

Discovery* MR750 3.0T Preinstallation Manual



OPERATING DOCUMENTATION

5500101
Revision 13.0



WARNING



STRONG MAGNETIC FIELD




NO PACEMAKERS*
NO NEUROSTIMULATORS*
NO CONDUCTIVE/METALLIC IMPLANTS*

**Persons with pacemakers,
neurostimulators or metallic
implants must not enter this area.**

Serious injury may result.

* In general, patients with conductive (e.g. metallic) implants are contraindicated for MR scans. For patients with implants that are labeled as 'MR Safe' or 'MR Conditional', consult the implant device manufacturer's documentation.
* WARNING: Only use quadrature transmit for 'MR Conditional' devices.

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Important Information

LANGUAGE

- ПРЕДУПРЕЖДЕНИЕ (BG)** Това упътване за работа е налично само на английски език.
- Ако доставчикът на услугата на клиента изиска друг език, задължение на клиента е да осигури превод.
 - Не използвайте оборудването, преди да сте се консултирали и разбрали упътването за работа.
 - Неспазването на това предупреждение може да доведе до нараняване на доставчика на услугата, оператора или пациента в резултат на токов удар, механична или друга опасност.
- 警告 (ZH-CN)** 本维修手册仅提供英文版本。
- 如果客户的维修服务人员需要非英文版本，则客户需自行提供翻译服务。
 - 未详细阅读和完全理解本维修手册之前，不得进行维修。
 - 忽略本警告可能对维修服务人员、操作人员或患者造成电击、机械伤害或其他形式的伤害。
- 警告 (ZH-HK)** 本服務手冊僅提供英文版本。
- 倘若客戶的服務供應商需要英文以外之服務手冊，客戶有責任提供翻譯服務。
 - 除非已參閱本服務手冊及明白其內容，否則切勿嘗試維修設備。
 - 不遵從本警告或會令服務供應商、網絡供應商或病人受到觸電、機械性或其他危險。
- 警告 (ZH-TW)** 本維修手冊僅有英文版。
- 若客戶的維修廠商需要英文版以外的語言，應由客戶自行提供翻譯服務。
 - 請勿試圖維修本設備，除非您已查閱並瞭解本維修手冊。
 - 若未留意本警告，可能導致維修廠商、操作員或病患因觸電、機械或其他危險而受傷。
- UPOZORENJE (HR)** Ovaj servisni priručnik dostupan je na engleskom jeziku.
- Ako davatelj usluge klijenta treba neki drugi jezik, klijent je dužan osigurati prijevod.
 - Ne pokušavajte servisirati opremu ako niste u potpunosti pročitali i razumjeli ovaj servisni priručnik.
 - Zanimarite li ovo upozorenje, može doći do ozljede davatelja usluge, operatera ili pacijenta uslijed strujnog udara, mehaničkih ili drugih rizika.

**VÝSTRAHA
(CS)**

Tento provozní návod existuje pouze v anglickém jazyce.

- V případě, že externí služba zákazníkům potřebuje návod v jiném jazyce, je zajištění překladu do odpovídajícího jazyka úkolem zákazníka.
- Nesnažte se o údržbu tohoto zařízení, aniž byste si přečetli tento provozní návod a pochopili jeho obsah.
- V případě nedodržování této výstrahy může dojít k poranění pracovníka prodejního servisu, obslužného personálu nebo pacientů vlivem elektrického proudu, respektive vlivem mechanických či jiných rizik.

**ADVARSEL
(DA)**

Denne servicemanual findes kun på engelsk.

- Hvis en kundes tekniker har brug for et andet sprog end engelsk, er det kundens ansvar at sørge for oversættelse.
- Forsøg ikke at servicere udstyret uden at læse og forstå denne servicemanual.
- Manglende overholdelse af denne advarsel kan medføre skade på grund af elektrisk stød, mekanisk eller anden fare for teknikeren, operatøren eller patienten.

**WAARSCHUWING
(NL)**

Deze onderhoudshandleiding is enkel in het Engels verkrijgbaar.

- Als het onderhoudspersoneel een andere taal vereist, dan is de klant verantwoordelijk voor de vertaling ervan.
- Probeer de apparatuur niet te onderhouden alvorens deze onderhoudshandleiding werd geraadpleegd en begrepen is.
- Indien deze waarschuwing niet wordt opgevolgd, zou het onderhoudspersoneel, de operator of een patiënt gewond kunnen raken als gevolg van een elektrische schok, mechanische of andere gevaren.

**WARNING
(EN)**

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.

**HOIATUS
(ET)**

See teenindusjuhend on saadaval ainult inglise keeles.

- Kui klienditeeninduse osutaja nõuab juhendit inglise keelest erinevas keeles, vastutab klient tõlketeenuse osutamise eest.
- Ärge üritage seadmeid teenindada enne eelnevalt käesoleva teenindusjuhendiga tutvumist ja sellest aru saamist.
- Käesoleva hoiatuse eiramine võib põhjustada teenuseosutaja, operaatori või patsiendi vigastamist elektrilöögi, mehaanilise või muu ohu tagajärjel.

**VAROITUS
(FI)**

Tämä huolto-ohje on saatavilla vain englanniksi.

- Jos asiakkaan huoltohenkilöstö vaatii muuta kuin englanninkielistä materiaalia, tarvittavan käännöksen hankkiminen on asiakkaan vastuulla.
- Älä yritä korjata laitteistoa ennen kuin olet varmasti lukenut ja ymmärtänyt tämän huolto-ohjeen.
- Mikäli tätä varoitusta ei noudateta, seurauksena voi olla huoltohenkilöstön, laitteiston käyttäjän tai potilaan vahingoittuminen sähköiskun, mekaanisen vian tai muun vaaratilanteen vuoksi.

**ATTENTION
(FR)**

Ce manuel d'installation et de maintenance est disponible uniquement en anglais.

- Si le technicien d'un client a besoin de ce manuel dans une langue autre que l'anglais, il incombe au client de le faire traduire.
- Ne pas tenter d'intervenir sur les équipements tant que ce manuel d'installation et de maintenance 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
(DE)**

Diese Serviceanleitung 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 diese Anlage zu warten, ohne diese Serviceanleitung gelesen und verstanden zu haben.
- Wird diese Warnung nicht beachtet, so kann es zu Verletzungen des Kundendienst-technikers, des Bedieners oder des Patienten durch Stromschläge, mechanische oder sonstige Gefahren kommen.

**ΠΡΟΕΙΔΟΠΟΙΗΣΗ
(EL)**

Το παρόν εγχειρίδιο σέρβις διατίθεται μόνο στα αγγλικά.

- Εάν ο τεχνικός σέρβις ενός πελάτη απαιτεί το παρόν εγχειρίδιο σε γλώσσα εκτός των αγγλικών, αποτελεί ευθύνη του πελάτη να παρέχει τις υπηρεσίες μετάφρασης.
- Μην επιχειρήσετε την εκτέλεση εργασιών σέρβις στον εξοπλισμό αν δεν έχετε συμβουλευτεί και κατανοήσει το παρόν εγχειρίδιο σέρβις.
- Αν δεν προσέξετε την προειδοποίηση αυτή, ενδέχεται να προκληθεί τραυματισμός στον τεχνικό σέρβις, στο χειριστή ή στον ασθενή από ηλεκτροπληξία, μηχανικούς ή άλλους κινδύνους.

**FIGYELMEZTETÉS
(HU)**

Ezen karbantartási kézikönyv kizárólag angol nyelven érhető el.

- Ha a vevő szolgáltatója angoltól eltérő nyelvre tart igényt, akkor a vevő felelőssége a fordítás elkészítése.
- Ne próbálja elkezdni használni a berendezést, amíg a karbantartási kézikönyvben leírtakat nem értelmezték.
- Ezen figyelmeztetés figyelmen kívül hagyása a szolgáltató, működtető vagy a beteg áramütés, mechanikai vagy egyéb veszélyhelyzet miatti sérülését eredményezheti.

**AÐVÖRUN
(IS)**

Þessi þjónustuhandbók er aðeins fánleg á ensku.

- Ef að þjónustuveitandi viðskiptamanns þarfnast annas tungumáls en ensku, er það skylda viðskiptamanns að skaffa tungumálaþjónustu.
- Reynið ekki að afgreiða tækið nema að þessi þjónustuhandbók hefur verið skoðuð og skilin.
- Brot á sinna þessari aðvörðun getur leitt til meiðsla á þjónustuveitanda, stjórnanda eða sjúklings frá raflosti, vélrænu eða öðrum áhættum.

**AVVERTENZA
(IT)**

Il presente manuale di manutenzione è disponibile soltanto in lingua inglese.

- Se un addetto alla manutenzione richiede il manuale in una lingua diversa, il cliente è tenuto a provvedere direttamente alla traduzione.
- Procedere alla manutenzione dell'apparecchiatura solo dopo aver consultato il presente manuale ed averne compreso il contenuto.
- Il mancato rispetto della presente avvertenza potrebbe causare lesioni all'addetto alla manutenzione, all'operatore o ai pazienti provocate da scosse elettriche, urti meccanici o altri rischi.

**警告
(JA)**

このサービスマニュアルには英語版しかありません。

- 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ください。
- 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。

**경고
(KO)**

본 서비스 매뉴얼은 영어로만 이용하실 수 있습니다.

- 고객의 서비스 제공자가 영어 이외의 언어를 요구할 경우, 번역 서비스를 제공하는 것은 고객의 책임입니다.
- 본 서비스 매뉴얼을 참조하여 숙지하지 않은 이상 해당 장비를 수리하려고 시도하지 마십시오.
- 본 경고 사항에 유의하지 않으면 전기 쇼크, 기계적 위험, 또는 기타 위험으로 인해 서비스 제공자, 사용자 또는 환자에게 부상을 입힐 수 있습니다.

**BRĪDINĀJUMS
(LV)**

Šī apkopes rokasgrāmata ir pieejama tikai angļu valodā.

- Ja klienta apkopes sniedzējam nepieciešama informācija citā valodā, klienta pienākums ir nodrošināt tulkojumu.
- Neveiciet aprikojuma apkopi bez apkopes rokasgrāmatas izlasīšanas un saprašanas.
- Šī brīdinājuma neievērošanas rezultātā var rasties elektriskās strāvas trieciena, mehānisku vai citu faktoru izraisītu traumu risks apkopes sniedzējam, operatoram vai pacientam.

**ĮSPĖJIMAS
(LT)**

Šis eksploatavimo vadovas yra tik anglų kalba.

- Jei kliento paslaugų tiekėjas reikalauja vadovo kita kalba – ne anglų, suteikti vertimo paslaugas privalo klientas.
- Nemėginkite atlikti įrangos techninės priežiūros, jei neperskaitėte ar nesupratote šio eksploatavimo vadovo.
- Jei nepaisysite šio įspėjimo, galimi paslaugų tiekėjo, operatoriaus ar paciento sužalojimai dėl elektros šoko, mechaninių ar kitų pavojų.

**ADVARSEL
(NO)**

Denne servicehåndboken finnes bare på engelsk.

- Hvis kundens serviceleverandør har bruk for et annet språk, er det kundens ansvar å sørge for oversettelse.
- Ikke forsøk å reparere utstyret uten at denne servicehåndboken er lest og forstått.
- Manglende hensyn til denne advarselen kan føre til at serviceleverandøren, operatøren eller pasienten skades på grunn av elektrisk støt, mekaniske eller andre farer.

**OSTRZEŻENIE
(PL)**

Niniejszy podręcznik serwisowy dostępny jest jedynie w języku angielskim.

- Jeśli serwisant klienta wymaga języka innego niż angielski, zapewnienie usługi tłumaczenia jest obowiązkiem klienta.
- Nie próbować serwisować urządzenia bez zapoznania się z niniejszym podręcznikiem serwisowym i zrozumienia go.
- Niezastosowanie się do tego ostrzeżenia może doprowadzić do obrażeń serwisanta, operatora lub pacjenta w wyniku porażenia prądem elektrycznym, zagrożenia mechanicznego bądź innego.

**ATENÇÃO
(PT-BR)**

Este manual de assistência técnica encontra-se disponível unicamente em inglês.

- Se outro serviço de assistência técnica solicitar a tradução deste manual, caberá ao cliente fornecer os serviços de tradução.
- Não tente reparar o equipamento sem ter consultado e compreendido este manual de assistência técnica.
- A não observância deste aviso pode ocasionar ferimentos no técnico, operador ou paciente decorrentes de choques elétricos, mecânicos ou outros.

**ATENÇÃO
(PT-PT)**

Este manual de assistência técnica só se encontra disponível em inglês.

- Se qualquer outro serviço de assistência técnica solicitar este manual noutra 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 colocar em perigo a segurança do técnico, do operador ou do paciente devido a choques eléctricos, mecânicos ou outros.

**ATENȚIE
(RO)**

Acest manual de service este disponibil doar în limba engleză.

- Dacă un furnizor de servicii pentru clienți necesită o altă limbă decât cea engleză, este de datoria clientului să furnizeze o traducere.
- Nu încercați să reparați echipamentul decât ulterior consultării și înțelegerii acestui manual de service.
- Ignorarea acestui avertisment ar putea duce la rănirea depanatorului, operatorului sau pacientului în urma pericolelor de electrocutare, mecanice sau de altă natură.

**ОСТОРОЖНО!
(RU)**

Данное руководство по техническому обслуживанию представлено только на английском языке.

- Если сервисному персоналу клиента необходимо руководство не на английском, а на каком-то другом языке, клиенту следует самостоятельно обеспечить перевод.
- Перед техническим обслуживанием оборудования обязательно обратитесь к данному руководству и поймите изложенные в нем сведения.
- Несоблюдение требований данного предупреждения может привести к тому, что специалист по техобслуживанию, оператор или пациент получит удар электрическим током, механическую травму или другое повреждение.

**UPOZORENJE
(SR)**

Ovo servisno uputstvo je dostupno samo na engleskom jeziku.

- Ako klijentov serviser zahteva neki drugi jezik, klijent je dužan da obezbedi prevodilačke usluge.
- Ne pokušavajte da opravite uređaj ako niste pročitali i razumeli ovo servisno uputstvo.
- Zanemarivanje ovog upozorenja može dovesti do povređivanja servisera, rukovaoca ili pacijenta usled strujnog udara ili mehaničkih i drugih opasnosti.

**UPOZORNENIE
(SK)**

Tento návod na obsluhu je k dispozícii len v angličtine.

- Ak zákazníkovi poskytovateľ služieb vyžaduje iný jazyk ako angličtinu, poskytnutie prekladateľských služieb je zodpovednosťou zákazníka.
- Nepokúšajte sa o obsluhu zariadenia, kým si neprečítate návod na obsluhu a neporozumiete mu.
- Zanedbanie tohto upozornenia môže spôsobiť zranenie poskytovateľa služieb, obsluhujúcej osoby alebo pacienta elektrickým prúdom, mechanické alebo iné ohrozenie.

**ATENCION
(ES)**

Este manual de servicio sólo existe en inglés.

- Si el encargado de mantenimiento de un cliente necesita un idioma que no sea el inglés, el cliente deberá encargarse de la traducción del manual.
- 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.

**VARNING
(SV)**

Den här servicehandboken finns bara tillgänglig på engelska.

- Om en kunds servicetekniker har behov av ett annat språk än engelska, ansvarar kunden för att tillhandahålla översättningstjänster.
- Försök inte utföra service på utrustningen om du inte har läst och förstår den här servicehandboken.
- Om du inte tar hänsyn till den här varningen kan det resultera i skador på serviceteknikern, operatören eller patienten till följd av elektriska stötar, mekaniska faror eller andra faror.

**OPOZORILO
(SL)**

Ta servisni priročnik je na voljo samo v angleškem jeziku.

- Če ponudnik storitve stranke potrebuje priročnik v drugem jeziku, mora stranka zagotoviti prevod.
- Ne poskušajte servisirati opreme, če tega priročnika niste v celoti prebrali in razumeli.
- Če tega opozorila ne upoštevate, se lahko zaradi električnega udara, mehanskih ali drugih nevarnosti poškoduje ponudnik storitev, operater ali bolnik.

**DİKKAT
(TR)**

Bu servis kılavuzunun sadece ingilizcesi mevcuttur.

- Eğer müşteri teknisyeni bu kılavuzu ingilizce dışında bir başka lisandan talep ederse, bunu tercüme ettirmek müşteriye düşer.
- Servis kılavuzunu okuyup anlamadan ekipmanlara müdahale etmeyiniz.
- Bu uyarıya uyulmaması, elektrik, mekanik veya diğer tehlikelerden dolayı teknisyen, operatör veya hastanın yaralanmasına yol açabilir.

