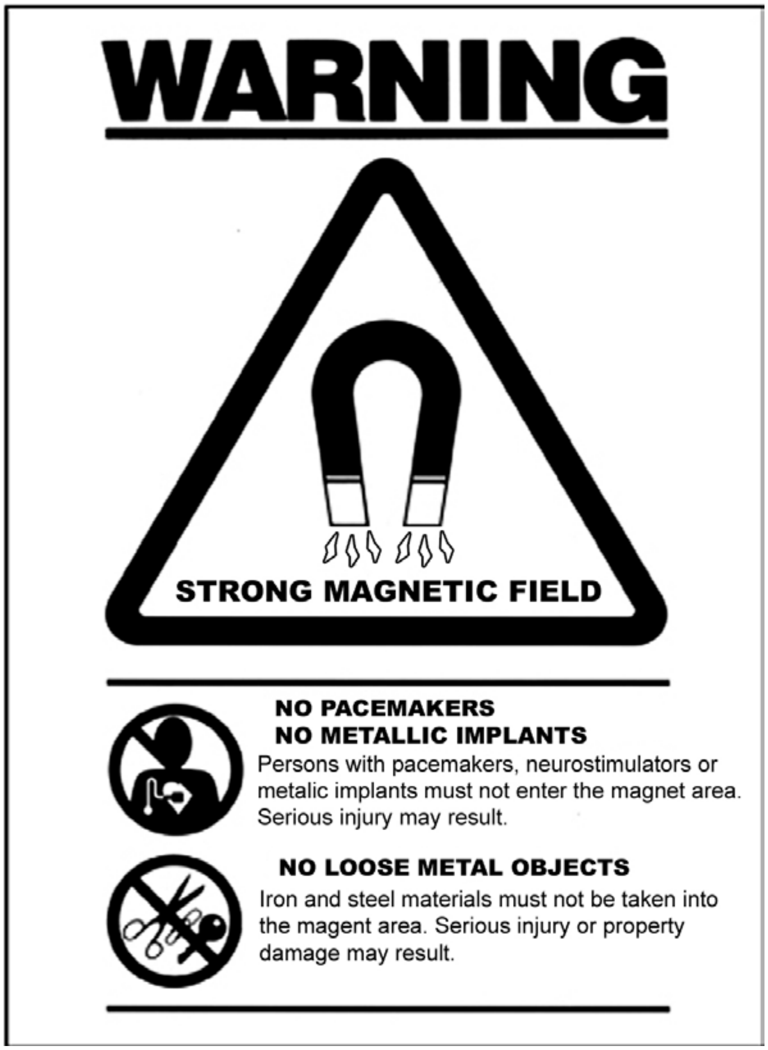
GE Healthcare

Signa EXCITE HD 3.0T
Pre-Installation

OPERATING DOCUMENTATION

5133303
Revision 6


WARNING
STRONG MAGNETIC FIELD
NO PACEMAKERS
NO METALLIC IMPLANTS
Persons with pacemakers, neurostimulators or metalic implants must not enter the magnet area. Serious injury may result.
NO LOOSE METAL OBJECTS
Iron and steel materials must not be taken into the magent area. Serious injury or property damage may result.

Important Information

LANGUAGE

WARNING

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

AVERTISSEMENT

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

WARNUNG

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

AVISO

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

ATENÇÃO

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

AVVERTENZA

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

警告

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

注意:

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

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Revision History

Revision	Date	Description
1	28 Oct 2004	initial product release
2	23 Nov 2004	Chapter 5, Section 4, Air Cooling 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. Chapter 7, Section 4.9, Customer Supplied Interconnects: Corrected graphic for “System Customer Supplied Interconnects Diagram” and deleted Group 77 (part of L2 groups). Interconnect Data Chapter: Introduction Chapter 7, Section 1.4, Definition of Terms subsection, Interconnects Location & Relative Length Provided table Note fixed link for reference to subsection titled Cable Groups Length Provided. Chapter 7, Section 8.2, Table titled “8KW MNS Additional Interconnects Details - L3“ added S2 Group Area and missing diameter and Plug Pull Dimensions for Runs 1236 & 1241.
3	28 April 2005	**Pre-Installation Introduction Chapter:** Added Critical To Image Quality section Chapter 1, Section 2, Crititcal To Image Quality
		System Configuration Chapter: Chapter 2, Section 3, M1060MB catalog deleted by MR Program direction, refer to M1060MA.
		Room Layouts Chapter: Added missing section MR System Interconnects Routing Chapter 3, Section 6, MR System Interconnects Routing. Revised MRCC Service Providers in Chapter 3, Section 8.2, MRCC Siting Considerations.
		Magnetic Field Considerations Chapter: Chapter 4, Section 3, Structural Steel Evaluation Of Proposed Sites: 1st paragraph restructured sentences to improve readability. Steel in close proximity to the magnet the actions revised to “must” from “may” be taken.
		Site Environment Chapter: Chapter 5, Section 2, IEC EMC Compliance Recommended Separation Distances corrected switched heading for 3rd & 4th columns. Chapter 5, Section 3, Temperature and Humidity Specifications added missing Operator's Control Room temperature & humidity specs. Chapter 5, Section 16, Vibration vibration definition section reworded to clarify meeting vibration criteria.
		Power Requirements: Chapter 6, Section 8, DC Lighting Controller (Facility Option) added paragraph to determine 20 or 28 Amp DC Lighting Controller.
		Interconnect Data:
		RF Shielded Room: Chapter 8, Section 6.5, Magnet Room Floors Section title changed from Floors to Magnet Room Floors; revised to include general requirements in this section. Finished Flooring requirements updated for surface resistance and grounding to RF Common Ground Stud requirement and no carpet, antistatic wax or spray on treatment solution allowed. Chapter 8, Section 7.1, Anchor Hardware For MR Equipment Inside RF Shield Customer Responsibilities subsection 3rd bullet deleted duplicated wording, added customer coordination responsibility.
		Shipping And Delivery Chapter: Chapter 9, Section 1, Shipment and Chapter 9, Section 2, Magnet Shipping Considerations LCC300 Magnet shipping weight updated per 2350040IDW Rev 2 values.
		Pre-Installation Checklist Chapter: Chapter 10, Section 2, Pre-Installation Checklist updated for wording symmetry with Critical To Image Quality Checklist
		Tools and Test Equipment Chapter: Chapter 11, Section 7, Added Non-Magnetic Tool large & small kits entries

Revision	Date	Description
4	30 March 2006	Topics modified throughout direction • Added NEC 2005 references: Chapter 3, Section 12.4, Main Disconnect Panel, Chapter 3, Section 9.6, Magnet Monitor, Chapter 6, Section 1, System Power Introduction, Chapter 6, Section 2, Critical Power Requirements, Chapter 6, Section 3.1, Main Disconnect Panel (MDP) Requirements, Chapter 6, Section 4, Grounding, Chapter 6, Section 5, Ground Fault Protection, • Added Remote MRU Option: Chapter 2, Section 3, Additional System Options, Chapter 3, Section 9.9, Remote MRU Option, Chapter 6, Section 1, System Power Introduction, Chapter 7, Section 11, Remote MRU Option Interconnects • Added 4KW MNS option for Signa EXCITE HD 3T: Chapter 2, Section 1, Basic System, Chapter 3, Section 11, Floor Loading and Weights, Chapter 3, Section 9.5, Spectroscopy, Chapter 3, Section 12.11, MNS Cabinet, Chapter 5, Section 4, Air Cooling, Chapter 7, Section 8.1, 4KW MNS Option Additional Interconnects • Add IPCM Option information: Chapter 2, Section 3, Additional System Options, Chapter 3, Section 2, Proximity Limits, Chapter 3, Section 9.10, IPCM Option For LCC300 Magnets ONLY, Chapter 3, Section 12.24, IPCM Option, Chapter 5, Section 4, Air Cooling, Chapter 6, Section 1, System Power Introduction, Chapter 6, Section 9, IPCM Option Power Requirements, Chapter 7, Section 12, IPCM Option Interconnects, Chapter 9, Section 1, Shipment
		System Configuration Chapter: Chapter 2, Section 3, Additional System Options Added catalog info for Remote MRU Option. Chapter 2, Section 4, Facility Options added Note of 50 Hz DC Lighting Controller contact info. Chapter 2, Section 1, Basic System illustration titled "EXCITE HD New System Additional Catalogs" corrected catalog numbers for all of the languages Warning Sign Kits.
		Room Layouts Chapter: Chapter 3, Section 6, MR System Interconnects Routing MR System Interconnects Routing Requirements/Recommendations table: Row titled Entire MR System: recommendation for use of access flooring deleted Magnet Room (changed to "recommended for use in ONLY the Equipment Room "); Row titled Magnet Room: Row titled Magnet Room: deleted "e.g. aluminum" from 1st bullet and Note. Chapter 3, Section 8.2, MRCC Siting Considerations added airflow Notices to MRCC Access & Air Considerations, MRCC start Chiller tasks responsibility changed, and updated Service Providers. Chapter 3, Section 9.5, Spectroscopy changed subsection title to 8KW from 4KW. Chapter 3, Section 11, Floor Loading and Weights table titled Notes For System Components Floor Loading Table, Note 5 2nd sentence changed to Contact your local GE Healthcare Project Manager, Installations for seismic information if the MR system equipment is required by code to be anchored." Chapter 3, Section 10, Architectural Reminders deleted storage cabinet for service docs/tools per MR Service Manager. Chapter 3, Section 12.2, Magnet and Enclosure Magnet Load Pattern With VibroAcoustic Damping Option removed Magnet feet dimensions, the mats are the load pattern. Magnet Load Pattern Without VibroAcoustic Damping Option added side-to-side dimension of Magnet Mounting Recessed Area, Magnet Mounting Recess Area requirements/information updated in Load Pattern tables. Chapter 3, Section 12.4, Main Disconnect Panel M3088TM weight revised to 350 lbs (158 kg) per vendor manual update. Chapter 3, Section 12.5, MR Common Chiller (MRCC) added airflow arrows, refer for airflow important notices, and revised MRCC Outdoor Mounting concrete pad dimensions for Front & Rear Views. Chapter 3, Section 12.9, RFS Cabinet corrected 3T RFS Cabinet metric weight value (changed to 263 kg from 172 kg). Chapter 3, Section 12.14, Magnet Monitor dimension illustration updated to Magnet Monitor 3 appearance (no change to mounting holes dimensions). Chapter 3, Section 12.17, Operator Workspace "seismic anchor holes" changed to BRACKETS MOUNTING HOLES and brackets callout to "BRACKETS SUPPLIED WITH CABINET FOR MOUNTING, IF REQUIRED."
		Magnetic Field Considerations Chapter: Chapter 4, Section 3, Structural Steel Evaluation Of Proposed Sites added Notice for existing shield must be evaluated.
		Site Environment Chapter: Chapter 5, Section 4, Air Cooling added DC Lighting Controller option equipment values. Chapter 5, Section 9, Room Ventilation Magnet Room exhaust fan and air inlet requirements change to minimum CFM (m^3/minute) **and** minimum of room air exchanges per hour. Also revised pressure equalizing waveguide location to include wall requirements. Chapter 5, Section 10.2, Requirements For Outside Magnet RoomTypical LCC300 Magnet Cryogenic Vent Detail illustration updated exhaust opening shaded areas added white behind text to improve text readability. Chapter 5, Section 12, Ambient Radio Frequency Interference (RFI)RFI site surveys broad band range changed to 150MHz ± 10MHz (match RF Shielded Room requirements).

Revision	Date	Description
4 (cont'd)		**Interconnect Data Chapter:** Chapter 7, Section 4.2, Cable Groups Length Provided added Group 34 to Location 5 of table titled “Cable Groups Length Provided By Fixed Site Cable Catalogs”. Chapter 7, Section 4.9, Customer Supplied Interconnects Customer Supplied Interconnects table, Note 2 corrected HFD/PDU Cabinet reference designator (MR3). Chapter 7, Section 4.10, Cable Group and Location Cross Reference Location & Cable Group Cross Reference To Run Details table: Groups 49 & 50 deleted not applicable configuration details reference; Group 72 correct FROM designator (MR8 changed to MR2. Chapter 7, Section 5.1, Interconnects For 2 MRCC Units Located Outdoors L1/L2 Group 86 and L3 Group 15 added Ball Valves to Customer equipment for “From” connection unit. Chapter 7, Section 5.2, Interconnects For 2 MRCC Units Located Indoors Interconnect Diagram changed Group 5 to 16 (matches Customer Supplied table Group number). Chapter 7, Section 6, GWHX Additional Interconnects subsection “Gradient Coil Water Cooling Lines & Hoses Requirements” 2nd bullet corrected wording for “connect from GWHX to the Gradient Coil”.
		RF Shielded Room Chapter: Chapter 8, Section 1, RF Shielded Room Requirements RF Shielded Room Requirements table, row titled Construction, Note text deleted 'e.g. aluminum'. Chapter 8, Section 5, RF Penetration Panel requirements reordered for clarity and completeness. Also added Notice pertaining to Penetration Panel mounting hardware must not loosen over time to maintain RF attenuation requirement. Chapter 8, Section 6.3, Ceiling Height ceiling height requirements table added Notes 1 & 2. Chapter 8, Section 6.2, Doors and Other Openings typical removable wall panel height dimension changed. Chapter 8, Section 6.5, Magnet Room Floors ”Magnet Room floor Requirements and Recommendations” table changes: • Table row titled Floor Design: Bullet stating 42.125 dimension finished floor to center of Magnet opening added missing minus (-) for tolerance +/- value. Access flooring Notice deleted “e.g. aluminum”. • Through out table deleted “e.g. aluminum” for Notice! pertaining to removable panels known source of RF Noise. • **Entire Floor Levelness row contents revised, Magnet Mounting recess area requirements including tolerance (+/-) values changed and recommendation added.** • Majority of Floor Construction row revised: Magnet Mounting Recessed area required with and without VibroAcoustic Damping Option and clarified requirements for both configurations. Added RF Shield material seams MUST NOT be under projected areas for VibroAcoustic Damping Option mats. Added Access flooring Notice. • Added tables with illustrations & references of revised Magnet Load Pattern with & without VibroAcoustic Damping Option. Chapter 8, Section 7.2, Physical Characteristics table titled “Equipment Characteristics” corrected value for Magnet “Maximum Clearance Above Equipment Base”.
		Shipping And Delivery Chapter: Chapter 9, Section 1, Shipment incorporated Storage Requirements section info into this section. Patient Table shipping dimensions and weights revised for new packaging. Chapter 9, Section 2, Magnet Shipping Considerations incorporated Cold-Shipped Magnet Deliveries info into this section.
		Tools and Test Equipment Chapter: Chapter 11, Section 3, Cryogenic Equipment Supplied By Rigger row contents changed to “Refer to *Direction 2340869 GE LCC300 Active Shield Magnet Delivery and Installation* for equipment and requirements.” Chapter 11, Section 4, Installation Equipment Added 3T shim related tools: -Shim case / cable kit 2135558, LCC300 Shim Camera Kit 2386028, LCC300 Passive Shimming Kit 2386029. Updated several part numbers: -Field Plotting Kit 46-251865G5 -Magnet Ramping Equipment Kit part number updated to 46-260703G5 -Non-Magnetic Tool Kit replaced by new Titanium Non-Magnetic Tool Kits. Chapter 11, Section 5, Test Equipment added item 8 missing info for 2372868 3.0T RF Power Measurement Kit with 2500 Watt load.

Revision	Date	Description
5	22 August 2006	Topic modified throughout direction: 3T System Magnet Enclosure vacuum system removed: - Chapter 3, Section 12.13, Twin Accessory Cabinet (TAC) cabinet weight and center of gravity updated; - Interconnect Group 13 deleted in Chapter 7, Section 1.3, Group Interconnects, Chapter 7, Section 4.2, Cable Groups Length Provided, Chapter 7, Section 4.5, L1 / L2 Interconnects, and Chapter 7, Section 4.10, Cable Group and Location Cross Reference. - Chapter 9, Section 1, Shipping And Delivery Data TAC weight updated.
		System Configuration Chapter: Chapter 2, Section 1, Basic System New System Additional Catalogs illustration deleted catalogs not listed in ePricebook MR pages (E1000LG, M1000NW, M1000MK). Chapter 2, Section 4, Facility Options DC Lighting Controller catalogs changed to E4502SC, E4502SD, E4502SE, and E4502SF for 18K AIC configurations.
		Room Layouts Chapter: Chapter 3, Section 3, Room Sizes added exit route wording to heading of Room Dimensions table. Chapter 3, Section 6, MR System Interconnects Routing MR System Interconnects Routing Requirements/Recommendations table reformatted to number requirements and updated requirements to be consistent with revised Magnet Room floor requirement of metal access floor tiles not allowed anywhere: Row titled Entire MR System;: recommendation for use of access flooring deleted.; Row titled Magnet Room: deleted access floor note and added metal floor access tiles not allowed with reference to Magnet Room Floors requirement in RF Shielded Room chapter. Chapter 3, Section 9.1, Blower Box (MG6) Blower Box mounting NOTICE deleted raised floor sentence to be consistent with metal floor access tiles not allowed per Magnet Room Floors requirement in RF Shielded Room chapter. Chapter 3, Section 9.3, Customer Site Storage Requirements added section with reference to *Direction 5182674 GE Healthcare Signa MRI Scanners Customer Site Storage Requirements* for size and weight of surface coils and phantoms that require customer provided storage locations. SPT Phantom Set Shipping/Storage Cart information included in Customer Site Storage Requirements subsection. Chapter 3, Section 11, Floor Loading and Weights deleted dewars information in Floor Loading table since Chapter 3, Section 5.1, Minimum Delivery Route Sizes and Capacity lists cryogen delivery route requirements. Chapter 3, Section 12.9, RFS Cabinet (MR2) added side Service Access Requirement.
		Site Environment Chapter: Chapter 5, Section 6, Altitude added Notice with Magnet Systems approval/direction contact info for Magnet located above 8100 ft (2469 m). Chapter 5, Section 9, Room Ventilation Ventilation Requirements/Recommendations table reformatted for 1 column with numbered list of requirements. Incorporated Magnet Room ventilation switch placement requirement (removed from RF Shielded Room Chapter). Chapter 5, Section 16, Vibration subsection titled “Steady State Vibration” table titled “LCC300 Magnet Steady State Vibration Specification” last row 40-50 Hz changed Vibration Threshold value to 750 (was 700); specification illustration already showed correct value 750.
		Interconnect Data Chapter: Reformatted Introduction section so subsections are now included in direction table of contents.
		RF Shielded Room Chapter: Chapter 8, Section 6.5, Magnet Room Floors major changes incorporated: • Rewrote entire section to simplify requirements, used feedback from Project Managers - Installations and Zone Support Engineers. • Same levelness dimension requirements for all Magnet Room floor areas. • Metal access floor time are NOT allowed in Magnet Room. • Illustration revised to show recessed area with Vibroacoustic mats projected locations. Anchor Hardware Requirements Chapter 8, Section 7.2, Physical Characteristics RF Shield Room Anchor Details illustration callouts updated to be consistent with Magnet Room Floors rewrite wording for RF Shield Room Vendor supplied Magnet Foot support plates materials.
		Pre-Installation Checklist Chapter 10, Section 2, Pre-Installation Checklist subsection titled “General Pre-Installation Reminders” item 1 revised for customer provided final site construction drawings reviewed using requirements documented in the PIM and MR Typical drawings. Section titled “Typical MR Installation Project Schedule” deleted per direction from Installation Services (C. Jackson).

Revision	Date	Description
6	5 April 2007	Interconnect routing requirements moved to Chapter 3, Section 6, MR System Interconnects Routing Table titled “MR System Interconnects Routing Requirements/Recommendations”, row titled “Magnet Room” from Chapter 8, Section 1, RF Shielded Room Requirements RF Shielded Room Requirements table. Also reworded moved requirements: - added anchors to mechanical fasteners list and clarified mechanical fastener not allowed within 2 ft (0.61 m) of Gradient Cables; - added unsecured or overlapped electrically conductive materials not allowed withing 2 ft (0.61m of Gradient Cables. [Resolution for iTrak 13067413, iTrak 13066436,]. RF Shielded Room Requirements table, Construction row deleted note concerning access floor since that material is not allowed in Magnet Room [iTrak 13076809]. Chapter 3, Section 3, Room Sizes, Chapter 3, Section 12.2, Magnet and Enclosure and Chapter 8, Section 6.3, Ceiling Height Illustration for LCC300 Magnet minimum ceiling corrected ceiling height front extension dimension: changed to 38.2 (969) from 70.8 (1800).
		Room Layout Chapter: Chapter 3, Section 3, Room Sizes Minimum Room Inside Clear Space Dimensions table added note for site needs to be planned for and included in site room layout drawings; included Direction 5182674 GE Healthcare Signa MRI Scanners Customer Site Storage Requirements website reference [iTrak 13098143]. Chapter 3, Section 12.17, Operator Workspace dimensions revised for new OW Table configuration.
		Site Environment Chapter: Chapter 5, Section 7, Lighting requirements changed to DC Lighting required in Magnet Room and additional rewording for clarification of requirements[iTrak 13068863]. Chapter 5, Section 14, Changing Magnetic Environment Specifications Definition of Moving Metal wording revised and Magnet Moving Metal Requirements table deleted 3 gauss line dimensions to be consistent with MR System Specification. Also revised wording for clarification in Distances For AC Power Lines, Transformers And Electric Motors subsection. Chapter 5, Section 15, Construction Materials revised section wording for traceable requirements. Chapter 5, Section 16, Vibration restructured, reformatted, and revised wording to simplify/clarify requirements. Magnet Room Site Vibration Testing And Requirements table added to list the requirements in place of several paragraphs.

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Table of Contents

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 to the power distribution unit, as well as emergency power lines and facility power lines to 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 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.

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 Main Disconnect Panel and 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, Chapter 4, Section 2, Homogeneity Requirements, Chapter 4, Section 3, Structural Steel Evaluation Of Proposed Sites, Chapter 4, Section 4, Magnetic Shielding, Chapter 4, Section 5, Magnetic Field, and Chapter 4, Section 6, Exclusion Zone • Chapter 5, Section 14, Changing Magnetic Environment Specifications
CTIQ#3	Structural Steel	Refer to • Chapter 4, Section 3, Structural Steel Evaluation Of Proposed Sites • 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, Acoustic 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 Chapter 3, 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 and Support Connectivity
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
CTIQ#12	Water Cooling	Refer to Chapter 5, Section 5.3, 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

Table 1-1: MR Site Critical To Image Quality (cont'd)

Number	Topic	Specifications
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

CTIQ#17	Environmental Controls	Refer to
		• Chapter 5, Section 3, Temperature and Humidity Specifications
		• Chapter 5, Section 4, Air Cooling
		• Water Cooling Requirements:
		  • Chapter 5, Section 5.1, Gradient Coil Temporary Backup Water Cooling
		  • Chapter 5, Section 5.2, Shield/Cryo Cooler Temporary Backup Water Cooling
		  • Chapter 5, Section 5.3, Shield/Cryo Cooler Requirements For Site Provided Water Cooling
		  • Chapter 5, Section 5.4, GWHX Water Cooling Requirements

CTIQ#18	RF Shielding	Refer to Chapter 8, Section 1, RF Shielded Room Requirements

3 Glossary

BB

Abbreviation for Broadband

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.

HFD

Abbreviation for High Fidelity Drivers

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 (B)

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 Sheilding

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

MGD Chassis

Abbreviation for Multi Generational Data Acquisition Chassis

NB

Abbreviation for Narrow Band

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.

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.

RRF Chassis

Abbreviation for Remote Radio Frequency Chassis

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

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

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Chapter 2 System Configuration

1 Basic System

The basic Signa EXCITE HD 3.0T system consists of the following major equipment:

- 3.0T (30 kilogauss) LCC300 Magnet with Magnet Enclosure and Magnet Accessories
- Shield/Cryo Cooler Compressor Cabinet
- TwinSpeed Gradient (TRM) and RF body coils and 3.0T General Purpose Head Coil
- Blower Box provides air to the Patient Comfort Module in the Magnet Enclosure.
- System electronics cabinets:
  - HFD/PDU Cabinet containing High Fidelity Drivers and Power Distribution Unit module with unregulated transformer 200/380/400/415/480 Volt, 50/60 Hz with power filter
  - RFS Cabinet containing the Multi Generational Data Acquisition (MGD) chassis with EXCITE 8 or 16 Channels, Remote RF chassis, Driver Module, and Array Processor (ReFlex 400 or Reflex 800).
    - Multi Generational Data Acquisition (MGD) chassis
    - Remote RF (RRF) chassis with EXCITE 8 or 16 Channels
    - Driver Module
    - Array Processor (ReFlex 400 or Reflex 800)
  - Narrow Band (NB) RF Amplifier Cabinet
  - Twin Accessory Cabinet (TAC) containing the Gradient Switch, the vacuum pump for Quiet Technology Magnet Enclosure, and 2nd Order Resistive Shim power supply.
- Penetration Panel with power supplies for the Magnet Enclosure system components, filters for system interconnects, and waveguides for non-wire connections routed through the panel.
- Operator Workspace equipment: GOC Computer Cabinet with Linux PC, SCSI Tower, Scan Control Interface Module (SCIM), Keyboard, Mouse and Mouse Pad, LCD panel, and chair
- Pneumatic Patient Alert System
- Patient Transport Table and cradle
- Main Disconnect Panel (MDP): GE pre-engineered unit to be ordered and utilized or customer supplied MDP which meets requirements Chapter 6, Section 3.1, Main Disconnect Panel (MDP) Requirements can be considered dependent on flowchart information in Illustration 2-2 .
- 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

Illustration 2-1 shows the major equipment of the system. The flowcharts in Illustration 2-2 and Illustration 2-3 list the catalogs which comprise the Signa EXCITE HD 13.0T system.

Illustration 2-1: Signa EXCITE HD 3.0T System

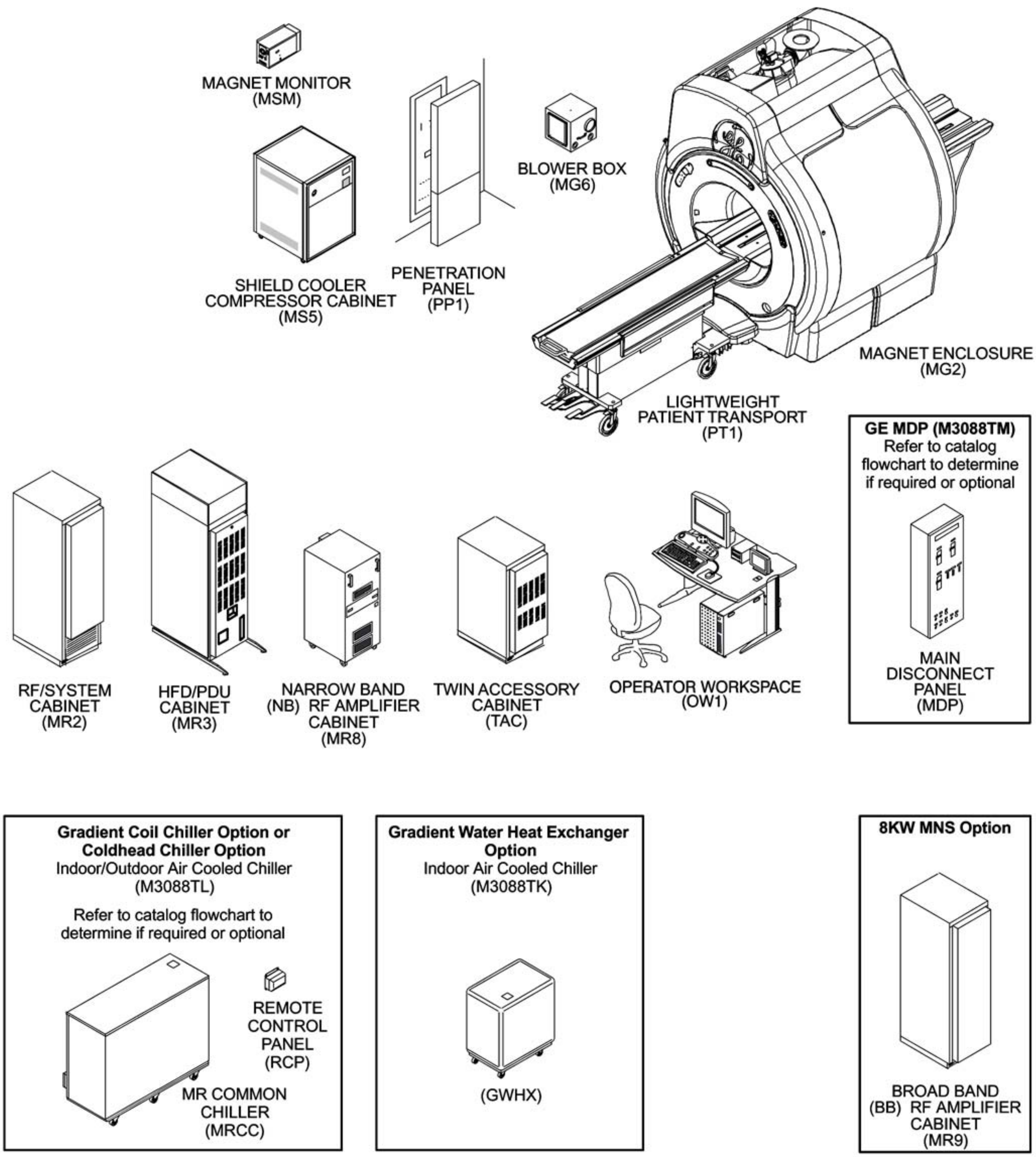


Illustration 2-2: Signa EXCITE HD 3.0T New System Catalogs

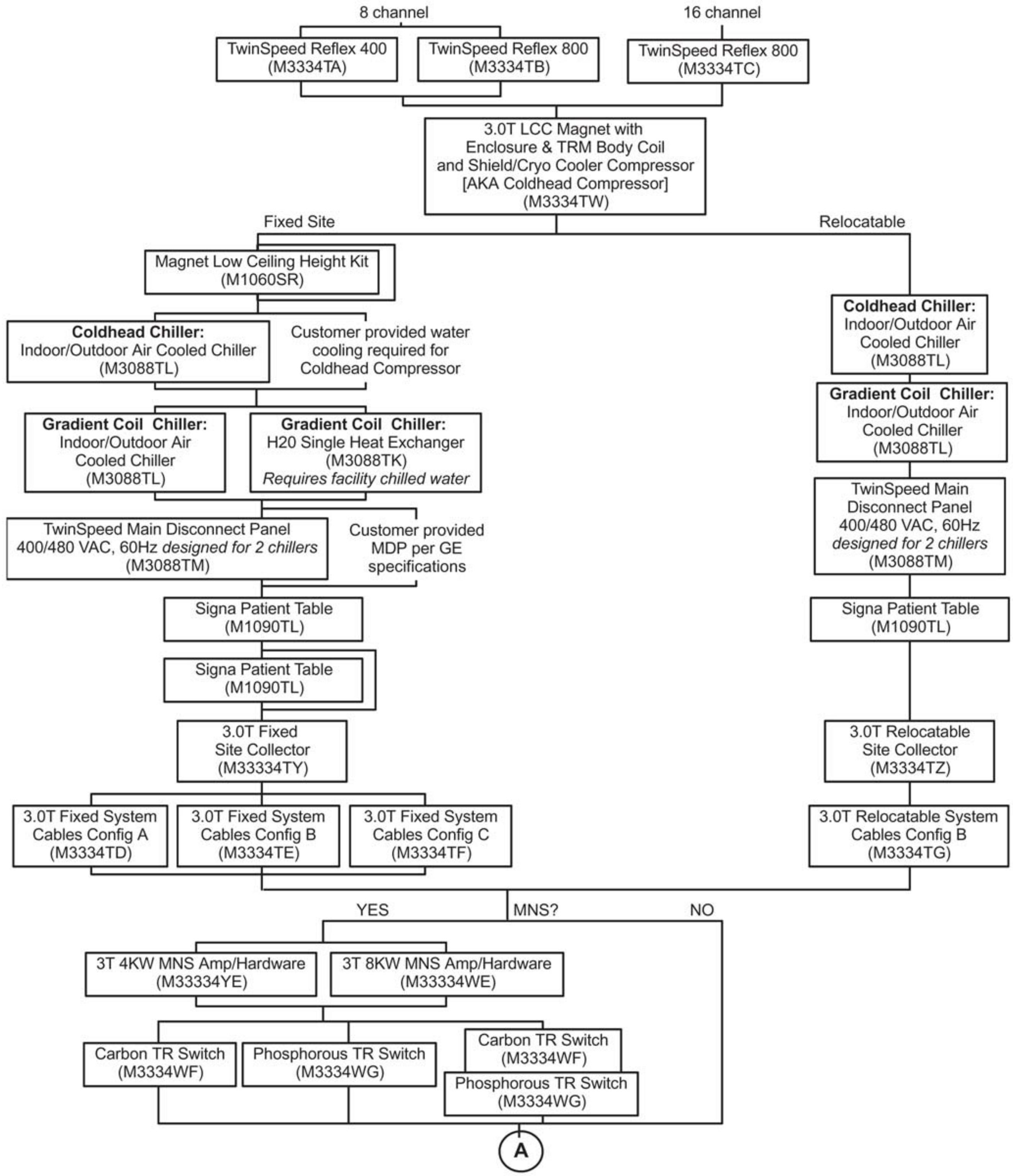
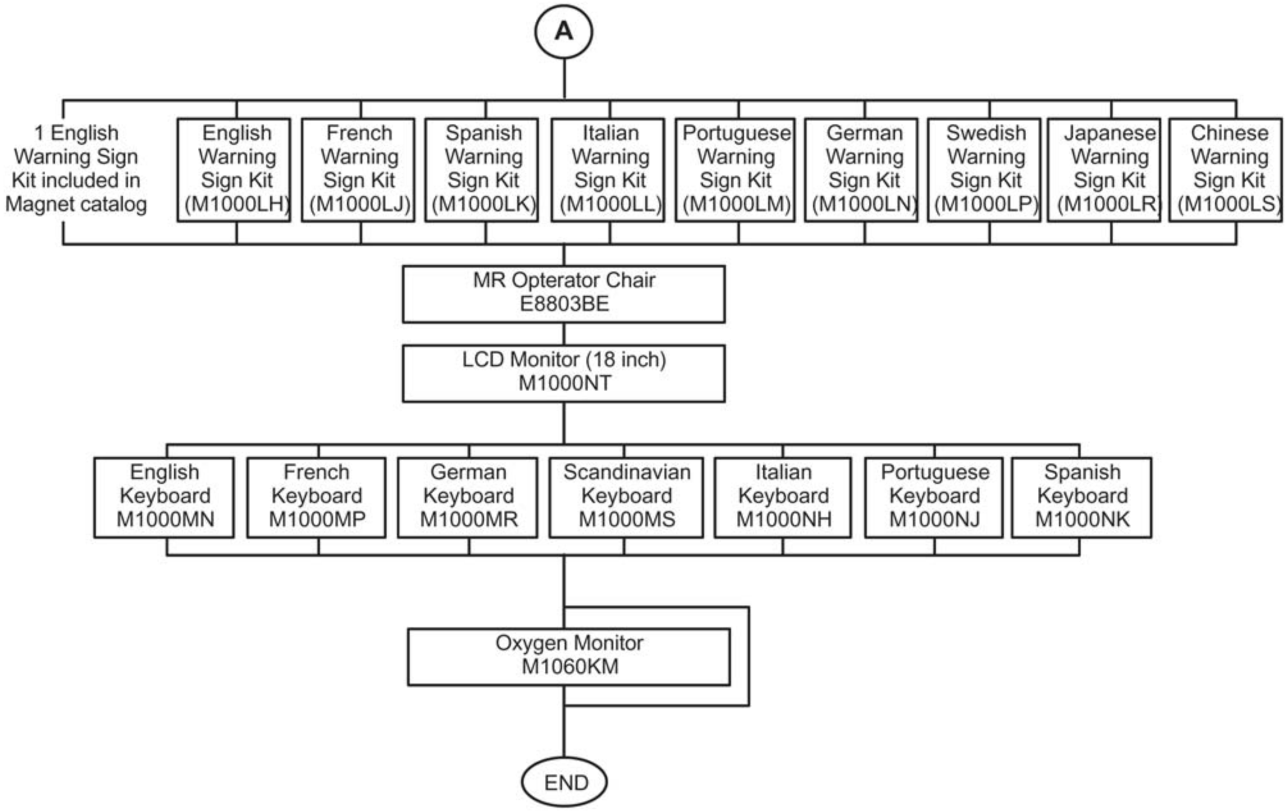


Illustration 2-3: EXCITE HD New System Additional Catalogs



2 System Cooling Equipment Selections

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

- MR Common Chiller (MRCC)
  The MRCC is a single-loop 10KW 50/60 Hz water chiller that can be used to cool either Shield/Cryo Cooler Compressor or the TRM Gradient Coil. 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. The MRCC power is supplied by the MR system Main Disconnect Panel (MDP). This chiller will be serviced by a third party vendor.
- Gradient Water Heat Exchanger (GWHX)
  The GWHX is a 10KW 50/60 Hz water-to-water heat exchanger that is used for cooling the TRM Gradient Coil. The GWHX is for indoor use only. The GWHX requires facility provided chilled water, for water cooling specifications refer to Chapter 5, Section 5.4, GWHX Water Cooling Requirements. The GWHX power is supplied by the MR system Power Distribution Unit (PDU). This heat exchanger will be serviced by GE Service. When the GWHX is used then the customer must supply water cooling for the Shield/Cryo Cooler Compressor.

There are several possible scenarios which a customer may utilize to meet the system water cooling requirements for the LCC Magnet Shield/Cryo Cooler Compressor Cabinet and the TRM Gradient Coil.

- Two MRCC installed outdoors where one unit provides Shield/Cryo Cooler Compressor cooling and the other provides Gradient Coil cooling. The 2 MRCC Remote Control Panels to be installed in the MR system Equipment Room.
- Two MRCC installed indoors where one unit provides Shield/Cryo Cooler Compressor cooling and the other provides Gradient Coil cooling. The 2 MRCC Remote Control Panels to be installed in the MR system Equipment Room. Customer supplied air cooling is required for the MRCC units.
- One GWHX installed indoors provides water cooling to the Gradient Coil (GWHX requires facility water cooling) and Customer provided facility water cooling for the LCC Magnet Shield/Cryo Cooler Compressor Cabinet. For water cooling specifications refer to Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling and Chapter 5, Section 5.4, GWHX Water Cooling Requirements.
- One MRCC installed outdoors provides water cooling to the Gradient Coil and Customer provided facility water cooling for the LCC Magnet Shield/Cryo Cooler Compressor Cabinet. The MRCC Remote Control Panel to be installed in the MR system Equipment Room. For water cooling specifications refer to Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling.
- One MRCC installed indoors provides water cooling to the Gradient Coil and Customer provided facility water cooling for the LCC Magnet Shield/Cryo Cooler Compressor Cabinet. The MRCC Remote Control Panel to be installed in the MR system Equipment Room. Customer supplied air cooling is required for the MRCC unit. For water cooling specifications refer to Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling.

Refer to Table 2-1 and Illustration 2-4 for system cooling equipment catalogs.

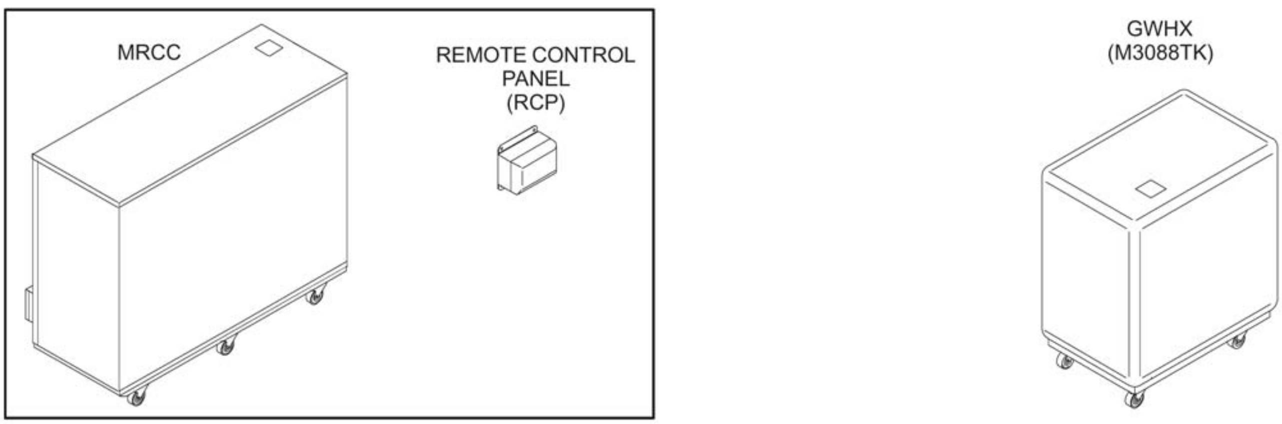
Table 2-1: System Cooling Equipment (See Table Note 1)

Catalog	Description
M3088TK	Gradient Water Heat Exchanger (GWHX) See Note 2
M3088TL	MR Common Chiller (MRCC) See Note 3

Notes

1. See Section 1, Basic System to determine system cooling equipment configurations and MDP to order and install.
2. When GWHX is selected, customer supplied water cooling is required for the LCC Magnet Shield/Cryo Cooler Compressor. Refer to Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling for water cooling specifications.
3. Two M3088TL installed outdoors is the standard cooling equipment configuration of Relocatable Mobile systems.

Illustration 2-4: System Cooling Cabinet Selections



3 Additional System Options

This section lists options for the MR system which have site preparation impact not included in Section 1, Basic System.

- The VibroAcoustic Damping Option (M1060MA) provides a method to reduce the probability of acoustic structureborne transmission throughout the customer facility.
- 700 Volt Amp UPS for MR Magnet Monitor Equipment (E4504AG)

NOTE: The GE pre-engineered MDP (M3088TM) must be ordered and installed when the UPS for MR Magnet Monitor (E4504AG) is installed. The GE pre-engineered MDP provides Emergency Off control of the output of the UPS for system safety.

- Advantage Workstation (AW)

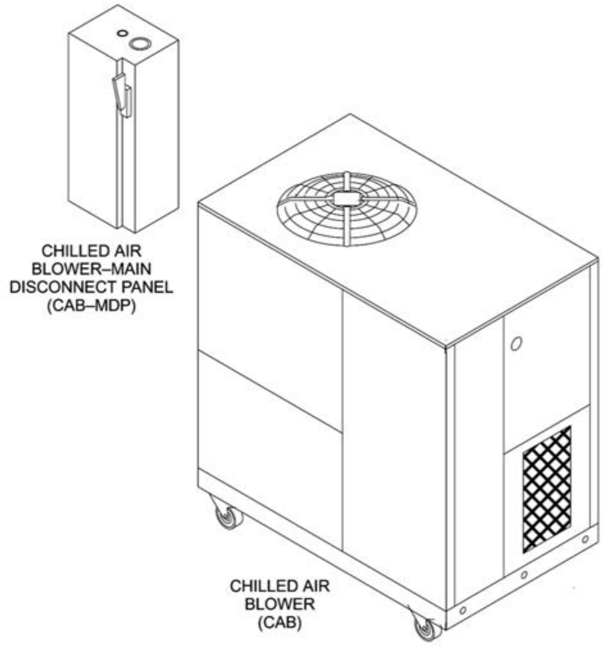
NOTE: LCD monitor is recommended for a AW to be located near the Signa system Operator Workspace due to gauss field proximity limits.

- Bar Code Reader (M1090PM) for use in conjunction with HIS/RIS software option.
- The BrainWave® HW Lite Option (M1033BL) 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 pushbutton 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.
- Other hard copy devices and patient accessories.
- Cryogen refill service.
- Various GE Healthcare Service contracts.
- Integrated Patient Comfort Module (IPCM) Option (M3033LH) for LCC300 Magnet ONLY: The IPCM option adds a bore liner to the inside diameter of the RF Body Coil . The bore liner directs chilled air from the Chilled Air Blower (CAB) to the inside diameter of the RF Body Coil. The IPCM Option provides the following hardware components:
  - Chilled Air Blower (CAB) (shown in Illustration 2-5)
  - Chilled Air Blower Main Disconnect Panel (CAB-MDP) (shown in Illustration 2-5)

NOTE: The CAB-MDP requires an additional power feed, not powered from the MR system MDP or PDU.

  - Thermal Bore Liner Assembly
  - Modified Penetration Panel waveguide
  - Bridge with notched sides
  - Bore Liner hardware including hoses and connectors
  - IPCM Option Key

Illustration 2-5: IPCM Cabinet & Panel



4 Facility Options

- 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. For details refer to RF Shielded Room chapter, Anchor Hardware Requirements 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, and Chapter 8, Section 7.6, Electrical Isolation.

- The GE pre-engineered Twin MDP and all configurations of MRCC require high voltage power. If system input voltage configuration does not meet specifications in Chapter 6, Section 2, Critical Power Requirements then a customer provided transformer may be needed. Refer to Table 2-2 for low voltage step up transformer options.

Table 2-2: Low Voltage (200 or 208 Volts) Step Up Transformer Options

Catalog See Note	Description
E4500AS	150 KVA 208 to 480Y277 Volt, 60 Hz transformer
R4500BD	150 KVA 200 to 400Y230 Volt, 50/60 Hz transformer
Note A step-up transformer is required if the site input voltage configuration does not meet specifications in Chapter 6, Section 2, Critical Power Requirements . The GE pre-engineered Main Disconnect Panel (MDP) and MR Common Chiller (MRCC) configurations require high voltage power.	

- Signature 5000 Series 3 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.

- Direct current (DC) lighting controller for the magnet room:
  - E4502SC 18K AIC 20 Amp Maximum Constant Lighting Level System, surface/semi-flush mount
  - E4502SD 18K AIC 20 Amp Maximum Variable Lighting Level System, surface/semi-flush mount
  - E4502SE 18K AIC 28 Amp Maximum Constant Lighting Level System, surface/semi-flush mount
  - E4502SF 18K AIC 28 Amp Maximum Variable Lighting Level System, surface/semi-flush mount.

NOTE: DC Lighting Controller 50 Hz designs are available by special order, for more information contact: Dwight Gilbert,GE Supply at 414-527-6638 Dwight.Gilbert@supply.ge.com or Lou Hernandez, GE Industrial Systems at 262-797-4910 lou.hernandez@indsys.ge.com.

- 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 Manufacturers Contact Information

Pre-Installation requirements may vary for specific Relocatable configurations and between Van Manufacturers. Listed below is contact information for GE Van Manufacturers.

- Ellis & Watts
  4400 Glen Willow Lake Lane
  Batavia, OH 45103
  Telephone: 513-752-9000
  FAX: 513-752-4983 USA
- PDC Facilities
  700 Walnut Ridge Drive, PO Box 900
  Hartland, WI 53029-0900
  Telephone: 262-367-7700
  FAX: 262-367-7744 USA
- SMIT Mobile Equipment
  Buys Ballotstraat 6
  3261 La Oud-Beijerland
  Holland
  Telephone: (31) 186-6-14322
  FAX: (31) 186-6-19367
- AK Specialty Vehicles
  16745 South Lathrop Avenue
  Harvey, IL 60426
  Telephone: 708-596-5066
  FAX: 708-596-2480 USA

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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 Section 2, Proximity Limits. Selected magnetic shielding of some devices and equipment is possible but must be handled on an individual basis. Refer to Chapter 7, Section 4.2, Cable Groups Length Provided 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, floor and ceiling. These shielding requirements impose special considerations which are addressed in RF Shielded Room chapter sections beginning with Chapter 8, Section 1, RF Shielded Room Specifications.

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	• RFS Cabinet • Twin Accessory Cabinet (TAC) • MRCC equipment	• GWHX equipment • Chilled Air blower (CAB) for IPCM Option
50 GAUSS (5mT) OR LESS	• GOC Computer Cabinet • LCD Color Monitor for OW (See note 5) • NB RF Amp Cabinet • HFD/PDU Cabinet • Main Disconnect Panel • Magnet Monitor • Telephones	• Metal detector for screening • LCD Color Monitor for Advantage Workstation • Broadband (BB) RF Amplifier Cabinet for 8KW MNS (Option) • BrainWave HW Lite Cabinet (option) • CAB–MDP for IPCM Option
100 GAUSS (10mT) OR LESS	• Shield/Cryo Cooler Compressor Cabinet • Service Tool Magnet Power Supply Cabinet • Service Tool Shim Power Supply Cabinet	• Pneumatic Patient Alert Control Box • Oxygen Monitor (Option)
200 GAUSS (20mT) OR LESS	• Penetration Panel • Blower Box	• Magnet Rundown Unit • Remote Oxygen Sensor Module

Notes

1. Refer to Chapter 4, Section 5, Magnetic Field 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 for additional proximity limits information.
5. If gauss limit is more than indicated for OW then contact GE to determine impacts on OW equipment.

3 Room Sizes

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

Table 3-2: Room Sizes Signa EXCITE HD 3.0T System Minimum Room Inside Clear Space Dimensions

Table 3-2: Room Sizes Signa EXCITE HD 3.0T System Minimum Room Inside Clear Space Dimensions (cont'd)

NOTICE

Room design must provide exit routes for evacuation in the event of an emergency. Local, national, and safety codes must be met. For example, USA regulation (29 CFR 1910.36) require an exit route to be at least 28 inches (711 mm) wide at all points.
The dimensions below do not include exit route.

System Configuration	Equipment Room Finished Minimum Values See Note 6 & 7		Magnet Room Finished Minimum Values See Note 4			Control Room Finished Minimum Values See Note 7		Total System Area
	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)	ft^2 (m^2)
System with 1 or 2 MRCC units located outdoors	8-6 x 17-0 (2.591 x 5.182) See Note 8	144.50 (13.424) See Note 8	11-1.3 X 19-7.65 (3.386 x 5.986) See Note 1, 2, 3, 5	218.140 (20.266)	8-9 (2.67) See Note 9	5* x 7 (1.52* x 2.13)	35 (3.24)	397.640 (36.942) See Note 8
System with 2 MRCC units located indoor	8-6 x 27-9 (2.591 x 8.458)	235.875 (21.914)						489.015 (45.431)
System with 1 MRCC unit located indoor	8-6 x 22-8 (2.591 x 6.9) See Note 8	192.667 (17.899) See Note 8						445.807 (41.417) See Note 8
System with Indoor Water Cooled GWHX	8-6 x 20-3 (2.591 x 6.172) See Note 8	172.125 (15.991) See Note 8						425.265 (39.508) See Note 8

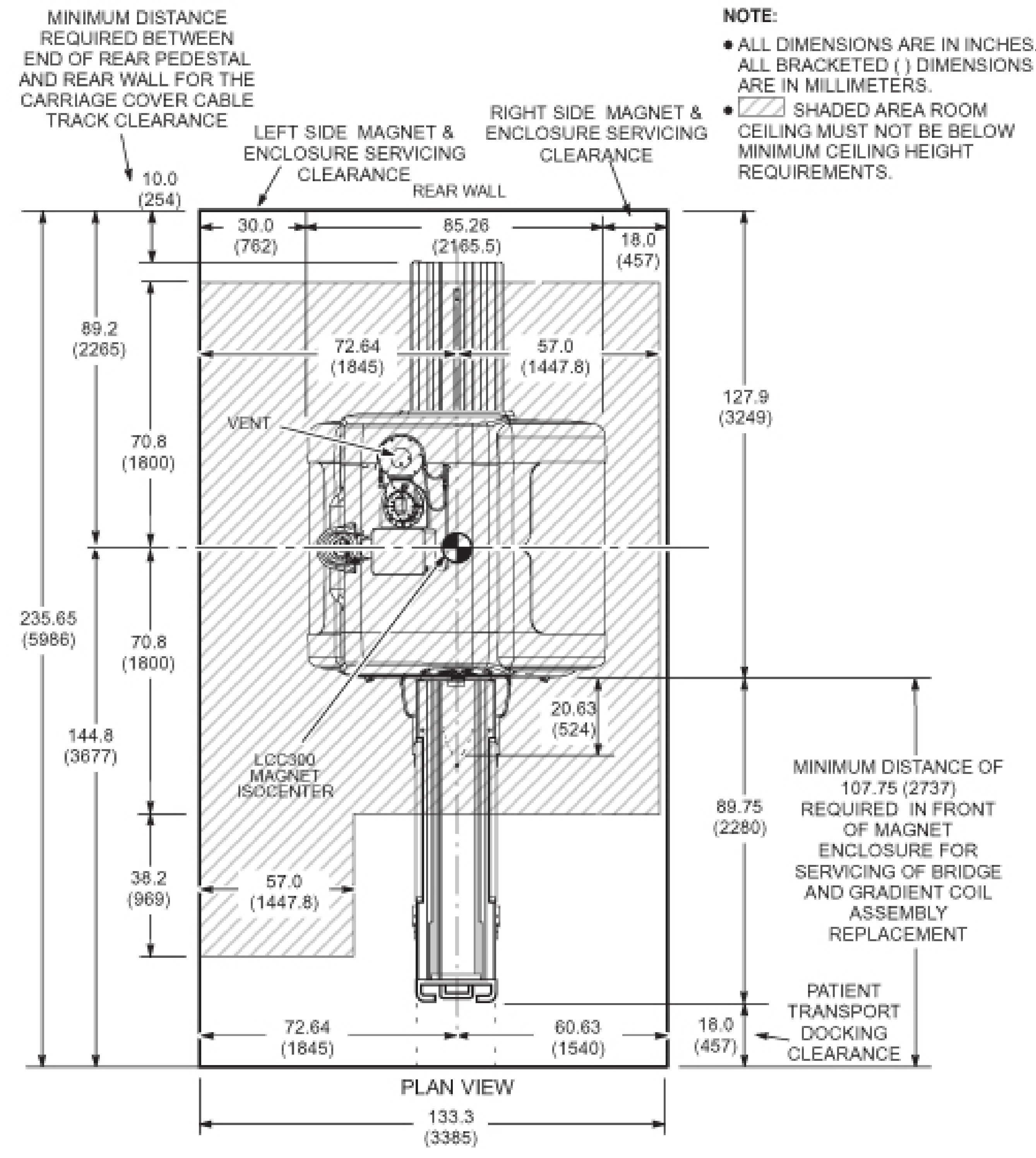
Note

* 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. The LCC Magnet 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. Magnet Room dimensions limitations:
   a. Listed room dimensions do not include storage space for MR system accessories such as system phantoms and surface coils. Storage space for system accessories and supplies needs to be planned for and included in site room layout drawings. Refer to *Direction 5182674 GE Healthcare Signa MRI Scanners Customer Site Storage Requirements* for size and weight of surface coils and phantoms that require customer provided storage locations. Direction 5182674 is available on-line at http://www.gehealthcare.com/company/docs/siteplanning.html.
   b. Absolute Minimum Magnet Room dimensions will result in limited operator clearances and increased Magnet Service time. Table 3-3 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 HFD/PDU Cabinet, RFS Cabinet, NB RF Amplifier Cabinet, TAC, BB RF Cabinet (8KW MNS Option), Shield/Cryo Cooler Compressor Cabinet, MDP, Magnet Monitor, RCP and values for MRCC located outside, 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 the room.
8. When only 1 MRCC or the GWHX is selected then the customer site must still provide water cooling for the LCC Magnet Shield/Cryo Cooler Compressor Cabinet. Minimum Equipment Room for system with 1 MRCC or the GWHX 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.

Table 3-3: Signa EXCITE LCC300 Magnet (Minimum Service Area)

Table 3-3: Signa EXCITE LCC300 Magnet (Minimum Service Area) (cont'd)



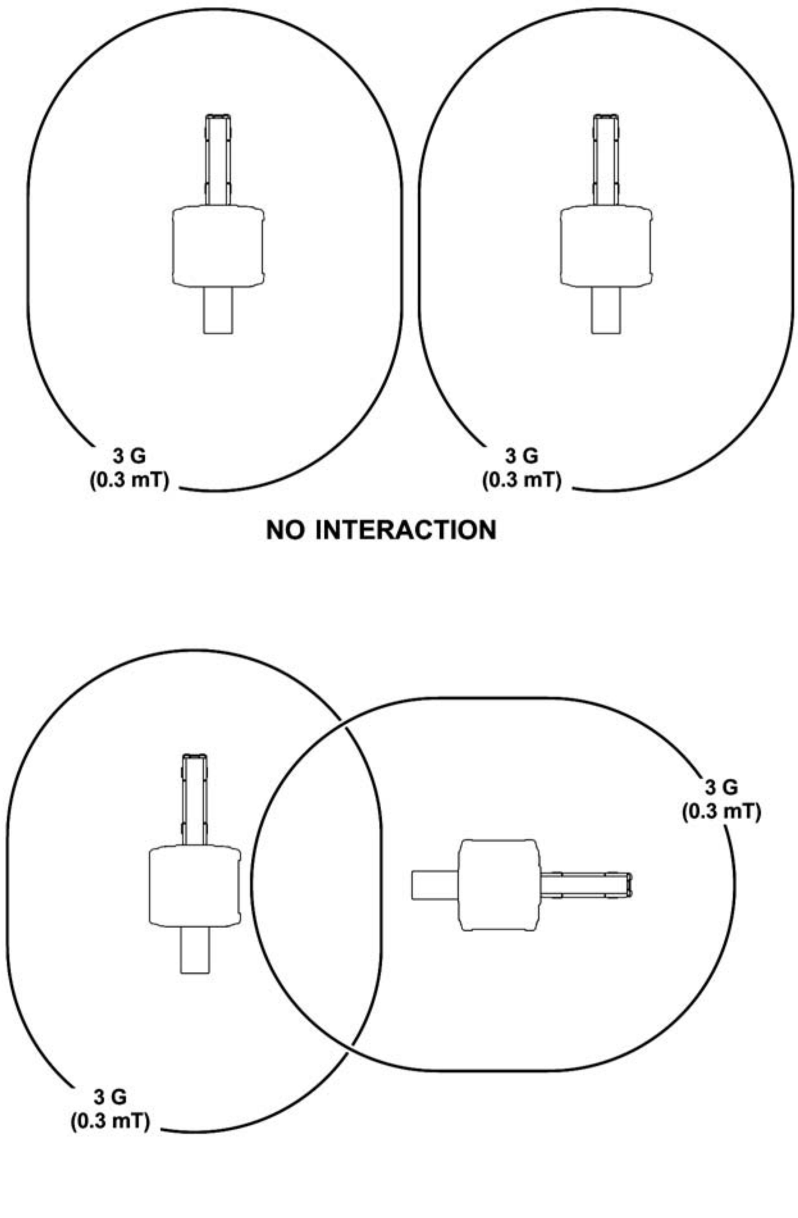
NOTE:	Shaded area shown must meet minimum room ceiling height requirements in Chapter 8, Section 6.3, Ceiling Height.

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, see Illustration 3-1 . If the 3 gauss lines intersect but remain outside each magnet's cryostat there will be interaction between the magnets when bringing to field, see Illustration 3-1 . The orientation of the magnets is irrelevant. Consult the GE Healthcare MR Siting & Shielding group for closer proximity of magnets.

Illustration 3-1: Two Magnet Installation



4.2 Equipment Room Shared By Multiple MR Systems

4.2.1 Introduction

When the Equipment Room is shared by more than one MR system 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 Specifications.

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 cabinets of one MR system relative to the other MR system equipment cabinets.

- Maximize separation distance between the RF transmitter (RF Amplifer) of one MR system and the RF receiver (RRF Chassis) of the other MR system of the same field strength.
- The RF transmitter (RF Amplifer) of one MR system and the RF receiver (RRF Chassis) of the other 3T MR system must be separated by a minimum of > 6.6 feet (2 meters) in all directions, see Illustration 3-2 and Illustration 3-3 .
- Signa EXCITE 3.0T Release 12.x: the RF Amplifier is located in the NB RF Amp Cabinet and the RRF Chassis is located in the RFS Cabinet.
- Signa EXCITE 3.0T Release 11.x: the RF Amplifier is located in the NB RF Amp Cabinet and the RRF Chassis is located in the EXCITE System Cabinet.

NOTE: The placement of the chiller, compressors and other non-RF Transmit/Receive MR System equipment relative to RF Transmit/Receive equipment should not be an RF noise issue.

Illustration 3-2: Multiple Signa EXCITE HD 3.0T (Release 12.x) Systems Electronics Cabinets Spacing

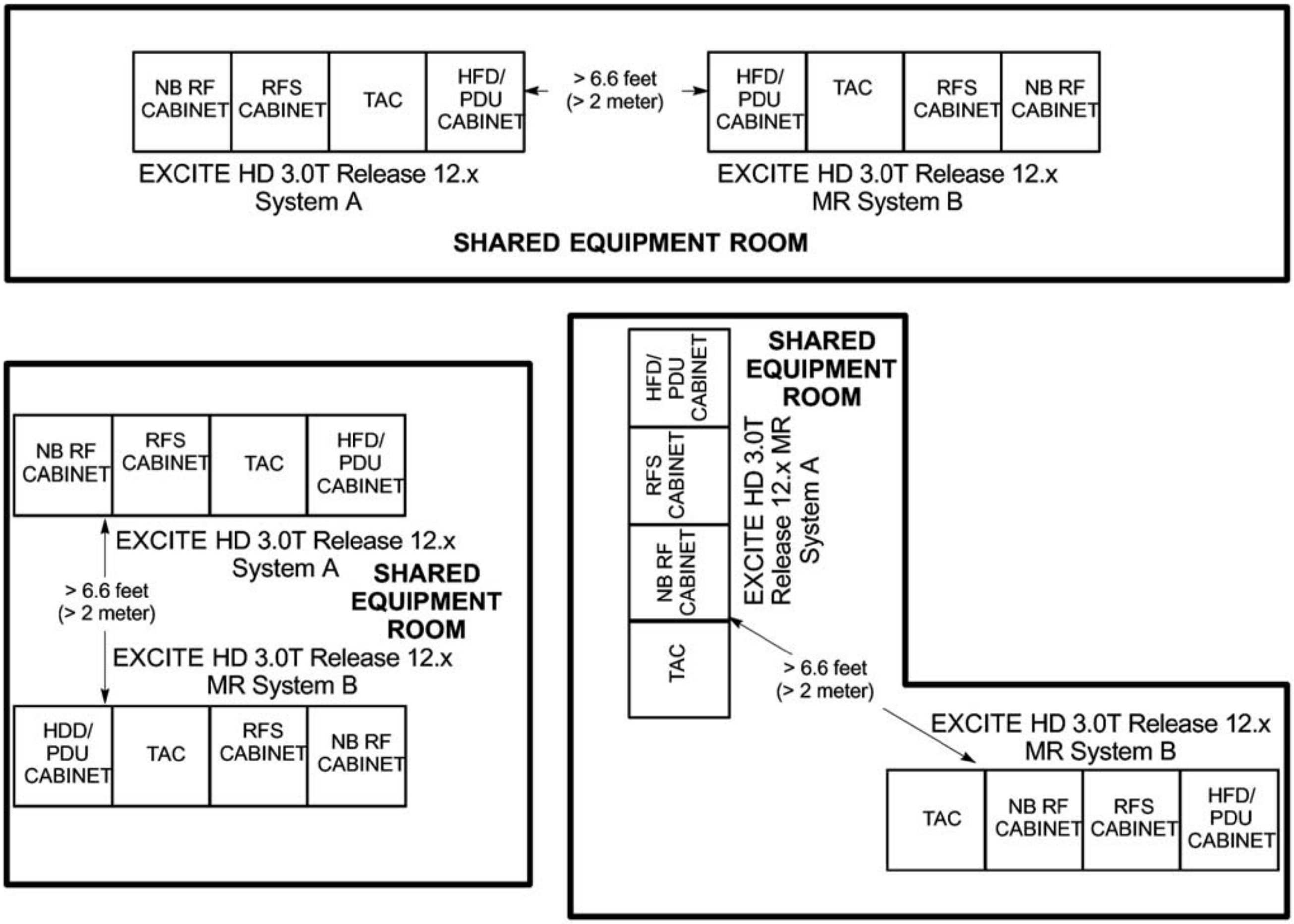
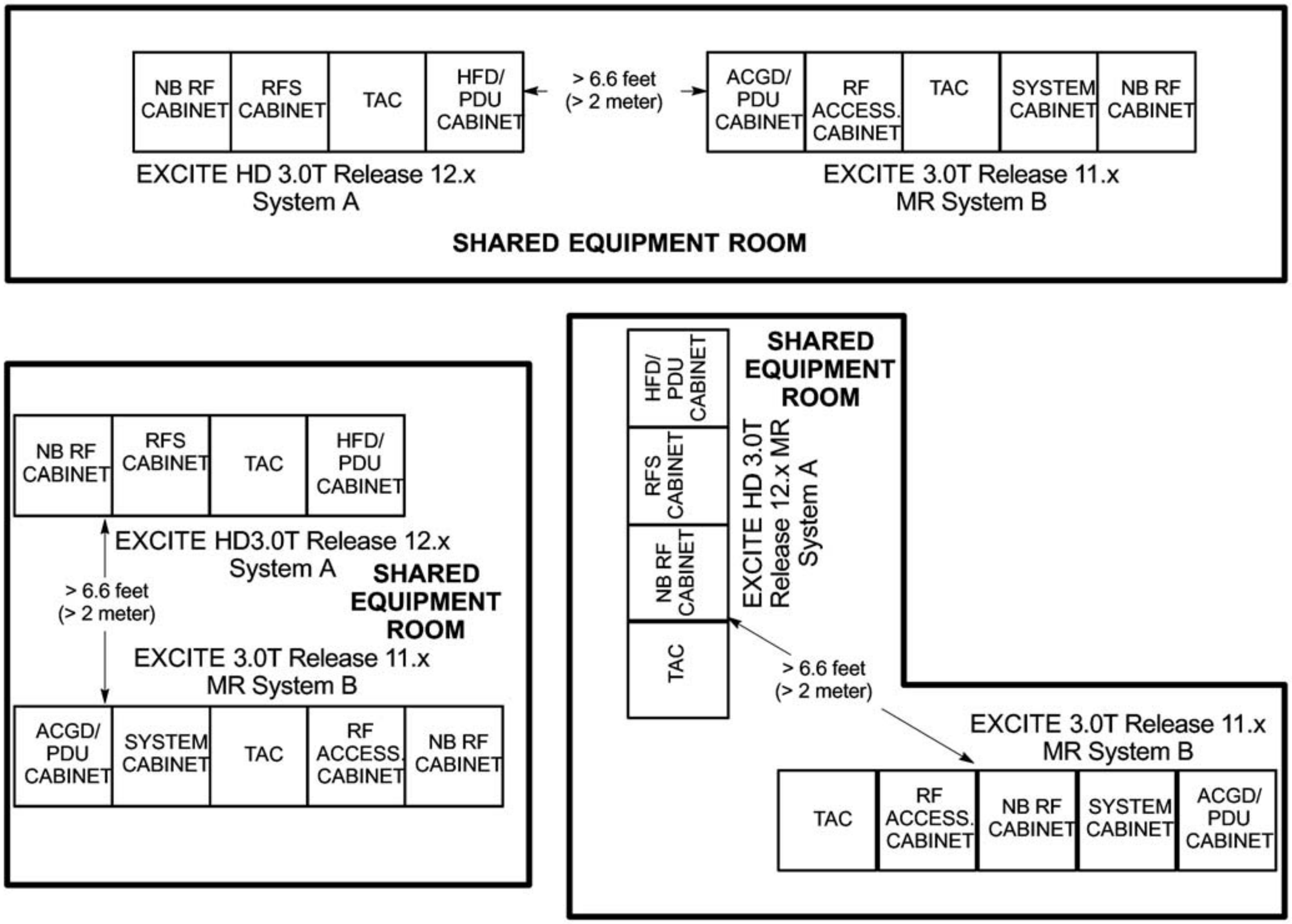


Illustration 3-3: Multiple Signa EXCITE HD 3.0T (Release 12.x) & Signa EXCITE 3.0T (Release 11.x) Systems Electronics Cabinets Spacing

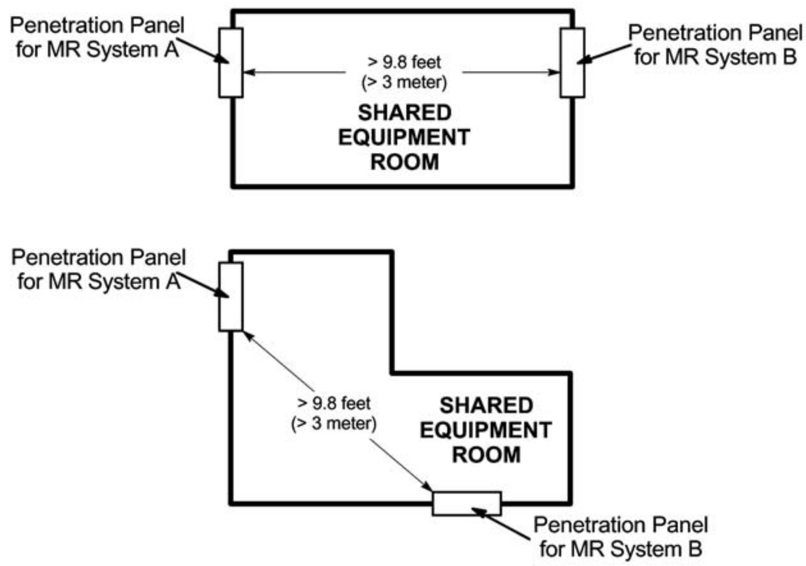


4.2.3 Penetration Panels Locations

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 3-4 .

Illustration 3-4: Multiple MR Systems Penetration Panel Spacing

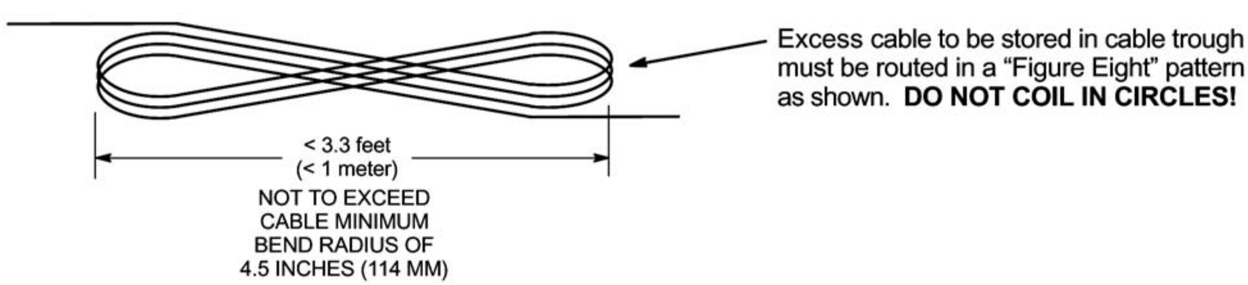


4.2.4 System Cables Requirements

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, Section 4.4, L2 Interconnects for Receive cable Run Numbers and Chapter 7, Section 4.5, L1 / L2 Interconnects 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 3-5 .

Illustration 3-5: Proper Storage Of Excess Receive Cables



5 Delivery Route Requirements

5.1 Minimum Delivery Route Sizes and Capacity

Table 3-4 lists minimum actual clearance opening dimensions for doors and hallways required by the MR system equipment. Installation or replacement of components listed in Table 3-5 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, Section 1, Shipment for Signa Component shipping dimensions.

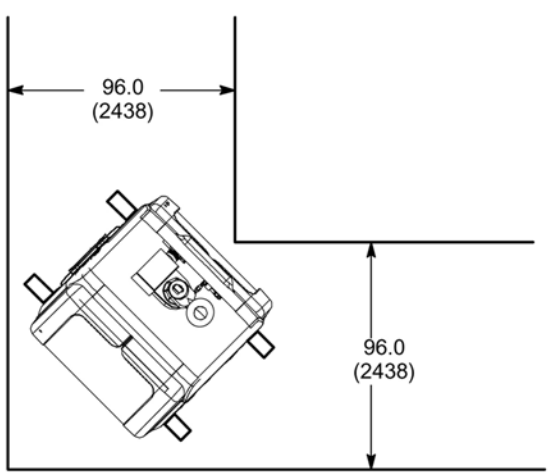
Table 3-4: Minimum Hallway/Door Dimensions

Component	Minimum Hallway/ Door Width*		Minimum Hallway/ Door Height*		Comments
	in.	mm	in.	mm	
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.
LCC Magnet	Refer to Note 1		Refer to Note 1		Refer to Table 3-5 for uncrated magnet dimensions.
RF Room Door	Chapter 8, Section 6.2, Doors and Other Openings				

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 3-6 shows dimensions for 90° turn.
2. Final dimension is dependent on rigger equipment used, refer to Chapter 9, Section 2, Magnet Shipping Considerations.

Illustration 3-6: LCC Magnet Minimum Door/Hallway Dimensions 90° Turn



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

Table 3-5: 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, Section 2, Magnet Considerations for dimensions, illustrations and weights.
Split Bridge	40 (18)	21.5 x 77.3 x 7 (546 x 1969 x 177.8)	Room dimensions in front of the Magnet MUST allow for bridge installation/servicing and Gradient Coil Replacement, See Note 3.
Replacement RF Body Coil	155 (70)	30 x 30 x 60 (762 x 762 x 1524)	Replacement coil is shipped in a protective case. Weight & dimensions are for coil & case.
Replacement TRM Gradient Coil Assembly on a Shipping Cradle/Cart	See Note 1	35.5 x 99.84 x 55.88 (902 x 2536 x 1420) See Note 2 & 3	Initial TRM 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, TRM Gradient Coil Assembly, Cradle and Cart Requirements.
Gradient Coil Replacement Tool Kit Crate	750 (340)	30 x 86 x 28 (762 x 2184 x 711)	See Note 3.

Note

1. The replacement TRM Gradient Coil Assembly weight is approximately 2850 lbs (1293 kg), the shipping cradle is 132 lbs (60 kg), and the Gradient Coil Assembly shipping/installation cart weighs 855 lbs (389 kg). Therefore total shipping weight is 3837 lbs (1742 kg). The coil assembly outside diameter x length dimensions are 35.0 x 74.6 in. (888 x 1895 mm). For illustrations of coil/cradle/cart refer to Section 5.2, TRM Gradient Coil Assembly, Cradle and Cart Delivery
2. Gradient 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. The LCC Magnet 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 107.75 in. (2737 mm) clear space in front of magnet.

5.2 TRM Gradient Coil Assembly, Cradle and Cart Delivery

Initial TRM Gradient Coil Assembly is shipped installed in the Magnet. Shipping/installation cart is required to be used to install replacement coil assembly. 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 Illustration 3-7 and Illustration 3-8 .

Illustration 3-7: Replacement TRM Gradient Coil Assembly & Cradle

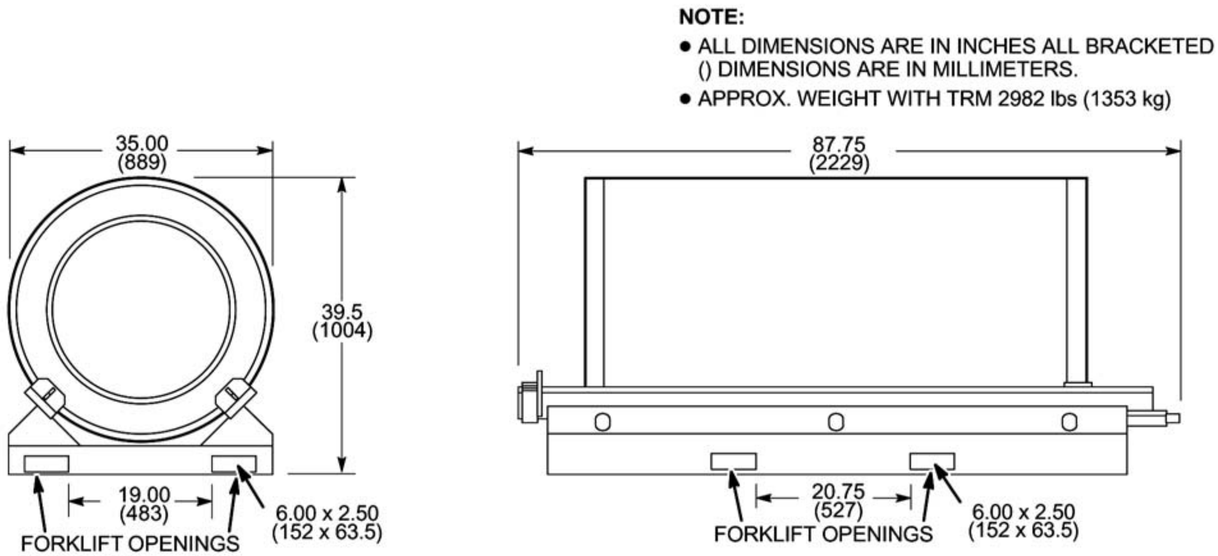
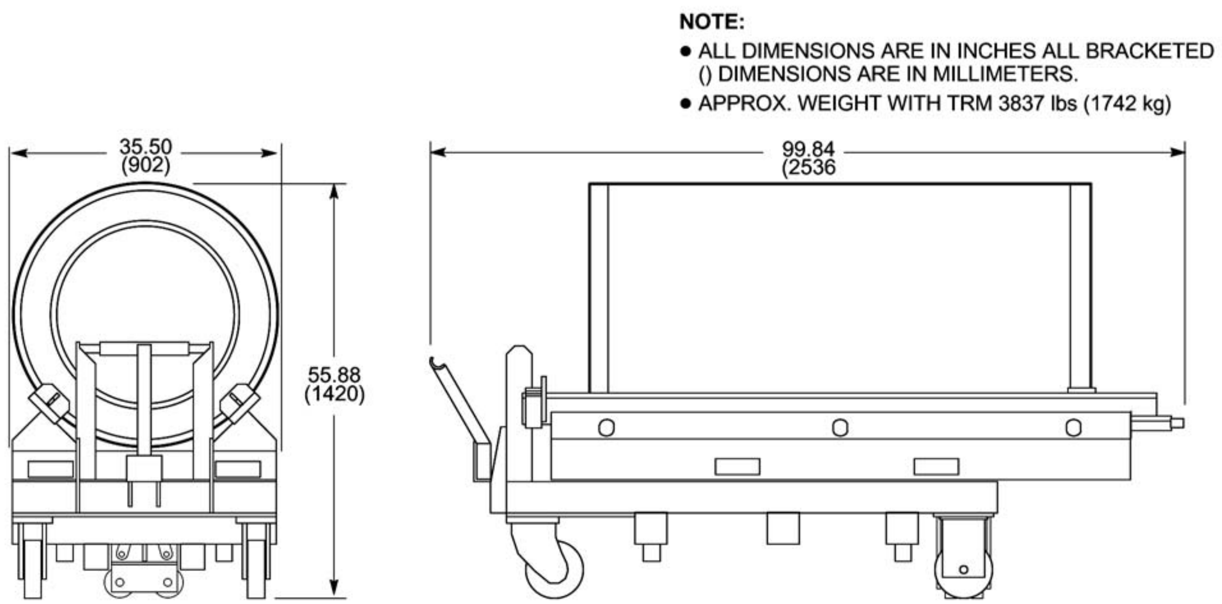


Illustration 3-8: Short Room Replacement TRM Gradient Coil Assembly & Cradle On Cart



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 3-6 for MR system interconnects routing requirements and recommendation.

