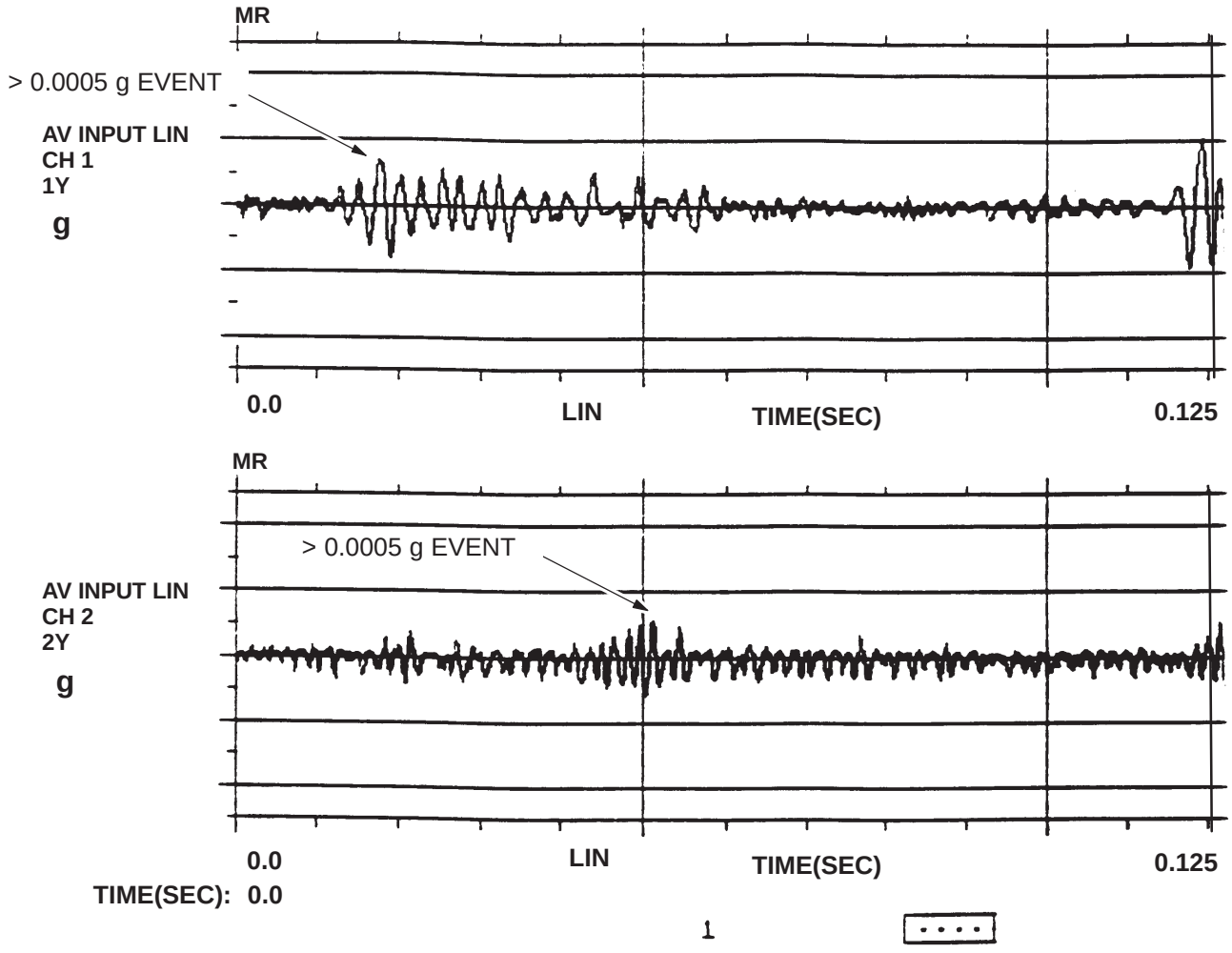
1–4 Presentation/Interpretation Of Results (Continued)