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Revision History

April 2016				
Location	Description	450w	750	750w
		All pages	Added Gemini product name to publication title.	x
Chapter 3, section 5.4.1	Correction of RF Shield Requirements: Removed "Cryo lines", which should not be installed when measuring SE.	x	x	x
Chapter 3, section 5.4.2	Moved items related to RF shield testing from 5.4.1 to 5.4.2, a new section called "RF Shield Test Requirements".	x	x	x
Chapter 3, section 6.5	Corrected dimensions on Magnet Mounting Detail illustration(s).	x	x	x
Chapter 3, section 6.5	Added a more accurate magnet image to the "Magnet Room Floor Levelness Area" illustration.	x	x	x
Chapter 3 section 8.5	Clarified information in "Cryogenic Venting" overview.	x	x	x
Chapter 3 section 8.6.5	Clarified vent construction requirements.	x	x	x
Chapter 4, section 7, illustrations	Corrected dimensions on PEN and SPW Wall illustrations; added "Pen Panel and SPW Wall Openings" illustration.	x	x	x
Chapter 6, section 3	Updated System Cable List table for DV26.	x	x	x
March 2016				
Location	Description	450w	750	750w
		Chapter 2	Removed the compliance declaration information for Edition 2.1. Added "MR" before "system."	x
Chapter 2, Section 1	Changed the word "Upgrade" to "System Level Requirements for Installing into Existing MR Suite"	x	x	x
Chapter 2, Section 3, under Caution	Within the caution note, added "The ceiling service area should be kept clear of overhead items, including soffits, HVAC, plumbing components, and brackets."	x	x	x
Chapter 2, Section 3	Added system pictures to graphics.	x	x	x
Chapter 2, Table 2-1	Added W x D dimensions to equipment room size.	x	x	x
Chapter 2, Illustration 2-4 Energy Transmitted Through Vibro	Added the new vibration plot graphic.	x	x	x
Chapter 2, Illustration	For "MR System Water Cooling Block Diagram": added the shutoff valves for both supply and return.	x	x	x
Chapter 2, Section 11	Added M7000WL MDP option. Added emergency backup power requirements.	x	x	x
Chapter 2, Illustration	For "Gradient Coil Cart": Updated the gradient coil Diameter XRMb to 892mm.		x	
Chapter 2, Illustration	For "Gradient Coil Cart": Updated the gradient coil Diameter XRMw to 907mm.	x		x
Chapter 2, Table	For "MR System Component Replacement Shipping Specifications": Changed the PGR international shipping weight to 3654 lbs, 1657 kg.	x	x	x
Chapter 3, Illustration 3-4	Modified the illustration to show the height of the stud from the floor to the top of the stud.	x	x	x
Chapter 3, Section 6.2	Changed text in step 6.2.3.g. from "SPW" to "PEN".			x

March 2016				
Location	Description	Applies To		
		450w	750	750w
Chapter 3, Section 6.2	Added "maintain the minimum service area outside 200G" to step 6.2.1.b.	x	x	x
Chapter 3, Illustration(s)	Updated Magnet Mounting Detail illustration(s) and specs for clarification, and added Ergopad illustration and specs.	x	x	x
Chapter 3, Illustration 3-7	Changed the metric measurement from 2487mm to 2362mm.		x	
Chapter 3, Illustration 3-10	Removed words in the illustration, and replaced them with callouts.	x	x	x
Chapter 3, Section 8	Added new vent graphics for clarity. Added combined vent illustration and details.	x	x	x
Chapter 4	Updated equipment room examples.	x	x	x
Chapter 4, illustrations 4-8, 4-10, 4-11	Changed the distance between the Pen and SPW from 5.4 to 7.8 inches.	x	x	x
Chapter 6, Section 1.2, Table 6-4	Changed the usable length value for "PEN cabinet, top panel" to "GOC, rear panel" from "141.7 (29000)" to "1141.7 (29000)".	x		x
Chapter 6, section 2	Added clarity: Removed redundant information in the requirements, illustrations and tables; re-organized requirements into smaller sections; cross-referenced from dimensions in the requirements to dimensions shown in the illustrations.	x	x	x
Chapter 6, Illustration 6-3, 6-4	Added dimension detail from the edge of the cable tray to the magnet isocenter to make sure the gradient cable aligns with the magnet isocenter.	x	x	x
Chapter 6, Illustration 6-1	Added detail to specify the dimensioned offset from magnet isocenter and cable tray edge (if stacked) or between trays (if side by side).	x	x	x
Chapter 6, Illustration 6-7	Transposed dimensions 13 and 7.25 to their correct positions on the graphic.	x	x	x
Chapter 6, Section 4	Added backup power specs for cryocooler.	x	x	x
Chapter 7, Section 4.3.8	Added a figure to illustrate the setup to measure ground isolation resistance. Added step 4 at the end of the procedure to tell the installer to reconnect the lines to ground after the measurement is complete.	x	x	x

Document review and approval per DOC0675747 R8, March 2014					
Location	Description	Applies To			
		450	450w	750	750w
Chapter 8, 3	Clarified requirement of position of the emergency air intake. The emergency air intake must be at the highest point of the finished ceiling. Additionally, there must be an emergency air intake between the finished ceiling and the RF ceiling.	x	x	x	x
Chapter 8, 3, Illustrations	Updated Magnet Room Exhaust Fan Schematic and Magnet Room Exhaust Fan Schematic with Optional Oxygen Monitor illustrations to reflect correct position of the emergency air intake.	x	x	x	x

Revision 10.0, Document review and approval per DOC0675747 R7, July 2013					
Location	Description	Applies To			
		450	450w	750	750w
Chapter 2, 2.2.6	Corrected profiling issue to remove a blank requirement.	x	x	x	x

Revision 10.0, Document review and approval per DOC0675747 R7, July 2013					
Location	Description	Applies To			
		450	450w	750	750w
Chapter 2, 3	Updated values in the Minimum Room Size table to reflect decreased cabinet installation area requirements. Corrected inches to mm conversions.	x	x	x	x
Chapter 2, 3 Note	Replaced text in Note after the Minimum Room Size table to read "Contact PMI to ensure correct ramp leads have been ordered."	x		x	
Chapter 2, 6-1	Changed the table title to "Acoustic Specifications (Under Ambient Conditions)"	x	x	x	x
Chapter 2, 6.2 Illustration 2-4, Note at end of 3.6.2	Changed titles on illustration to "Vibration Transmitted through VibroAcoustic Mat." In Note, corrected references of "energy" to "vibration."	x	x	x	x
Chapter 2, 7.4	Clarified the information about non-MR system equipment in the vicinity of the MR system and the potential sensitivity to magnetic fields. Emphasized that the table listing the types of equipment is for reference only and the listed gauge limit may not be accurate for the customer specific equipment.	x	x	x	x
Chapter 2, 10.1	Updated the Facility Liquid Coolant Requirements table with the inlet temperature for the wide bore systems.			x	x
Chapter 2, 10-1, Illustration 2-14	Create new Allowable Facility Water Temperature and Flow illustration with temperature range for wide bore systems.			x	x
Chapter 2, 11.2	Added new requirement for Main Disconnect Panel (MDP). For the emergency-off circuit, the wire size should be 12-22 AWG and is supplied by the customer.	x	x	x	x
Chapter 2, 12.3	Removed Note from MR system Component Replacement Shipping Specifications table. Added it to weight tables in Magnet chapter.	x	x	x	x
Chapter 2, 12	Checked conversions from inches to millimeters and pounds to kilograms. Corrected where needed on tables Delivery Route Requirements, MR System Component Shipping Specifications, MR System Optional Component Shipping Specifications, and MR System Component Replacement Shipping Specifications.	x	x	x	x
Chapter 3, 2.3	Added table to clarify measurements for Magnet Steady State Vibration Specifications diagramed in Illustration 3-2.	x	x	x	x
Chapter 3, 5.3.1	Added +/- 0.5 MHz tolerance to frequencies listed in first requirement. Added Cyro Lines to the list of items that must be installed before measuring shielding effectiveness.	x	x	x	x
Chapter 3, 5.3.2	Added new requirement for the RF Shield Test Report. Added the need to perform a dock anchor pull test. Verify pull that is greater than 600 lbs. Clarified Ground isolation test results by adding the sentence "this test must be performed before the site is turned over to the general contractor for electrical installation." Add requirement "Blank pen wall is installed."	x	x	x	x
Chapter 3, 7.1	Expanded magnet weight totals in table listing major components of magnet assembly. Added Note from MR System Component Replacement Shipping Specifications table.	x	x	x	x
Chapter 3, 7.1	Added 450w GEM magnet cover dimensions.		x		
Chapter 3, 7.3	In MRU Facility Power Requirements table, added qualifier to connection type requirement to read "Hard wired/permanently wired directly to facility power, no plugs or connectors allowed."	x	x	x	x

Revision 10.0, Document review and approval per DOC0675747 R7, July 2013					
Location	Description	Applies To			
		450	450w	750	750w
Chapter 3, 8.3.2	Changed "All exhaust vent system components must be non-magnetic" to "All items within the RF enclosure must be non-magnetic."	x	x	x	x
Chapter 3, 8.4.1	Added qualifier to requirement to read "A pressure equalizing vent is required in the magnet room ceiling or in the wall, at the highest point possible."	x	x	x	x
Chapter 3, 8.6.5	Added "ONLY" to the beginning of the requirement "ONLY one dielectric break in the vent system (i.e., Ventglas) is required in the Magnet room	x	x	x	x
Chapter 3, 8.7.2	Added requirement "GE Engineering recommends that the cryogen vent be constructed to the same specification as required inside the Magnet Room."	x	x	x	x
Chapter 3, 8.7.3 Illustration 3-15	Updated the Cryogenic Venting (Interior) illustration to show the required distance for the vent stack between the waveguides.	x	x	x	x
Chapter 4, 3 Illustration 4-3	In the Power, Gradient, RF (PGR) Cabinet illustration, corrected the meter measurement of the width of the PGR Cabinet Side View.	x	x	x	x
Chapter 6, 2-1 Illustration 6-2	On the Cable Bends and Obstructions illustration, moved the cables closer to the leading edge of the cable tray.	x	x	x	x
Chapter 6, 2-2, Illustration 6-3	Added an inset to the Cable Tray Requirements (Side by Side) illustration, showing a side view of cable trays and the cable and lines as they are routed around the non-ferrous cable support.	x	x	x	x
Chapter 6, 2-2, Illustration 6-4	Added an inset to the Cable Tray Requirements (Stacked) illustration, showing a side view of cable trays and the cable and lines as they are routed around the non-ferrous cable support.	x	x	x	x
Chapter 6, 2-3 Illustration 6-6	In the Gradient Cable Drop to SPW (Side View) illustration, included the dimension from the bottom of the cable tray to the floor.	x	x	x	x
Chapter 6, 2.4	In the table for Minimum Cable Tray Width, changed the component type for the PGR from electrical to air/water.	x	x	x	x
Chapter 6, 4	In the note at the end of Facility Supplied System Interconnects Specifications, add a paragraph providing more details about the RF door switch.	x	x	x	x
Chapter 7 4.3.8	Change the requirement "To help prevent personal hazard, it is necessary for the enclosure to be properly grounded." to a warning."	x	x	x	x
All	In the continuing effort to prepare these documents for translation, some illustrations were updated with call-outs and descriptive tables.	x	x	x	x

Revision 9.0, Document review and approval per DOC0675747 R6, November 2012					
Location	Description	Applies To			
		750	450	450w	750w
Ch 2, Sec 3, Table 2-1	Updated the Minimum Room Size values to reflect decreased cabinet installation area requirements.	X	X	X	X
Ch 2, Sec 11.1	Reorganized and reworded the requirements to support MDP requirements	X	X	X	X

Ch 2, Sec 11.1, Table 17	<ul style="list-style-type: none"> Removed Power Demand information Changed Requirement for Power Availability to read "Facility power is required at all times for operation of the Cryocooler (CRY) to minimize cryogen consumption." Removed MDP information from Power Availability row. Removed Emergency Off Button information. 	X	X	X	X
Ch 2, Sec 11.1, Table 18	Added table to provide specifications for System Power Demand.	X	X	X	X
Ch 2, Sec 11.2	Added new section to add requirements for MDP electrical requirements.	X	X	X	X
Ch 3, Sec 5.3.3.5.I	Corrected Newton conversion for torque value specified for the dock anchor.	X	X	X	X
Ch 3, Sec 8.7.3, Illustration 3-15 and Table 3-11	Added Item 12 to illustration to show that height from floor to bottom of contractor-supplied wave guide is a maximum of 116.9 inches.	X	X	X	X
Ch 3 Sec 8.7.3, Illustration 3-16	Revised cryovent drawing for 450w.			X	
Ch 4, Sec 1, Illustration 4-1	Updated Equipment Room Layout Example Illustration to reflect decreased cabinet installation area requirements.	X	X	X	X
Ch 4, Sec 1, Illustration 4-1 and Table 4-1	<ul style="list-style-type: none"> Updated the Equipment Room layout notes to support new illustration (. Added requirement "If you use the minimum service area, then riggers are required to install the equipment." 	X	X	X	X
Ch 4, Sec 2	Added "optionally" to the introductory sentence.	X	X	X	X
Ch 4, Sec 7, Table 4-2	Changed Item 1 to show minimum ceiling height.	X	X	X	X
Ch 4, Sec 7, Illustration 4-10, 4-11, 4-12	Updated Closet Service Hatch Space illustrations to correct standard to metric conversions.	X	X	X	X
Ch 6, Sec 1.2, Table 6-3	Added a paragraph and table to explain the order configurations for cables.	X	X	X	X
Ch 6, Sec 2.2, Table 6-11, Item 9	Added a reference to Illustration 6-3, Item 8.	X	X	X	X

Revision 8.0, Document review and approval per DOC0675747 R5, May 2012					
Location	Description	Applies To			
		750	450	450w	750w
Ch 2, Sec 3, Illustration 2-1	Rear magnet dimension shown as 84". Changed to 73".			x	
Ch 2, Sec 9, Note 3	Removed "(contact install base support in Florence SC for altitudes from 8100 to 11808 feet (2468.9 to 3600 m) above sea level"	x	x	x	x
Ch 2, Sec 11	Updated Voltage/Frequency power requirements to include 415/400/380 VAC 60 ±3 Hz	x	x	x	x
Ch 2, Sec 11	Updated daily voltage variation to +10% / -10%	x	x	x	
Ch 2, Sec 11, Table 2-16	Clarified text to: "Optional customer supplied" backup power must be provided the facility breaker ...	x	x	x	x
Ch 2, Sec 12.3	Updated magnet shipping dimensions and weights; added lifting bar details; clarified additional shipping details	x	x	x	x

Ch 3, Sec 2.2	Clarified environmental steel limits	x	x	x	x
Ch 3, Sec 2.3, Illustration 2-3	Changed vibration specification to start at 0.5 Hz	x			x
Ch 3, Sec 5.3.3.1.5.l	Clamping force is 600 lbs (2669 N)	x	x	x	x
Ch 3, Sec 5.3.3 Figure 3-4	Updated drawing to show removable portion of dock anchor	x	x	x	x
Ch 3, Sec 6.2	Clarified text: "minimum service area" changed to "200 Gauss"	x	x	x	x
Ch 3, Sec 8.6.5.1.c	Removed note for second Ventglas joint requirement	x	x	x	x
Ch 4, Sec 7, Table 4-2	Clarified text: Magnet room service areas for PEN and SPW must not overlap "200 G" in magnet minimum service area	x	x	x	x
Ch 7, Sec 8.2.f	Changed R/D = 0.5 for standard sweep elbows to R/D = 1.0 for standard sweep elbows	x			x

Revision	Date	Description		
7.0	Mar2012	Document review and approval per DOC0675747 R4		
		Reason For Change	Location	Description
			Various Illustrations	Replace text callouts with numbers and in-line notes to facilitate translations
		Specification Update	Ch 2, Sec 1	Clarified HSS assessment for upgrades and eliminated redundant requirements and focused on essential requirements
		Specification Update	Ch 2, Sec 3	Simplified room size table
		Specification Update	Ch 2, Sec 3	Updated Minimum Magnet Room Size for consistency across platforms (also revised illustration to show new design tradeoff area)
		Specification Update	Ch 2, Sec 6.1	Added note to clarify customer need to contain noise within each of the three rooms
		Specification Update	Ch 2, Sec 6.2	Added chart to show energy transmitted through VibroAcoustic Mat
		Specification Update	Ch 2, Sec 9.2	Added CAD Stream heat load to System Heat Output for Air Cooling
		Specification Update	Ch 2, Sec 10.1	Added requirement for HEC, CRY, and PGR to be located on the same floor
		Specification Update	Ch 2, Sec 11	Updated Voltage Variation, Voltage Transients, and Regulation. Removed requirement for input power neutral wire. Added restriction to disallow use of corner grounded DELTA source. Added note to MDP illustration for backup power requirement
		Specification Update	Ch 3, Sec 4	Added detail to allow customer acoustic engineer to design an MR Suite to contain the air and structure borne noise levels
		Specification Update	Ch 3, Sec 5 & Ch 7, Sec 4	New RF Shield Effectivity test requirements with a focus on the test methods, equipment, test procedures and report format
		Specification Update	Ch 3, Sec 6	Added subsection for PEN closet requirements
		Specification Update	Ch 3, Sec 6.2 & Ch 4 Sec 7	Added requirements for Closet service hatch; Updated 15 in. to 381 mm
Specification Update	Ch 3, Sec 6.3	Removed ceiling interface drawing and added reference to cable concealment kit		
Specification Update	Ch 3, Sec 6.4	Changed floor levelness requirement from 0.3125 in. over 120 in. to 0.125 over entire floor levelness area		

Revision	Date	Description		
		Specification Update	Ch 3, Sec 7.1	Updated magnet specifications
		Specification Update	Ch 3, Sec 8	Added note to prohibit use of magnetic parts in Magnet room
		Specification Update	Ch 3, Sec 8.3, 8.5, 8.6, 8.7	Simplified requirements and updated Cryogen Venting illustrations (3–15, 16, 17) eliminating nonessential details, focusing on requirements
		Specification Update	Ch 3, Sec 9.2	Added note to prohibit use of magnetic parts in Magnet room
		Specification Update	Ch 4, Sec 1	Added note that optional equipment is not shown
		Specification Update	Ch 4, Sec 2, 3, 4	Added location of seismic anchors and updated service install access
		Specification Update	Ch 4, Sec 4	Removed lifting hole detail from HEC illustration and updated service clearances
		Specification Update	Ch 4, Sec 5	Dimensioned blower box hose service clearance
		Specification Update	Ch 4, Sec 6	Added center of gravity dimensions to SPW illustration
		Specification Update	Ch 4, Sec 7	Updated/added PEN and SPW opening illustrations to show required service area
		Specification Update	Ch 6, Sec 2	Updated allowable obstruction distance to 7 in. above the bottom of the tray
		Specification Update	Ch 6, Sec 2.2	Updated cable tray height (104 in to 101.5 in) and distance from back of magnet (45.5 to 49.8)
		Specification Update	Ch 6, Sec 2.4	Added minimum cable tray widths between equipment room components
6.0	Nov2010	Document review and approval per DOC0675747 R3 V4		
		SPR	Location	Description
		MRlhc47102, MRlhc47103	Ch 4, Sec 11	Changed input power requirements to MDP: 415/400/380 VAC 50 Hz
		MRlhc49467	Ch 3, Sec 5.5, 5.6	Updated Illustration 3-3: Magnet or Dock Anchor Mounting Details to show magnet feet flush with the floor.
		MRlhc50449	Ch 3, Sec 5.5, 5.6	Added maximum bolt length to both sections
		MRlhc51083	Ch 3, Sec 4	Clarified text
		MRlhc51455	Ch 3, Sec 7.3	Added remote MRU note
		MRlhc51974	Ch 3, Sec 6.1	Added air flow rate of 400CFM into the PEN closet
		MRlhc48846	Ch 2, Sec 5; Ch 7, Sec 3 and 4	RF Shielded room requirements updated. RF shielded room testing guidelines updated.
		MRlhc50268	Ch 6, Sec 2	Cable tray requirements updated
		MRlhc51454	Multiple	A. Pen Panels should be 118 (3000) in illustration 2-11 B. 5 (127) should be 2.5 (64) in ill. 3-6 C. Illustration titles 2-7 and 2-8 are reversed top/side views
		MRlhc51746	Ch 2, Sec 10	Added charts for coolant specifications (for clarity)
		MRlhc51442	Ch 3, Sec 8.5	Removed Ventglas requirement for dielectric break outside Magnet room; Added 0.25 in tolerance to vent location
		MRlhc51080	Ch 6, Sec 3	Updated system cable list
MRlhc51082	Ch 4, Sec 2	Clarified cable strain relief dimensions on PGR cabinet		