Table 3-6: MR System Interconnects Routing Requirements/Recommendations

Area	Requirements
Entire MR System	1. All MR system interconnects routing must be in accordance with local and national codes. 2. Consult local/national code for interconnects separation requirements (i.e. signal, power, water, air, etc.). 3. Must protect fiber optic interconnects, water lines, hoses and tubing from physical damage including liquids (i.e. condensation, coolants, etc.) 4. The majority of MR system cables require routing that accommodates the dimensions of the cable connectors. a. Raceway or conduit for routing interconnects must be sized to allow for the dimension of the connectors. b. Raceway or conduit always to be sized to allow the cable to pass through with all other cables already installed. 5. The MR system interconnect cables are FT4 or equivalent rated, not plenum rated. 6. If the area under any access floor is used for an air plenum then the cables may have to be in raceway depending on local and national codes. 7. MR system interconnects must be accessible for equipment servicing including troubleshooting and future enhancements or upgrades.
Magnet Room	1. Metal access floor tiles are NOT allowed anywhere in the Magnet Room, refer to requirements in Chapter 8, Section 6.5, Magnet Room Floors. 2. Only non-magnetic metal material can be used when routing cables in the Magnet Room. 3. Any electrically conductive materials utilized for interconnects routing (i.e. raceway, access flooring) must comply with Chapter 8, Section 1, RF Shielded Room Requirements to minimize the possibilities of electrical discharge which can cause RF broadband noise. a. All electrical and mechanical connections and fasteners including screws, nails, nuts, bolts, clips clamps, concrete anchors, seismic anchors, etc. must be tightened and secured to supplier specifications so as not to become a potential broadband noise source. b. No mechanical fasteners are allowed 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. c. Unsecured or overlapped electrically conductive materials (i.e cable routing dividers, trough/duct z-joints) must not be located within 2 feet (0.61 m) of the Gradient Cables. d. RF broadband noise can be avoided with quality design and construction that will remain solid over time and usage (i.e. no loose or micro vibrating materials). e. All fasteners must be solid locking devices such as t-nuts, PEM nuts or welded nuts; no self tapping screws allowed. 4. Floor or wall ducts/raceways used in the Magnet Room must meet the requirements in Chapter 8, Section 1, RF Shielded Room Requirements and Chapter 8, Section 6.5, Floors. 5. Cable routing methods must not interfere with an unobstructed path from the Patient Table to the area directly behind the Magnet Enclosure Rear Pedestal for MR personnel usage.

Table 3-6: MR System Interconnects Routing Requirements/Recommendations (cont'd)

Area	Requirements
Recommendations	
• Raceway or conduit for routing interconnects should be oversized to allow for the possiblity of additional cables being added as the system is upgraded in the future. • Conduit should not be used for running the majority of GE MR system cables in the Magnet Room due to the number and size of conduits needed.	

7 Flooring

Flooring consists of all materials above the structural floor support including subflooring and equipment support/mounting. Refer to Table 3-7 for requirements and recommendations.

Table 3-7: 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 LCC Magnet Shield/Cryo Cooler Compressor Cabinet and the TRM Gradient Coil located in the Magnet bore. The following system cooling equipment is available with the MR system:

- MR Common Chiller (MRCC)The MRCC is a single-loop 10KW 50/60 Hz water chiller that can be used to cool either a Shield/Cryo Cooler Compressor or the TwinSpeed Gradient Coil. 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. The MRCC power is supplied by the MR system Main Disconnect Panel (MDP). This chiller will be serviced by a third party vendor.

NOTE: MRCC is used for Fixed Site or Relocatable system configurations.

- Gradient Water Heat Exchanger (GWHX)The GWHX is a 10KW 50/60 Hz water-to-water heat exchanger that is used for cooling the TwinSpeed Gradient Coil. The GWHX is for indoor use only. The GWHX requires facility provided chilled water, for water cooling specifications refer to Chapter 5, Section 5.4, GWHX Water Cooling Requirements. The GWHX power is supplied by the MR system Power Distribution Unit (PDU). This heat exchanger will be serviced by GE Service. When the GWHX is used the customer must supply water cooling for the Shield/Cryo Cooler Compressor.

NOTE: GWHX is used for Fixed Site system configurations but not used for Relocatable system configurations.

NOTE: TRM Gradient Coil water cooling must be supplied by cooling equipment (MRCC or GWHX) supplied with the MR system to prevent contamination/damage to the coil and for proper image quality.

There are several possible scenarios which a customer may utilize to meet the system water cooling requirements for the LCC Magnet Shield/Cryo Cooler Compressor Cabinet and the TRM Gradient Coil.

- Two MRCC installed outdoors where one unit provides Shield/Cryo Cooler Compressor cooling and the other provides Gradient Coil cooling. The 2 MRCC Remote Control Panels to be installed in the MR system Equipment Room.
- Two MRCC installed indoors where one unit provides Shield/Cryo Cooler Compressor cooling and the other provides Gradient Coil cooling. The 2 MRCC Remote Control Panels to be installed in the MR system Equipment Room. Customer supplied air cooling is required for the MRCC units.
- One GWHX installed indoors provides water cooling to the Gradient Coil (GWHX requires facility water cooling) and Customer provided facility water cooling for the LCC Magnet Shield/Cryo Cooler Compressor Cabinet. For water cooling specifications refer to Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling and Chapter 5, Section 5.4, GWHX Water Cooling Requirements.
- One MRCC installed outdoors provides water cooling to the Gradient Coil and Customer provided facility water cooling for the LCC Magnet Shield/Cryo Cooler Compressor Cabinet. The MRCC Remote Control Panel to be installed in the MR system Equipment Room. For water cooling specifications refer to Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling.

- One MRCC installed indoors provides water cooling to the Gradient Coil and Customer provided facility water cooling for the LCC Magnet Shield/Cryo Cooler Compressor Cabinet. The MRCC Remote Control Panel to be installed in the MR system Equipment Room. Customer supplied air cooling is required for the MRCC unit. For water cooling specifications refer to Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling.

NOTE: See Chapter 2, Section 1, Basic System for system cooling equipment configurations options and relationship to other system equipment/options selections.

CAUTION

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 5.2, Shield/Cryo Cooler Temporary Backup Water Cooling.

8.2 MRCC Siting Considerations

The MR Common Chiller (MRCC) is a single-loop device used to provide constant temperature coolant for either the Shield/Cryo Cooler Compressor or the Gradient Coil. Two MRCC units are needed if both Gradient Coil and Shield/Cryo Cooler Compressor water cooling is planned to be provided by MRCC units. The MRCC consists of a refrigeration unit, coolant reservoir and pump contained within an enclosure that allows the MRCC to be operated indoors or outdoors. The unit has a microprocessor controller, digital set/read and readout in degrees C.

!

NOTICE

When only 1 MRCC is selected for the system Gradient Coil water cooling then the customer site must still provide cooling for the LCC Magnet Shield/Cryo Cooler Compressor Cabinet.

8.2.1 MRCC Interconnects/Separation Limitations

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

- MRCC located outdoors and the Gradient Coil located inside the magnet 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 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 Gradient Coil located inside the magnet must not be separated by a distance greater than 100 ft (30.5 m) water line length.
- 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 9.8 ft (3.0 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 the system Main Disconnect Panel (MDP) via customer supplied wiring. For additional interconnects information and requirements refer to appropriate configuration interconnect information:

- Chapter 7, Section 5.1, Interconnects For 2 MRCC Units Located Outdoors
- Chapter 7, Section 5.2, Interconnects For 2 MRCC Units Located Indoors
- Chapter 7, Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors
- Chapter 7, Section 5.4, Interconnects For 1 MRCC Unit Located Indoors

8.2.2 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 Section 12.5, MR Common Chiller (MRCC) 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 Section 12.5, MR Common Chiller (MRCC).

8.2.3 MRCC Outdoor Installation Mounting

The MRCC must be located on a strong, level surface, see Section 12.5, MR Common Chiller (MRCC) 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 shown in MRCC Outdoor Mounting illustration in Section 12.5, MR Common Chiller (MRCC) to rigidly mount the unit.

8.2.4 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.

8.2.5 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 Service provider, refer to Table 3-9). Table 3-8 lists the responsibility for the specific tasks. Refer to vendor manual for additional information concerning tasks.

Table 3-8: MRCC Equipment Installation Tasks Responsibility

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 Provider See Table 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 Providers are listed in Table 3-9 .				

Table 3-9: 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	1-925-997-72.63	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

8.3 GWHX Siting Considerations

NOTICE

When a GWHX is selected for the Gradient Coil cooling then the customer site must still provide cooling for the LCC Magnet Shield/Cryo Cooler Compressor Cabinet.

The GWHX is a single-loop device used to circulate water through the TRM Gradient Coil with the purpose of removing heat generated during operation and transferring this heat to the facility chilled water system. The GWHX consists of a heat exchanger unit, coolant reservoir and pump contained in an enclosure to be operated indoors. The unit has a microprocessor controller, digital set/read and readout in degrees C.

8.3.1 GWHX Interconnects/Separation Limitations

Location of the GWHX (indoors) must meet the following limitations for the water lines:

- GWHX and the Gradient Coil located inside the magnet must not be separated by a distance greater than 98 ft (30 m) water line length.
- Maximum vertical separation from the Gradient Coil located inside the magnet is not to exceed 15 ft (4.6 m) with the GWHX above or below the MR system.

The GWHX is powered from the MR system Power Distribution Unit (PDU) by a power cable supplied with the unit. Refer to Chapter 7, Section 6, GWHX Additional Interconnects for additional interconnects information and requirements.

8.3.2 GWHX Indoor Installation and Access

The GWHX must be located indoors on a strong, level surface or slightly inclined surface (not to exceed 5° incline). Ensure there is easy access to the top cover of the unit. The minimum clearances shown in Section 12.6, Indoor Gradient Water Heat Exchanger (GWHX). The wheels can be locked to keep the unit in place while operating.

8.3.3 Responsibility For Installation Tasks For GWHX

The GWHX will be installed by the MR system Installation Team with assistance required from site facility personnel for connection to facility water cooling.

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

9 Special Siting Considerations

9.1 Blower Box (MG6)

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

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 7.5, RF Shield Integrity, Chapter 8, Section 7.6, Electrical Isolation, and Chapter 8, Section 7.2, Physical Characteristics.

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

The Blower Box (MG6) provides cooling air for the Patient Comfort Module in the Magnet Enclosure. The Blower Box will be mounted within the RF Shielded Room and connects to the Patient Comfort Module by 4.0 inch (101.6 mm) OD flexible vinyl air ducting.

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 Section 12.7, Blower Box for box and mounting dimensions.

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 Section 12.18, Pneumatic Patient Alert for Control Box mounting dimensions.

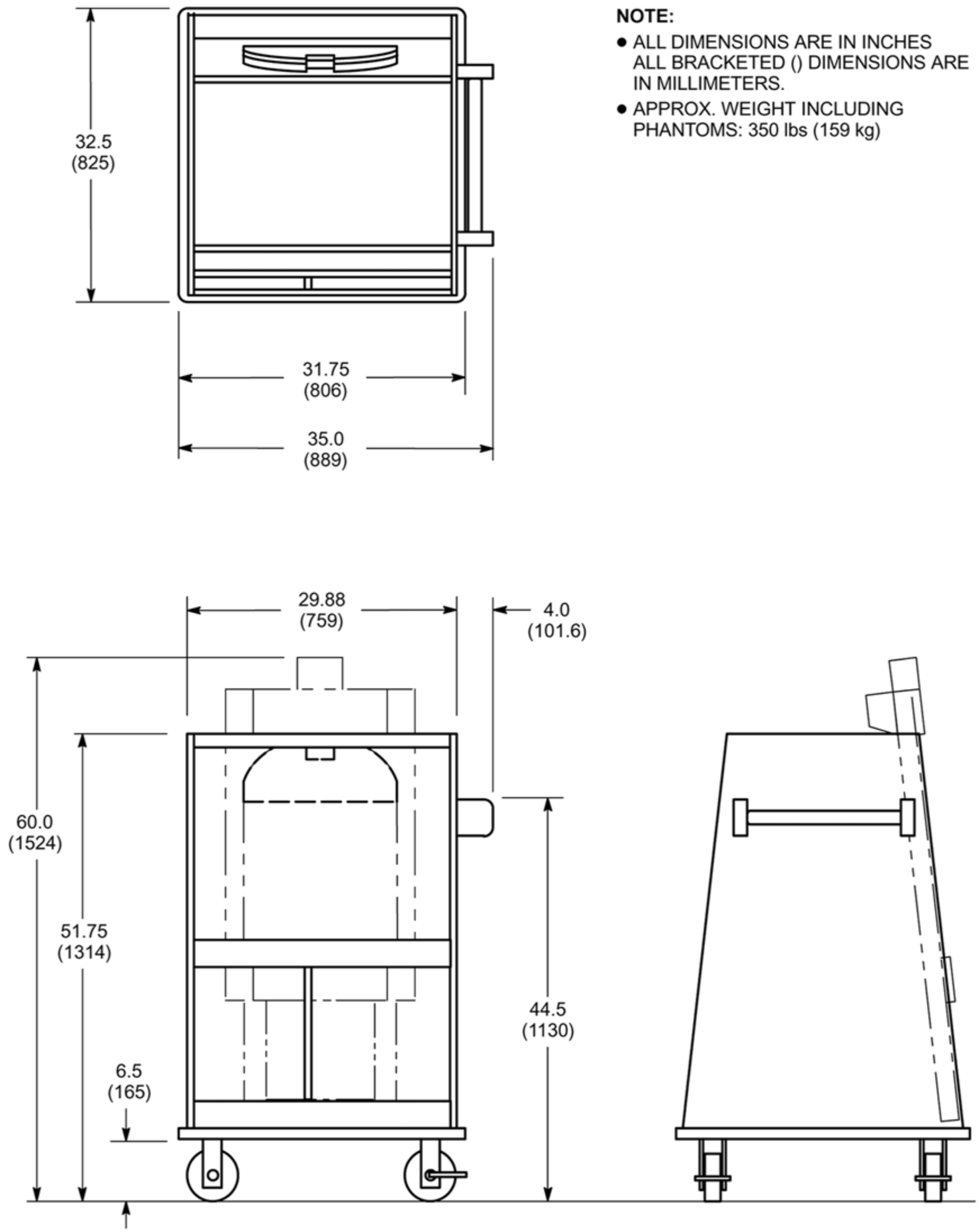
9.3 Customer Site Storage Requirements

The MR system has several system accessories such as system phantoms and surface coils. There are many optional surface coils available. Storage space for system accessories and supplies needs to be planned for and included in room layout drawings.

Refer to *Direction 5182674 GE Healthcare Signa MRI Scanners Customer Site Storage Requirements* for size and weight of surface coils and phantoms that require customer provided storage locations. Direction 5182674 is available on-line at http://www.gehealthcare.com/company/docs/siteplanning.html.

SPT Phantom Set Shipping and Storage Cart is provided as part of the MR system. System Performance Test (SPT) 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 a phantoms and a nesting plate for proper positioning of the phantoms on the Patient Table. The phantom set and nesting plate are provided on a cart 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 3-9 for cart dimensions information.

Illustration 3-9: SPT Phantom Set Shipping/Storage Cart



9.4 Oxygen Monitor Option

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. See Section 12.22, Oxygen Monitor Option illustrations.

9.5 Spectroscopy

9.5.1 Multi-Nuclear Spectroscopy (MNS) - 4 KW

The 4 KW MNS option consists of the 3.0T MNS Amp Cabinet (see Section 12.11,)MNS Cabinet and system cabling for this cabinet. Refer to Chapter 7, Section 8.1, 4KW MNS Option Additional Interconnects for cable length information and other cable data.

9.5.2 Multi-Nuclear Spectroscopy (MNS) - 8KW

The MNS 8 KW option consists of the Broadband RF Amp Cabinet and system cabling for this cabinet (see Section 12.12, Broadband RF Amplifier Cabinet For 8KW MNS Option). Refer to Chapter 7, Section 8.2, 8KW MNS Option Additional Interconnects for 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 Service contract. Refer to Section 9.7, System Monitoring and Support Connectivity for broadband connectivity requirements.

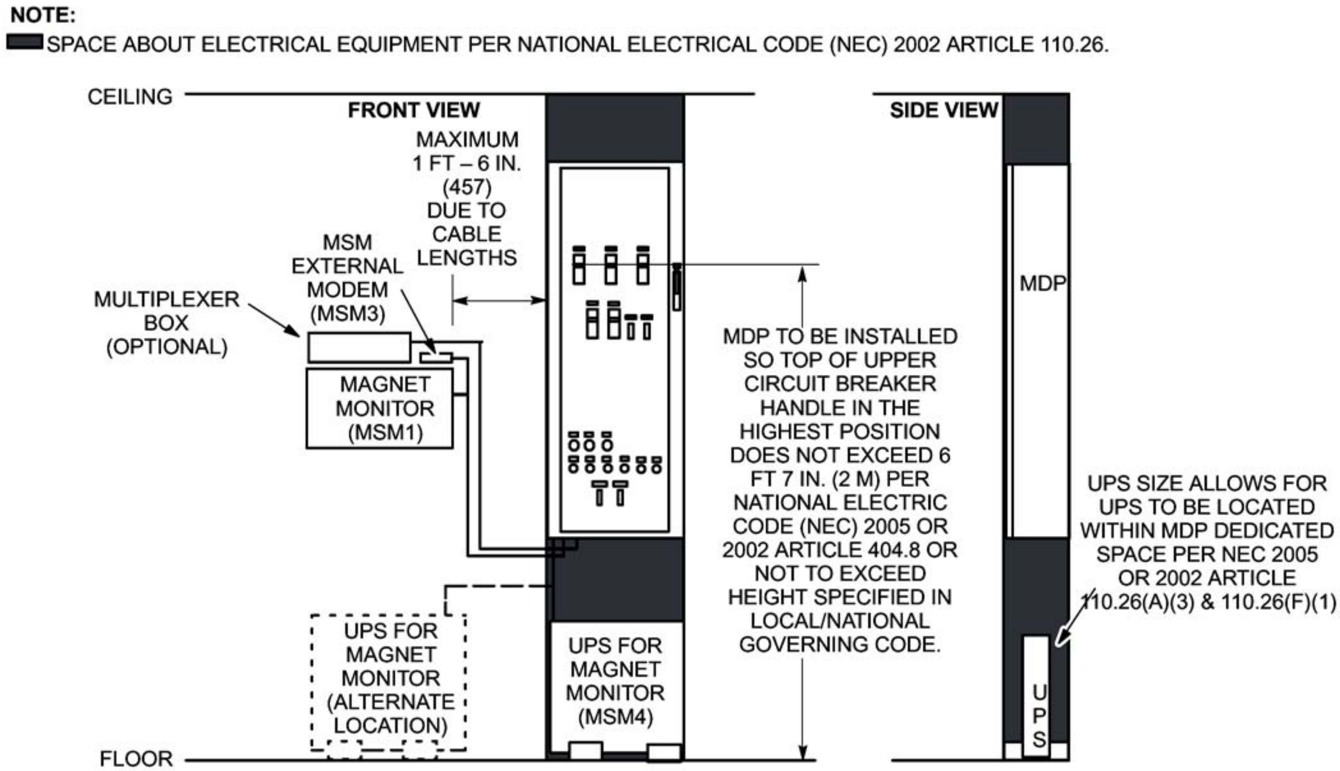
Magnet Monitor remote monitoring operation is valuable to maximize proper uninterrupted magnet operation. The Magnet Monitor is to be powered from the Main Disconnect Panel (MDP) and must be mounted near the MDP, see Illustration 3-10 . The Magnet Monitor should be mounted approximately 60 in. (1524 mm) above the floor in the Equipment Room but outside the 10 gauss zone.

For details of Magnet Monitor, optional UPS, and system interconnects refer to the following sections in the Interconnect Data chapter:

- Chapter 7, Section 1.2, Component Designators
- Chapter 7, Section 1.3, Group Interconnects
- Chapter 7, Section 4.2, Cable Groups Length Provided
- Chapter 7, Section 4.4, L2 Interconnects
- Chapter 7, Section 4.6, L3 Interconnects
- Chapter 7, Section 4.8, L5 Interconnects

An optional small Uninterruptible Power System (UPS) is available for the Magnet Monitor. This optional UPS provides power to the Magnet Monitor equipment via the MDP. In the event of facility power outage, the UPS will maintain Magnet Monitor operation for sufficient time to communicate status via the remote monitoring.

Illustration 3-10: Magnet Monitor (MSM) & Associated Equipment, UPS For Magnet Monitor, And MDP Locations



9.7 System Monitoring and Support Connectivity

One of the system monitoring and support connectivity configurations listed in Table 3-10 must be provided for system installation and serviceability purposes. The broadband network connection and telephone lines are to be provided and paid for by the customer.

Table 3-10: System Monitoring & Support Connectivity Requirements

Configuration	Connection Type	Use/Location
Broadband Network Connection & Telephone Line **(Recommended)**	Two Broadband Internet Accessible connections with individual Static IP addresses See Note 1	One access located near the Operator Workspace (OW) in the Control Room.
	Two Broadband Internet Accessible connections with individual Static IP addresses See Note 1	One access located near the Magnet Monitor (MSM) in the Equipment Room for remote monitoring of magnet pressure levels. This Broadband 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 Notes 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 Notes 2 & 3

Notes

1. **For Europe:** An ISDN Connection with static IP address may be substituted for Broadband Internet Accessible 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 BrainWave HW Lite Option

The BrainWaveHW Lite Option (M1033BL) 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 10, BrainWave HW 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 be 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 11, Remote MRU Option Interconnects for cable length information and other cable data.

9.10 IPCM Option For LCC300 Magnets ONLY

Integrated Patient Comfort Module (IPCM) Option consists of hardware and software that can be used in combination with fMRI scanning. The IPCM Option hardware consists of the Chilled Air Blower (CAB), CAB Main Disconnect Panel (CAB-MDP), Bore Liner hardware, modified Penetration Panel waveguide, Bridge with notched sides, Bore Liner hardware including hoses and connectors, and IPCM Option Key.

The CAB provides chilled air to the 2 piece Bore Liner via an air hose routed through the Penetration Panel (provided waveguide) to the back end of the Rear Pedestal. At the Rear Pedestal additional provided hardware, hoses and connectors are used to connect the air hose to both pieces of the Bore Liner. Refer to Chapter 7, Section 12, IPCM Option Interconnects for interconnect specifications.

NOTE: The CAB-MDP is not powered from the MR system MDP or PDU and therefore requires facility provided power. The CAB-MDP must also be connected to the MR system MDP Emergency Power Off control circuit via a customer supplied cable.

The CAB-MDP requires customer supplied facility power. Customer supplied Emergency Power Off control wiring is required between the CAB and CAB_MDP. Refer to Chapter 6, Section 9, IPCM Option Power Requirements for power specifications.

The CAB requires airflow clearance for front, back, and top during operation. Refer to Section 12.24, IPCM Option for dimensions information.

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°).
   a. 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.
   b. 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. Refer to Chapter 5, Section 8.2, Acoustics Background since viewing window location and material may impact site acoustics.
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. Refer to Chapter 5, Section 8.2, Acoustics Background since viewing window location and material may impact site acoustics.
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 and Support Connectivity.
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.

11. Recommend protecting floors while moving heavy pieces of equipment (e.g. HFD/PDU Cabinet, Body Coil Assembly, MRCC, etc).
12. There needs to be a site plan for the MR system replacement component delivery (i.e. corridor, doors, elevators, etc.) which meets the specifications in Section 5.1, Minimum Delivery Route Sizes and Capacity.

11 Floor Loading and Weights

11.1 MR System Components

NOTICE

It is the responsibility of the customer to obtain any and all approvals necessary for the construction of equipment support and seismic anchoring.

Listed in Table 3-11 are the weights, floor loading, and normal mounting methods for MR system components.

Table 3-11: System Components Floor Loading

Component	Weight & Dimensions See Table 3-12 Note 2 & 5	Normal Mounting Method
LCC300 Magnet, RF/Gradient Body Coils (TRM), and Enclosure including Table Dock and Rear Pedestal	See Table 3-12 Notes 1 & 3. Refer to Section 12.2, Magnet and Enclosure	Magnet & Table Dock Asm. resting on base, for mounting requirements refer to • with VibroAcoustic Damping option: Section 11.2.1 • without VibroAcoustic Damping option: Section 11.2.2 Rear Pedestal floor contact must meet requirements in Section 7, Flooring.
Patient Table	See Section 12.15, Patient Transport Table	Mobile
Blower Box	See Section 12.7, Blower Box	Anchor to floor or shelf, see Table 3-12 Note 6 for additional mounting requirements.
NB RF Amplifier Cabinet	See Section 12.10, Narrow Band RF Amplifier Cabinet	Set on floor on casters
RFS Cabinet	See Section 12.9, RFS Cabinet	Set on floor on casters
HFD/PDU Cabinet	See Section 12.8, HFD/PDU Cabinet	Set on floor on casters
Twin Accessory Cabinet	See Section 12.13, Twin Accessory Cabinet (TAC)	Set on floor on casters
Shield/Cryo Cooler Compressor Cabinet (See Table 3-12 Note 4)	See Section 12.3, Shield/Cryo Cooler Compressor Cabinet	Set on floor and rest on casters.
Operator Workspace Table with LCD display & GOC Computer Cabinet	See Section 12.17, Operator Workspace	Table set on floor on leveling pads & Cabinet set on floor and rest on casters.
UPS for Magnet Monitor*	See Section 12.20, UPS For Magnet Monitor	Set on floor on 2 mounting brackets.
3T MNS Cabinet for 4KW MNS option*	See Section 12.11, MNS Cabinet	Set on floor on casters
BB RF Amplifier Cabinet for 8KW MNS option*	See Section 12.12, Broadband RF Amplifier Cabinet For 8KW MNS Option	Set on floor on casters
BrainWave HW Lite Cabinet*	See Section 12.23, BrainWave HW Lite Cabinet Option	Casters for location. Set on floor on leveling pads.
Chilled Air Blower (CAB) for IPCM Option*	See Section 12.24, IPCM Option	Set on floor on casters
System Water Cooling Equipment Configurations (See Note 4)		

Table 3-11: System Components Floor Loading (cont'd)

Component	Weight & Dimensions See Table 3-12 Note 2 & 5	Normal Mounting Method
MR Common Chiller (MRCC)* See Table 3-12 Note 4	See Section 12.5, MR Common Chiller (MRCC)	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.
Gradient Coil Water Heat Exchanger (GWHX)* See Table 3-12 Note 4	See Section 12.6, Indoor Gradient Water Heat Exchanger (GWHX)	Indoors: Set on floor and rest on casters

Table 3-12: Notes For System Components Floor Loading Table

Notes

* Optional Equipment

1. Weight of LCC300 Magnet with Enclosure, RF/Gradient (TRM) Body Coil, VibroAcoustic Damping Option mats, and cryogens is 24,810 lbs (11,253 kg).
   Weight of LCC300 Magnet with Enclosure, RF/Gradient (TRM) Body Coil, and cryogens is 24,300 lbs (11,020 kg).
   The Rear Pedestal installed weight is 176 lbs (79.8 kg).
2. Consult a structural engineer on method of calculating proper weight/unit area for floor loading.
3. Refer to Section 5.1, Minimum Delivery Route Sizes and Capacity for Gradient Coil Assembly replacement weight and dimension requirements.
4. The MR System requires water cooling for the Gradient Coil and the Shield/Cryo Cooler Compressor.
   - Gradient Coil water cooling must be supplied by cooling equipment (MRCC or GWHX) 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 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling.
     Sites requiring seismic anchoring by code for MRCC or GWHX should have the site architect and engineer review the response spectra and/or Uniform Builders Code (UBC) for their location and then contact MRCC Service Provider for assistance in seismic planning of the site. MRCC Service Providers are listed in Section 8.2, MRCC Siting Considerations.
5. The center of gravity for MR system components are given in the illustrations for use in seismic calculations. Contact your local GE Healthcare Project Manager, Installations for seismic information if the MR system equipment is required by code to be anchored.
6. Blower Box mounting must meet the requirements in the flowing:
   - Chapter 8, Section 7.1, Anchor Hardware For MR Equipment Inside RF Shield
   - Chapter 8, Section 7.2, Physical Characteristics
   - 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

11.2 Magnet and Dock Mounting

11.2.1 Magnet Installed 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, Anchor Hardware Requirements 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

11.2.2 Magnet Installed 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, Anchor Hardware Requirements 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

12 Components Dimensions

12.1 Component Dimensions

To assist in completing your room layout, refer to Table 3-13 for list of component Illustrations.

Table 3-13: Signa EXCITE HD 3.0T System Component Illustrations List

Illustration Name	Illustration Location
• LCC300 Magnet & Enclosure Room Minimum Service Area • LCC300 Magnet Enclosure Front And Rear Views • LCC300 Magnet Enclosure Cable Access • LCC300 Magnet Load Pattern	Section 12.2, Magnet and Enclosure
Shield/Cryo Cooler Compressor Cabinet (MS5)	Section 12.3, Shield/Cryo Cooler Compressor Cabinet
Signa TwinSpeed Main Disconnect Panel (MDP) M3088TM	Section 12.4, Main Disconnect Panel
NOTE: An MRCC can be used to provide Shield/Cryo Cooler Compressor water cooling or Gradient Coil cooling Water. Two units needed if planned to provide water cooling for both subsystems. • MR Common Chiller (MRCC) • MRCC Outdoor Mounting • Remote Control Panel (RCP) For MRCC	Section 12.5, MR Common Chiller (MRCC)
Indoor Gradient Water Heat Exchanger (GWHX) for Gradient Coil Cooling Water ONLY	Section 12.6, Indoor Gradient Water Heat Exchanger (GWHX)
Blower Box (MG6)	Section 12.7, Blower Box
HFD/PDU Cabinet (MR3)	Section 12.8, HFD/PDU Cabinet
3T RFS Cabinet (MR2)	Section 12.9, RFS Cabinet
Narrow Band (NB) RF Amplifier Cabinet (MR8)	Section 12.10, Narrow Band RF Amplifier Cabinet
3.0T MNS Cabinet (MR10) for 4KW MNS Option	Section 12.11, MNS Amp Cabinet
Broadband (BB) RF Amplifier Cabinet (MR9) - 8KW MNS Option	Section 12.12, Broadband RF Amplifier Cabinet For 8KW MNS Option
Twin Accessory Cabinet (TAC)	Section 12.13, Twin Accessory Cabinet (TAC)
Magnet Monitor (MSM1)	Section 12.14, Magnet Monitor
Patient Transport Table (PT1)	Section 12.15, Patient Transport Table
• Penetration Panel (PP1) • Penetration Panel Cover	Section 12.16, Penetration Panel

Table 3-13: Signa EXCITE HD 3.0T System Component Illustrations List (cont'd)

Illustration Name	Illustration Location
• Operator Workspace (OW1) Overall Dimensions • GOC Computer Cabinet (OW1 A2) • Operator Worspace Components Position on Table Top - Host LCD • Operator Worspace Components Position on Table Top - SCSI Tower and 15 Inch LCD • Operator Worspace Components Position on Table Top - Keyboard	Section 12.17, Operator Workspace
Pneumatic Patient Alert Control Box (PA1)	Section 12.18, Pneumatic Patient Alert
Magnet Rundown Unit (MS4)	Section 12.19, Magnet Rundown Unit
Optional UPS for Magnet Monitor	Section 12.20, UPS For Magnet Monitor
DC Lighting Controller Option	Section 12.21, DC Lighting Controller Option
• Oxygen Monitor (OM1) • Remote Oxygen Sensor Module (OM3)	Section 12.22, Oxygen Monitor Option
Brainwave HW Lite Cabinet Option	Section 12.23, BrainWave HW Lite Cabinet Option

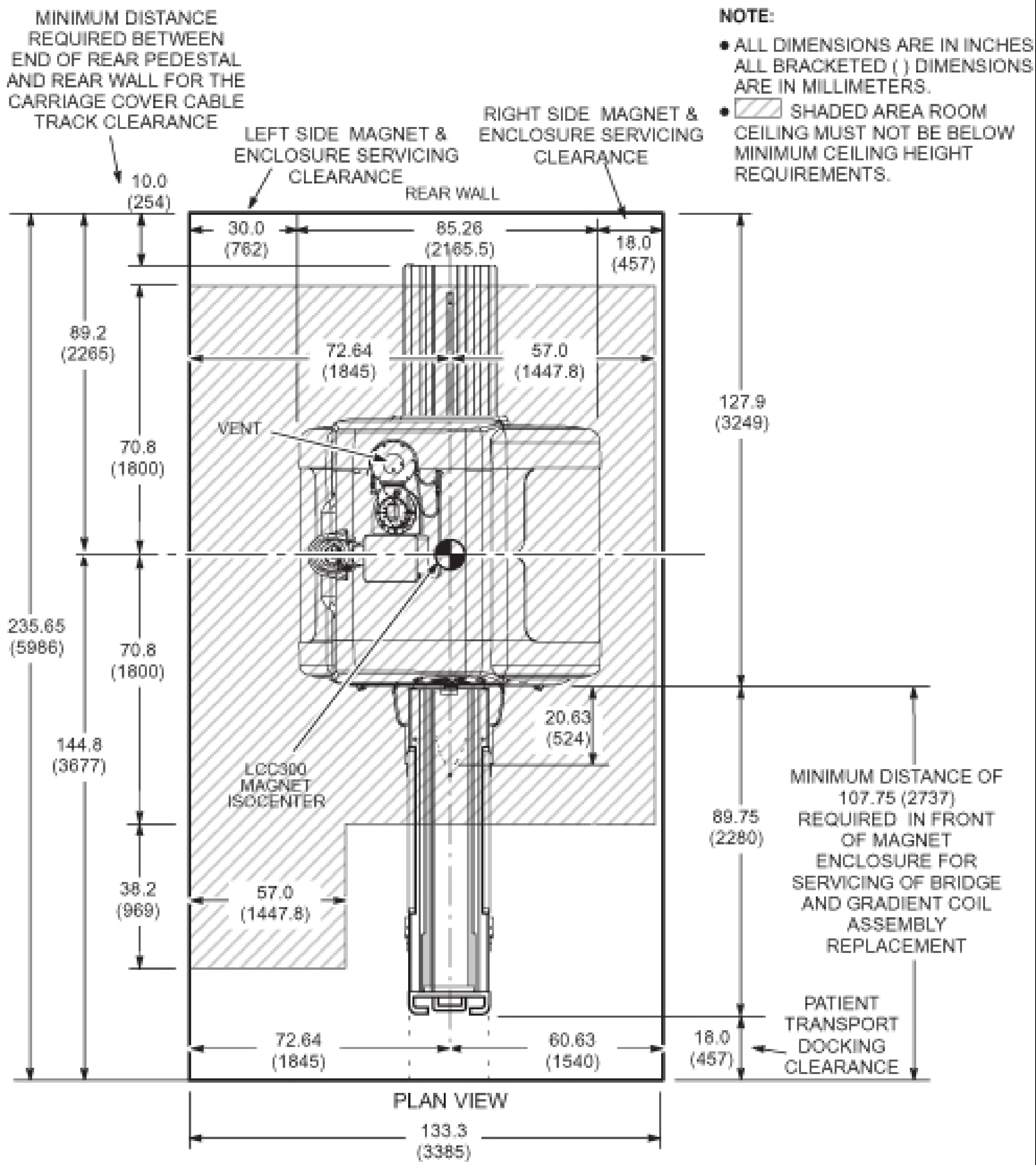
12.2 Magnet and Enclosure

Table 3-14: Magnet & Enclosure List of Dimension Illustrations

Illustration Name	Illustration Number
Magnet Room Minimum Service Area	Table 3-15
Magnet Enclosure Front And Rear Views	Illustration 3-11
Magnet Enclosure Cable Access	Illustration 3-12
Magnet Load Pattern with VibroAcoustic Damping Option	Table 3-16
Magnet Load Pattern without VibroAcoustic Damping Option	Table 3-18

Table 3-15: Magnet Room Minimum Service Area

Table 3-15: Magnet Room Minimum Service Area (cont'd)



NOTE: Shaded area shown must meet minimum room ceiling height requirements in Chapter 8, Section 6.3, Ceiling Height

Illustration 3-11: Magnet Enclosure Front And Rear Views

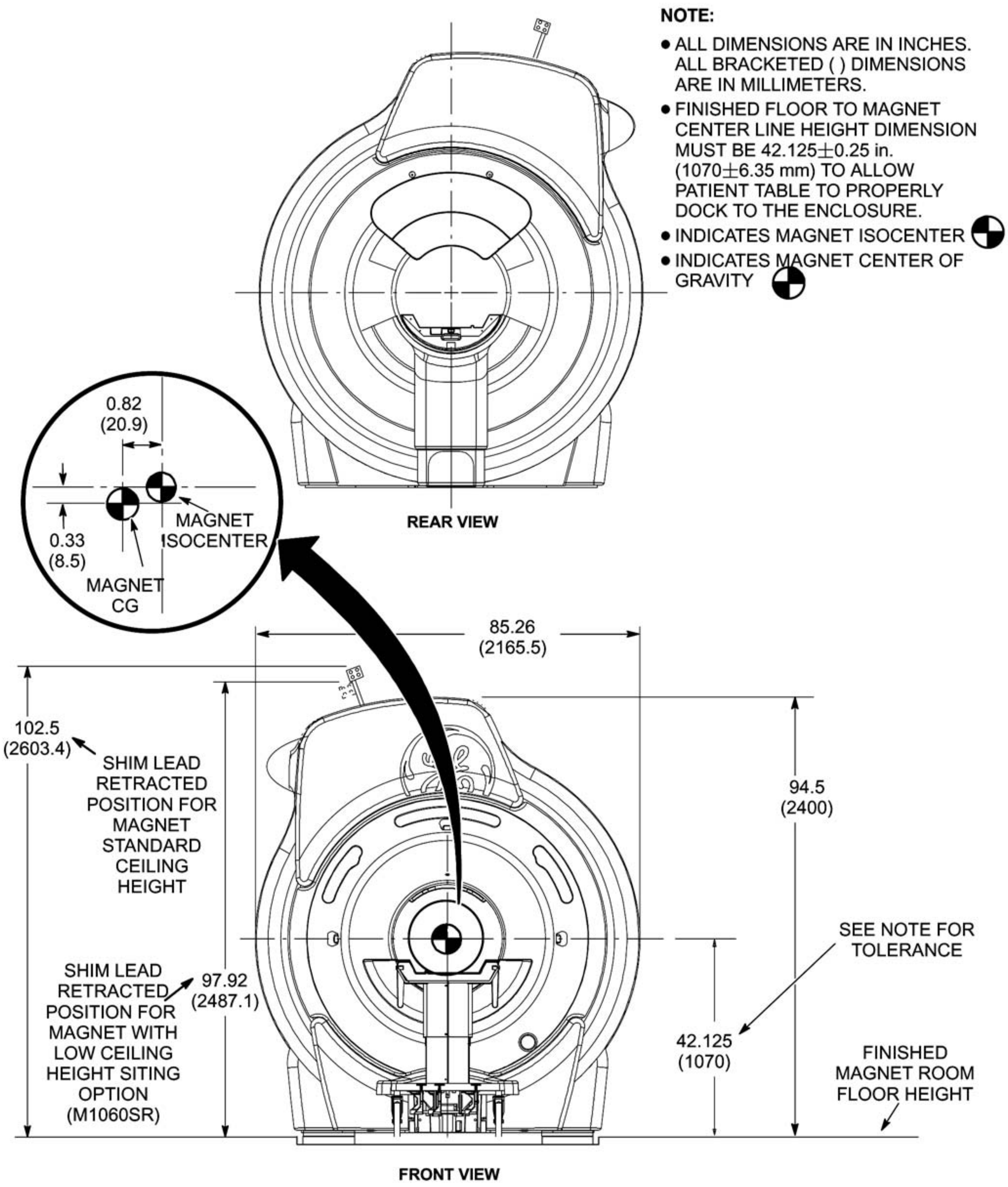


Illustration 3-12: Magnet Enclosure Cable Access

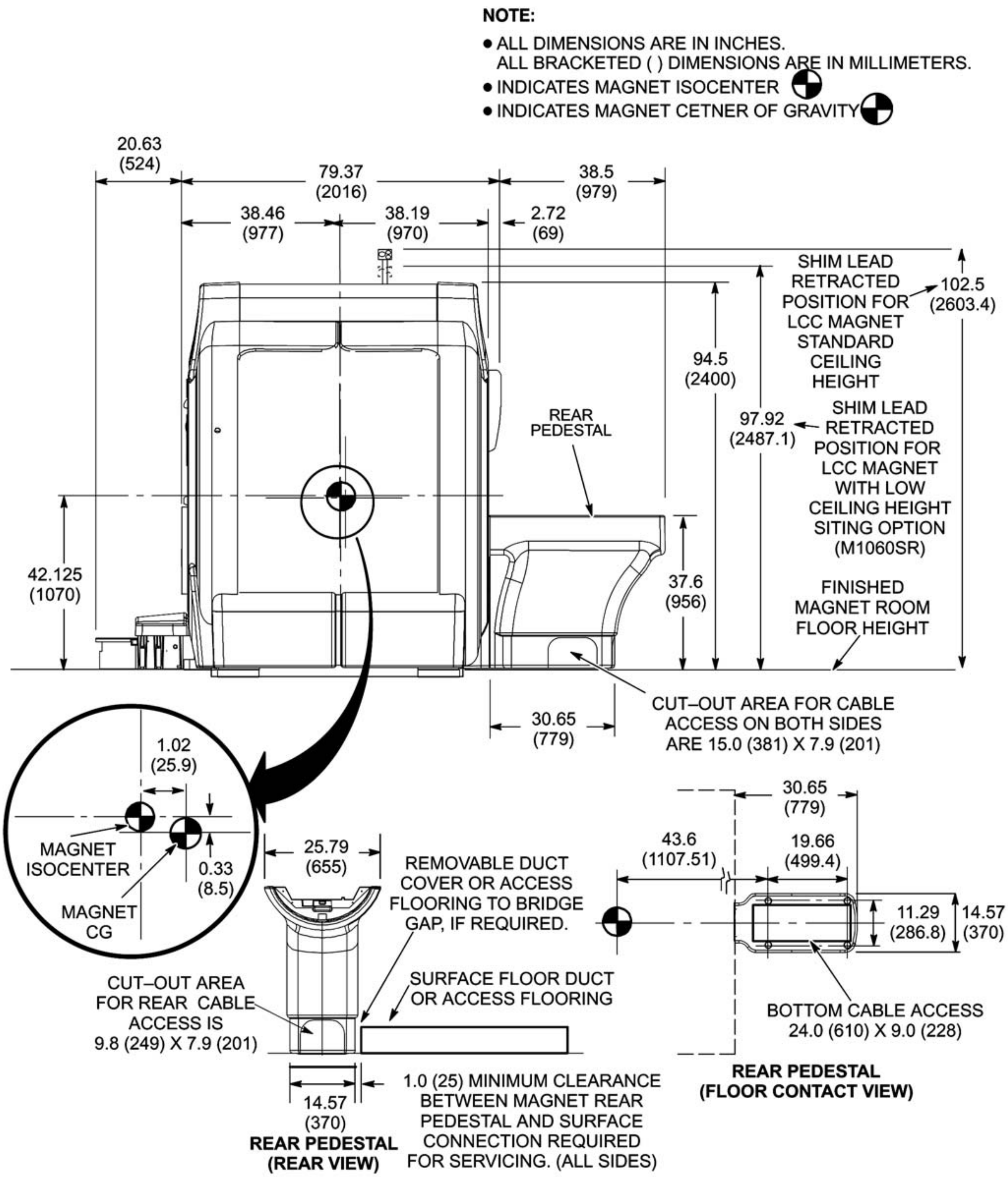
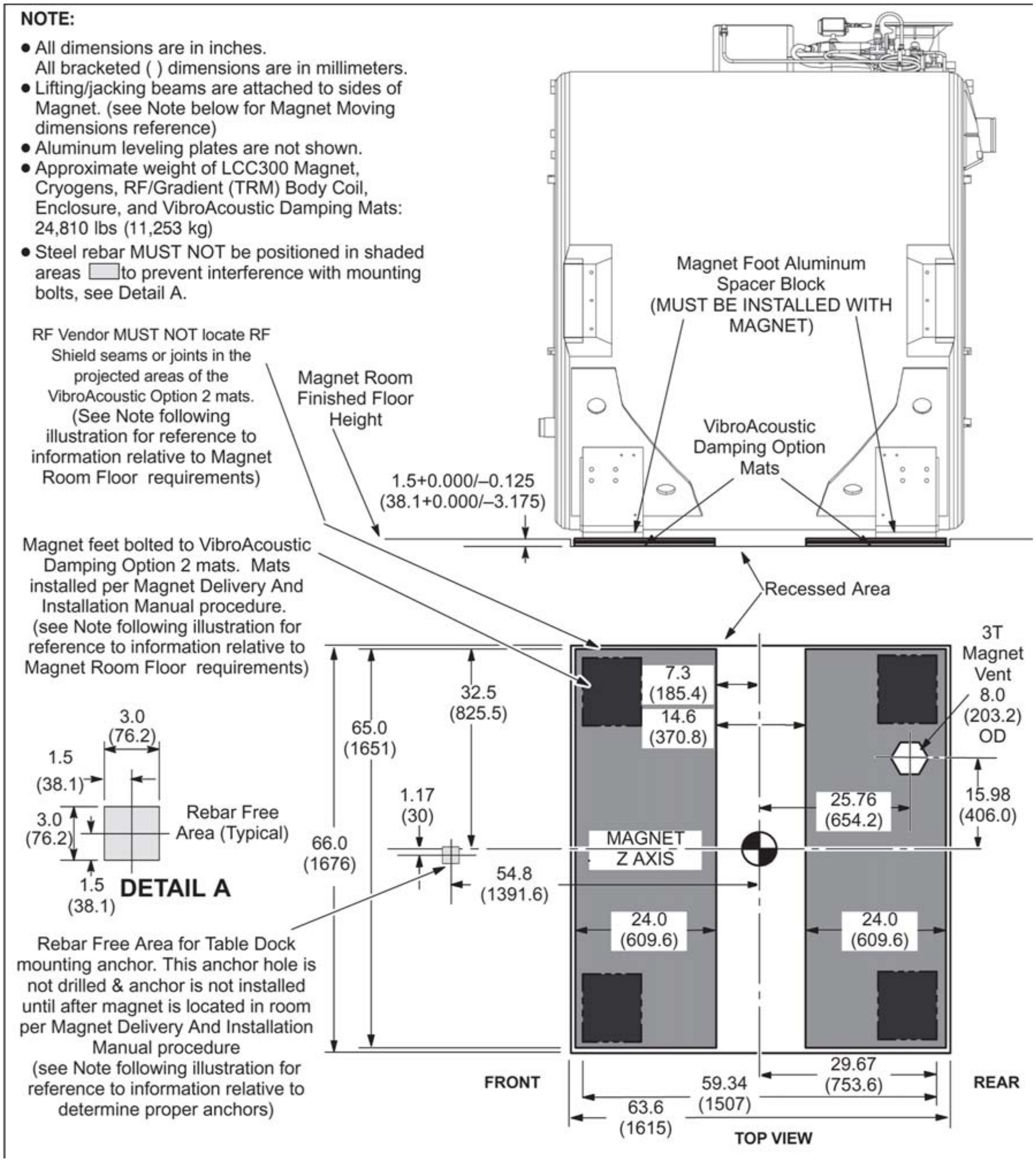


Table 3-16: Magnet Load Pattern With VibroAcoustic Damping Option

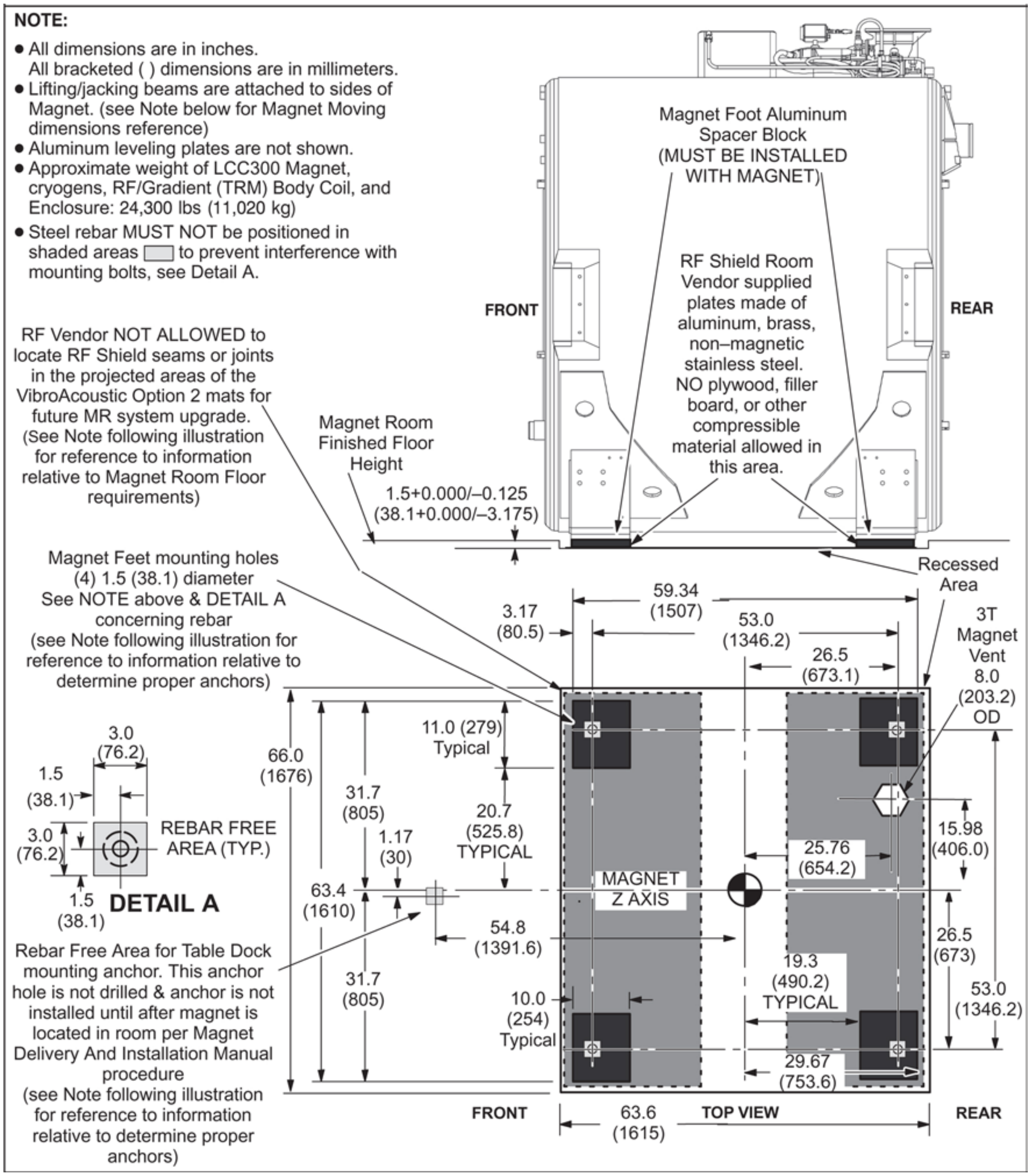


NOTE: See Table 3-17 for references.

Table 3-17: Notes For Preceding Table

1. For LCC magnet shipping weight and moving dimensions with lifting/jacking beams attached to the sides of the magnet refer to Chapter 9, Section 2, Magnet Shipping Considerations.
2. For additional Magnet Room floor requirements for VibroAcoustic Damping Option refer to Chapter 8, Section 6.5, Magnet Room Floors.
3. The Table Dock is still required to be anchored to the Magnet Room floor per the RF Shielded Room chapter, Anchor Hardware Requirements 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, and Chapter 8, Section 7.6, Electrical Isolation.

Table 3-18: Magnet Load Pattern Without VibroAcoustic Damping Option



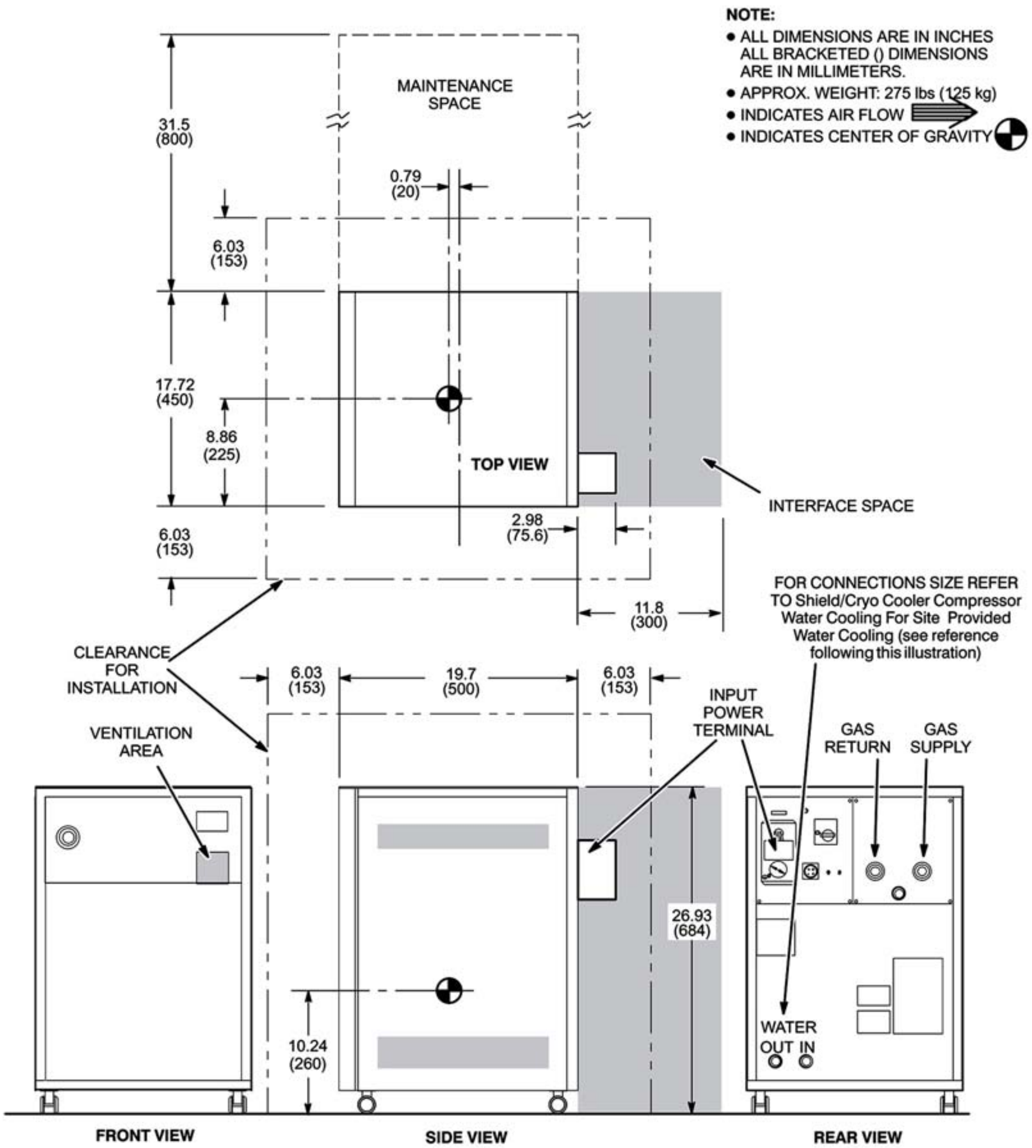
NOTE: See Table 3-19 for references.

Table 3-19: Notes For Preceding Table

1. For magnet moving dimensions with lifting/jacking beams attached to the sides of the magnet refer to Chapter 9, Section 2, Magnet Shipping Considerations
2. For additional Magnet mounting and Dock anchor information and to determine proper anchors, refer to the following located in anchor Hardware Requirements sections RF Shield Room chapter: 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, and Chapter 8, Section 7.6, Electrical Isolation

12.3 Shield/Cryo Cooler Compressor Cabinet

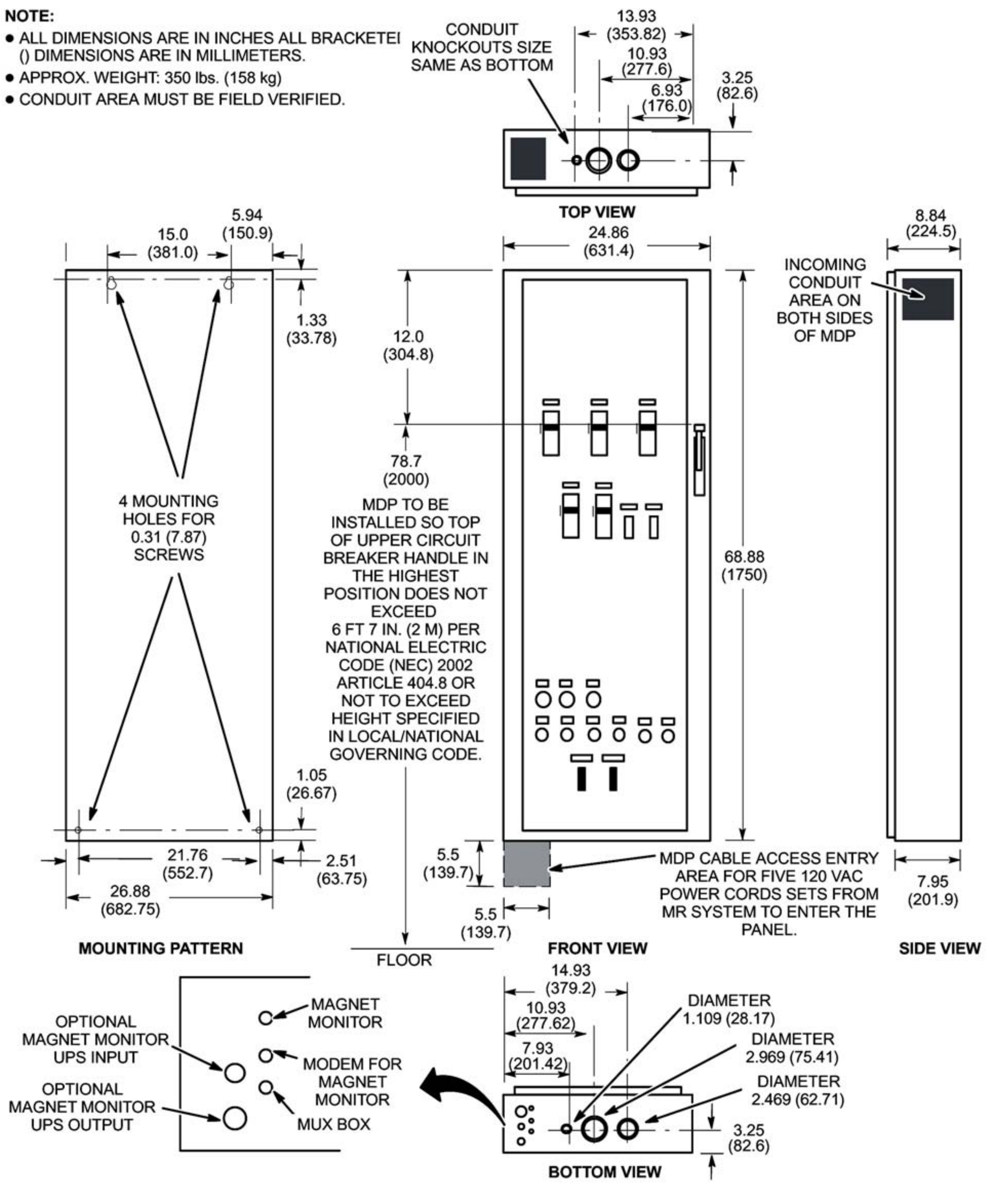
Table 3-20: Shield/Cryo Cooler Compressor Cabinet (MS5)



NOTE:	For water cooling specifications and materials needed for Shield/Cryo Cooler Compressor Cabinet, refer to Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling.

12.4 Main Disconnect Panel

Illustration 3-13: Signa TwinSpeed Main Disconnect Panel (MDP) M3088TM

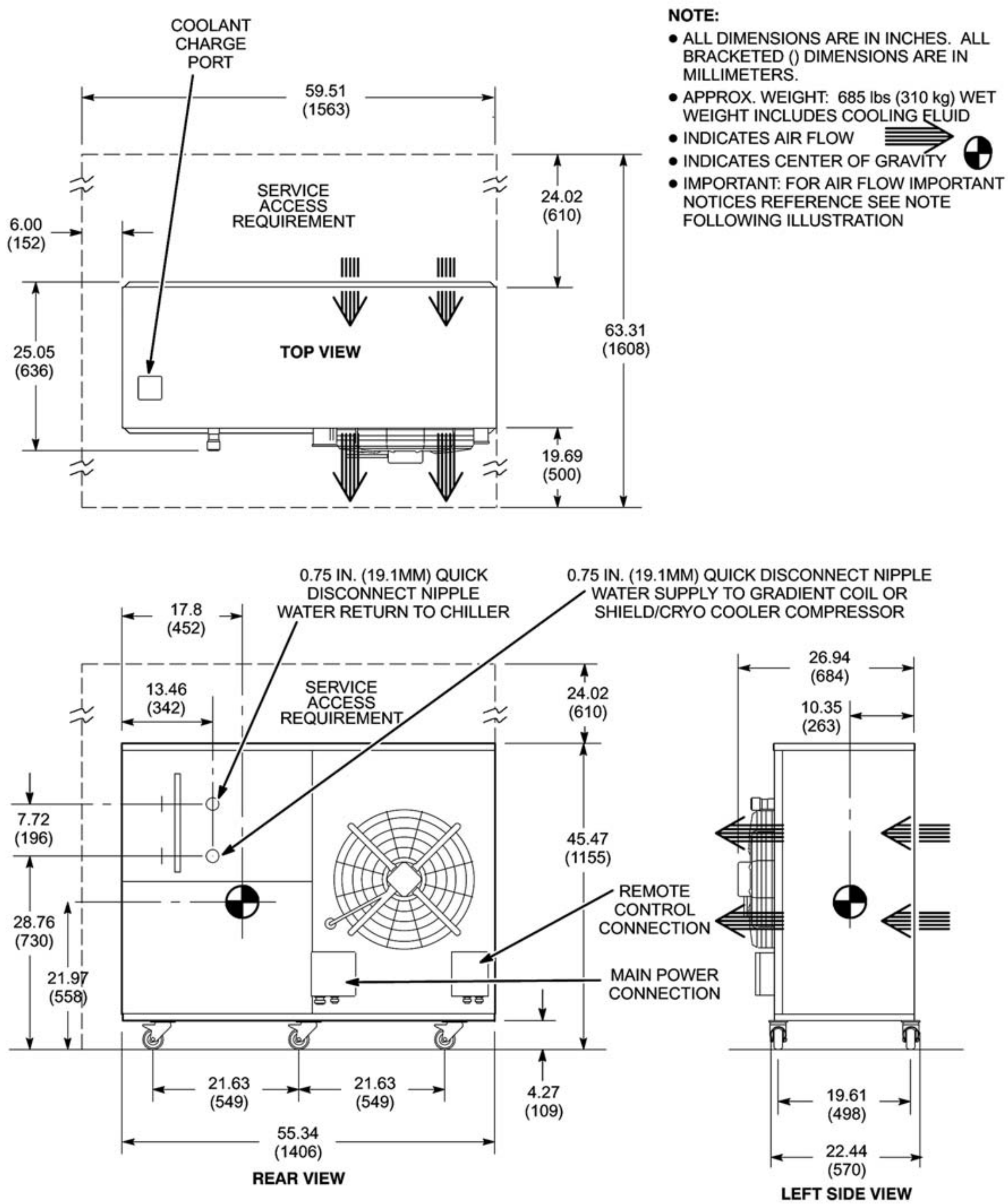


12.5 MR Common Chiller (MRCC)

Table 3-21: MRCC List of Illustrations

Illustration Name	Illustration Number
MR Common Chiller (MRCC)	Table 3-22
MRCC Outdoor Mounting	Illustration 3-14
Remote Control Panel (RCP) For MRCC	Illustration 3-15

Table 3-22: MR Common Chiller (MRCC)



NOTE:	Refer to Section 8.2, MRCC Siting Considerations for airflow important Notices.

Illustration 3-14: MRCC Outdoor Mounting

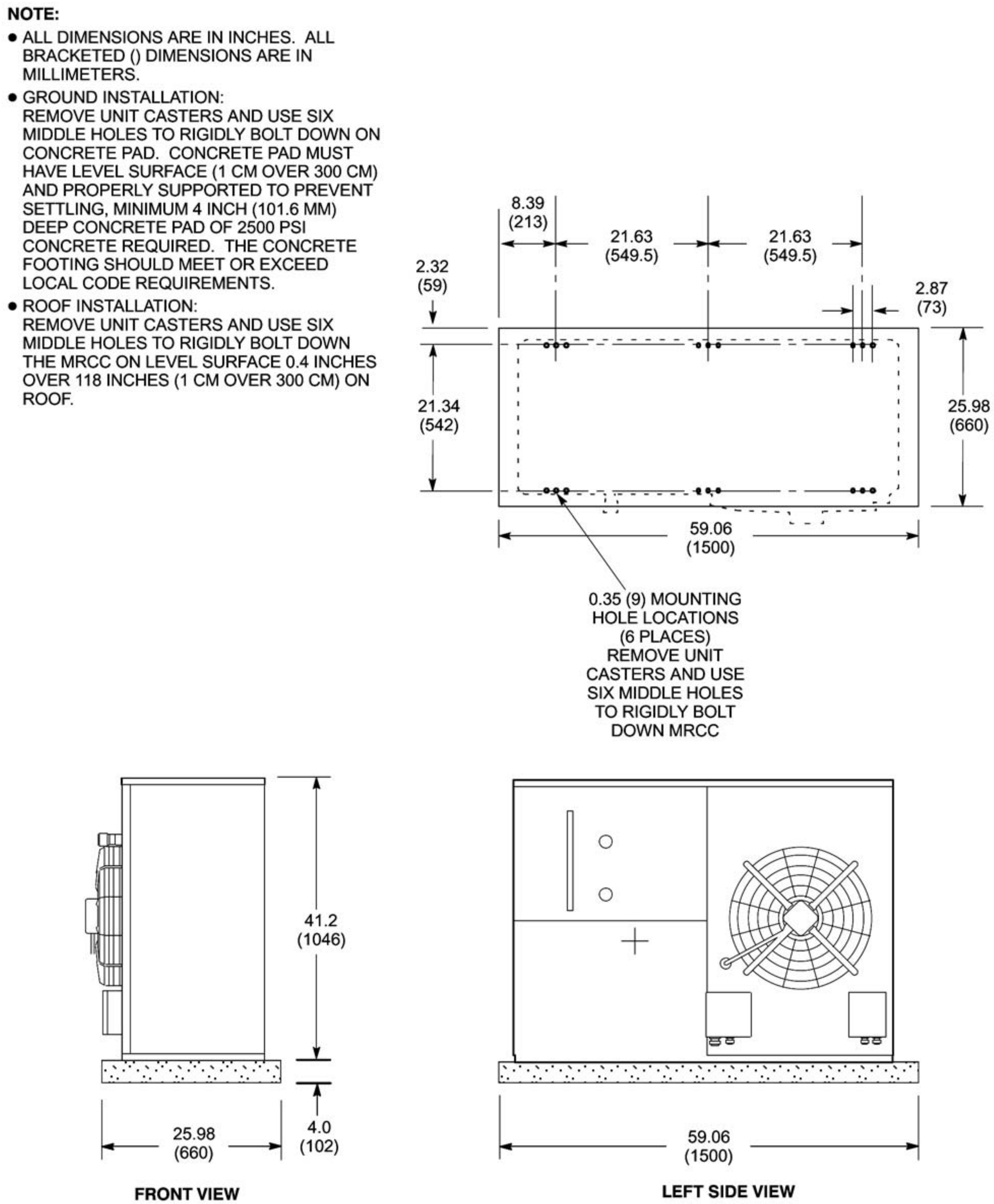
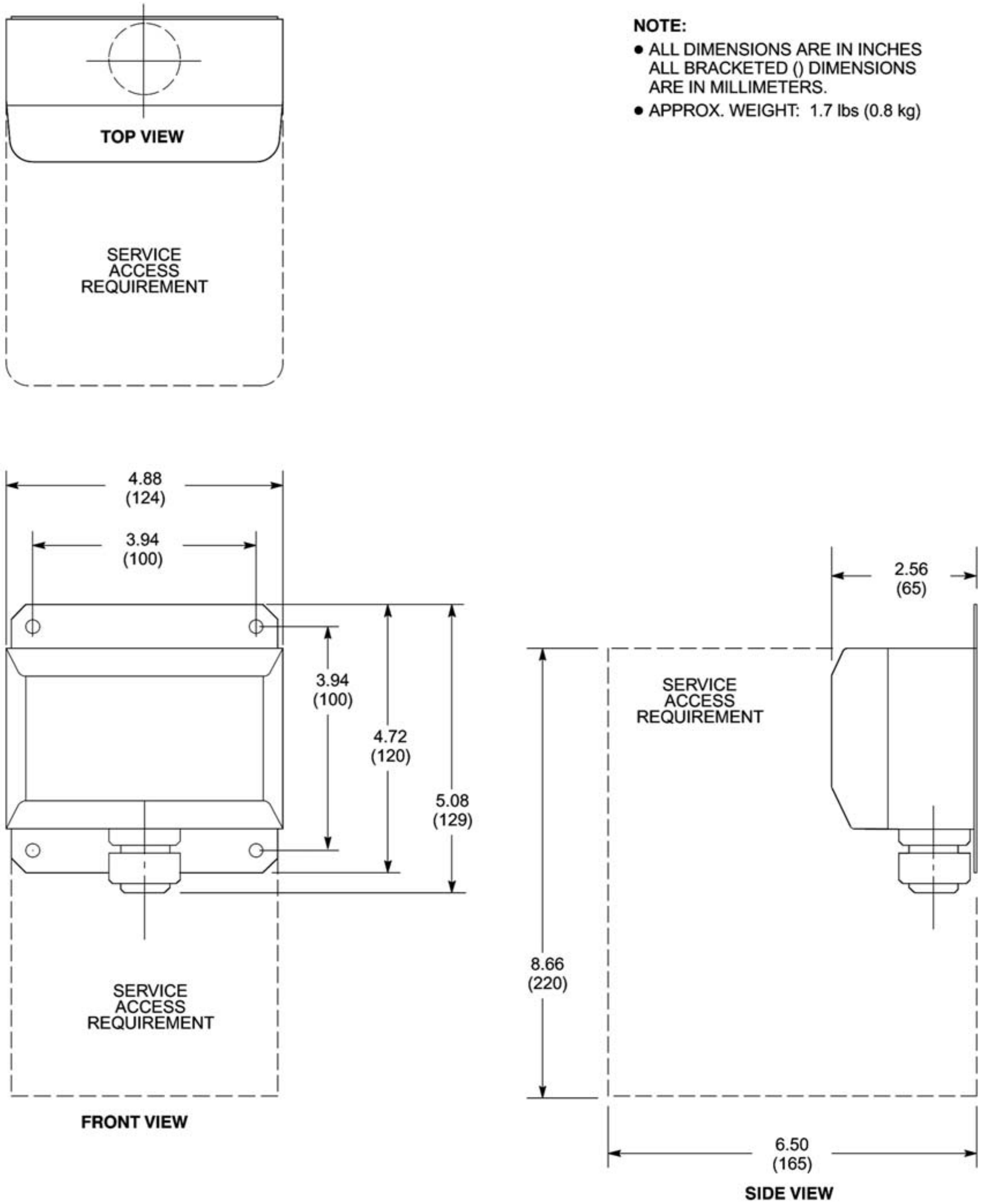
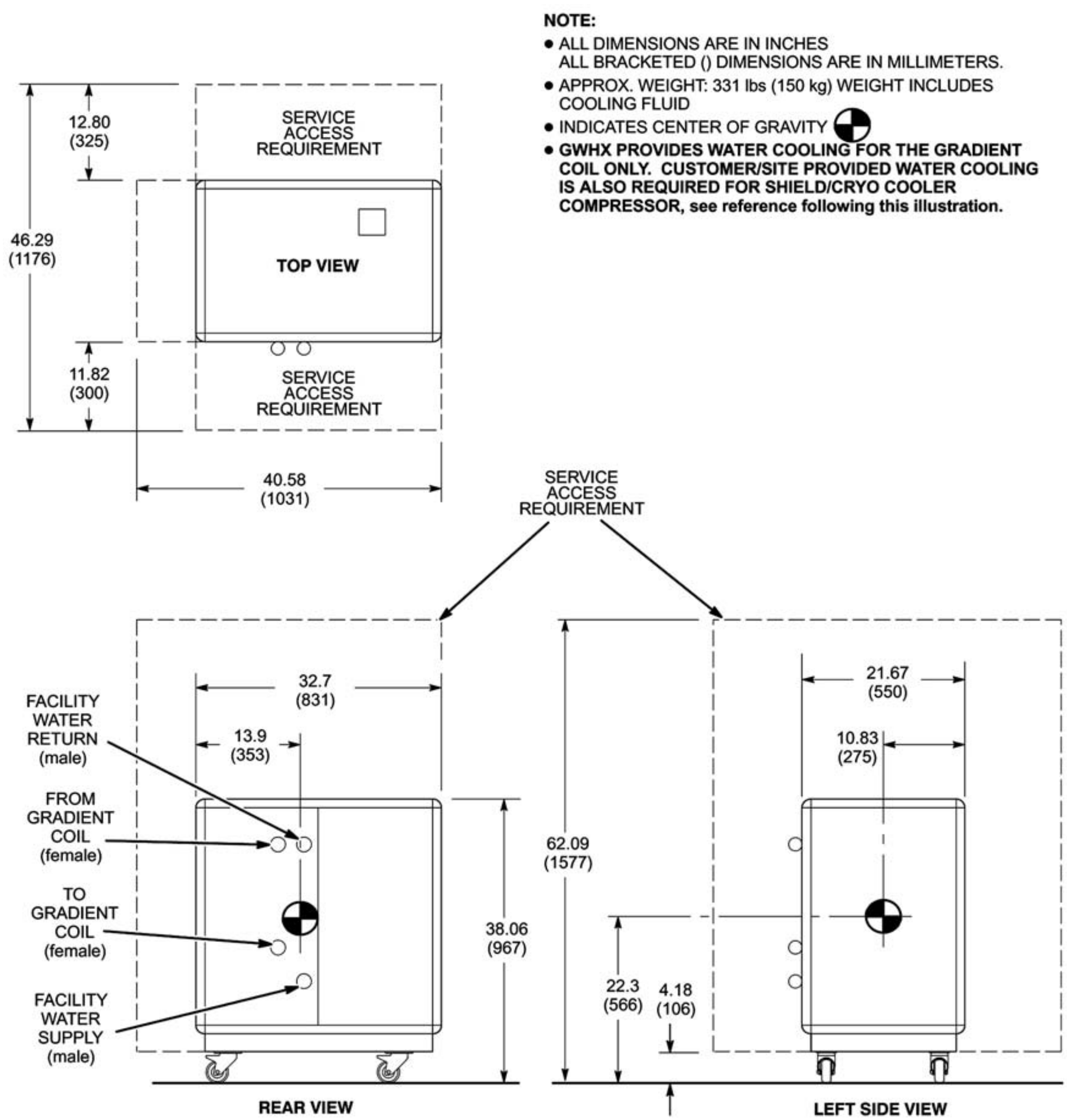


Illustration 3-15: Remote Control Panel (RCP) For MRCC



12.6 Indoor Gradient Water Heat Exchanger (GWHX)

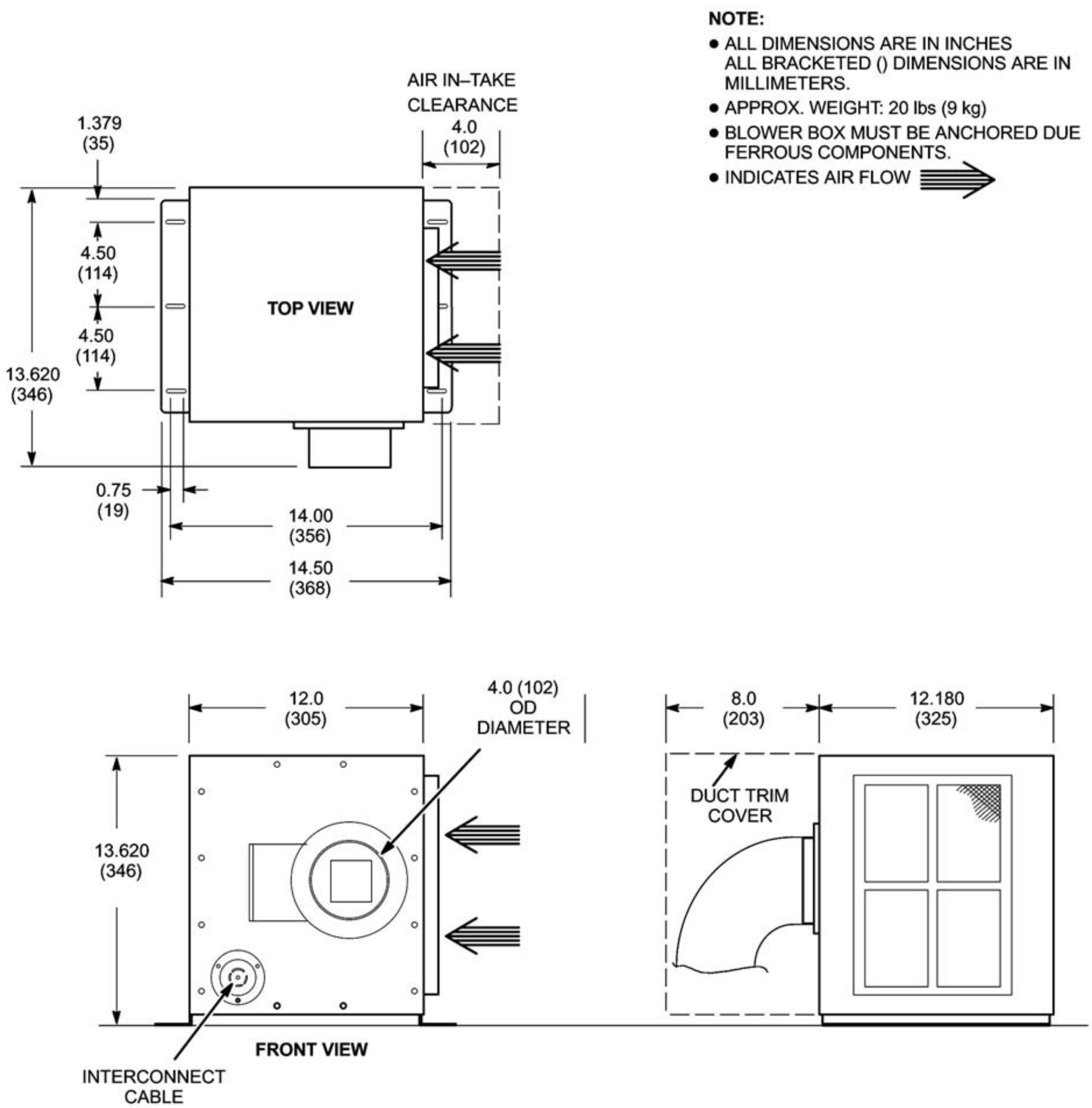
Table 3-23: Indoor Gradient Water Heat Exchanger (GWHX) for TRM Gradient Coil Cooling Water ONLY



NOTE:	For water cooling specifications and materials needed for Shield/Cryo Cooler Compressor Cabinet, refer to Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling. For water cooling specifications for the GWHX refer to Chapter 5, Section 5.4, GWHX Water Cooling Requirements.