EXAMPLE: Site Environmental Vibration vs. GE Spec. for 1.5T K4 Magnet
20 Lin Ave Hann 0.125Hz



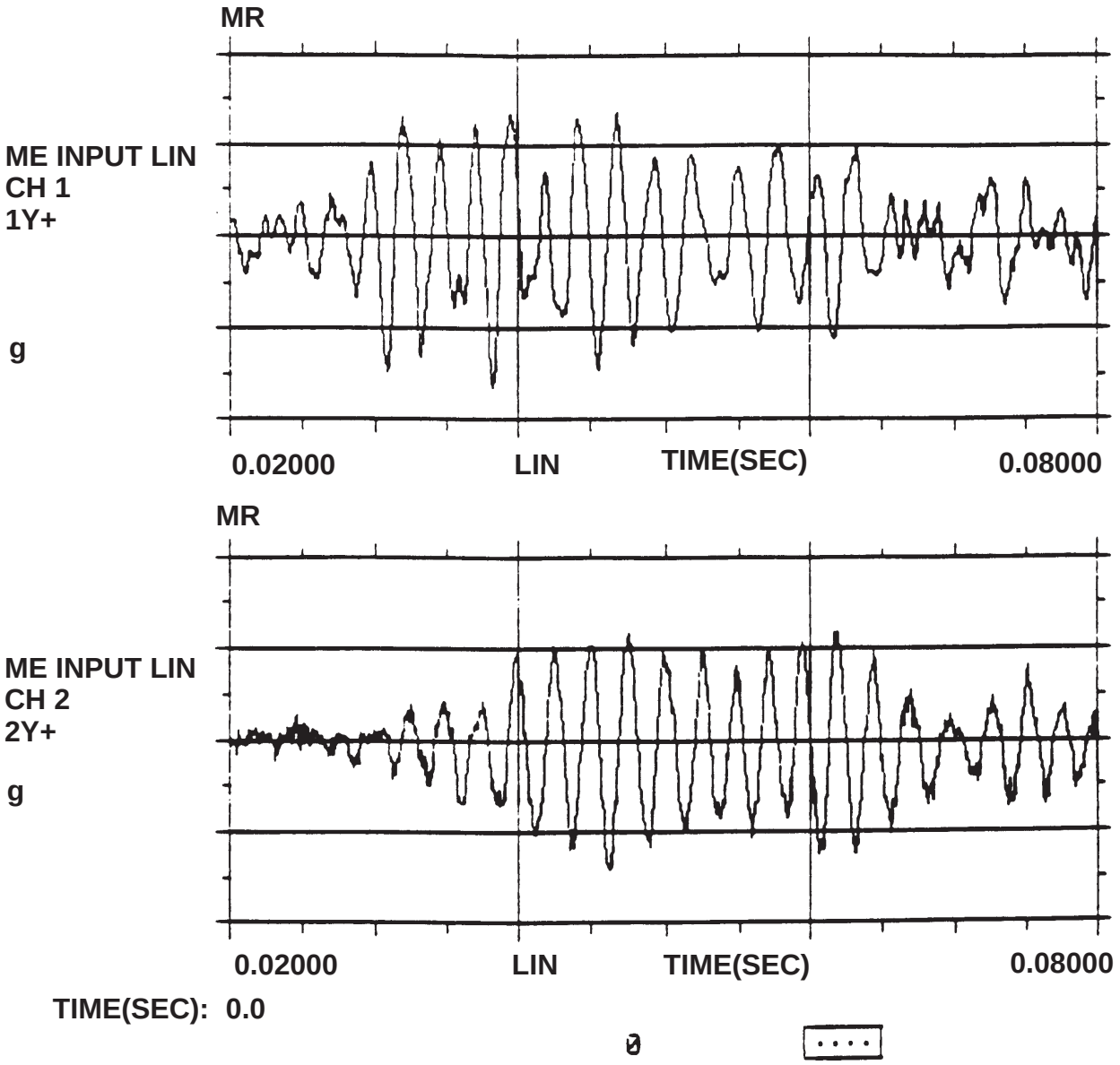
EXAMPLE SITE ENVIRONMENTAL VIBRATION VS. GE SPECIFICATION FOR 1.5T LCC MAGNET
ILLUSTRATION 12–2