Revision	Date	Description		
		MRlhc51352	Ch 2, Sec 11, Ill. 2-14; Ch 6, Sec 4, Ill 6-11	Clarified that E-Off location and wiring is determined by customer
		MRlhc51413	Ch, Sec 2, Ill. 2-1; Ch 3, Sec 7.2	Added optional surgical suite table illustration
		MRlhc49328; MRlhc51413	Ch 3, Sec 6	Added recommendations not to use ferrous material/ components in the Magnet room
		MRlhc49327	Ch 2, Sec 10.2	Updated Emergency Coolant Requirements for clarity
5.0	01Dec2009	Document review and approval per DOC0675747 R2 V3		
		iTrak No.	Location	Description
		13252239	Ch 6, Sec 1.3	Added MNS and Brainwave cable information
		13230415	Ch 3, Sec 8.2	Clarified Incoming air must contain 5% outside air (from outside the room)
		13254391	Ch 4, Sec 5	Updated Pen cabinet installed height and width
		13275765	Ch 2, Sec 11.3	Corrected Magnet weight (per 5304995IDW)
		SPR No.	Location	Description
		MRlhc45228; MRlhc45709	Ch 6, Sec 3	Updated system cable list
		MRlhc45702	Ch 2, Sec 11	Standby (no scan) should be 17 kVA
			Ch 3, Sec 5.6	Magnet anchor drawing titled "Magnet and Dock Anchor Mounting Details"
		MRlhc45703	Ch 3, Sec 2.2	Updated steel limit table (distance from isocenter values)
		MRlhc45706	Ch 4, Sec 4; Ch 4, Sec 5	Updated gauss limits for PEN and HEC cabinets to 50 Gauss
		MRlhc45707	Ch 2, Sec 4	Updated EMC declaration per 60601-1-2 Edition 2.1
		MRlhc45708	Ch 3, Sec 7.2	Updated Table Illustration to show DV table (minor dimension changes)
		MRlhc45709	Ch 2, Sec 9; Ch 6, Sec 4	Added/updated Facility cooling requirements and hose/ hose insulation specifications
		MRlhc45714	Ch 3, Sec 9.3	Updated Common Ground Stud requirement to increase allowable filter and pipe distances
		MRlhc45715	Ch 2, Sec 11	Changed MDP Regulation specification to 2%
		MRlhc45718	Ch 3, Sec 6.4	Added Vibromat dimensions to allow floor loading calculations
		MRlhc46104	Ch 2, Sec 12.3	PEN, HEC, PGR, SPW cabinet shipping dimensions updated
		Other	Location	Description
			Ch 2, Sec 10	Illustration 2-15, changed "Top of HEC" to "Terminal Strip" and remove E3027
		ECO 2076814	Ch 3, Sec 7.3	New MRU specifications and requirements added
			Ch 2, Sec 8	Added shared room requirements
			Ch 4, Sec 7	Updated PEN Panel mounting drawing

Revision	Date	Description
4.0	01April2009	Updated for: Consistency with MR450 PIM: Changed Quench caution to text. Updated fringe field drawings for legibility in MR Suite Magnetic Field Specifications; Added F-50 Pressure Drop information in Cryocooler Compressor (CRY) Emergency Facility Coolant Requirements section; Updated MR Suite Electrical requirements; Updated MNS cabinet and XRM cart shipping info in the MR System Component Shipping Specifications section; Updated Table 3-1 in environmental Steel Limits sections; Updated Doors and Magnet Access Openings section; Updated Pressure Equalization vent Requirement section; Updated Usable Cable Lengths and Facility Supplied System Interconnects Specifications section; 3.6.4.5, Updated floor levelness requirement 3.6.4.3 and ill. 3-4, 3-5 SPR MRIhc40422: Updated MRU power requirements in MRU Specifications and Requirements section; MRIhc40347, 3.3.7, Added: Accessory storage. MRIhc40422, 7.3.4, MRU power is required continuously ITraks 13207611, 13207615, 13212136, 13214972: Updated MR System Interconnects Routing, Typical Cable Track Layout, and added MR System Cable Specifications; 13207696: Updated Magnet Monitor Requirements and Specifications section; 13210019: Added CoG spec to F-50 Cryocooler Specifications section; 13210306: Updated PEN and SPW Wall Opening requirements section; 13210013: Updated HEC weight specification in Heat Exchanger Cabinet (HEC) specifications section; 13210785: Updated Ills. 4-3, 4-4, 4-5 to show cable access requirements in Equipment room section; 13209995: Added Magnet Center of Gravity specifications in Magnet (MAG) Specifications section; 13210101: Added Rear Pedestal dimensions in Magnet (MAG) Specifications section; 13210075: Updated floor resistance and levelness requirements in Magnet Room Floors section; 13210774: Added in-line flow meter and feeder hose requirements in the Facility Water Requirements section; 13209776: Updated PEN Closet requirements in Finished Room Requirements section; 13210075: Removed high-resistance flooring requirement from Magnet Room, Finished Room Requirements, Magnet Room Floors section; 13207696: Changed location of MON to side of HEC only; added power cord length specification in Magnet Monitor (MON) Requirements and Specifications section; 13210785: Updated PGR, HEC, and PEN cabinet drawings to show overhead cable clearance requirements in Equipment room section; 13212453, 13209814: Updated upgrade requirements in the Upgrade Requirements section; 13209982: Updated minimum magnet room size and minimum ceiling height requirements in MR Suite Minimum Room Size Requirements. 13210075, 3.6.4.2.4, Added requirement for High Resistance Flooring 13209995, 13210019, 3.7.1, 4.8.2, Added Center of Gravity for magnet (updated illustration 3-6) and updated CRY COG ill. 4-9 13225818 13236584, 2.10 Updated HEC Power Requirements 13218037, 2.10, Removed run 3003 from illustration. 2-15 13230398, 2.9.1, Changed "Heat Output to Water" to "Chiller Size" 13223045, 3.9.3, Updated ground dwg 3-13 to include E4009 and E4010 and reference to chapter 6, usable cable lengths Other 2.7.1, Updated gauss plots (Front/side/top view) with table and rear ped outlines 2.6.2, Updated graphic and text for clarity 3.8.5.2.3, Updated exhaust area is for 1.5T 6.2.1, 6.2.2, Updated requirement 12 a, b, c. and illustration 6.2 for new cable track requirements 3.6.4, Added Dock anchor hole to Illustration 3-5 and added anchor mounting requirements (Section 3.6.6)
		SPRs MRIhc45228, 6.3, Updated system cable list; MRIhc45702: Typos: 2.8.2, 79.2 in. is shown as is 3000 mm. Should be 79 (2000); MRIhc45703: 3.2.2, updated steel limit table; MRIhc45705, 3.5.2.5, Updated RF shielding test requirement; MRIhc45706, 4.4, 4.5, Updated gauss limits; 2.4, MRIhc45707, Updated EMC declaration; MRIhc45708, 3.7.2, Updated Table Illustration; MRIhc45709, 2.9, 6.4, Added/updated Facility cooling requirements and hose specifications; MRIhc45714, 3.9.3, Updated Common Ground Stud requirement; MRIhc45715, 2.11, Changed MDP Regulation specification; MRIhc45718, 3.6.4 Added vibromat dimensions. Other: 2.10, Illustration 2-15 "Top of HEC" and remove E3027; 3.7.3, MRU Updates Updated to match DVw: 2.1.5b,f and 8 8.2 10 6.2.1.22
3.0	24Jul2008	Updated for spr MRIhc39009
2.0	08Jul2008	Updated for sprs MRIhc36353, MRIhc36791, MRIhc37587, MRIhc37634, MRIhc38161, MRIhc38597
1.0	15Apr2008	Initial Release

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Chapter 1 Introduction

1 Preinstall Manual Introduction



WARNING

EQUIPMENT FAILURE OR PERSONNEL INJURY
FAILURE TO IMPLEMENT ALL REQUIREMENTS AND ADHERE TO ALL SPECIFICATIONS IN THIS MANUAL MAY RESULT IN PERSONAL INJURY, EQUIPMENT DAMAGE, SCAN FAILURE, OR WARRANTY VOID. THE IMPLEMENTATION OF ALL REQUIREMENTS AND ADHERENCE TO ALL SPECIFICATIONS IN THIS MANUAL IS THE RESPONSIBILITY OF THE CUSTOMER OR ITS ARCHITECT AND ENGINEERS. REFER ANY QUESTIONS TO THE GE HEALTHCARE PROJECT MANAGER OF INSTALLATION (PMI).



NOTICE

The customer is responsible for compliance with all local and National codes and regulations.

1.1 Document Purpose

This preinstallation manual provides the necessary information to prepare a site for system installation. Specifically, this manual provides information:

1. To define system requirements and interactions
2. For the effective arrangement and interconnection of system components

1.2 Intended User

The primary user of this manual is the customer's architectural planner. Customer is responsible for:

1. National and local building codes
2. Customer site procedures (medical, MR, safety, etc.)
3. Any special architectural requirements

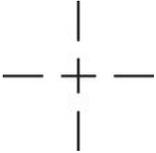
1.3 Document Overview

This manual describes requirements and specifications for the following:

1. General System Requirements
2. Shipping and Delivery
3. Magnet Room
4. Equipment Room
5. Control Room
6. Interconnects

2 Symbols Key

Table 1-1: Symbols Key

Symbol/Unit	Definition
in (mm)	All units of measurement are inches with millimeters in parentheses, unless otherwise noted.
	Center of gravity
	Center of magnet

Chapter 2 General System Level

1 System Level Requirements for Installing into Existing MR Suite

When upgrading to a Discovery MR750 3.0T system, all requirements in this manual must be met. Ensure the following:

NOTE: When planning installation in a non-GE Healthcare MR suite all requirements in this manual must be met as these rooms are considered new installations.

When upgrading from an HFO system, extensive building updates are required. The facility must remove any magnet room isolation system.

1. Magnetic field stability tests (HSS tool) may be used for vibration environmental assessment (for GE cylindrical magnets only)

NOTE: The customer may have to hire a vibration consultant based on the results of the analysis

2. Remove, cover, or fill-in abandoned ducts or troughs and remove access/computer room flooring from the Equipment and Magnet rooms
3. The VibroAcoustic dampening kit must be surface mounted (if the floor is recessed, it must be filled in)
4. RF vendor responsibilities:
 - a. The old dock anchor cannot be reused. It must be removed and the hole filled in. The new anchor is reset after the magnet is installed
 - b. The RF shield ceiling must support the cable routing mechanism and cables. Reinforce RF shield ceiling (see [Chapter 6, MR System Interconnects Routing Requirements](#))
 - c. Two penetration panel openings are required and must meet the requirements in: [Chapter 4, PEN and SPW Wall Opening Requirements](#) (includes PEN and SPW panels)
 - d. RF shield attenuation must comply with: [Chapter 3, RF Shielded Room Requirements](#)
5. Cryogen vent must be relocated to align with the Magnet Cryogen Vent opening (see [Chapter 3, Magnet Room Venting Requirements](#))

2 System Components

The Discovery MR750 3.0T system consists of the following components:

2.1 Magnet Room

1. 3.0T G3 Magnet and Magnet Enclosure (MAG) and VibroAcoustic Dampening Kit
2. Rear Pedestal (PED)
3. Patient Transport Table (PT)
4. Optional: Surgical suite table
5. Magnet Rundown Unit (MRU). Note: An optional remote MRU may be located outside the magnet room.

2.2 Equipment Room

1. Main Disconnect Panel (MDP) (may be customer supplied)
2. Power, Gradient, RF Cabinet (PGR)
3. Heat Exchanger Cabinet (HEC)
4. Penetration Panel Cabinet (PEN)
5. Secondary Penetration Wall (SPW)
6. Cryocooler Compressor Cabinet (CRY)
7. Magnet Monitor (MON)
8. Optional: Multi-Nuclear Spectroscopy (MNS)
9. Optional: Brainwave Lite (BW)
10. Optional: CADstream
11. Optional: MR Guided Focus Ultrasound (FUS)

2.3 Control Room

1. Operator Workspace equipment (OW)
2. Pneumatic Patient Alert System (PA1)
3. Optional: Oxygen Monitor (OXY)

2.4 Accessories

1. Patient accessories, including phantoms, cushions, sponges, straps, and wedges
2. Gating accessories, including patient cardiac leads, peripheral gating probe, and respiratory bellows

3 MR Suite Minimum Room Size Requirements



CAUTION

Procedure Failure

The minimum service area shown must be kept clear of permanent or installed cabinetry, mill work, shelving, coil storage fixtures, furniture, etc.

The ceiling service area should be kept clear of overhead items, including soffits, HVAC, plumbing components, and brackets. Permanent or installed objects in this area may prevent or delay magnet service or operation.

Room dimensions shown in the table below lists the minimum finished room space requirements to properly and safely operate and service the MR system. The items listed below are not included in the minimum area dimensions:

1. Building code requirements (e.g., exit routes, door placement, local and national electrical codes, etc.)

NOTE: The customer must provide Equipment and Magnet Room evacuation routes to comply with facility emergency procedures.

2. System requirements, including cable run locations, cryogen venting, patient observation requirements, and penetration panel placements (e.g., the Equipment room and Magnet room must share a common wall to allow penetration panel installation)
3. Penetration panel closet and all associated areas (must be outside the minimum finished room dimensions)
4. Non-GEHC equipment options (such as additional AC or water cooling equipment in the Equipment room)
5. Accessory storage. Refer to the *Customer Site Storage Requirements* manual (document number 5182674) or contact the GE Healthcare Project Manager of Installation (PMI) for any additional accessory storage requirements

Table 2-1: Minimum Finished Room Dimensions

Configuration	Equipment Room			Magnet Room (See the illustrations below for specific dimensions)			Control Room		Total System Area ft ² (m ²)
	W x D in. (mm)	Area ft ² (m ²)	Ceiling Height in. (mm)	W x D in. (mm)	Area ft ² (m ²)	Finished Ceiling Height in. (mm)	W x D in. (mm)	Area ft ² (m ²)	
Minimum Room Size (2050 mm Scan Range)	124.75 (3167) x 112.75 (2863)	85 (7.9)	114 (2896)	143.5 x 253 (3645 x 6426)	228.3 (21.2)	98.5 (2502)	60 x 84 (1524 x 2134)	35 (3.2)	348.3 (40.8)
With MR Guided Focused Ultrasound	Contact the Project Manager of Installation (PMI) for FUS site planning details.								
With MNS	Add: 15 (1.4)								
With CADStream								Add: 1.25 (0.11)	
With Brainwave	Add: 13.25 (1.25)								

Illustration 2-1: Minimum Magnet Service Area (Top View)

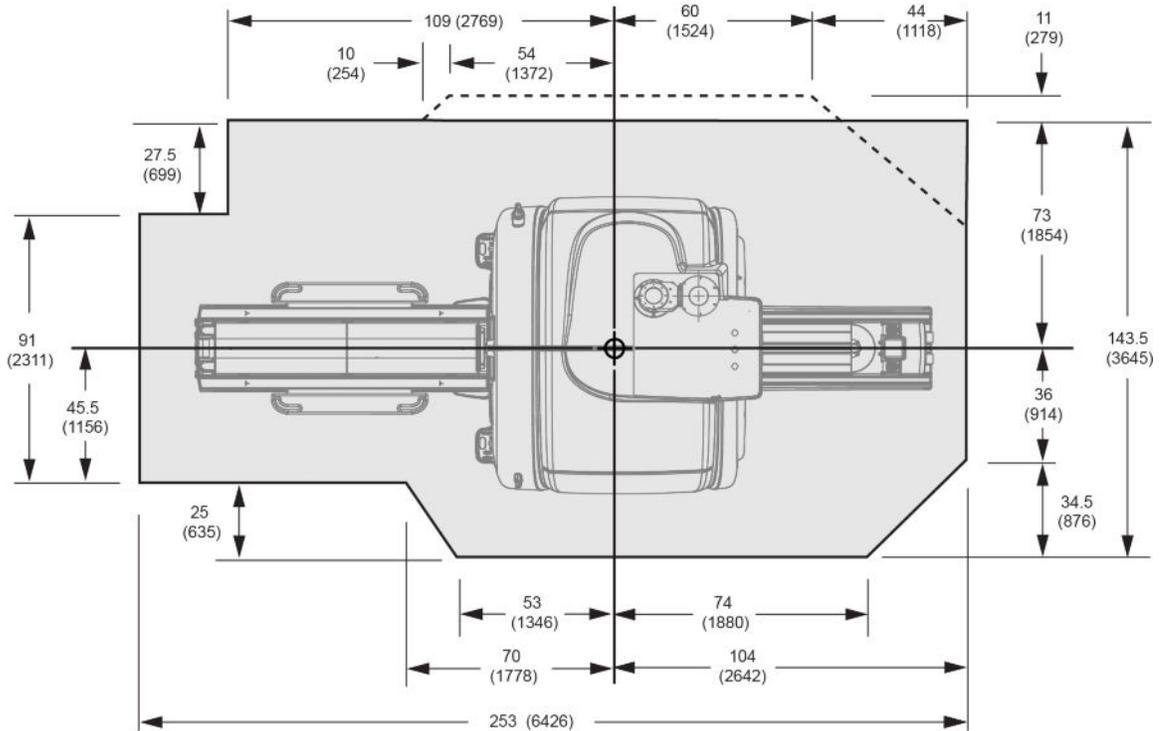
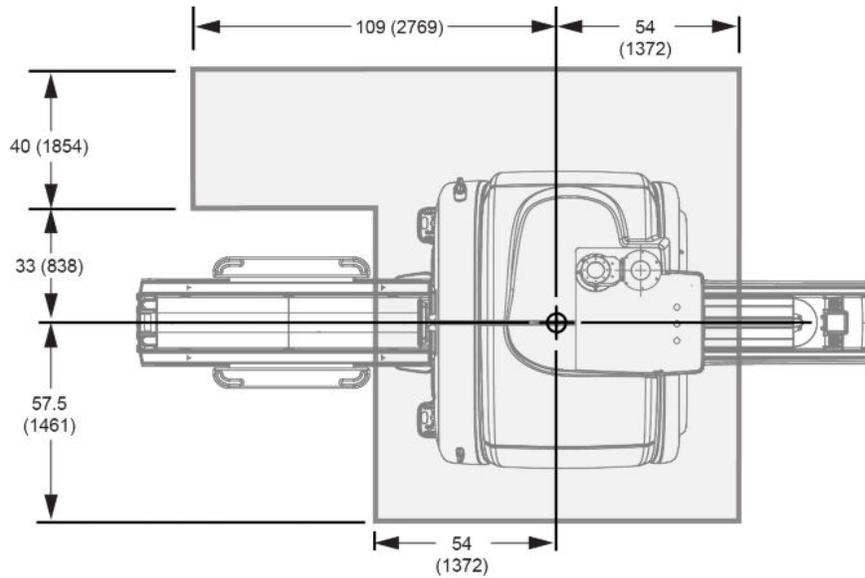


Table 2-2: Minimum Magnet Service Area Notes

Shaded area within solid lines indicates minimum service area; dashed line indicates alternate design tradeoff area

- NOTE:** Shaded area within solid lines indicates floor to ceiling minimum height of 98.5 (2500)
- NOTE:** Special service procedures are required if ceiling height is between 98.5 in. (2500 mm) and 105 in. (2667 mm). Contact PMI to ensure the correct ramp leads have been ordered.