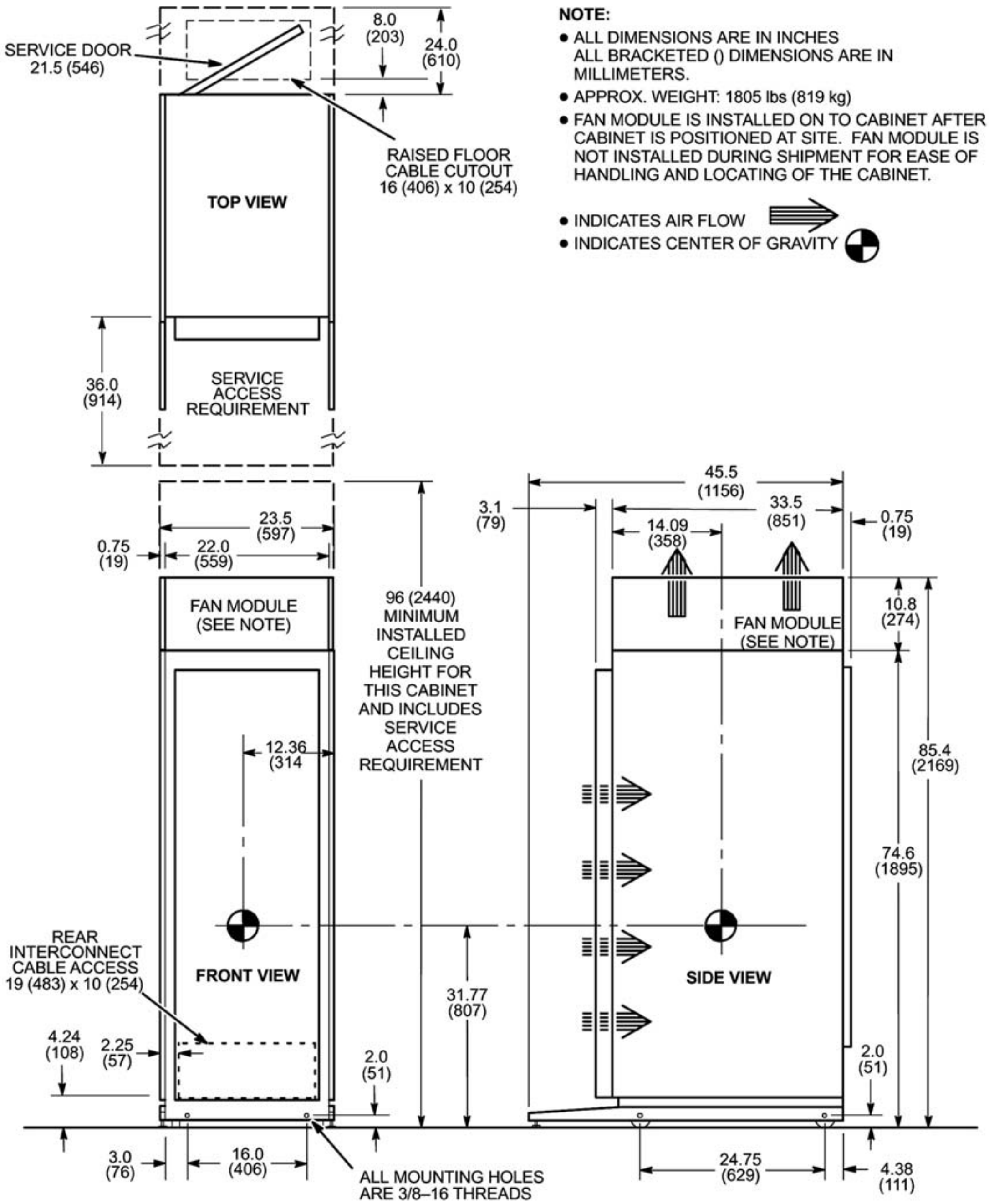
12.7 Blower Box

Illustration 3-16: Blower Box (MG6)



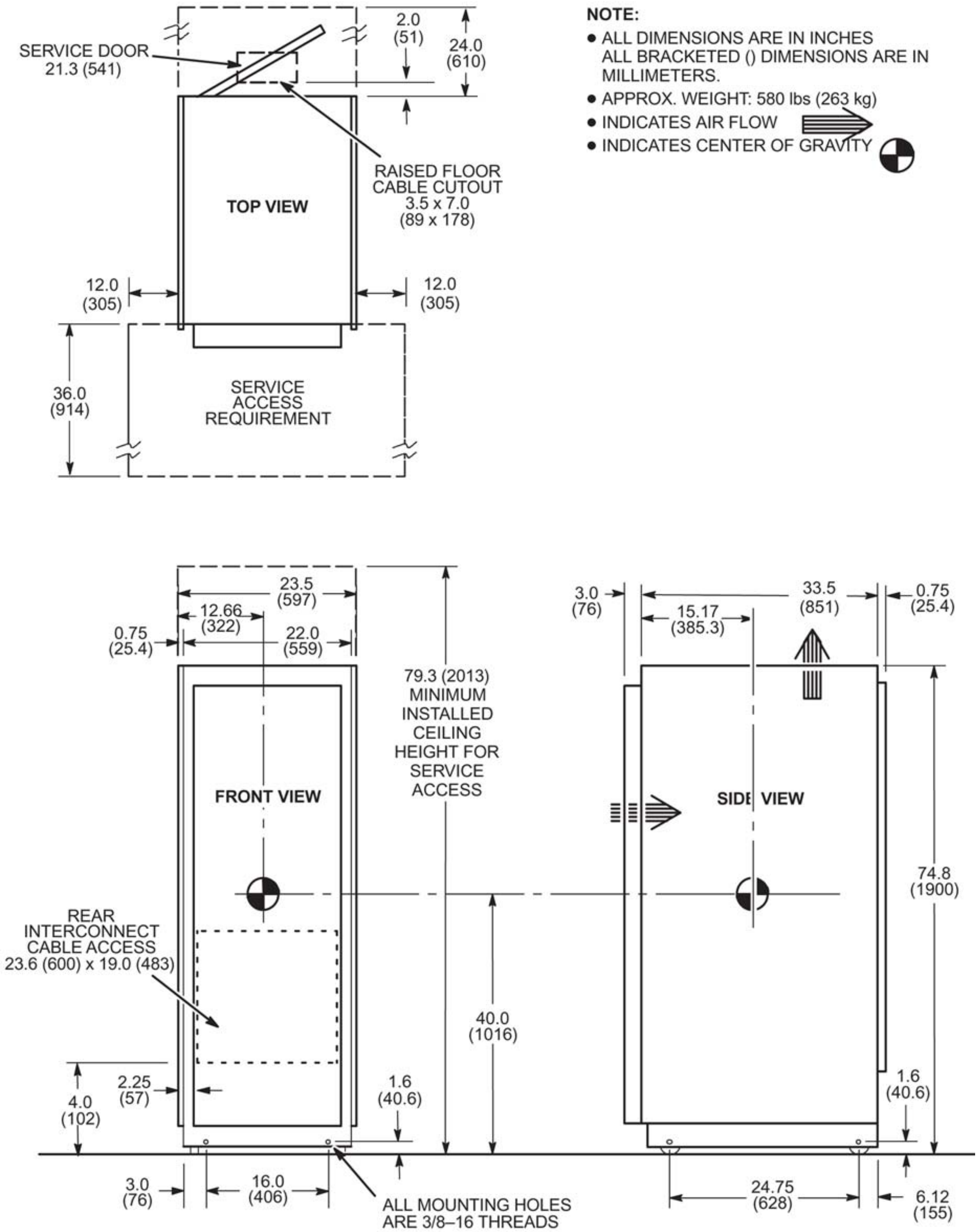
12.8 HFD/PDU Cabinet (MR3)

Illustration 3-17: HFD/PDU Cabinet (MR3)



12.9 RFS Cabinet (MR2)

Illustration 3-18: 3T RFS Cabinet



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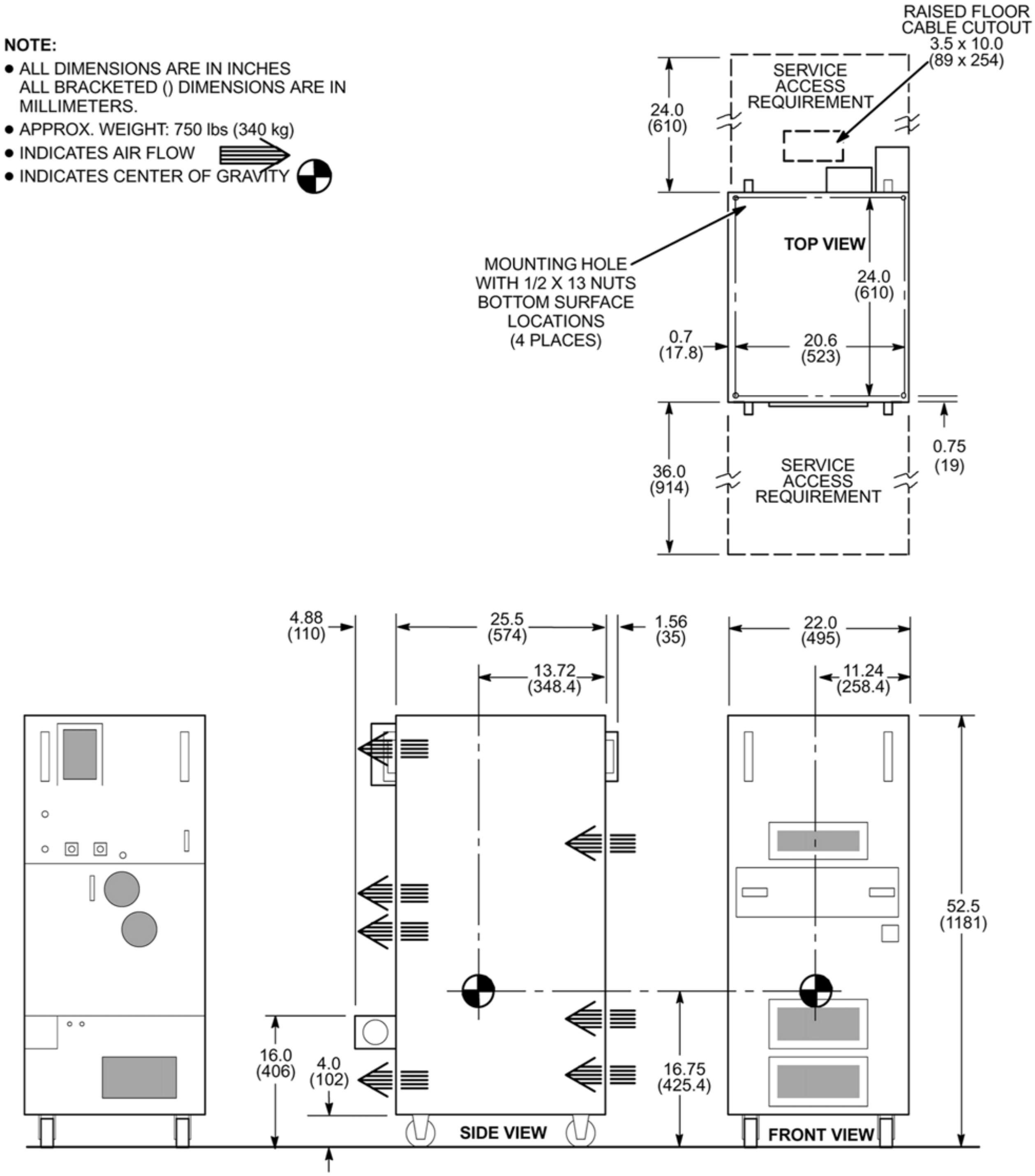
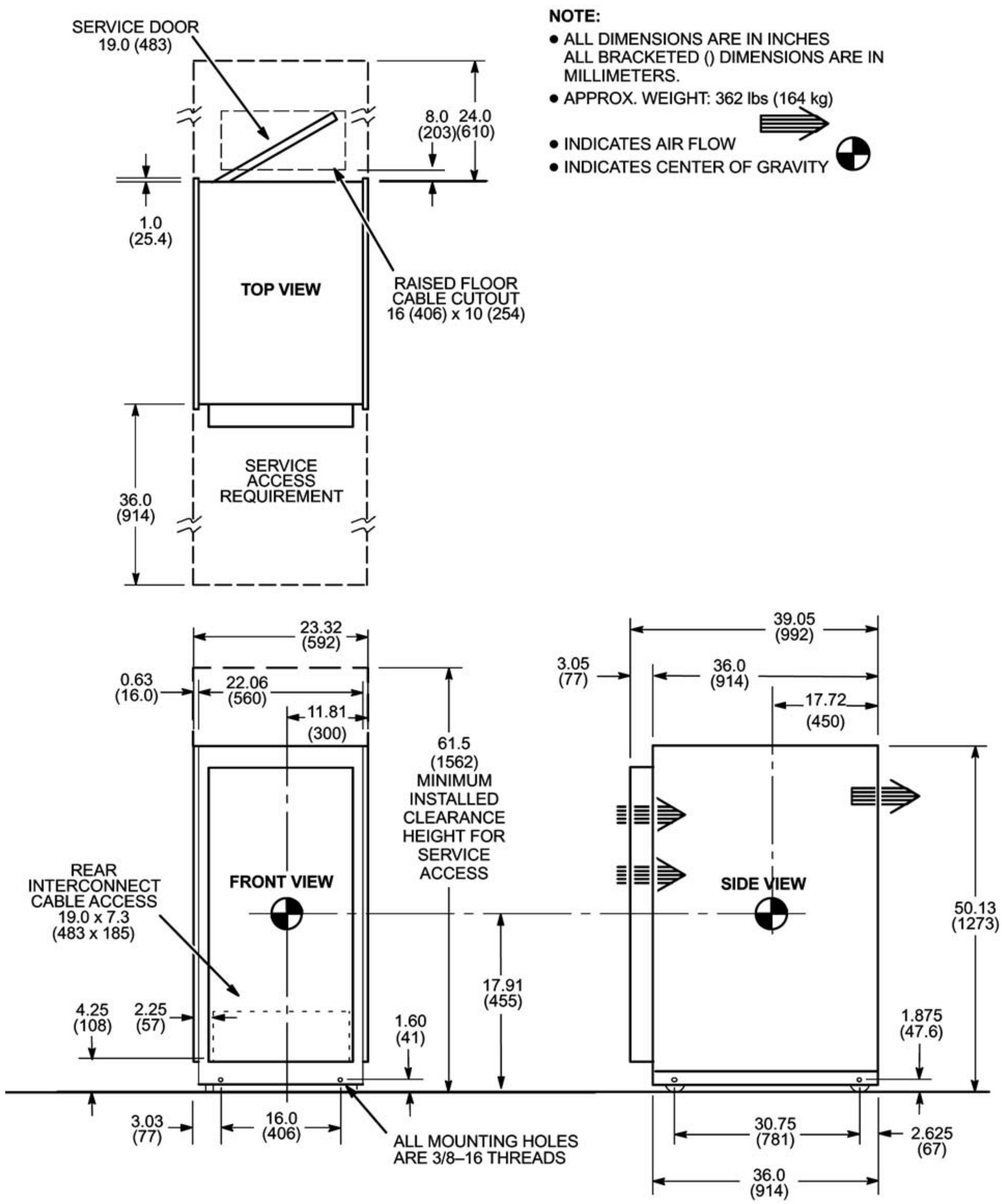
12.10 Narrow Band RF Amplifier Cabinet

Illustration 3-19: Narrow Band (NB) RF Amplifier Cabinet (MR8)



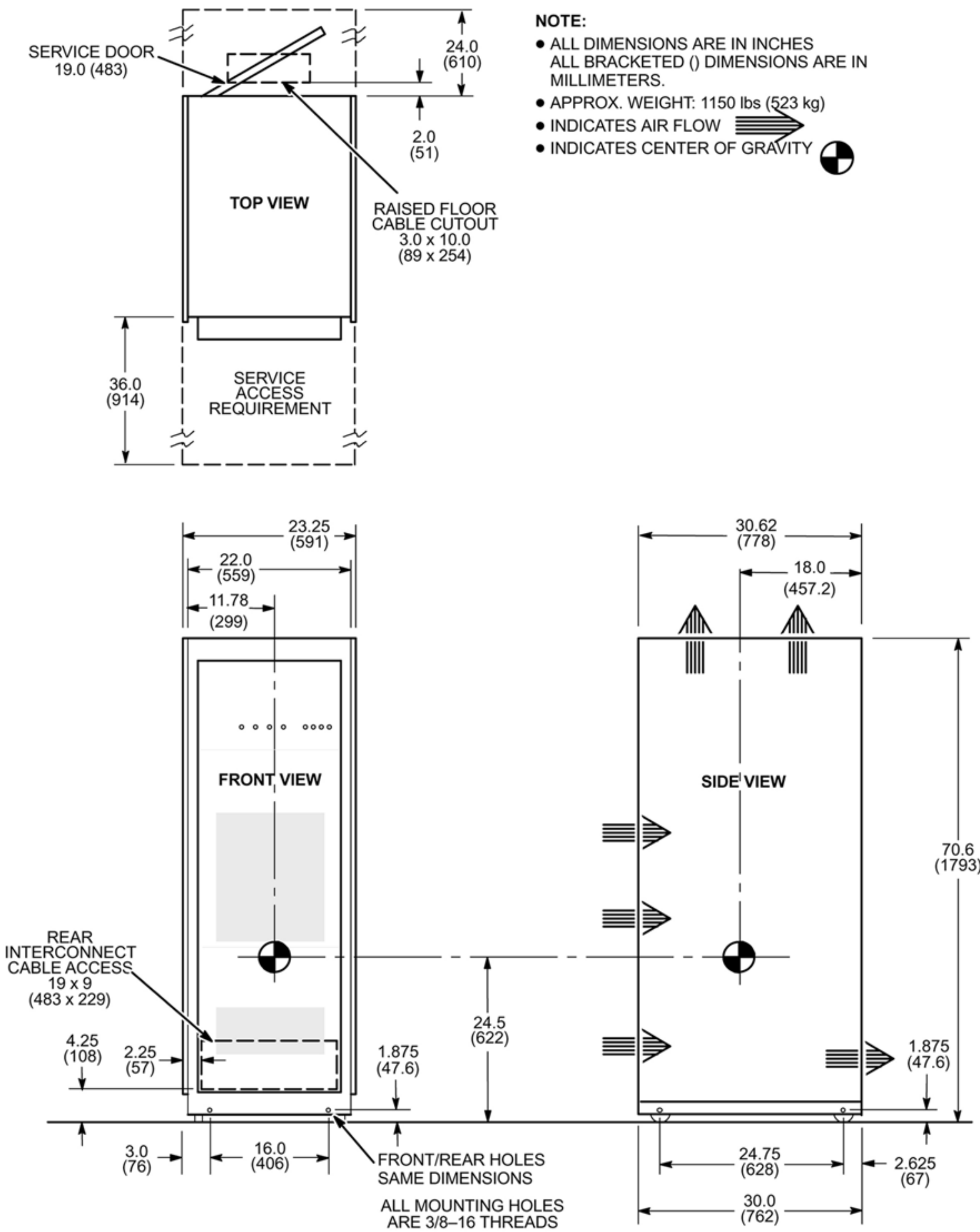
12.11 MNS Amp Cabinet

Illustration 3-20: 3.0T MNS Cabinet (MR10) for 4KW MNS Option



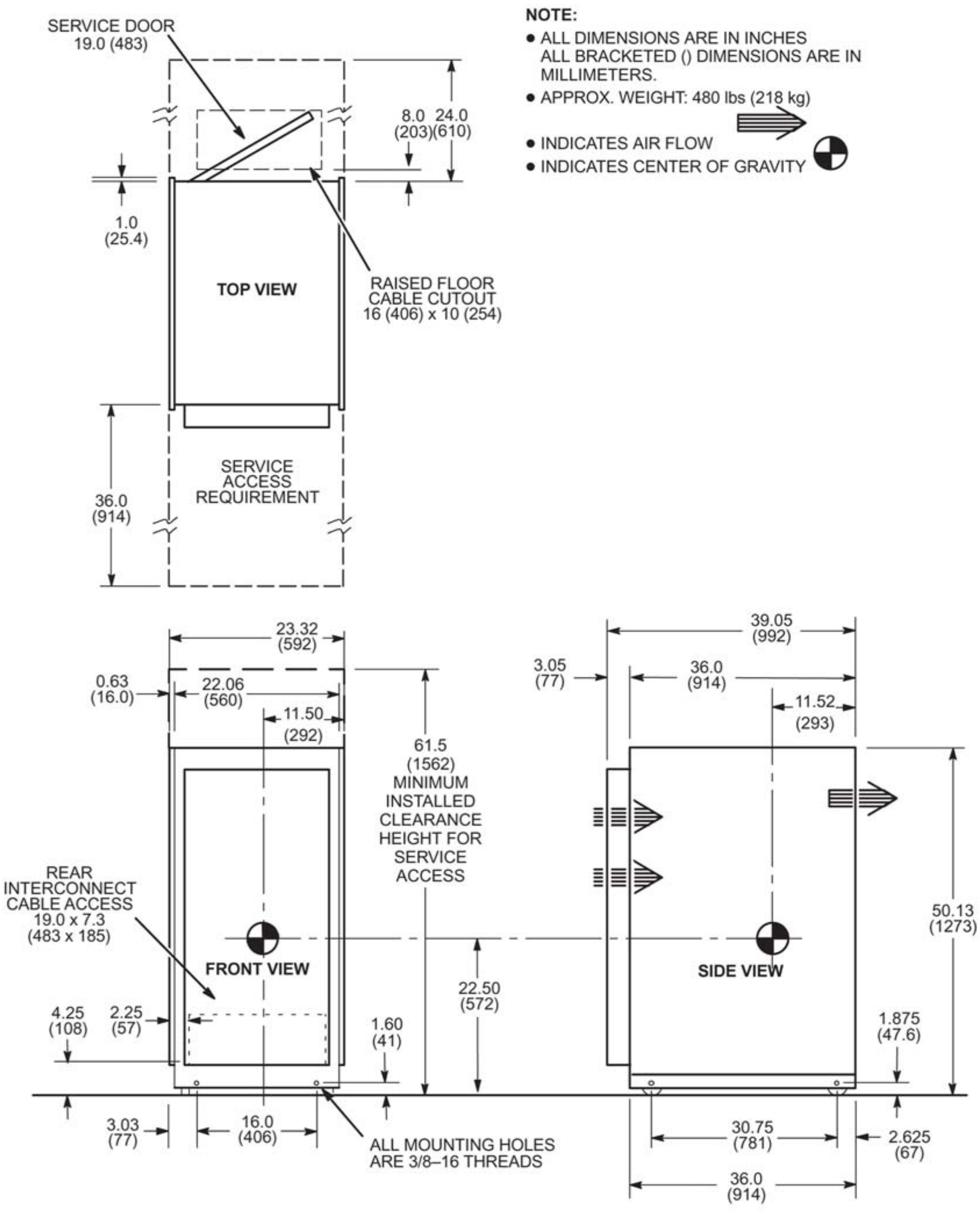
12.12 Broadband RF Amplifier Cabinet For 8KW MNS Option

Illustration 3-21: Broadband (BB) RF Amplifier Cabinet (MR9) - 8KW MNS Option



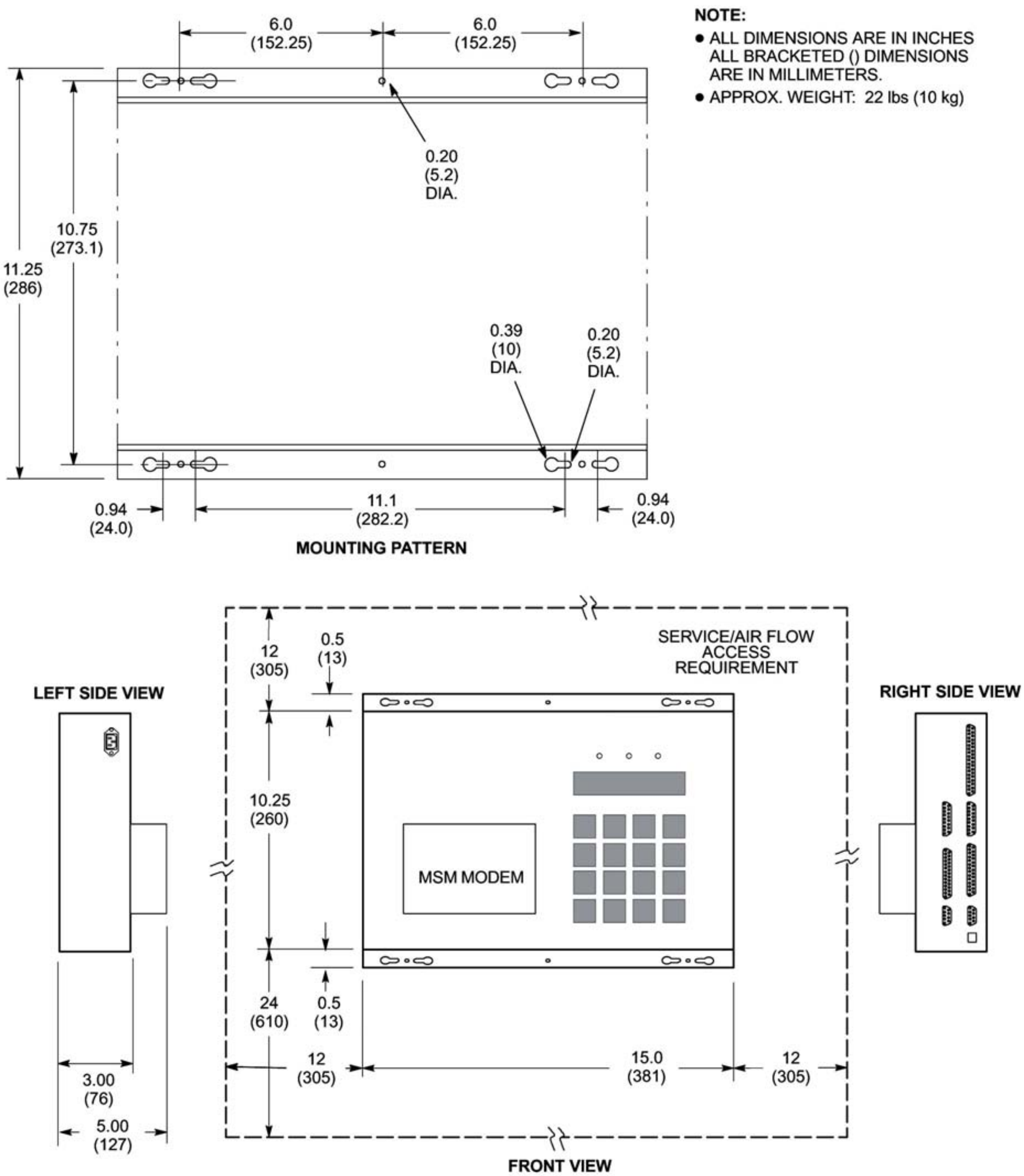
12.13 Twin Accessory Cabinet (TAC)

Illustration 3-22: 3T Twin Accessory Cabinet (TAC)



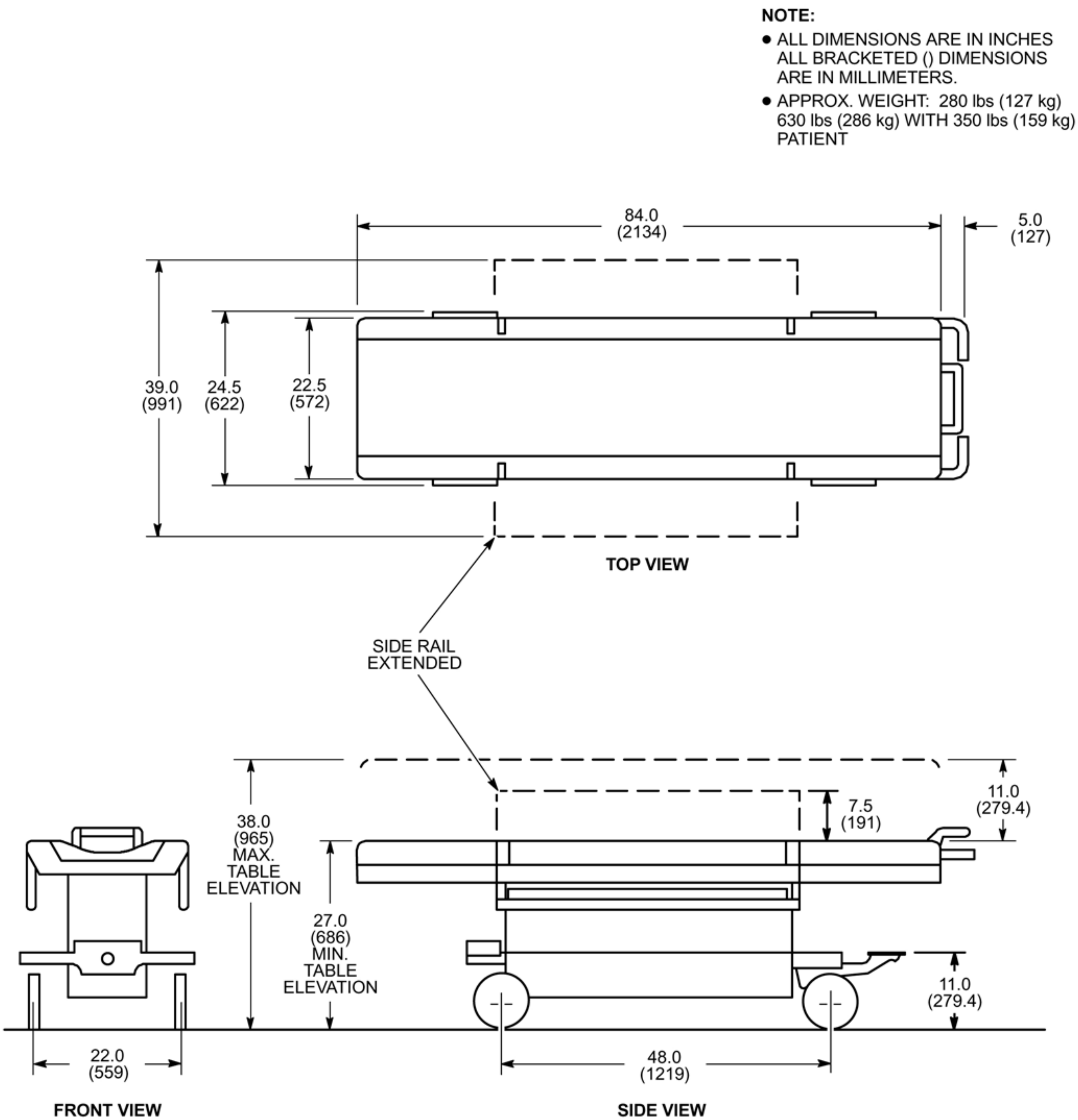
12.14 Magnet Monitor

Illustration 3-23: Magnet Monitor (MSM1)



12.15 Patient Transport Table

Illustration 3-24: Patient Transport Table



12.16 Penetration Panel

Table 3-24: Penetration Panel List of Illustrations

Illustration Name	Illustration Number
Penetration Panel (PP1)	Illustration 3-25
Penetration Panel Cover	Illustration 3-26

Illustration 3-25: Penetration Panel (PP1)

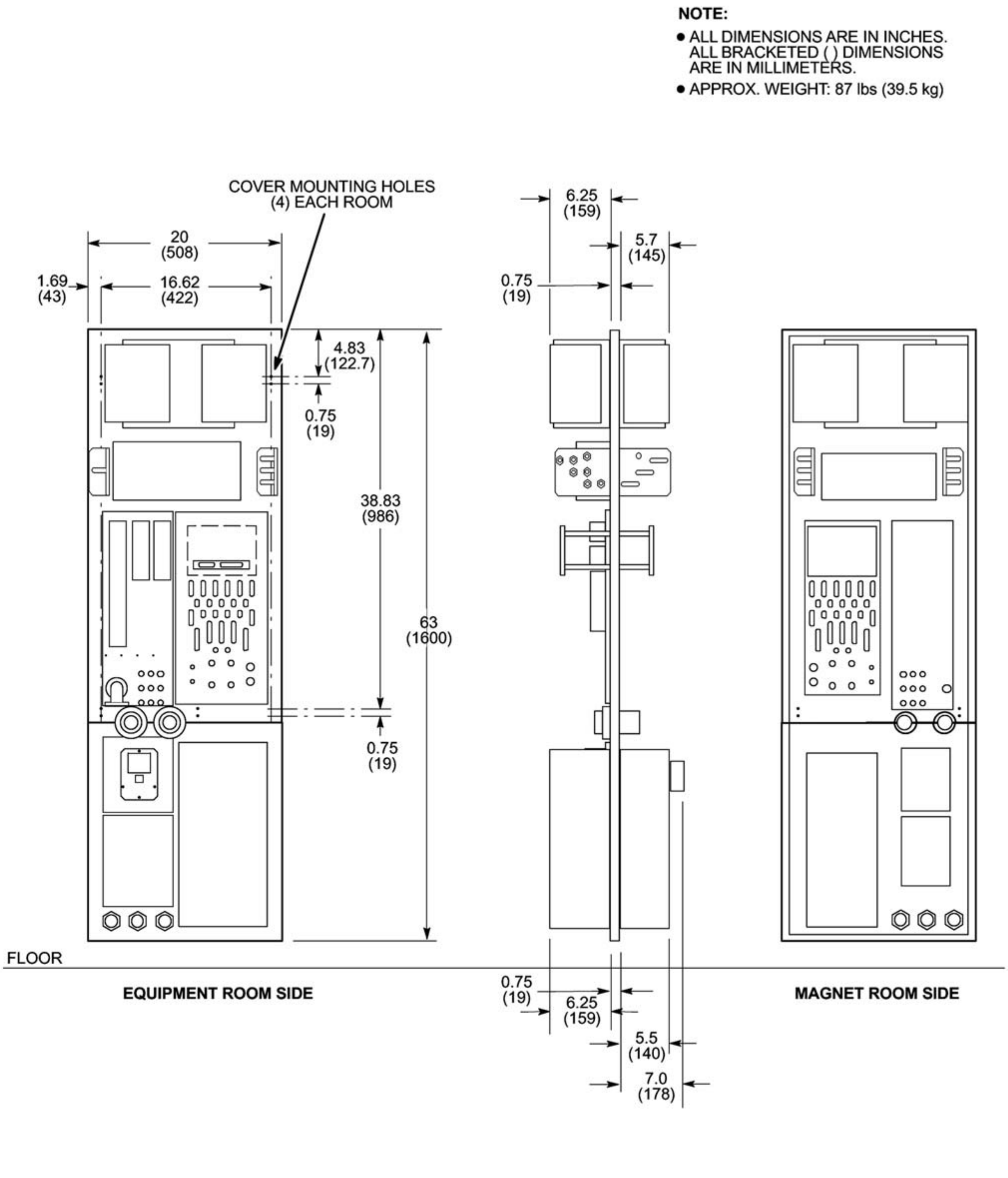
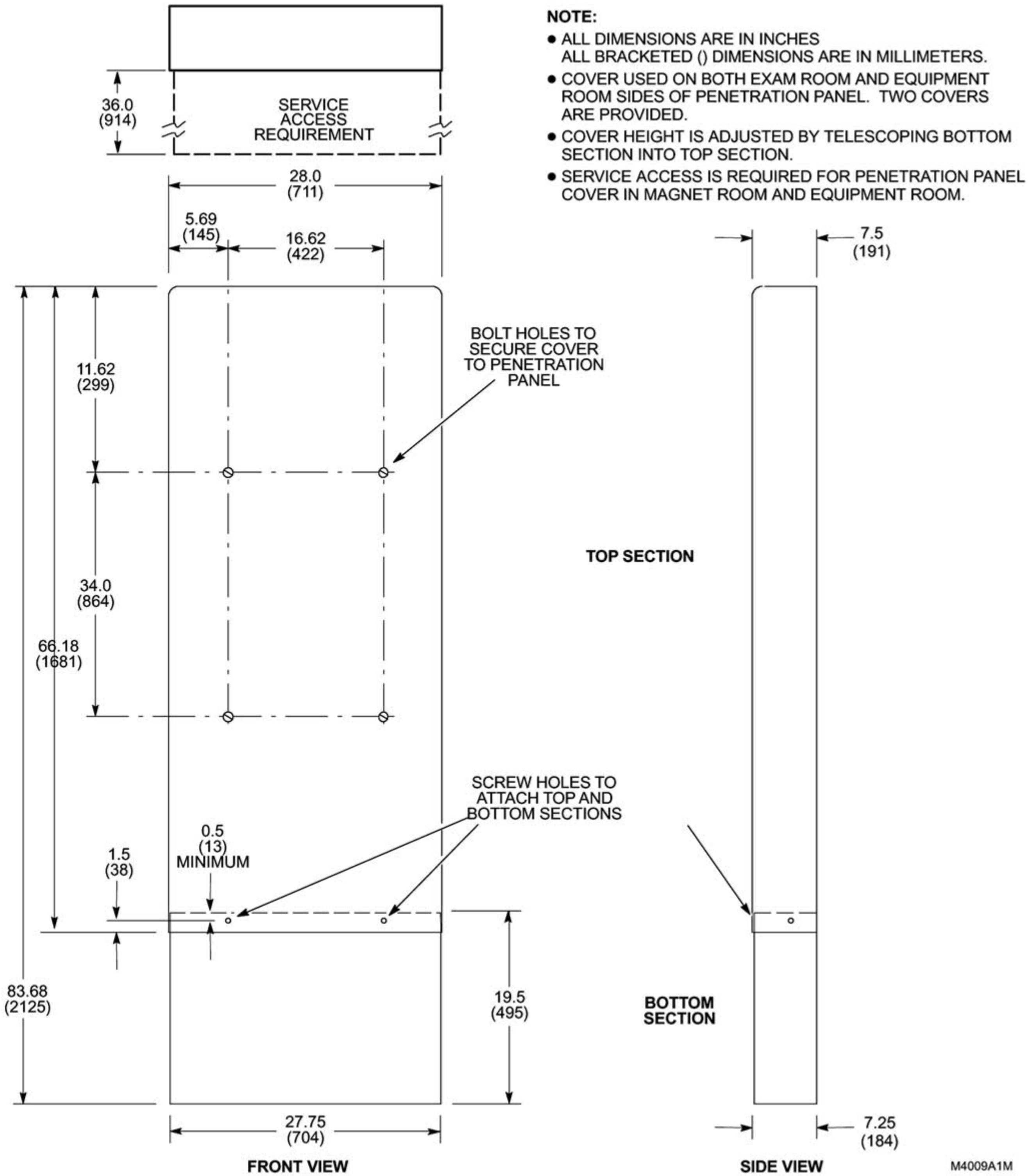


Illustration 3-26: Penetration Panel Cover



12.17 Operator Workspace

Table 3-25: Operator Workspace List of Illustrations

Illustration Name	Illustration Number
Operator Workspace (OW1) Overall Dimensions	Illustration 3-27
GOC Computer Cabinet (OW1 A2)	Illustration 3-28
Operator Workspace Components Position on Table Top - Host LCD	Illustration 3-29
Operator Workspace Components Position on Table Top - SCSI Tower and 15 Inch LCD	Illustration 3-30
Operator Workspace Components Position on Table Top - Keyboard	Illustration 3-31

Illustration 3-27: Operator Workspace (OW1) Overall Dimensions

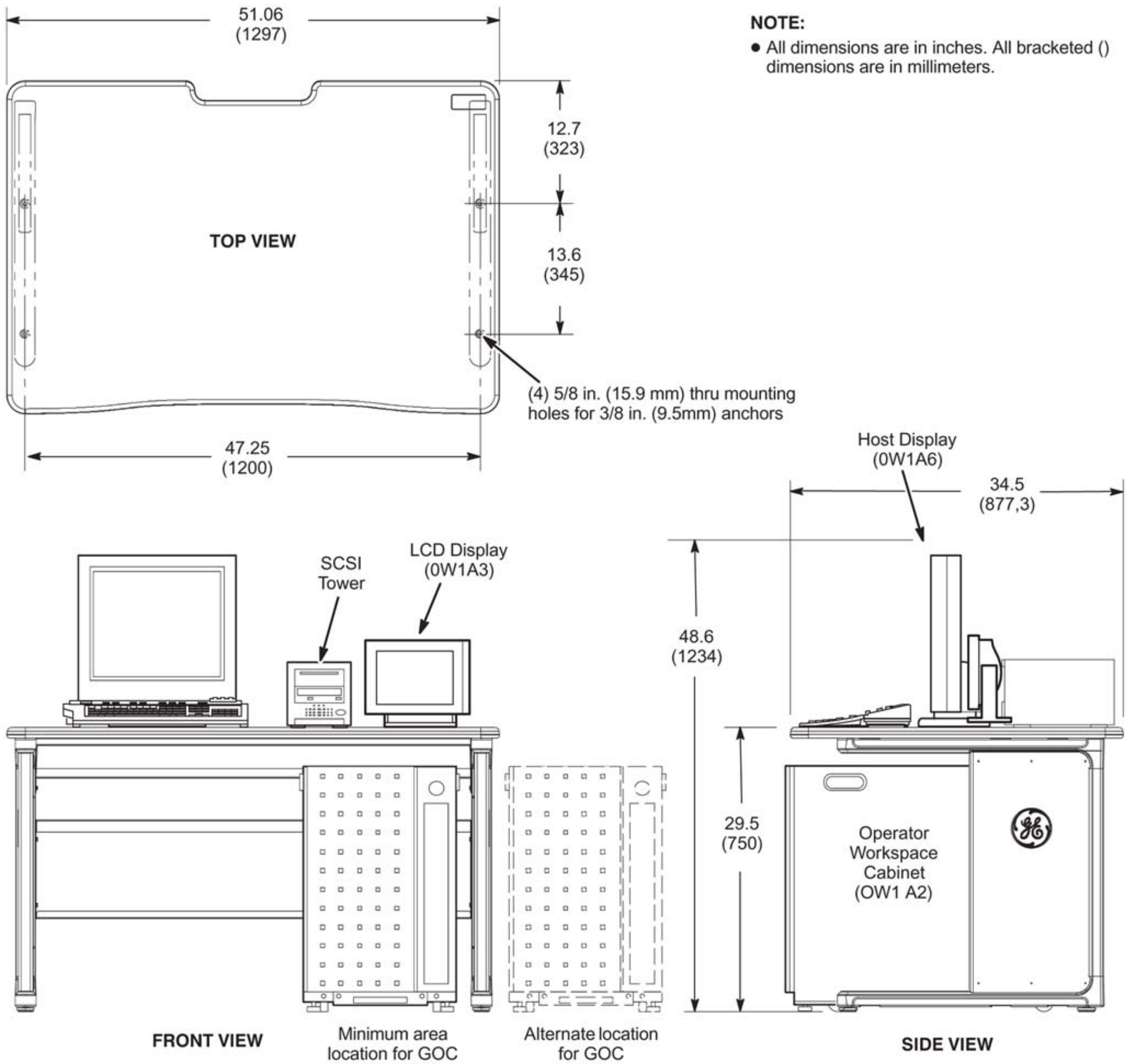


Illustration 3-28: GOC Computer Cabinet (OW1 A2)

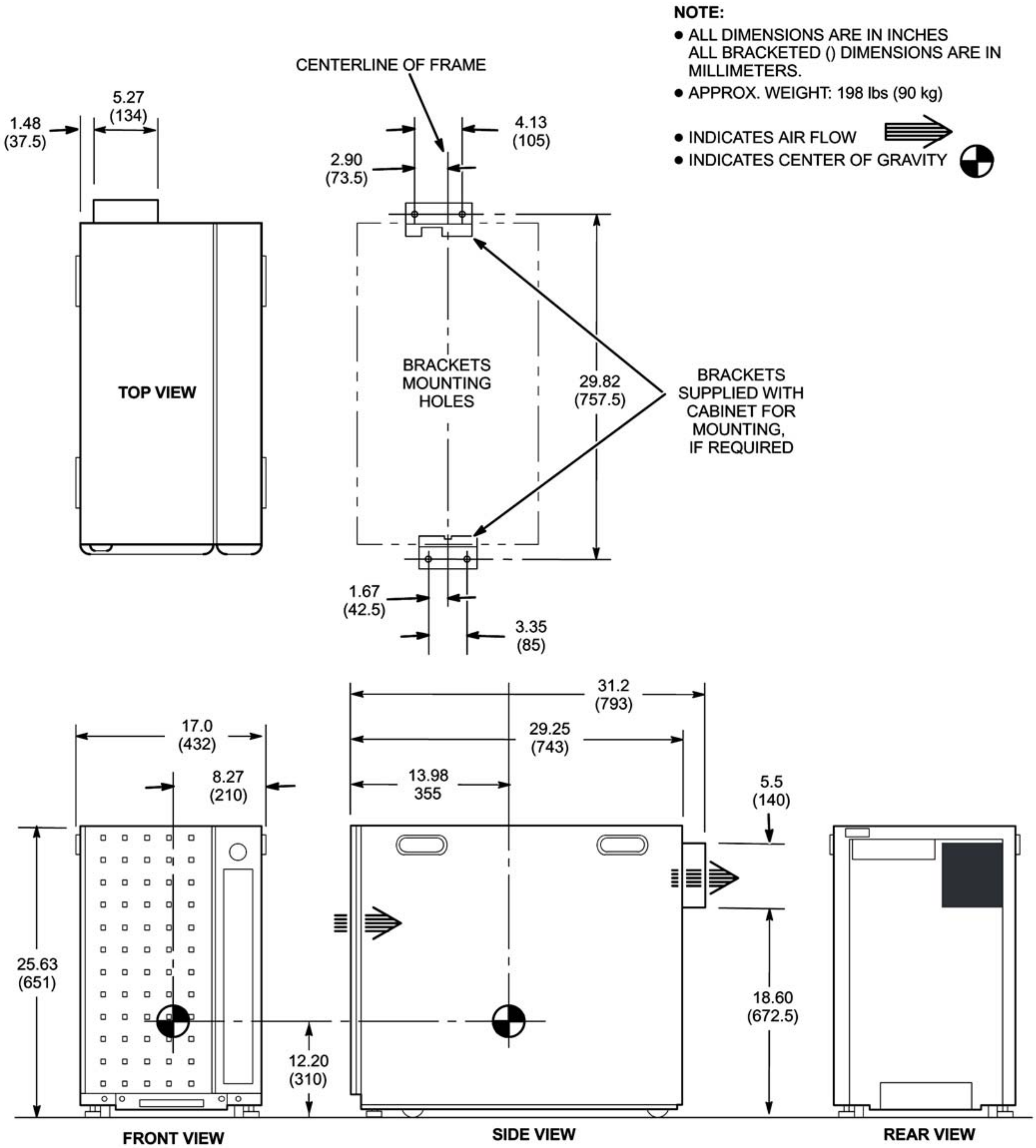
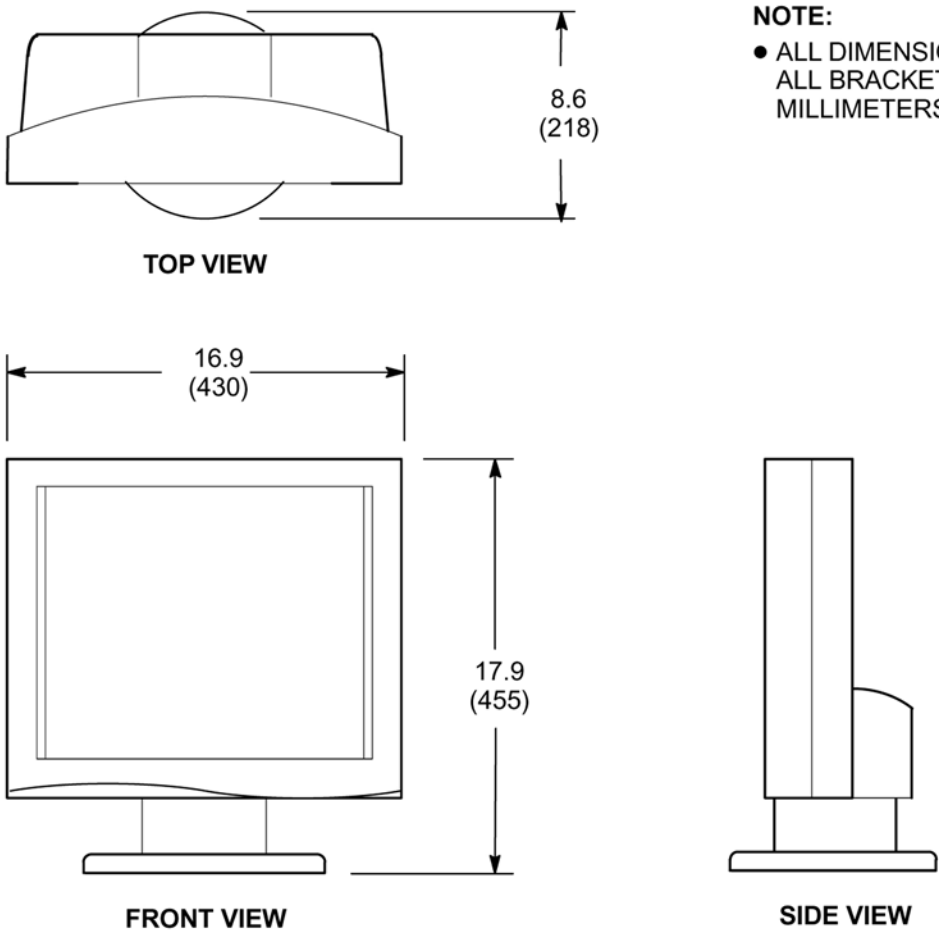


Illustration 3-29: Operator Worspace Components Position on Table Top - Host LCD



NOTE:

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

Illustration 3-30: Operator Workspace Components Position on Table Top - SCSI Tower and 15 Inch LCD

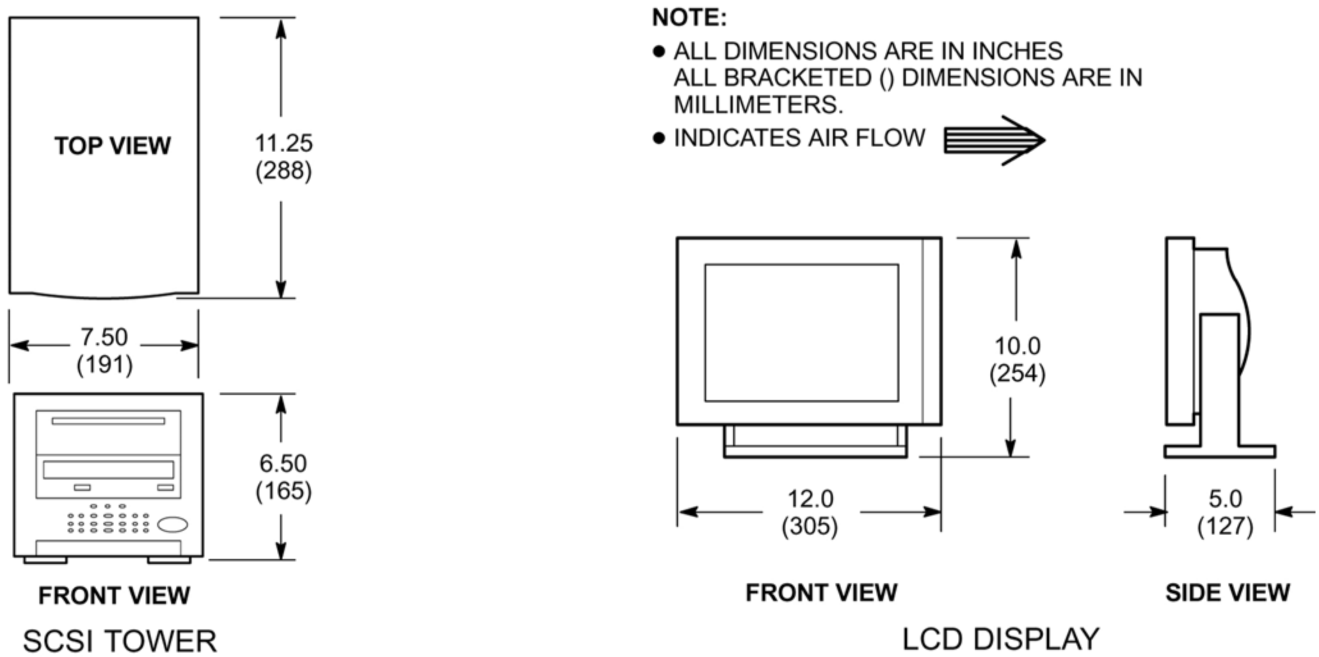
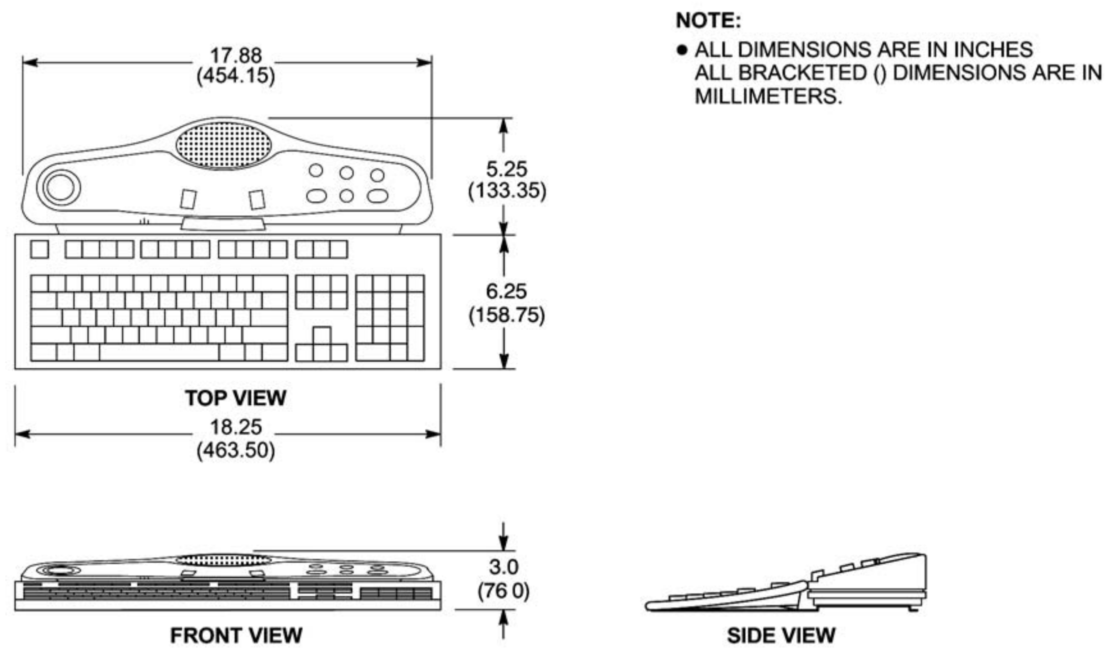
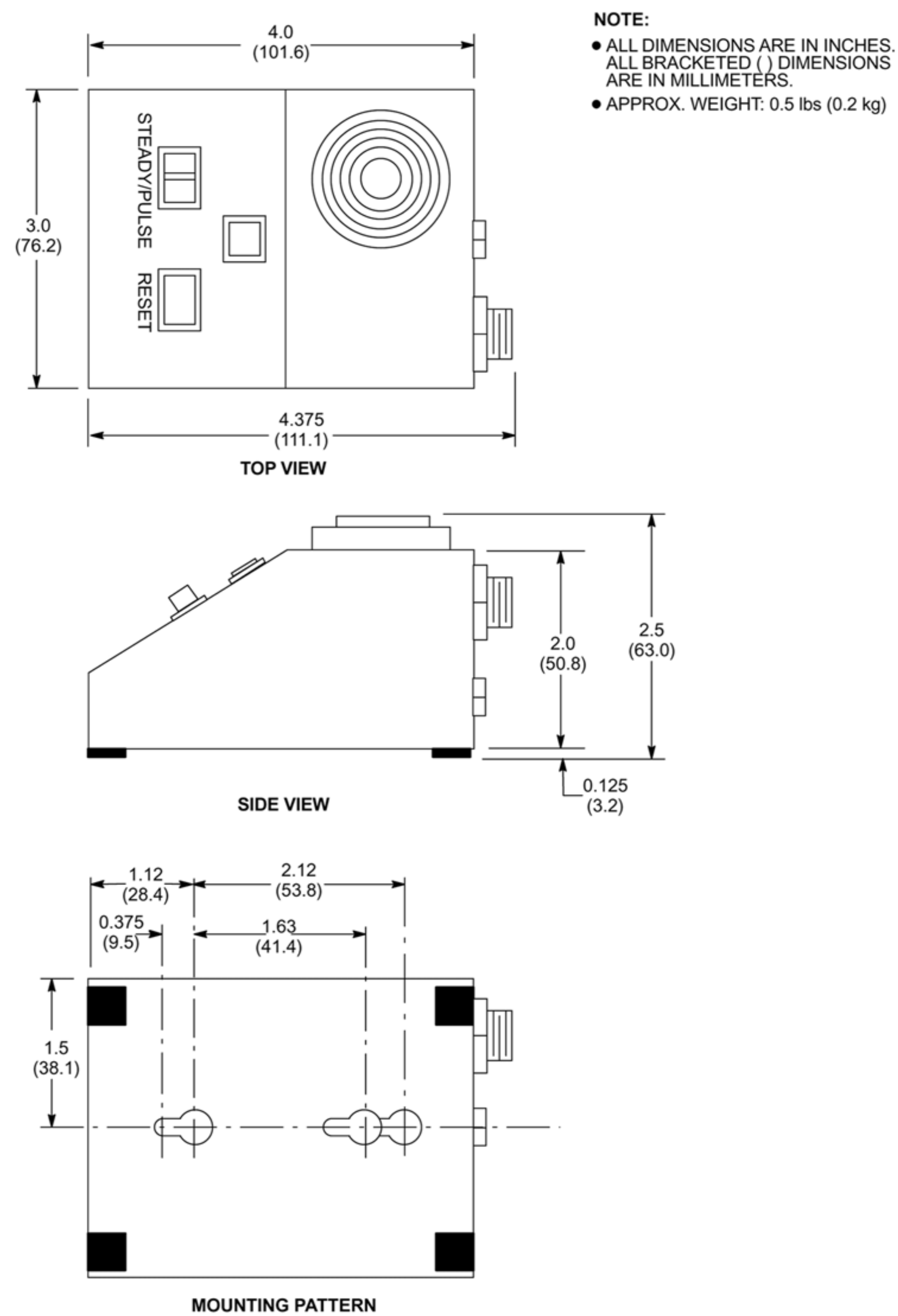


Illustration 3-31: Operator Worspace Components Position on Table Top - Keyboard



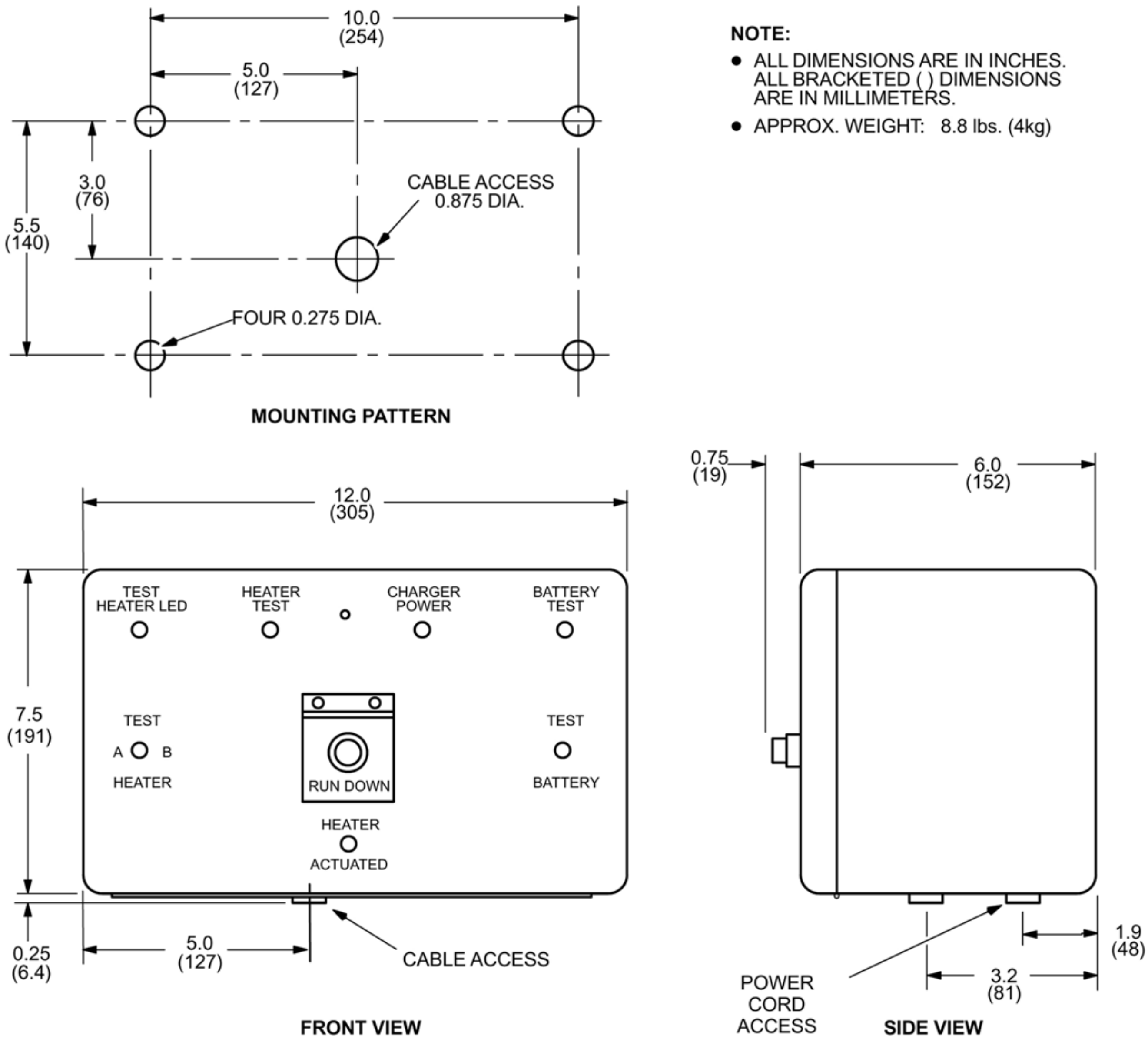
12.18 Pneumatic Patient Alert

Illustration 3-32: Pneumatic Patient Alert Control Box (PA1)



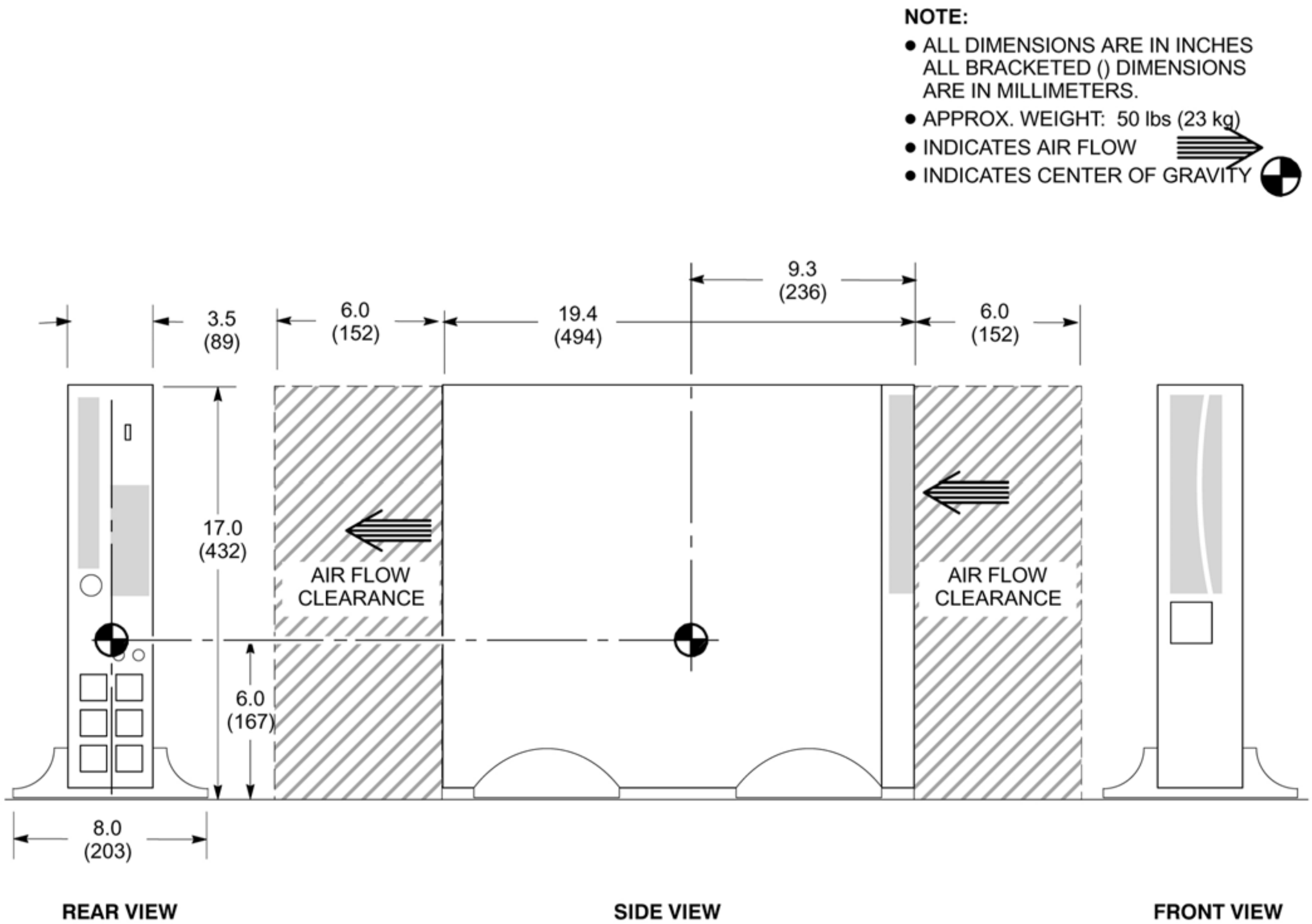
12.19 Magnet Rundown Unit

Illustration 3-33: Magnet Rundown Unit (MS4)



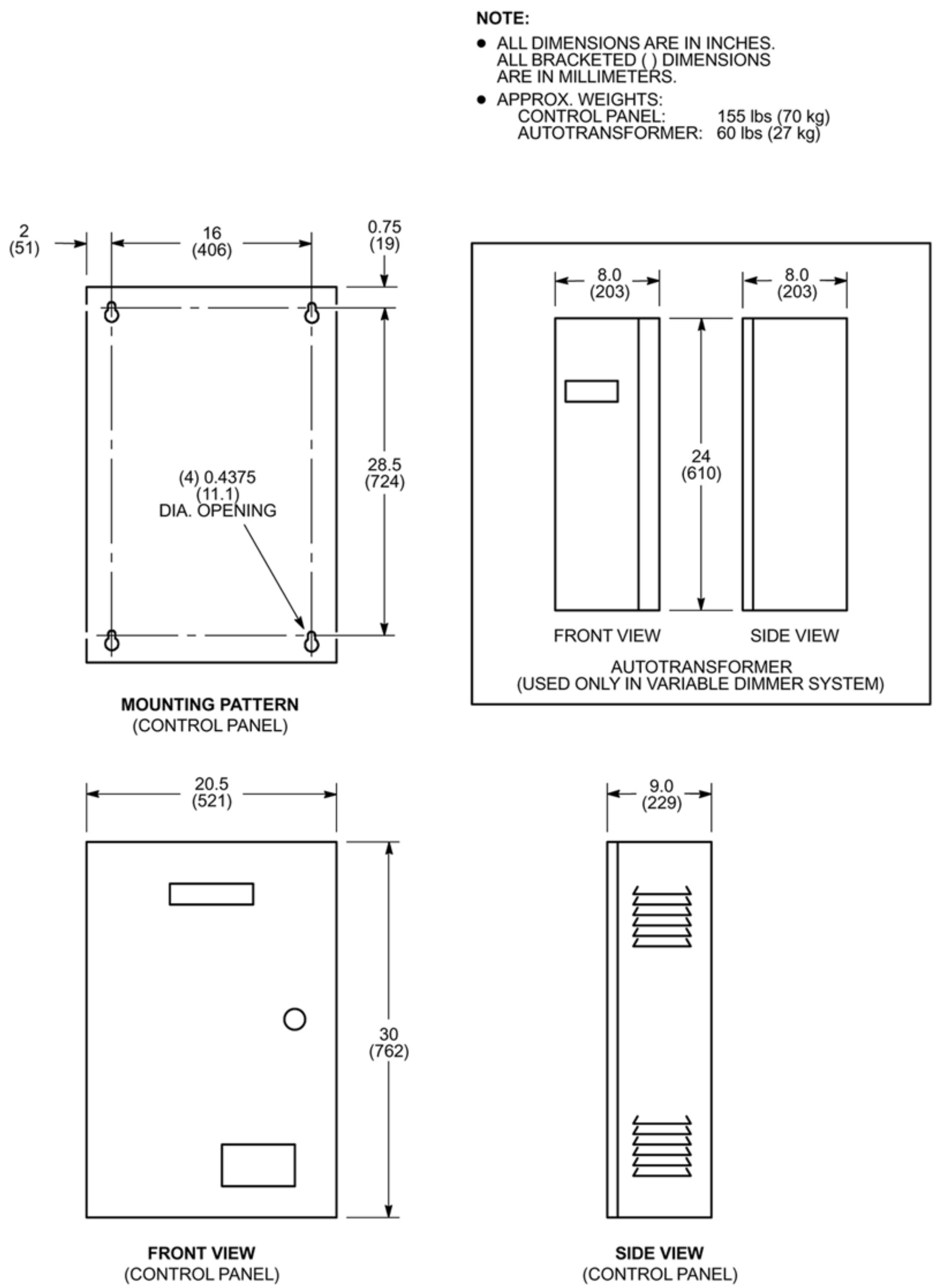
12.20 UPS For Magnet Monitor

Illustration 3-34: Optional UPS for Magnet Monitor



12.21 DC Lighting Controller Option

Illustration 3-35: DC Lighting Controller Option



12.22 Oxygen Monitor Option

Table 3-26: Oxygen Monitor Option List of Illustrations

Illustration Name	Illustration Number
Oxygen Monitor (OM1)	Illustration 3-36
Remote Oxygen Sensor Module (OM3)	Illustration 3-37

Illustration 3-36: Oxygen Monitor (OM1)

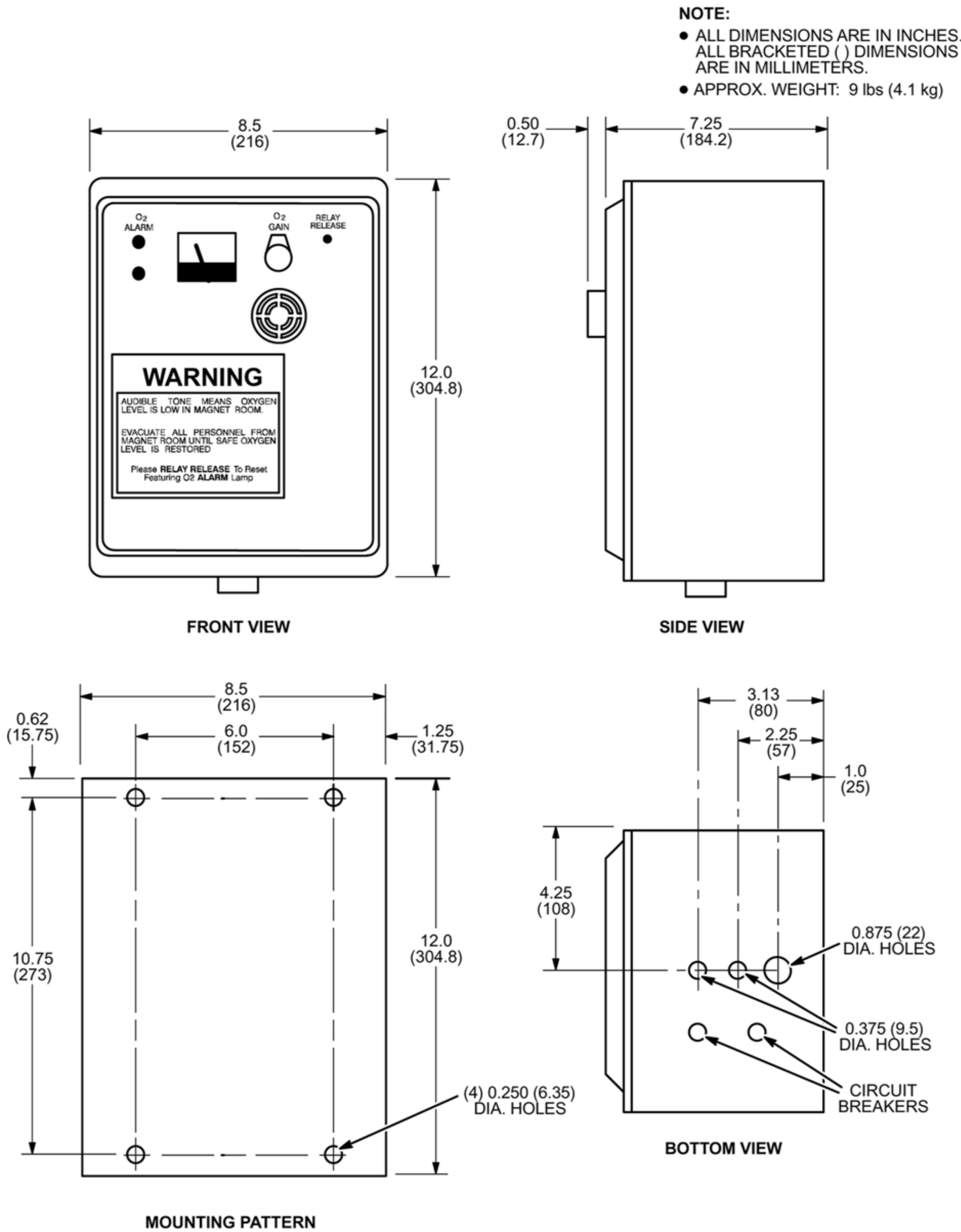
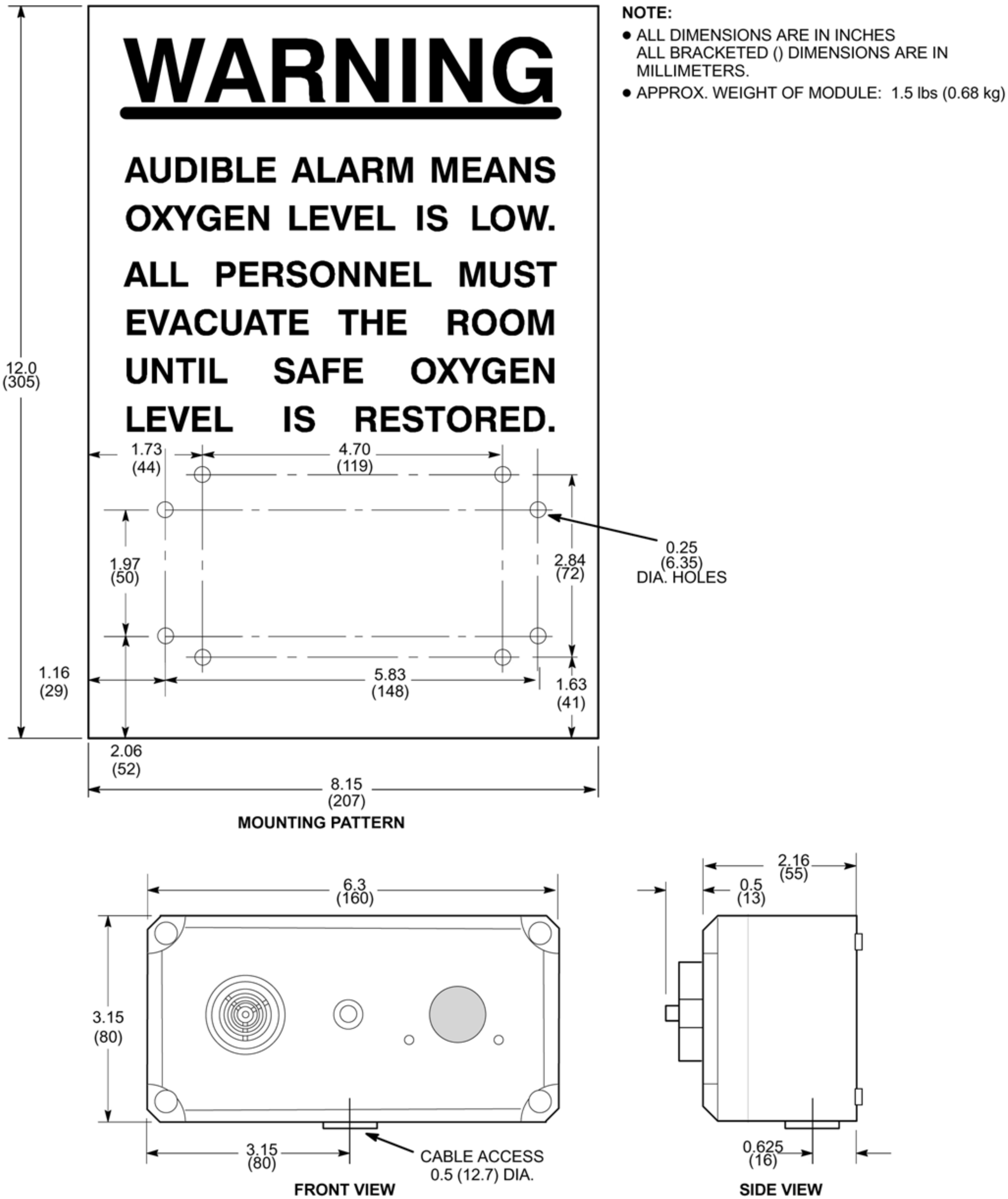
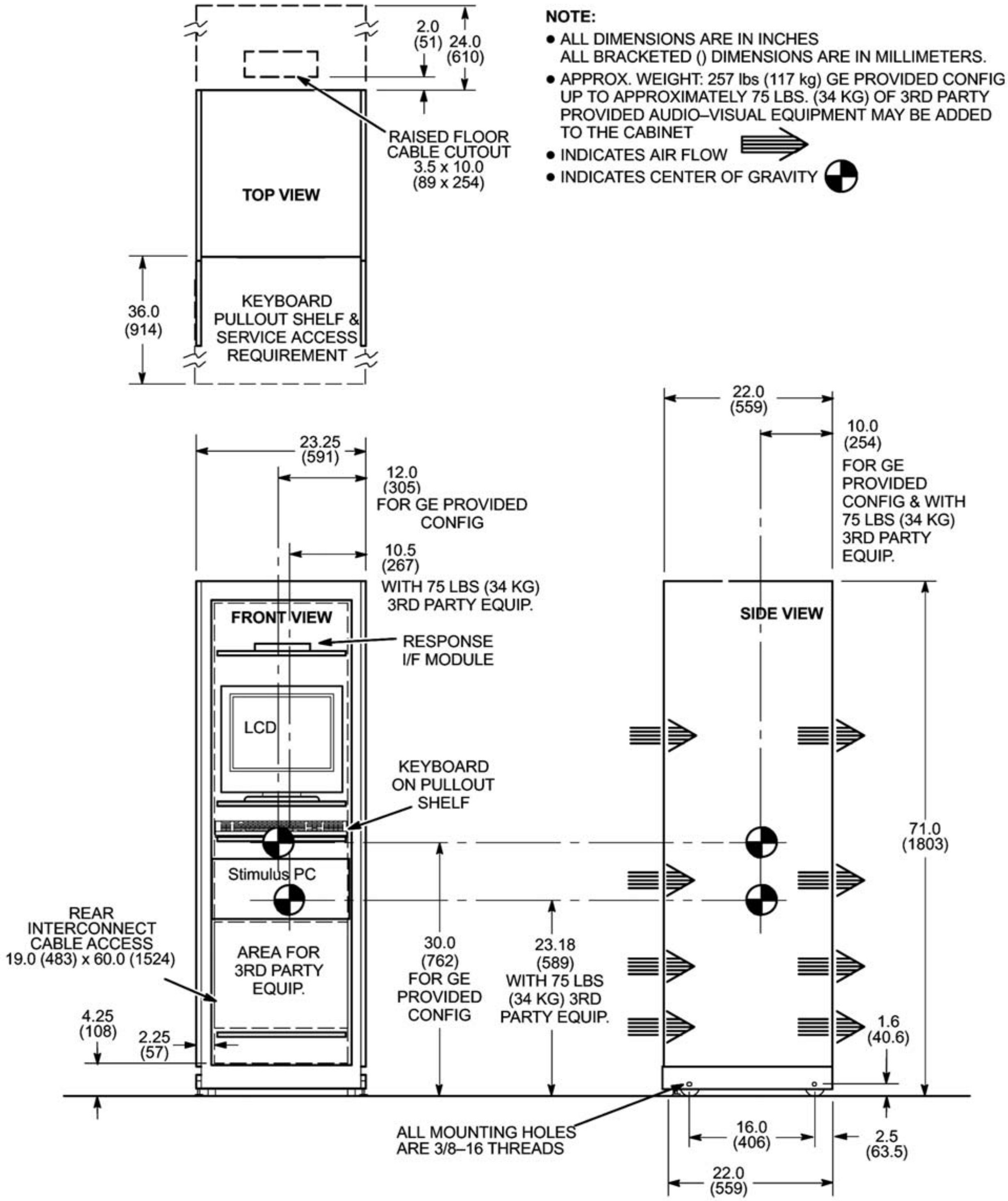