1–4 Presentation/Interpretation Of Results (Continued)



ACCELERATION TIME HISTORY
ILLUSTRATION 12–3

1–4 Presentation/Interpretation Of Results (Continued)



ACCELERATION TIME HISTORY (ZOOM IN ON TRANSIENT EVENT)
ILLUSTRATION 12–4

2 RF Shielded Enclosure Test Guideline

2–1 Introduction

This document describes the procedure and methodology of performing an RF shielding effectiveness verification test on enclosures which will house GE Medical Systems (GEMS) Magnetic Resonance Imaging (MRI) equipment. MRI equipment is sensitive to RF energy from sources outside of the shielded enclosure. To ensure proper operation of the MRI equipment, the shielded enclosure must attenuate local RF signals to levels that do not cause interference.

Note

RF Shielding Performance is based on **planewave** measurements. “H” field and “E” field tests are not required, but are allowed as needed for diagnostic purposes.

2–1–1 Purpose Of Test Plan

The purpose of this test plan is to describe a series of RF shielding effectiveness tests to demonstrate compliance of an MRI shielded enclosure to the requirements of GE Medical Systems.

The test procedure described in this guideline is a modification of MIL–STD–285 and IEEE Std 299–1991. This procedure provides a through evaluation of the shield integrity at the upper end of the frequency range of interest showing any RF leakage which may cause imaging problems. These test guidelines ensure that the electromagnetic environment inside of the enclosure will meet the requirements of General Electric Medical Systems.

2–2 Applicable Documents

MIL–STD–285	MILITARY STANDARD ATTENUATION MEASUREMENTS FOR ENCLOSURES, ELECTROMAGNETIC SHIELDING, FOR ELECTRONIC TEST PURPOSES, METHOD OF; 25 June 1956
IEEE Std 299–1991	IEEE STANDARD FOR MEASURING THE EFFECTIVENESS OF ELECTROMAGNETIC SHIELDING ENCLOSURES; 2 July 1991

2–3 Test Sample Setup

The shielded enclosure under test shall be set–up in a normal configuration, which consists of the following:

1. Magnet installed including all floor mounting bolts
2. RF shielded door(s)
3. Waveguide penetrations, HVAC, vents, medical gas lines, etc.
4. AC power supplied through low–pass filters
5. Patient view window, skylights, windows, hatches, etc.
6. Blank penetration panel installed, dimensionally equivalent to the GE panel and the same mounting hardware to be used with the GE penetration panel.

For safety reasons, the enclosure shall be electrically grounded during the shielding effectiveness test. Any variances from the normal configuration shall be noted in the certification report.

2–4 Shielding Effectiveness

This test procedure determines the worst case shielding effectiveness based on the lowest test point reading obtained. The lowest reading obtained will be the reading of the room.

2–5 Measurement Procedure

To simulate the effects of external RF sources, the transmit antenna shall be located outside the enclosure on a plane parallel to the face of the enclosure wall, at a distance of 6 feet (1.8 meters) unless physically constrained to a lesser separation. The areas of least effectiveness are located by searching the inside of enclosure with the antenna connected to the spectrum analyzer.