Illustration 2-2: Minimum Magnet Ceiling Height (Top View)



NOTE: Contact the GE Healthcare Project Manager of Installation (PMI) for additional information or to request designs.

4 IEC EMC Compliance

Per IEC 60601-1-2 Medical Electrical Equipment requires special precautions regarding Electromagnetic Compatibility (EMC) and must be installed and put into service according to the EMC information provided in the following tables. Full declaration is stored on-site in the user manual delivered with the system.

The MR system is designed and tested to the following standards:

Table 2-3: Guidance And Manufacturer's Declaration – Electromagnetic Emissions

The system is intended for use in the electromagnetic environment specified below. The customer or the user of the system should assure that it is used in such an environment.		
Emissions Test	Compliance	Electromagnetic Environment – Guidance
RF Emissions CISPR 11	Group 2	The system must emit electromagnetic energy in order to perform its intended function. Nearby electronic equipment may be affected
RF Emissions CISPR 11	Class A	The system is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes

Table 2-4: Guidance And Manufacturer's Declaration – Electromagnetic Immunity

The system is intended for use in the electromagnetic environment specified below. The customer or the user of the system should assure that it is used in such an environment.		
Immunity test	IEC 60601 test level	Compliance Level
Electrostatic discharge (ESD) IEC 61000-4-2	±6 kV contact	±6 kV contact
	±8 kV air	±8 kV air
Electrical fast transient / burst IEC 61000-4-4	±2 kV for power supply lines	±2 kV for power supply lines
	±1 kV for input/output lines	±1 kV for input/output lines
Surge IEC 61000-4-5	±1 kV line(s) to line(s)	±1 kV differential mode
	±2 kV line(s) to earth	±2 kV common mode
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	<5 % U_T (>95 % dip in U_T) for 5 sec.	<5 % U_T (>95 % dip in U_T) for 5 sec.
Power Frequency (50/60Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 Vrms
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2,5 GHz	3 V/m

5 MR System Seismic Requirements

Contact the Project Manager of Installation with any questions.

1. The customer is responsible for seismic anchoring of GE components
2. Center of gravity, weight, physical dimensions, and attachment points are provided for seismic calculations. Refer to the specifications or illustrations for each component (see [Chapter 3, Magnet Room Equipment Specifications](#), Chapter 4, Equipment Room, and Chapter 5, Control Room)

6 MR Suite Acoustic Specifications

6.1 Acoustic Specifications

The following table lists the acoustic output of GE Healthcare equipment:

Table 2-5: Acoustic Specifications (Under Ambient Conditions)

	GE Equipment Acoustic Output	Notes
Control Room	62 dBA	
Equipment Room	80 dBA	The 80 dBA level is for GE equipment only. The Equipment room acoustic level must not exceed 85 dBA
Magnet Room	See Chapter 3, Acoustic Room Specifications	

The customer must use acoustic noise containment solutions to control leakage of acoustic noise from one room to the next. Refer to [Chapter 7, Acoustic Background and Design Guidelines](#) for guidance to contain the noise within the magnet room.

NOTE: All GE equipment acoustic output values are for base equipment configuration in each room.

6.2 Structureborne Vibration Control Specifications

Structureborne acoustic issues tend to occur at MR installations above the ground floor of the facility. Two options to mitigate structureborne acoustic transmission are:

1. GE Healthcare provides a VibroAcoustic Dampening kit (which must be surface mounted). Contact the GE Healthcare Project Manager of Installation for information
2. The customer may design and implement a custom solution in addition to the VibroAcoustic Dampening kit (see [Illustration 2-3](#) for the plot of spectral vibration transmitted through the VibroAcoustic mat into the floor. If required, the customer should consult an acoustic engineer for a solution to further attenuate this transmitted vibration)

NOTE: The amount of vibration attenuation provided by the VibroAcoustic Dampening kit will be site dependent.

Illustration 2-3: Vibration Transmitted through VibroAcoustic Mat

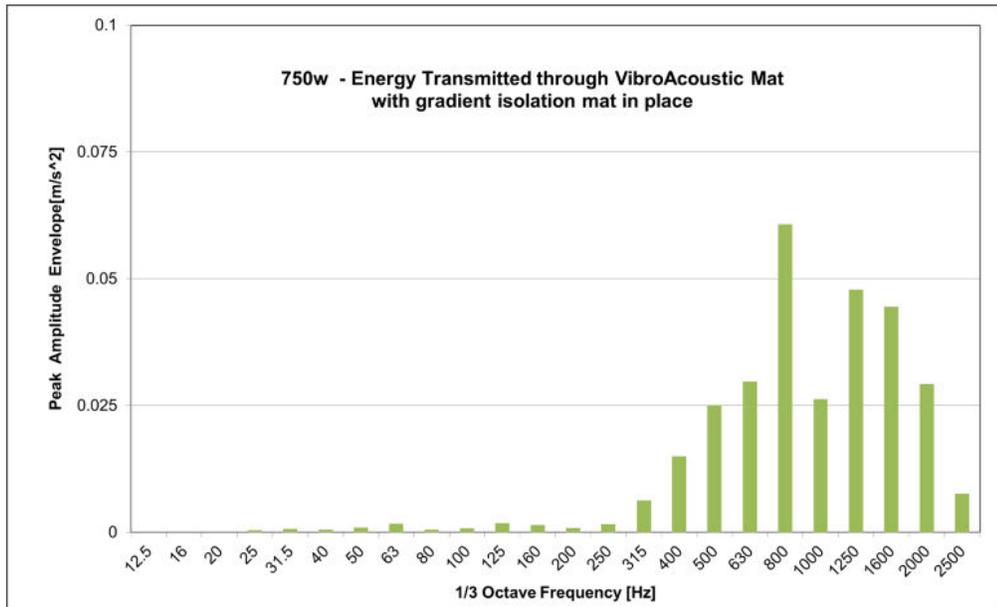
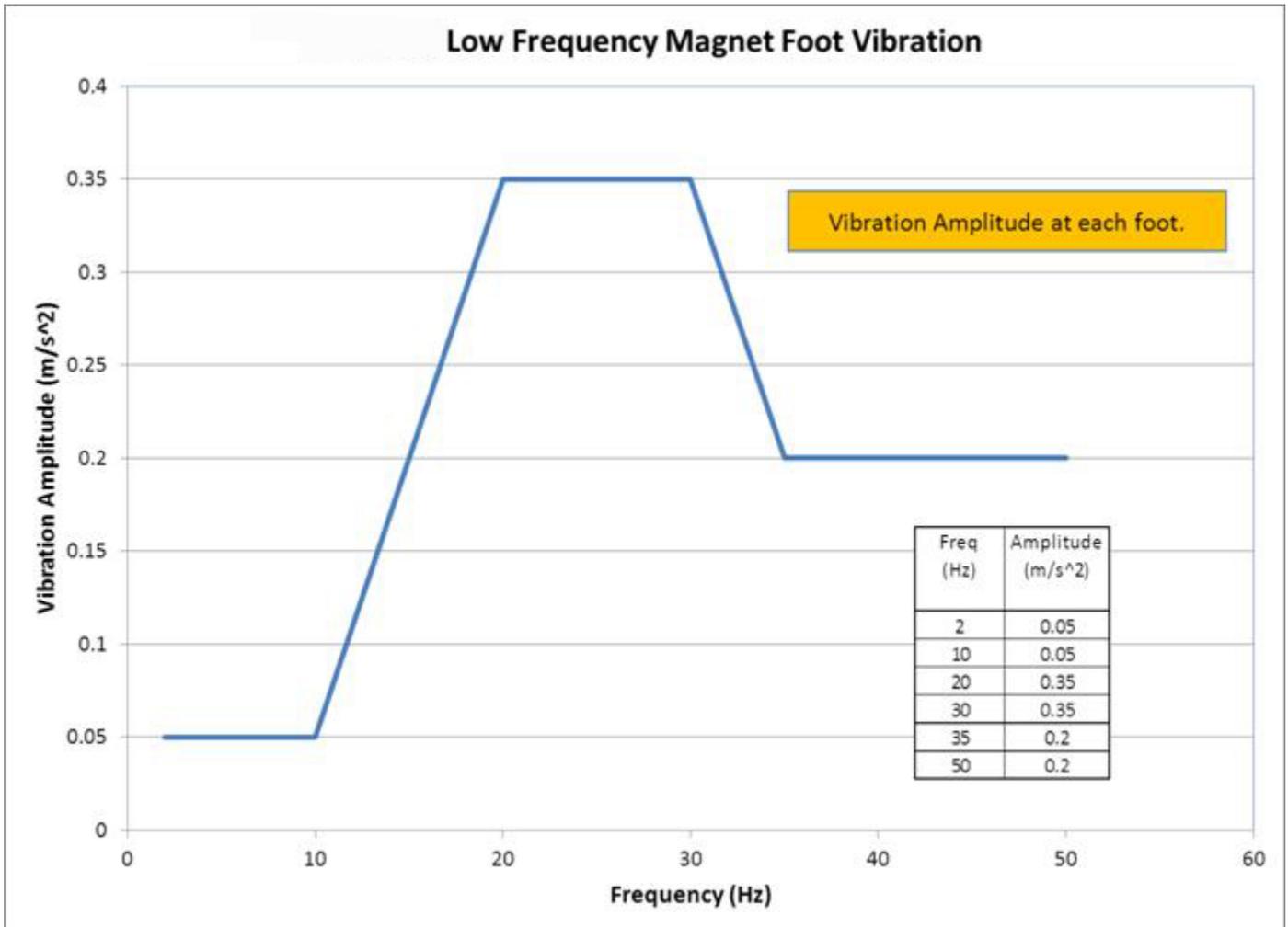


Illustration 2-4: Low Frequency Magnet Floor Vibration (Vibration Amplitude at Each Foot)



NOTE: Low Frequency Magnet Floor Vibration Notes:

1. Illustrations above define the potential vibration level that may pass into the customer site. [Illustration 2-3](#) is the high frequency audible vibration. [Illustration 2-4](#) is low frequency vibration that may dynamically displace the floor
2. Vibration transfer may be the result of customer specific building construction as low levels of vibration transmit into the building via air- and structureborne paths. Customer MR clinicians recognize the vibration defined in the tables is typically short bursts of vibration repeated multiple times as the scan progresses
3. The customer should consider the impact of this vibration for evaluation and design solution

7 MR Suite Magnetic Field Specifications

7.1 Magnetic Fringe Field

The following illustrations show the static magnet isogauss plot lines for a 3.0T G3 magnet. This information must be used to evaluate potential site interaction of GE Healthcare equipment with other non-GE Healthcare equipment, interaction with magnetic materials on the site, and to locate personnel and equipment within the site.

The 5 gauss line can expand to 24.61 ft (7.5 m) axially and 19.68 ft (6.0 m) radially for up to 100 seconds in the rare event of a quench.

The isogauss plots show an idealized magnetic field relative to magnet isocenter. The actual field strength can be affected by any of the following:

- Magnetic shielding
- Earth's magnetic field
- Other magnetic fields
- Stationary or moving metal

Illustration 2-5: Magnetic Fringe Field Side View

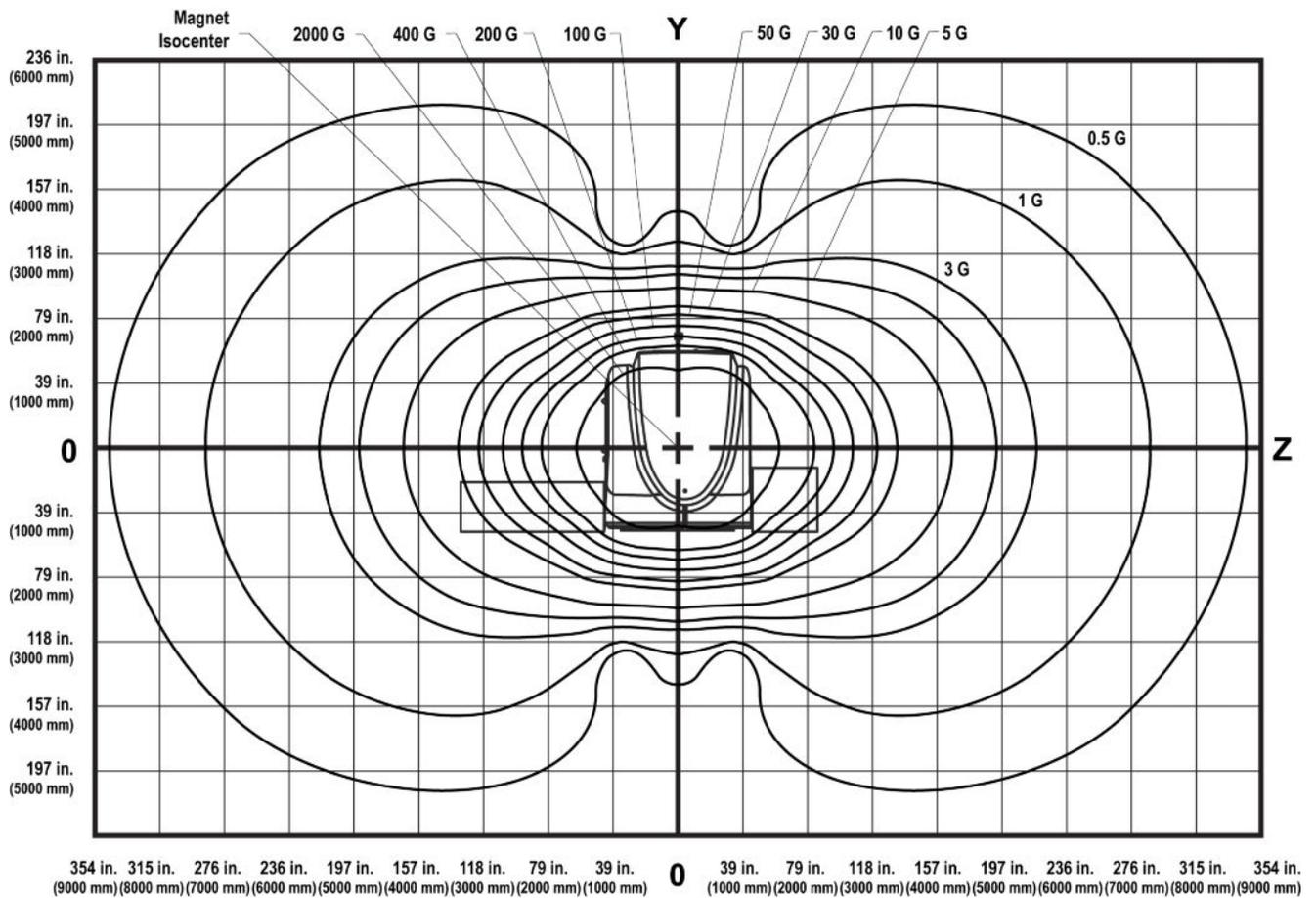


Illustration 2-6: Magnetic Fringe Field Top View

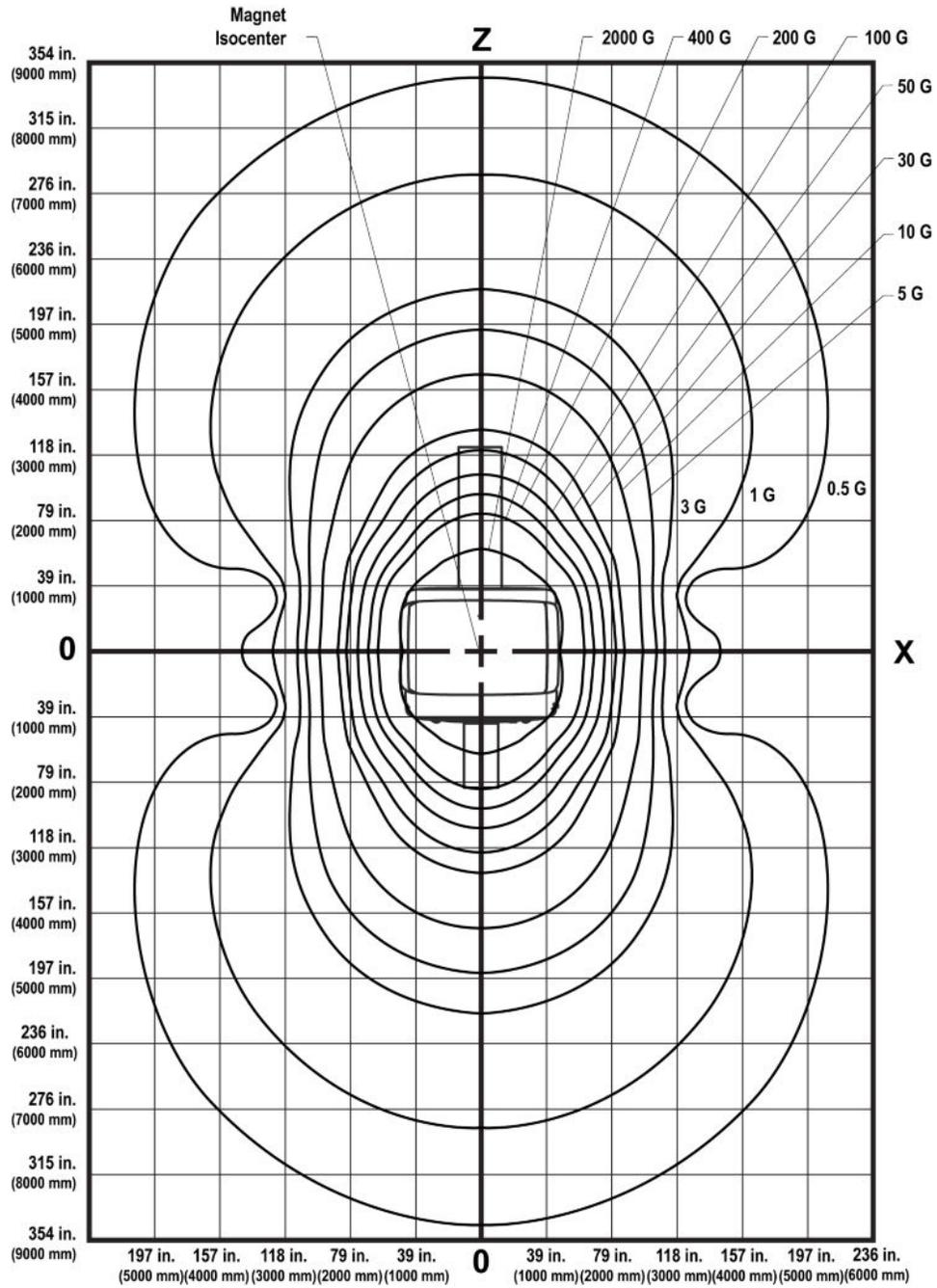
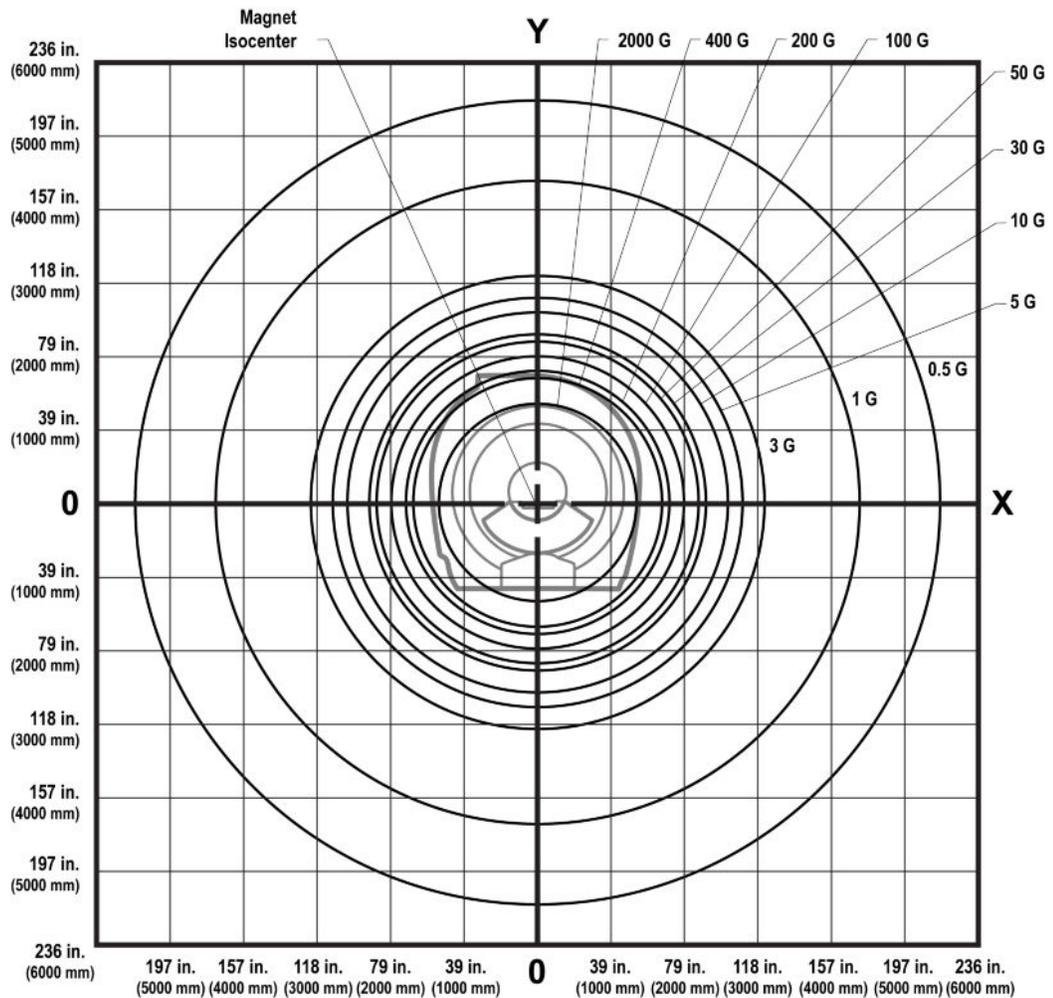