Illustration 3-37: Remote Oxygen Sensor Module (OM3)



12.23 BrainWave HW Lite Cabinet Option

Illustration 3-38: Brainwave HW Lite Cabinet



12.24 IPCM Option

Table 3-27: Integrated Patient Comfort Module (IPCM) Equipment List of Dimension Illustrations

Illustration Name	Illustration Number
Chilled Air Blower (CAB)	Illustration 3-39
Chilled Air Blower - Main Disconnect Panel (CAB-MDP)	Illustration 3-40

Illustration 3-39: Chilled Air Blower (CAB)

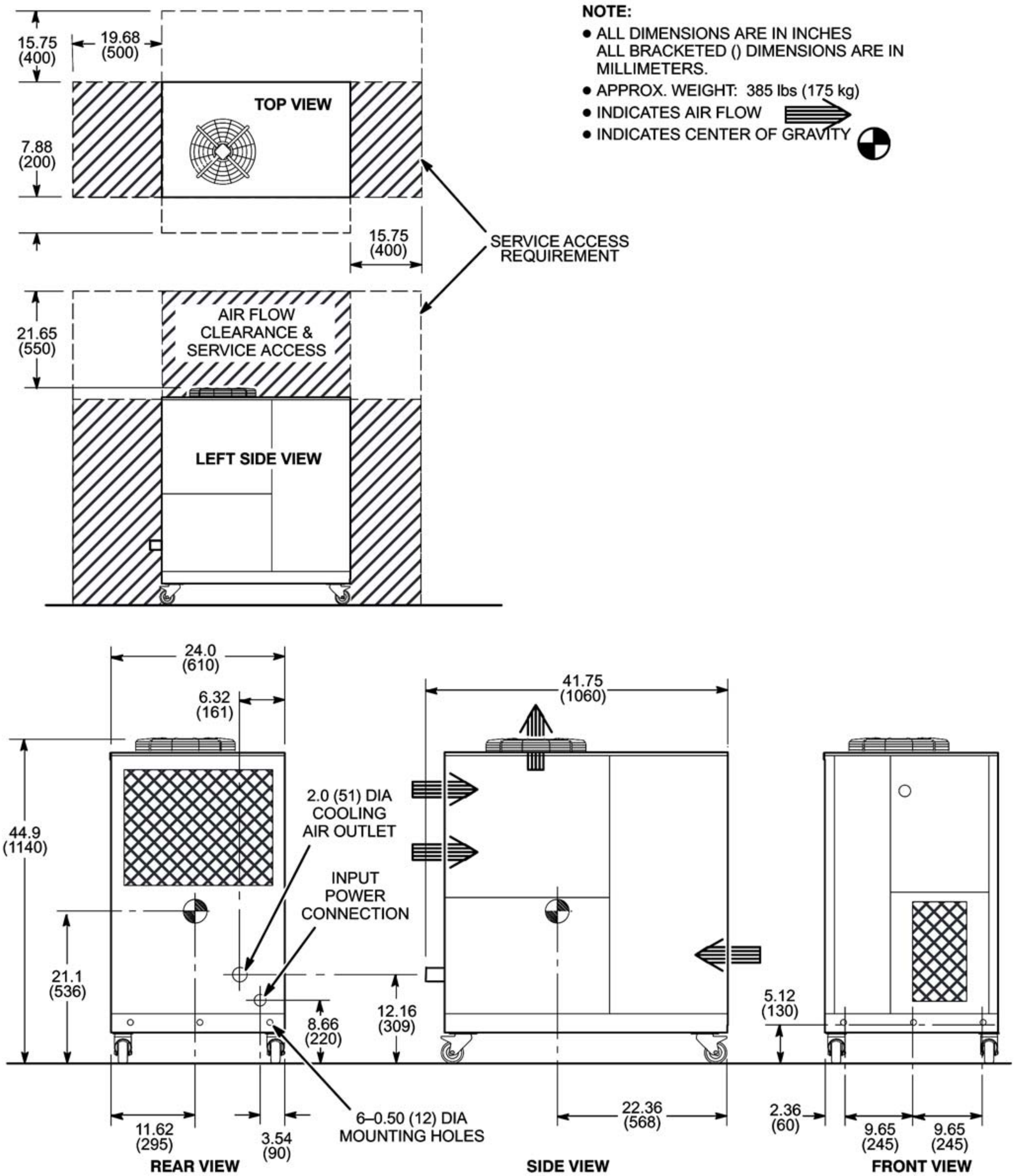
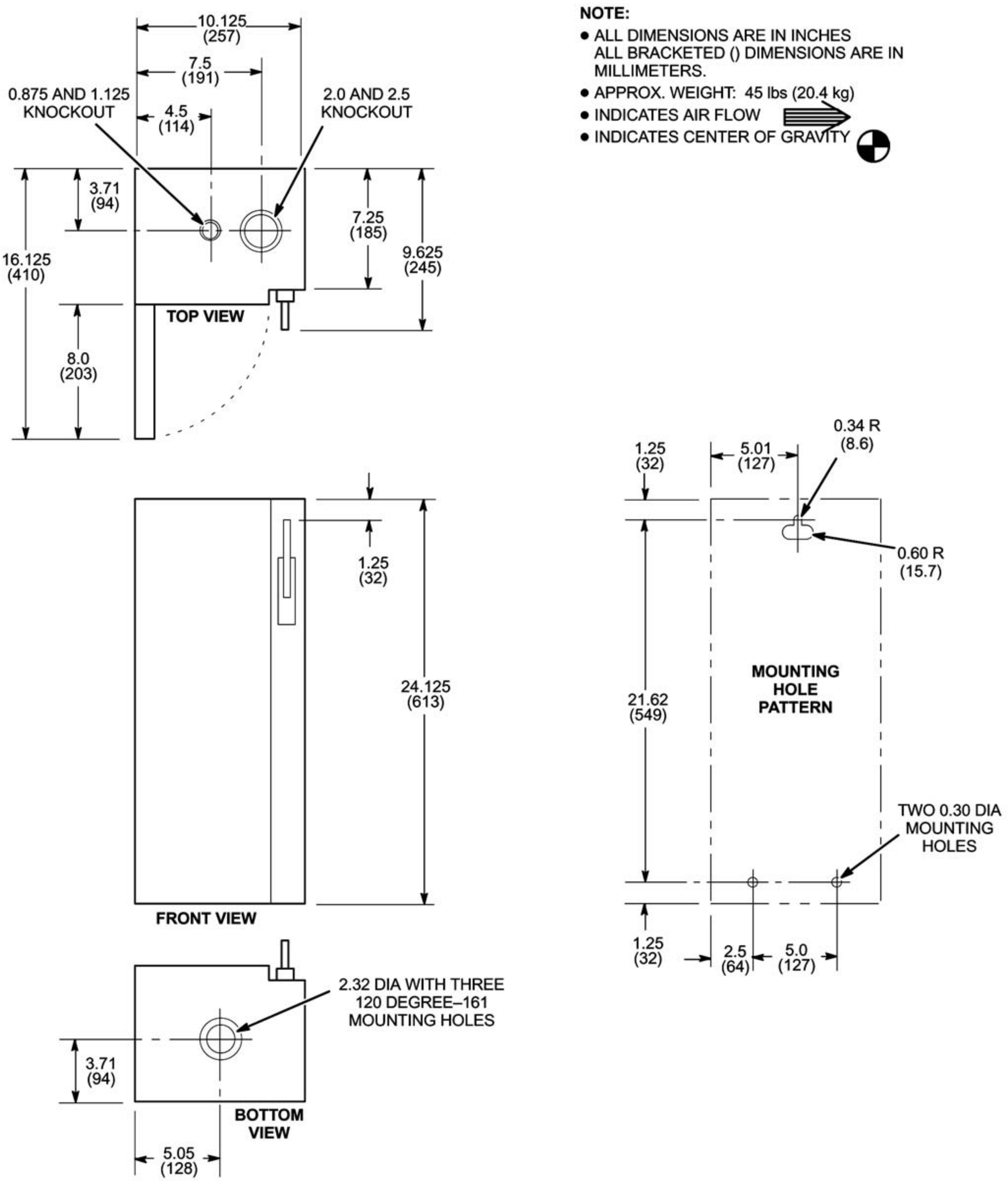


Illustration 3-40: Chilled Air Blower-Main Disconnect Panel (CAB-MDP)



Chapter 4 Magnetic Field Consideration

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 causes perturbations in the magnetic field within the imaging region of the magnet. Excessive steel will degrade the homogeneity of the magnet and thus system performance, refer to Chapter 5, Section 15, Magnet Room Floors Magnetic Properties under Construction Materials in Site Environment chapter. An evaluation of the effects of structural steel on the magnet is required in some instances.

The customer must provide information indicating mass and location of all iron and steel within an 9.84 feet (3 meter) radius of the LCC300 Magnet isocenter. This 9.84 foot (3 meter) radius is shown as the shaded region in the isogauss line plot illustrations in Section 5, Magnetic Field. 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 Section 5, Floors then one of the following actions must be taken:

- Choose an alternate site.
- Redesign steel structure.
- Request a steel analysis by the GE Healthcare MR Siting & Shielding group to determine if there are options to address the 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. Refer to Section 5, Magnetic Field for the fringe field plots for 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

5.1 Fringe Field

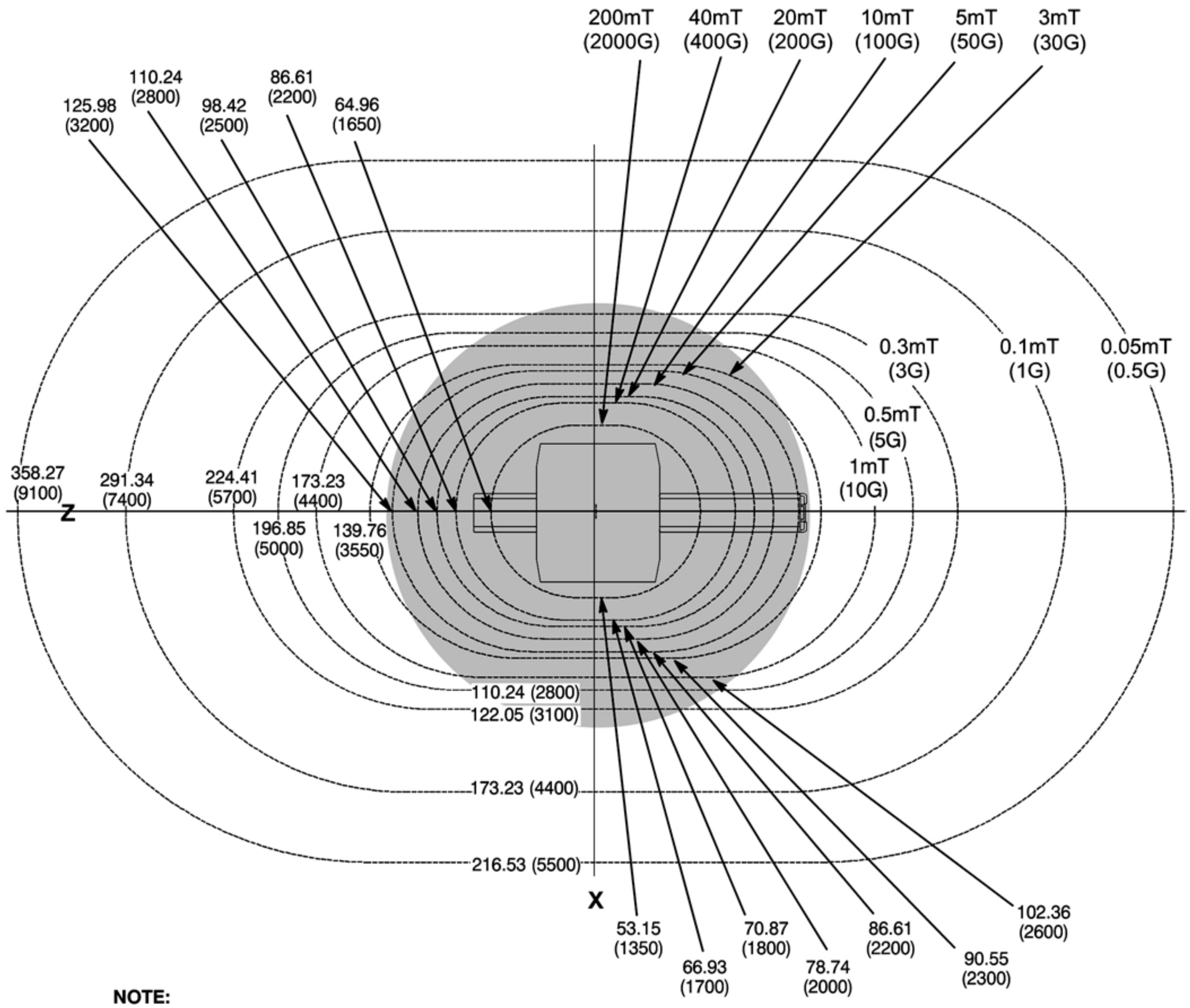
Illustration 4-1 , Illustration 4-2 , and Illustration 4-3 are the fringe field plots for the LCC300 Magnet. These plots illustrate the three-dimensional area of magnetic field without the influence of any nearby ferrous objects or the earth's ambient magnetic field. Actual magnetic field intensity at 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.

NOTE: The magnetic attractive force of a 3T magnet is significantly greater than a 1.5T magnet.

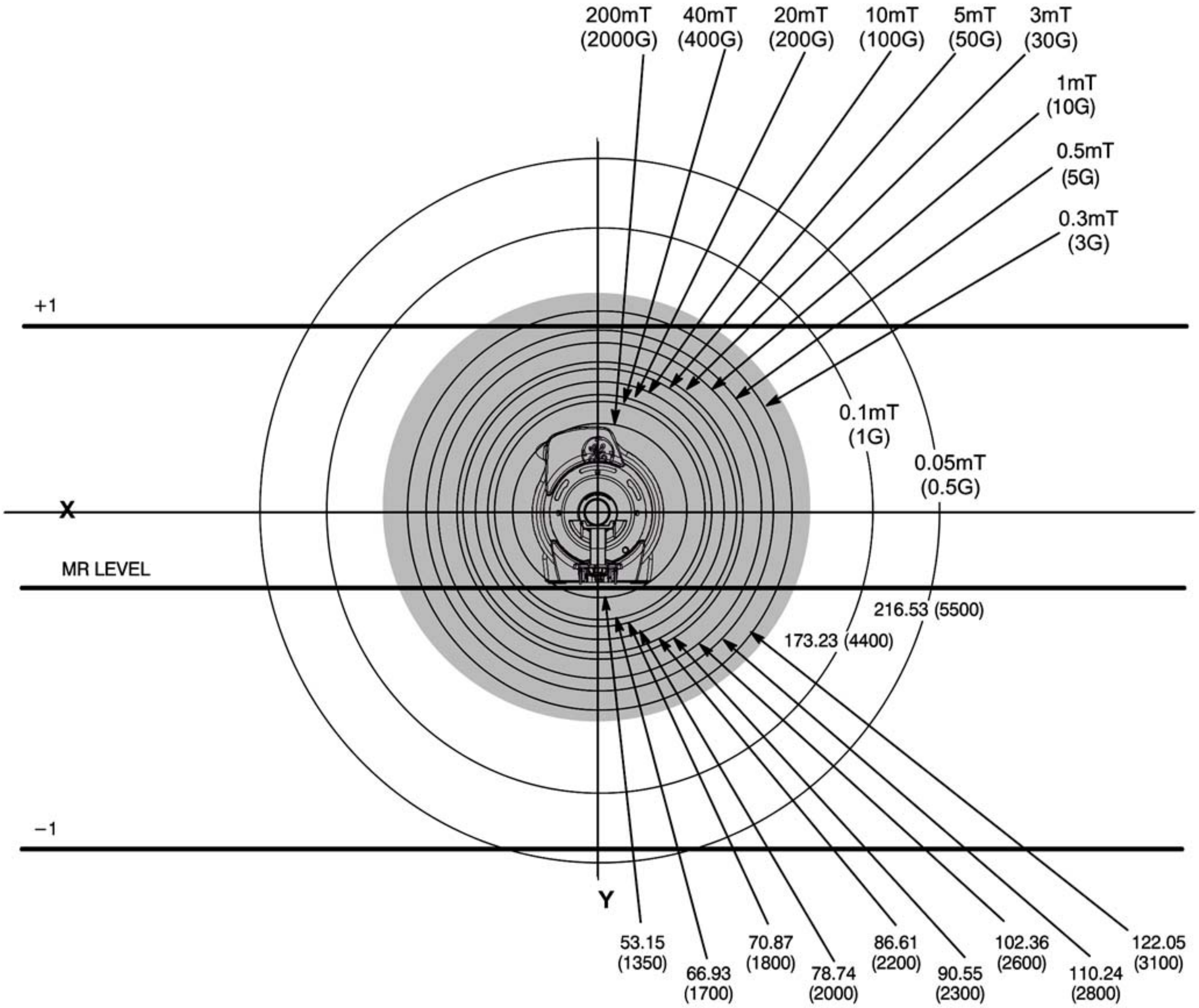
Illustration 4-1: 3.0 Tesla LCC300 Magnetic Isogauss Line Plot - Top View



NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- 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 24.61 ft (7.5 m) AXIALLY AND 19.68 ft (6.0 m) RADIALLY FOR 100 SECONDS OR LESS.

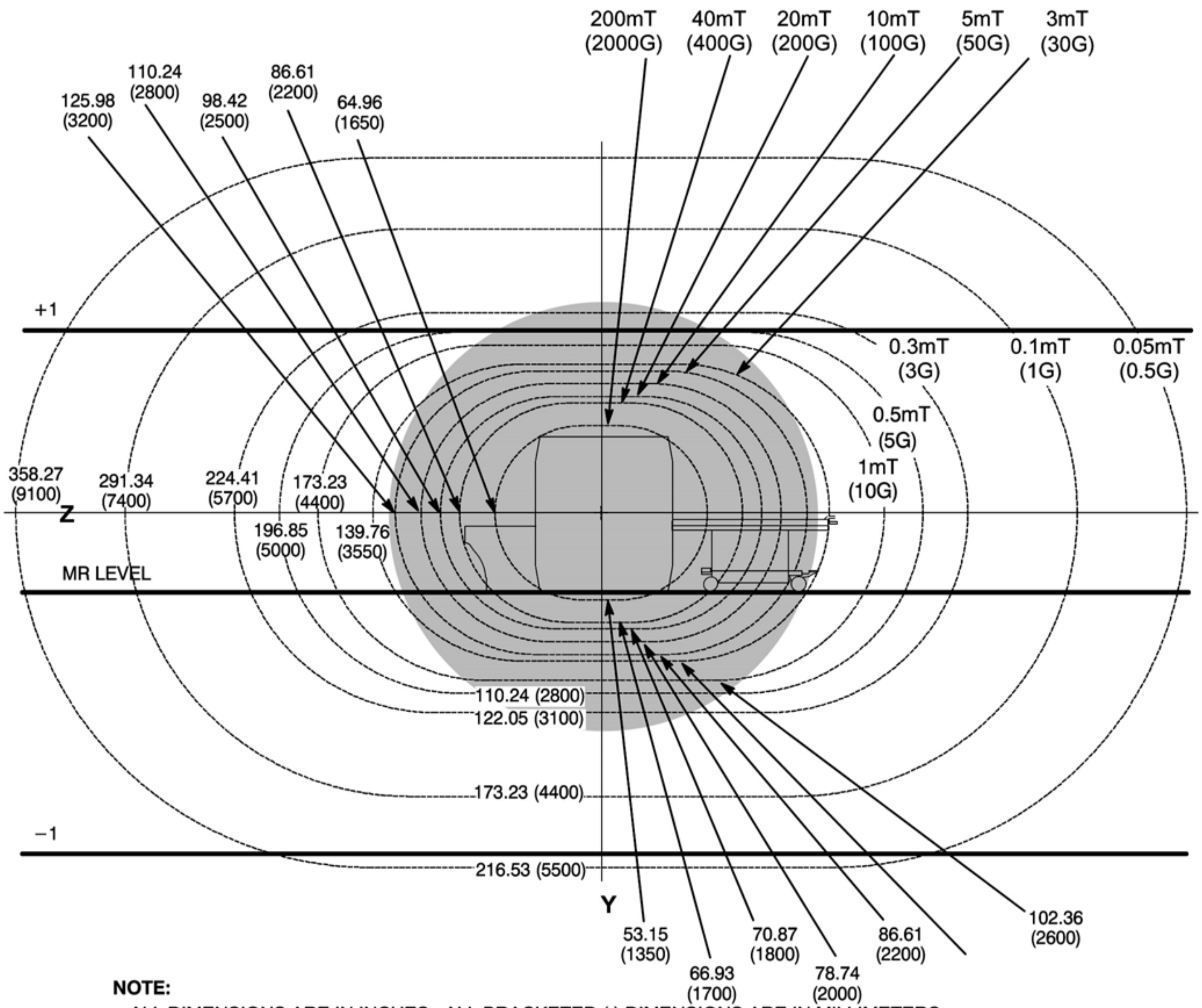
Illustration 4-2: 3.0 Tesla LCC300 Magnetic Isogauss Line Plot - Front View



NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- 12 ft (3.66 m) BETWEEN FLOORS.
- 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 19.68 ft (6.0 m) RADIALLY FOR 100 SECONDS OR LESS.

Illustration 4-3: 3.0 Tesla LCC300 Magnetic Isogauss Line Plot - Side View



NOTE:

- ALL DIMENSIONS ARE IN INCHES. ALL BRACKETED ( ) DIMENSIONS ARE IN MILLIMETERS.
- 12 ft (3.66 m) BETWEEN FLOORS.
- 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 24.61 ft (7.5 m) AXIALLY AND 19.68 ft (6.0 m) RADIALLY FOR 100 SECONDS OR LESS.

5.2 Decay Characteristics

A magnet quench or Magnet Rundown Unit (MRU) initiated quench will require 100 seconds for the field strength in the center of the LCC300 Magnet to fall below 20 mT.

6 Exclusion Zone

The 5 gauss exclusion zone for cardiac pacemakers, neurostimulators, and other biostimulation devices is shown in isogauss line plot illustrations in Section 5, Magnetic Field for LCC300 Magnet. 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.

NOTICE

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 magnetic field transient resulting in the magnetic field expanding for 100 seconds or less. The 5 gauss (0.5mT) exclusion zone field expansion is noted in the isogauss line plot illustrations in Section 5, Magnetic Field for LCC300 Magnet.

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.

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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 MR system 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. Table 5-1 , Table 5-2 , and Table 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.			
Emisions Test	**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. Near by 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. Near by 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	

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.			
Immunity test	**IEC 60601 test level**	**Compliance Level**	**Electromagnetic environment – guidance**
Electrostatic discharge (ESD) 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 Plane 2, 4, 6, 8kVolts	
Electrical fast transient / burst IEC 61000-4-4	±2 kV for power supply 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	
Surge 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	
Power Frequency (50/60Hz) magnetic field IEC 61000-4-8	3 A/m	4.5A/m at 50 Hz. and 60 Hz.	
Voltage dips, short interruptions and voltage variations on power supply input lines 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.

Table 5-2: Guidance And Manufacturer’s Declaration – Electromagnetic Immunity (cont'd)

<table>
<tr><th colspan="4">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.</th></tr>
<tr><th>Immunity test</th><th>IEC 60601 test level</th><th>Compliance Level</th><th>Electromagnetic environment – guidance</th></tr>
<tr><td>Conducted RF IEC 61000-4-6</td><td>V1 = 3 Vrms 150 kHz to 80 MHz</td><td>0.15-80 MHz @5 VRMS with AM 80% @ 1kHz 1% Frequency steps</td><td rowspan="2">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.

Recommended separation distance

$d = [\frac{3,5}{V_1}]\sqrt{P}$ 150 kHz to 80 MHz

$d = [\frac{3,5}{E_1}]\sqrt{P}$ 80 MHz to 800 MHz

$d = [\frac{7}{E_1}]\sqrt{P}$ 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 frequency range.[b]

Interference may occur in the vicinity of equipmentmarked with

the following symbol:</td></tr>
<tr><td>Radiated RF IEC 61000-4-3</td><td>E1 = 3 V/m 80 MHz to 2,5 GHz</td><td>80-2500 MHz, 5 V/m with AM 80% @ 1kHz or 2 Hz</td></tr>
<tr><td colspan="4">NOTE 1 At 80 MHz and 800 MHz, the higher frequency range applies.

NOTE 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.</td></tr>
</table>

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)	$d=[\frac{3,5}{V_1}]\sqrt{P}$ 150 kHz to 80 MHz	$d=[\frac{3,5}{E_1}]\sqrt{P}$ 80 MHz to 800 MHz	$d=[\frac{7}{E_1}]\sqrt{P}$ 800 MHz to 2,5 GHz
0.01	0.12 m	0.12m	0.23m
0.1	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. NOTE 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 HFA modules of the HFD/PDU Cabinet may occur.

Use the specifications listed in Table 5-4 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.

NOTE: 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 5-4: Temperature And Humidity Specifications

Area	Temperature		Humidity		Max. Room Gradient °F (°C)
	Range °F (°C)	Change °F/Hr (°C/Hr)	Range %	Change %/Hr	
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 Operating Environment

The 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

Table 5-5 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 (i.e. protocols used, patient load, etc.). Note any variations of equipment location for your site when calculating your cooling requirements for each room.

Table 5-5: 3T System with LCC300 Magnet Maximum Heat Output For Air Cooling *

MR Component	Magnet Room See Note 1 listed below		Equipment Room See Note 2 listed below		Operator/Control Room	
	BTU/hr	Watt	BTU/hr	Watt	BTU/hr	Watt
RF/Gradient Body Coil Assembly, Magnet Enclosure Equipment	8189	2400				
Patient Blower Box	1366	400				
Penetration Panel			324	95		
GE pre-engineered Main Disconnect Panel			900	264		
NB RF Amp Cabinet			21,336	6253		
3.0T RFS Cabinet			8640	2532		
HFD/PDU Cabinet			34,120	10,000		
Twin Accessory Cabinet			2354	690		
Magnet Monitor			205	60		
Operator Workspace with LCD Color Display (See Note 3)					4950	1450
Shield/Cryo Cooler Compressor			Heat dissipation to air neglible requires water cooling, See Note 4			
Water cooled GWHX** option for providing Gradient Coil water cooling (requires site provided cooling for Shield Cooler Compressor) (See Note 4)			1707	500		
MRCC** option for providing Gradient Coil water cooling (See Note 4)			57,320	16,800		
MRCC** option for providing Shield/Cryo Cooler Compressor water cooling (See Note 4)			52,550	15,400		
Magnet Monitor UPS ** & Modem **			450	132		
3T MNS Cabinet for 4KW MNS option **			5118	1500		
BB RF Amp Cabinet **			24,600	7205		
BrainWave HW Lite Cabinet ** (see Note 5)			2337	685		
DC Lighting Controller Panel **			1024	300		
DC Lighting Controller Autotransformer **			171	50		
Chilled Air Blower (CAB) for IPCM Option **			14,330	4200		

Table 5-5: 3T System with LCC300 Magnet Maximum Heat Output For Air Cooling * (cont'd)

MR Component	Magnet Room See Note 1 listed below		Equipment Room See Note 2 listed below		Operator/Control Room	
	BTU/hr	Watt	BTU/hr	Watt	BTU/hr	Watt
Not used						

Notes

* Maximum heat output is defined for temperature and humidity as defined in Section 3, Temperature and Humidity Specifications.

** Optional equipment

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. Operator Workspace equipment includes the following: LCD Color Monitor, GOC Computer Cabinet, Workspace Cabinet, Mouse and Mouse Pad, LCD Panel, and Keyboard.
4. The MR System requires water cooling for the Gradient Coil and the Shield/Cryo Cooler Compressor.
   - Gradient Coil water cooling must be supplied by cooling equipment (MRCC or GWHX) 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 second MRCC or by customer provided facility water cooling. MRCC can be located outdoor or indoor. Refer to Section 5.3, Shield/Cryo Cooler Requirements For Site Provided Water Cooling.
5. Addition of 3rd party provided audio-visual equipment to the BrainWave HW Lite Cabinet may increase cabinet heat maximum output to 2781 BTU/Hr (815 Watts).

4.1 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, Section 5, Magnetic Field 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 and Blower Box air intake for patient cooling.

4.2 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

5 Water Cooling

5.1 Gradient Coil Temporary Backup Water Cooling

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

NOTICE

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

5.2 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 the 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 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling.

NOTE: These water cooling specifications are the requirements at the water entry to the equipment. The backup cooling system design must have allowances for pressure/temperature changes due 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.

5.3 Shield/Cryo Cooler Requirements For Site Provided Water Cooling

NOTE: When the site plan is to have only 1 MRCC or have a GWHX to provide water cooling for the Gradient Coil ONLY then customer provided water cooling is required for the water cooled Shield/Cryo Cooler Compressor.

The Shield/Cryo Cooler Compressor customer provided water cooling system must be closed loop design. The 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 Table 5-6 and Table 5-7 for water cooling specifications.

NOTE: The Shield/Cryo Cooler Compressor requires customer supplied flexible hose for mating with water cooling. 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.

Table 5-6: 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.

Table 5-7: LCC Magnet Shield/Cryo Cooler Compressor Water Cooling Specifications

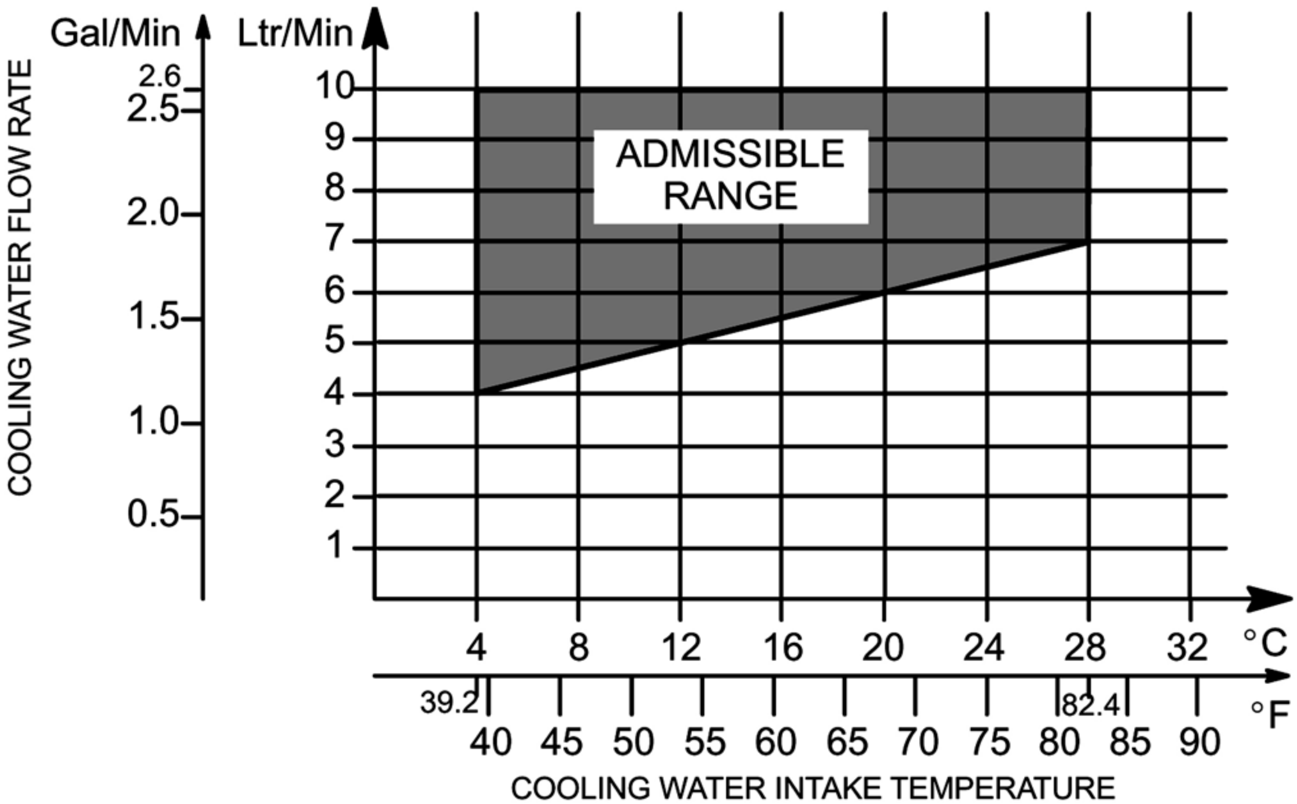
Equipment	Inlet Temperature Range $^{\circ}$F ($^{\circ}$C)	Inlet Pressure psi (KPa)	Recom-mended Flow Rate gal/min (liter/min) See Notes 3 & 4	Pressure Drop psi (bar) [KPa] See Note 1 & 7	Temperature Rise Δ°F (Δ°C) See Notes 1, 4, 6, & 8	Typical Heat Output BTU/hr (Watts) See Notes 6 & 8	Maximum Heat Output BTU/hr (Watts) See Notes 6 & 8
Shield/Cryo Cooler Compressor **	39.2 - 82.4 (4 - 28) See Note 9	Minimum 29 (200)	Minimum 1.1 (4) See Notes 2, 3 & 9	7.5 (0.5) [52] at minimum flow rate See Notes 2, 5 & 9	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 100 (690)	Maximum 2.6 (10) See Notes 2, 3 & 9	47 (3.2) [324] at maximum flow rate See Note 2, 5 & 9	at maximum flow rate 19.4 (10.8) for 60 Hz operation 15.7 (8.7) for 50 Hz operation		

Notes

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

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% 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. There is a risk of damaging the Shield/Cryo Cooler Compressor with water inlet low temperature and low flow range. 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)

Illustration 5-1: Shield/Cryo Cooler Compressor Requirements



5.4 GWHX Water Cooling Requirements

NOTE: The GWHX is a selection for providing TRM Gradient Coil water cooling for a system upgrading to TwinSpeed configuration at the time of EXCITE HD as shown in the upgrade catalogs flowcharts .

The GWHX contains a single closed loop, liquid-to-liquid heat exchanger system providing water cooling for the Gradient Coil ONLY. The GWHX requires customer provided water cooling, refer to Table 5-8 for cooling water requirements. The GWHX has two 0.75 inch (19.1 mm) corrosion-resistant, metallic, double-shutoff type quick disconnects, two 0.75 inch (19.1 mm) hose barbs and provided with four hose clamps. Refer to Illustration 5-2 for water supply and return connection location details.

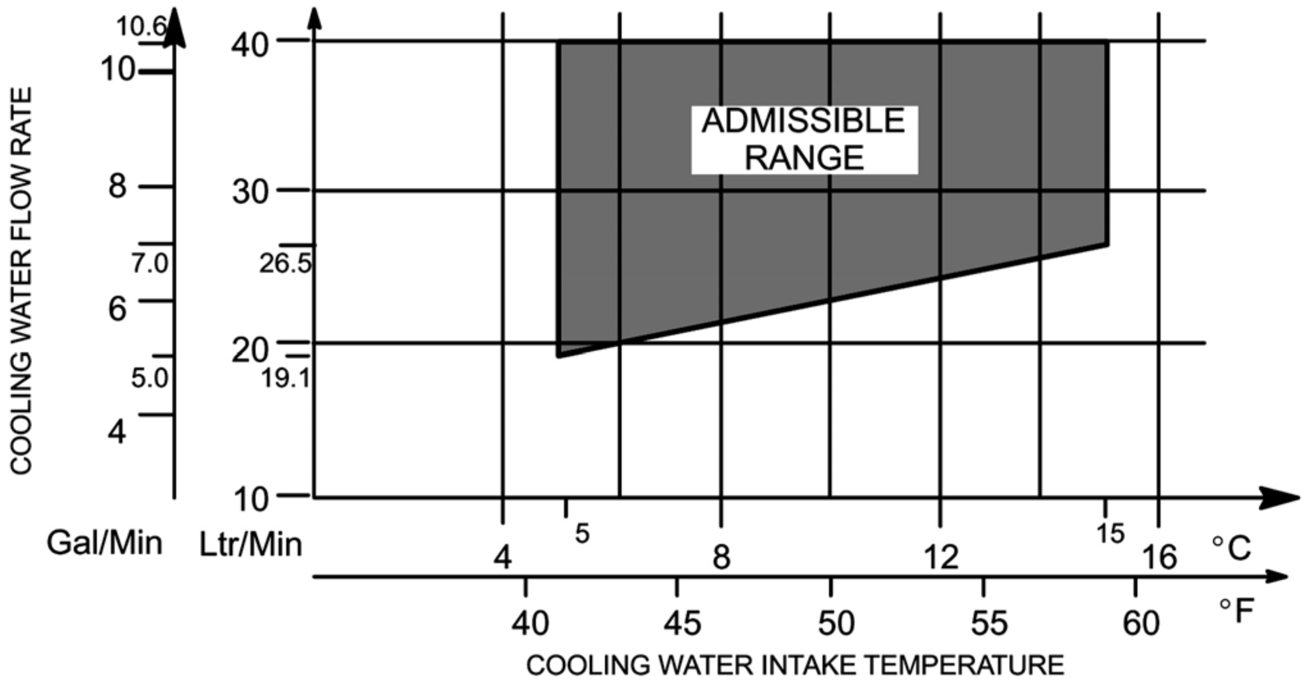
NOTICE

The GWHX provides water cooling for the TRM Gradient Coil ONLY. Therefore customer provided water cooling is required for the water cooled Shield/Cryo Cooler Compressor. Refer to Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling for customer provided water cooling requirements.

Table 5-8: GWHX Cooling Water Requirements

Parameter	Requirement	Notes
Composition	Water	Maximum of 50% glycol in water mixture
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 GWHX 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 GWHX filter at cabinet inlet.
Maximum Heat Output	34,144 BTU/Hr 10,000 Watts	Refer also to Section 4, Air Cooling
Pressure Drop	11.6 PSIG (80 kPa) at minimum flowrate of 5.0 gpm (19.1 liters/minutes) 17.4 PSIG (120 kPa) at maximum flowrate of 10.6 gpm (40.0 liters/minute)	These pressure drop values are for pure water is used. Multiply the values by 1.55 if 50/50 Propylene Glycol / water is used.
Inlet Pressure	150 psi maximum	

Illustration 5-2: GWHX Cooling Water Flowrate/Temperature Requirement



6 Altitude

MR System Operating Range: 100 ft (30.5 m) below sea level to 11,808 ft (3600 m) above sea level

NOTICE

If MR System site (Magnet) is located above 8100 ft (2469 m) must obtain approval and direction from Engineering Installed Base Leader at Magnet & Gradient Systems in Florence, SC USA phone number 843-667-9799.

7 Lighting

Magnet Room Lighting requirements are listed in Table 5-9

Table 5-9: Magnet Room Direct DC Lighting Requirements

Requirements

NOTICE

Fluorescent lighting is not allowed in the Magnet Room due to the RF noise generated by the fluorescent light tubes.

1. Direct Current (DC) lighting is required in the magnet room to avoid RF broadband noise impacts to image quality.
2. Illumination of 300 lux around the front of the magnet for patient access.
3. Need to provide 300 lux above the magnet service work (non-magnetic, portable lighting is acceptable).
4. The AC ripple from the DC power should be no greater than 5%.
5. Discrete switch or variable lighting level DC Lighting Controller (GE option available refer to Chapter 6, Section 8, DC Lighting Controller (Facility Option)) must be used for selectable light levels. Dimmers (i.e. SCR, rheostats, etc.) are not allowed.
6. Lighting fixtures selection and installation must comply with requirements in Chapter 8, Section 1, RF Shielded Room Requirements to minimize the possibilities of electrical discharge.
7. 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, Grounding System Ground subsection.
8. Light Emitting Diode (LED) lighting, if used, must meet the following:
   a. Power source must be located external to the Magnet Room RF Shield.
   b. All wiring, filters, and ground requirements must be met, refer to Chapter 6, Section 4, Grounding System Ground subsection.
9. Battery chargers (e.g. emergency lighting) are required to be located outside the Magnet Room.

Comments

- Short filament length is recommended, linear lamps are not recommended because of the filament length and high incidence of filament failure.
- Track lighting fixtures do not comply with light fixtures requirement listed above.

8 Acoustics

8.1 Introduction

The 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 within the rooms in which the 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 structureborne 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 Safety Guide included in the User 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) 75 dBA
- GWHX (Gradient Water Heat Exchanger) 69 dBA

8.3.2 Operating Conditions

8.3.2.1 Condition 1

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

- Average SPL 120 dBA SPL= Sound Pressure Level
- Peak 126 dB
- Frequency Range 20 to 20k Hz

8.3.2.2 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 90 to 105 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.

8.4.2.1 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 Illustration 5-3 and Illustration 5-4 .

- 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.

Illustration 5-3: Example Of Wall Construction For Airborne Noise Control - Option 1

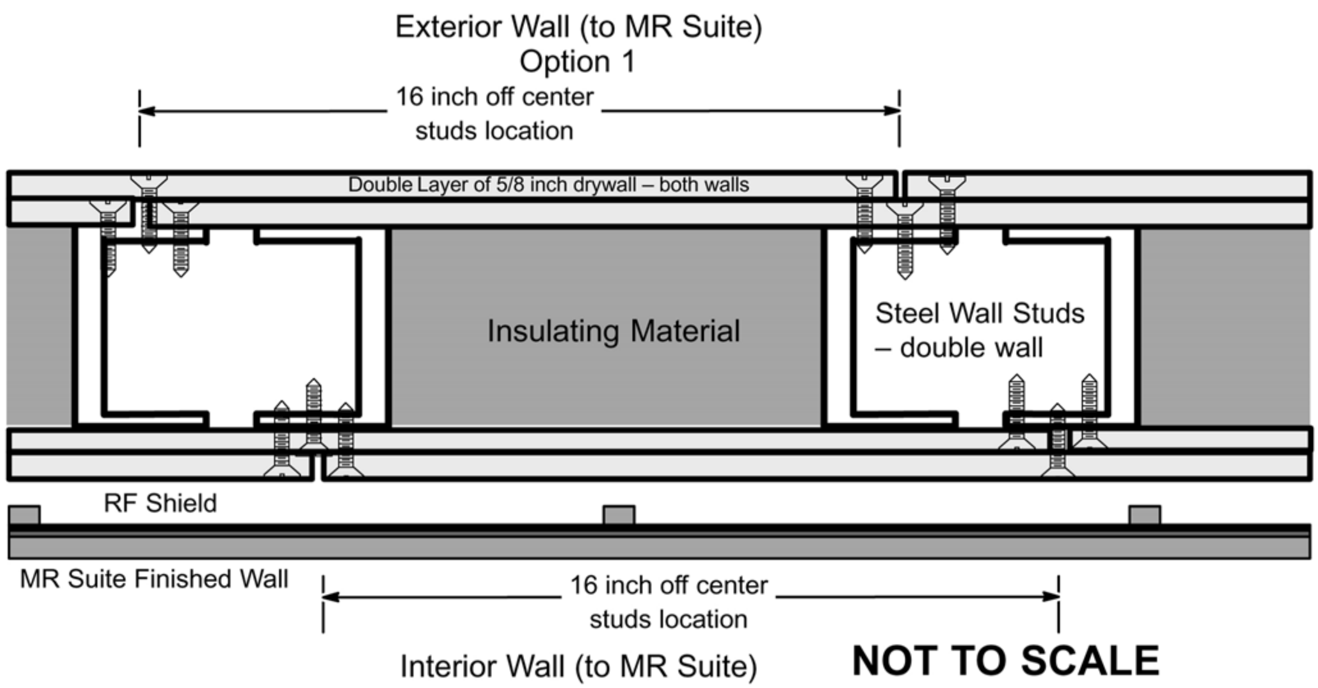
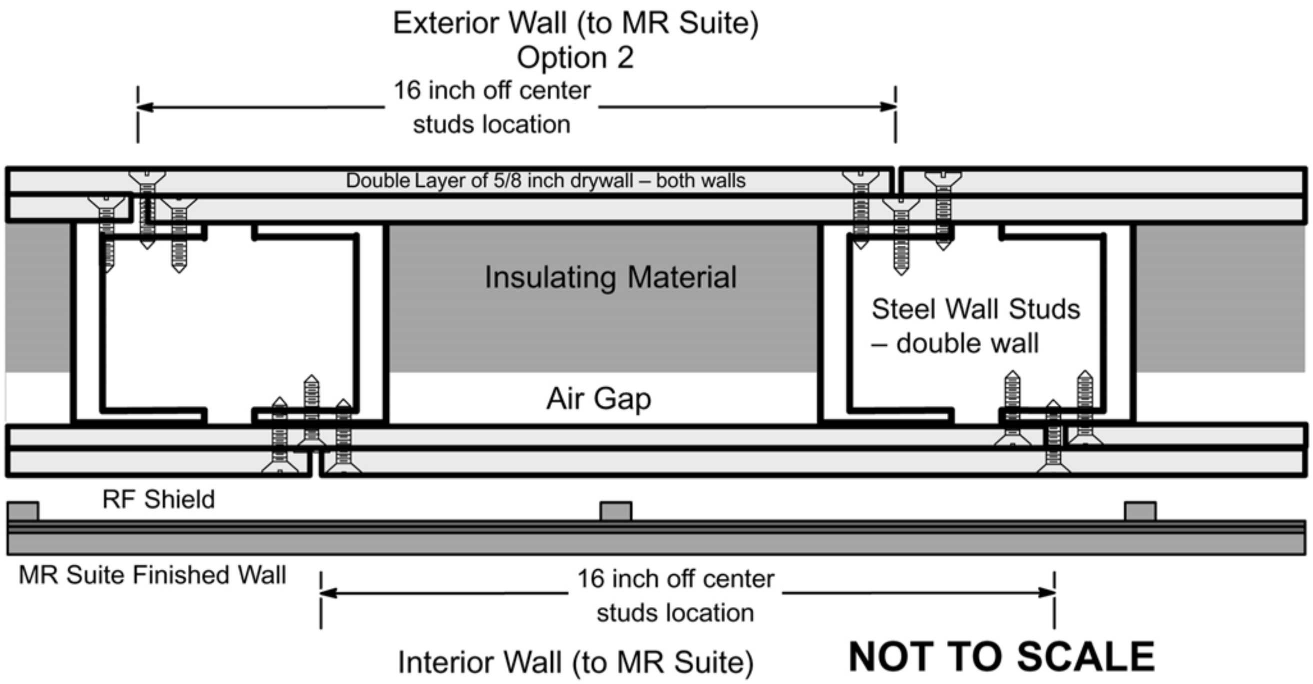


Illustration 5-4: Example Of Wall Construction For Airborne Noise Control - Option 2



8.4.2.2 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".

8.4.2.3 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.

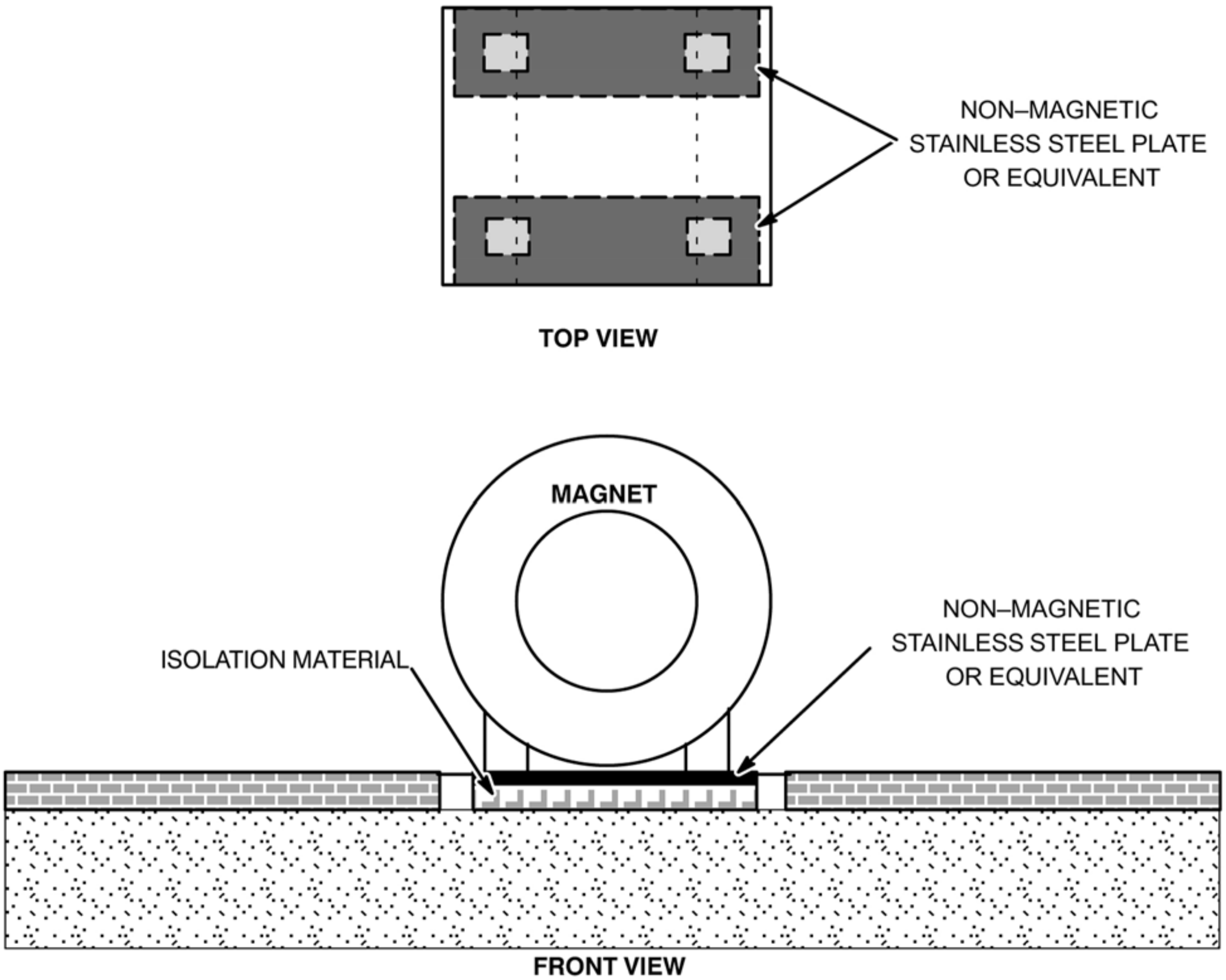
- RF windows should be purchased as window/frame units with an STC rating obtained from laboratory testing per ASTM standards. STC 50 to 60 windows are needed. The installation must include proper sealing to avoid sound leaks.
- RF doors should be selected to provide an STC 50 to 60 to quell the noise. 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 5-5 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.

Illustration 5-5: Overview Structureborne Vibration Control Solution Concept



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 then 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.

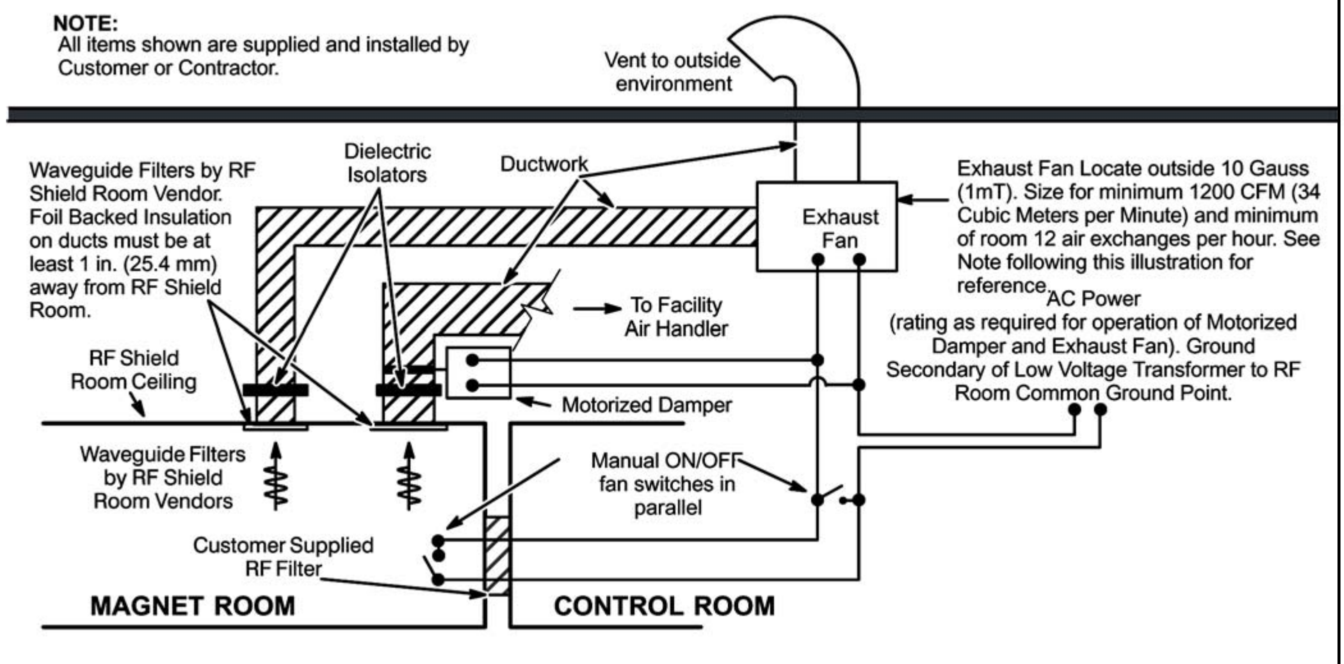
9 Room Ventilation

Refer to Table 5-10 for ventilation specifications for the magnet. Refer to Section 13, Pollution for air quality specifications.

Table 5-10: Magnet Room Ventilation Requirements/Recommendations

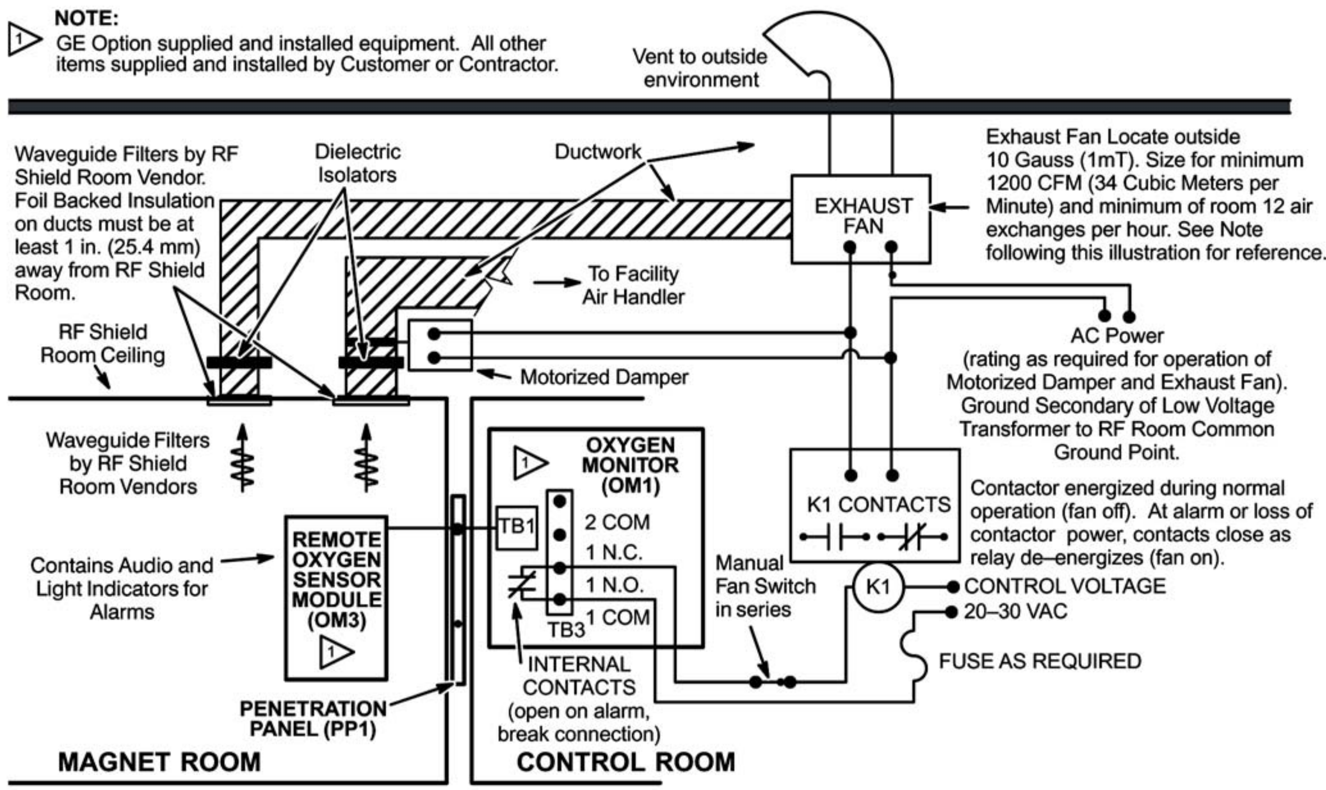
Requirements
1. Sufficient air ventilation in the Magnet Room must be maintained, not only for patient comfort during scans but also to maintain proper oxygen level during cryogen replenishment. 2. An exhaust fan to be placed above RF shielding with appropriate wave guide filtering for quick removal of helium gas if large amounts of helium disperse into magnet room. Inert gas containers, such as dewars, are not air tight. 3. **The Magnet Room exhaust fan intake vent must be located at the highest ceiling plane near the magnet cryogen vent.** 4. The Magnet Room exhaust fan to exhaust to safe outside area and be independent of cryogenic venting. 5. The Magnet Room exhaust fan and air inlet must be sized for a minimum of 1200 CFM (34 m^3/minute) and minimum of room 12 air exchanges per hour. 6. Two manual exhaust fan controls connected parallel, one to be located near the Operator Workspace and second control located in the Magnet Room. a. The Magnet Room ventilation switch should be mounted near the Magnet Room door and is the responsibility of the architect and mechanical contractor. b. Refer to Table 5-11 for exhaust fan recommended set-up or Table 5-12 for recommended set-up with optional Oxygen Monitor. 7. Exhaust fan (customer supplied) to be installed and operating before magnet is moved into room. 8. 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. 9. 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.
Comments
• Minimum 5-7% of outside makeup air to be vented into the 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.

Table 5-11: Exhaust Fan Set-Up



NOTE: Refer to Table 5-10 for Exhaust Fan capacity.

Table 5-12: Exhaust Fan Set-Up With Optional Oxygen Monitor



NOTE:	Refer to Table 5-10 for Exhaust Fan Capacity.

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 100% 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 10K to 150K depending on the location along the pipe. As a result, the gas will expand to 25-400 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.

NOTE: For the waveguide requirements, the vent size is described by the outside diameter because sealing the Ventglas® and matching the outside diameters are the critical issues.

NOTE: This document is not 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. See Table 5-16 for a typical cryogenic vent setup. Note that ventglass and clamps are provided by GE Healthcare for use at contractor's option.

Table 5-13 contains the requirements which must be strictly adhered to in order to prevent failure of the vent system during a magnet quench. Also see requirements table in Section 10.3, Requirements for Inside Magnet Room for recommended vent material.

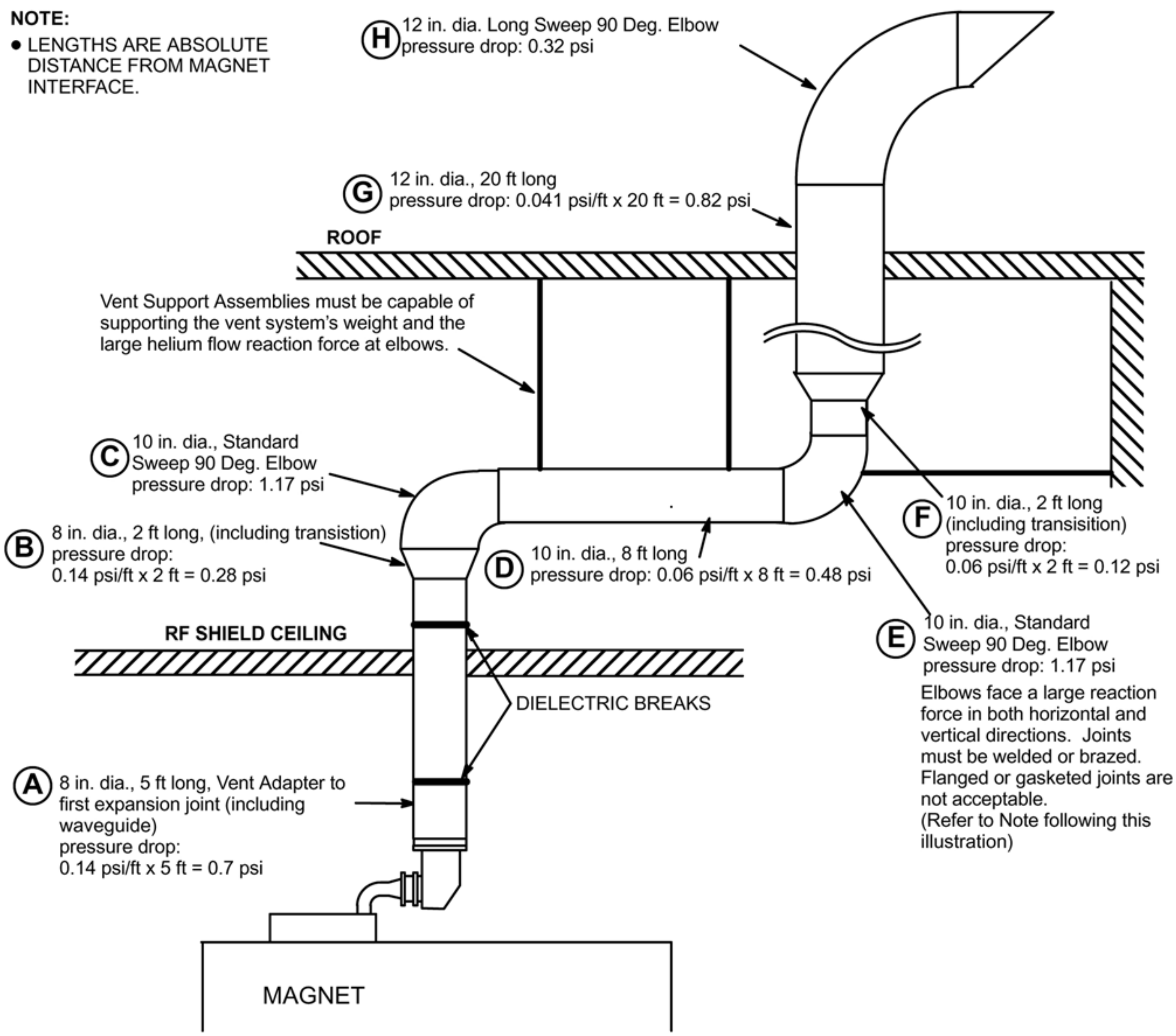
Table 5-13: LCC300 Magnet Cryogenic Venting Requirements For Outside Magnet Room

Parameter	Cryogenic Venting Requirements
Vent Size	• The total pressure drop of the entire cryogenic vent system must be less than 20 psi (138 KPa). The calculation starts at the magnet vent interface and ends at the termination point outside of the building. Use requirements table in Section 10.3, Requirements for Inside Magnet Room to determine proper vent sizes. See Note 1. See Table 5-14 for a sample pressure drop 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 and Table 5-16 . • 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. Refer to Chapter 8, Section 2.2, Determining Cryogenic Vent Location for routing of vent pipe.
Vent Construction	• 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). • The location of the isolation joint must be readily accessible for inspection and/or replacement. • All components must be able to withstand the minimum static pressure as calculated from Table 5-15 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 2500 lbs (11125 N) for LCC300 magnet at the vent elbows. • Non-metallic (i.e Ventglas) joints **must not** be used as the support for the vent system.

Table 5-13: LCC300 Magnet Cryogenic Venting Requirements For Outside Magnet Room (cont'd)

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 35 FEET LONG X 15 FEET WIDE (10.7 M LONG X 4.6 M WIDE) FOR LCC300 MAGNETS.** • **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.** • **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 TABLE 5-16. 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 SNOW.**
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.	

Table 5-14: LCC300 Magnet Sample Pressure Drop Calculation Of Cryogenic Venting



TOTAL PRESSURE DROP IN THE VENTING SYSTEM

= A + B + C+ D + E + F + G + H
= 0.7 + 0.28 + 1.17 + 0.48 + 1.17 + 0.12 + 0.82 + 0.32
= 5.06

5.06 psi < 20 psi

NOTE: For the preceding illustration Pressure Drop E refer to Table 5-15 for elbows force details and Table 5-13 for joints welded or brazed requirement.

Table 5-15: 3.0T LCC Magnet Cryogenic Vent System Pressure Drop Matrix

Inside dia. of pipe (D)	Distance of vent system component from magnet		Pressure drop for straight pipe		Std sweep 45° elbow		Long sweep 45° elbow		Std sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	ft	m	psi/ft	kPa/m	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa
8 in. (200 mm)	0- 10	0.00 -3.05	0.14	3.22	1.12	7.70	0.74	5.13	2.09	14.43	1.40	9.62	4.19	28.86
	10- 20	3.05 -6.10	0.24	5.49	1.83	12.63	1.22	8.42	3.43	23.67	2.29	15.78	6.87	47.34
	20- 30	6.10 -9.15	0.36	8.23	2.49	17.20	1.66	11.45	4.67	32.21	3.11	21.48	9.34	64.43
	30- 40	9.15 -12.2	0.47	10.65	3.11	21.42	2.07	14.26	5.82	40.11	3.88	26.74	11.64	80.23
	40- 50	12.20 -15.25	0.57	12.80	3.67	25.32	2.45	16.86	6.88	47.42	4.58	31.61	13.75	94.84
	50- 60	15.25 -18.30	0.65	14.68	4.20	28.93	2.79	19.26	7.86	54.17	5.24	36.11	15.71	108.33
	60-80	18.29-24.39	0.77	17.44	5.13	35.35	3.41	23.53	9.60	66.16	6.40	44.11	19.19	132.33
	80-100	24.39-30.49	0.88	19.90	5.92	40.83	3.94	27.17	11.08	76.40	7.39	50.94	--	--
	100-120	30.49-36.58	0.98	22.14	6.60	45.51	4.39	30.27	12.35	85.14	8.23	56.76	--	--
	120-140	36.58-42.67	1.04	23.40	7.18	49.50	4.77	32.92	13.43	92.60	8.95	61.73	--	--
	140-160	42.67-48.77	1.08	24.32	7.57	52.23	5.04	34.73	14.17	97.69	9.45	65.12	--	--
	160-180	48.77-54.87	1.11	25.00	8.01	55.23	5.33	36.73	14.98	103.30	9.99	98.87	--	--
	180-200	54.87-60.96	1.12	25.42	8.38	57.80	5.57	38.43	15.68	108.09	10.45	72.06	--	--
10 in. (250 mm)	0- 20	0.00 - 6.10	0.06	1.280	0.62	4.29	0.41	2.86	1.17	8.04	0.78	5.36	2.33	16.07
	20- 40	6.10 -12.22	0.12	2.725	1.05	7.25	0.70	4.83	1.97	13.58	1.31	9.05	3.94	27.16
	40- 60	12.22 -18.29	0.17	3.904	1.43	9.86	0.95	6.56	2.67	18.44	1.78	12.29	5.35	36.88
	60- 80	18.29 -24.39	0.21	4.859	1.76	12.14	1.17	8.07	3.29	22.70	2.19	15.13	6.58	45.40
	80- 100	24.39 -30.49	0.25	5.626	2.05	14.14	1.36	9.40	3.83	26.43	2.56	17.62	7.67	52.86
	100-120	30.49-36.58	0.28	6.370	2.30	15.89	1.53	10.56	4.31	29.70	2.87	19.80	8.61	59.80
	120-140	36.58-42.67	0.30	6.822	2.53	17.43	1.68	11.58	4.72	32.56	3.15	21.71	9.44	65.12
	140-160	42.67-48.77	0.32	7.172	2.68	18.45	1.78	12.25	5.00	34.46	3.33	22.97	10.00	68.92
	160-180	48.77-54.87	0.33	7.451	2.85	19.66	1.89	13.06	5.33	36.73	3.55	24.49	10.65	73.46
	180-200	54.87-60.96	0.34	7.656	3.01	20.73	2.00	13.77	5.62	38.72	3.74	25.81	11.23	77.44

Table 5-15: 3.0T LCC Magnet Cryogenic Vent System Pressure Drop Matrix (cont'd)

Inside dia. of pipe (D)	Distance of vent system component from magnet		Pressure drop for straight pipe		Std sweep 45° elbow		Long sweep 45° elbow		Std sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	ft	m	psi/ft	kPa/m	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa
12 in. (300 mm)	0- 20	0.00 - 6.10	0.020	0.441	0.26	1.78	0.17	1.19	0.48	3.34	0.32	2.22	0.97	6.67
	20- 40	6.10 -12.22	0.041	0.937	0.43	3.00	0.29	1.99	0.81	5.61	0.54	3.74	1.63	11.22
	40- 60	12.22 -18.29	0.060	1.353	0.59	4.08	0.39	2.72	1.11	7.64	0.74	5.09	2.22	15.27
	60- 80	18.29 -24.39	0.075	1.702	0.73	5.06	0.49	3.36	1.37	9.45	0.91	6.30	2.74	18.89
	80- 100	24.39 -30.49	0.088	1.991	0.86	5.92	0.57	3.93	1.60	11.06	1.07	7.37	3.21	22.12
	100-120	30.49-36.58	0.10	2.283	0.97	6.70	0.64	4.44	1.81	12.50	1.21	8.33	3.63	25.00
	120-140	36.58-42.67	0.11	2.469	1.07	7.39	0.71	4.90	2.00	13.78	1.33	9.19	4.00	27.57
	140-160	42.67-48.77	0.12	2.617	1.14	7.83	0.75	5.19	2.12	14.60	1.41	9.74	4.24	29.21
	160-180	48.77-54.87	0.12	2.741	1.22	8.40	0.81	5.57	2.27	15.66	1.51	10.44	4.54	31.32
	180-200	54.87-60.96	0.13	2.840	1.29	8.90	0.86	5.90	2.41	16.60	1.61	11.07	4.82	33.20
14 in. (350 mm)	0- 20	0.00 - 6.10	0.008	0.180	0.123	0.85	0.082	0.57	0.231	1.59	0.154	1.06	0.462	3.18
	20- 40	6.10 -12.22	0.017	0.380	0.206	1.42	0.137	0.95	0.386	2.66	0.257	1.77	0.771	5.32
	40- 60	12.22 -18.29	0.024	0.552	0.281	1.94	0.187	1.29	0.525	3.62	0.350	2.42	1.051	7.25
	60- 80	18.29 -24.39	0.031	0.699	0.349	2.41	0.232	1.60	0.652	4.50	0.435	3.00	1.304	8.99
	80- 100	24.39 -30.49	0.036	0.824	0.411	2.83	0.272	1.88	0.766	5.28	0.511	3.52	1.533	10.57
	100-120	30.49-36.58	0.04	0.954	0.47	3.22	0.31	2.13	0.87	6.00	0.58	4.00	1.74	11.99
	120-140	36.58-42.67	0.05	1.040	0.52	3.56	0.34	2.36	0.96	6.64	0.64	4.43	1.93	13.28
	140-160	42.67-48.77	0.05	1.109	0.55	3.78	0.36	2.50	1.02	7.04	0.68	4.69	2.04	14.07
	160-180	48.77-54.87	0.05	1.169	0.59	4.07	0.39	2.70	1.10	7.58	0.73	5.05	2.20	15.16
	180-200	54.87-60.96	0.05	1.219	0.63	4.34	0.42	2.87	1.17	8.07	0.78	5.38	2.34	16.14

Table 5-15: 3.0T LCC Magnet Cryogenic Vent System Pressure Drop Matrix (cont'd)

Inside dia. of pipe (D)	Distance of vent system component from magnet		Pressure drop for straight pipe		Std sweep 45° elbow		Long sweep 45° elbow		Std sweep 90° elbow		Long sweep 90° elbow		90° miter bend	
	ft	m	psi/ft	kPa/m	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa
16 in. (400 mm)	0- 20	0.00 - 6.10	0.004	0.083	0.065	0.45	0.043	0.30	0.122	0.84	0.081	0.56	0.244	1.68
	20- 40	6.10 -12.22	0.008	0.174	0.108	0.75	0.072	0.50	0.202	1.39	0.135	0.93	0.404	2.79
	40- 60	12.22-18.29	0.011	0.253	0.148	1.02	0.098	0.68	0.275	1.90	0.184	1.27	0.551	3.80
	60- 80	18.29 -24.39	0.014	0.323	0.184	1.27	0.122	0.84	0.342	2.36	0.228	1.57	0.685	4.72
	80- 100	24.39 -30.49	0.017	0.383	0.217	1.49	0.144	0.99	0.404	2.78	0.269	1.86	0.807	5.57
	100-120	30.49-36.58	0.020	0.447	0.25	1.70	0.16	1.13	0.46	3.17	0.31	2.11	0.92	6.34
	120-140	36.58-42.67	0.022	0.490	0.27	1.89	0.18	1.25	0.51	3.52	0.34	2.35	1.02	7.04
	140-160	42.67-48.77	0.023	0.525	0.29	2.00	0.19	1.32	0.54	3.73	0.36	2.48	1.08	7.45
	160-180	48.77-54.87	0.025	0.556	0.31	2.17	0.21	1.43	0.58	4.03	0.39	2.69	1.17	8.06
	180-200	54.87-60.96	0.026	0.583	0.34	2.32	0.22	1.53	0.62	4.31	0.42	2.87	1.25	8.61

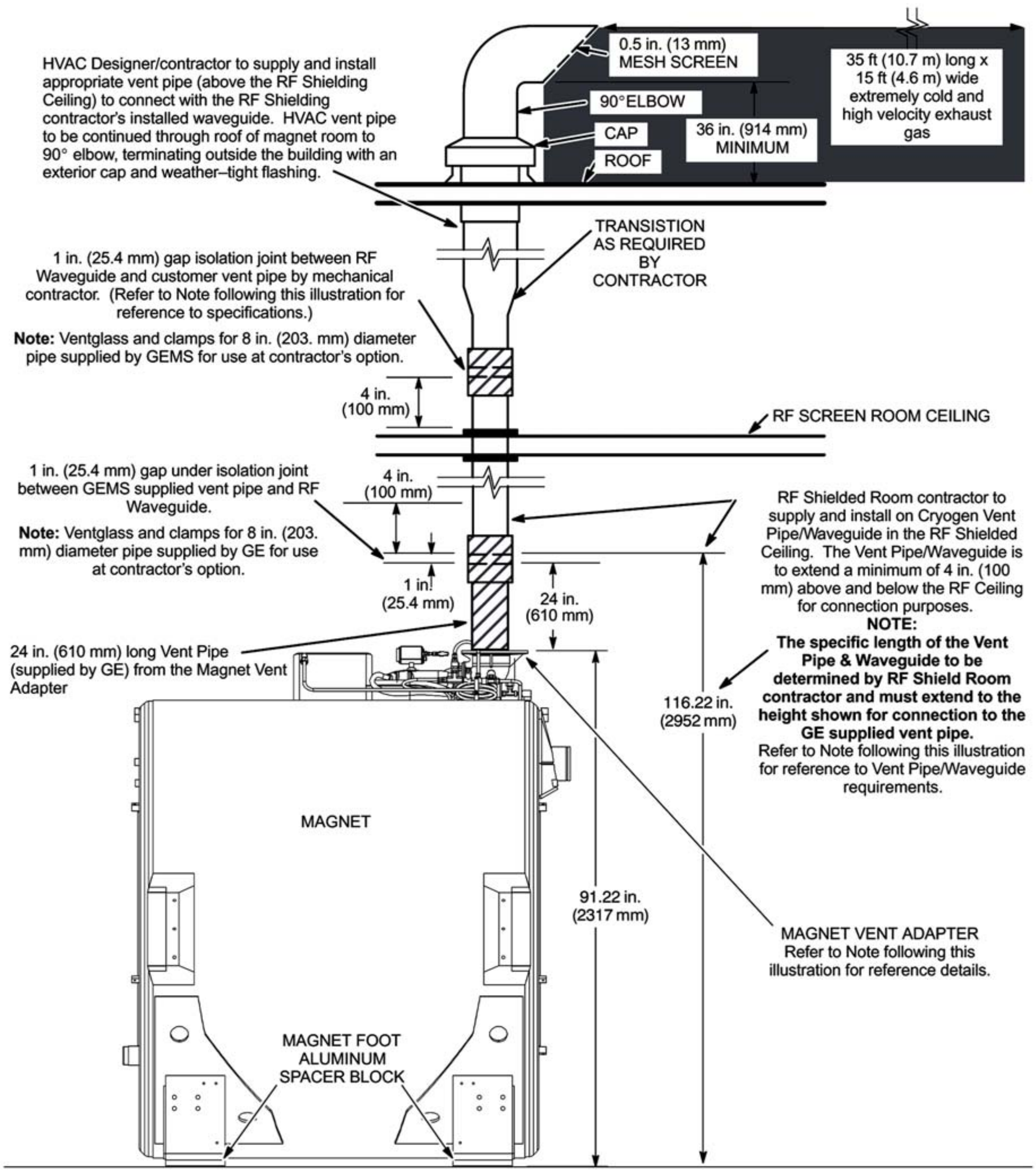
NOTICE

THIS TABLE MUST BE USED IN CONJUNCTION WITH ALL OTHER REQUIREMENTS FOR CRYOGENIC VENT SYSTEM DESIGN IN PRE-INSTALLATION DIRECTION.