2–5–1 Test Position

The transmitting antenna will be positioned in front of all critical areas (doors, windows, filters, penetration areas, etc.) and at a minimum of every 20 feet (6.1 meters) of wall. The receiving antenna is scanned over all panel section joints (where accessible), at floor, wall, and ceiling for a minimum of 10 feet (3.05 meters) in all directions from the location of transmitting antenna. The receiving antenna shall be at a minimum of 1 foot (0.3 meters) from the shield. For areas that are inaccessible for direct location of the transmitting antenna, the inside of that area will still be scanned using the receiving antenna with the transmitting antenna positioned in front of the adjacent wall or adjacent test position.

2–5–2 Frequency Range

The standard frequency for shielding measurements shall be 100 MHz $\pm$ 10 MHz. This allows the frequency to be adjusted slightly to avoid interference from local active transmitters and/or RF noise from other sources. Test frequency utilized shall be noted in the certification report.

2–5–3 Free Field Calibration

The incident field, i.e. “free field”, is measured by the following procedure:

Position the transmit antenna parallel to the exterior wall of the enclosure at a distance of 6 feet (1.8 meters) (unless physically constrained to a lesser separation, in which case a separate reference will be established and documented at the new test distance), using horizontal polarization. The receive antenna shall be placed between the transmit antenna and 1 foot (0.3 meters) from the exterior wall of the enclosure. The receive antenna will be moved vertically and horizontally to achieve maximum signal strength. The receive antenna shall be placed no closer than 2 inches (51 mm) from the exterior wall of the enclosure and in line with the transmit antenna. The maximum received voltage at the test frequency will be recorded.

2–6 Enclosure Power Reference Isolation

To prevent personnel hazard, it is necessary for the enclosure to be properly grounded.

To minimize common mode currents, the ungrounded enclosure should be isolated from ground with a minimum of 1000 ohms of DC resistance. The isolation measurement is performed by the following procedure:

All power to the enclosure is removed. For safety reasons, an AC voltage measurement will be made to verify that no power is connected. With electrical power and intentional ground disconnected, connect the test instrument between the shielded enclosure and AC power ground. Take a reading and record the value. This test shall be made using either an isolated, current limited high voltage (>150 VDC) DC source and DMM to read drop across the limiting resistor or a megger instrument capable of reading values less than 1000 ohms. Conventional resistance meters employing test sources of 9 VDC or less shall not be used.

2–7 Test Equipment

Test equipment shall be selected to provide measuring capabilities as described in this test guideline. The signal source, amplifier, antennas, and receiver or spectrum analyzer shall be such that the difference between the induced reference voltage and the receiver sensitivity shall be at least 6 dB greater than the required attenuation specification.

The signal source and power amplifier shall output a CW signal for a nominal test frequency of 100 MHz. Receiver or spectrum analyzer and preamplifier (if required), shall provide adequate sensitivity to permit attenuation measurements to be made to the specified limits. Dipole antennas and other miscellaneous equipment required to transmit and receive the proper RF fields shall be used.

The absolute performance calibration, of the equipment requiring calibration, shall be performed on an as needed basis in accordance with MIL–STD–45662. The calibration period shall not exceed one year. The test equipment tolerances of at least $\pm$ 2% frequency and $\pm$ 2 dB amplitude shall be met. Equipment certifications shall be traceable to the National Institute of Standards and Technology (NIST). All equipment will be verified for proper operation between and after each series of tests by repeating the reference readings at the specified frequency(s).

2–8 Data Recording And Verification

Measurements shall be performed by qualified responsible EMC test personnel. The test must be performed in the presence of a GE representative unless other arrangements have been made by GEMS. All data collected during the course of the tests will be recorded on standardized data sheets. The data sheets will include the test location, frequency, reference level, measured enclosure level, and attenuation level.

2–9 Test Report

A final certification report will be provided after the test is performed. This report will include all recorded data necessary for the evaluation of the shielded enclosure test results and will list any changes pertinent to the test set–up or the shielding effectiveness. The certification report will also include the test procedures and a list of the actual equipment used during the test.

Along with the data sheet, there will be a presentable drawing showing the shape of the enclosure, all test point locations, doors, filters, windows, and existing building walls.