Illustration 2-7: Magnetic Fringe Field Front View



7.2 Interference from Changing Magnetic Fields

Metal objects moving within the magnet sensitivity lines can produce a field disturbance during clinical imaging. If the metal object is moving it will produce a fluctuating dipole type of field which causes image artifacts. As an example, a car driven inside the moving metal line will act as a dipole and produce a time varying field which changes the magnet's main field during the imaging time. The same vehicle may park within the moving metal line and remain parked during clinical scanning without impact to the main field.

Illustration 2-8: Magnet Moving Metal Sensitivity Line Plot (Side View)

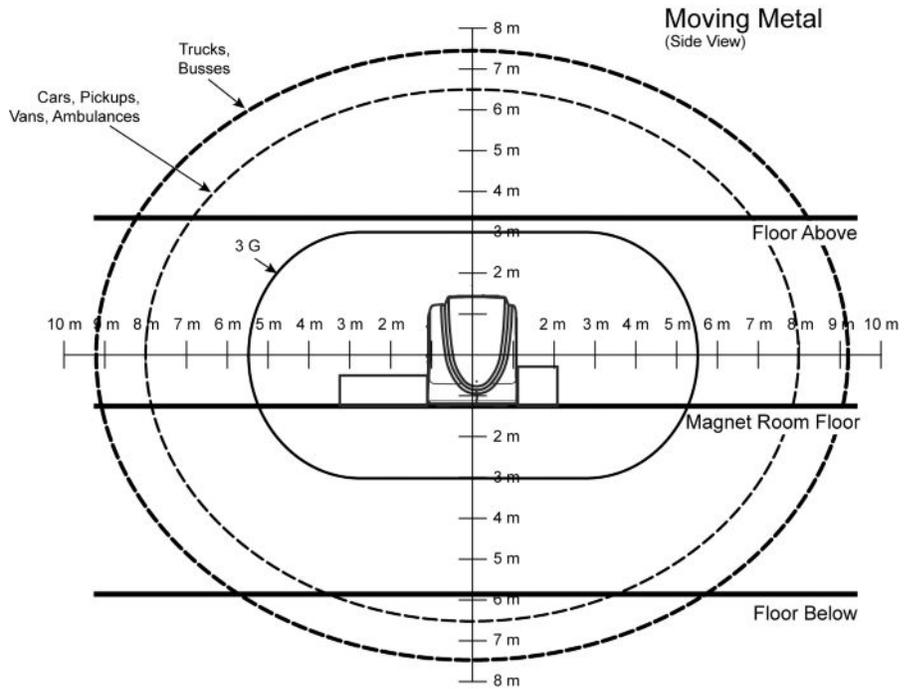


Illustration 2-9: Magnet Moving Metal Sensitivity Line Plot (Top View)

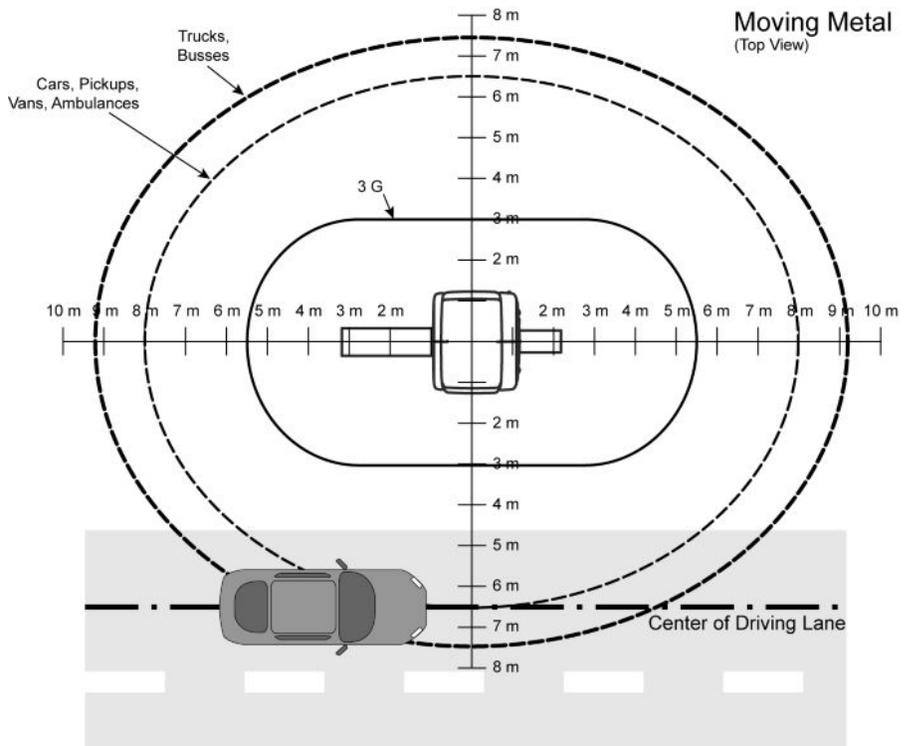


Table 2-6: Magnet Moving Metal Requirements

Metal Objects Category	Definition Of Distance Location	Magnet Minimum Distance Radial X Axial ft (m) See Note 1
Objects 100 - 400 lbs	Distance from isocenter radial x axial	3 Gauss line
Cars, Minivans, Vans, Pickup Trucks, Ambulances	Distance from isocenter measured to center of driving or parking lane radial x axial	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	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 peak-to-peak magnetic field change (DC).	Refer to the notes below:

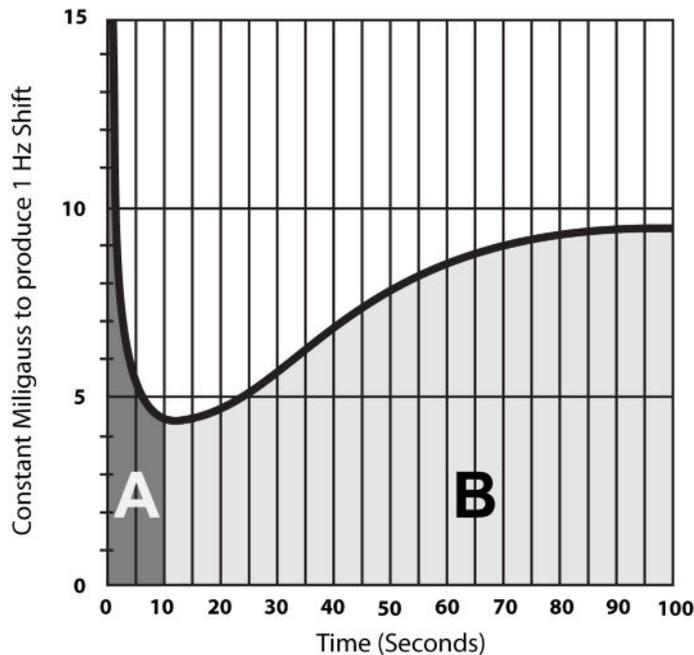
Notes:

1. Radial distances are magnet X and Y axis. Axial distances are magnet Z axis.
2. If the object causes a disturbance for less than 10 seconds (shaded section A) use the peak-to-peak milligauss value shown on the graph.
3. If the object causes a disturbance for more than 10 seconds (shaded section B), use the lowest peak-to-peak milligauss value in that section (i.e., 4.43).

Note: This value may be used in all cases.

Illustration 2-10: Actual Axial Shielding Performance

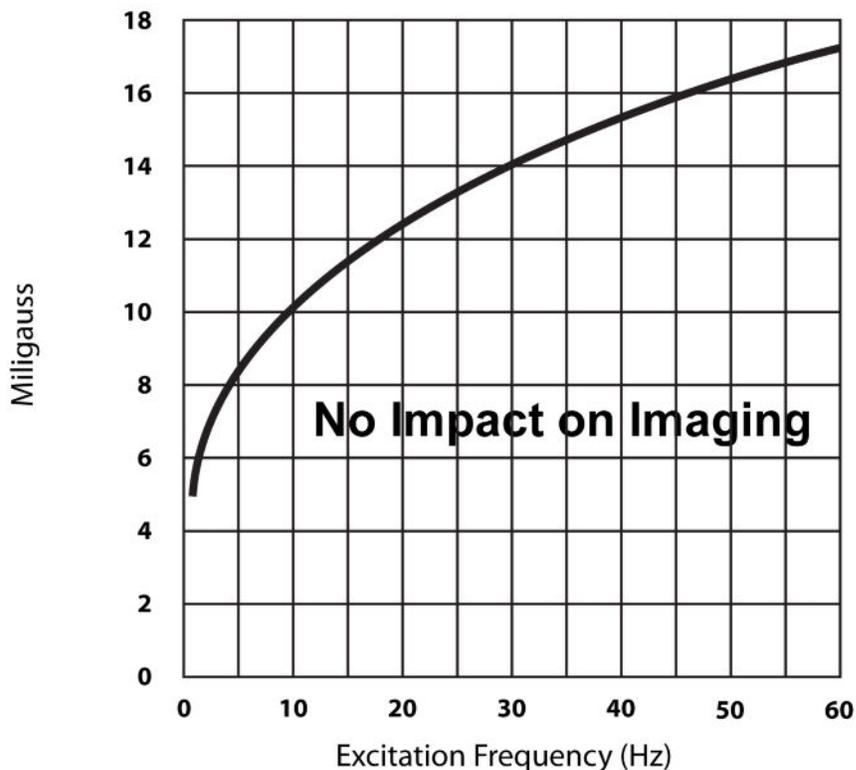
Actual Axial
Shielding Performance



7.3 Electrical Current

1. Electrical current in high voltage power lines, transformers, motors, or generators near the magnet may affect magnetic field homogeneity
2. 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 2-11](#))
3. 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:
 - a. For 3.0T Magnet: $I = (8.55X^2)/S$, where:
 - b. I = Maximum allowable RMS single phase current (in amps) or maximum allowable RMS line current (in amps) in three phase feeder lines
 - c. S = Separation (in meters) between single phase conductors or greatest separation between three phase conductors
 - d. X = Minimum distance (in meters) from the feeder lines to isocenter of the magnet

Illustration 2-11: Magnet Allowable Milligauss vs. Line Frequency for AC Equipment
AC Field EMI Limits



Refer to [Chapter 7, Sample Calculation AC Power Equipment Minimum Distance](#) for additional examples.

7.4 Non-MR System Equipment Sensitivity to Magnetic Fields

This section lists equipment known to be sensitive to high magnetic fields. Recommended limits given 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.

Site plans must include consideration for magnetic field interaction with all customer equipment.

Use the table for reference only. The gauss limits in the table are approximate for that type of equipment. Refer to OEM manuals for the equipment at your site to determine the actual Gauss limits.

Table 2-7: Magnetic Proximity Limits (For Reference Only)

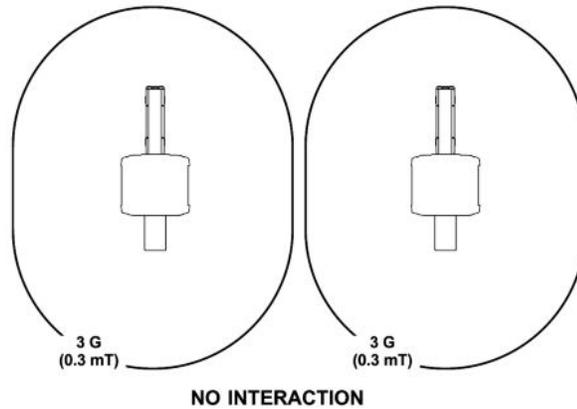
Gauss (mT) Limit	Equipment	
0.5 gauss (0.05mT)	Nuclear camera	
1 gauss (0.1mT)	Positron Emission Tomography scanner	Video display (tube)
	Linear Accelerator	CT scanner
	Cyclotrons	Ultrasound
	Accurate measuring scale	Lithotripter
	Image intensifiers	Electron microscope
	Bone Densitometers	
3 gauss (0.3mT)	Power transformers	Main electrical distribution transformers
5 gauss (0.5mT)	Cardiac pacemakers	Biostimulation devices
	Neurostimulators	
10 gauss (1mT)	Magnetic computer media	Telephone switching stations
	Hard copy imagers	Water cooling equipment
	Line printers	HVAC equipment
	Video Cassette Recorder (VCR)	Major mechanical equipment room
	Film processor	Credit cards, watches, and clocks
	X-ray tubes	
	Large steel equipment, including:	
	Emergency generators	Air conditioning equipment
	Commercial laundry equipment	Fuel storage tanks
	Food preparation area	Motors greater than 5 horsepower
50 gauss (5mT)	Metal detector for screening	Telephones
	LCD panels	
No Limit	Digital Detectors	

8 Multiple MR System Requirements

8.1 Multiple Magnets

When installing multiple magnets, the 3 gauss lines must not intersect or the magnets will be interactive. Contact the GE Healthcare Project Manager of Installation (PMI) for any questions regarding magnetic field interaction.

Illustration 2-12: Two Magnet Installation



8.2 Shared Equipment Rooms

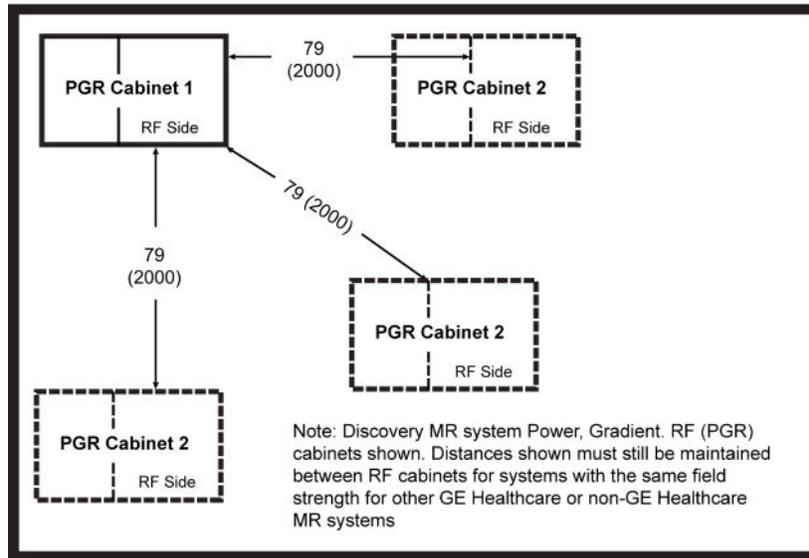
When installing multiple MR systems in a shared equipment room, the following conditions must be met:

1. RF cabinets must be separated by at least 79 in. (2000 mm)
Refer to [Illustration 2-13](#) for cabinet location examples.
2. Cables from different MR systems must not be routed together
3. Penetration panels must be separated by at least 118 in (3000 mm)

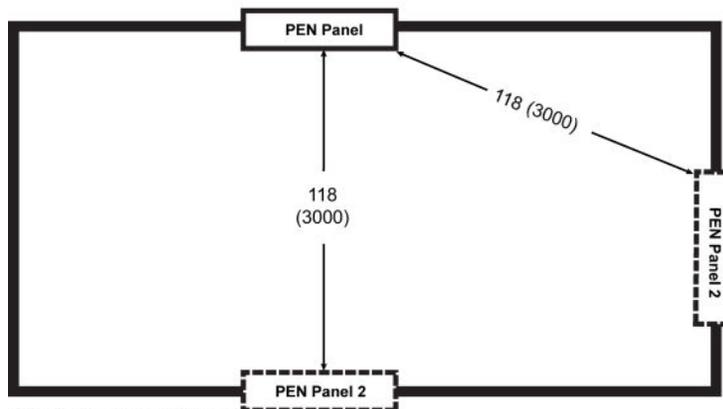
Illustration 2-13: Equipment Room Cabinet Separations (Equipment Room, Top View)

**Shared Equipment Room
 Minimum Separation Distances**

All Dimensions are in inches
 Bracketed dimensions are in millimeters



Shared Equipment Room
 (Top View)



Shared Equipment Room
 (Top View)

9 MR Suite Temperature and Humidity



CAUTION

Equipment Failure

Failure to maintain the required temperature or humidity at all times (i.e., both working and non-working hours) may result in equipment failure, scanning failure, or warranty void.