Notes

1. Elbows with angles greater than 90 deg must not be used
2. Data in Table 2 is based on the following facts and assumptions:
   a. Initial flow conditions at magnet interface
   b. EM energy (13MJ) is dumped to He during quench and rises He temperature to 10Kelvin
   c. Gas temperature starting at 10Kelvin and increase with length determined by thermal energy balance
   d. 90% He is assumed to be evacuated within 30 sec. No He left during quench.
   e. Absolute roughness is assumed to be 0.25mm.
   f. R/D = 0.5 for standard sweep elbows, R/D = 1.5 for long sweep elbows where D = inside diameter of pipe; R = radius of bend

Table 5-16: Typical LCC300 Magnet Cryogenic Vent Detail



NOTE:	For the preceding illustration refer to the following for requirements details: Chapter 8, Section 2.4, Guide for Outside RF Room Isolation Joint, Chapter 8, Section 2.2, Determining Cryogenic Vent Location and Table 5-13 for RF Shielded Room contractor supplied cryogenic vent pipe/waveguide requirements.

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 5-17 . 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 5-17 contains the GE requirements for vent design within the magnet room.

Table 5-17: LCC300 Magnet 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 20 psi (138 kPa). The calculation starts at the magnet vent interface and ends at the termination point outside of the building. Use Table 2 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 8 inch (203.2 mm) outside diameter straight pipe for the waveguide for 3.0T magnet. 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. • 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 5-18 . • Venting wall thickness: SS 304 Minimum 0.035 in. (0.89 mm) Maximum 0.125 in. (3.18mm) AL 6061-T6 Minimum 0.083 in. (2.11 mm) Maximum 0.125 in.(3.18mm) CU DWV, M or L Minimum 0.083 in. (2.11 mm) Maximum 0.140 in.(3.56 mm)

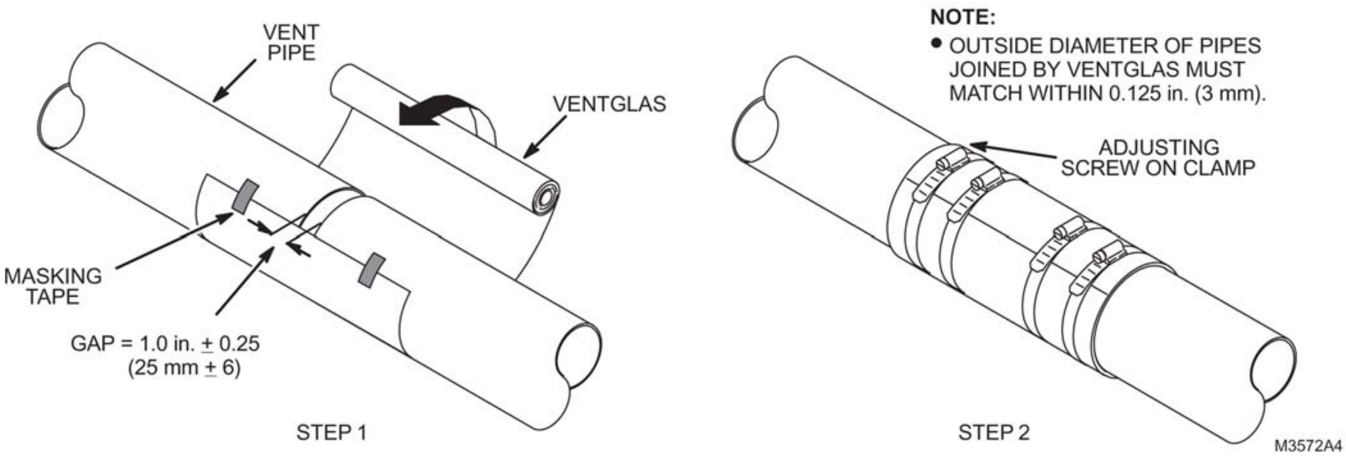
Table 5-17: LCC300 Magnet Cryogenic Venting Requirements For Inside Magnet Room (cont'd)

Parameter	Cryogenic Venting Requirements
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. • The vent support assemblies must be capable of supporting the weight of the vent system and 2500 lbs (11125 N) helium flow reaction force at vent elbows. • Non-metallic (i.e. Ventglass) joint must not be used as the support for the vent system.
Vent Construction	• One dielectric break in the vent system (ie. Ventglass) is required within the Magnet Room. A non-metallic isolation joint must be provided between the GE Healthcare supplied 24 in. (610 mm) long vent pipe and the cryogen vent system to 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. Ventglass) must be welded or brazed. No clamped, sealed flanges permitted. • All isolation/thermal expansion joints except 1 non-metallic isolation (ie. Ventglass) must be able to withstand temperatures from 4.5 K (-451° F or -268° C) and above. For 3.0T magnets, these joints must also withstand pressures up to 35 psi (241.4 kPa). • GE requires Ventglass 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 Ventglass 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 Figure 3. Use 2 hose clamps on each side of the joint for securing the Ventglass 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.

Table 5-18: 3T Magnet Type Matrix

Magnet Types	Helium Volume gallons (liters)	Peak Liquid Helium Flow During Quench ft³ per min (m³ per min)	Magnet Vent Pipe OD inches (mm)	Vent Location On Magnet
3.0T LCC Magnet	528.3 (2000)	141 (4.00)	8 (203.2)	Chapter 8, Section 2.2, Determining Cryogenic Vent Location illustration

Illustration 5-6: Vent Glass Continuous Wrap



11 Alarm Devices, Water Sensors and Thermostats

11.1 RFS Cabinet

The RFS Cabinet has 104°F (40°C) and 122°F (50°C) temperature sensors. When the temperature in the RFS Cabinet reaches 104°F (40°C) a Warning Message will be displayed on the Operator Workspace. When the temperature in the RFS 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 RFS 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 Workspace 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 Chapter 8, Section 1, RF Shielded Room Requirements 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 5-19 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 5-19: 3.0T System Radio Frequency Survey Specifications

Isotope	Bandcenter MHz	Bandwidth Hz
^{1}H	127.72	681,183
^{19}F	120.23	641,229
^{31}P	51.75	276,010
^{23}Na	33.80	180,291
^{13}C	32.13	171,335

When required, RFI site surveys are to be performed by cycling through the preceding frequency bands and a broad band range of 150MHz ± 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:

$$\text{BW (resolution)} = f_0 / 50$$

where: BW = Bandwidth (resolution)

f_0 = Center frequency (for 1H: at 3.0 Tesla 127.72 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.

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

The main field of the MR magnet can be negatively impacted when installed in areas where dynamically changing magnetic fields exist. Two possible sources of changing magnetic fields include

- Moving Metal
- AC Power Lines, Transformers and Motors.

NOTE: Also refer to Chapter 3, Section 2, Proximity Limits for additional proximity limitations.

14.1 Definition Of Moving Metal

Metal objects moving within the magnet sensitivity lines can produce a negative impact during clinical scanning. The moving metal object will cut flux lines distorting the main field. As an example, cars driven inside the 3 gauss line will impact the magnets main field. The same vehicle may park within the 3 gauss line and remain parked during clinical scanning without impact to the main field.

14.2 Magnet Steel Objects Categories And Requirements

Refer to Table 5-20 for LCC300 Magnet moving metal requirements and see Illustration 5-8 and Illustration 5-9 .

Table 5-20: LCC300 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
Cars, Minivans, Vans, Pickup Trucks, Ambulances	distance from isocenter measured to center of driving or parking lane radial x axial (See Note 1)	21 x 26 (6.40 x 7.92)
Bus, Trucks (Utility, Dump, Semi)	distance from isocenter measured to center of driving or parking lane radial x axial (See Note 1)	24.5 x 30.3 (7.47 x 9.25)
Objects > 400 lbs, Elevators, Trains, Subways	Place a directional probe (e.g. flux gate sensor) at isocenter of proposed magnet location aligned along the Z-axis. Measure p-p magnetic field change (dc).	See Illustration 5-7 and see Example in Note 2

Notes

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 13 seconds (which is usually the case), you need to use a shielding factor of 94.3% and a resulting peak-to-peak milligauss reading of 4.10.
   b. If the site has a subway nearby and the field disturbance is less than 5 seconds, you can use a shielding factor of 95.3% and a resulting peak-to-peak milligauss reading of 5.00.
   c. Therefore, be conservative and use 4.10 milligauss peak-to-peak.

Illustration 5-7: Actual Axial Shielding Performance

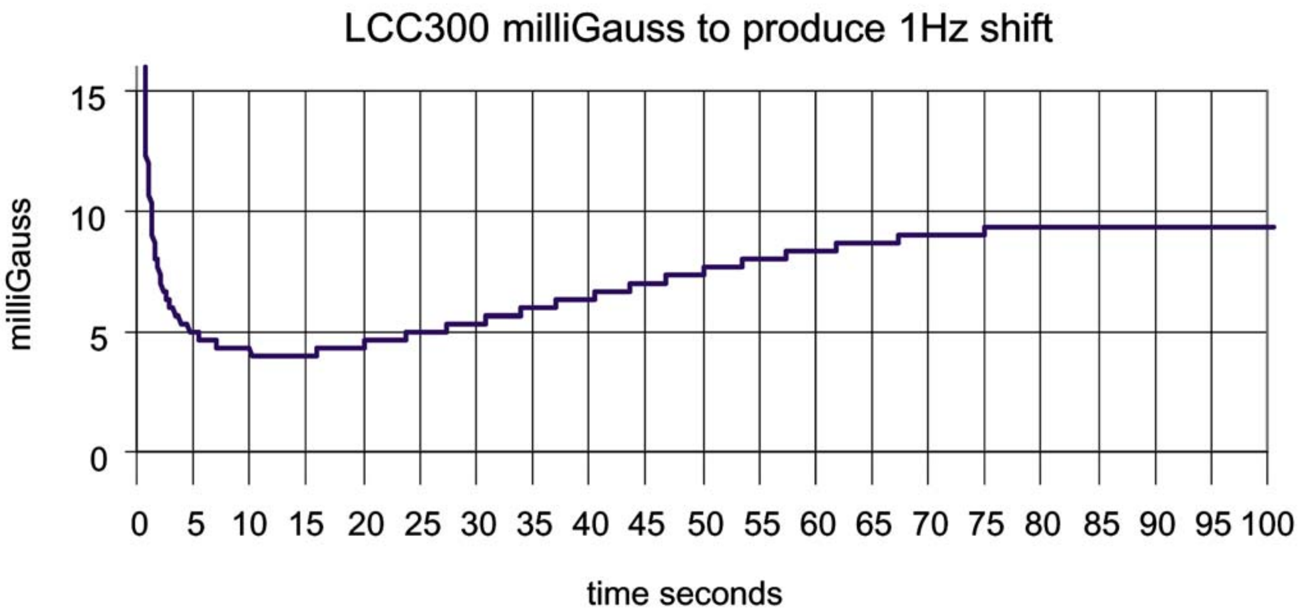


Illustration 5-8: Magnet Moving Metal Sensitivity Line Plot (MR Center Level)

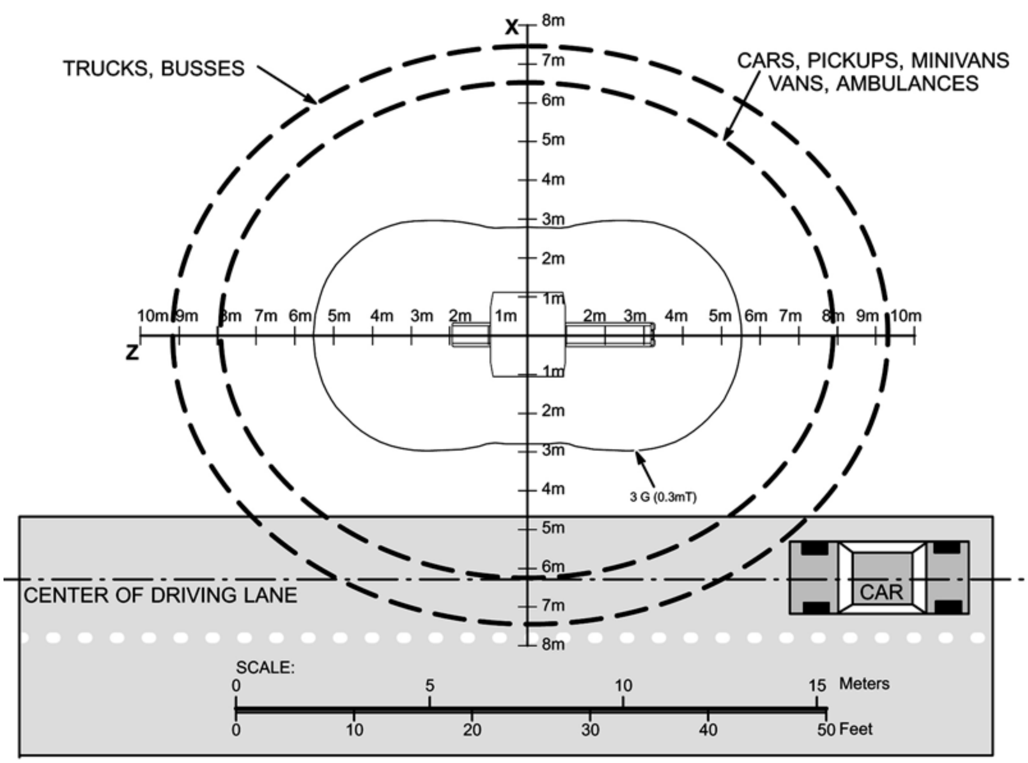
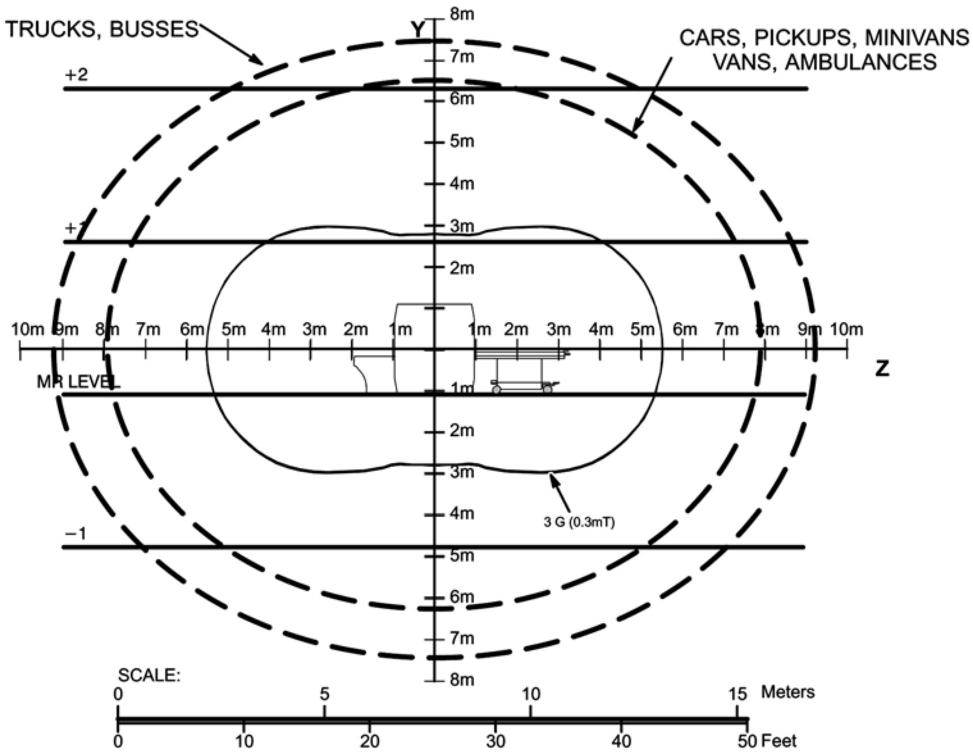


Illustration 5-9: Magnet Moving Metal Sensitivity Line Plot (Vertical View)



14.3 Distances For AC Power Lines, Transformers And Electric Motors

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.

Magnetic field interference at 50 or 60 Hz must not exceed 16.22 or 17.10 milligauss RMS respectively at the magnet location, refer to Illustration 5-10 . 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.

$$I = (8.55X^2)/S$$

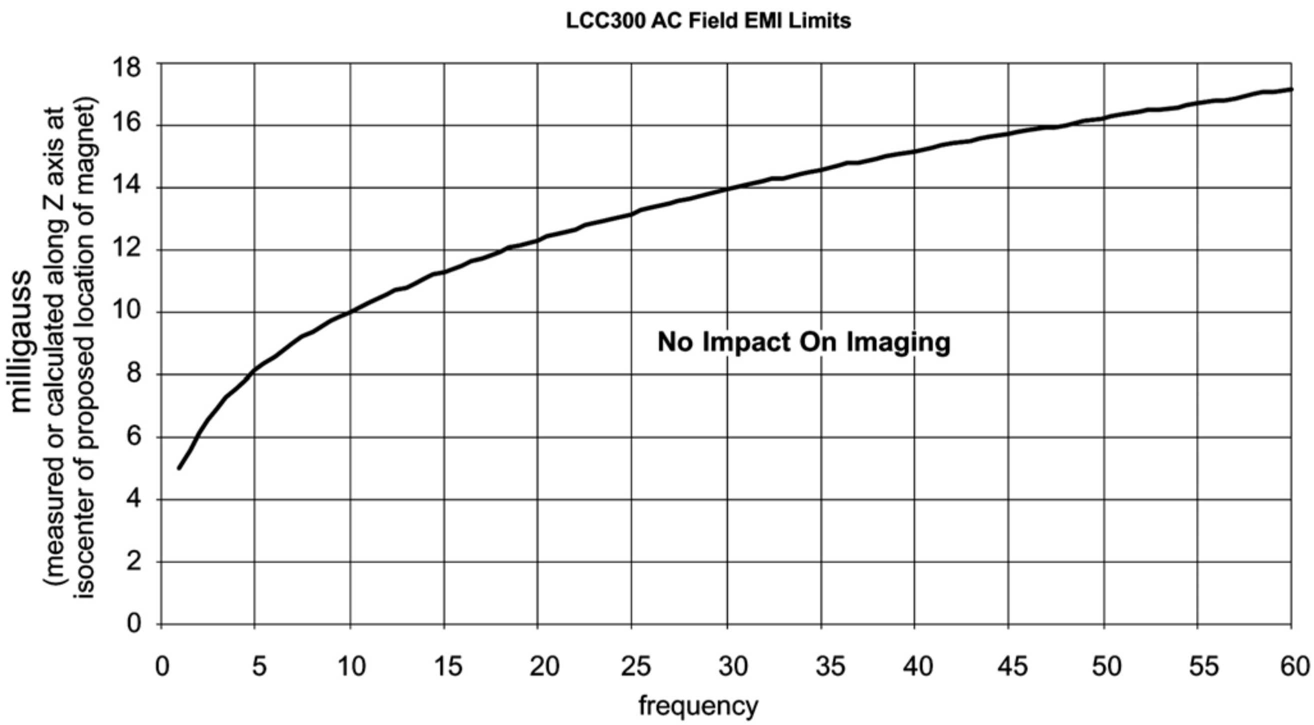
where:

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

Illustration 5-10: Allowable Milligauss VS Line Frequency For AC Equipment



14.4 Sample Calculation Determine Minimum Distance From AC Power Lines, Transformers, And Electric Motors

This is a sample calculation to determine minimum distance from a feeder, transformer, or other AC electrical source, using the Formula found in Section 14.3 Distances For AC Power Lines, Transformers And Electric Motors.

I (amps) = 8.55X^2 (meters) ÷ 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.

$$X^2(meters) = [I(amps) \times S(meters)] \div 8.55$$

Rearranging:

$$X = \sqrt{\left\{\frac{[I(amps) \times S(meters)]}{8.55}\right\}}$$

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 diameter of the conduit.

S = 5 inches = 0.127 meters

$$X = \sqrt{\left\{\frac{\{450(amps) \times 0.127(meters)\}}{8.55}\right\}}$$

X = 2.58 meters = 8.5 feet

So in this example, the conduit should be 2.58 meters or 8.5 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 between 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 horizontally (magnet z-axis). Also the calculation does not account for any magnetic shielding effect of steel conduit.

15 Construction Materials

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

15.1 Magnet Room Floors Magnetic Properties

Table 5-21 information must be used to evaluate site steel in close proximity of the magnet isocenter.

Table 5-21: Steel Mass Proximity To Magnet Isocenter Requirements

Distance From Magnet Isocenter in. (mm)	Distance Below Top Surface Of Floor in. (mm)	Limits Of Steel Mass lbs/ft2 (kg/m2) See Notes 1 & 2
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. Limited site materials include steel rebars and other steel building components within a 10 foot by 12 foot (3.1 meter by 3.6 meter) area directly below the magnet.
2. If non-uniform steel is present or if these mass proximity limits are exceeded then the steel must be analyzed by the MR Siting and Shielding Team. Refer to *Magnetic Field Consideration* Chapter 4, Section 1, Introduction, Chapter 4, Section 3, Structural Steel Evaluation Of Proposed Sites, and Chapter 4, Section 5, Magnetic Field. It is highly recommended to use non-magnetic structural components in the floor below the Magnet.
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.

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 requirements. 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 Project Manager, Installations.

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

15.3 Electrical conduits

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 requirement. Electrical conduit within the magnet room may be steel provided it is inside walls and ceilings. Note, conduit for a receptacle must be metallic. Ferromagnetic material inside the magnet room could inadvertently become a projectile.

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 10.1, Cryogenic Venting, Section 10.2, Requirements For Outside Magnet Room, and Section 10.3, Requirements for Inside Magnet Room for cryogenic vent materials requirements.

16 Vibration

16.1 Types of Vibration Image Quality Issues

MR image quality can be impacted by 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 are exhaust fans, air conditioning blower units, compressors, pumps (air and water), etc. Transient vibrations are typically a function of the building structure or the building foundation and are associated with vehicular traffic, pedestrian motion, patient transport, door slamming, etc. A transient event would typically decay from a high vibration amplitude to lower levels in short periods of time.

16.2 Site Planning Vibration Requirements

Magnet Room vibration testing and site planning requirements are listed in Table 5-22 .

Table 5-22: Magnet Room Site Vibration Testing And Requirements

Requirements
1. The customer is responsible for contracting a vibration consultant or qualified engineer to implement design modifications to meet the vibration specifications as stated in Section 16.3 . 2. **The vibration tests outlined in** Chapter 12, Section 1, MR Site Vibration Test Guidelines **must be used to assess the vibration environment.** The vibration effects on image quality can be minimized early in the site planning of the MR suite. a. Sites which meet the vibration criteria may proceed with the installation planning. b. 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. i. Resolution/solution of measured issue(s) must be communicated to customer/architect, local GE Healthcare Field Service, and GE Project Manager, Installations. ii. A formal report defining the measured issue(s) and resolution/solution to be provided to customer/architect, GE Healthcare Field Service, and GE Project Manager, Installations. c. Sites building a new complex to house the MR suite must use MR Site Vibration Test Guidelines information in the design of the facility. 3. Air conditioning unit(s) installed for the purpose of cooling the MR Suite must be vibration isolation. 4. Magnet vibration isolation is not an acceptable solution for environmental vibration issue(s). The magnet must be bolted rigid to a structure or to VibroAcoustic Damping Option mats which set on the recessed floor area.

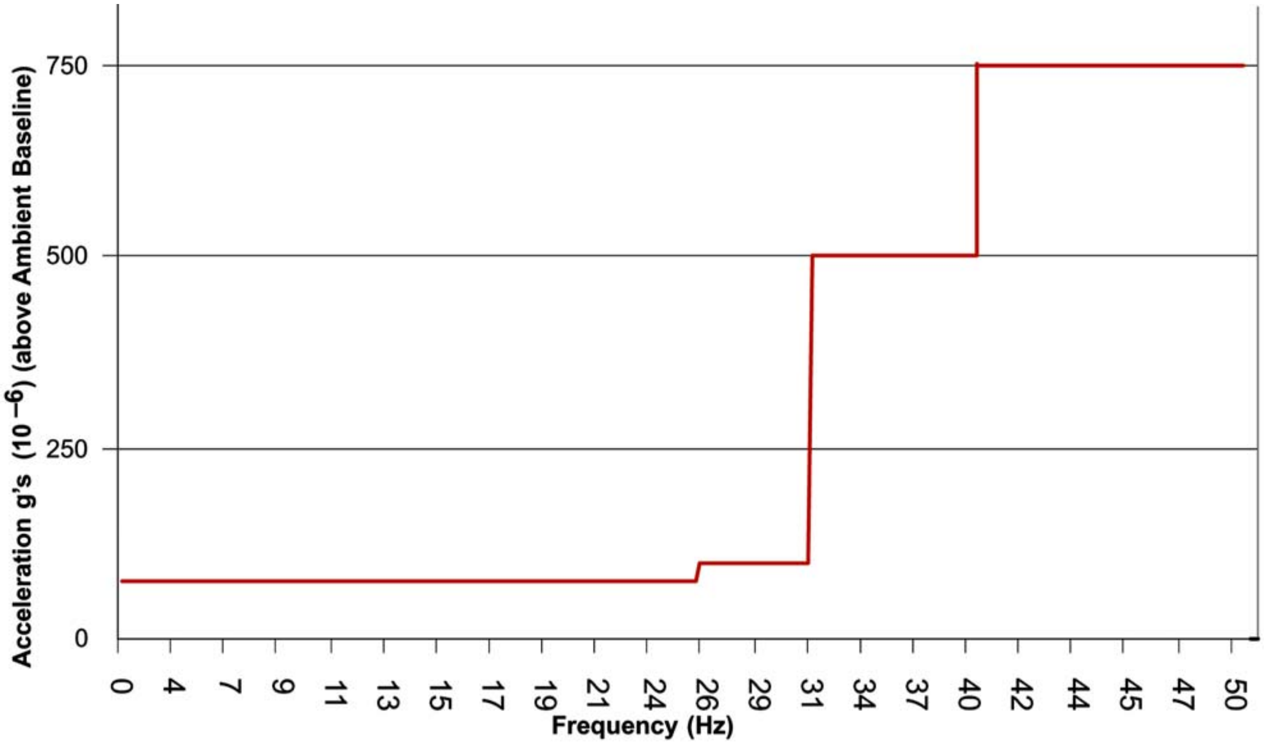
16.3 Vibration Specifications

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

16.3.1 Steady State Vibration Specifications

The maximum steady state vibration transmitted through the floor must not exceed the maximum single frequency components above ambient baseline listed in and Illustration 5-11 .

Illustration 5-11: LCC300 Magnet Steady State Vibration Specifications



Refer to *Appendix* Chapter 12, Section 1, MR Site Vibration Test Guidelines example illustrations for an example applying the steady state specifications with ambient baseline and zoomed in for analysis purposes.

Discrete signal must represent a real mechanical vibration source, that is the signal must have a bandwidth that typifies dynamic system response.

16.3.2 Transient Vibration Specifications

NOTE: Transient vibration analysis requires the elimination of all steady state vibration so as not to mask the transient signal. I.E. Variations in acceleration amplitudes due to rotating equipment must not be confused with transient vibration.

1. Time history transient levels exceeding 500 micro-g, zero to peak must be fully analyzed to assess impact to the building structure.
2. 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 Section 16.3.1 .
    a. The vibration consultant must measure and report the transient disturbance of concern.
    b. The consultant must determine (assess) the frequency, amplitude, and duration of the transient.
    c. The consultant must 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 Section 16.3.1 .

Chapter 6 Power Requirements

1 System Power Introduction

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

WARNING

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

WARNING

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

WARNING

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.

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.

Table 6-1: Required Customer Power

Signa EXCITE HD 3.0T System					
MR Component	**Voltage (VAC)**	**Frequency**	**Phase**	**Max. Amps**	**Comments**
GE pre-engineered Main Disconnect Panel (MDP) See Notes 1, 2, 3, & 4 See Note 5 if customer MDP	480Y/277 VAC ± 10% or 400Y/230 VAC ± 10%	60 Hz 50 Hz	(3+GND) See Comments	See Note 6	Recommend input configuration: 3 phase Grounded WYE with Neutral and Ground (5 wire system). Note, Neutral must be terminated prior to PDU or inside the Main Disconnect Panel and not brought to the PDU or its cabinet. (See Note 7) Optional input configuration: 3 phase DELTA with Ground (4 wire) input, recommend corner Grounded Delta configuration.
Magnet Rundown Unit	100-120 or 200-240	50/60 Hz	1	1.0	Hard wired in unit.
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.
* Remote Magnet Rundown Unit	100-120 or 200-240	50/60 Hz	1	1.0	Hard wired in unit
* O^2 Monitor	110-120 or 200-240	50/60 Hz	1	3.0	Hard wired in monitor

Table 6-1: Required Customer Power (cont'd)

Signa EXCITE HD 3.0T System					
MR Component	**Voltage (VAC)**	**Frequency**	**Phase**	**Max. Amps**	**Comments**
* Integrated Patient Comfort Module (IPCM) for LCC300 Magnet ONLY	200-240	50/60	1	30.0	Refer to Section 9, IPCM Option Power Requirements
	200-277	60	1	30.0	

Notes

* 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. Signa TwinSpeed MDP controls power to the following system equipment:
   - Power Distribution Unit
   - Coldhead MRCC (option to provide water cooling for Shield/Cryo Cooler Compressor)
   - Gradient MRCC
   - Shield/Cryo Cooler Compressor
   - Magnet Monitor equipment including the Magnet Monitor, Modem, Uninterruptible Power Supply (UPS*) (optional) for Magnet Monitor, Multiplexer Box (optional).
3. MDP power circuits for MRCC if providing Shield/Cryo Cooler Compressor water cooling, Magnet Monitor, and Shield/Cryo Cooler Compressor Cabinet, along with cooling for these units, are required immediately upon magnet arrival to minimize cryogen consumption. If permanent site power is not ready, temporary power drop line and cooling 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.
   MDP power circuits for MRCC if providing Shield/Cryo Cooler Compressor water cooling, Magnet Monitor, and Shield/Cryo Cooler Compressor Cabinet, along with cooling for these units, are required immediately upon magnet arrival to minimize cryogen consumption. If permanent site power is not ready, temporary power drop line and cooling 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. Refer to Chapter 2, Section 4, Facility Options for listing of step up transformers options.
4. The complete MR System Digital Energy SG Series UPS 100 KVA (E4502FB) option requires 480 VAC, 3-phase, 4 wire + ground, 60 Hz input power.
5. 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) Requirements.
6. Maximum amps dependent on voltage selected. Refer to Section 2, Critical Power Requirements for configuration.
7. PDU Module is located in the lower portion of the HFD/PDU Cabinet (MR3).

2 Critical Power Requirements

The system Main Disconnect Panel is a Low Voltage Low Energy local control unit, with multi-point remote control capability, connected to the feeder lines that supply input power to the following:

- Power Distribution Unit (PD1)
- Shield/Cryo Cooler Compressor Cabinet
- Coldhead MRCC (option to provide water cooling for Shield/Cryo Cooler Compressor)
- Gradient MRCC (option to provide water cooling for the Gradient Coil)
- Shield/Cryo Cooler Compressor Cabinet (MS5)
- Magnet Monitor equipment.

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) Requirements for Main Disconnect Panel capability and set up.

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

WARNING

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

WARNING

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.

Table 6-2: Critical Power Requirements

Parameter	Requirements
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 HFD/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

Table 6-2: Critical Power Requirements (cont'd)

Parameter	Requirements
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 Voltage	380/400/415 VAC 50 Hz or 460/480 VAC 60Hz
Coldhead MRCC Voltage Gradient MRCC Voltage	380/400 VAC 10% 50 Hz or 460/480 VAC 10% 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 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 Signa system 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.

Table 6-2: Critical Power Requirements (cont'd)

Parameter	Requirements
Average (while scanning) Power Demand	Refer to Table 6-4
Standby (no scan) Power Demand	27.7 KVA at 0.9 lagging Power Factor including 4.4 KVA for PDU, 9.8 KVA for 2 MRCC units for system water cooling, 9KVA (continuous operation) for Shield/Cryo Cooler Cabinet, and 1.5 KVA 1 phase for Magnet Monitor equipment (4.5 KVA 3 phase equivalent).

Table 6-3: System With TRM Coil Peak Power Demand

Cooling Equipment	MR System Cooling Equipment For Both Gradient Coil & Shield/Cryo Cooler Compressor Water Cooling See Note 1	MR System Cooling Equipment For Gradient Coil ONLY See Note 2	
System Equipment ⌵	**2 MRCC Units**	**1 MRCC Unit**	**1 GWHX Unit**
PDU draw for 5.0 sec	~61.2 KVA	~61.2 KVA	~61.2 KVA
PDU draw for 1.0 sec or less See Note 3	~65 KVA	~65 KVA	~65 KVA
Magnet Monitor See Note 4	4.5 KVA	4.5 KVA	4.5 KVA
Shield/Cryo Cooler Compressor	9 KVA	9 KVA	9 KVA
System Cooling equipment (configuration indicated in column heading)	15.8 KVA	7.9 KVA	0 KVA See Note 5
TOTAL for 5.0 sec	~90.5 KVA	~82.6 KVA	~74.7 KVA
TOTAL for 1.0 sec or less	~94.3 KVA	~86.4 KVA	~78.5 KVA

Notes

1. Two MRCC units are used to provide water cooling for the Gradient Coil and for the Shield/Cryo Cooler Compressor.
2. Customer provided water cooling for the Shield/Cryo Cooler Compressor is required when either 1 MRCC or the GWHX is used to provide Gradient Coil water cooling. Customer provided water cooling equipment power demands are not included in the values in this table.
3. 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 65 KVA.
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 65 KVA.
4. The Magnet Monitor equipment power is 1.5 KVA 1 phase on an unbalanced leg of 3 phase input (4.5 KVA 3 phase equivalent).
5. The GWHX is powered from the PDU and therefore included in the PDU draw value.

Table 6-4: System With TRM Coil Average (Continuous) Scanning Power Demand

Cooling Equipment	MR System Cooling Equipment For Both Gradient Coil & Shield/Cryo Cooler Compressor Water Cooling See Note 1	MR System Cooling Equipment For Gradient Coil ONLY See Note 2	
System Equipment ∨	**2 MRCC Units**	**1 MRCC Unit**	**1 GWHX Unit**
PDU draw See Note 3	48.1 KVA	48.1 KVA	49.5 KVA
Magnet Monitor	4.5 KVA	4.5 KVA	4.5 KVA
Shield/Cryo Cooler Compressor	9 KVA	9 KVA	9 KVA
System Cooling equipment (configuration indicated in column heading)	12.4 KVA	6.2 KVA	0 KVA See Note 4
TOTAL See Note 5	74.0 KVA	67.8 KVA	63.0 KVA

Notes

1. Two MRCC units are used to provide water cooling for the Gradient Coil and for the Shield/Cryo Cooler Compressor.
2. Customer provided water cooling for the Shield/Cryo Cooler Compressor is required when either 1 MRCC or the GWHX is used to provide Gradient Coil water cooling. Customer provided water cooling equipment power demands are not included in the values in this table.
3. The PDU is rated for 50 KVA continuous power.
4. The GWHX is powered from the PDU and therefore included in the PDU draw value.
5. GE pre-engineered Main Disconnect Panel (MDP) is rated continuous power draw is 77 KVA but MDP continuous draw does not exceed listed demands.

3 Power Distribution System

3.1 Main Disconnect Panel (MDP) Requirements

NOTICE

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

WARNING

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

WARNING

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.

3.1.1 Twin MDP

The GE pre-engineered Twin MDP option provides multi-point remote control capability which is shown in Illustration 6-1 .

The design of the MDP shall incorporate an adjustable time delay auto restart control circuit for the Cryo Cooler Compressor Chiller, Gradient Chiller, the Shield/Cryo Cooler Compressor Cabinet, and the single phase transformer for Magnet Monitor equipment (Magnet Monitor, optional UPS for Magnet Monitor, modem and the optional Multiplexer Box). The PDU shall not be included in the auto restart control circuit. Operation of any remote Emergency Off push button MUST disable all MDP power and control circuits. LED pilot lights shall indicate system power status.

All control shall be low voltage. Power components shall be selected to provide type 2 coordination between overcurrent devices and all contactors. The 120 VAC supply receptacles for remotely mounted Magnet Monitor UPS (option) and Mux Box (option) must be included along with properly protected control power transformer. The 120 VAC UPS output power shall be connected back into the MDP for distribution to the Magnet Monitor and Modem. Operation of the Emergency Power Off push buttons shall disconnect and isolate the Magnet Monitor UPS output circuits from the Magnet Monitor and modem as well as disable the auto restart function.

The GE pre-engineered Twin MDP consists of the following:

- A three-pole Main Circuit breaker rated for the total current of all the sub-breakers circuits. The short-circuit current interrupting rating of the breaker is 25,000 Amperes minimum or higher interrupting rating sufficient to interrupt the facility available short circuit current at its installed location per National Electric Code (NEC) 2005 or 2002 Article 110.9.
- A three-pole circuit breaker rated for the current of the PDU circuit. The short-circuit current interrupting rating of the breaker is 25,000 Amperes minimum or higher

interrupting rating sufficient to interrupt the facility available short circuit current at its installed location per NEC 2005 or 2002 Article 110.9.

- A three-pole circuit breaker rated for the current of the Cryo Cooler Compressor Chiller (1st MRCC unit) circuit. The short-circuit current interrupting rating of the breaker is 25,000 Amperes to accommodate facility available short circuit current.
- A three-pole circuit breaker rated for the current of the Gradient Chiller (2nd MRCC unit) circuit. The short-circuit current interrupting rating of the breaker is 25,000 Amperes to accommodate facility available short circuit current.
- A three-pole circuit breaker rated for the current of the Shield/Cryo Cooler Compressor Cabinet circuit. The short-circuit current interrupting rating of the breaker is 25,000 Amperes to accommodate facility available short circuit current.
- A circuit to provide 120VAC single phase power to the Magnet Monitor, Modem, UPS for Magnet Monitor (optional), and Multiplexer Box (optional). The short-circuit current interrupting rating of the breaker is 25,000 Amperes to accommodate available fault current. The MDP includes a single phase step down transformer for 120VAC loads such as Magnet Monitor equipment (Magnet Monitor, optional UPS for Magnet Monitor, modem and the optional Multiplexer Box).
- The Twin MDP Panel has receptacles inside the panel enclosure for connections of the UPS for Magnet Monitor input and output, Multiplexer Box, Magnet Monitor, and modem. The enclosure has provision for these cables to enter through the access panels in the bottom left side of the enclosure. Mounting of the panel must allow for 5-6 inch (127-152 mm) of free space to allow for cable bending and installation. Strain relief bushings are provided with the individual equipment for each of these cables, not provided with the MDP.

The MDP is to be located so the top of the upper circuit breaker handle when in the ON position does not exceed 79 inches (2000 mm) from the floor and visible to Power Distribution Unit (PD1), MRCC or its RCP, Shield/Cryo Cooler Compressor Cabinet, and the service personnel. The optional UPS for the Magnet Monitor may be located below the MDP if sufficient space is available or adjacent if sufficient space is not available, refer to Chapter 3, Section 9.7, System Monitoring and Support Connectivity.

NOTE: The GE pre-engineered Twin MDP circuits for the Cryo Cooler Compressor Chiller, Gradient Chiller, the Shield/Cryo Cooler Compressor Cabinet, and the single phase transformer for Magnet Monitor equipment (Magnet Monitor, optional UPS for Magnet Monitor, modem and the optional Multiplexer Box) have auto restart upon return of normal power after a time delay of 3 to 30 seconds (field adjustable) to minimize cryogen consumption of the system. The MDP Emergency Off circuit turns off power to all branch circuits including the Magnet Monitor UPS option output and turns off the auto restart function.

NOTE: The PDU circuit has low voltage release feature which disconnects power from the PDU upon the first loss of power. Power to the PDU is not restored automatically after a power interruption. Emergency Off operation disconnects power from all circuits including the PDU.

NOTE: The GE pre-engineered Twin MDP circuits for the Cryo Cooler Compressor Chiller, Gradient Chiller, the Shield/Cryo Cooler Compressor Cabinet, and the single phase transformer for Magnet Monitor equipment (Magnet Monitor, optional UPS for Magnet Monitor, modem and the optional Multiplexer Box) have auto restart upon return of normal power after a time delay of 3 to 30 seconds (field adjustable) to minimize cryogen consumption of the system. The MDP Emergency Off circuit turns off power to all branch circuits including the Magnet Monitor UPS option output and turns off the auto restart function.

The circuit breakers or fuses ahead of the MDP must be capable of handling the magnetizing inrush currents of the Coldhead MRCC, Gradient MRCC, Shield/Cryo Cooler Compressor, Magnet Monitor equipment, and transformer of the PDU module (PD1) in the ACGD/PDU Cabinet (MR3). If fuses are used time delayed fuses are recommended.

Check local and national codes to determine if an interlock to the air-conditioning unit in the Equipment Room is required in the protective disconnect setup.

The GE pre-engineered Twin MDP option provides two Emergency Off buttons to be connected to the MDP to disable the power to all system equipment in emergency situations. Two Emergency Off buttons must be provided by the customer if GE pre-engineered Twin MDP Option is not used. The Emergency Off buttons are to be mounted near each exit in the Magnet Room and Equipment Room 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. The Emergency Off buttons are to be clearly labeled “Emergency Off" and visible to personnel. It is important the buttons are labeled “off" and not “stop" since there exists an “Emergency Stop" button in the Signa system which powers down only a portion of system equipment for patient safety.

NOTE: The emergency off circuit disconnects power to the PDU, Gradient MRCC, Coldhead MRCC, Shield/Cryo Cooler Compressor Cabinet, the single phase 120V transformer output and optional UPS (if purchased) for Magnet Monitor equipment. Power can be restored to the MDP outputs by pressing the MAIN POWER ON push button on the MDP for the Gradient MRCC, Coldhead MRCC, Shield/Cryo Cooler Compressor Cabinet, Magnet Monitor equipment (Magnet Monitor, optional UPS for Magnet Monitor, modem and the optional Multiplexer Box). Power to the PDU is restored by pressing the PDU POWER ON push button and also requires pressing the EMO Reset button on the PDU.

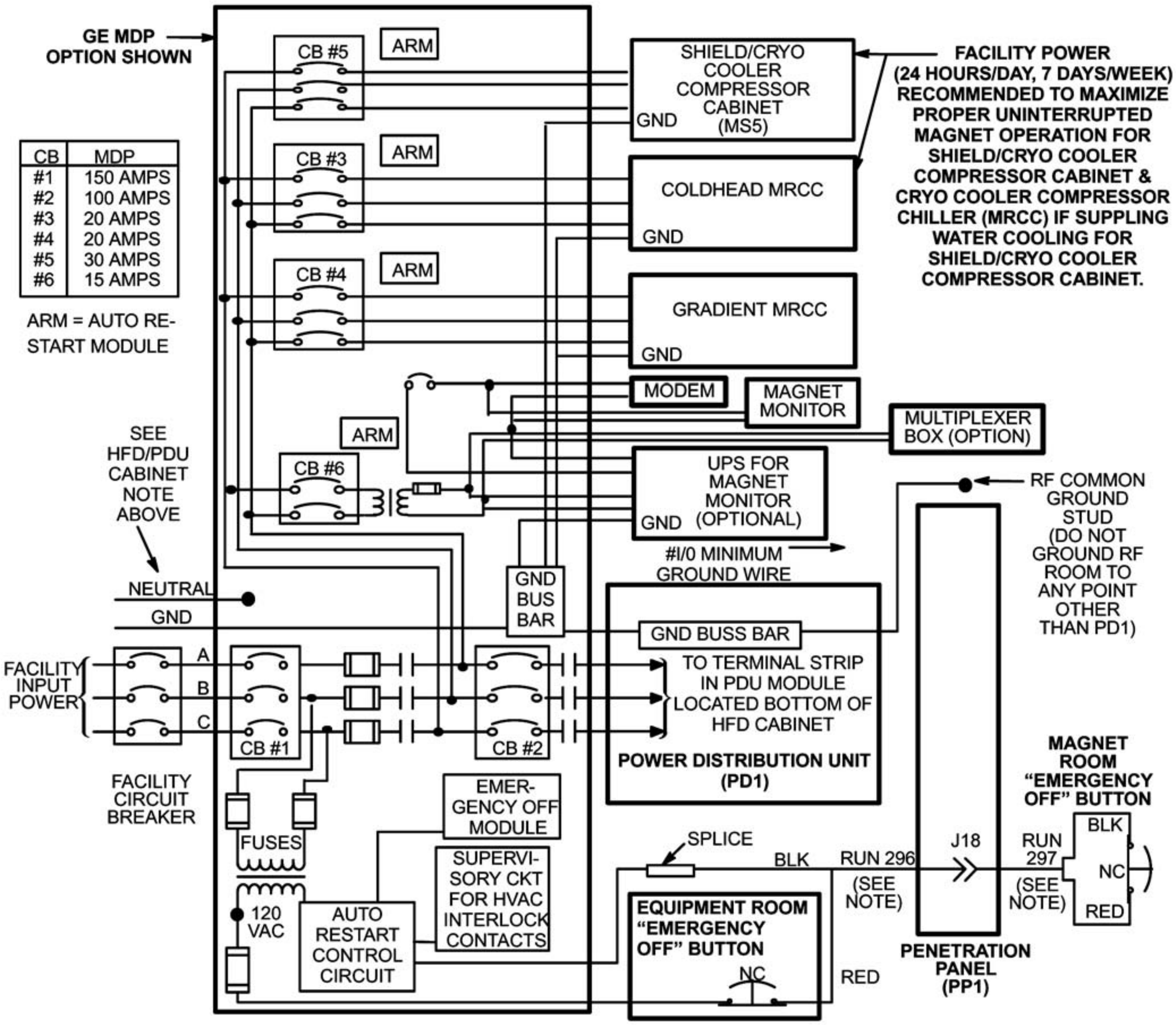
The MDP must be lockable to provide for single point power Lockout/Tagout requirements. The MDP provides for the disconnection of the facility power to the PDU, Coldhead Compressor Chiller, Gradient Chiller, and Shield/Cryo Cooler Compressor Cabinet. Individual branch circuits for the PDU, Magnet Monitor equipment, Coldhead MRCC, Gradient MRCC, and Shield/Cryo Cooler Compressor Cabinet must be lockable circuit breakers. The GE pre-engineered MDP has lockable GE Spectra circuit breakers and also has electrical contacts for an interlock to the air-conditioning units in the Equipment Room. 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.

The MDP must be listed and labeled by a Nationally Recognized Testing Lab (NRTL) such as Underwriters Laboratory (UL) in accordance with NEC 2005 or 2002 Article 110.2. The GE pre-engineered MDP option is UL labeled in accordance with NEC 2005 or 2002 Article 110.2 and is cUL and CE labelled. A customer designed and manufactured MDP labeling must bear the appropriate markings per local/national regulations.

NOTE: The maximum conductor the GE pre-engineered MDP can accept is #3/0 AWG (83 mm2). For feeders larger than 3/0 AWG (83 mm2) the wires must be reduced (ie. splice, junction box, etc.) to 3/0 AWG (83 mm2) 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 2/0 AWG (70 mm2).

Illustration 6-1: Twin MDP Protective Disconnect Set-Up

NOTE:
- RUNS 296 AND 297, & POWER CORDS FOR SHIELD/CRYO COOLER COMPRESSOR CABINET, MRCC, & MAGNET MONITOR EQUIPMENT (MAGNET MONITOR, UPS INPUT & OUTPUT, MODEM, OPTIONAL MULTIPLEXER) ARE GE SUPPLIED CABLES. **ALL OTHER WIRING IS CUSTOMER SUPPLIED.**
- TWO REMOTE EMERGENCY "OFF" BUTTONS ARE SUPPLIED WITH GE MDP OPTION, **EMERGENCY OFF BUTTONS ARE CUSTOMER SUPPLIED IF GE MDP OPTION NOT USED** .
- CIRCUIT BREAKERS ARE PROVIDED FOR PDU, CRYO COOLER COMPRESSOR CHILLER, GRADIENT CHILLER, SHIELD/CRYO COOLER COMPRESSOR CABINET, MAGNET MONITOR EQUIPMENT CIRCUITS.
- ALL BRANCH CIRCUITS DROP OUT ON LOSS OF POWER. COLDHEAD MRCC, GRADIENT MRCC, SHIELD/CRYO COOLER COMPRESSOR CABINET, & MAGNET MONITOR EQUIPMENT AUTOMATICALLY RESTART AFTER 3 SEC TIME DELAY UPON RESTORATION OF POWER. EMERGENCY OFF LOCKS OUT ALL CONTACTORS.
- IF 3 PHASE WYE WITH NEUTRAL AND GROUND (5 WIRE SYSTEM) INPUT USED THEN NEUTRAL MUST BE TERMINATED INSIDE THE MAIN DISCONNECT PANEL AND NOT BROUGHT TO THE HFD/PDUCABINET
- SUPERVISORY CIRCUIT FOR HVAC INTERLOCK CONTACTS OPEN ON LOSS OF DC POWER OR EMERGENCY OFF OPERATION.



3.2 System Power Distribution Unit

The PDU Module in the lower portion of HFD/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 mm2). Larger feeder wires can be connected to the MDP with 3/0 AWG (83 mm2) 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 HFD/PDU Cabinet (MR3).

NOTE: When the full MR system UPS option [Signature 5000 Series 3 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.

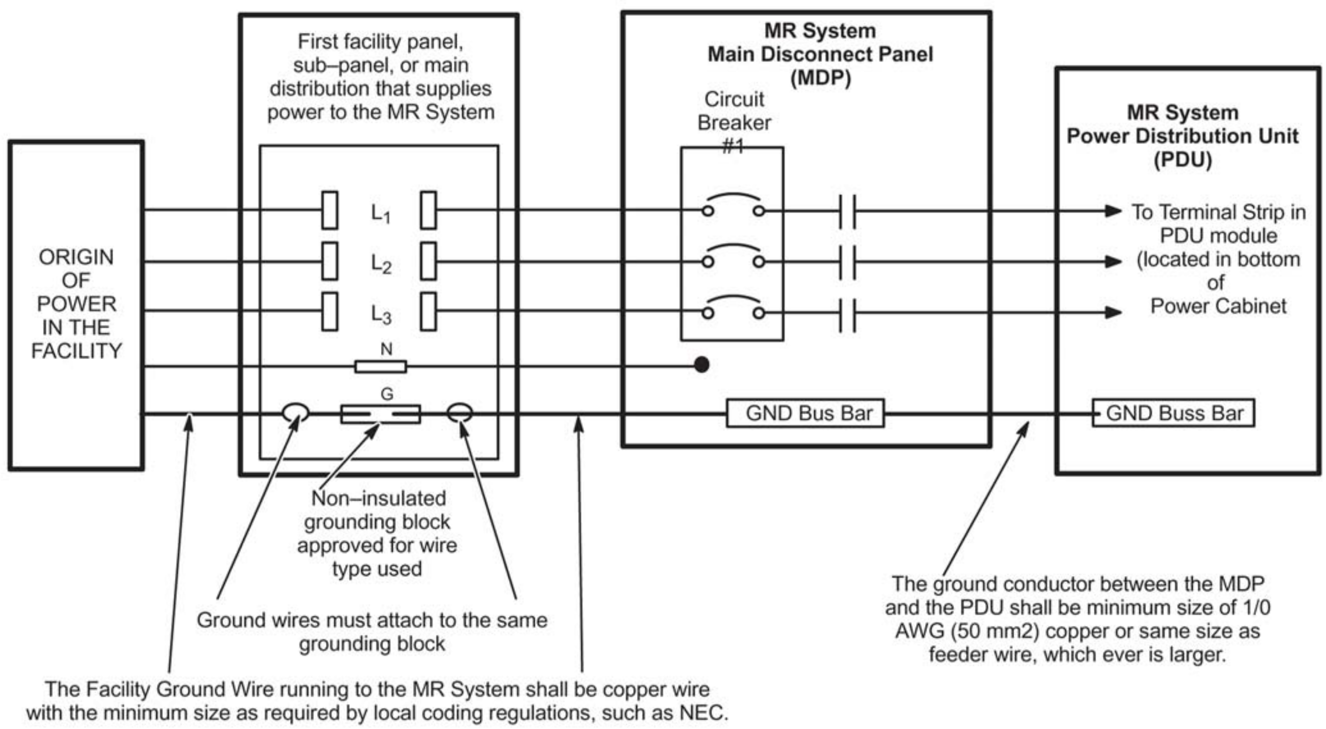
4 Grounding

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 the facility, and be continuous to the MR system Main Disconnect Panel (MDP) 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.

Illustration 6-2: Ground Wire To MR System & Ground Connection At Distribution Panel



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. 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.

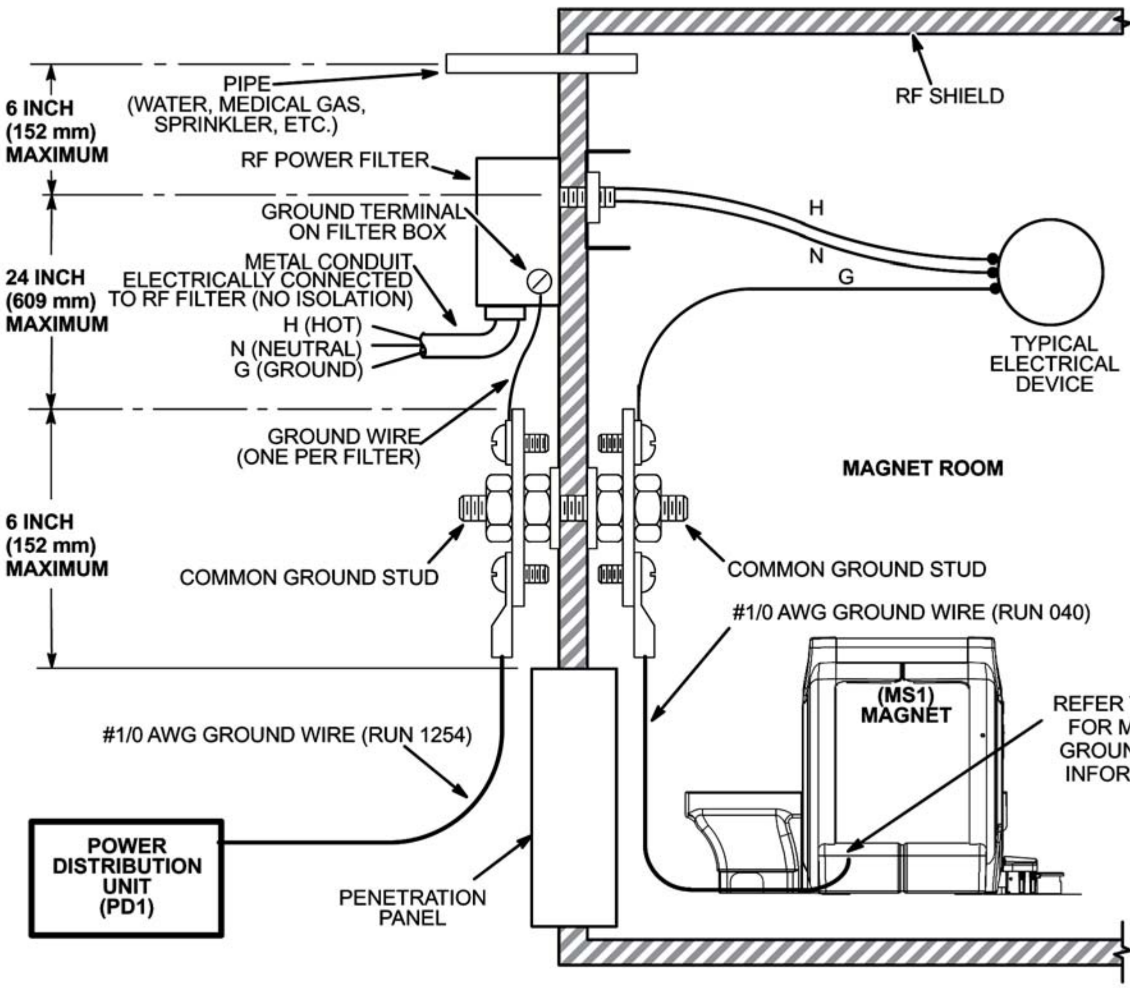
The three major grounding points in the MR system are: the system ground point (bus) in the System PDU (PD1), the enclosure ground points (ground studs located in each cabinet or enclosure), and the RF shielded room common ground point. This RF shielded room common ground point is to be located within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

Illustration 6-3: MR Magnet Room Grounding Requirements And Typical Diagram

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 AND ONE #1/0 AWG GROUND WIRE BETWEEN PD1 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 PER NEC 2005 ACTICLE 517.13 (A) & (B).
- 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 4 GROUND STUDS, ONE ON EACH FOOT. HOWEVER, THERE IS ONLY ONE #1/0 AWG GROUND WIRE TO BE CONNECTED TO ONLY ONE OF THE GROUND STUDS.



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 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 2002 Article 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 (B) 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 under System Grounding heading in Section 4, Grounding. Always check national and local codes for other emergency power requirements.

8 DC Lighting Controller (Facility Option)

Direct current (DC) powered lighting is required 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 Illustration 6-4 and Illustration 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 = Total Lamp Wattage ÷ 115V**. If **I** ≤ **20** then a 20 Amp system can be used. If **I** ≥**20 but <28** then use the 28 Amp system.

Illustration 6-4: DC Lighting Controller (Facility Option) Wiring Diagram

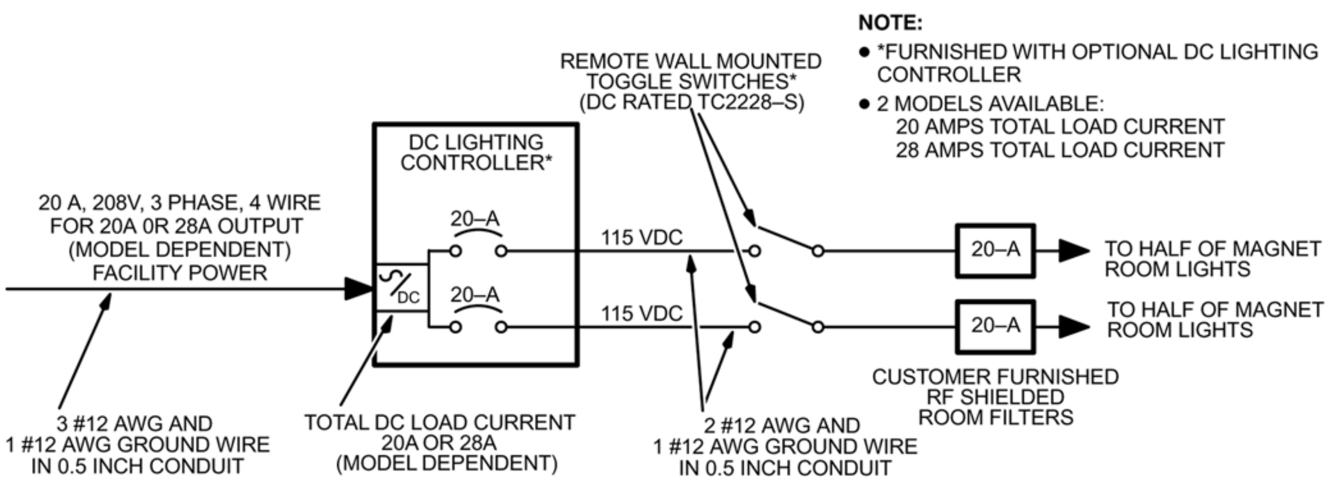
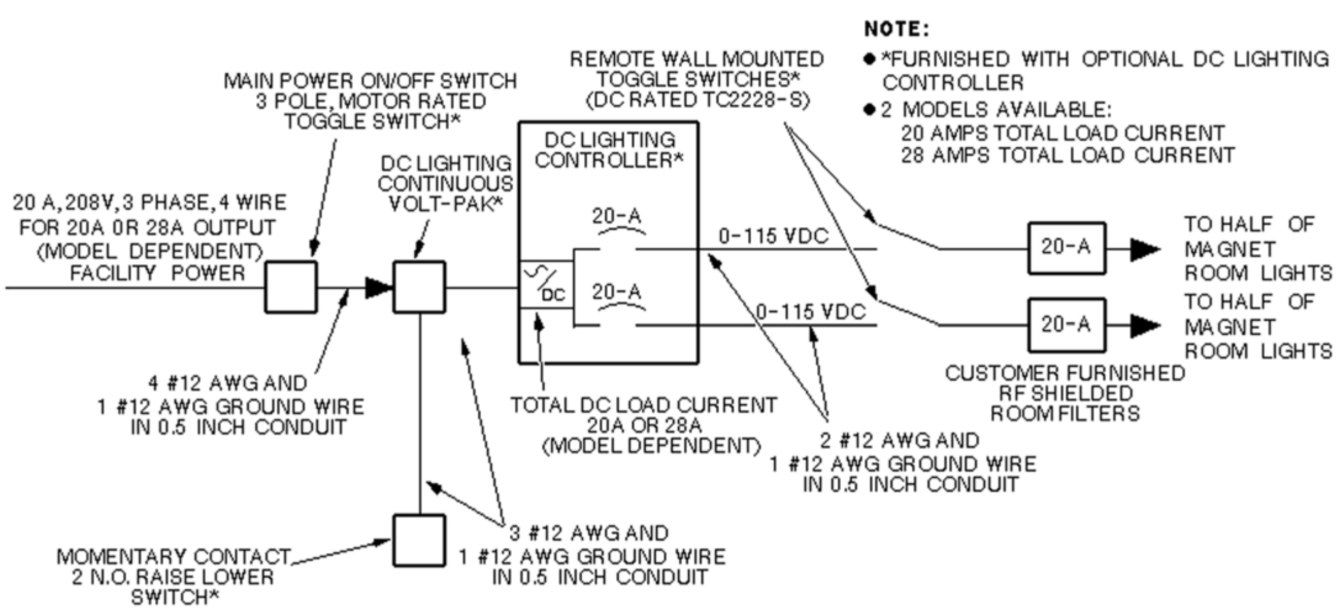


Illustration 6-5: Variable DC Lighting Controller (Facility Option) Wiring Diagram



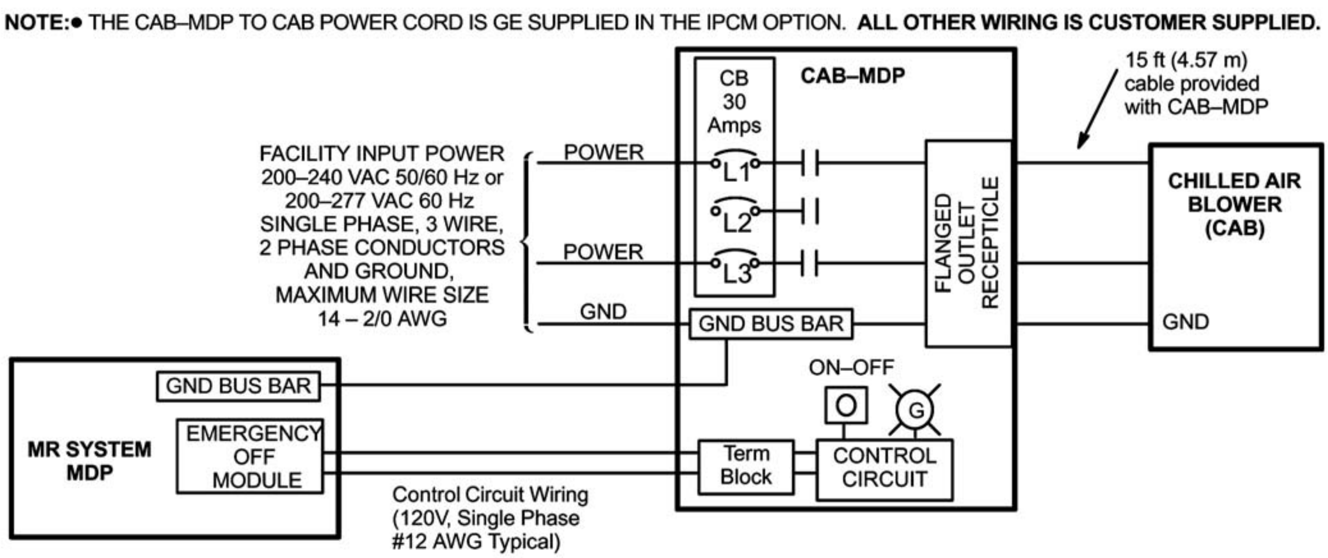
9 IPCM Option Power Requirements

The IPCM Option hardware consists of the Chilled Air Blower (CAB), CAB Main Disconnect Panel (CAB-MDP), Bore Liner hardware, modified Penetration Panel waveguide, Bridge with notched sides, Bore Liner hardware including hoses and connectors, and IPCM Option Key.

The Chilled Air Blower (CAB) provides chilled air to the 2 piece Bore Liner via an air hose routed through the Penetration Panel (provided waveguide) to the back end of the Rear Pedestal. At the Rear Pedestal additional provided hardware, hoses and connectors are used to connect the air hose to both pieces of the Bore Liner.

The CAB-MDP is not powered from the MR system MDP or PDU and therefore requires facility provided power. The CAB-MDP must also be connected to the MR system MDP Emergency Power Off control circuit via a customer supplied cable. Refer to Illustration 6-6 for IPCM Main Disconnect Panel set-up.

Illustration 6-6: IPCM Main Disconnect Panel Set-up



Chapter 7 Interconnect Data

1 Interconnect Data Overview

1.1 Introduction

System and interconnects installation must be in accordance with local and national code.

The sections in the Interconnect Data Chapter contain details of GE supplied MR system interconnections and customer supplied components for the MR system install.

1.2 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 the Interconnect Data sections.

Refer to Table 7-1 for all component designators.

Table 7-1: MR System Component Designations

Basic System Or Option	Component Designator	Description
Basic System	EO1/EO2	Emergency Off Buttons
	GWHX	Indoor Gradient Coil Water Heat Exchanger
	MDP	Main Disconnect Panel
	MG2	Magnet Enclosure
	MG3	Magnet Rear Pedestal
	MG6	Blower Box
	MR2	RFS Cabinet
	MR3	HFD/PDU Cabinet has PD1 in lower portion cabinet
	MR8	Narrow Band RF Amplifier Cabinet
	MRCC	MR Common Chiller (may have Unit #1 and Unit #2)
	MS1	Superconducting Magnet
	MS4	Magnet Rundown Unit
	MS5	Shield/Cryo Cooler Compressor Cabinet
	MSM1	Magnet Monitor
	MSM3	Modem for Magnet Monitor
	OW1	Operator Workspace
	PD1	Power Distribution Unit (PDU) is a module in lower portion of HFD/PDU Cabinet
	PA1	Pneumatic Patient Alert Control Box
	PP1	Penetration Panel
	PT1	Patient Transport Table
	RCP	Remote Control Box for MRCC located outdoors or indoors
	TAC	Twin Accessory Cabinet

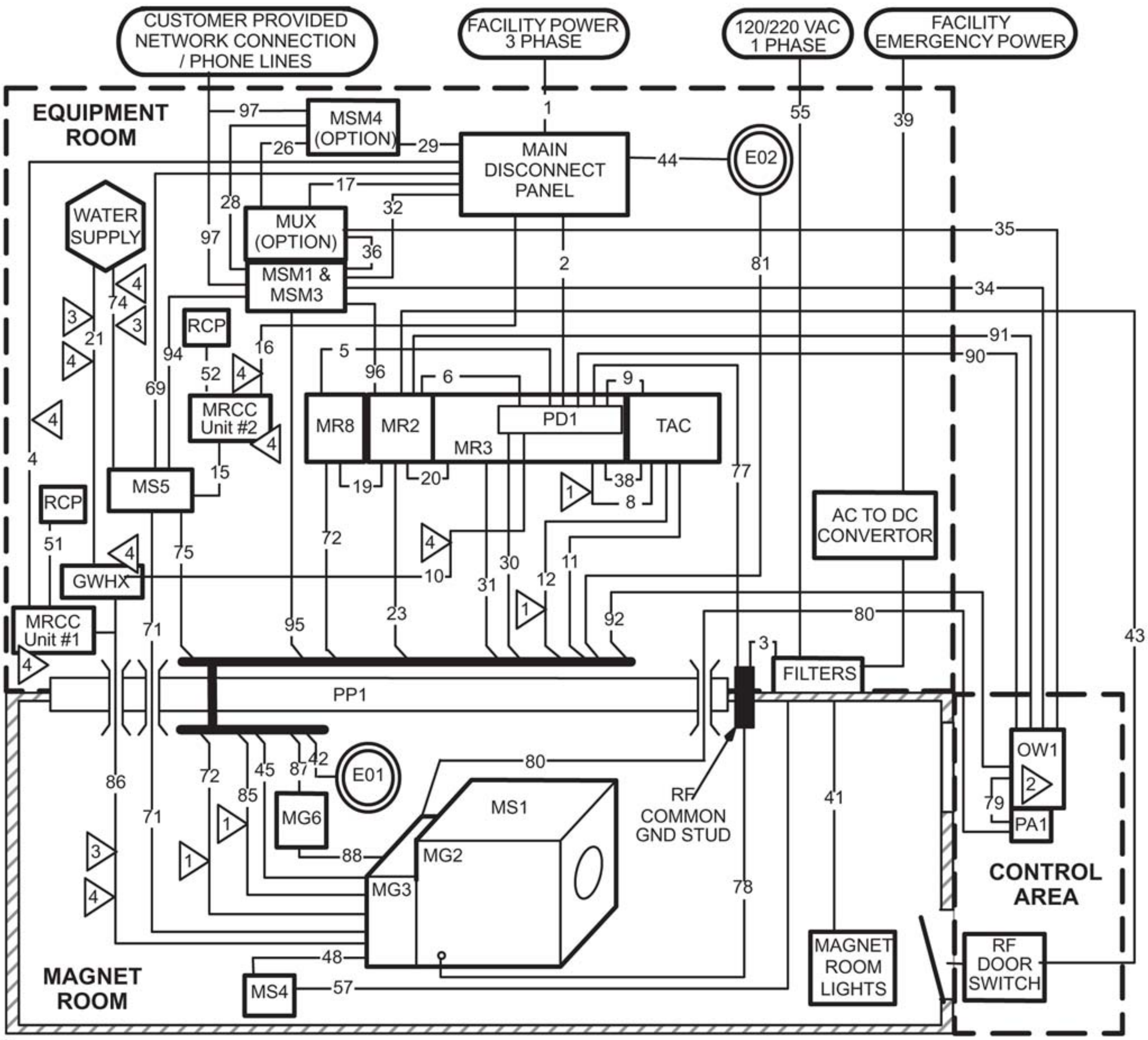
Table 7-1: MR System Component Designations (cont'd)

Basic System Or Option	Component Designator	Description
System Options	BW	BrainWave HW Lite Cabinet
	MSM4	UPS for Magnet Monitor
	MR9	BroadBand RF Amplifier Cabinet for 8KW MNS option
	MR10	3T MNS Amp Cabinet for 4KW MNS option
	not used	
	MUX	Phone Line Multiplexer for Magnet Monitor
	OM1	Oxygen Monitor
	OM3	Remote Oxygen Sensor Module

1.3 Group Interconnects

Illustration 7-1 shows the Group Interconnect Diagram for the Signa system. Each group contains one or more cables. This diagram should be referred to when using the tables in this chapter.

Illustration 7-1: Signa Group Interconnect Diagram



1. MUST BE CUT AND CONNECTED TO 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.
OW INTERCONNECTS ARE ROUTED THROUGH TABLE CABLE TRAY.

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

4. FOR GROUPS 4, 10, 15, 16, 21, 49, 50, 51, 52, 74, & 86 REFER TO **MRCC ADDITIONAL INTERCONNECTS** OR **GWHX ADDITIONAL INTERCONNECTS** SECTION FOR CONFIGURATION APPROPRIATE INTERCONNECTS AND DETAILS.

NOTE: For Groups 4, 10, 15, 16, 21, 50, 51, 74, & 86 for configuration appropriate interconnects and details refer to Section 5.1, Interconnects For 2 MRCC Units Located Outdoors, Section 5.2, Interconnects For 2 MRCC Units Located Indoors, Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors, Section 5.4, Interconnects For 1 MRCC Unit Located Indoors, or Section 6, GWHX Additional Interconnects.

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1.4 Definition of Terms

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

L1 (Location 1)

Location of interconnects between Penetration Panel (PP1) and components in Magnet Room and Within Magnet Room between components

L2 (Location 2)

Location of interconnects between Penetration Panel (PP1) and components in Equipment Room

L1/L2 (Location 1 / Location 2)

Location of 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

L3 (Location 3)

Location of interconnects between components within Equipment Room

L4 (Location 4)

Location of interconnects between Operator Workspace (OW) and PP1

L5 (Location 5)

Location of interconnects between OW and components in Equipment Room

Table 7-2 lists the relative length for each location.

Table 7-2: Signa EXCITE HD 3T Interconnects Location & Relative Length Provided

Location	Relative Length Provided By Catalog See Table Note		
	M3334TD	**M3334TE**	**M3334TF**
L1	short	short	long
L2	short	long	short
L1/L2	short	long	medium
L3	same length for all catalogs		
L4	same length for all catalogs		

Table 7-2: Signa EXCITE HD 3T Interconnects Location & Relative Length Provided (cont'd)

Location	Relative Length Provided By Catalog See Table Note		
	M3334TD	M3334TE	M3334TF
L5	same length for all catalogs		
NOTE: Refer to Section 4.2, Cable Groups Length Provided for cable groups specific length provided by each catalog.			

NOTE: Chapter 2, Section 1, Basic System lists the Fixed Site cable collector catalogs which provide the different length of interconnects for several cable groups. Groups usable length for each catalog are listed in Section 4.2, Cable Groups Length Provided.

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.

Group Number

Identifying number referenced to bundles (i.e. groups) of cables as shown in illustrations in Section 1.3, Group Interconnects

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 chapter, for designators descriptions refer to Section 1.2, Component Designators.

Run Number

Unique number assigned to each GE-supplied cable.

NOTE: The Run Number must be used when making special cable order inquiries.