Ensure the HVAC system has the correct capacity for the room size, equipment heat output, and environmental conditions to maintain proper temperature and humidity.

This section provides temperature and humidity requirements for the MR suite. Specific construction requirements for each room can be found in the following sections:

- Magnet Room
- Equipment Room
- Control Room

9.1 Temperature and Humidity Requirements

Table 2-8: Room Temperature and Humidity Requirements

Room	Temperature		Humidity	
	Range °F (°C)	Change °F/Hr (°C/Hr) ¹	Range %RH	Change %RH/Hr ²
Equipment Room (at Inlet to Equipment)	59-89.6 (15-32) ³	5 (3)	30-70	5
Magnet Room	59-69.8 (15-21)	5 (3)	30-60	5
Operator Room	59-89.6 (15-32)	5 (3)	30-70	5

Notes:

1. Operating temperature gradient limits shall be between -5° F/Hr (-3° C/Hr) and 5° F/Hr (3° C/Hr), when averaged over 1 hour
2. Operating humidity gradient limits shall be between -5% RH/hour and 5% RH/hour, when averaged over 1 hour
3. Maximum ambient temperature is derated by 1 degree C per 300 m above 2000 m (not to exceed 2600 m)

1. The customer is responsible for HVAC system design, purchase, and installation
2. The temperature requirements must not be exceeded at any point during the day (both working or non-working hours)
3. A separate thermostat must be provided for the Magnet room

9.2 Equipment Heat Output Specifications

This section details the heat output for specific components. These heat outputs define the minimum, maximum and an assumed average condition over a 12 hour period. Actual heat output and room temperature may vary due to environmental factors, room insulation, actual usage, and any non-GE Healthcare equipment used in the MR suite. Also, due to large variations in heat loads, the HVAC system may require unloaders, hot gas bypass, and reheat to maintain humidity levels.

Table 2-9: System Heat Output for Air Cooling

Component	Magnet Room BTU/hr (W)			Equipment Room BTU/hr (W)			Control Room BTU/hr (W)		
	Maximum	Average	Idle	Maximum	Average	Idle	Maximum	Average	Idle
Magnet (MAG) and Patient Transport Table (PT)	8,189 (2,400)	4,095 (1,200)	1,915 (561)						
Blower Box	1,535 (450)	1,535 (450)	1,535 (450)						
Penetration Panel Cabinet (PEN)	1,024 (300)	512 (150)	0	10,697 (3,135)	5,349 (1,568)	5,349 (1,568)			
Secondary Penetration Wall (SPW)	0			0					
Main Disconnect Panel (MDP)				901 (264)	450 (132)	450 (132)			
Power, Gradient, RF Cabinet (PGR)				20,940 (6,137)	10,470 (3,068)	8,530 (2500)			
Cryocooler Compressor (CRY)				1,706 (500)	1,706 (500)	1,706 (500)			
Heat Exchanger Cabinet (HEC)				3,412 (1,000)	1,706 (500)	1,706 (500)			
Magnet Monitor (MON)				819 (240)	819 (240)	819 (240)			
Operator Workspace equipment (OW)							4,947 (1,450)		

Table 2-10: System Options Heat Output for Air Cooling

Component	Magnet Room BTU/hr (W)			Equipment Room BTU/hr (W)			Control Room BTU/hr (W)		
	Maximum	Average	Idle	Maximum	Average	Idle	Maximum	Average	Idle
Multi-Nuclear Spectroscopy Cabinet (MNS)				24,584 (7,205)					
BrainWave HW Lite Cabinet (BW)				2337 (685) base (2781 (815) with options)					
CADstream				6049 (1773)	2725 (799)	1209 (354)	Note: May be located in either Equipment or Control Room per site requirements		

10 Facility Coolant Requirements



NOTICE

Equipment Failure. A continuous supply of facility liquid coolant to the Heat Exchanger Cabinet (HEC) is required at all times for proper system operation. Failure to provide liquid coolant with the requirements listed in this section may cause equipment failure.

10.1 Heat Exchanger Cabinet (HEC) Coolant Requirements

1. The facility must provide liquid coolant to the Heat Exchanger Cabinet (HEC)
2. The facility must provide pipe/hose, filter, and connectors to the HEC
3. The facility must provide an uninterrupted supply of liquid coolant to the HEC at magnet delivery
4. The vertical distance between the coolant connection points of the HEC and the Gradient Coil must be less than 196.8 in. (5 meters)
5. The HEC, CRY, and PGR Cabinets must be located on the same floor
6. The customer must provide and install an in-line flow meter on either the supply or return facility coolant hose. The flow meter must be capable of visually displaying volumetric flow between 20 and 50 gpm (76 and 189 L/min) and configured for the properties of the cooling fluid in use

Table 2-11: Facility Liquid Coolant Requirements

Parameter	Requirements
Availability	Continuous
Antifreeze	no more than 40% propylene glycol
Minimum Flow	30 gpm (114 L/min)
Maximum Flow	35 gpm (132 L/min)
Maximum Pressure Drop in HEC at Minimum Flow	34.8 psi (2.4 bar) with 40% propylene glycol-water; 1021 kg/m ³ density
Maximum Pressure Drop in HEC at Maximum Flow	47.8 psi (3.3 bar) with 40% propylene glycol-water; 1021 kg/m ³ density
Temperature rise at Minimum Flow	17.3°F (9.6°C) with 40% propylene glycol-water; 3730 J/(kg K) specific heat; 1021 kg/m ³ density; 70 kW heat
Temperature rise at Maximum Flow	15.1°F (8.4°C) with 40% propylene glycol-water; 3730 J/(kg K) specific heat; 1021 kg/m ³ density; 70 kW heat
Maximum Inlet Pressure to HEC	87 psi (6 bar)
Chiller Size	Minimum 70 KW
Condensation Protection	Facility Plumbing to the HEC must be properly routed and insulated to prevent equipment damage or safety hazards
Minimum Continuous Heat Load	7.5 KW
Inlet Temperature	42.8 to 53.6°F (6 to 12°C) measured at the inlet to the HEC
Customer supplied feeder hose (from main water supply to HEC)	1.5 inch (38.1 mm) minimum hose inside diameter
Hose connections to the HEC	1.5 inch (38.1 mm) male NPT

Illustration 2-14: Allowable Facility Water Temperature and Flow

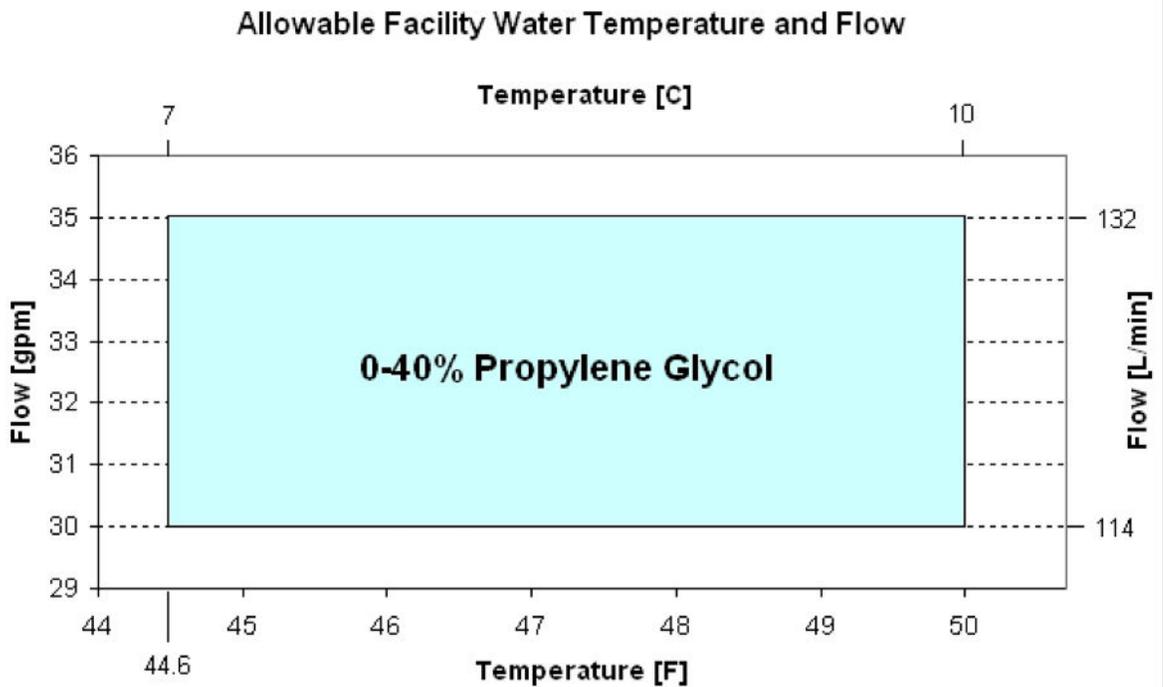


Illustration 2-15: Pressure Drop through HEC (40% PGW, 1021 kg/m³)

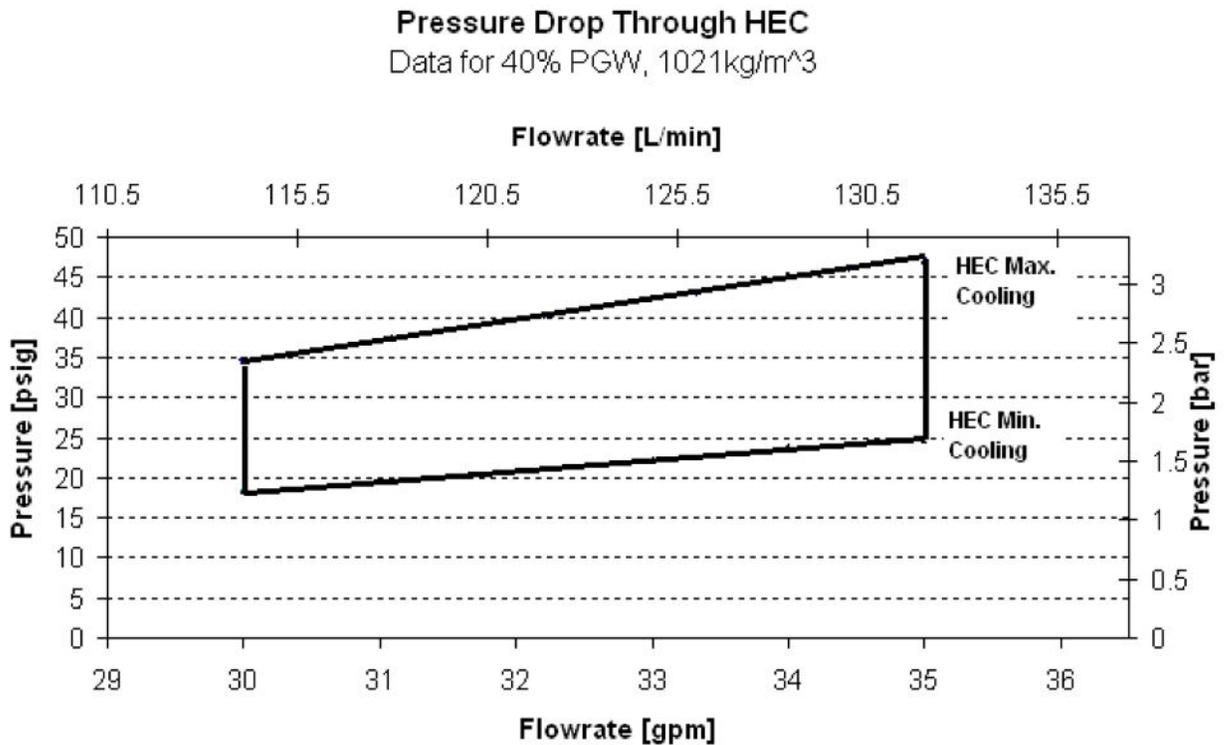


Illustration 2-16: Temperature Rise through HEC (40% PGW, 3730 J/kg-K, 1021 kg/m³)

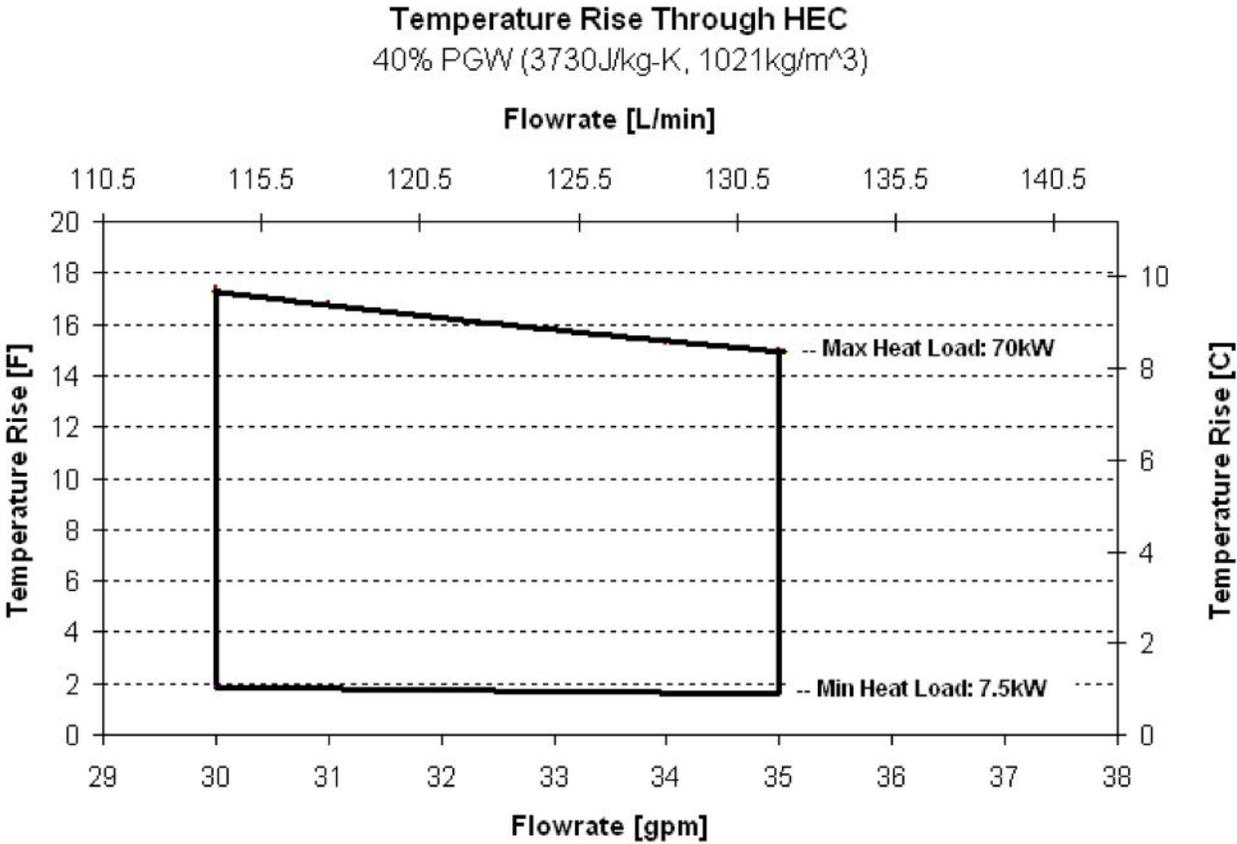


Illustration 2-17: Temperature Rise through HEC (0% PGW, 4182 J/kg-K, 997 kg/m³)

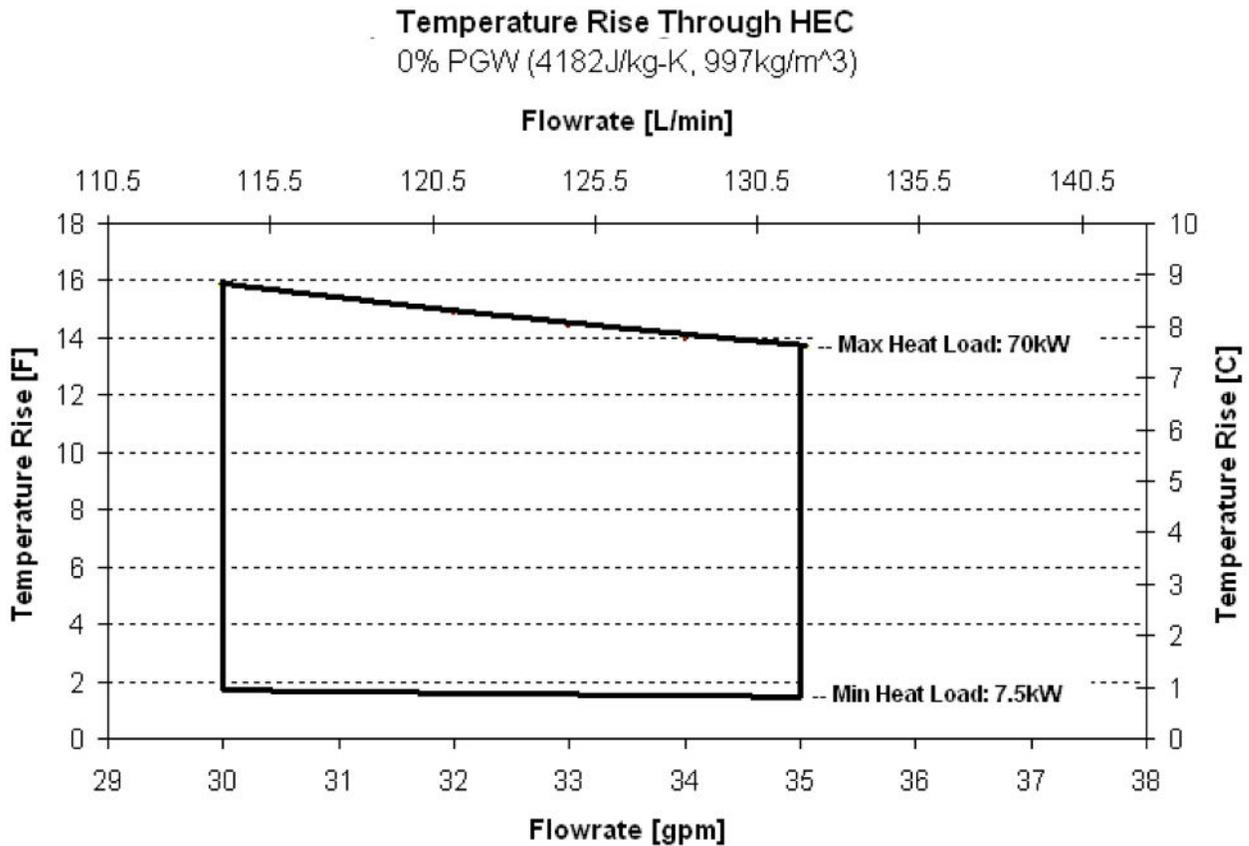
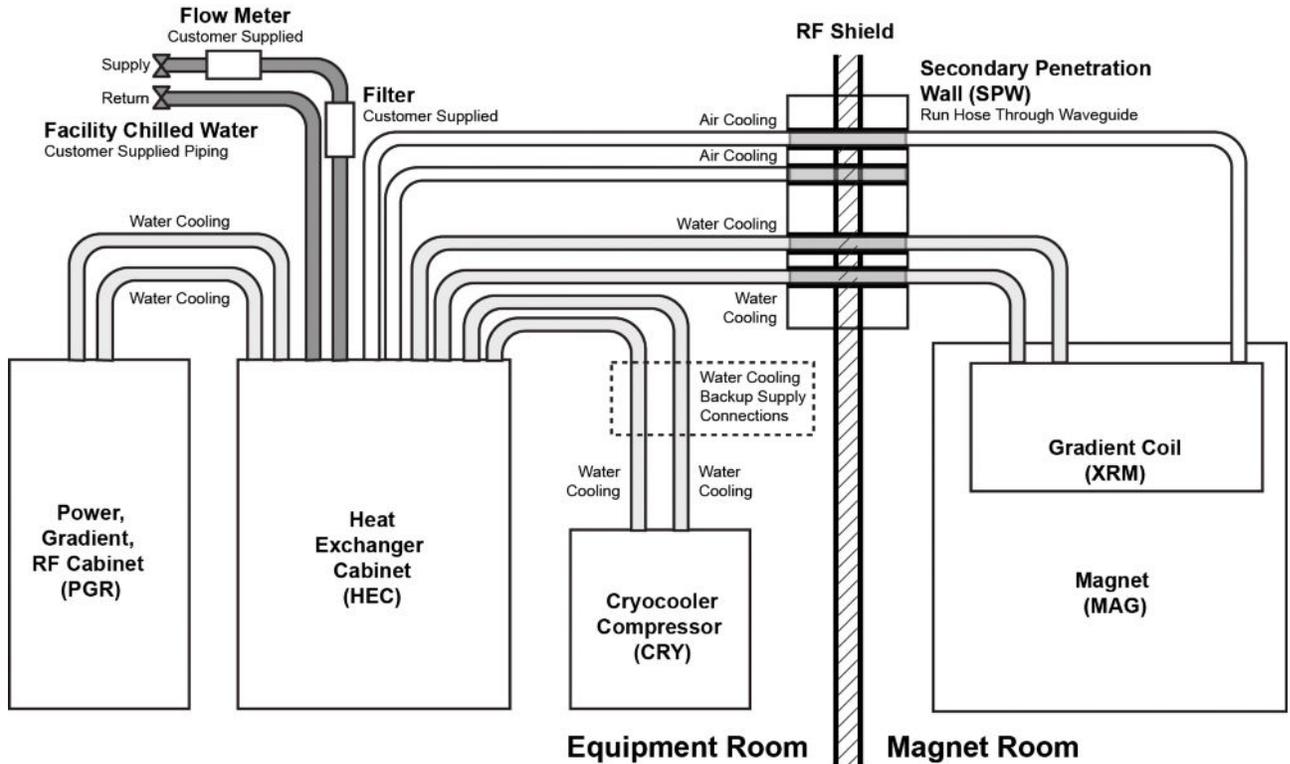


Table 2-12: Facility Water Quality Requirements

pH Value	6.5 to 8.2 at 77 °F (25 °C)
Electrical Conductivity	< 0.8 mmho/cm
Chloride Ion	< 200 ppm
Sulfate Ion	< 200 ppm
M-Alkalinity	< 100 ppm
Total Hardness	< 200 ppm
Calcium Hardness	< 150 ppm
Ionic Silica	< 50 ppm
Iron	< 1.0 ppm
Copper	< 0.3 ppm
Sulfide Ion	None, not detectable
Ammonium Ion	< 1.0 ppm
Residual Chlorine	< 0.3 ppm
Free Carbon Dioxide	< 4.0 ppm
Stability Index	6.0 to 7.0

Suspended Matter	< 10 ppm
Particle Size	< 100 micron (with field changeable filter)

Illustration 2-18: MR System Water Cooling Block Diagram



10.2 Emergency Facility Coolant Requirements

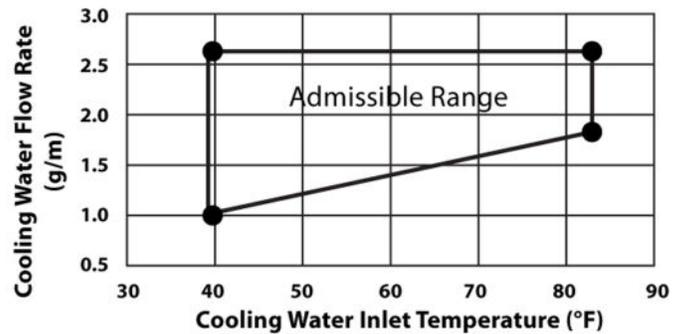
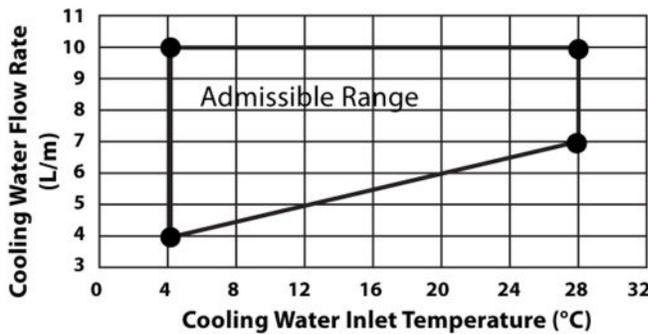
The facility may provide an optional backup coolant supply in one of the following configurations:

1. Full system functionality: Backup coolant is routed through the HEC and meets all HEC coolant requirements in [Section 10.1](#)
2. Cryocooler operation only: Backup coolant is routed through the HEC and meets all HEC coolant requirements except temperature. Temperature must meet the requirements listed in [Illustration 2-19](#). (Note: Full HEC flow requirements must still be met. The HEC will split off 6 L/min to the cryocooler compressor)
3. Cryocooler operation only: Coolant may be routed directly to the Cryocooler compressor at the location indicated in with the following requirements:
 - a. The facility is responsible for coolant, pipe/hose, filters, and connectors to supply the coolant to the CRY
 - b. The emergency coolant supply must isolate the Cryocooler Compressor and not back-feed the HEC
 - c. Coolant must meet all other HEC coolant requirements listed in [Table 2-12](#)

- d. The supplied water cooling hoses between the HEC and CRY are Parker Push-lok 801-8, 0.5 in. I.D.
- e. The charts below shows the coolant flow rate and temperature requirements for the Cryocooler Compressor:

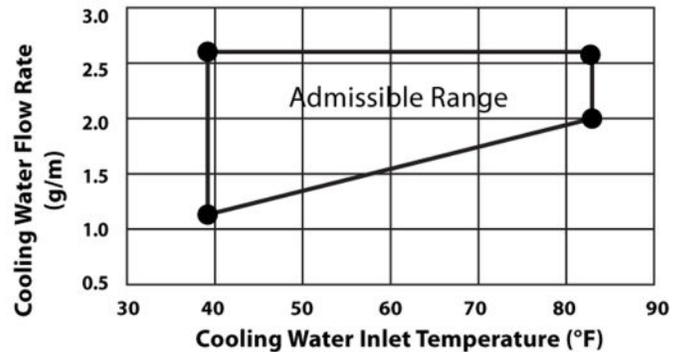
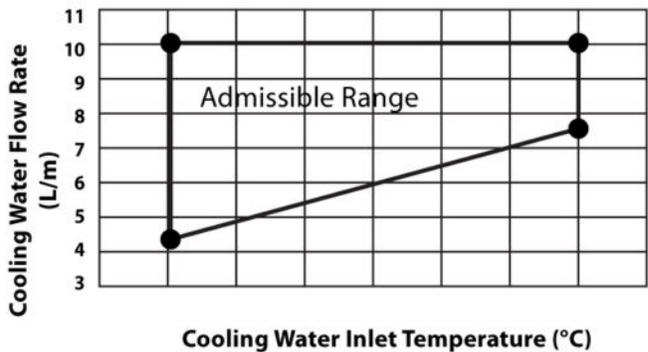
Illustration 2-19: Cryocooler Water Cooling Requirements

For Water

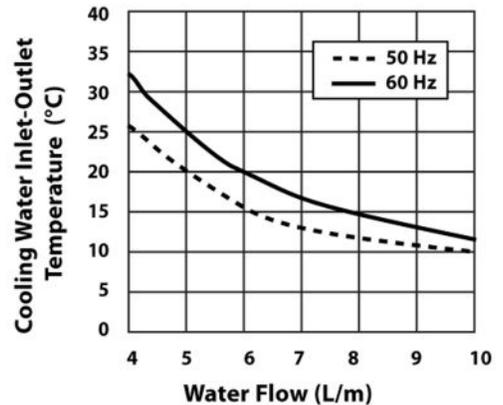
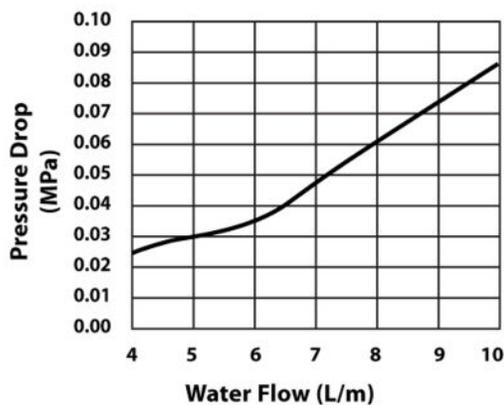


For Antifreeze

(50/50% mixture of water and ethylene glycol)



Pressure Drop and Temperature Rise



11 MR Suite Electrical Requirements

11.1 General Electrical Requirements

1. Customer is required to install a Main Disconnect Panel (MDP)
 - a. GEHC supplied MDP option, M7000WL
 - b. Customer Supplied Option
 - i. MDP Design Requirements (see [Section 11.2](#))
 - ii. MDP Design Setup (see [Illustration 2-20](#))
2. The facility must provide system power to the MDP
3. All associated transformers and cables must be correctly sized for system power requirements
4. The facility must provide cabling from the MDP to the Power, Gradient, RF (PGR) cabinet and from the MDP to the Heat Exchanger Cabinet (HEC)

Table 2-13: Facility Power Requirements

Component	Parameter	Requirements	
At Main Disconnect Panel (MDP)	Voltage / Frequency	480 VAC	60 ±3 Hz
		415 VAC	50 ±3 Hz, 60 ±3 Hz
		400 VAC	50 ±3 Hz, 60 ±3 Hz
		380 VAC	50 ±3 Hz, 60 ±3 Hz
	Daily Voltage Variation	Customer to provide +10% / -10% from nominal at MDP input under all line and load conditions. This includes variation of power source and transmission losses up to the MDP.	
	Phase	Input power to the MDP may use one of the following configurations: <ul style="list-style-type: none"> • A 3 phase solidly grounded WYE with Ground (4-wire system) If a neutral wire exists, it must be terminated prior to or inside the MDP <ul style="list-style-type: none"> • A 3 phase floating DELTA with Ground (4-wire). Do not connect a corner grounded DELTA source Note: Some UPS options may require a neutral (refer to manufacturer documentation for requirements).	
	Phase Balance	Difference between the highest phase line-to-line voltage and the lowest phase line-to-line voltage must not exceed 2%	
Power Quality	Recommended THD of less than 2.5%		
Facility Zero Voltage Reference Ground	<ul style="list-style-type: none"> • The facility ground for the MR system must originate at the system power source (i.e., transformer or first access point of power into the facility) and be continuous to the MR system Main Disconnect Panel (MDP) in the room. • Main facility ground conductor to Main Disconnect Panel (MDP) must be appropriately sized insulated copper wire. • The main facility ground to the Main Disconnect Panel (MDP) must meet local codes. 		

Component	Parameter	Requirements	
	Power Availability	Continuous facility power is required at all times for operation of the Cryocooler (CRY) to minimize cryogen consumption.	
Service receptacle in Magnet Room	Voltage / Frequency	100-120 VAC 50/60 Hz	Receptacle required for small power tools. Local voltage and portable transformers for voltage values.
	Phase	1	
	Maximum Amps	2.0	

Table 2-14: System Power Demand

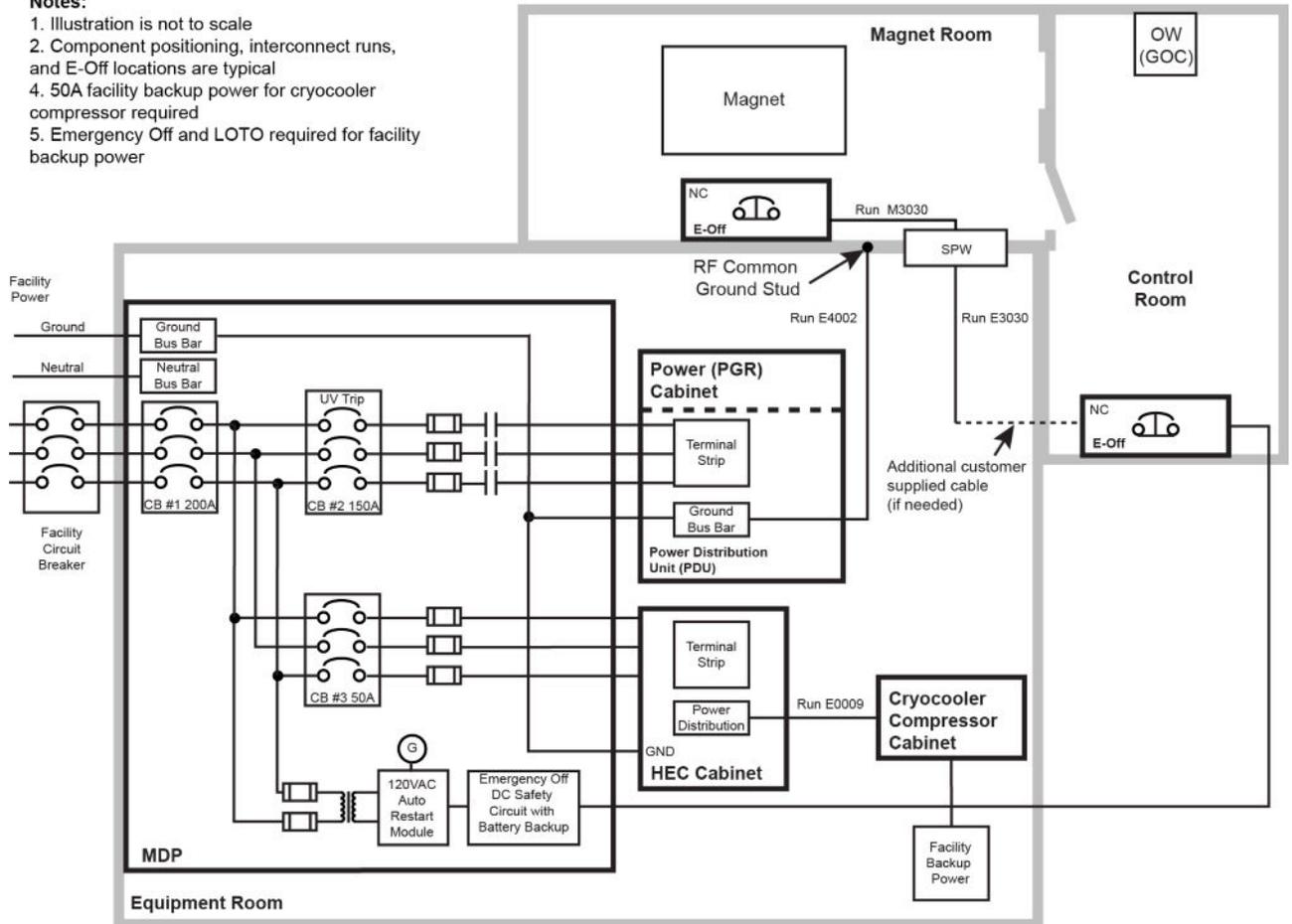
Equipment	Power Draw (kVA)
PDU Continuous Power	79
PDU 5 Second Power	103
HEC Continuous Power (including Cyro)	20
Cryo Compressor Continuous Power	9
Total System 5 Second Power	123
Total system Continuous Power	99
Standby Consumption (no scan) (PDU, HEC, CRY)	< 17

Illustration 2-20: MR System Main Disconnect Panel (MDP) Set-Up

Main Disconnect Panel (MDP)

Notes:

1. Illustration is not to scale
2. Component positioning, interconnect runs, and E-Off locations are typical
4. 50A facility backup power for cryocooler compressor required
5. Emergency Off and LOTO required for facility backup power



NOTE: Optional customer supplied backup power must be provided to the facility breaker (see Standby Power Demand for minimum power requirement)

11.2 Main Disconnect Panel (MDP) Requirements



WARNING

**PERSONNEL INJURY OR EQUIPMENT DAMAGE
 CUSTOMER SUPPLIED MDP MUST HAVE CORRECTLY SIZED WIRES AND
 RATED COMPONENTS TO MEET THE MR SYSTEM POWER
 REQUIREMENTS.**



WARNING

PERSONNEL INJURY OR EQUIPMENT DAMAGE
IF THE HEC POWERS THE CRYO COMPRESSOR, THE MDP EMERGENCY-OFF FUNCTION MUST DISABLE THE AUTO RESTART FUNCTIONALITY WHEN ACTUATED.