Cable Diameter

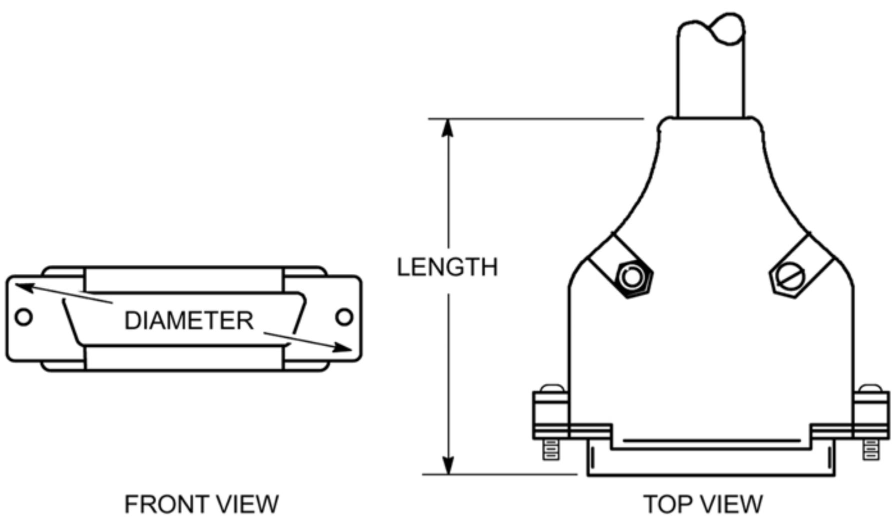
Diameter of an individual cable

Plug Pulling Diameter x Length

Cable plug dimensions as shown in Illustration 7-2

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). The same number of connectors apply to the metric dimensions as well.

Illustration 7-2: Subminiature-D Connector Plug Pulling Dimensions



2 Power Interconnects

The interconnects for the MDP include:

- Facility Main power; refer to Chapter 6, Section 1, System Power Introduction and Chapter 6, Section 2, Critical 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 HFD/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)

- System Cooling Cabinet, for power interconnect details refer to the appropriate configuration:

- Section 5.1, Interconnects For 2 MRCC Units Located Outdoors
- Section 5.2, Interconnects For 2 MRCC Units Located Indoors
- Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors
- Section 5.4, Interconnects For 1 MRCC Unit Located Indoors
- Section 6, GWHX Additional Interconnects

- Magnet Monitor equipment

The interconnects for the PD1 include:

- Power cables GE supplied subsystems for Operator Workspace, RFS Cabinet, Twin Accessory Cabinet, NB RF Amp Cabinet.

- 2 auxiliary ground cables to PD1

- 2 control cables to 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 routing power cables.

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

Unless otherwise specified, cables and components listed in the following subsections 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 3.1, Main Disconnect Panel (MDP) for information on the recommended protective disconnect device and emergency off button locations and mounting.

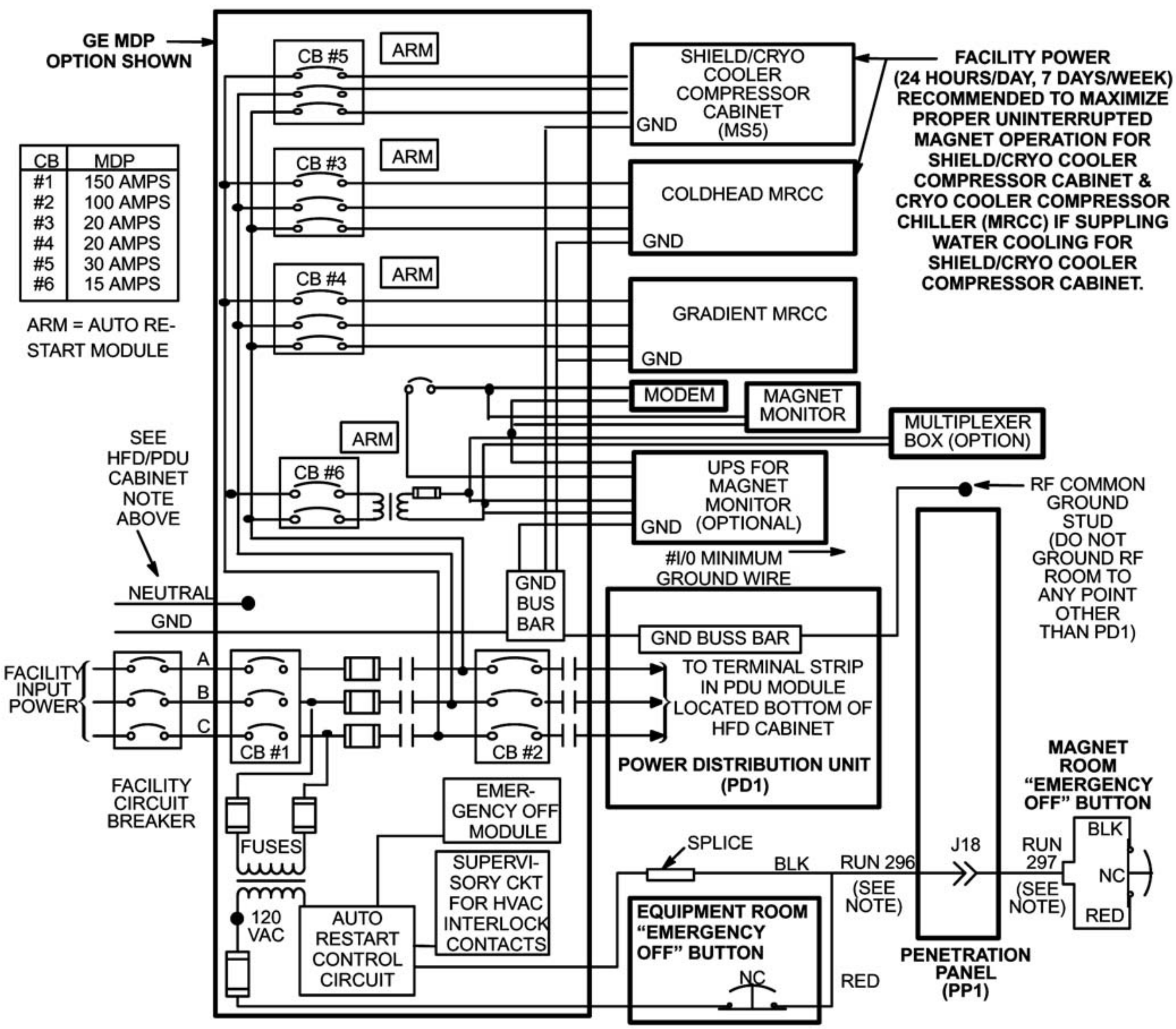
The emergency off wiring for the MR system is unique because the wiring into the Magnet Room must be RF tight.

3.2 Main Disconnect Panel Connections

The emergency off circuit is shown in Illustration 7-3 . The circuit utilizes the normally closed series loop shown. The GE pre-engineered MDP Option provides 2 emergency off buttons.

Illustration 7-3: Protective Disconnect Set-Up

NOTE:
- RUNS 296 AND 297, & POWER CORDS FOR SHIELD/CRYO COOLER COMPRESSOR CABINET, MRCC, & MAGNET MONITOR EQUIPMENT (MAGNET MONITOR, UPS INPUT & OUTPUT, MODEM, OPTIONAL MULTIPLEXER) ARE GE SUPPLIED CABLES. **ALL OTHER WIRING IS CUSTOMER SUPPLIED.**
- TWO REMOTE EMERGENCY "OFF" BUTTONS ARE SUPPLIED WITH GE MDP OPTION, **EMERGENCY OFF BUTTONS ARE CUSTOMER SUPPLIED IF GE MDP OPTION NOT USED** .
- CIRCUIT BREAKERS ARE PROVIDED FOR PDU, CRYO COOLER COMPRESSOR CHILLER, GRADIENT CHILLER, SHIELD/CRYO COOLER COMPRESSOR CABINET, MAGNET MONITOR EQUIPMENT CIRCUITS.
- ALL BRANCH CIRCUITS DROP OUT ON LOSS OF POWER. COLDHEAD MRCC, GRADIENT MRCC, SHIELD/CRYO COOLER COMPRESSOR CABINET, & MAGNET MONITOR EQUIPMENT AUTOMATICALLY RESTART AFTER 3 SEC TIME DELAY UPON RESTORATION OF POWER. EMERGENCY OFF LOCKS OUT ALL CONTACTORS.
- IF 3 PHASE WYE WITH NEUTRAL AND GROUND (5 WIRE SYSTEM) INPUT USED THEN NEUTRAL MUST BE TERMINATED INSIDE THE MAIN DISCONNECT PANEL AND NOT BROUGHT TO THE HFD/PDUCABINET
- SUPERVISORY CIRCUIT FOR HVAC INTERLOCK CONTACTS OPEN ON LOSS OF DC POWER OR EMERGENCY OFF OPERATION.



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.

Section 3.2 illustration black and red wires are used for connections on the ends of Runs 296 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.

Details of cable group lengths provided by specific system configuration catalogs are contained in Section 4.2, Cable Groups Length Provided. Individual interconnects dimensional details are provided in the following:

- Section 4.3, L1 Interconnects
- Section 4.4, L2 Interconnects
- Section 4.5, L1 / L2 Interconnects
- Section 4.6, L3 Interconnects
- Section 4.7, L4 Interconnects
- Section 4.8, L5 Interconnects

4.2 Cable Groups Length Provided

Table 7-3 lists the specific usable length provided for each interconnect Group to determine the fixed site cable catalog which will best meet the specific site layout requires.

Table 7-3: Cable Groups Length Provided By Fixed Site Cable Catalogs

Location	Group	Between Units		Usable Length		
		From	To	M3334TD ft (m)	M3334TE ft (m)	M3334TF ft (m)
L1	42	PP1	EO1	68 (20.7) 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, & 3		
	48	MS4	MS1	81 (24.7) See Note 3		
	78	RF Common Ground Stud	MS1	19 (5.79)	19 (5.79)	40 (12.2)
				minus takeup at RF Common Ground Stud		
	85	PP1	MG3	19 (5.79)	19 (5.79)	40 (12.2)
	87	PP1	MG6	16 (4.88)	16 (4.88)	37 (11.3)
	88	MG6	MG3	11 (3.35) allows 2 ft (0.6 m) takeup at MG6 See Note 4		
L2	11	TAC	PP1	21 (6.40)	55 (16.76)	21 (6.40)
	12	TAC	PP1	43* (13.11*)	50* (15.24*)	43* (13.11*)
				*Group 8 and Group 12 are both cut to length at site from the total usable length of cable supplied.		
	23	MR2	PP1	25 (7.62)	55 (16.8)	25 (7.62)
	30	PD1	PP1	59 (17.98)		
	31	MR3	PP1	25 (7.62)	61 (18.59)	25 (7.62)
	75	MS5	PP1	42 (12.8) See Note 3		
	77	PD1	RF Common Ground Stud	83 (25.3)		
	81	EO2	PP1	30 (9.14)	50 (15.24)	30 (9.14)
	95	MSM1	PP1	67 (20.42) allows 8 ft (2.44 m) takeup at MSM1 See Note 1		

Table 7-3: Cable Groups Length Provided By Fixed Site Cable Catalogs (cont'd)

Location	Group	Between Units		Usable Length		
		From	To	M3334TD ft (m)	M3334TE ft (m)	M3334TF ft (m)
L1/L2	71	MS5	MS1	42 (12.80) Runs are routed through waveguides in PP1. Runs have a 8 in. (203.2 mm) bend radius. See Note 3		
	72	MR2	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	MRCC/ GWHX See Usable Length	MG2	To determine FROM connection, for length requirements, & details refer to appropriate configuration: Section 5.1, Interconnects For 2 MRCC Units Located Outdoors, Section 5.2, Interconnects For 2 MRCC Units Located Indoors, Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors, Section 5.4, Interconnects For 1 MRCC Unit Located Indoors, or Section 6, GWHX Additional Interconnects.		
L3	5	PD1	MR8	24 (7.315)		
	6	PD1	MR2	16 (4.88)		
	8	MR3	TAC	43* (13.11*)	50* (15.24*)	43* (13.11*)
				*Group 8 and Group 12 are both cut to length at site from the total usable length of cable supplied.		
	9	PD1	TAC	16 (4.88)		
	10	PD1	GWHX	Section 6, GWHX Additional Interconnects		
	15	MS5	MRCC Unit #2	Refer to appropriate configuration: Section 5.1, Interconnects For 2 MRCC Units Located Outdoors, Section 5.2, Interconnects For 2 MRCC Units Located Indoors, Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors, or Section 5.4, Interconnects For 1 MRCC Unit Located Indoors.		
	17	MDP	MUX	6 (1.8)		
	19	MR2	MR8	24 (7.315)		
	20	MR2	MR3	16 (4.88)		
	28	MSM1 & MSM3	MSM4	6 (1.8) minus takeup at each end ONLY USED WITH UPS OPTION FOR MAGNET MONITOR: Customer provided phone line, cable diameter & plug pull information are estimates.		
	29	MDP	MSM4	6 (1.8) minus takeup at each end		
	32	MDP	MSM1 & MSM3	6 (1.8) minus takeup at each end		
	36	MSM3	MUX	6 (1.8) minus takeup at each end ONLY NEEDED WHEN MULTIPLEXER FOR PHONE LINE IS USED		
	38	MR3	TAC	16 (4.88)		

Table 7-3: Cable Groups Length Provided By Fixed Site Cable Catalogs (cont'd)

Location	Group	Between Units		Usable Length		
		From	To	M3334TD ft (m)	M3334TE ft (m)	M3334TF ft (m)
L3 continued	51	MRCC Unit #1	RCP	Refer to appropriate configuration: Section 5.1, Interconnects For 2 MRCC Units Located Outdoors, Section 5.2, Interconnects For 2 MRCC Units Located Indoors, Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors, or Section 5.4, Interconnects For 1 MRCC Unit Located Indoors.		
	52	MRCC Unit #2	RCP	Refer to Section 5.1, Interconnects For 2 MRCC Units Located Outdoors or Section 5.2, Interconnects For 2 MRCC Units Located Indoors		
	69	MDP	MS5	27 (8.23) allows 3 ft (0.91 m) takeup at MDP		
	94	MSM1	MS5	49 (14.94) allows 8 ft (2.44 m) takeup at MSM1		
	96	MSM1	MR2	50 (15.24) allows 8 ft (2.44 m) takeup at MSM1		
L4	79	OW1	PA1	5 (1.5) minus takeup at PA1		
	80	PA1	MG2	72 (21.9.5) allows 5 ft (1.52 m) takeup at PA1 (See Note 5) Pneumatic tubing is continuously routed from PA1 through PP1 and MG3 to MG2		
	92	PP1	OW1	80 (24.4)		
L5	34	MSM1	OW1	75 (22.9)		
	43	MR2	RF Door Switch	83 (25.3) allows 15 ft (4.57 m) takeup at RF Door Switch		
	90	PD1	OW1	80 (24.4)		
	91	MR2	OW1	80 (24.4)		

Notes

1. 3.0T Magnet Catalog (M3334TW) provides Magnet Monitor interconnects and Shield/Cryo Cooler Compressor to Magnet interconnects included in this Group.
2. 3.0T Magnet Catalog (M3334TW) provides some Penetration Panel to Magnet Enclosure interconnects included in this Group.
3. 3.0T Magnet Catalog (M3334TW) provides Shield/Cryo Cooler Compressor to Magnet interconnects in this Group.
4. 3.0T Fixed Site Collector Catalog (M3333TY) provides Group 88 interconnect.
5. If installation requires greater than listed for 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 7-4 shows the cable Groups which are included in Location 1 interconnects within the Magnet Room.

Illustration 7-4: System L1 Interconnects Diagram

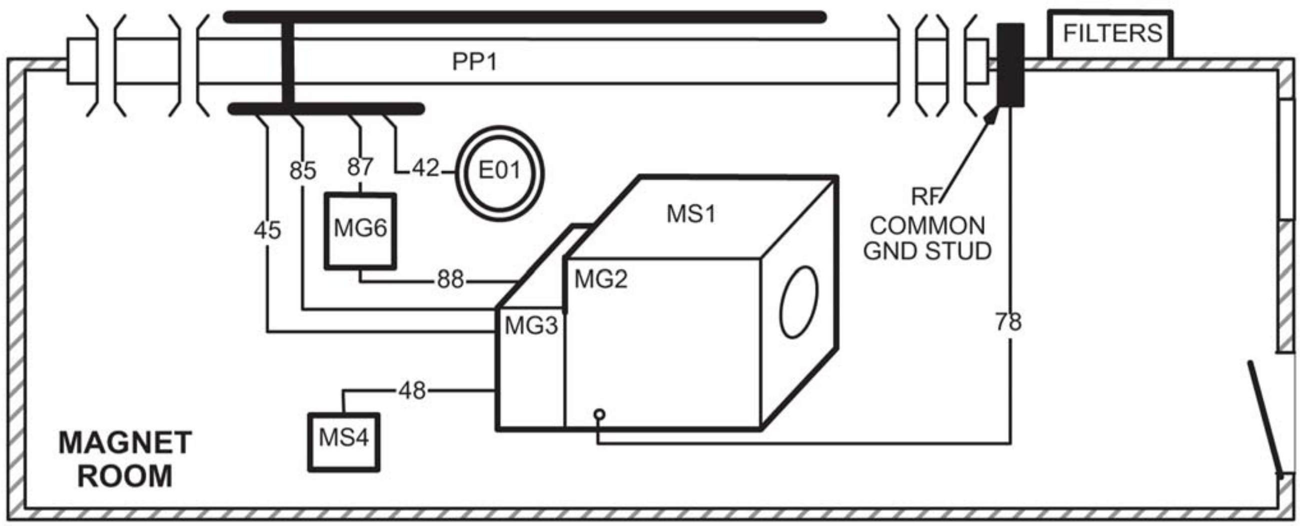


Table 7-4 contains details of the specific interconnects for each Group. Conduit or pipe is not recommended for cable runs since the system uses many prefabricated cables with large connectors. Unless otherwise specified, cables and components listed are supplied by GE.

Table 7-4: L1 Cable Groups Interconnects Details

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
42	0.096 (61.94)	PP1	EO1	297	0.35 (8.9)	1.30x2.00 (33.5x50.8)	Hard Wired	Refer to Section 3, Emergency Off Wiring

Table 7-4: L1 Cable Groups Interconnects Details (cont'd)

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
45	5.021 (3192)	PP1	MG2/3	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)	2.30x2.00 (57.2x50.8)	Run provided by Magnet catalog
				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)	Run provided by Magnet catalog
				387	0.415 (10.5)	2.30x2.00 (57.2x50.8)	2.30x2.00 (57.2x50.8)	
				624	0.26 (6.6)	Ring Terminals	1.00x1.38 (25.4x35.1)	Run provided by Magnet catalog
				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). Run provided by Magnet catalog
				715	0.525 (13.3)	2.80x2.00 (70.4x50.8)	2.80x2.00 (70.4x50.8)	Run provided by Magnet catalog
				716	0.34 (8.64)	1.60x2.00 (40.6x50.8)	1.60x2.00 (40.6x50.8)	Run provided by Magnet catalog
				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)	

Table 7-4: L1 Cable Groups Interconnects Details (cont'd)

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
45 cont.				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 provided by Magnet catalog
				829	0.30 (7.62)	1.30x2.00 (33.5x50.8)	1.30x2.00 (33.5x50.8)	Run provided by Magnet catalog
				1152	0.69 (16.0)	1.75x3.80 (44.5x96.5)	1.75x3.80 (44.5x96.5)	Run for 2nd Order Resistive Shim, provided by Magnet catalog
				1197	0.305 (7.75)	1.30x2.00 (33.0x50.8)	1.30x2.00 (33.0x50.8)	**RF Transmit Cable**
				1198	0.59 (15.0)	1.50x2.50 (38.1x63.5)	1.50x2.50 (38.1x63.5)	**RF Transmit Cable** Cut to length at site
				1199	0.59 (15.0)	1.50x2.50 (38.1x63.5)	1.50x2.50 (38.1x63.5)	**RF Transmit Cable** Cut to length at site
				1200	0.71 (18.0)	2.75x2.25 (69.9x57.2)	2.75x2.25 (69.9x57.2)	**RF Receive Cable**
				1201	0.71 (18.0)	2.75x2.25 (69.9x57.2)	2.75x2.25 (69.9x57.2)	**RF Receive Cable**
				1203	0.525 (13.3)	2.80x2.00 (71.1x50.8)	2.80x2.00 (71.1x50.8)	
				1216	0.45 (11.4)	1.60x2.00 (40.6x50.8)	1.60x2.00 (40.6x50.8)	
				1217	0.525 (13.3)	2.80x2.00 (71.1x50.8)	2.80x2.00 (71.1x50.8)	
				1219	0.71 (18.0)	2.75x2.25 (69.9x57.2)	2.75x2.25 (69.9x57.2)	**RF Receive Cable**
48	0.071 (45.6)	MS4	MS1	606	0.30 (7.6)	0.65x1.85 (16.5x47.0)	0.65x1.85 (16.5x47.0)	Run provided by Magnet catalog
78	0.338 (218)	RF Common Ground Stud	MS1 Ground Stud	040	0.464 (11.79)	Hard Wired	Ring Terminal	1 ground wire
85	6.899 (4441)	PP1	MG3	982	1.21 (30.7)	Ring Terminals	Hard Wired	These cables have a minimum bend radius of 8 in. (203 mm). These runs are cut to length and connected at site.
				983	1.21 (30.7)	Ring Terminals	Hard Wired	
				984	1.21 (30.7)	Ring Terminals	Hard Wired	
				985	1.21 (30.7)	Ring Terminals	Hard Wired	
				986	1.21 (30.7)	Ring Terminals	Hard Wired	
				987	1.21 (30.7)	Ring Terminals	Hard Wired	

Table 7-4: L1 Cable Groups Interconnects Details (cont'd)

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
87	0.352 (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)	
88	15.9 (8544)	MG6	MG3	--	4.5 (104.3)	Flexible vinyl hose	Flexible vinyl hose	The flexible vinyl hose is cut to length during installation. Site Collector catalog provides this interconnect.

4.4 L2 Interconnects

Illustration 7-5 shows the cable Groups which are included in Location 2 between Penetration Panel (PP1) and components in Equipment Room.

Illustration 7-5: System L2 Interconnects Diagram

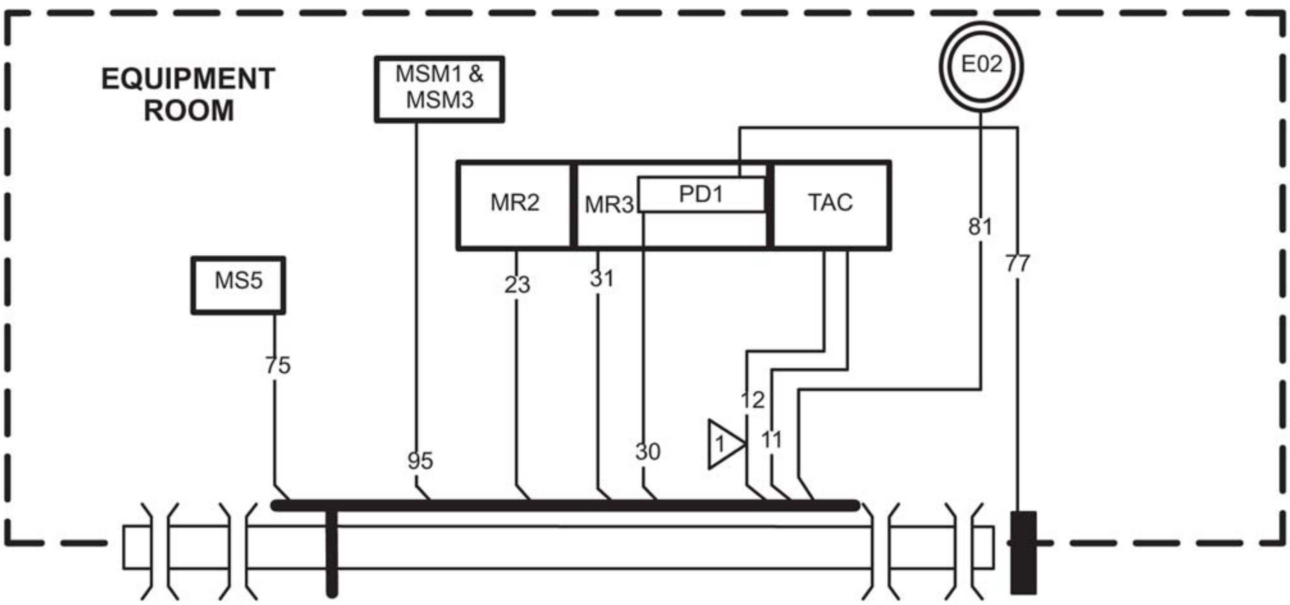


Table 7-5 contains information on interconnects between Penetration Panel (PP1) and components in Equipment Room (Location L2). Conduit or pipe is not recommended for cable runs since the system uses many prefabricated cables with large connectors. Unless otherwise specified, cables and components listed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

Table 7-5: L2 Cable Groups Interconnects Details

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
11	0.385 (248)	TAC	PP1	1151	0.63 (16.0)	1.75x3.80 (44.5x96.5)	1.75x3.80 (44.5x96.5)	Run for 2nd Order Resistive Shim Option, provided by Option catalog
				1233	0.305 (7.75)	1.30x2.00 (33.0x50.8)	1.30x2.00 (33.0x50.8)	

Table 7-5: L2 Cable Groups Interconnects Details (cont'd)

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
12	3.61 (2323)	TAC	PP1	979	1.21 (30.7)	Hard Wired	Ring Terminal	Runs 979, 980, & 981 are cut and connected to TAC at site. Total length supplied is used for Group 8 & 12 routing from MR3 to TAC to PP1.
				980	1.21 (30.7)	Hard Wired	Ring Terminal	
				981	1.21 (30.7)	Hard Wired	Ring Terminal	
				988 X 3	0.26 X 3 (6.6 X 3)	Ring Terminal	Ring Terminal	1 ground wire for each of Runs 979, 980, & 981
23	2.891 (1860)	MR2	PP1	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).
				1184	0.44 (11.2)	2.30x2.00 (57.2x50.8)	2.30x2.00 (57.2x50.8)	
				1185	0.71 (18.0)	2.75x2.25 (69.9x57.2)	2.75x2.25 (69.9x57.2)	**RF Receive Cable**
				1186	0.71 (18.0)	2.75x2.25 (69.9x57.2)	2.75x2.25 (69.9x57.2)	**RF Receive Cable**
				1329 1188	0.34 (8.6)	1.60x2.00 (40.6x50.8)	1.60x2.00 (40.6x50.8)	
				1330 1189	0.525 (13.3)	2.80x2.00 (71.1x50.8)	2.80x2.00 (71.1x50.8)	
				1190	0.525 (13.3)	2.80x2.00 (71.1x50.8)	2.80x2.00 (71.1x50.8)	
				1191	0.19 (4.8)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1192	0.19 (4.8)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1193	0.19 (4.8)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1194	0.19 (4.90)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1195	0.19 (4.90)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1218	0.45 (11.4)	2.75x2.25 (69.9x57.2)	2.75x2.25 (69.9x57.2)	**RF Receive Cable**
				1238	0.59 (150)	1.50x2.50 (38.1x63.5)	1.40x1.55 (35.6x39.4)	**RF Receive Cable** Cut to length at site
30	0.154 (99)	PD1 See Note 1	PP1	1182	0.433 (11.25)	Ring Terminals	1.78x2.59 (45.2x65.8)	
31	0.073	MR3	PP1	1181	0.305 (7.75)	1.30x2.00 (33.0x50.8)	1.30x2.00 (33.0x50.8)	

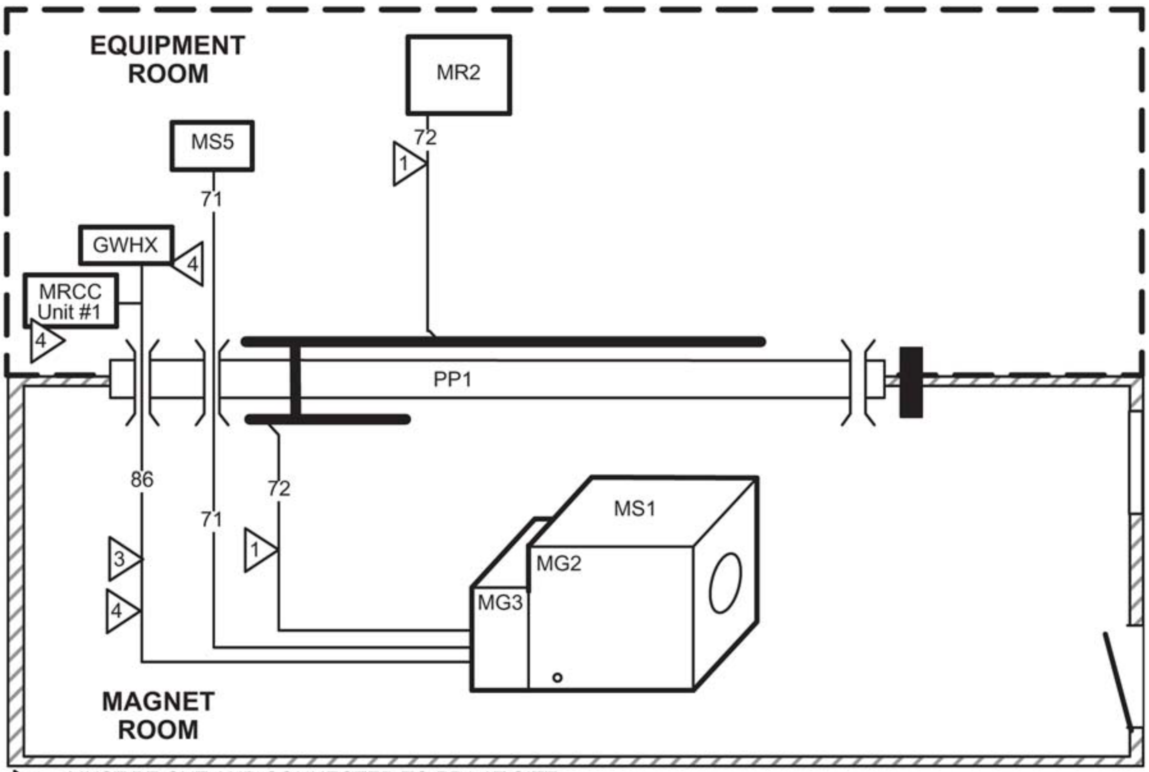
Table 7-5: L2 Cable Groups Interconnects Details (cont'd)

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
75	0.035 (22)	MS5	PP1	623	0.21 (5.28)	1.00x1.38 (25.4x35.1)	Ring Terminals	Run provided by Shield/Cryo Cooler Compressor catalog
77	0.035 (218)	PD1 See Note 1	RF Common Ground Stud	1254	0.464 (11.79	Ring Terminal	Ring Terminal	1 ground wire
81	0.460 (297.3)	EO2	PP1	296	0.35 (8.9)	Hard Wired	1.30x2.00 (33.5x50.8)	Refer to Section 3, Emergency Off Wiring
95	0.22 (144)	MSM1	PP1	824	0.44 (11.2)	2.30x2.00 (57.2x50.8)	2.30x2.00 (57.2x50.8)	Run provided by Magnet catalog
				825	0.30 (7.62)	1.30x2.00 (33.5x50.8)	1.30x2.00 (33.5x50.8)	Run provided by Magnet catalog
Note 1 The PDU is a module (PD1) in the lower portion of the HFD/PDU Cabinet (MR3).								

4.5 L1 / L2 Interconnects

Illustration 7-6 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).

Illustration 7-6: System L1/L2 Interconnects Diagram



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).

4 FOR GROUPS 4, 5, 10, 15, 21, 49, 50, 51, 52, 74, & 86 REFER TO **MRCC ADDITIONAL INTERCONNECTS** OR **GWHX ADDITIONAL INTERCONNECTS** FOR CONFIGURATION APPROPRIATE INTERCONNECTS AND DETAILS.

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 are supplied by GE.

Table 7-6: L1/L2 Shared Cable Groups Interconnects Details

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
71	4.28 (2758)	MS5	MS1	621	1.65 (41.9)	2.00x3.75 (50.8x95.3)	2.00x3.75 (50.8x95.3)	Runs provided by Magnet catalog
				622	1.65 (41.9)	2.00x3.75 (50.8x95.3)	2.00x3.75 (50.8x95.3)	
	Note: Group 71 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	0.87 (22.1)	MR8	MG2/3	1125 & 1127	0.87 (22.1)	1.5x2.50 (38.1x63.5)	1.5x2.50 (38.1x63.5)	
	Note: **These runs are RF Transmit Cables.** Runs 1125/1127 must be cut to length and connected via PP1 at site. Usable length provided is for routing in Equipment Room and Magnet Room.							
86	--	MRCC/ GWHX See Section reference at right	MG2	To determine FROM connection, for length requirements, & details refer to appropriate configuration: Section 5.1, Interconnects For 2 MRCC Units Located Outdoors, Section 5.2, Interconnects For 2 MRCC Units Located Indoors, Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors, Section 5.4, Interconnects For 1 MRCC Unit Located Indoors, or Section 6, GWHX Additional Interconnects.				

4.6 L3 Interconnects

Illustration 7-7 shows the cable Groups which are included in Location 3 between components within Equipment Room.

Illustration 7-7: System L3 Interconnects Diagram

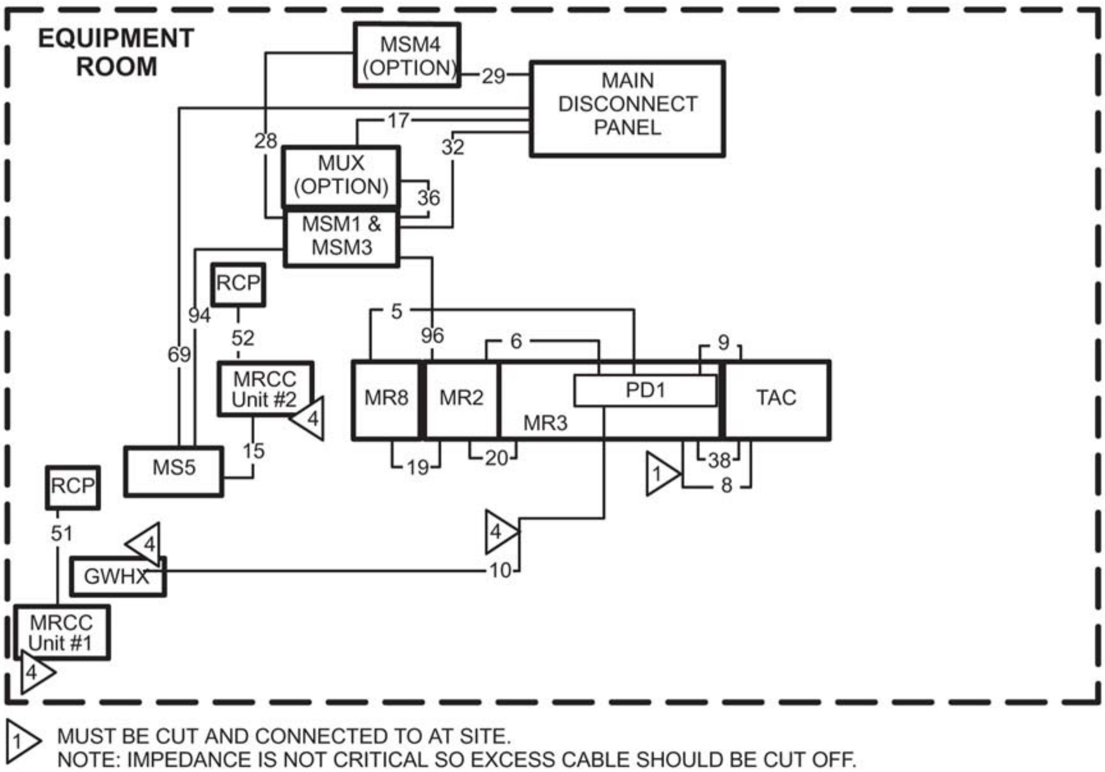


Table 7-7 contains information on interconnects between components within Equipment Room (Location L3). Conduit or pipe is not recommended for cable runs since the system uses many prefabricated cables with large connectors. Unless otherwise specified, cables and components listed are supplied by GE.

Table 7-7: L3 Cable Groups Interconnects Details

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
5	0.73 (462)	PD1 See Note 1	MR8	1113	0.2 (4.95)	Hard Wired	4.5x9.5 (114.3x241.3)	#8 AWG / 4 wire Power cable
				1150	0.94 (23.75)	Hard Wired	Hard Wired	#10 AWG / 1 wire Ground cable
6	0.803 (518)	PD1 See Note 1	MR2	037	0.188 (4.78)	Hard Wired	Hard Wired	#10 AWG / 1 wire Ground cable
				968	0.92 (23.37)	Hard Wired	Hard Wired	#8 AWG / 5 wire Power cable
				971	0.375 (9.50)	1.60x2.00 (41.1x50.8)	1.60x2.00 (41.1x50.8)	
8	3.45 (2221)	MR3	TAC	976	1.21 (30.7)	Hard Wired	Hard Wired	Runs 976, 977, & 978 are cut and connected to TAC at site. Total length of 65 ft (19.8 m) is supplied for use in Group 8 & 12 for routing from MR3 to TAC to PP1.
				977	1.21 (30.7)	Hard Wired	Hard Wired	
				978	1.21 (30.7)	Hard Wired	Hard Wired	
9	0.43 (278)	PD1 See Note 1	TAC	989	0.74 (18.80)	Hard Wired	2.33x3.86 (59.2x98.0	#10 AWG / 3 wire Power cable
10	--	PD1 See Note 1	GWHX	Refer to Section 6, GWHX Additional Interconnects .				
15	--	MS5	MRCC Unit #2	Refer to Section 5.1, Interconnects For 2 MRCC Units Located Outdoors or Section 5.2, Interconnects For 2 MRCC Units Located Indoors.				
16	--	MDP See Notes	MSCC Unit # See Notes	For length requirements & details refer to appropriate configuration: Section 5.1, Interconnects For 2 MRCC Units Located Outdoors or Section 5.2, Interconnects For 2 MRCC Units Located Indoors.				
17	0.05 (32.3)	MDP	MUX	--	0.25 (6.35)	1.00x2.50 (25.4x63.5)	1.00x2.50 (25.4x63.5)	MUX is an option, refer to Chapter 3, Section 9.7, System Monitoring and Support Connectivity in Room Layouts chapter. Run provided by Magnet catalog.
19	0.436 (281)	MR2	MR8	1231	0.44 (11.18)	2.30x2.00 (57.2x50.8)	2.30x2.00 (57.2x50.8)	
				1232	0.45 (11.4)	2.75x2.25 (69.9x57.2)	2.75x2.25 (69.9x57.2)	
				1239	0.23 (5.84)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1240	0.23 (5.84)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1242	0.23 (5.84)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
20	0.923 (595)	MR2	MR3	1179	1.04 (26.4)	1.04x2.00 (26.4x50.8)	1.04x2.00 (26.4x50.8)	Run 1179 is flexible conduit containing fiber optic cable(s) with a minimum bend of 2 in. (50 mm).
				1180	0.305 (7.75)	1.30x2.00 (33.0x50.8)	1.30x2.00 (33.0x50.8)	

Table 7-7: L3 Cable Groups Interconnects Details (cont'd)

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
28	0.07 (45.2)	MSM1 & MSM3	MSM4	--	0.30 (7.62)	1.30x2.00 (33.5x50.8)	1.30x2.00 (33.5x50.8)	ONLY USED WITH UPS OPTION FOR MAGNET MONITOR: Customer provided phone line, cable diameter & plug pull information are estimates.
29	0.22 (142)	MDP	MSM4	--	0.375 (9.53)	1.00x2.50 (25.4x63.5)	Hard Wired	UPS Power IN (for Magnet Monitor UPS option)
				939	0.375 (9.53)	1.00x2.50 (25.4x63.5)	1.00x2.50 (25.4x63.5)	UPS Power OUT (for Magnet Monitor UPS option)
32	0.159 (103)	MDP	MSM1 & MSM3	--	0.375 (9.5)	1.2x3.00 (30.5x76.2)	1.25x2.5 (31.8x63.5)	MSM1 power cable. Run provided by Magnet catalog.
				--	0.25 (6.35)	2.00x2.50 (50.8x63.5)	2.00x2.50 (50.8x63.5)	Modem for MSM1 power cable. Modem located on top of MSM1. Refer to Chapter 3, Section 9.6, Magnet Monitor
36	0.09 (58)	MSM3	MUX	--	0.34 (8.64)	0.50x0.75 (12.7x19.1)	0.50x0.75 (12.7x19.1)	Modem-MUX phone line Only needed when Multiplexer for phone line is used
38	0.10 (66)	MR3	TAC	974	0.36 (9.14)	1.30x2.00 (33.5x50.8)	1.30x2.00 (33.5x50.8)	
51	--	MRCC Unit #1	RCP	For details and to determine FROM unit refer to appropriate configuration: Section 5.1, Interconnects For 2 MRCC Units Located Outdoors, Section 5.2, Interconnects For 2 MRCC Units Located Indoors, Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors, or Section 5.4, Interconnects For 1 MRCC Unit Located Indoors.				
52	--	MRCC Unit #2	RCP	Refer to Section 5.1, Interconnects For 2 MRCC Units Located Outdoors or Section 5.2, Interconnects For 2 MRCC Units Located Indoors.				
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.
94	0.09 (58.6)	MSM1	MS5	826	0.34 (8.64)	1.60x2.00 (40.6x50.8)	1.60x2.00 (40.6x50.8)	Provided by Magnet Catalog
96	0.09 (58.6)	MSM1	MR2	823	0.34 (8.64)	1.60x2.00 (40.6x50.8)	1.60x2.00 (40.6x50.8)	Provided by Magnet Catalog
Note 1 The PDU is a module (PD1) in the lower portion of the HFD/PDU Cabinet (MR3).								

4.7 L4 Interconnects

Illustration 7-8 shows the cable Groups which are included in Location 4 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 are supplied by GE.

Illustration 7-8: System L4 Interconnects Diagram

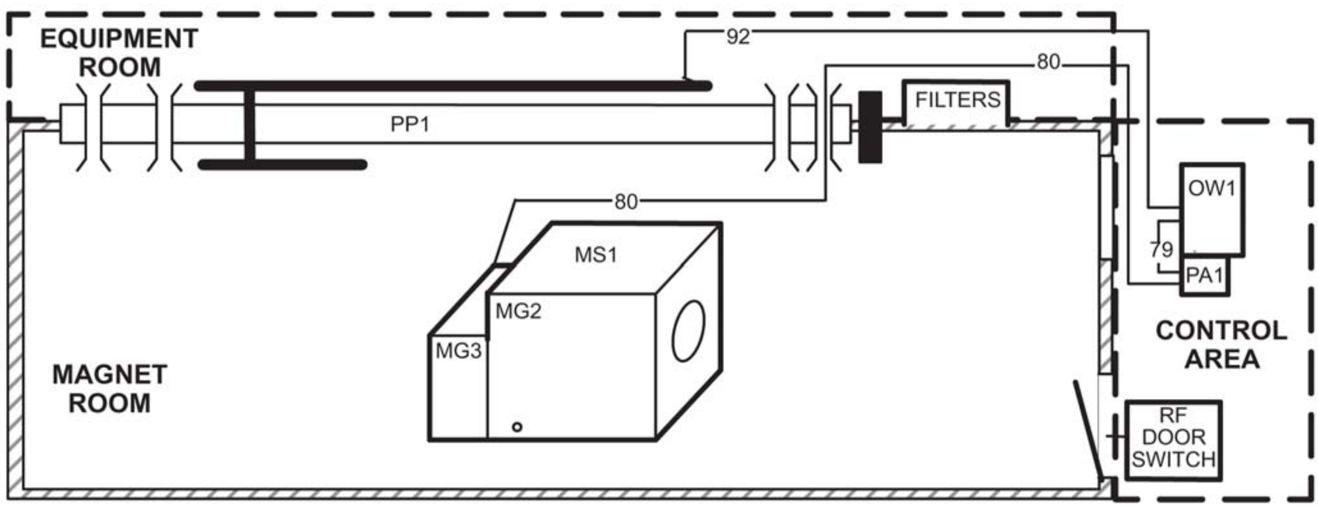


Table 7-8: L4 Cable Groups Interconnects Details

Group	Group Area in.^{2} mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
79	0.02 (8)	OW1	PA1	--	0.13 (3.2)	3.00x3.00 (76.2x76.2)	0.38x1.75 (9.6x44.5)	Run provided by Magnet catalog
80 See Note 1	0.05 (32)	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	0.15 (99)	PP1	OW1	1085	0.44 (11.2)	2.30x2.00 (57.2x50.8)	2.30x2.00 (57.2x50.8)	
Note: 1 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's Console or 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.								

4.8 L5 Interconnects

Illustration 7-9 shows the cable Groups which are included in Location 3 between the Operator Workspace (OW) and components in Equipment Room.

Illustration 7-9: System L5 Interconnects Diagram

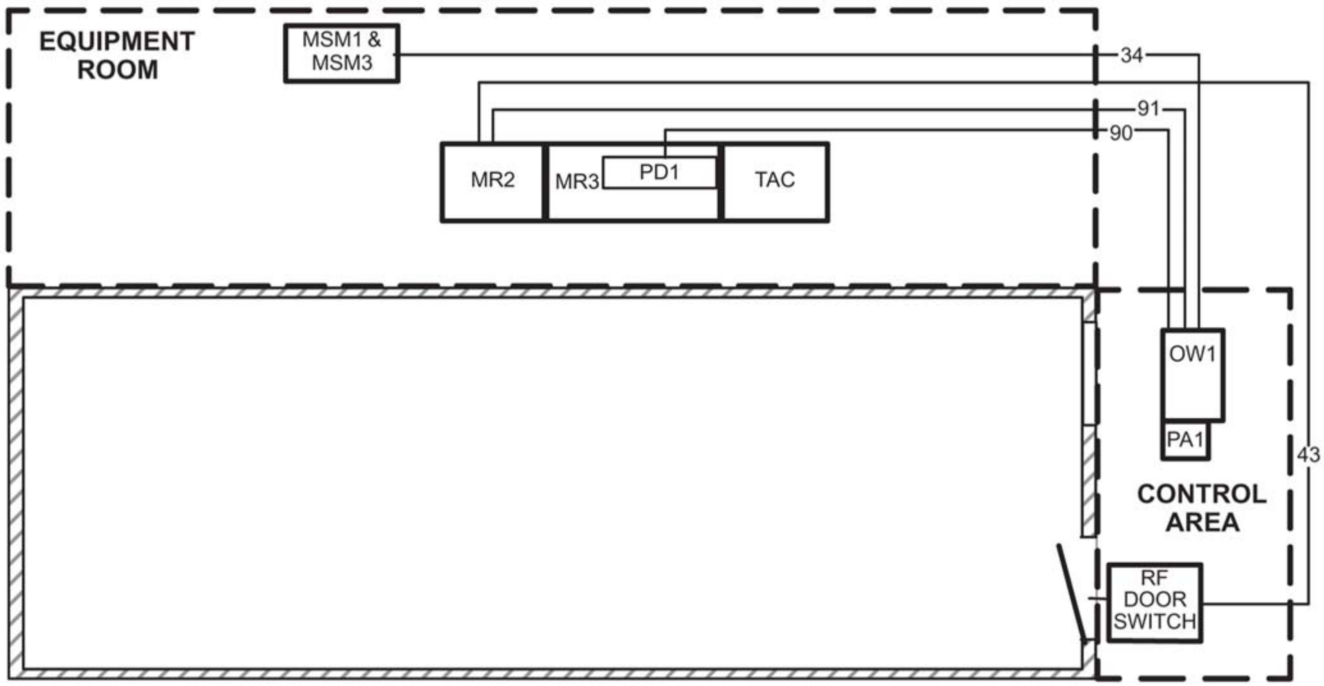


Table 7-9 contains information on interconnects between the OW and components in Equipment Room (Location L5). Conduit or pipe is not recommended for cable runs since the system uses many prefabricated cables with large connectors. Unless otherwise specified, cables and components listed are supplied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

Table 7-9: L5 Cable Groups Interconnects Details

Group	Group Area in.^{2} mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
34	0.09 (58)	MSM1	OW1	1077	0.34 (8.64)	0.50x0.75 (12.7x19.1)	0.50x0.75 (12.7x19.1)	
43	0.10 (62)	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	0.03 (18)	PD1 See Note 1	OW1	1081	0.70 (17.78)	Hard Wired	Hard Wired	#10 AWG / 4 wire power cable

Table 7-9: L5 Cable Groups Interconnects Details (cont'd)

Group	Group Area in.^{2} mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
91	0.14 (90)	MR2	OW1	1082	0.25 (6.35)	0.5x0.75 (12.7x19.1)	0.5x0.75 (12.7x19.1)	
				1083	0.33 (8.30)	1.75x2.00 (44.5x50.8)	1.75x2.00 (44.5x50.8)	
				1255	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 HFD/PDU Cabinet (MR3).								

4.9 Customer Supplied Interconnects

Illustration 7-10 shows the cable Groups which are customer supplied.

Illustration 7-10: System Customer Supplied Interconnects Diagram

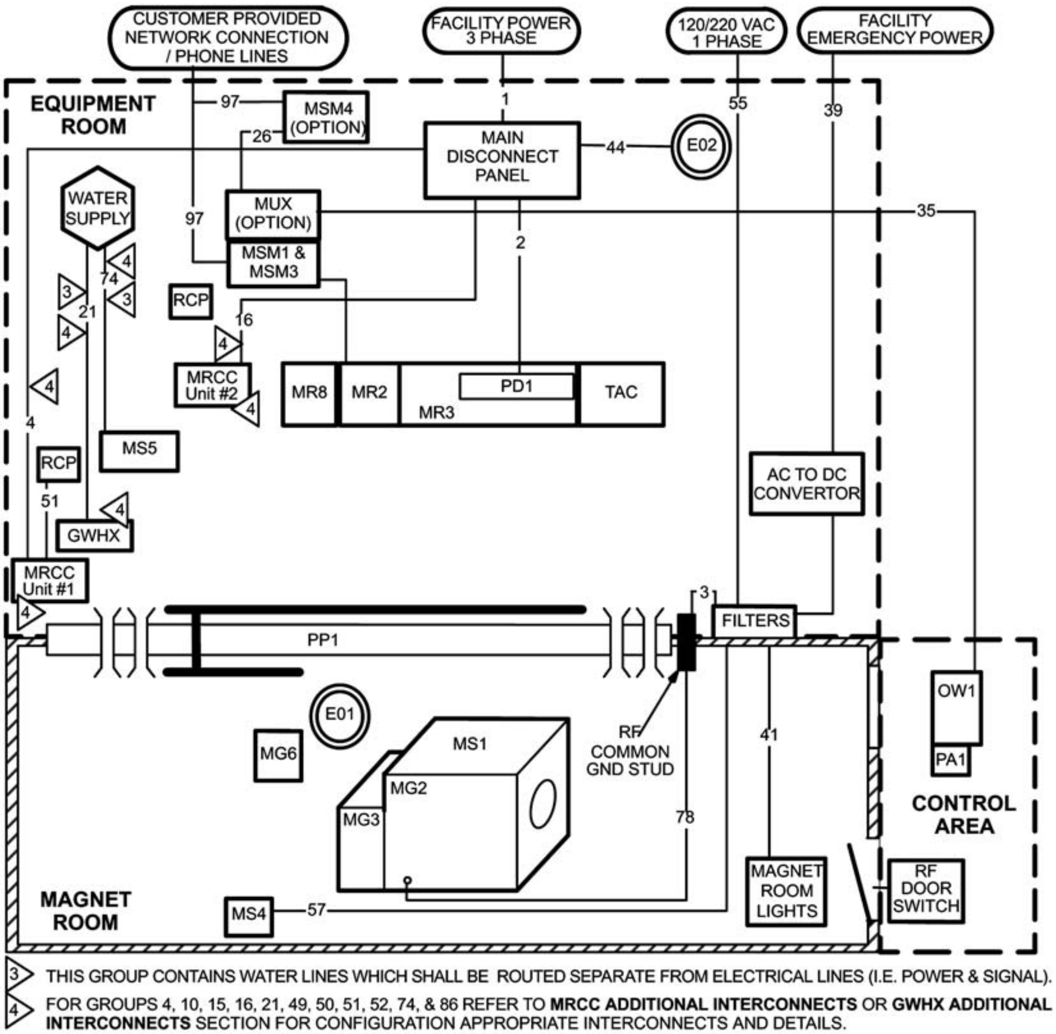


Table 7-10 contains the list of customer supplied interconnects for the MR system and references to location of detail information for the specific interconnects.

Table 7-10: Customer Supplied Interconnects

Group #	Between Units		Notes
	From	To	
1	Facility Power	MDP	See Note 1.
2	MDP	PD1 See Note 2	Refer to Chapter 6, Section 3.2, System Power Distribution Unit for wire size information.
3	Facility Emerg Power Filter	PP1	Customer supplied Ground.
4	MDP	MRCC Unit #1	Refer to appropriate configuration: Section 5.1, Interconnects For 2 MRCC Units Located Outdoors, Section 5.2, Interconnects For 2 MRCC Units Located Indoors, Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors or Section 5.4, Interconnects For 1 MRCC Unit Located Indoors.
16	MDP	MRCC Unit #2	Refer to appropriate configuration: Section 5.1, Interconnects For 2 MRCC Units Located Outdoors or Section 5.2, Interconnects For 2 MRCC Units Located Indoors
21	Facility Water Supply	GWHX	Refer to Section 6, GWHX Additional Interconnects
26	MSM4	MUX	ONLY USED WITH UPS FOR MAGNET MONITOR: Customer provided phone line routed through UPS for transient protection.
35	MUX	OW1 InSite Modem	Customer provided phone line.
39	Facility Emergency Power	Filter	Refer to Chapter 6, Section 8, DC Lighting Controller (Facility Option) for DC Lighting Controller cabling.
41	Filter	Magnet Room Lights	Refer to Chapter 6, Section 7, Emergency Power and Chapter 6, Section 8, DC Lighting Controller (Facility Option).
44	MDP	EO2	Refer to Section 3, Emergency Off Wiring.
49	MRCC Unit #1 Outdoor	See Notes	Refer to Section 5.1, Interconnects For 2 MRCC Units Located Outdoors or Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors.
50	MRCC Unit #2 Outdoor	See Notes	For cable lengths & details refer to Section 5.1, Interconnects For 2 MRCC Units Located Outdoors or Section 5.1, Interconnects For 2 MRCC Units Located Indoors.
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	Facility Water Supply	MS5	For details refer to Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors, Section 5.4, Interconnects For 1 MRCC Unit Located Indoors or Section 6, GWHX Additional Interconnects .

Table 7-10: Customer Supplied Interconnects (cont'd)

Group #	Between Units		Notes
	From	To	
97	Network &/or Phone Line Connection	MSM1 or MSM4 (Option)	Refer to Chapter 3, Section 9.7, System Monitoring and Support Connectivity for additional customer network and/or phone line information. WITH UPS FOR MAGNET MONITOR OPTION: Customer provided phone line routed through UPS for transient protection, refer to Group 26.

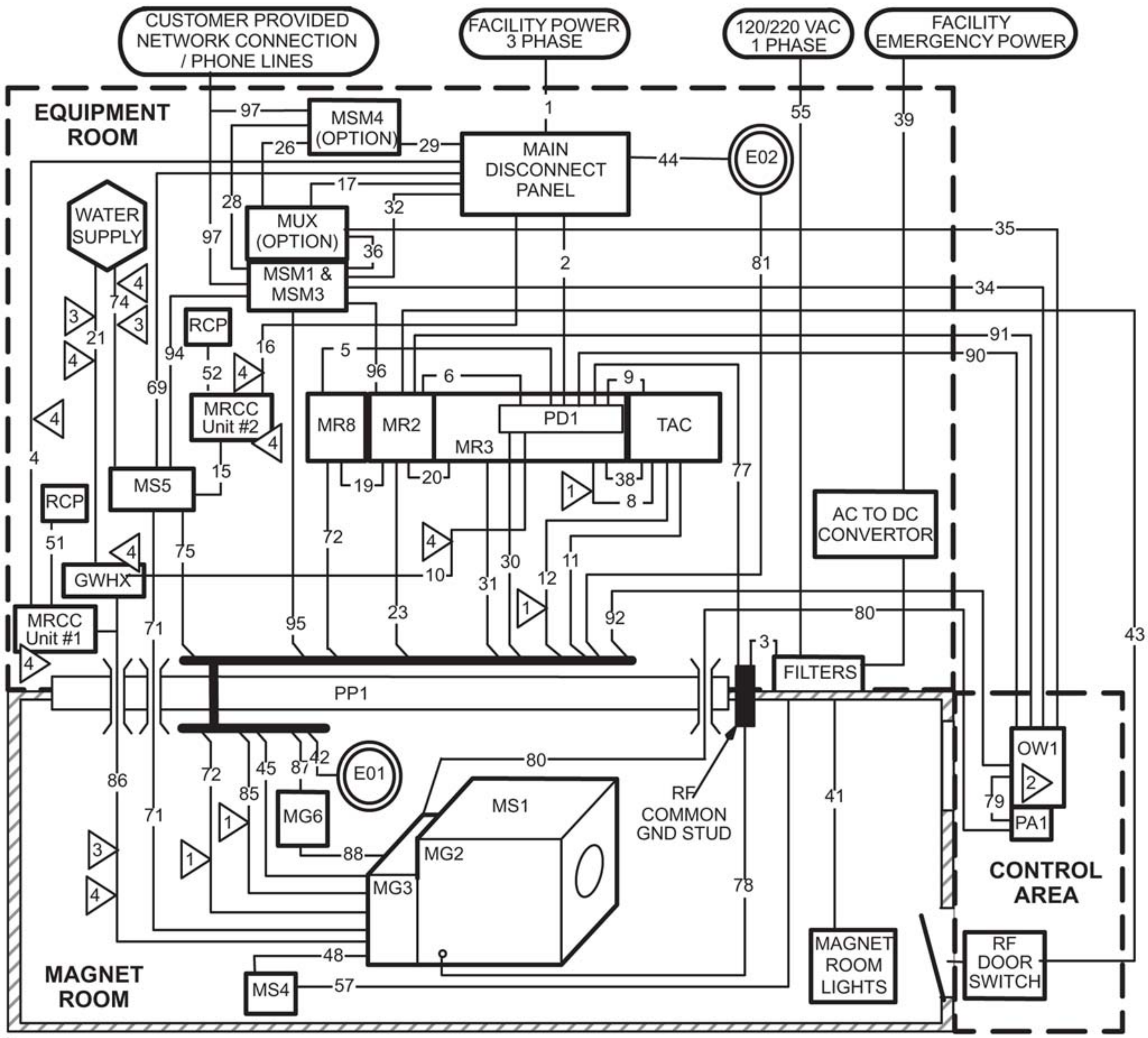
Notes

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 HFD/PDU Cabinet (MR3).
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 7-11 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.

Illustration 7-11: Signa EXCITE HD 3.0T System Group Interconnect Diagram



1. MUST BE CUT AND CONNECTED TO 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.
OW INTERCONNECTS ARE ROUTED THROUGH TABLE CABLE TRAY.
3. THIS GROUP CONTAINS WATER LINES WHICH SHALL BE ROUTED SEPARATE FROM ELECTRICAL LINES (I.E. POWER & SIGNAL).
4. FOR GROUPS 4, 10, 15, 16, 21, 49, 50, 51, 52, 74, & 86 REFER TO **MRCC ADDITIONAL INTERCONNECTS** OR **GWHX ADDITIONAL INTERCONNECTS** SECTION FOR CONFIGURATION APPROPRIATE INTERCONNECTS AND DETAILS.

Table 7-11: Location & Cable Group Cross Reference To Run Details

Cable Group #	Between Units		Location See Note 1 for L numbers definition	Group Content Details Shown
	From	To		
1	Facility Power	MDP	Customer Supplied	Section 4.9, Customer Supplied Interconnects
2	MDP	PD1	Customer Supplied	Section 4.9, Customer Supplied Interconnects
3	Facility Emer-gency Power Fil-ter	PP1	Customer Supplied	Section 4.9, Customer Supplied Interconnects
4	MDP	MRCC Unit #1	Customer Supplied	Refer to appropriate configuration: • Section 5.1, Interconnects For 2 MRCC Units Located Outdoors • Section 5.2, Interconnects For 2 MRCC Units Located Indoors • Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors • Section 5.4, Interconnects For 1 MRCC Unit Located Indoors
5	PD1	MR8	L3	Section 4.6, L3 Interconnects
6	PD1	MR2	L3	Section 4.6, L3 Interconnects
7	--	--	Group Not Used	--
8	MR3	TAC	L3	Section 4.6, L3 Interconnects
9	PD1	TAC	L3	Section 4.6, L3 Interconnects
10	PDU	GWHX	L3	Refer to Section 6, GWHX Additional Interconnects
11	TAC	PP1	L2	Section 4.4, L2 Interconnects
12	TAC	PP1	L2	Section 4.4, L2 Interconnects
13	--	--	Group Not Used	--
14	--	--	Group Not Used	--
15 See Note 2	MS5	MRCC Unit #2	L3	Refer to appropriate configuration: • Section 5.1, Interconnects For 2 MRCC Units Located Outdoors • Section 5.2, Interconnects For 2 MRCC Units Located Indoors
16	MDP	MRCC Unit #2	Customer Supplied	Refer to appropriate configuration: • Section 5.1, Interconnects For 2 MRCC Units Located Outdoors • Section 5.2, Interconnects For 2 MRCC Units Located Indoors
17	MDP	MUX	L3	Section 4.6, L3 Interconnects
18	--	--	Group Not Used	--
19	MR2	MR8	L3	Section 4.6, L3 Interconnects
20	MR2	MR3	L3	Section 4.6, L3 Interconnects

Table 7-11: Location & Cable Group Cross Reference To Run Details (cont'd)

Cable Group #	Between Units		Location	Group Content Details Shown
	From	To	See Note 1 for L numbers definition	
21 See Note 2	Facility Water Supply	GWHX	Customer Supplied	Section 6, GWHX Additional Interconnects
22	--	--	Group Not Used	--
23	MR2	PP1	L2	Section 4.4, L2 Interconnects
24 to 25	--	--	Group Not Used	--
26	MSM4	MUX	Customer Supplied	Section 4.9, Customer Supplied Interconnects
27	--	--	Group Not Used	--
28	MSM1 & MSM3	MSM4	L3	Section 4.6, L3 Interconnects
29	MSM4	MDP	L3	Section 4.6, L3 Interconnects
30	PD1	PP1	L2	Section 4.4, L2 Interconnects
31	MR3	PP1	L2	Section 4.4, L2 Interconnects
32	MDP	MSM1 & Modem	L3	Section 4.6, L3 Interconnects
33	--	--	Group Not Used	--
34	MSM1	OW1	L5	Section 4.8, L5 Interconnects
35	MUX	OW1 InSite Modem	Customer Supplied	Section 4.9, Customer Supplied Interconnects
36	MSM3	MUX	L3	Section 4.6, L3 Interconnects
37	--	--	Group Not Used	--
38	MR3	TAC	L3	Section 4.6, L3 Interconnects
39	Facility Emer-gency Power	Filter	Customer Supplied	Refer to Chapter 6, Section 8, DC Lighting Controller (Facility Option)
40	--	--	Group Not Used	--
41	Filter	Magnet Room Lights	Customer Supplied	Refer to Chapter 6, Section 7, Emergency Power and Chapter 6, Section 8, DC Lighting Controller (Facility Option)
42	PP1	EO1	L1	Section 4.3, L1 Interconnects
43	MR2	RF Door Swtich	L5	Section 4.8, L5 Interconnects
44	MDP	EO2	Customer Supplied	Section 4.9, Customer Supplied Interconnects
45	PP1	MG2/3	L1	Section 4.3, L1 Interconnects
46 to 47	--	--	Group Not Used	--
48	MS4	MS1	L1	Section 4.3, L1 Interconnects

Table 7-11: Location & Cable Group Cross Reference To Run Details (cont'd)

Cable Group #	Between Units		Location	Group Content Details Shown
	From	To	See Note 1 for L numbers definition	
49	MRCC Unit #1 outdoor	See Section reference at right	Customer Supplied	Refer to appropriate configuration: • Section 5.1, Interconnects For 2 MRCC Units Located Outdoors • Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors
50	MRCC Unit #2 outdoor	See Section reference at right	Customer Supplied	Refer to Section 5.1, Interconnects For 2 MRCC Units Located Outdoors
51	MRCC Unit #1	RCP	L3	Refer to appropriate configuration: • Section 5.1, Interconnects For 2 MRCC Units Located Outdoors • Section 5.2, Interconnects For 2 MRCC Units Located Indoors • Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors • Section 5.4, Interconnects For 1 MRCC Unit Located Indoors
52	MRCC Unit #2	RCP	L3	Refer to appropriate configuration: • Section 5.1, Interconnects For 2 MRCC Units Located Outdoors • Section 5.2, Interconnects For 2 MRCC Units Located Indoors
53 to 54	--	--	Group Not Used	--
55	Facility Power	Filter	Customer Supplied	Section 4.9, Customer Supplied Interconnects
56	--	--	Group Not Used	--
57	Filter	MS4	Customer Supplied	Section 4.9, Customer Supplied Interconnects
58 to 68	--	--	Group Not Used	--
69	MDP	MS5	L3	Section 4.6, L3 Interconnects
70	--	--	Group Not Used	--
71	MS5	MS1	L1/L2	Section 4.5, L1 / L2 Interconnects
72	MR2	MG2/3	L1/L2	Section 4.5, L1 / L2 Interconnects
73	--	--	Group Not Used	--
74 See Note 2	Facility Water Supply	MS5	Customer Supplied	For details refer to Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling and the appropriate configuration: • Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors • Section 5.4, Interconnects For 1 MRCC Unit Located Indoors • Section 6, GWHX Additional Interconnects
75	MS5	PP1	L2	Section 4.4, L2 Interconnects
76	--	--	Group Not Used	--

Table 7-11: Location & Cable Group Cross Reference To Run Details (cont'd)

Cable Group #	Between Units		Location	Group Content Details Shown
	From	To	See Note 1 for L numbers definition	
77	PD1	RF Common Ground Stud	L2	Section 4.4, L2 Interconnects
78	RF Common Ground Stud	MS1 Ground Stud	L1	Section 4.3, L1 Interconnects
79	OW1	PA1	L4	Section 4.7, L4 Interconnects
80	PA1	MG2	L4	Section 4.7, L4 Interconnects
81	EO2	PP1	L2	Section 4.4, L2 Interconnects
82 to 84	--	--	Group Not Used	--
85	PP1	MG3	L1	Section 4.3, L1 Interconnects
86 See Note 2	MRCC Unit #1 / GWHX	MG2	L1/L2	For details & to determine FROM connections refer to appropriate configuration: • Section 5.1, Interconnects For 2 MRCC Units Located Outdoors • Section 5.2, Interconnects For 2 MRCC Units Located Indoors • Section 5.3, Interconnects For 1 MRCC Unit Located Outdoors • Section 5.4, Interconnects For 1 MRCC Unit Located Indoors • Section 6, GWHX Additional Interconnects
87	PP1	MG6	L1	Section 4.3, L1 Interconnects
88	MG6	MG2/3	L1	Section 4.3, L1 Interconnects
89	--	--	Group Not Used	--
90	PD1	OW1	L5	Section 4.8, L5 Interconnects
91	MR2	OW1	L5	Section 4.8, L5 Interconnects
92	PP1	OW1	L4	Section 4.7, L4 Interconnects
93	--	--	Group Not Used	--
94	MSM1	MS5	L3	Section 4.6, L3 Interconnects
95	MSM1	PP1	L2	Section 4.4, L2 Interconnects
96	MSM1	MR2	L3	Section 4.6, L3 Interconnects
97	Network or Phone Line Connec-tion	MSM1 or MSM4 (Option)	Customer Supplied	Section 4.9, Customer Supplied Interconnects

Notes

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).

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5 MRCC Additional Interconnects

5.1 Interconnects For 2 MRCC Units Located Outdoors

NOTE: Refer to Chapter 3, Section 8.2, MRCC Siting Considerations MRCC Equipment Installation Tasks Responsibility table 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 2 MRCC units 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.**

5.1.1 Vertical Separation Requirements

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.

5.1.2 MRCC for Gradient Coil: Water Cooling Lines & Hoses Requirements

- AirSys provides two 0.75 in. (19 mm) quick disconnect fittings at the MRCC for the Gradient Coil water cooling lines connections, refer to Chapter 3, Section 12.5, MR Common Chiller (MRCC) illustration for location of fittings on MRCC.
- 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 Gradient Coil. Site layout for the Gradient Coil water cooling lines and hoses must meet the following:
  - Total line length from the MRCC located outdoor to the Gradient Coil 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.

5.1.3 MRCC for 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 Chapter 3, Section 12.5, MR Common Chiller (MRCC) illustration 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.

5.1.4 RCP Data Cables Requirements

AirSys provides 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.

5.1.5 Power Wiring Requirements

Power wiring between the MRCC and the system MDP is customer supplied. The MRCC maximum wire size is 6 AWG (16 mm2).

5.1.6 System Additional Interconnects

Illustration 7-12 shows the additional system Group Interconnect Diagram for 2 MRCC units located outdoor. Each group contains one or more cables, refer to Table 7-12 , Table 7-13 , and Table 7-14 for specifics.

Illustration 7-12: 2 MRCC Units Located Outdoor & RCP Subsystem Group Interconnect Diagram

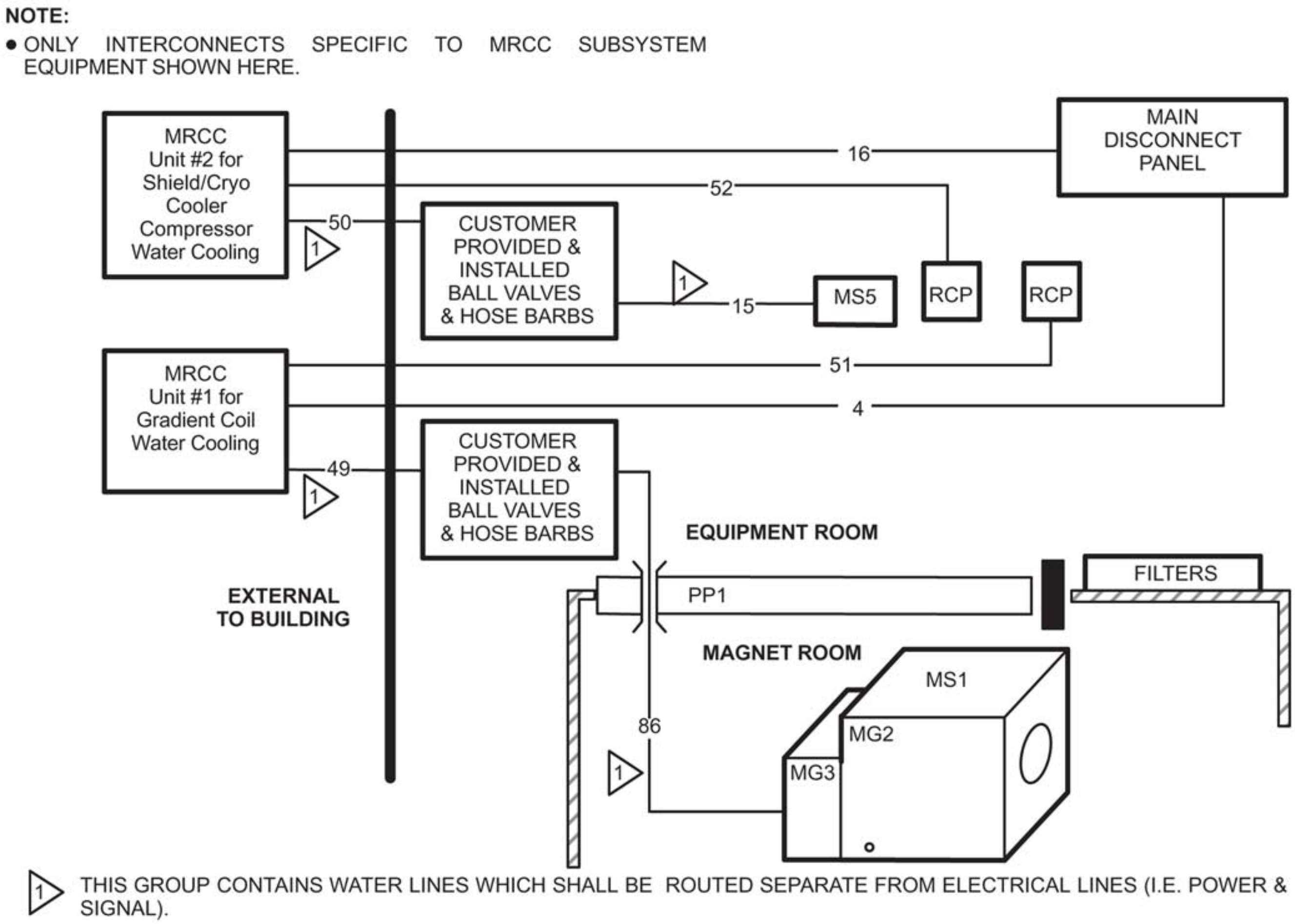


Table 7-12: 2 MRCC Units Outdoor & RCP Additional Interconnects - Customer Supplied

Group	Group Area in.^{2}(mm^2)	Between Units		Usable Length	Run #	Cable Diameter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
4	--	MDP	MRCC Unit #1	--	--	--	--	--	Power wiring Customer supplied, refer to Section 5.1.5
16	--	MDP	MRCC Unit #2	--	--	--	--	--	Power wiring Customer supplied, refer to Section 5.1.5
49 See Note 1	--	MRCC Unit #1 outdoor	Customer ball values & hose barbs for Gradient Coil	See Note 2	--	--	copper supply line	copper supply line	See Note 3
							copper return line	copper return line	

Table 7-12: 2 MRCC Units Outdoor & RCP Additional Interconnects - Customer Supplied (cont'd)

Group	Group Area in.^{2}(mm^2)	Between Units		Usable Length	Run #	Cable Diameter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
50 See Note 1	--	MRCC Unit #2 outdoor	Customer ball values & hose barbs for Shield/ Cryo Cooler	See Note 4	--	--	copper supply line	copper supply line	See Note 5
							copper return line	copper return line	

Notes

1. This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).
2. Groups 49 & 86 MUST NOT EXCEED Gradient Coil water cooling lines and hoses limitations specified in Section 5.1.2 .
3. Customer to provide & install 0.75 (19 mm) ID copper lines for Gradient Coil water cooling supply & return with ball valve and hose barb terminations in the Equipment Room.
4. Groups 50 & 15 MUST NOT EXCEED Shield/Cryo Cooler Compressor water cooling lines and hoses limitations specified in Section 5.1.3 .
5. Customer to provide & install 0.75 (19 mm) ID copper lines for Shield/Cryo Cooler Compressor water cooling supply & return with ball valve and hose barb terminations in the Equipment Room.

Table 7-13: 2 MRCC Units Outdoor & RCP Additional Interconnects - L1/L2

Group	Group Area in.^{2} (mm^2)	Between Units		Usable Length	Run #	Cable Diameter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
86 See Note 1	1.571 (1013)	customer provided ball valves & hose barbs for Gradient Coil	MG2	80 (24.4) minus takeup at hose barbs See Note 2	--	1.0 (25.4)	flexible tubing	flexible tubing	See Note 3
					--	1.0 (25.4)	flexible tubing	flexible tubing	

Notes

1. This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).
2. Groups 49 & 86 MUST NOT EXCEED Gradient Coil water cooling lines and hoses limitations specified in Section 5.1.2
3. These AirSys supplied Gradient Coil water cooling lines are routed through waveguides in PP1 and cut to length at site. They have a minimum bend radius of 7 in. (178 mm).

Table 7-14: 2 MRCC Units Outdoor & RCP Additional Interconnects - L3

Group	Group Area in.^{2} (mm^2)	Between Units		Usable Length	Run #	Cable Diam-eter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
15 See Note 1	1.571 (1013)	cus-tomer provided ball valves & hose barbs for Shield/ Cryo Cooler	MS5	55 (16.7) minus takeup at hose barbs See Note 2	--	1.0 (25.4)	flexible tubing	flexible tubing	
					--	1.0 (25.4)	flexible tubing	flexible tubing	
51	0.110 (71)	MRCC Unit #1 outdoor	RCP	92 (28.0) See 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.
52	0.110 (71)	MRCC Unit #2 outdoor	RCP	92 (28.0) See 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.

Notes

1. This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).
2. Groups 50 & 15 MUST NOT EXCEED Shield/Cryo Cooler Compressor water cooling lines and hoses limitations specified in Section 5.1.3

5.2 Interconnects For 2 MRCC Units Located Indoors

NOTE: Refer to Chapter 3, Section 8.2, MRCC Siting Considerations MRCC Equipment Installation Tasks Responsibility table 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 2 MRCC units 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.**

5.2.1 Vertical Separation Requirements

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.

5.2.2 MRCC for Gradient Coil: Water Cooling Lines & Hoses Requirements

- AirSys provides two 0.75 in. (19 mm) quick disconnect fittings at the MRCC for the Gradient Coil water cooling lines connections, refer to Chapter 3, Section 12.5, MR Common Chiller (MRCC) illustration for location of fittings on MRCC.
- AirSys provides two 0.75 inch (19.1 mm) ID rubber hoses of 100 ft (30.5 m) total length to connect from quick disconnect fittings at the MRCC to Gradient Coil.

5.2.3 MRCC for 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 Chapter 3, Section 12.5, MR Common Chiller (MRCC) illustration 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.

5.2.4 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.

5.2.5 Power Wiring Requirements

Power wiring between the MRCC and the system MDP is customer supplied. The MRCC maximum wire size is 6 AWG (16 mm2).

5.2.6 System Additional Interconnects

Illustration 7-13 shows the additional system Group Interconnect Diagram for 2 MRCC units located indoor. Each group contains one or more cables, refer to Table 7-15 , Table 7-16 and Table 7-17 for specifics.

Illustration 7-13: 2 MRCC Units Located Indoor & RCP Subsystem Group Interconnect Diagram

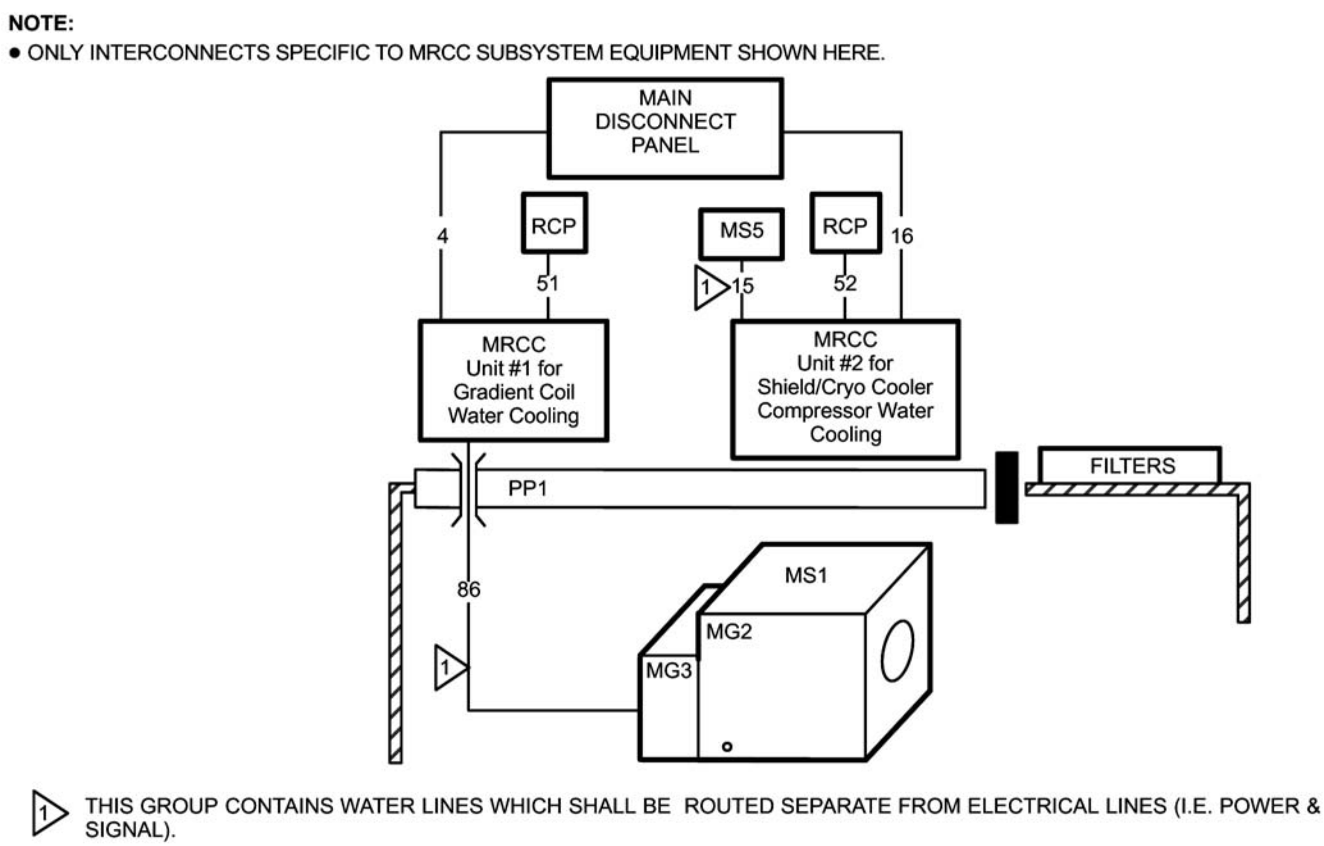


Table 7-15: 2 MRCC Units Indoor & RCP Additional Interconnects - Customer Supplied

Group	Group Area in.^{2} (mm^2)	Between Units		Usable Length	Run #	Cable Diameter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
4	--	MDP	MRCC Unit #1	--	--	--	--	--	Power wiring Customer supplied, refer to Section 5.2.5
16	--	MDP	MRCC Unit #2	--	--	--	--	--	Power wiring Customer supplied, refer to Section 5.2.5

Table 7-16: 2 MRCC Units Indoor & RCP Additional Interconnects - L1/L2

Group	Group Area in.^{2} (mm^2)	Between Units		Usable Length	Run #	Cable Diameter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
86 See Note 1	1.571 (1013)	MRCC unit #1	MG2	80 (24.4) minus takeup at hose barbs See Note 2	--	1.0 (25.4)	flexible tubing	flexible tubing	See Note 3
					--	1.0 (25.4)	flexible tubing	flexible tubing	

Notes

1. This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).
2. Group 86 MUST NOT EXCEED Gradient Coil water cooling lines and hoses limitations specified in Section 5.2.2
3. These AirSys supplied Gradient Coil water cooling lines are routed through waveguides in PP1 and cut to length at site. They have a minimum bend radius of 7 in. (178 mm).

Table 7-17: 2 MRCC Units Indoor & RCP Additional Interconnects - L3

Group	Group Area in.^{2} (mm^2)	Between Units		Usable Length	Run #	Cable Diameter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
15 See Note 1	1.571 (1013)	MS5	MRCC unit #2	55 (16.7)See Note 2	--	1.0 (25.4)	flexible tubing	flexible tubing	
					--	1.0 (25.4)	flexible tubing	flexible tubing	
51	0.110 (71)	MRCC Unit #1	RCP	92 (28.0) See 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.

Table 7-17: 2 MRCC Units Indoor & RCP Additional Interconnects - L3 (cont'd)

Group	Group Area in.^{2} (mm^2)	Between Units		Usable Length	Run #	Cable Diam-eter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
52	0.110 (71)	MRCC Unit #2	RCP	92 (28.0) See 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.

Notes

1. This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).
2. Group 15 MUST NOT EXCEED Shield/Cryo Cooler Compressor water cooling lines and hoses limitations specified in Section 5.2.3

5.3 Interconnects For 1 MRCC Unit Located Outdoors

NOTICE

When only 1 MRCC unit is planned this unit provides water cooling for the Gradient Coil ONLY. Therefore customer provided water cooling is required for the water cooled Shield/Cryo Cooler Compressor.

NOTE: Refer to Chapter 3, Section 8.2, MRCC Siting Considerations MRCC Equipment Installation Tasks Responsibility table 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 1 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.**

5.3.1 Vertical Separation Requirements

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.

5.3.2 MRCC for Gradient Coil: Water Cooling Lines & Hoses Requirements

- AirSys provides two 0.75 in. (19 mm) quick disconnect fittings at the MRCC for the Gradient Coil water cooling lines connections, refer to Chapter 3, Section 12.5, MR Common Chiller (MRCC) illustration for location of fittings on MRCC.
- 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 Gradient Coil. Site layout for the Gradient Coil water cooling lines and hoses must meet the following:
  - Total line length from the MRCC located outdoor to the Gradient Coil 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.

5.3.3 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.

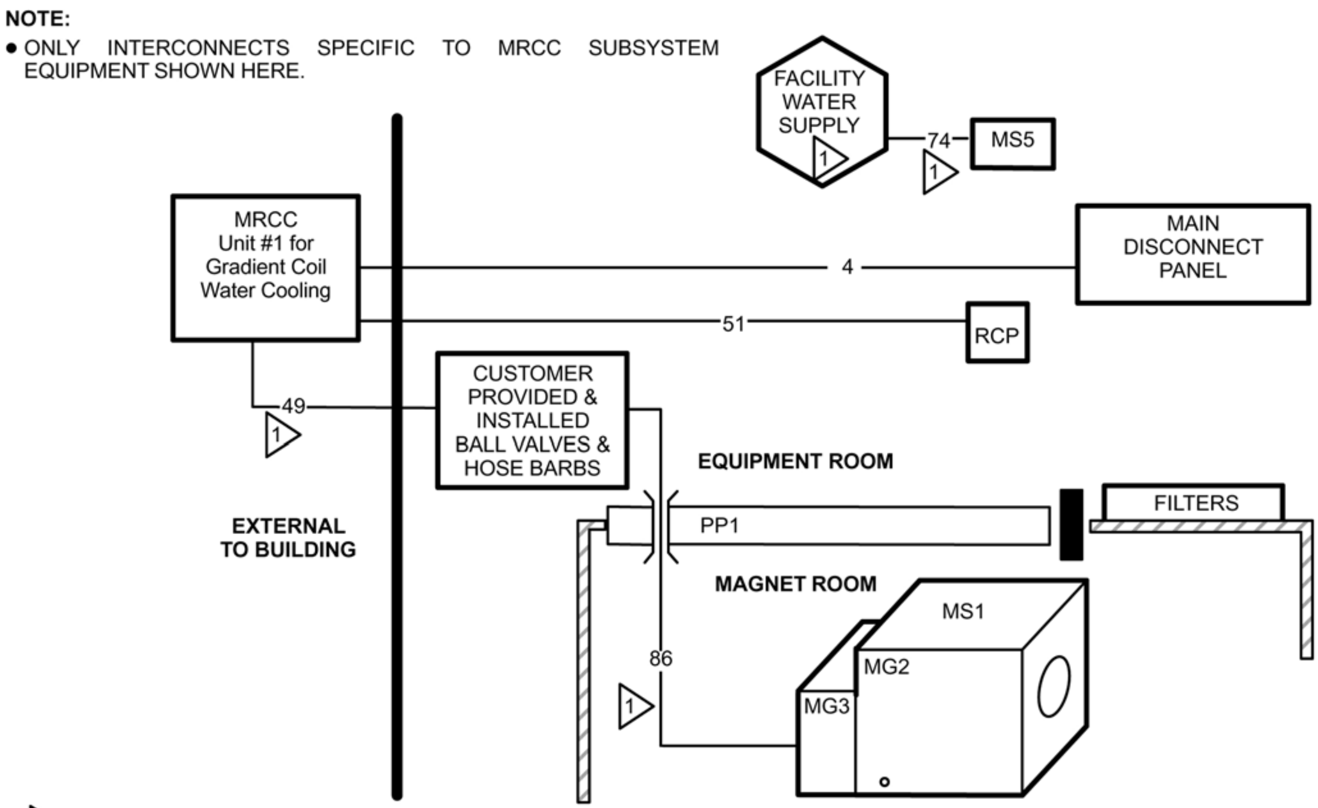
5.3.4 Power Wiring Requirements

Power wiring between the MRCC and the system MDP is customer supplied. The MRCC maximum wire size is 6 AWG (16 mm2).

5.3.5 System Additional Interconnects

Illustration 7-14 shows the additional system Group Interconnect Diagram for a MRCC unit located outdoor. Each group contains one or more cables, refer to Table 7-18 , Table 7-19 , and Table 7-20 for specifics.

Illustration 7-14: 1 MRCC Unit Located Outdoor & RCP Subsystem Group Interconnect Diagram



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

Table 7-18: 1 MRCC Unit Outdoor & RCP Additional Interconnects - Customer Supplied

Group	Group Area $in.^2$ (mm^2)	Between Units		Usable Length	Run #	Cable Diam-eter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
4	--	MDP	MRCC Unit #1	--	--	--	--	--	Power wiring Customer supplied, refer to Section 5.3.4
49 See Note 1	--	MRCC Unit #1 outdoor	Cus-tomer ball val-ues & hose barbs for Gradient Coil	See Note 2	--	--	copper supply line	copper supply line	See Note 3
					--	--	copper return line	copper return line	
74 See Note 1	--	facility water cooling	MS5	--	--	--	--	--	See Note 4

Notes

1. This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).
2. Groups 49 & 86 MUST NOT EXCEED Gradient Coil water cooling lines and hoses limitations specified in Section 5.3.2
3. Customer to provide & install 0.75 (19 mm) ID copper lines for Gradient Coil water cooling supply & return with ball valve and hose barb terminations in the Equipment Room.
4. Group 74 is customer supplied water lines, refer to Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling and Chapter 6, Section 1, System Power Introduction.

Table 7-19: 1 MRCC Unit Outdoor & RCP Additional Interconnects - L1/L2

Group	Group Area $in.^2$ (mm^2)	Between Units		Usable Length	Run #	Cable Diam-eter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
86 See Note 1	1.571 (1013)	cus-tomer provided ball valves & hose barbs	MG2	80 (24.4) minus takeup at hose barbs See Note 2	--	1.0 (25.4)	flexible tubing	flexible tubing	See Note 3
					--	1.0 (25.4)	flexible tubing	flexible tubing	

Notes

1. This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).
2. Groups 49 & 86 MUST NOT EXCEED Gradient Coil water cooling lines and hoses limitations specified in Section 5.3.2
3. These AirSys supplied Gradient Coil water cooling lines are routed through waveguides in PP1 and cut to length at site. They have a minimum bend radius of 7 in. (178 mm).

Table 7-20: 1 MRCC Unit Outdoor & RCP Additional Interconnects - L3

Group	Group Area in.^{2} (mm^2)	Between Units		Usable Length	Run #	Cable Diam-eter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
51	0.110 (71)	MRCC Unit #1 outdoor	RCP	92 (28.0) See 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.

5.4 Interconnects For 1 MRCC Unit Located Indoors

NOTICE

When only 1 MRCC unit is planned this unit provides water cooling for the Gradient Coil ONLY. Therefore customer provided water cooling is required for the water cooled Shield/Cryo Cooler Compressor.

NOTE: Refer to Chapter 3, Section 8.2, MRCC Siting Considerations MRCC Siting Considerations table 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 an 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.

5.4.1 Vertical Separation Requirements

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.

5.4.2 MRCC for Gradient Coil: Water Cooling Lines & Hoses Requirements

- AirSys provides two 0.75 in. (19 mm) quick disconnect fittings at the MRCC for the Gradient Coil water cooling lines connections, refer to Chapter 3, Section 12.5, MR Common Chiller (MRCC) illustration for location of fittings on MRCC.
- AirSys provides two 0.75 inch (19.1 mm) ID rubber hoses of 100 ft (30.5 m) total length to connect from quick disconnect fittings at the MRCC to Gradient Coil.

5.4.3 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.

5.4.4 Power Wiring Requirements

Power wiring between the MRCC and the system MDP is customer supplied. The MRCC maximum wire size is 6 AWG (16 mm2).

5.4.5 System Additional Interconnects

Illustration 7-15 shows the additional system Group Interconnect Diagram for 2 MRCC units located indoor. Each group contains one or more cables, refer to Table 7-21 , Table 7-22 , and Table 7-23 for specifics.

Illustration 7-15: 1 MRCC Unit Located Indoor & RCP Subsystem Group Interconnect Diagram

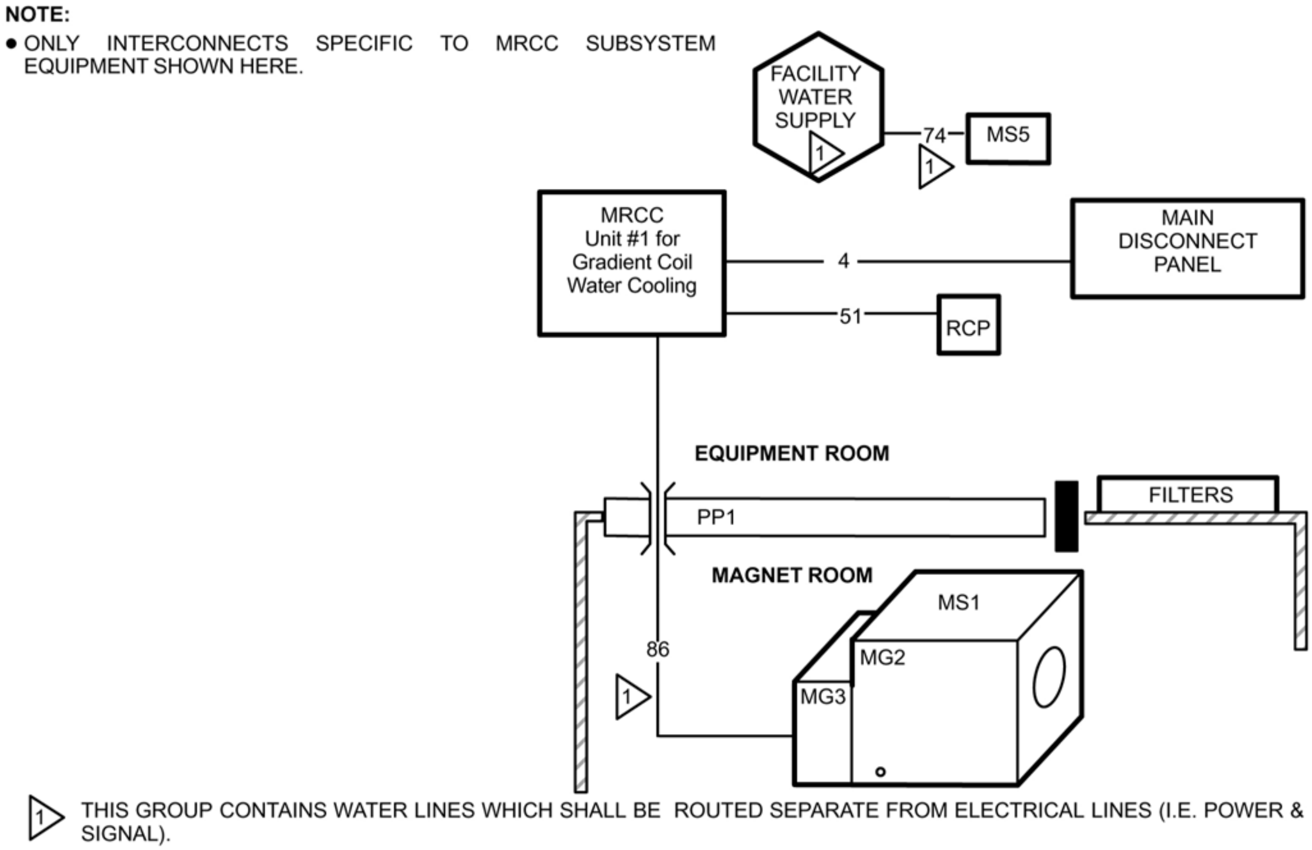


Table 7-21: 1 MRCC Unit Indoor & RCP Additional Interconnects - Customer Supplied

Group	Group Area in.^{2} (mm^2)	Between Units		Usable Length	Run #	Cable Diam-eter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
4	--	MDP	MRCC Unit #1	--	--	--	--	--	Power wiring Customer supplied, refer to Section 5.4.4

Table 7-21: 1 MRCC Unit Indoor & RCP Additional Interconnects - Customer Supplied (cont'd)

Group	Group Area in.^{2} (mm^2)	Between Units		Usable Length	Run #	Cable Diam-eter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
74 See Note 1	--	facility water cooling	MS5	--	--	--	--	--	See Note 2

Notes

1. The PDU is a module (PD1) in the lower portion of the ACGD/PDU Cabinet (MR3).
2. Group 74 is customer supplied water lines, refer to Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling and Chapter 6, Section 1, System Power Introduction.

Table 7-22: 1 MRCC Unit Indoor & RCP Additional Interconnects - L1/L2

Group	Group Area in.^{2} (mm^2)	Between Units		Usable Length	Run #	Cable Diam-eter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
86 See Note 1	1.571 (1013)	MRCC unit #1	MG2	80 (24.4) See Note 2	--	1.0 (25.4)	flexible tubing	flexible tubing	See Note 3
					--	1.0 (25.4)	flexible tubing	flexible tubing	

Notes

1. The PDU is a module (PD1) in the lower portion of the ACGD/PDU Cabinet (MR3).
2. Group 86 MUST NOT EXCEED Gradient Coil water cooling lines and hoses limitations specified in Section 5.4.2
3. These AirSys supplied Gradient Coil water cooling lines are routed through waveguides in PP1 and cut to length at site. They have a minimum bend radius of 7 in. (178 mm).

Table 7-23: 1 MRCC Unit Indoor & RCP Additional Interconnects - L3

Group	Group Area in.^{2} (mm^2)	Between Units		Usable Length	Run #	Cable Diam-eter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
51	0.110 (71)	MRCC Unit #1	RCP	92 (28.0) See 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.

6 GWHX Additional Interconnects

NOTE: The GWHX provides water cooling for the Gradient Coil ONLY. Therefore customer provided water cooling is required for the water cooled Shield/Cryo Cooler Compressor.

NOTE: Refer to Chapter 3, Section 8.3, GWHX Siting Considerations subsection titled Responsibility For Installation Tasks For GWHX. Also refer to *AirSys Group User Manual: MEDICOOL 10.0 P6 R407C 10K Watt Gradient Water Heat Exchanger* for additional information and details.

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

6.1 Vertical Separation Requirements

Max vertical separation for the GWHX is 16 ft above or below the Gradient Coil.

6.2 Gradient Coil Water Cooling Lines & Hoses Requirements

- AirSys provides two 0.75 in. (19 mm) quick disconnect fittings at the GWHX for the Gradient Coil water cooling lines connections, refer to Chapter 3, Section 12.6, Indoor Gradient Water Heat Exchanger (GWHX) for location of fittings on GWHX.
- AirSys provides two 0.75 inch (19.1 mm) ID rubber hoses of 100 ft (30.5 m) total length to connect from GWHX to the Gradient Coil.

6.3 Facility Water Cooling Lines & Hoses Requirements

AirSys provides two 0.75 in. (19 mm) quick disconnect fittings and 0.75 in. (19 mm) hose barbs at the GWHX for connection to facility water cooling, refer to Chapter 3, Section 12.6, Indoor Gradient Water Heat Exchanger (GWHX) for location of fittings on GWHX.

6.4 System Additional Interconnects

Illustration 7-16 shows the indoor GWHX subsystem additional system Group Interconnect Diagram. Each group contains one or more cables, for specifics refer to Table 7-24 , Table 7-25 , and Table 7-26 .

Illustration 7-16: Indoor Water Cooled GWHX Subsystem Group Interconnect Diagram

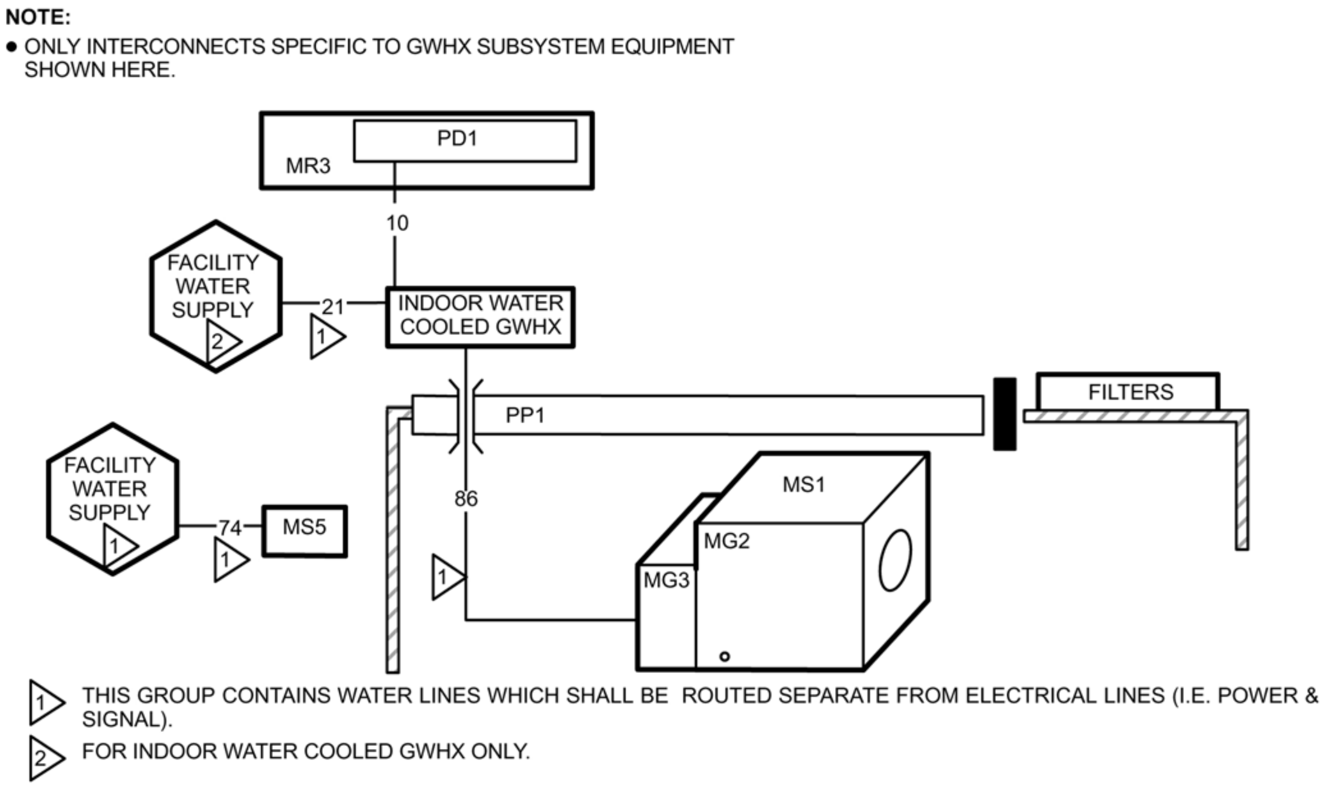


Table 7-24: Indoor Water Cooled GWHX Additional Interconnects - Customer Supplied

Group	Group Area in.2 mm2)	Between Units		Usable Length	Run #	Cable Diam-eter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
21 See Note 1	--	Facility Water Supply	GWHX	--	--	--	--	--	Customer supplied, refer to Chapter 5, Section 5.4, GWHX Water Cooling Requirements
74 See Note 1	--	Facility Water Supply	MS5	--	--	--	--	--	Customer supplied water lines (refer Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling
Note 1 This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).									

Table 7-25: Indoor GWHX Additional Interconnects - L1/L2

Group	Group Area in.^{2} mm^2)	Between Units		Usable Length	Run #	Cable Diam-eter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
86 See Note 1	1.67 (1078)	Cus-tomer provided hose barbs	MG2	80 (24.4) minus takeup at hose barbs See Notes	536	1.03 (26.2)	flexible tubing	flexible tubing	See Table Notes 2 & 3
					537	1.03 (26.2)	flexible tubing	flexible tubing	

Notes

1. This Group contains water lines which shall be routed separate from electrical lines (i.e. power & signal).
2. Group 86 AirSys supplied Gradient Coil water cooling lines are routed through waveguides in PP1 and have a minimum bend radius of 7 in. (178 mm).
3. Group 86 MUST NOT EXCEED limitations specified under Section 6.1 and Section 6.2 .

Table 7-26: Indoor GWHX Additional Interconnects - L3

Group	Group Area in.^{2} mm^2)	Between Units		Usable Length	Run #	Cable Diam-eter in. (mm)	Plug Pulling Diamter X Length in. (mm)		Notes
		From	To				From	To	
10	0.173 (113)	PD1 See Note 1	GWHX	24.7 (7.5)	--	0.47 (12)	hard wired	1.53x2.78 (3.89x70.6)	AirSys provided power cable 3 wire 12 AWG

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

7 Contractor Furnished Components

Table 7-27 lists contractor furnished components and details for connections to the system.

Table 7-27: Contractor Furnished Components

Associated Equipment	Material/Labor Provided By Customer Contractor
Main Disconnect Panel & System Emergency Off Buttons	Provide and install Main Disconnect Panel which meets the requirements of Chapter 6, Section 3.1, Main Disconnect Panel (MDP) Requirements.
Power In Magnet Room	Provide and install power and wall duct for magnet rundown unit. (For power specifications see Chapter 6, Section 1, System Power Introduction.)
System Ground	Provide ground cable between RF shielded room common ground point and Power Distribution Unit (PD1). (For cable specifications see Chapter 6, Section 4, Grounding.)
Equipment Power • Main Disconnect Panel (MDP) • Magnet Rundown Unit • MDP to Power Distribution Unit (PDU) • MDP to MR Common Chiller (MRCC) • Service Outlet in Magnet Room • * Oxygen Monitor	Provide and install power, duct work, receptacle, and coverplate for each item listed. (For power specifications refer to Chapter 6, Section 1, System Power Introduction, Chapter 6, Section 2, Critical Power Requirements, Chapter 6, Section 3.1, Main Disconnect Panel (MDP)).
Plumbing	Provide and install all water cooling equipment, for customer supplied components & requirements refer to • Chapter 5, Section 5.2, Shield/Cryo Cooler Tempoary Backup Water Cooling • Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling • Chapter 5, Section 5.4, GWHX Water Cooling Requirements
Cryogenic Venting	Provide and install cryogenic vent system, refer to: • Chapter 5, Section 10.1, Cryogenic Venting Introduction, Chapter 5, Section 10.2, Requirements For Outside Magnet Room, and Chapter 5, Section 10.3, Requirements for Inside Magnet Room • Chapter 8, Section 2.1, Cryogenic Vent, Chapter 8, Section 2.2, Determining Cryogenic Vent Location, Chapter 8, Section 2.3, Waveguide, and Chapter 8, Section 2.4, Guide for Outside RF Room Isolation Joint
Room Ventilation	Provide and install all room ventilation equipment (e.g. Magnet Room exhaust fan) for room ventilation specifications listed in Chapter 5, Section 9, Room Ventilation .
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.)

Table 7-27: Contractor Furnished Components (cont'd)

Associated Equipment	Material/Labor Provided By Customer Contractor
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, Section 9, RF Door Switch.)
Notes * Optional Equipment ** The Pneumatic Patient Alert Control Box can be powered from an outlet on the Operator Workspace.	

8 Spectroscopy Options Additional Interconnects

8.1 4KW MNS Option Additional Interconnects

Illustration 7-17 shows the system interconnect groups which have additional system interconnects for 4 KW MNS option. Table 7-28 contains cable length for the system additional interconnects provided by the MNS Option catalog. Table 7-29 and Table 7-30 contains the cable data for the additional interconnects.

Illustration 7-17: 4KW MNS Option Additional Groups Interconnects

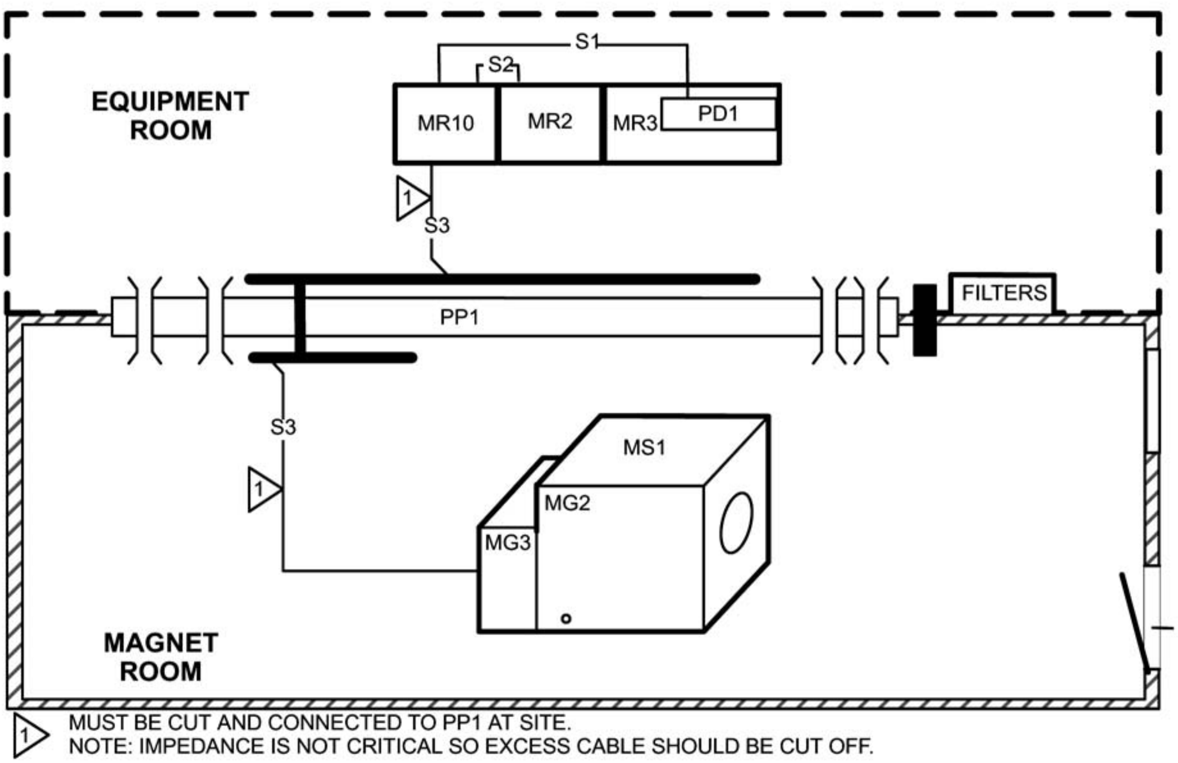


Table 7-28: 4KW MNS Option Additional Interconnects Cable Length Provided

Location	Group	Between		Usable Length
		From	To	M3334YE
L1/L2	S3	MR9	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	S1	PD1	MR10	16 (4.88)
	S2	MR2	MR10	21 (6.40)

Table 7-29: 4KW MNS Additional Interconnects Details - L1/L2

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
S3	0.273 (109)	MR10	MG2/3	1146/ 1147	0.59 (14.99)	1.44x0.87 (36.6x22.1)	1.44x0.87 (36.6x22.1)	**RF Transmit cable**

Table 7-30: 4KW MNS Additional Interconnects Details - L3

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
S1	0.273 (109)	PD1 See Note 1	MR10	1237	0.59 (11.8)	Hard Wired	Hard Wired	#8 AWG / 5 wire Power cable
S2	0.317 (205)	MR2	MR10	1221	0.24 (6.10)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1222	0.24 (6.10)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1223	0.24 (6.10)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1224	0.24 (6.10)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1225	0.24 (6.10)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1226	0.24 (6.10)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1227	0.24 (6.10)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	

8.2 8KW MNS Option Additional Interconnects

Illustration 7-18 shows the system interconnect groups which have additional system interconnects for 8KW MNS option. Table 7-31 contains cable length for the system additional interconnects provided by the 8KW MNS Option catalog. Table 7-32 and Table 7-33 contains the cable data for the additional interconnects.

Illustration 7-18: Signa EXCITE HD 3.0T 8KW MNS Option Additional Groups Interconnects

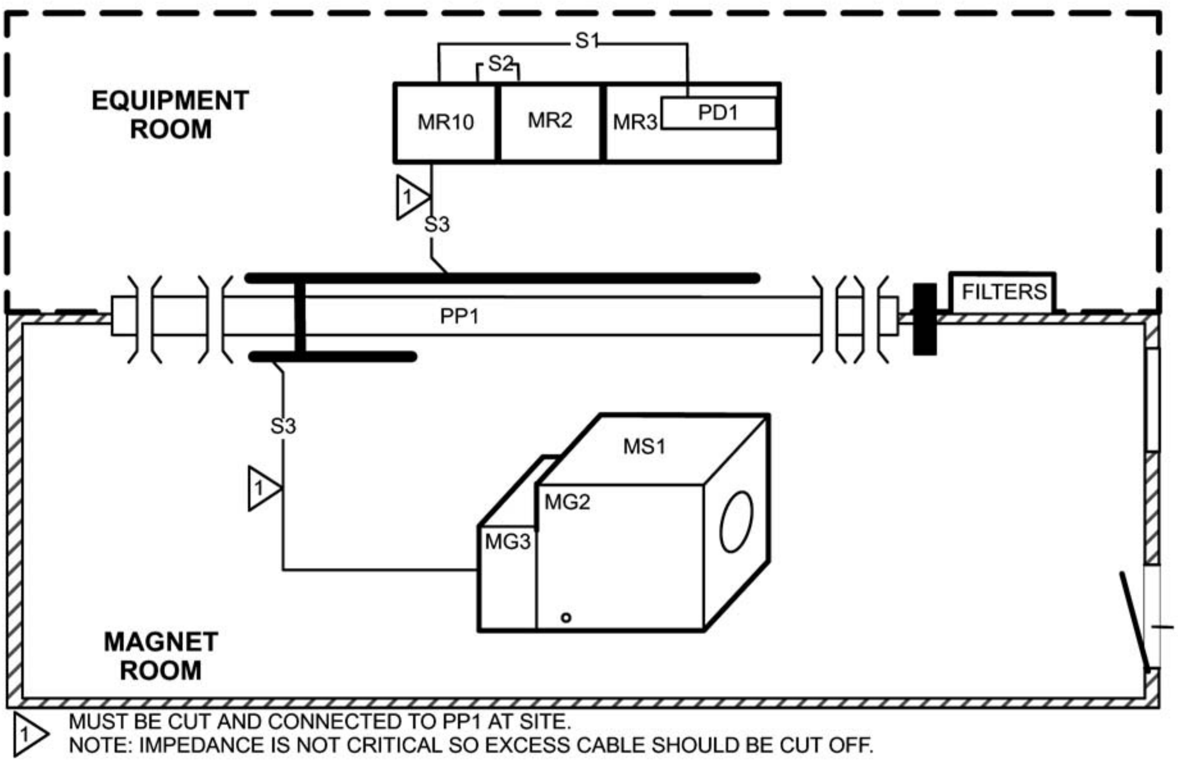


Table 7-31: 8KW MNS Option Additional Interconnects Cable Length Provided

Location	Group	Between		Usable Length
		From	To	M3000LA
L1/L2	S3	MR9	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	S1	PD1	MR9	16 (4.88)
	S2	MR2	MR9	21 (6.40)

Table 7-32: 8KW MNS Additional Interconnects Details - L1/L2

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
S3	0.273 (109)	MR10	MG2/3	1146/ 1147	0.59 (14.99)	1.44x0.87 (36.6x22.1)	1.44x0.87 (36.6x22.1)	**RF Transmit cable**

Table 7-33: 8KW MNS Additional Interconnects Details - L3

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
S1	0.273 (109)	PD1 See Note 1	MR9	1138	0.59 (11.8)	Hard Wired	Hard Wired	#8 AWG / 5 wire Power cable
S2	0.420 (272)	MR2	MR9	1139	0.24 (6.10)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1141	0.24 (6.10)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1142	0.24 (6.10)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1143	0.24 (6.10)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1144	0.24 (6.10)	0.57x1.125 (14.5x28.6)	0.57x1.125 (14.5x28.6)	
				1236	0.44 (11.18)	2.30x2.00 (57.2x50.8)	2.30x2.00 (57.2x50.8)	
				1241	0.23 (5.94)	0.57x1.125 (14.5x25.58)	0.57x1.125 (14.5x25.58)	

9 Oxygen Monitor Option Interconnects

The Oxygen Monitor option consists of the following items:

- Oxygen Monitor
- Remote Oxygen Sensor Module
- Interconnect cables

Illustration 7-19 shows the Interconnect Diagram. Table 7-34 contains the cable data.

Illustration 7-19: Oxygen Monitor Option Cabling

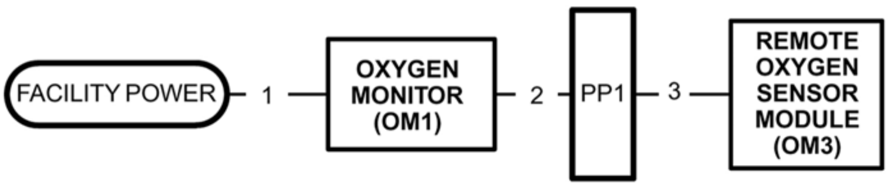


Table 7-34: Oxygen Monitor Interconnect List

Group	Group Area in.^{2} (mm^2)	Between Units		Usable Length	Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To				From	To	
1	--	Facility Power	OM1	--	--	--	--	--	Customer supplied, recommended power source for OM1 (refer to Chapter 6, Section 1, System Power Introduction).
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	

10 BrainWave HW Lite Option Interconnects

The BrainWaveHW Lite option consists of the following items:

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

Illustration 7-20 shows the BrainWave HW Lite option interconnect diagram. For cable lengths and details refer to Table 7-35 , Table 7-36 , Table 7-37 , and Table 7-38 .

Illustration 7-20: BrainWaveHW Lite Option Group Interconnects Diagram

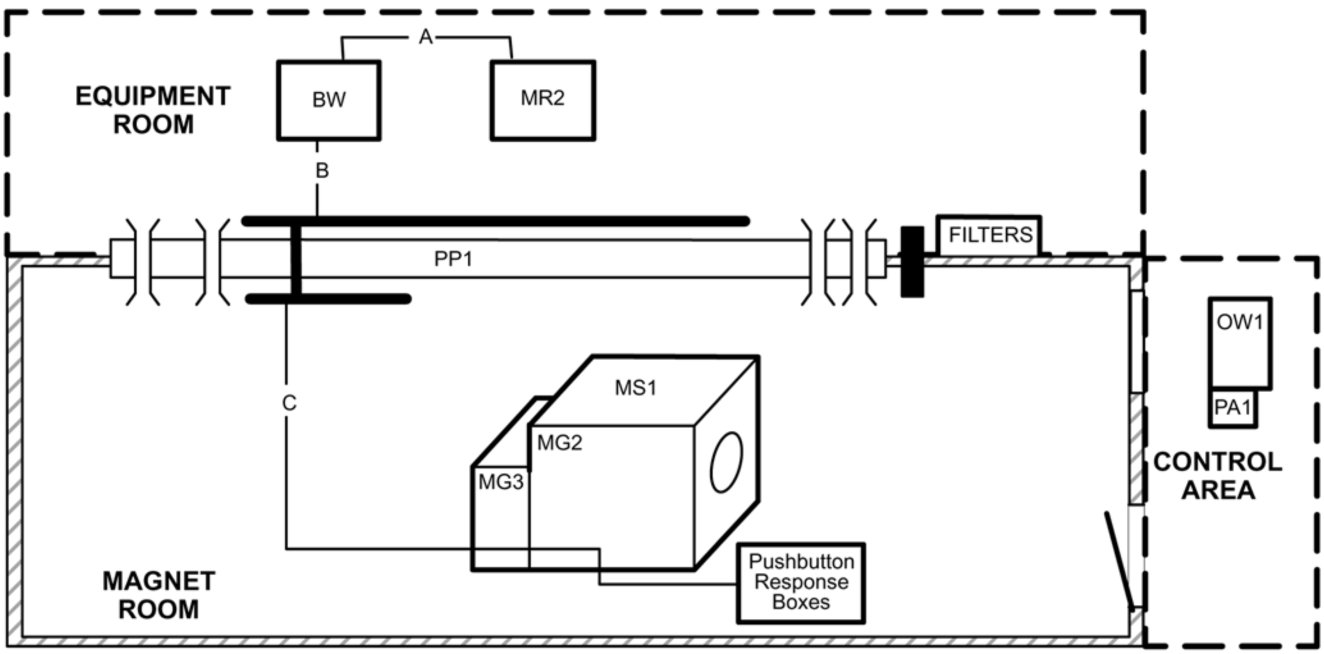


Table 7-35: BrainWave HW Lite Option Additional Interconnects Length Provided

Location	Group	Between		Usable Length
		From	To	M1033BL ft (m)
L1	C	PP1	Push button Response Boxes	53 (16.2) The Run in the Group contains a connector at MG2 with a separate cable routed out to the Push button Response Boxes.
L2	B	BW	PP1	60 (18.3)
L3	A	BW	MR2	10 (3.0)

Table 7-36: BrainWave HW Lite Option Additional Interconnects - L1

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
C	0.113 (74)	PP1	Push button Response Boxes	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.

Table 7-37: BrainWave HW Lite Option Additional Interconnects - L2

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
B	0.113 (74)	BW	PP1	979153	0.38 (9.7)	0.72x2.43 (18.3x61.7)	1.26x1.75 (32.0x44.5)	DC Power - Response

Table 7-38: BrainWave HW Lite Option Additional Interconnects - L3

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
A	0.243 (158)	BW	MR2	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)	hard wired	AC Power
				758616	0.25 (6.4)	0.50x0.88 (12.7x22.3)	0.50x0.88 (12.7x22.3)	Network Cable

11 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 7-21 shows the Interconnect Diagram , Table 7-39 contains the cable data.

Illustration 7-21: Remote MRU Interconnect Diagram

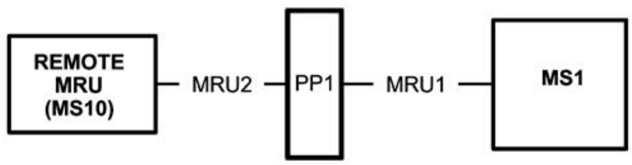


Table 7-39: Remote MRU Interconnects Details

Group	Between Units		Usable Length ft. (m)	Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
	From	To				From	To	
MRU1	PP1	MS1	81.0 (24.69)	1265	0.30 (7.6)	1.30x2.00 (33.5x50.8)	1.30x2.00 (33.5x50.8)	
MRU2	MS10	PP1	88.0 (26.82)	1266	0.30 (7.6)	0.787x2.33 (20.0x59.2)	1.30x2.00 (33.5x50.8)	

12 IPCM Option Interconnects

The IPCM Option for LCC300 Magnet (M3033LH) consists of the following items:

- Chilled Air Blower (CAB)
- CAB Main Disconnect Panel (CAB-MDP)
- Bore Liner (2 pieces) installed in Magnet
- Interconnect cables.

Illustration 7-22 shows the system interconnect groups for IPCM Option for LCC300 Magnet.

For cable lengths refer to Table 7-40 and for cable details refer to Table 7-41 and Table 7-42 .

Illustration 7-22: IPCM Option Group Interconnects Diagram

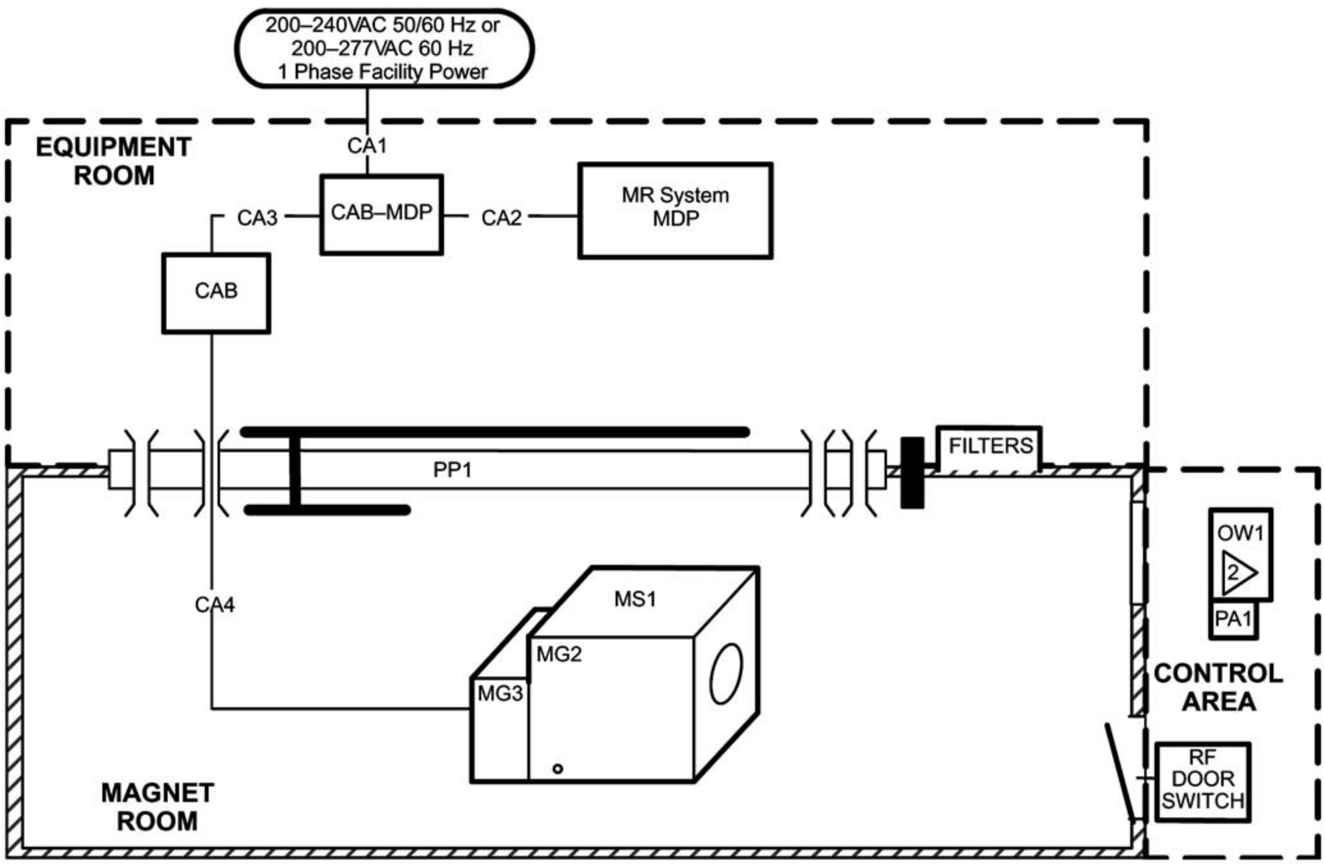


Table 7-40: IPCM Option Interconnects Length Provided

Location	Group	Between		Usable Length ft (m)
		From	To	
L1/L2	CA4	CAB	MG3	72 (22)
L3	CA1	Facility Power	CAB-MDP	Customer supplied
	CA2	CAB-MDP	MDP	Customer supplied
	CA3	CAB-MDP	CAB	10 (3.05)

Table 7-41: IPCM Option Interconnects - L1/L2

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
CA4	3.98 (2570)	CAB	MG3	--	2.25 (57.2)	air hose	air hose	Air hose routed to MG3. Outside MG3 connects to Y junction and two 1.75 in. (44.5mm) hoses routed to Bore Liner 2 pieces.

Table 7-42: IPCM Option Interconnects - L3

Group	Group Area in.^{2} (mm^2)	Between Units		Run #	Cable Diameter in. (mm)	Plug Pulling Diameter x Length in. (mm)		Notes
		From	To			From	To	
CA1	--	Facility Power	CAB-MDP	--	--	--	--	Customer supplied, refer to Chapter 6, Section 9, IPCM Option Power Requirements
CA2	--	CAB-MDP	MDP	--	--	--	--	Customer supplied 120 control circuit wire, refer to Chapter 6, Section 9, IPCM Option Power Requirements
CA3		CAB-MDP	CAB	--	0.5 (12.7)	2.00x3.25 (50.8x82.6)	2.00x3.25 (50.8x82.6)	Power cable

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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 does 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, for system imaging frequencies 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. The electrical discharge can occur due to electrical arcing (micro arcing) or merely a static discharge. Some potential sources capable of producing electrical discharge 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 (150MHz ± 10MHz) planewave, refer to Chapter 12, Section 2, RF Shielded Enclosure Test Guideline Frequency Range subsection.
Ground	1. Ground Isolation: 1,000 ohms or greater 2. 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 RF 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.
	3. 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. 4. Refer to Section 7.6, Electrical Isolation for additional information on electrical isolation requirement.

Table 8-1: RF Shielded Room Requirements (cont'd)

Parameter (See Note *)	Requirements (See Note *)
Materials	1. The choice of RF Shield material including fasteners is the responsibility of the customer's architect and RF vendor. 2. 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.
	3. The floor under the Magnet in a 10 ft x 12 ft (3.048 m x 3.658 m) area must not be fabricated from magnetic materials, refer to Magnet Room Floors Magnetic Properties in Chapter 5, Section 15, Construction Materials. 4. The Magnet Room floor materials must meet the requirements in Section 6.5, Magnet Room Floors. 5. The door or any other moving or non-rigid parts must not be fabricated from magnetic materials. 6. 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: a. Avoid direct contact of materials of different solution potential (e.g. dissimilar metals galvanic corrosion) when selecting fastens to secure the RF screen material to the RF supporting structure. b. Ensure the RF shield seams/joints have overlaps that are properly dressed selecting proper material to avoid galvanic corrosion. c. 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.
	d. 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. e. 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 <55 db acoustic attenuation have caused customer acoustics issues. Refer to Chapter 5, Section 8.4, Acoustic Design Guidelines for additional information.

Table 8-1: RF Shielded Room Requirements (cont'd)

Parameter (See Note *)	Requirements (See Note *)
Construction	1. The design of the shield support system is the responsibility of the customer's architect and RF vendor. 2. RF Shield construction methods must not compromise RF Shield integrity (attenuation) for the anticipated duration of usage for MR imaging. a. When RF shield seams/joints are sealed with solder: all solder drips, cold solder joints, and cracked solder joints must be cleaned and repaired. b. RF Shield movement can cause micro electrical arcs (static discharge or broadband RF noise) that will cause MR image artifact known as White Pixel. c. 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. d. All electrical and mechanical connections and fasteners including screws, nails, nuts, bolts, clips clamps, concrete anchors, seismic anchors, etc. must be tightened and secured to supplier specifications so as not to become a potential broadband noise source. e. All fasteners must be solid locking devices such as t-nuts, PEM nuts or welded nuts; no self tapping screws allowed. f. The Magnet Room floor design and construction must meet the requirements in Section 6.5, Floors. g. 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. 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. **CAUTION** **For safety reasons, magnetic materials must be secured to ensure magnetic components do not become projectiles.** **Methods of securing must not loosen due to repeated use, some options include (but not limited to) redundant restrains straps or anchors/bolts with locking nuts.**
Testing	1. The customer's architect and RF vendor are responsible for conducting testing to verify compliance with the requirements for RF attenuation and ground isolation. 2. The RF shielded room verification test is to be performed in the presence of a GE representative. 3. The FINAL RF Shielded room acceptance test shall be performed in accordance with Chapter 12, Section 2, RF Shielded Enclosure Test Guideline.
Maintenance	1. 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. 2. 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 Vent

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, as per Section 2.2, Determining Cryogenic Vent Location 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 Chapter 5, Section 10.3, Requirements for Inside Magnet Room for exceptions.

2.2 Determining Cryogenic Vent Location

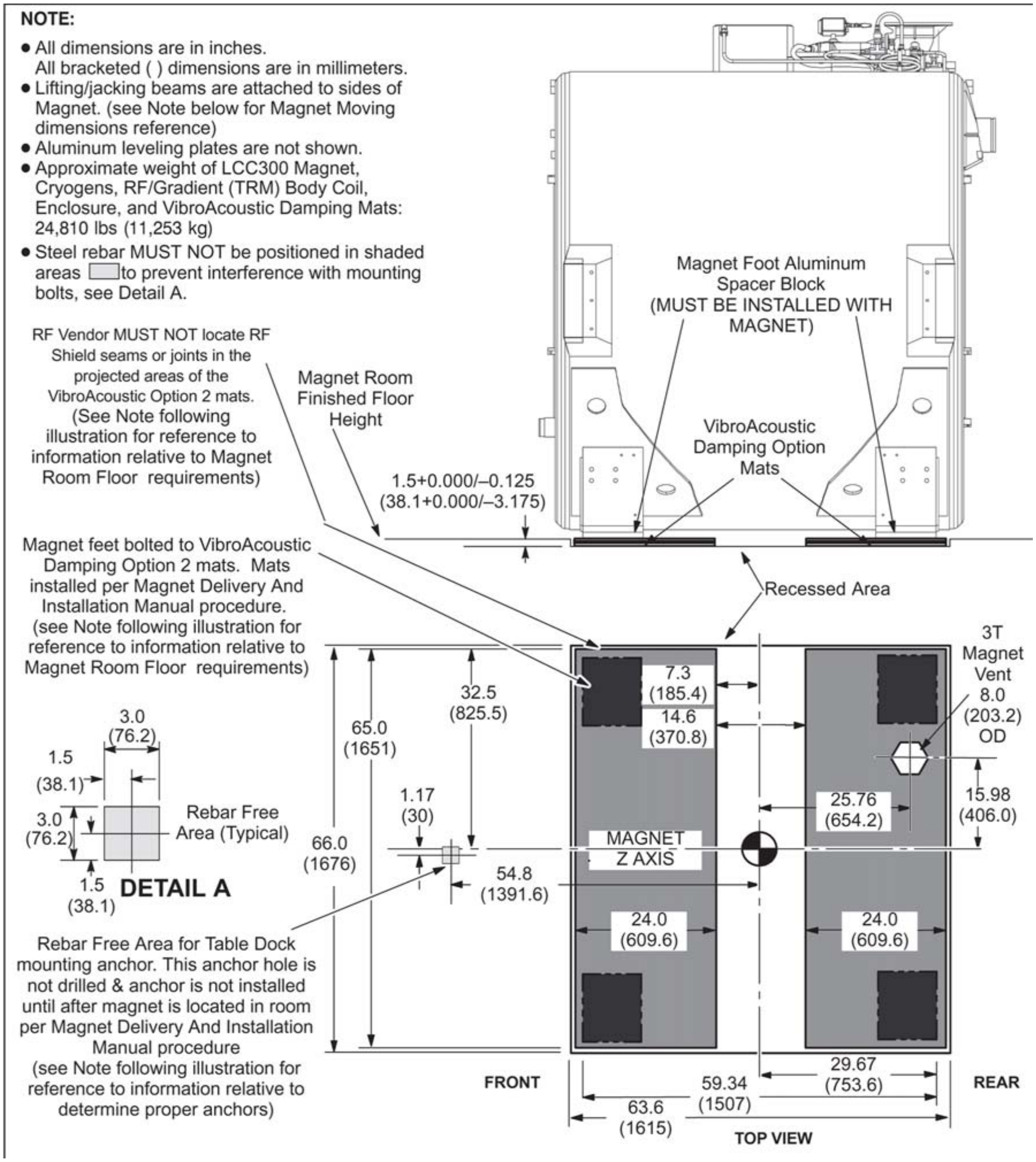
Shown in Table 8-2 and Table 8-3 is the LCC Magnet vent location.

It is important that the 0.25 in. (6.35 mm) tolerance for vent opening be met. Included with the LCC Magnet system is an 8 in. OD by 0.125 in. wall (203.2 mm x 3.2 mm) 6061-T6511 Aluminum per ASTM B241 vent tube. A typical route for this vent tube is shown in Illustration 8-1 . However, if the tolerances shown in Table 8-3 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 10.1, Cryogenic Venting, Chapter 5, Section 10.2, Requirements For Outside Magnet Room, and Chapter 5, Section 10.3, Requirements for Inside Magnet Room *subsections*.

GE provides a Floating Flange Vent Adaptor Kit with the LCC 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 Table 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±0.25 inch (25±6 mm) gap between the Vent Pipe and the Ceiling Waveguide for dielectric isolation to ensure the integrity of the RF shield room.

Table 8-2: LCC Magnet Mounting & Cryogenic Vent Location With VibroAcoustic Damping Option

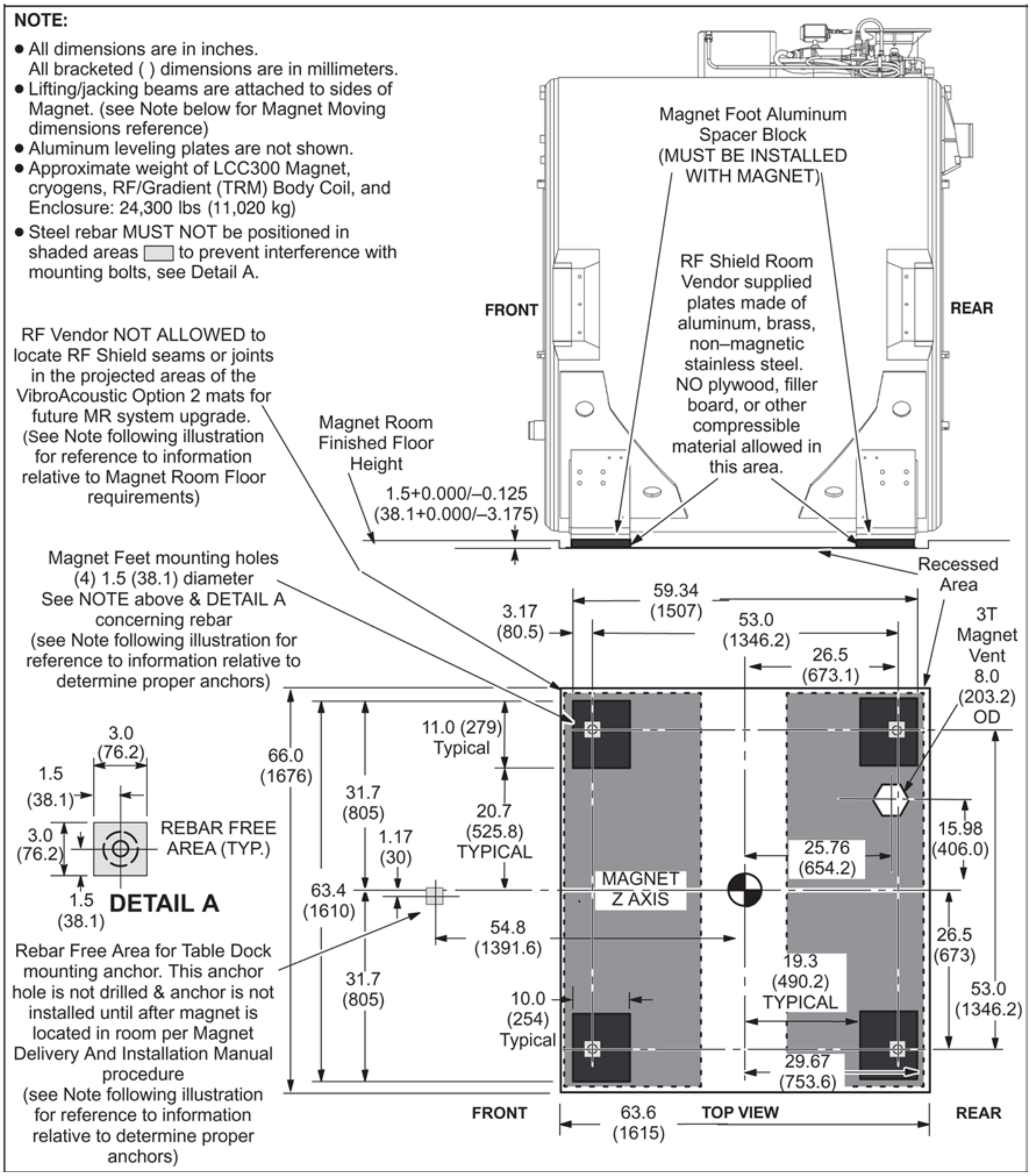
Table 8-2: LCC Magnet Mounting & Cryogenic Vent Location With VibroAcoustic Damping Option (cont'd)



NOTE: 1. Refer to Chapter 9, Section 2, Magnet Shipping Considerations for magnet moving dimensions with lifting/jacking beams attached to the sides of the magnet.

NOTE: 2. For additional magnet mounting information and to determine proper anchors, refer to the following located in RF Shield Room chapter, Anchor Hardware Requirements sections: 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, and Section 7.6, Electrical Isolation.

Table 8-3: LCC Magnet Mounting & Cryogenic Vent Location Without VibroAcoustic Damping Option



NOTE: 1. Refer to Chapter 9, Section 2, Magnet Shipping Considerations for magnet moving dimensions with lifting/jacking beams attached to the sides of the magnet.

NOTE: 2. For additional magnet mounting information and to determine proper anchors, refer to the following located in RF Shield Room chapter, Anchor Hardware Requirements sections: 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, and Section 7.6, Electrical Isolation.

Illustration 8-1: Cryogenic Vent Routing

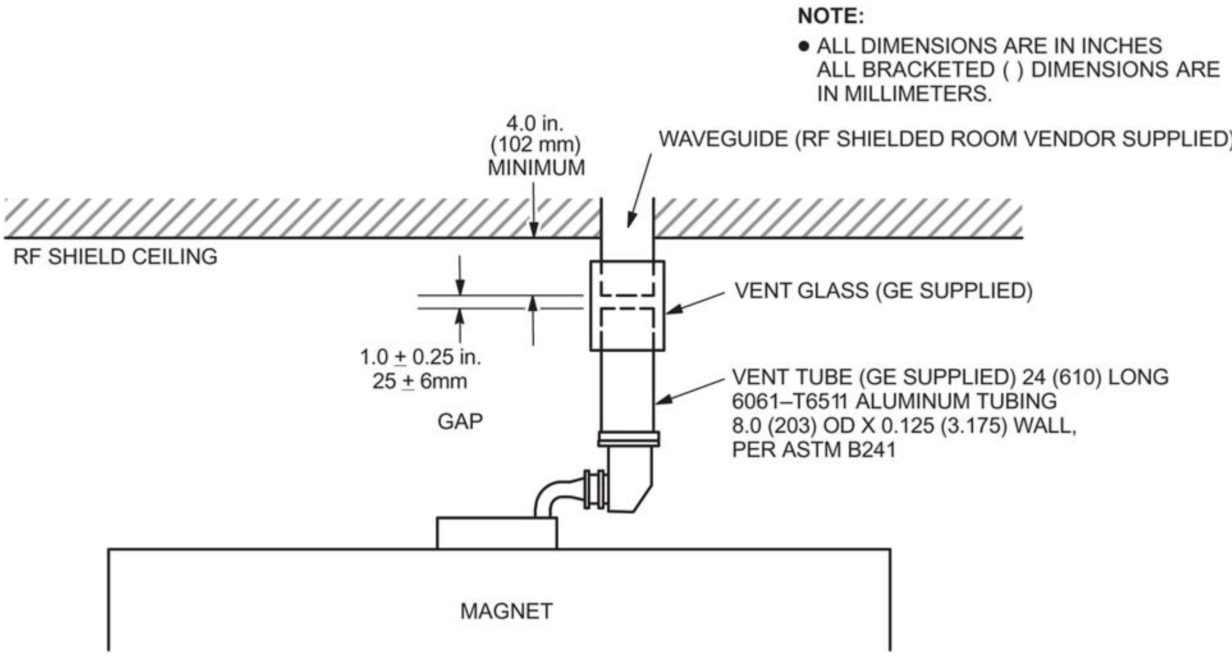
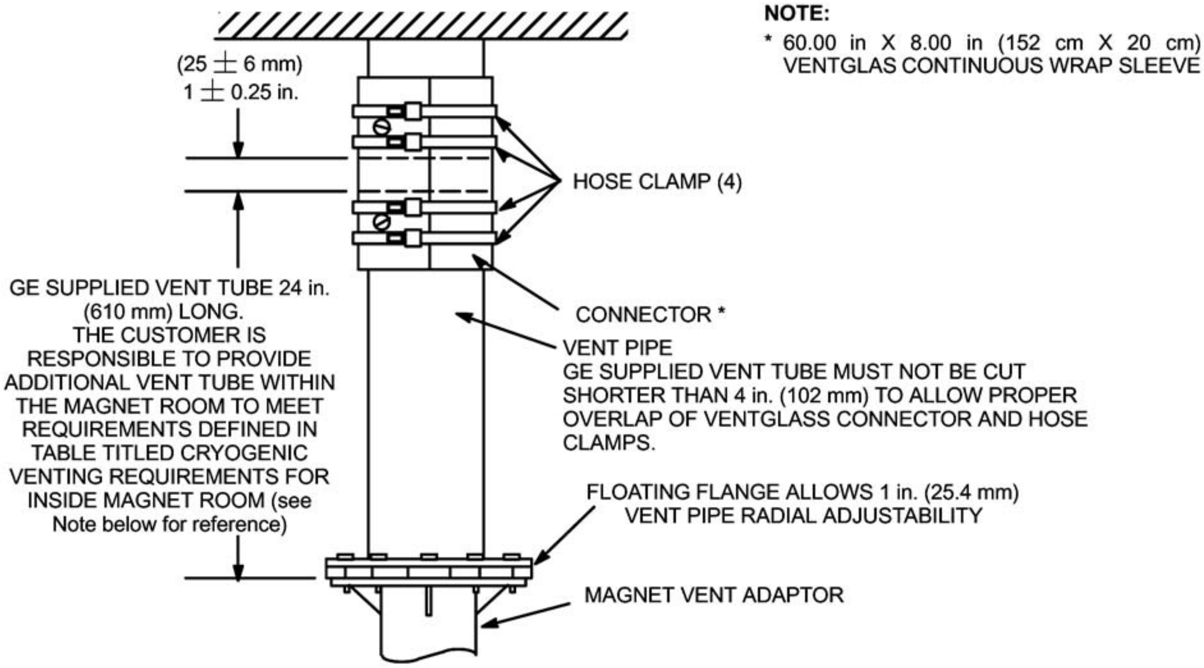


Table 8-4: Floating Flange



NOTE: For details of cryogenic venting requirements inside the Magnet Room refer to Chapter 5, Section 10.3, Requirements for Inside Magnet Room under Cryogenic Venting heading.

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 8-5 for list of GE requirements for the waveguide.

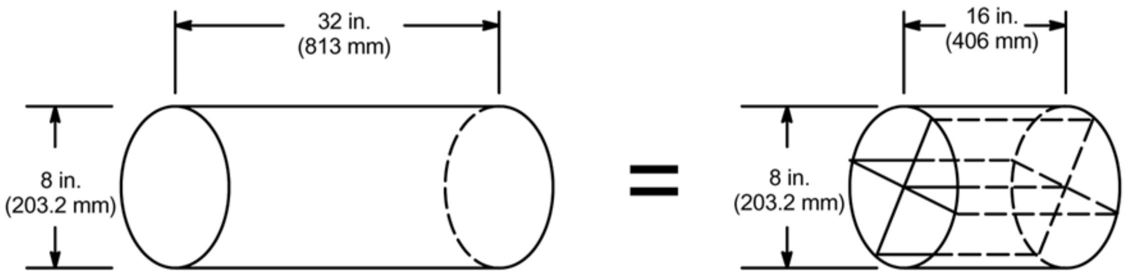
Table 8-5: Waveguide Requirements

Parameter	Requirements
Waveguide Size	• If the provided GE vent tube is to be connected directly to the waveguide via the GE Ventglass 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 8-2 , 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. (Refer to *Site Environment chapter sections:* Chapter 5, Section 10.1, Cryogenic Venting, Chapter 5, Section 10.2, Requirements For Outside Magnet Room, Chapter 5, Section 10.3, Requirements for Inside Magnet Room.) • Flat, honeycomb type waveguide is not acceptable.

Illustration 8-2: 4 Chamber Waveguide

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.



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 8-6 contains suggestions for the RF room isolation joint.

NOTE: GE supplies Ventglass and clamps which can be used for 8 in. (203 mm) diameter pipe ONLY. These materials may be used for isolation joint outside RF room at the contractor's option if the material meets the contractor's design requirements.

Table 8-6: 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. • Ventglass and Lorenz clamp is a GE recommended method of achieving the isolation.

Table 8-6: Outside RF Room Isolation Joint Suggestions (cont'd)

Parameter	Isolation Joint Suggestions
Isolation Joint Construction	• Ventglass: If the connection diameter is 8 in. (203.2 mm), a Ventglass connection method as shown in Illustration 8-3 is recommended. • Lorenz clamp: If the connection diameter is 8 in. (203.2 mm), a Lorenz clamp connection as shown in Illustration 8-4 is recommended. • The mating diameters must match within ± 0.125 in. (3 mm). • The Ventglass **must not** be used for structural support.
Suppliers	Ventglass information may be obtained from: Industrial Machine & Fabricating Inc. 2808 E. Sammy's Lane Florence, SC 29506-3841 USA (843) 667-4582 indmachfab@aol.com Vent Fabric Inc. 5520 N. Lynch Avenue Chicago, IL 60630-1418 USA (800) 621-1207 or (773) 775-4477 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

Illustration 8-3: Vent Glass Continuous Wrap

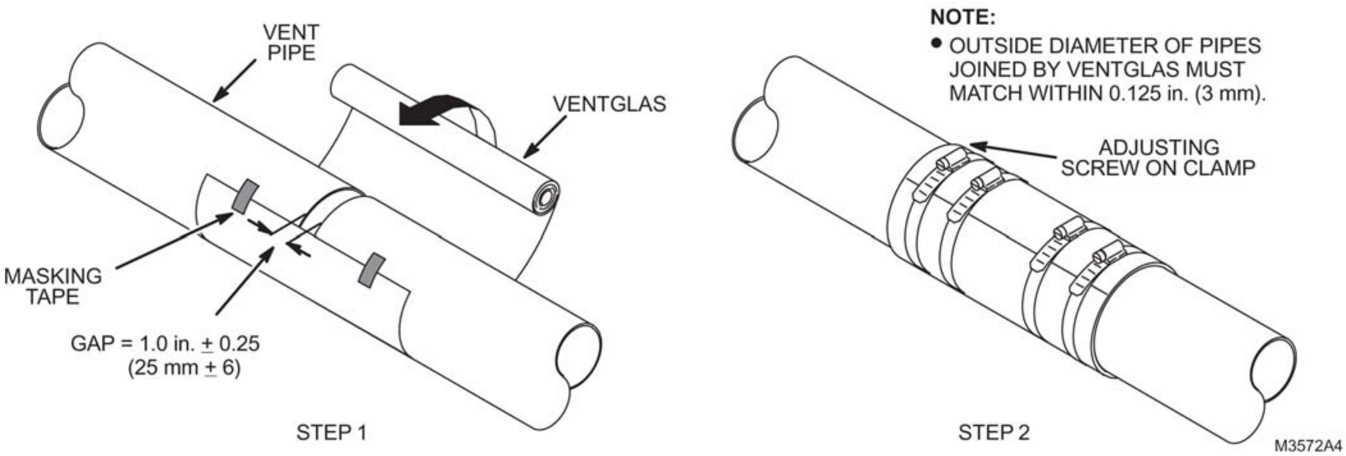
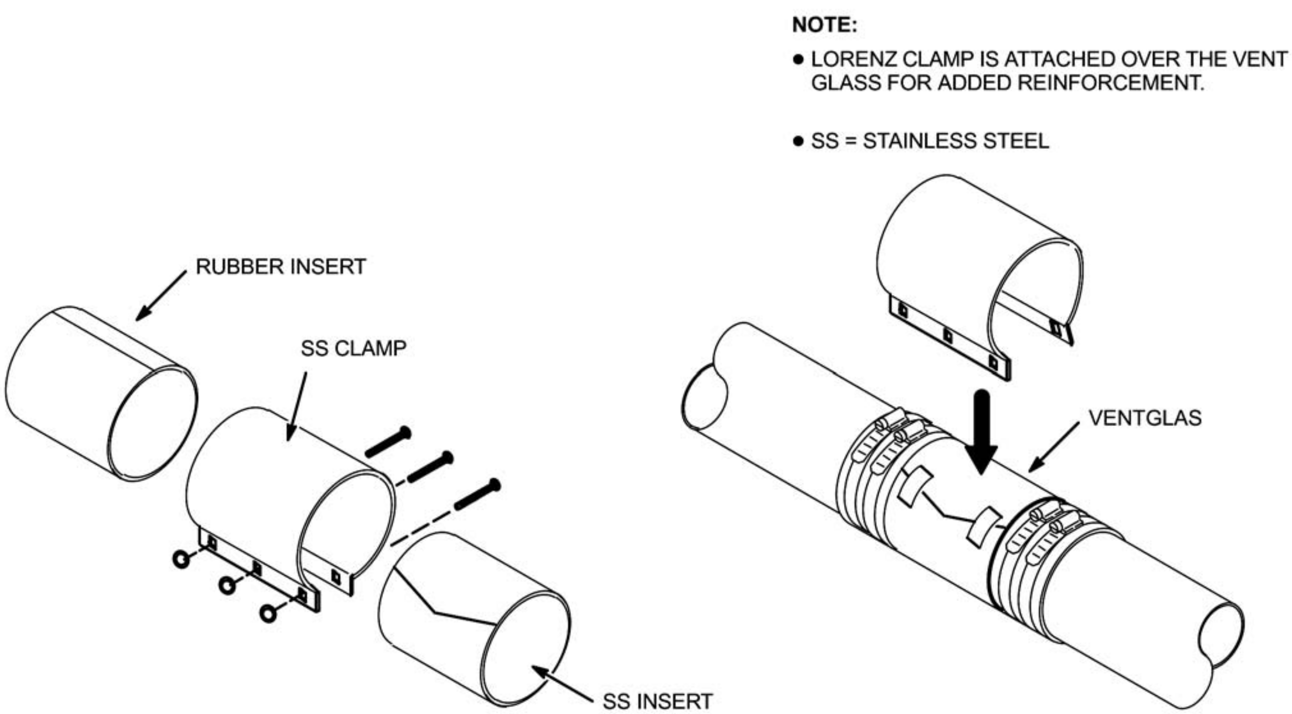


Illustration 8-4: Lorenz Clamp



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 waveguides 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 Chapter 5, 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 requirements in Section 1, RF Shielded Room 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 comply with requirements in Section 1, RF Shielded Room Requirements to minimize the possibilities of electrical discharge which can cause RF broadband noise. All plumbing must be in accordance with local and national 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 compliancy with the RF Shielded Room attenuation requirements. 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.

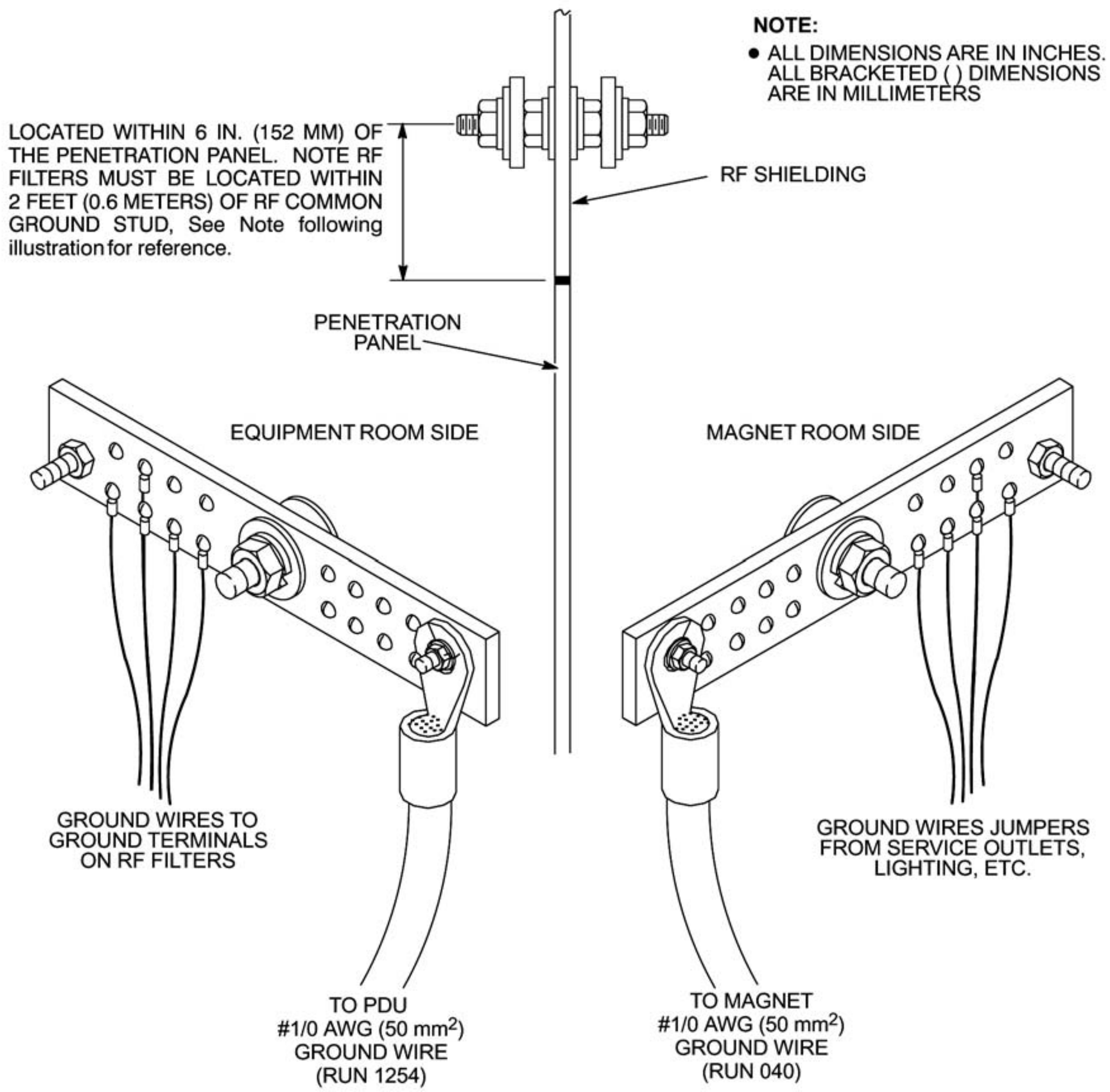
NOTE: All electricals lines and filters must comply with requirements in Section 1, RF Shielded Room Requirements to minimize the possibilities of electrical discharge can cause RF broadband noise.

RF Shielded Room vendor should review with the electrical contractor the number of incoming power lines to the Magnet Room to determine 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 2, Critical Power Requirements and 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 Stud. 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 Table 8-7). The RF Common Ground Stud and terminal bars must be accessible for servicing purposes on both sides of shield room. It is recommended that the RF Common Ground Stud be positioned above the Penetration Panel so it is concealed behind the Penetration Panel Covers (see Section 5,)RF Penetration Panel.

Table 8-7: RF Common Ground Penetration Stud



NOTE: RF Common Ground Stud location to be per Chapter 6, Section 4, Grounding

4.2 Room Lighting

NOTICE

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

Fluorescent lighting is not allowed in the Magnet Room due to the RF noise generated by the fluorescent 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).

Also refer to Chapter 7, Section 4.9, Customer Supplied Interconnects.

5 RF Penetration Panel

The RF Shielded Room Vendor must provide the opening in the RF shielding and appropriate mounting hardware for the GE Penetration 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.

NOTICE

The Penetration Panel mounting hardware must not loosen over time to maintain RF attenuation requirement in Section 1, RF Shielded Room Requirements for the anticipated duration of usage for MR imaging. Some of the design parameter that can contribute to loosen of the Penetration Panel mounting hardware are: wall material compression over time, insufficient fasteners quantity or spacing, over or under tightness of mounting fasteners, insufficient locking mechanism (i.e. Locktight, double/locking nuts), etc.

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 Specifications.

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. The mounting and clearance dimensions for the Penetration Panel GE covering are shown in Penetration Panel/Covering Mounting Requirements illustration in Table 8-8 .

Illustration 8-5 and Illustration 8-6 show two possible methods for mounting the GE MR Penetration Panel. Either method may be used depending on RF shielded room wall thickness. Make sure if the mounting method in Illustration 8-5 is used then the RF wall thickness must be 0.75 in. (19 mm) 0.0625 in. (1.6 mm). Refer to the two preceding Notices. Check with RF Shielded Room Vendor to determine appropriate mounting method.

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 Illustration 8-5 and Illustration 8-6 .

Illustration 8-5: Penetration Panel Cut Out For 0.75 Inch (19 MM) Thick RF Wall

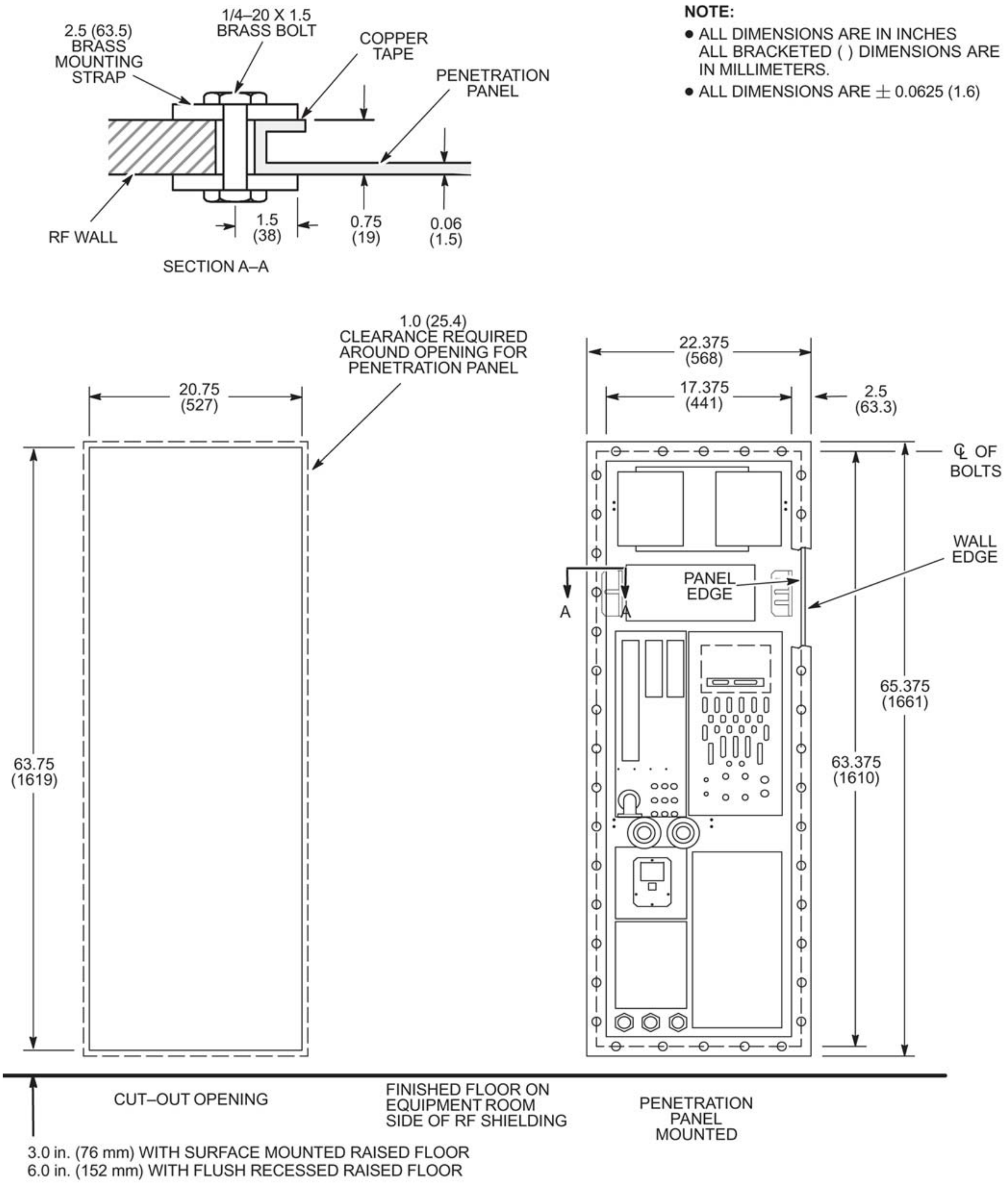


Illustration 8-6: Penetration Panel Cut Out For RF Wall Thickness Varying From Small To Large

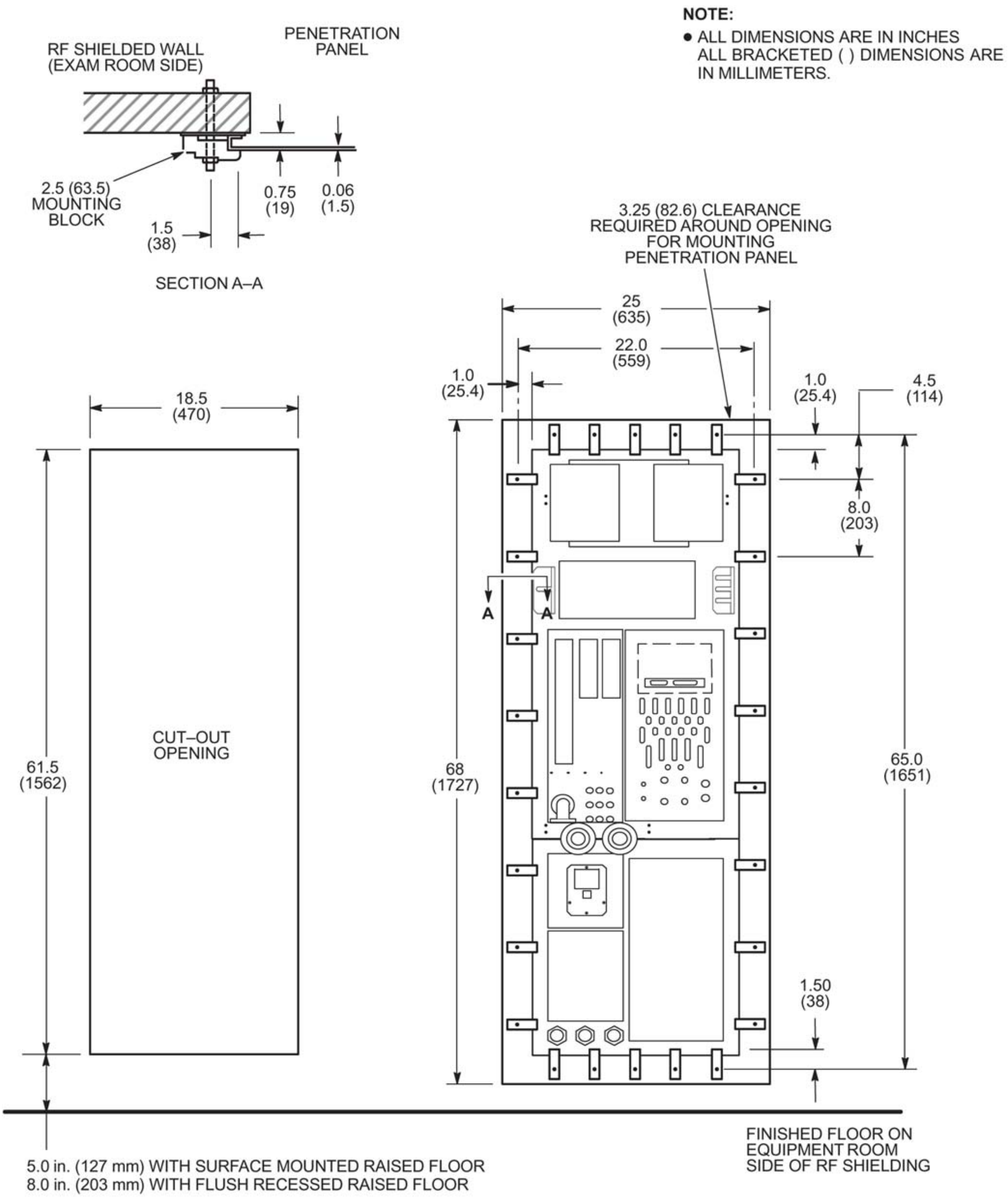
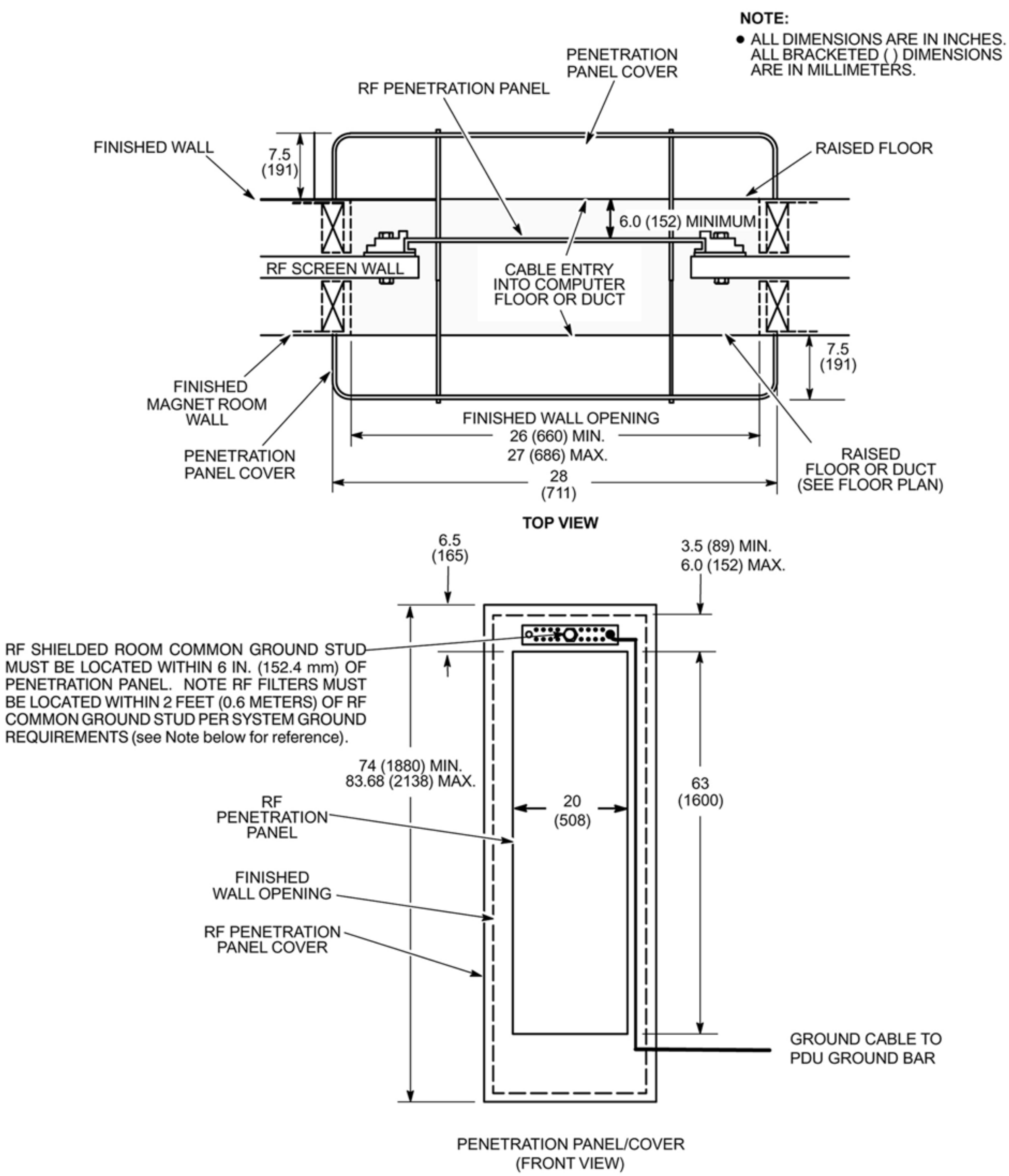


Table 8-8: Penetration Panel/Covering Mounting Requirements



NOTE: RF Commonn Ground Stud location to be per System Ground subsection in Chapter 6, Section 4, Grounding

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 (2.74 m) wide by 9 ft (2.74 m) high removable wall panel or 9 ft (2.74 m) by 10 ft (3.05 m) 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 8-9 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 8-9 and shown in Illustration 8-7 . The Design Center group can be reached at (262) 548-4500.

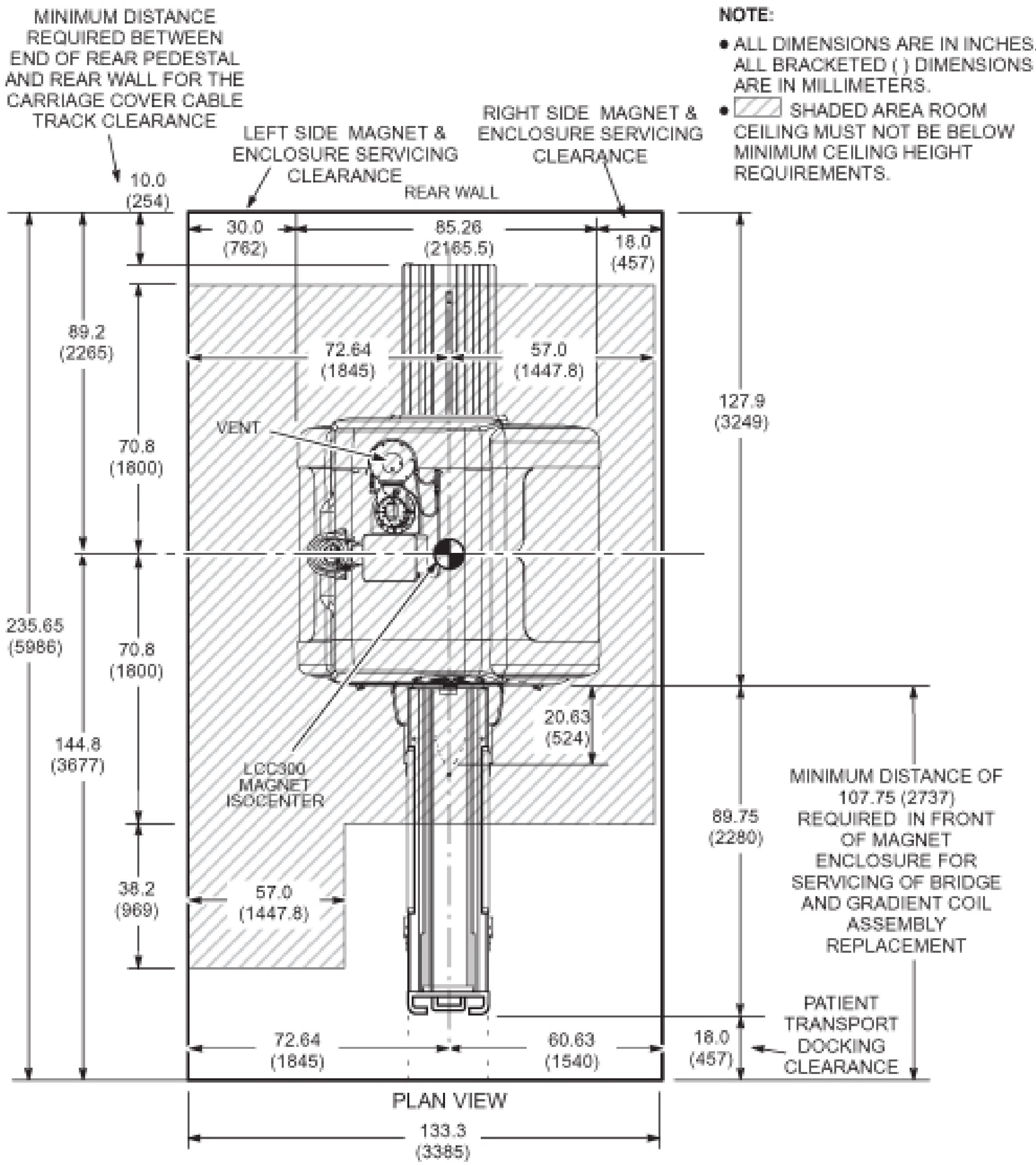
Table 8-9: Magnet Servicing Ceiling Height Requirements

Magnet Type	Absolute Minimum Ceiling Height * See Notes 1 & 2		Comments
	in.	**mm**	
LCC300	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.
LCC300 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 insertion.

Note * Absolute minimum ceiling height values are from magnet room finished floor to fixed ceiling.

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.

Illustration 8-7: Minimum Ceiling Height for Magnet Servicing



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 8.4, Acoustic Design Guidelines.

NOTE: Walls materials and installation including all electrical and mechanical connections, mounting hardware, and installation must comply with the 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 Operator Workspace position. For potential acoustic impact of window location refer to Chapter 5, Section 8.2, Acoustics Background, Chapter 5, Section 8.3, System Acoustic Noise Levels, Chapter 5, Section 8.4, Acoustic Design Guidelines.

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 8-10 for Magnet Room floor requirements and comments.

NOTICE

Magnet Mounting recessed area is required for all installations. The recessed area enables future system upgrades.

Table 8-10: Magnet Room Floor Requirements And Comments

Requirements
1. The floor/flooring (i.e. structural, sub-floor and finished flooring) must meet local and national codes. 2. The floor under the Magnet in a 10 ft x 12 ft (3.048 m x 3.658 m) area must not be fabricated from magnetic materials per Magnet Room Floors Magnetic Properties in Chapter 5, Section 15, Construction Materials. 3. Floor/flooring must support the weight of equipment during system installation and throughout the operation and Service life. 4. Magnet, Enclosure, and Patient Table areas (shown shaded in Illustration 8-8) must be level and flat defined as less then 0.125 in. (3.175 mm) between high and low spots in the area. 5. Magnet Mounting Recess Area shown in Illustration 8-8 : a. Area depth must be 1.500 + 0.000 / - 0.125 inch (38.1 + 0.000 / - 3.175 mm) from the top of the finished floor material to all points of the bottom of the recess floor. b. Area must be level and flat defined as not greater than 0.125 inches (3.175 mm) between high and low points in the entire projected area of each of the 2 VibroAcoustic Mats. RF shield seams, joints or overlaps MUST NOT be located in the projected areas of the 2 VibroAcoustic Mats. c. The material in the bottom of the Magnet Mounting Recess must not be compressible. No plywood or filler board type materials are allowed within this recess. i. For VibroAcoustic Damping Option sites: self-leveling grout, self-leveling epoxy, or self-leveling mortar are acceptable non-compressible materials ii. For non-VibroAcoustic Damping Option sites: RF Shield Vendor to provide Aluminum, Brass or Stainless Steel plates support the Magnet feet (non-compressible material to maintain the depth and level requirements stated in preceding bullets). 6. Metal access floor tiles are NOT allowed anywhere in the Magnet Room. 7. Rear Pedestal floor support: a. The floor under the Rear Pedestal must support 550 lbs (250 kg) distributed across the 4 leveling feet (1.2 meter). b. The Rear Pedestal leveling feet must be positioned on one solid floor member, no joints or seams are allowed. 8. The Magnet Room finished floor surface resistance must measure between 10E6 ohms and 10E9 ohms. a. The finished floor grounding device must be fastened/secured to the RF Shield Common Ground Stud. b. No carpets, antistatic wax or spray on treatments are allowed for use on the magnet room finished flooring. 9. Electrically conductive materials 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. 10. The finished floor needs to be water resistant and protect the RF/Magnetic Shield and subfloor from possible water damage.

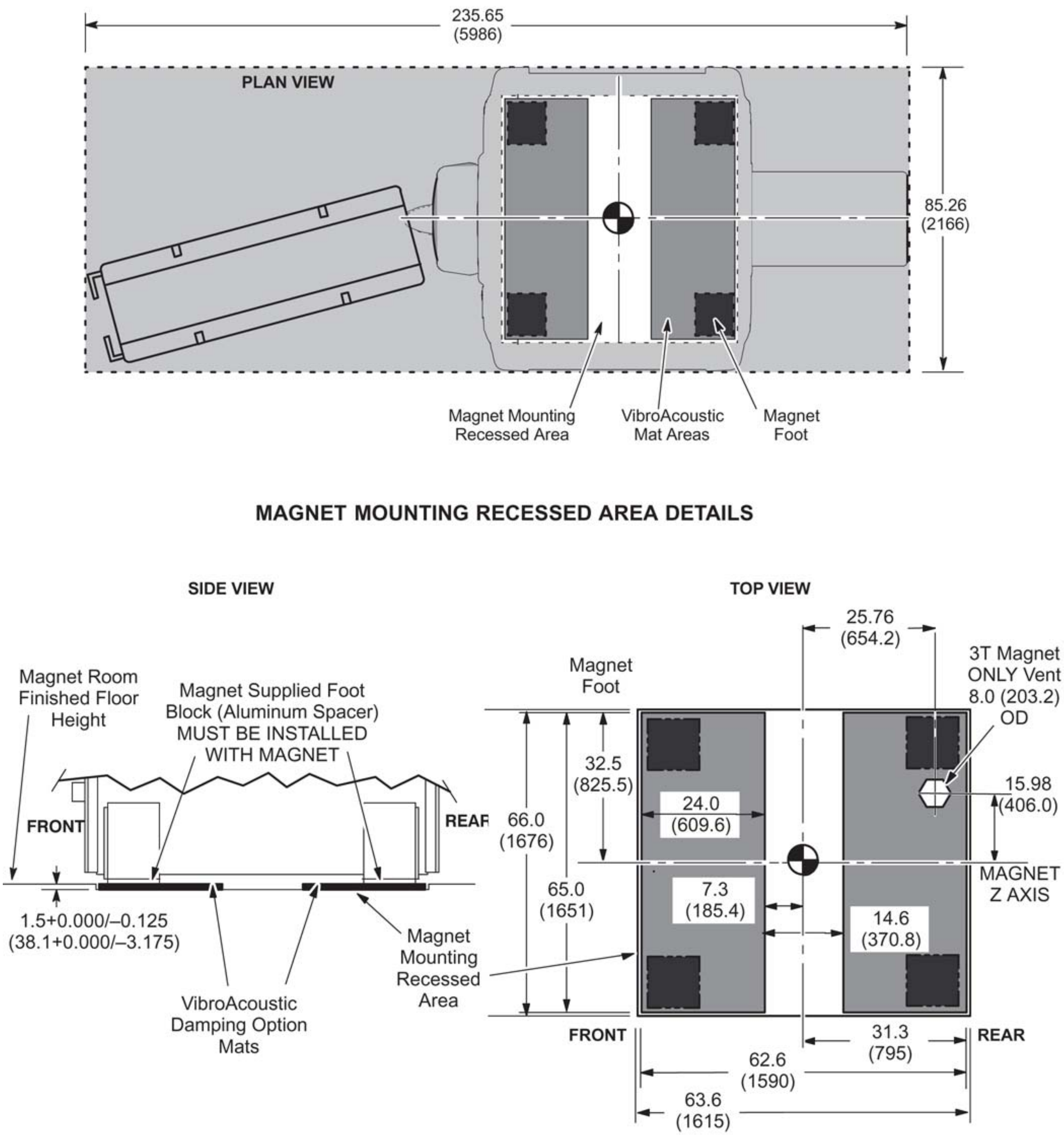
Table 8-10: Magnet Room Floor Requirements And Comments (cont'd)

Comments
• MR System Interconnection cables are FT4 or equivalent rated; not plenum rated. • The VibroAcoustic Damping Option mats must be continuously supported to function per design. Failure to meet all levelness requirements will result in excessive settlement of the Magnet and mats contributing to mis-alignment of the Magnet Enclosure, Patient Table and Table Docking Assembly. • The flooring grounding device and fastener/securing equipment are supplied by the customer or customer contractor and must be installed as the manufacturer defines. Local and national codes must be met when grounding the floor system to the RF Ground Stud.

Illustration 8-8: Magnet Room Floor Levelness Area

NOTE:

- All dimensions are in inches. All bracketed ( ) dimensions are in millimeters.



7 Anchor Hardware Requirements

7.1 Anchor Hardware For MR Equipment Inside RF Shield

An RF Shielded Room is required per Section 1, RF Shielded Room Requirements and 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 RF Shielded Room requirements.

When the anchors penetrate the RF shield then the installation of the anchors must meet the requirements of Section 1, RF Shielded Room Requirements. 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 requirements table, 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 locations 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 requirements table, Section 7.2, Physical Characteristics, and Section 7.3, Anchor Location And Installation.
- Procurement of commercially available anchors, bolts / removable 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 for 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.
  - 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 Project Manager, Installations 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/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 Section 7.2, Physical Characteristics 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 Damping mats stainless steel top plate. The VibroAcoustic Damping 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 8-11 .
- 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 8-11
- 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 8-11
- Seismic codes (affect the length and diameter of the bolt/removable rod and anchor size)

Refer to Table 8-13 for Equipment Characteristics.

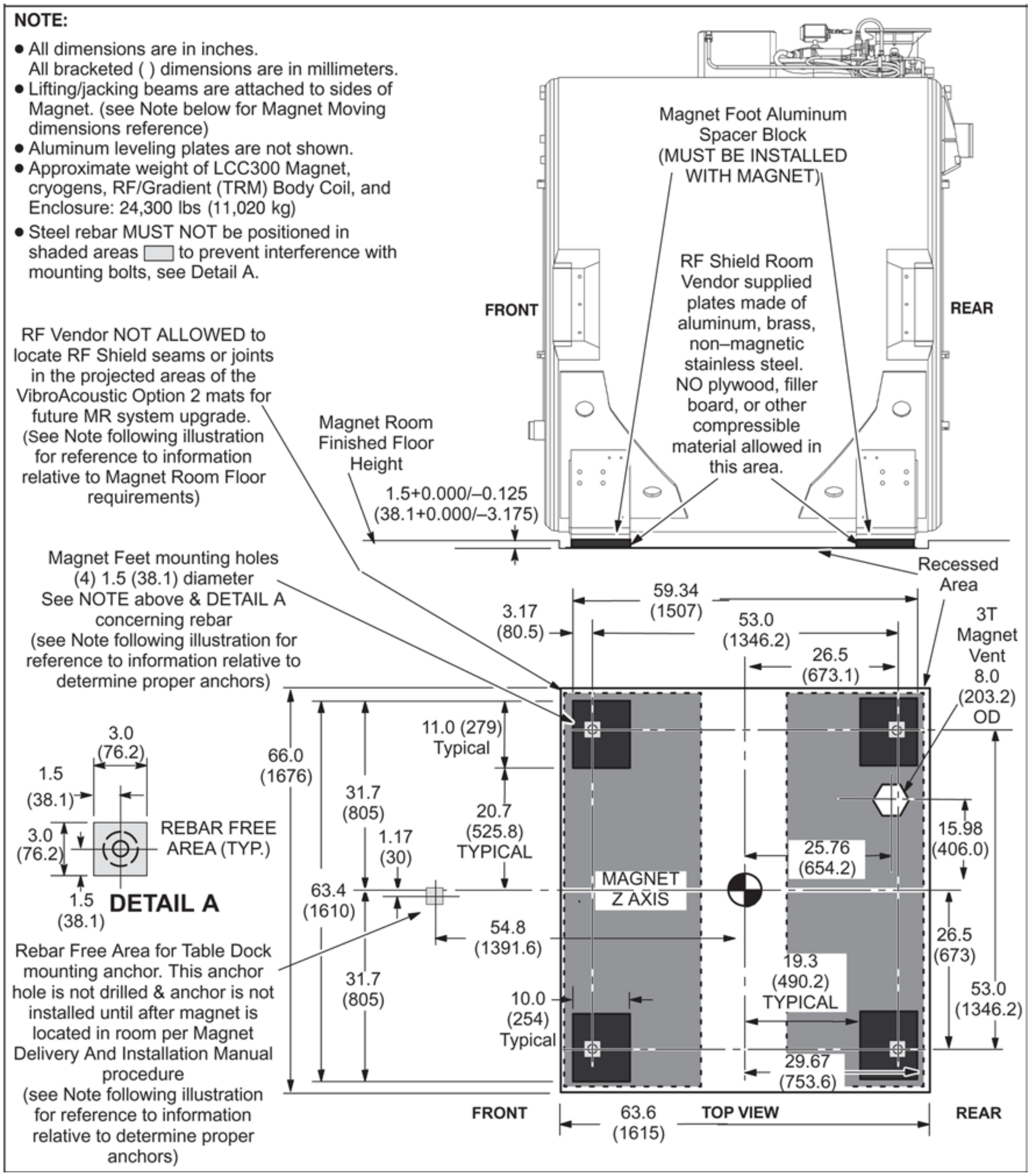
Table 8-11: Equipment Clamping Force (Tension) Requirements

Equipment Type	**Clamping Force (Tension) To The Floor Applied To Each Anchor** **See Note 1**	
	lbs	**N**
LCC300 Magnet without VibroAcoustic Damping Option (See Note 2 & 3)	2,500 ± 200	11,100 ± 900
Dock Assembly for LCC300 Magnet	600 ± 100	2700 ± 450
Blower Box (See Note 4)	100 ± 10	450 ± 45

Note

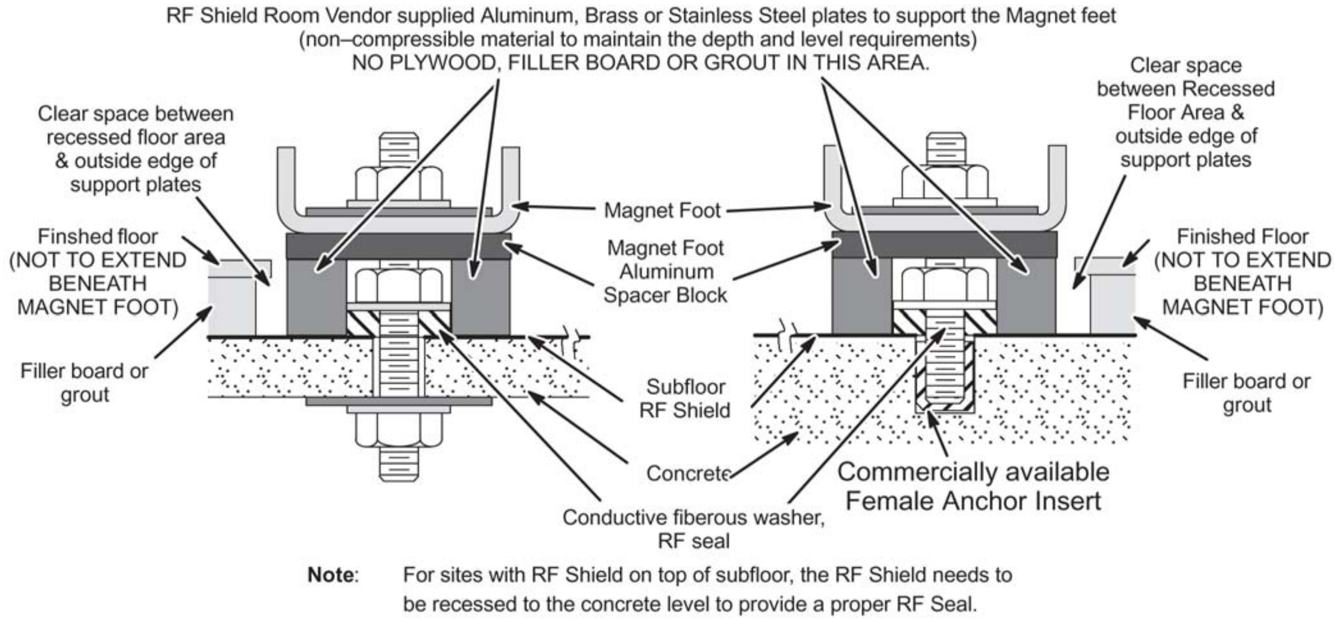
1. The RF Screen Room Vendor must perform a pull test on each anchor, equal to the clamping force (tension) required for the equipment, prior to equipment delivery. A copy of the pull test results, anchor ground impedance measurements and building inspection certification must be given to given to the customer to be maintained with the site documentation.
2. Compressible material must not be present in the recessed floor area under the Magnet, refer to Table 8-12 and Illustration 8-9 . 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.

Table 8-12: Magnet Load Pattern Without VibroAcoustic Damping Option



NOTE: For details of Magnet feet support for anchoring in RF Shield Room refer to Illustration 8-9 .

Illustration 8-9: RF Shield Room Anchor Details



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 Project Manager Installations.

Table 8-13: Equipment Characteristics (See Note 1 in this Table)

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 Stud Diameter in. (mm) See Note 3	Equipment Mounting Illustration
LCC300 Magnet without VibroAcoustic Damping Option See Note 4	1.75 (44) See Note 5	1.5 (38)	2.5 (64)	1.0 (M24)	Table 8-12 & Illustration 8-9
Dock Assembly for LCC Magnet	0.75 (20)	0.43 (11)	2.0 (50)	Pre-approval not required. Select anchor/stud to clamping force (tension).	Table 8-12

Table 8-13: Equipment Characteristics (See Note 1 in this Table) (cont'd)

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 Stud Diameter in. (mm) See Note 3	Equipment Mounting Illustration
Blower Box See Note 6	0.25 (6)	0.25 (6)	0.5 (13)	Pre-approval not required. Select anchor/stud to clamping force (tension).	

Notes

1. All equipment mounting methods and installation must meet requirements in Section 1, RF Shielded Room Requirements.
2. Maximum Clearance Above Equipment Base is the dimension for protrusion of the bolt or rod inside the equipment base including clearance for tools to tighten hardware to meet specifications in Table 8-11 .
3. Seismic codes do not allow for any gap between the bolt or rod and clearance hole in the base of the equipment. 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, provinces 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 bolted to the floor. The bolt 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 Chapter 3, Section 12.2, Magnet and Enclosure Magnet Enclosure Front And Rear Views illustration.
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 Ground requirements in RF Shielded Room Requirements table in Section 1, RF Shielded Room Requirements.

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 Ground requirements in RF Shielded Room Requirements table Section 1, RF Shielded Room Requirements.

Refer to equipment dimensional illustration references in the Equipment Characteristics table in Section 7.2, Physical Characteristics.

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 hardware must maintain RF shield integrity. This is accomplished by electrically sealing the stud 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 stud 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 stud and the RF shield.

Refer to Appendix 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 8-14 for anchor hardware electrical isolation requirements and recommendations.

Table 8-14: Anchor Hardware Electrical Isolation Requirements & Recommendations

Requirements
1. Ground Isolation: 1,000 ohms or greater (refer to Section 1, RF Shielded Room Requirements requirements table) 2. 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 1, RF Shielded Room Requirements requirements table) **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. 3. 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.
Comments
Electrical isolation test of each anchor and bolt/rod should be performed prior to Magnet placement.

Table 8-15:

Requirements	Recommendations

7.7 Example - Select Magnet Anchor Size

The following is an example to illustration the selection of proper anchors to install a 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 Section 7.4, Clamping Force (Tension) and Pull Test.
   2500 lbs + 200 lbs = 2700 lbs or 11,100 N + 900 N = 12,000 N
2. Refer to Illustration 8-10 or Illustration 8-11 (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
   For 8 inch embedment select 3/4 inch diameter
   For 4.5 inch embedment select 1 inch diameter
   or
   Diameter : Min. M16 Max. M32
   For 130 mm embedment select M20 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.

Illustration 8-10: 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.

Illustration 8-11: 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 7, Emergency Power.

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 Emergency 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.

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Chapter 9 Shipping and Delivery Data

1 Shipment

NOTE: The MR system is shipped in 3 steps: 1) GE pre-engineered MDP and MRCC or GWHX equipment 2) Magnet with partial Enclosure and accessories 3) remaining system equipment.

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. Refer to Table 9-1 for transportation environmental conditions.

See Table 9-3 for the shipping weights and dimensions of the major Signa EXCITE HD 3.0T system components. Actual shipping may vary, international shipment may require equipment to be crated.

Table 9-1: Transportation & Storage Environmental Conditions

System Equipment	Temperature Range °F (°C)	Temperature Change °F/Hr (°C/Hr)	Relative Humidity %	Humidity Change %/Hr	Atmospheric Pressure hPa
Electronics Cabinets & equipment	-30 to 140 (-34 to 60)	176 (80)	0-90 non-condensing	30	1012 to 525
Magnet	-31 to 122 (-35 to 50)	176 (80)	0-90 non-condensing	30	1012 to 525

Table 9-2: Transportation & Storage Environmental Conditions

System Equipment	Temperature Range °F (°C)	Temperature Change °F/Hr (°C/Hr)	Relative Humidity %	Humidity Change %/Hr	Atmospheric Pressure hPa
Electronics Cabinets & equipment	-30 to 140 (-34 to 60)	176 (80)	0-90 non-condensing	30	1012 to 525

The GE LCC 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 .

There are two scenarios for storing the LCC300 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 LCC300

Magnet can be moved cold or warm, refer to *Direction 2340869 GE LCC300 Active Shield Magnet Delivery and Installation* for magnet moving requirements and details. Contact GE Service for necessary servicing before moving the magnet.

Table 9-3: 3.0T MR System Shipping Data

MR Component	Approximate WxDxH		Approximate Weight		Method Of Shipment
	in.	mm	lbs	kg	
LCC300 Magnet with cryogens, partial Quiet Technology Enclosure installed	93 x 144 x 107	2362 x 3658 x 2718	See Note 1		Domestic - Tarped International - crate/pallet
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
Rear Pedestal Assembly with Rear Split Bridge Assembly, Low Profile Carriage Cover	34 x 58 x 48	864 x 1473 x 1219	310	132	box on pallet
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
Patient Table	94 x 29 x 38	2377 x 722 x 952	474	215	pallet
Patient Blower Box	24 x 30 x 24	610 x 762 x 610	30	14	box
NB RF Amp Cabinet	24 x 30 x 50	610 x 762 x 1270	1100	499	wood crate
HFD/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 HFD/PDU Cabinet	28 x 38 15	711 x 965 x 381	160	73	on pallet
RFS Cabinet	24 x 36 x 77	610 x 914 x 1956	585	320	on cabinet casters, wrapped with plastic
Twin Accessory Cabinet (TAC)	23 x 39 x 50	584 x 991 x 1270	480	218	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	24 x 35 x 31	600 x 900 x 780	243	110	wood pallet with cardboard cover
Operator Workspace LCD Panel	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
BB RF Amp Cabinet for 8KW MNS *	24 x 37 x 71	1143 x 1372 x 940	180	82	on cabinet casters, wrapped with plastic
BrainWaveHW Lite Cabinet *	24 x 23 x 72	610 x 584 x 320	320	147	on cabinet casters, wrapped with plastic
VibroAcoustic Damping Option *	36 x 65 x 12	914 x 1651 x 305	575	261	box on pallet

Table 9-3: 3.0T MR System Shipping Data (cont'd)

MR Component	Approximate WxDxH		Approximate Weight		Method Of Shipment
	in.	mm	lbs	kg	
Chilled Air Blower for IPCM Option *	24 x 42 x 45	610 x 1060 x 1140	375	170	special pallet
Outdoor/Indoor Air Cooled MRCC Unit					
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
Indoor Water Cooled GWHX Unit					
GWHX unit	39 x 30.3 x 51.2	990 x 770 x 1300	470	213	crate
Ship loose items	31.5 x 31.5 x 36	800 x 800 x 920	394	178.5	box

Notes

* Optional Equipment

1. Approximate magnet shipping weight of magnet with cryogens, TRM Gradient & RF coils, Enclosure parts installed on magnet, and lifting beams (i.e. minus packaging material): 25,245 lbs (11,451 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 titled Shipping Date in Section 1, Shipment 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 30º 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 Project Manager, Installations 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.

NOTICE

Power and cooling water for the Shield/Cryo Cooler Compressor Cabinet must be available when the Magnet is delivered to minimize cryogen usage. For specifications see Site Environment chapter sections:

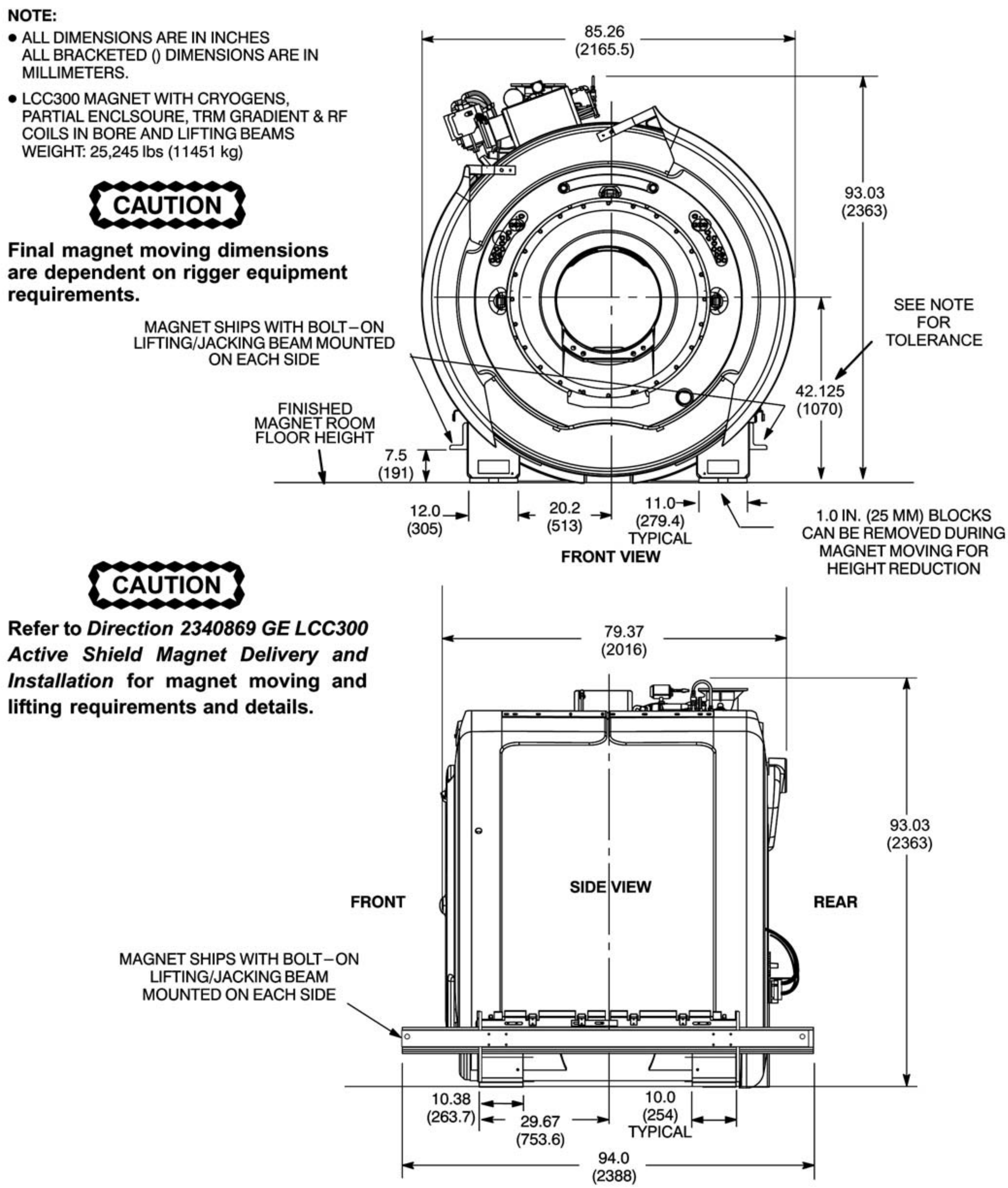
- **Chapter 5, Section 5.2, Shield/Cryo Cooler Temporary Backup Water Cooling for temporary backup water specifications**
- **Chapter 5, Section 4, Air Cooling for sites using air cooled MRCC unit**
- **Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling for details of Shield/Cryo Cooler Compressor Cabinet requirements**

and Power Requirements chapter sections:

- **Chapter 6, Section 1, System Power Introduction**
- **Chapter 6, Section 2, Critical Power Requirements**
- **Chapter 6, Section 3.1, Main Disconnect Panel (MDP) Requirements**

Means must be provided for venting of the cryogenic gases, refer to specifications in Chapter 5, Section 10.1, Cryogenic Venting Introduction, Chapter 5, Section 10.2, Requirements For Outside Magnet Room, and Chapter 5, Section 10.3, Requirements For Inside Magnet Room.

Illustration 9-1: Magnet Moving Dimensions



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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 Project Manager, Installations 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 Project Manager, Installations 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 codes.

2 Pre-Installation Checklist

NOTE: CTIQ numbers listed in following items are defined in Chapter 1, Section 2, Crititcal To Image Quality.

2.1 General Pre-Installation Reminders

1. The customer's architect has fully reviewed the customer provided final site construction drawings using the requirements documented in the Pre-Installation manual and the MR Typical drawings 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 Magnetic Field Consideration Chapter 4, Section 1, Introduction, Chapter 4, Section 2, Homogeneity Requirements, Chapter 4, Section 3, Structural Steel Evaluation Of Proposed Sites, Chapter 4, Section 4, Magnetic Shielding, Chapter 4, Section 5, Magnetic Field, Chapter 4, Section 6, Exclusion Zone
   - 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
   - Magnet Room Floors Magnetic Properties section in Chapter 5, Section 15, Construction Materials.
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 Chapter 8, Section 6.5, Magnet Room 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 Chapter 5, 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 Chapter 6, Section 2, Critical Power Requirements.
8. **CTIQ#7 Lighting:** The Magnet Room lighting design and installation complies with the requirements so as to not to 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 Chapter 3, Section 4.2, Equipment Room Shared By Multiple MR Systems.

2.2 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 Site Environment Chapter:
   - 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.
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 and Support Connectivity.
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, Chapter 5, Section 10.2, Requirements For Outside Magnet Room, and Chapter 5, Section 10.3, Requirements for Inside Magnet Room.

2.3 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 Chapter 5, Section 4, Air Cooling.
2. **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 5.3, Shield/Cryo Cooler Water Cooling 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 been defined for magnet installation. 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 been completed or suspended, the Magnet Room closed off to provide a dust-free, closed environment and all equipment 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

2.4 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, Section 3, Temperature and Humidity Specifications
   - Chapter 5, Section 4, Air Cooling
   - Water Cooling Requirements:
     - Chapter 5, Section 5.1, Gradient Coil Temporary Backup Water Cooling
     - Chapter 5, Section 5.2, Shield/Cryo Cooler Temporary Backup Water Cooling
     - Chapter 5, Section 5.3, Shield/Cryo Cooler Water Cooling For Site Provided Water Cooling

- Chapter 5, Section 5.4, GWHX Water Cooling Requirements

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) Requirements and Chapter 6, Section 3.2, System Power Distribution Unit.

2.5 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, RF Shielded Room Specifications. 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 (removable section closed up and sealed) and all ferrous metal objects 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) Requirements and Chapter 6, Section 3.2, System Power Distribution Unit.
6. The Penetration Panel been installed. Refer to Chapter 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.

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Chapter 11 Tools and Test Equipment

1 Moving Metal Measurement Equipment

Table 11-1: Moving Metal Measurement Equipment

Item	GE Part Number	Description
1	2175019 or equivalent	Multiwave II Kit with Barrington 3 axis probe

2 Rigger/Customer Supplied Equipment

Table 11-2: Rigger/Customer Supplied Equipment

Supplied By	Item	Description
Rigger	1	Refer to *Direction 2340869 GE LCC300 Active Shield Magnet Delivery and Installation* for equipment and requirements.
Customer	2	Equipment for off loading electronics and other miscellaneous components. (e.g. fork lift, hand trucks, straps, etc.)
	3	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	4	Resistance meter: • Megger Insulation Tester - **preferred test unit** • Analog d'Arsonval Meter (meter must have test source >9 VDC per specification in *Appendix* Chapter 12, Section 2, RF Shielded Enclosure Test Guideline *titled Enclosure Power Reference Isolation*)

3 Cryogenic Equipment

Table 11-3: Cryogenic Equipment

Item	GE Part Number	Description
1	5111049	Gaswatch personal Oxygen monitor
2	46-306734G1	Low Pressure Regulator Kit (Non-magnetic gas cylinder regulator / hose assembly consisting of regulator, hose, and case) (See Note 2)
3	---	Liquid helium in non-magnetic dewars is needed for refilling the magnet (See Note 2). Refer to appropriate magnet manual for helium volume.
4	46-306717G1	Non-magnetic gaseous helium cylinder cart (See Note 2)
5	46-294705G1	Universal Fill Line Kit (See Note 2)
6	46-294511P1	250 Liter Dewar Stinger (See Note 2)
7	46-294511P2	500 Liter Dewar Stinger (See Note 2)
8	46-294512P1 (12 ft) 46-294512P2 (8 ft)	Transfer Line (See Note 2)
9	46-282336P2	Dewar stinger assembly (High Efficiency) (See Note 2)
10	46-306812G1	Dewar tube "Thumper" tool (See Note 2)
11	2253802	Burst Disk and Gasket Assembly for LCC Magnet Helium Vessel (See Note 1)
12	46-271136G1	Dewar Adapting Kit including O-ring Kit for Dewar Adapting kit (46-271135P9) (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	2362622	Remote Helium Meter
17	46-306781G1	Helium Mechanical Gas Flowmeter (See Note 2)
18	46-301477G1	Helium Mechanical Gas Flowmeter (See Note 2)
19	46-252210P1	3 Inch Valve Operator (vacuum break tool) (See Note 1)
20	46-294872G2	SAV-CON / Instrumentation Lead Service Kit (See Note 2)
21	46-318784G2	Shield Cooler Test Kit (See Note 2)
22	46-318696G1	Water Tee for Shield Cooler Water Samples access (See Note 2)
23	46-294052G1	Water Flow Meter Kit (for checking flow of water to Shield Cooler Compressor) (See Note 2)
24	2171219	RUO Temperature Monitor for LCC 1.5T , 1.0T, & 3.0T Magnet (See Note 2)
25	---	Torch for de-icing
26	---	Fuel for torch

Table 11-3: Cryogenic Equipment (cont'd)

Item	GE Part Number	Description
27	46-252805P2 (10 ft) 46-252805P3 (15 ft)	Nitrogen Transfill line (only needed if magnet is warmer than nitrogen temperature)
28	46-260201P1	N2 Precool Syphon (only needed if magnet is warmer than nitrogen temperature)
29	5160887	Standard mid arm cryo gloves medium size
30	5160896	Standard mid arm cryo gloves large size
31	5160897	Standard mid arm cryo gloves X-L size
32	TBD	safety galsses
33	TBD	face shield

Notes

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 11-4: 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	---	Magnet Log Book
6	---	Installation log book
7	---	4 foot or equivalent carpenter level
8	2319156	Aluminum platform ladder, 47.5 inches (1206.5mm) (See Note 1)
9	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
10	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).
11	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).
12	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).
13	2135558	Shim case / cable kit
14	2386028	LCC300 Shim Camera Kit
15	2386029	LCC300 Passive Shimming Kit
16	46-306763G1	Subminiature-D Connector Removal/Re-termination Repair Kit for Robinson-Nugent Sub-D connectors
17	46-251865G5 or 46-251865G4 + 2295525-5	3T Field Plotting Kit - Metro Lab Teslameter to include #6 Probe with Pre-Amp Metro Lab Teslameter Kit + Probe
18	46-260703G5	Magnet Ramping Equipment Kit
19	2135435	750 Amp Ramp Cart / Cable Kit
20	46-318833G1	Ramp Cable Holder
21	46-294998G1	Ramping Supply and Equipment kit includes the following: • 46-260703G3 Magnet Ramping Equipment Kit (see Item 15) • 46-260776G3 Magnet Service Tool Power Supply Cabinet (see Item 10)

Table 11-4: Installation Equipment (cont'd)

Item	GE Part Number	Description
22	M1060SR	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 Project Manager, Installations to determine if this is a required option.
23	5112581	Large (Installation) Titanium Non-Magnetic Tool Kit
24	5113258	Small (Maintenance) Titanium Non-Magnetic Tool Kit

Notes

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 11-5: Test Equipment

Item	GE Part Number	Description
1	2284754-2	Textronic TDS3012B digital scope 100 MHz Bandwidth
2	2284754	Textronic TDS3012 digital scope 100 MHz Bandwidth
3	2284763	Fluke FLK196M scopemeter for medical applications
4	46-194427P226	Dual trace oscilloscope, 100 MHz bandwidth, 2 channel, digital storage, Textronic 2232 (End of Product Life)
5	46-194427P222	Dual trace oscilloscope, 350 MHz bandwidth, 4 channel, Textronic 2465 (End of Product Life)
6	46-194427P284	Battery operated digital multi-meter, Fluke 87, 4.5 digits with frequency counter and capacitance
7	46-208572P9	Clamp-on Ammeter, 1-200A, AC/DC
8	2372868	3.0T RF Power Measurement Kit with 2500 Watt load
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	2293050	Portable Gauss Meter with probe and case
14	46-194427P248	Microguard or ECOS leakage tester
15	46-306797G1	Fogg (ECG) Simulator and Memory Module
16	46-320433P1	Infrared Scanner 0 - 100°C
17	46-317830G1	Fiber Optic Light Meter Kit
18	46-294047G1	Shield Cooler Vacuum Pump Kit
19	46-251867G1	Main Vacuum Pump Down Kit
20	46-1944278P448	AEMC Clamp-On Ground Rod Impedance Meter

6 Calibration Tools and Fixtures

Table 11-6: Calibration Tools and Fixtures

Item	GE Part Number	Description
1	2371509	System Performance Test (SPT) Phantom Set for Systems with LCC300 (Active Shield) systems (See Note 1) consisting of the following: • 2125247-13 Nesting Plate • 2360054 Large Volume Shim Phantom Assembly which includes sphere (2360051), small half (236049), and large half (2360050) • 2371511 Short Loader Assembly • 2371512 Daily Quality Assurance (DQA) Phantom • 2170481 EPI Foam Positioner • 2291292 EPI Head Loader Positioner • 5110241 Head Loader Positioner
2	2373141	Head TLT Sphere (2359877) and Loader (2360031) See Note 1
3	46-265434G1	Magnet Rundown Unit Test Box
4	2386042	3.0T ECMT/GRAFIDY Kit
5	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.
6	2106236	Portable Oxygen Monitor (Connecticut Analytical)
7	2107184	Permanent Oxygen Monitor (Enmet)
8	46-306712G1	Torque driver kit
9	46-306864G1	Magnet Helium Resistance Box Kit
10	2101360	Power Supply Calibration Kit
11	2371477	100 mm Silicon Oil sphere (2360034) and Universal Phantom Holder (46-328383P1) (See Note 1)
12	2372868	RF Power Measurement Kit
13	Not used	

Notes

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 11-7: 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	---	rule, standard and metric markings
26	---	Alignment tool (tweaker)
27	---	Hex/alignment tool
28	---	Hemostat, 5 in., curved
29	---	Wrist grounding strap
30	Xcelite 110CG	Diagonal Cutting Pliers, 4-1/2 in.

Table 11-7: Tool Kit (cont'd)

Item	GE Part Number	Description
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
35	5112581	Large set Non-Magnetic Titanium Tool kit with aluminum case (generally used for installations)
36	5113258	Small Non-Magnetic Titanium Tool kit with soft case (generally used for routine maintenance)

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 .
- 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.

Table 12-1: Frequency Bands For FFT'S

Frequency Band	Frequency Resolution
0.2 to 50 Hz	Δf= 0.125 Hz

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 Section 1.2 must be made in a ‘quiet' 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 Magnet specifications in Chapter 5, Section 16, Vibration 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 LCC Magnet specifications in Chapter 5, Section 16, Vibration.

1.4 Presentation/Interpretation Of Results

The recommended format for site vibration data collection, presentation, and analysis is illustrated in the examples shown in Illustration 12-1 , Illustration 12-2 , Illustration 12-3 , Illustration 12-4 , and Illustration 12-5 . 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.

All plots must be properly annotated with:

- Instrumentation setup including number of averages, frequency resolution, etc.
- Test location
- Test conditions
  - Steady State
  - Transient
  - Heal drop
  - Normal Environment
  - Typical traffic

NOTE: Please note that other conditions not listed could also be conditions necessary to demonstrate understanding of potential sources of vibration.

It is the responsibility of the customer's vibration testing service to interpret the results and determine if that site meets GE's specifications. Illustration 12-1 , Illustration 12-2 , and Illustration 12-3 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.

Illustration 12-1 , Illustration 12-2 , Illustration 12-3 , Illustration 12-4 , and Illustration 12-5 are examples provided to assist a test consultant in the use of GE Transient specifications. The 500 micro-g, 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 LCC300 Magnet Steady State vibration specifications in Chapter 5, Section 16, Vibration.

Any questions regarding test equipment requirements, test parameters, or general questions should be discussed with your GE Project Manager, Installations.

Illustration 12-1: Example Site Environmental Vibration

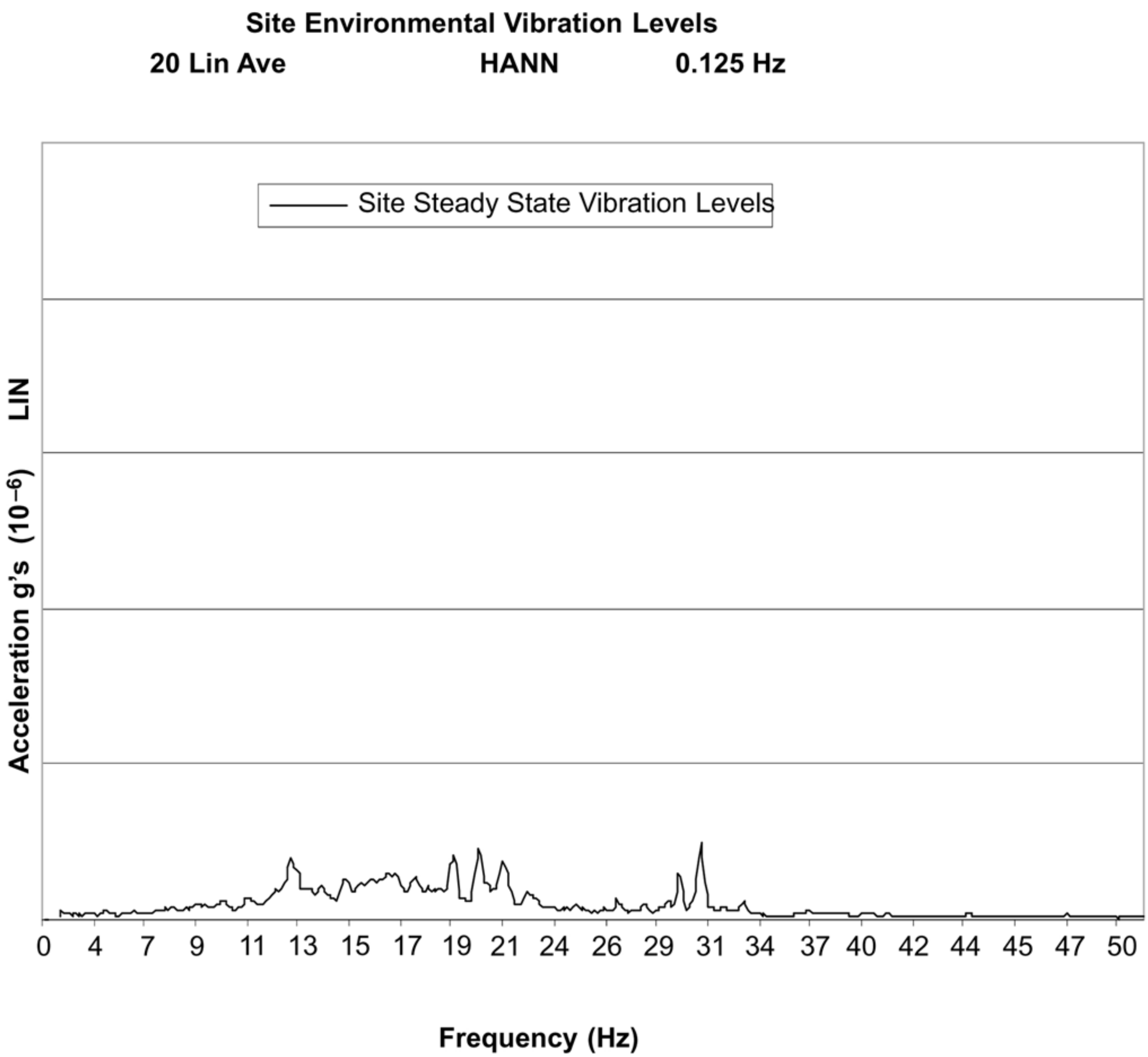


Illustration 12-2: Example Site Environmental Vibration

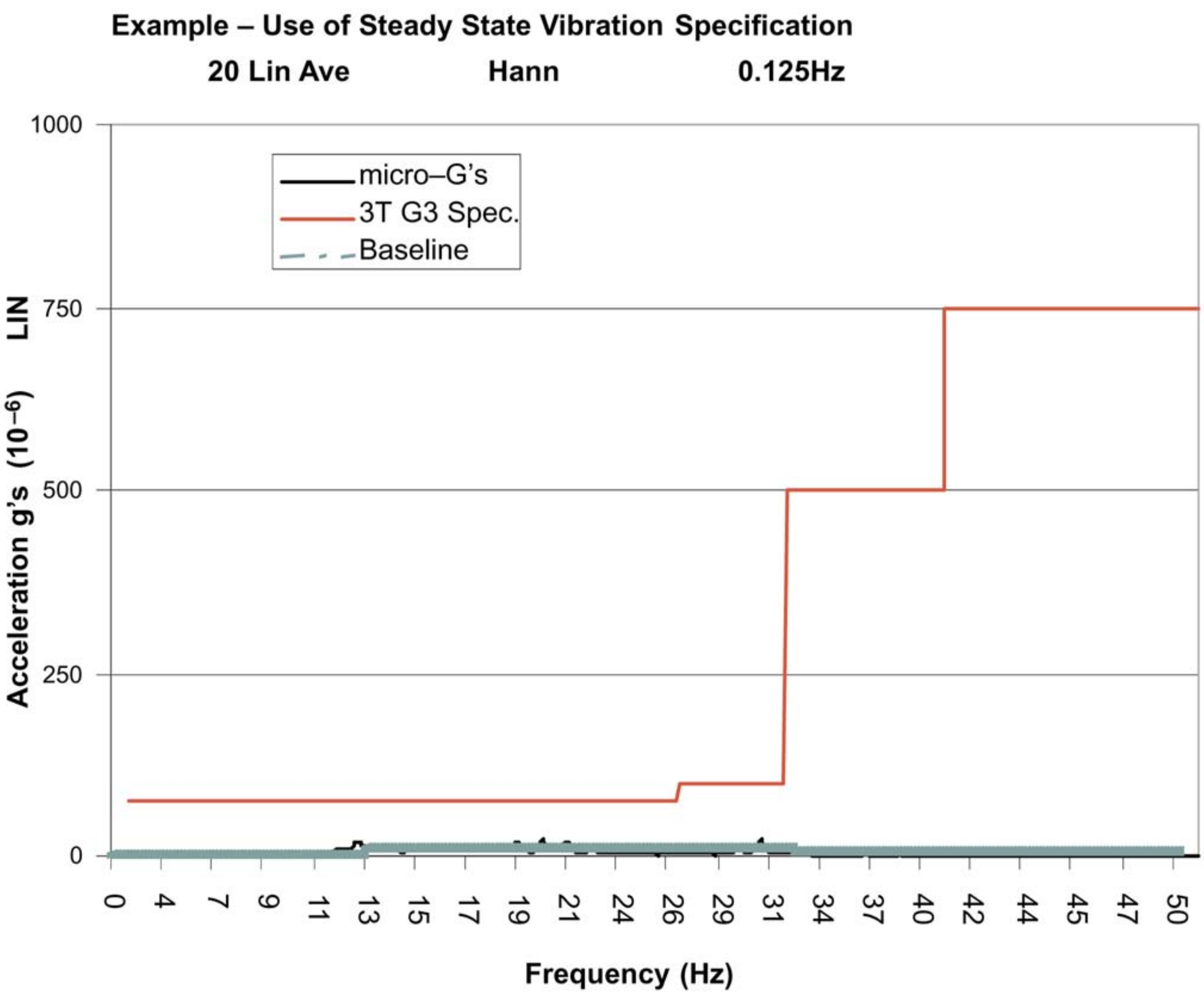


Illustration 12-3: Example Site Environmental Vibration Vs. GE Specification For LCC Magnet

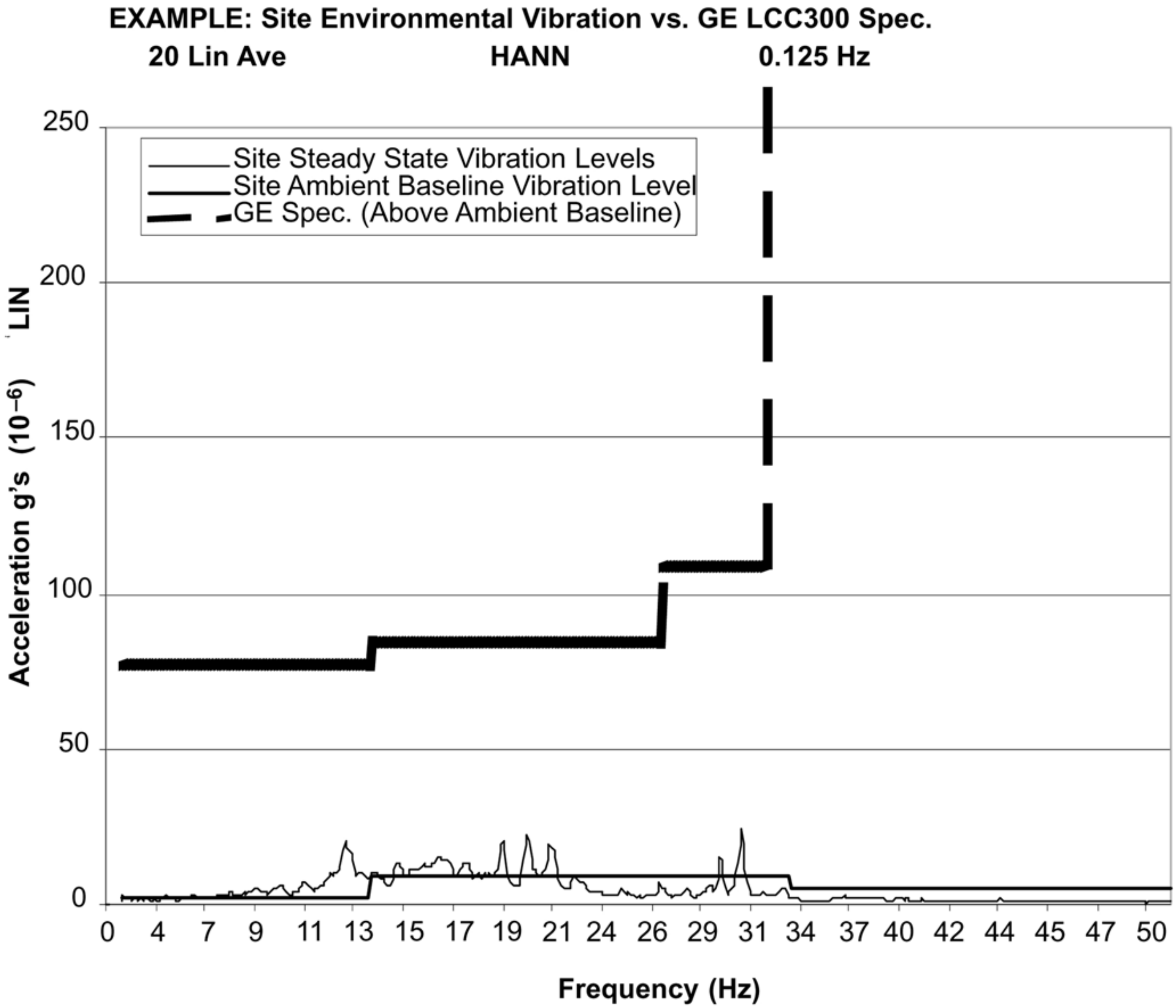


Illustration 12-4: Acceleration Time History

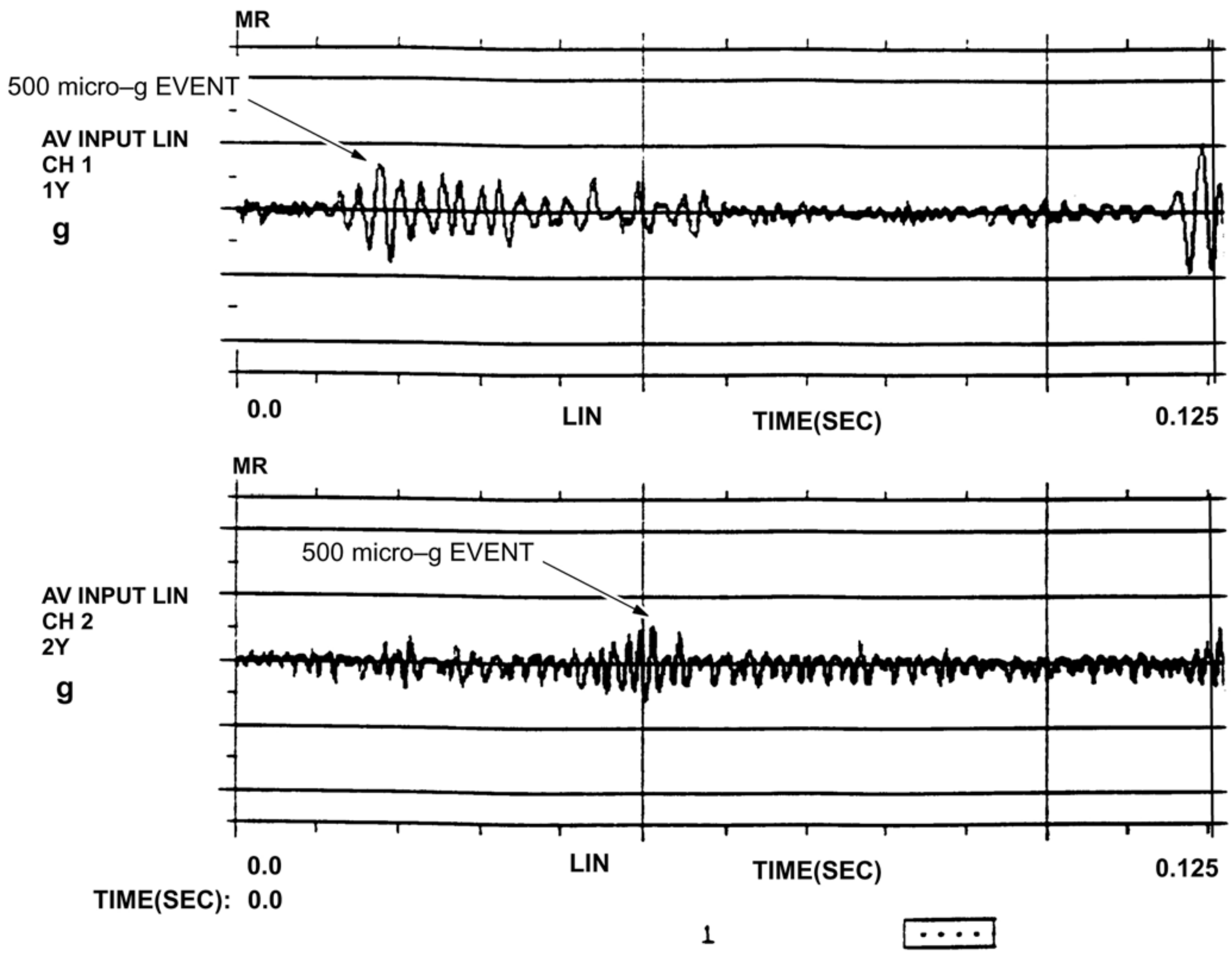
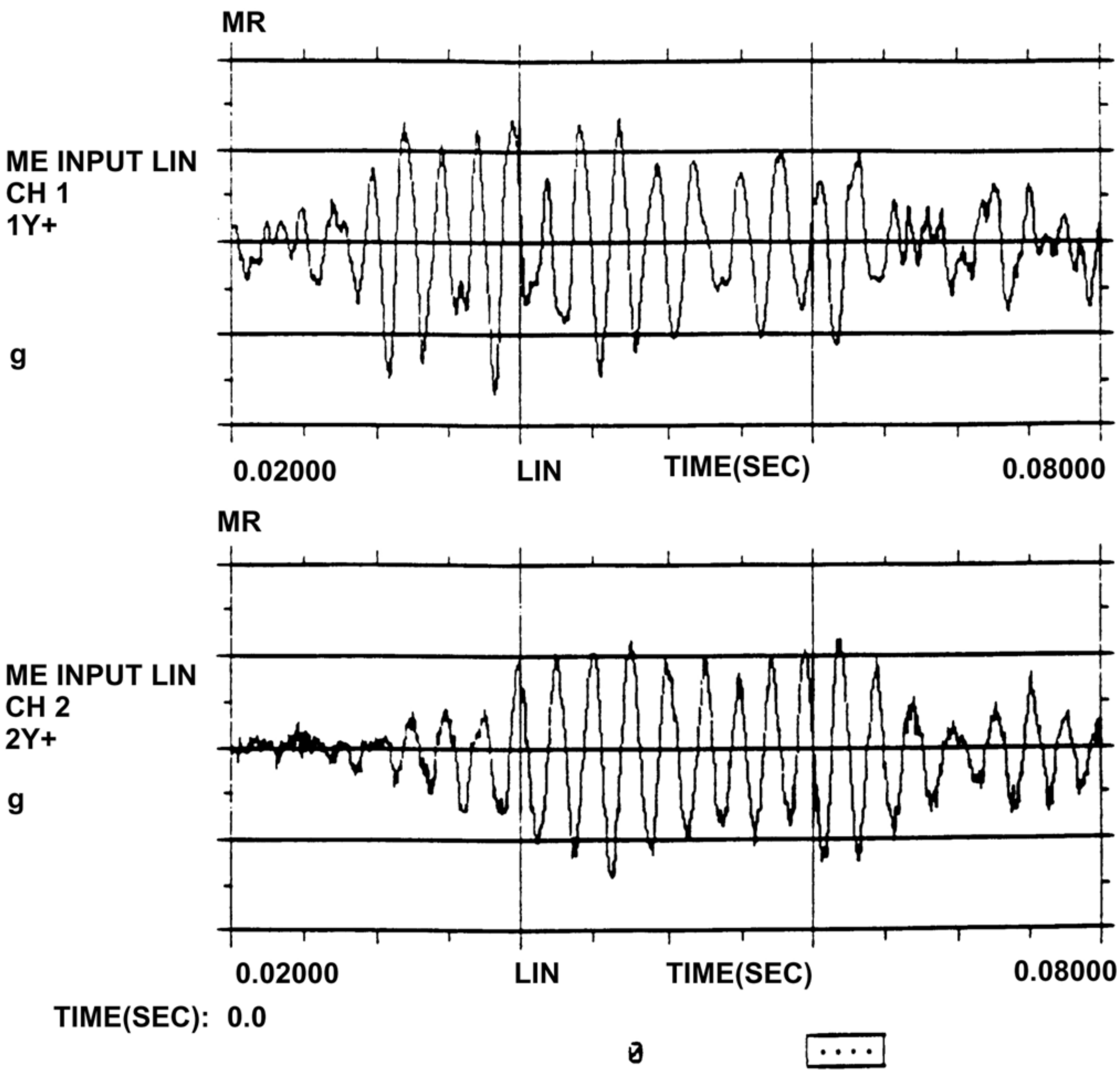


Illustration 12-5: Acceleration Time History (Zoomed In On Transient Event)



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 Healthcare 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 Healthcare.

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 GE Healthcare.

2.1.2 Not used

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 ± 10 MHz (150 MHz ± 10 MHz for 3T). 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 (150 MHz for 3T). 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 ±2% frequency and ±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 GE Healthcare. 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.

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