1. MDP to provide Auto-Restart. Auto-Restart to provide power to the Cryo compressor. See [Table 2-14](#)
2. Manual Restart Capability
 - a. A low voltage release feature to disconnect the PDU upon power loss
 - b. The PDU circuit must require a manual restart when power is reapplied to the main panel
3. Emergency Off Circuit
 - a. The MDP must have an emergency off control circuit that disables power to the entire MR system
 - b. The emergency off circuit must be actuated by remotely located push button(s) (see [Illustration 2-20](#))
 - c. The wire size for the emergency-off circuit is 12–22 AWG and is supplied by the customer.
 - d. The manual reset must be required to restore power to the entire system
 - e. Two sets of isolated, normally closed contacts that open when an emergency off button is actuated must be provided for optional accessories
4. Lock-out/Tag-out
 - a. The MDP break must have capability to lock-out for single point Lock-out/Tag-out requirements
 - b. A standard sized hasp for lock-out
5. The MDP must be marked as required by national/local regulations
6. The MDP must provide terminations for all grounds entering, leaving and residing within the panel
7. The MDP must provide terminations of appropriate size for all power wiring entering and leaving the panel
 - a. Terminal blocks that can accept 3/0 AWG on the main panel
 - b. Terminal blocks to accept 8 AWG on the HEC
 - c. Terminal blocks to accept 1/0 AWG on the PDU
8. The optional GE Healthcare DV MDP consists of the following:
 - a. A 3-pole 200A main circuit breaker rated for the total current of all the sub-breaker circuits

- b. A 3-pole 150A circuit breaker rated for the current of the PDU circuit
- c. A 3-pole 50A circuit breaker rated for the current of the HEC circuit
- d. All circuit breakers have a short circuit current interrupting rating of 25000 Amps
- e. Auto restart on the HEC circuit
- f. Emergency off circuit including 2 pushbuttons to be installed external to the MDP
- g. Terminal blocks that can accept 3/0 AWG on the main, 8 AWG on the HEC and 1/0 AWG on the PDU
- h. Input neutral terminal block
- i. Multiple ground terminal blocks as required by panel design
- j. Listed and labeled by a Nationally Recognized Testing Lab (NRTL) in accordance with UL 508A and IEC/EN 60204–1 and bear the CE Marking in accordance with the EU Low Voltage Directive (2006/95/EC) and Electromagnetic Compatibility Directive (2004/108/ED).
- k. Power on indicators
- l. Two isolated, normally open contact pairs that open when e-OFF is pressed for use with optional accessories

11.3 Emergency Power Backup Requirements

If facility power is interrupted, the cryogen compressor and MagMon3 must continue to operate. Thus, the facility must provide backup power to these units.

NOTE: The compressor requires emergency chilled water backup defined in the [Emergency Facility Coolant Requirements](#).

- The facility must provide a dedicated, single power supply to the compressor
- The MagMon3 must always have power, including emergency power (110V / 220V, 2A). Refer to [Chapter 4, Magnet Monitor \(MON\) Requirements and Specifications](#).
- Emergency Off Circuit (EOF) is required for the emergency backup to the compressor. LOTO is also required for the power source between the generator and compressor.
- The customer must provide a transfer switch to remove the primary power source from the compressor when in emergency backup power mode.

Table 2-15: Emergency Power Requirements to Cyrocooler Compressor

Power Line Voltage	AC 380, 400, 415V / 50 Hz, 3 phase (3W+PE) AC 460, 480V / 60 Hz, 3 phase (3W+PE) Commercial Power Source
	  <p>DO NOT USE AN INVERTER FOR THE MAIN POWER SOURCE.</p>

Operating Current	Max. 13A (Both 50 and 60 Hz)
Starting current	75 / 80 A (50/60 Hz)
Minimum Circuit Ampacity	17A
Maximum Fuse or Circuit Breaker Size	30A
Power Requirement	Minimum 9 kVA
Power Consumption	Max. 8.3 kW / Steady State 7.5 kW at 60 Hz Max. 7.2 kW / Steady State 6.5 kW at 50 Hz

12 MR System Shipping and Receiving



NOTICE

All shipping dimensions and weights are approximate and may vary based on ship-to location, required rigging, or other requirements. Some shipping or access routes may have requirements in addition to those listed in this section. Contact the GE Healthcare Project Manager of Installation (PMI) to verify magnet shipping, rigging, and access.

12.1 Receiving Requirements

1. The customer must provide an area for unloading system components from the truck and delivering to the MR suite

NOTE: Contact the GE Healthcare Project Manager of Installation (PMI) for a list of experienced rigging companies.

2. The customer is responsible for ensuring:
 - a. All floors along the route will support the weight of the magnet (GE Healthcare recommends a structural analysis)
 - b. Doors or other openings are sufficiently wide to allow passage
 - c. Sufficient room is provided for any required rigging tools

12.2 Facility Delivery Route Requirements

The following table lists the delivery dimensions of system components. Upon delivery, verify the component dimensions and weight. The delivery route must be planned to accommodate the dimensions listed.

Table 2-16: Delivery Route Requirements

Component	Width		Depth		Height		Weight		Notes
	in	mm	in	mm	in	mm	lbs	kg	
Magnet	See Magnet shipping dimensions Table 2-17								
Cryogen	Dimensions vary depending on dewar type used. Verify with cryogen supplier.								
PGR Cabinet	78.75	2000	34.3	871	83	2108	3459	1569	Cabinets are moved with dollies attached to each side (adding 20 in. (520 mm) to the width and 180 lbs (82 kg) to the weight). Cabinets must be raised to remove the pallet but may be lowered almost to floor level while moving.
HEC Cabinet	55.2	1402	34.3	871	75	1905	1130	513	
PEN Cabinet	44.1	1120	39.4	1001	76	1930	819	371	

12.3 MR System Component Shipping Specifications

MR system component shipping dimensions and weight are listed below:

Table 2-17: MR System Component Shipping Specifications

MR Component	W x D x H		Weight		Notes
	in.	mm	lbs	kg	
Magnet (as shipped but without lifting bars) — See Illustration 2-21	89 x 84 x 93	2261 x 2127 x 2362	25,709	11,661	Tarped wood frame
Magnet (as shipped with lifting bars)	89 x 94 x 93	2261 x 2388 x 2362	25,969	11,779	
Magnet (Crated for International Shipping)	96 x 114 x 96	2438 x 2896 x 2438	28,169	12,777	
Magnet Accessory Equipment	48 x 48 x 28	1219 x 1219 x 711	400	182	Crate
VibroAcoustic Damping Kit	36 x 65 x 12	914 x 1651 x 305	575	261	Box on pallet
Cryocooler Compressor	26 x 28 x 42	660 x 711 x 1067	275	125	Pallet 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	141	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	2388 x 737 x 965	618	280	Pallet
Power Gradient RF Cabinet (PGR) (Domestic)	67.25 x 41 x 88	1701 x 1041 x 2235	3654	1657	Pallet
Power Gradient RF Cabinet (PGR) (International)	68.25 x 42 x 92	1727 x 1067 x 2337	3654	1657	Pallet
Penetration Panel Cabinet (PEN) (Domestic)	43.75 x 35.25 x 80.75	1117 x 895 x 2051	710	322	Pallet
Penetration Panel Cabinet (PEN) (International)	44.75 x 35.25 x 84.75	1137 x 895 x 2153	770	350	Pallet
Heat Exchanger Cabinet (HEC) (Domestic)	45 x 44.75 x 80	1143 x 1137 x 2032	1075	488	Pallet
Heat Exchanger Cabinet (HEC) (International)	46 x 45.75 x 84	1168 x 1162 x 2134	1150	522	Pallet
Secondary Penetration Wall	21 x 24 x 64	533 x 610 x 1626	101	46	Pallet with cardboard cover
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	610 x 889 x 787	243	110	Wood pallet with cardboard cover
Operator Workspace Display	27 x 33 x 27	686 x 838 x 686	125	57	Pallet
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

Table 2-18: MR System Optional Component Shipping Specifications

4kw MNS Amplifier Cabinet	23 x 39 x 50	584 x 991 x 1270	600	272	On cabinet casters, wrapped with plastic
8kw MNS Amplifier Cabinet	24 x 37 x 71	610 x 940 x 1803	180	82	On cabinet casters, wrapped with plastic
BrainWaveHW Lite Cabinet	24 x 23 x 72	610 x 584 x 1829	320	145	On cabinet casters, wrapped with plastic

Illustration 2-21: Magnet Dimensions (as Shipped)

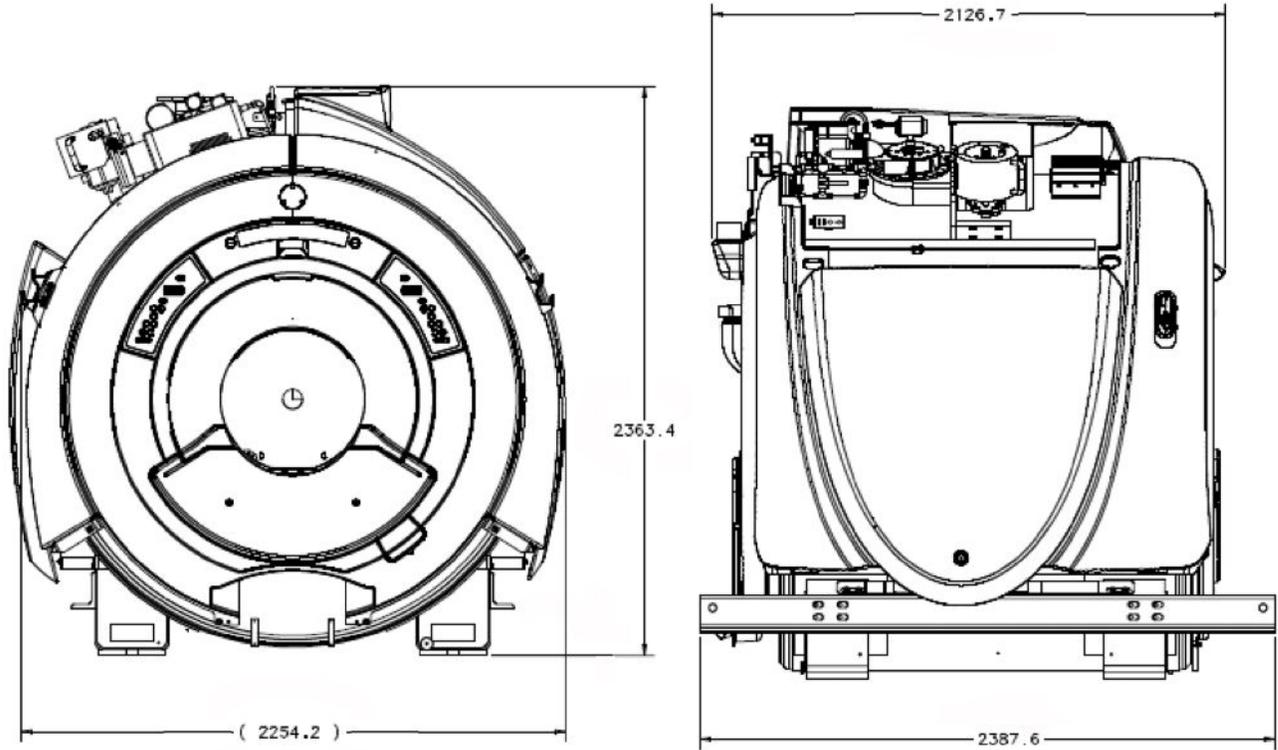
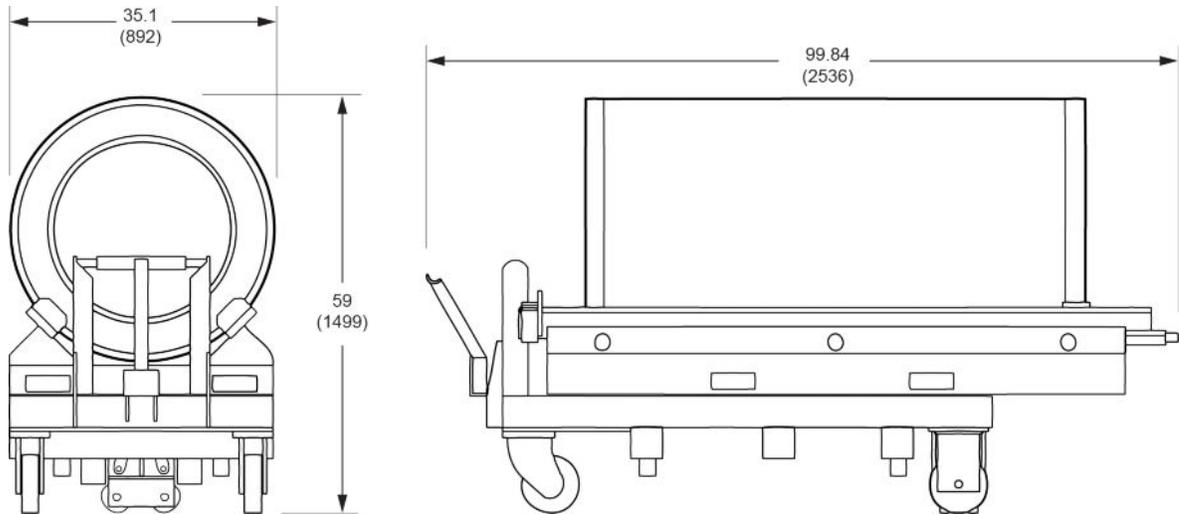


Table 2-19: MR System Component Replacement Shipping Specifications

Component	W x D x H		Weight		Notes
	in.	mm	lbs	kg	
Split Bridge	21.5 x 77.3 x 7	546 x 1963 x 178	40	18	
Power Gradient RF Cabinet (PGR) (Domestic)	67.25 x 41 x 88	1708 x 1041 x 2335	3654	1657	Pallet
Power Gradient RF Cabinet (PGR) (International)	68.25 x 42 x 92	1734 x 1069 x 2336	3654	1657	Pallet
3.0T RF Amplifier	19 x 27 x 24	483 x 686 x 610	400	181	Pallet
HEC Pump	41 x 25 x 39	1041 x 635 x 991	220	100	
HEC Blower	41 x 25 x 39	1041 x 635 x 991	150	68	

Component	W x D x H		Weight		Notes
	in.	mm	lbs	kg	
Replacement RF Body Coil	30 x 30 x 60	762 x 762 x 1524	155	70	Replacement coil is shipped in a protective case. Weight & dimensions are for coil & case.
Replacement XRM Gradient Coil Assembly on a Shipping Cradle/Cart	39 x 99.84 x 59 See Note	991 x 2536 x 1499	3837	1742	Initial Gradient Coil Assembly is shipped installed in the Magnet. Shipping/installation cart is used to install replacement coil assembly only.
Gradient Coil Replacement Tool Kit Crate	30 x 86 x 28	762 x 2184 x 711	750	340	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).

Illustration 2-22: Gradient Coil Cart



NOTE: Dimensions are in inches. Bracketed dimensions are in millimeters.

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Chapter 3 Magnet Room

1 Magnet Room Introduction

The Magnet Room is best understood as a series of layers, or “rooms within a room.” Each of these rooms has a specific function and associated requirements. All requirements in this chapter must be followed to ensure safe and proper operation of the MR system.

1. The Magnetic shielded room contains the MR Magnet fringe field within a confined space. A site survey is required to determine magnet shield requirements (not all sites require magnetic shielding). Because of the added cost of magnetic shielding, room location should be carefully considered.
2. The Acoustic room is a layer used to help attenuate the noise produced during a scan. An acoustic engineer is strongly recommended to assess the environment.
3. The RF Shielded room is critical to the proper MR system operation. RF shielding prevents interaction of external RF radiation with MR system operation and it also prevents MR system RF radiation from interfering with external systems, such as aircraft control. Special care must be used when installing all fixtures penetrating the RF shield (e.g., vents, electrical conduit, penetration panels) to ensure the integrity of the RF shield is maintained.
4. The Finished room includes the wall coverings, ceiling tile, ceiling grid, other fixtures, Magnet (MAG) and Patient Table (PT). When planning the finished room, ensure the following:
 - a. All building codes are met (such as maintaining egress routes)
 - b. Items which may generate or create RF interference (including florescence lighting) are not allowed for installation within the Magnet room
 - c. Customer is responsible for the selection and installation of all locally required safety devices (e.g., smoke detectors, oxygen monitors, etc.)
 - d. Ferrous or metallic items which could become projectiles when the magnet is installed (including wall coverings, ceiling tile, ceiling grid, or other fixtures) are not used or properly secured

Illustration 3-1: Magnet Room Layers

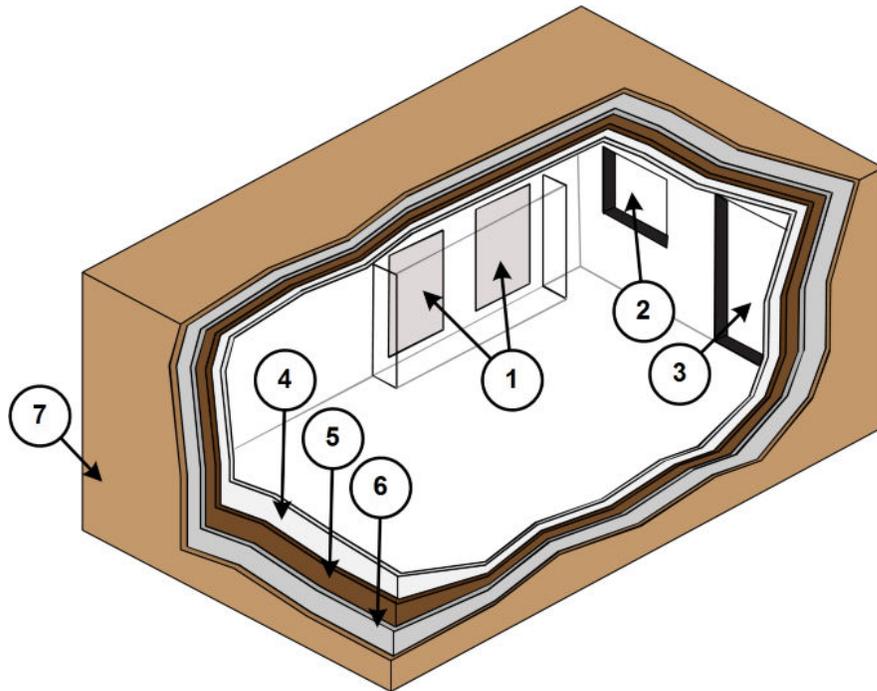


Table 3-1: Magnet Room Layers Notes

1	Penetration panels	5	RF shielding
2	Window	6	Acoustic barrier
3	Door	7	Magnetic shielding
4	Finished room		

2 Magnet Room Structural Requirements

This section lists the structural requirements that must be considered when performing site evaluation and planning of the Magnet room.

2.1 Overview

1. When preparing a building plan or evaluating a potential site for an MR system, care should be taken to ensure the MR suite will not interact with the surrounding environment (i.e., magnetic, acoustic, environmental steel, and vibration)
2. The customer is responsible for vibration testing required to verify suitability of a proposed site. All test results and any questions regarding testing, results, or analysis must be forwarded to the GE Healthcare Project Manager of Installation (PMI)

2.2 Environmental Steel Limits

A static magnetic field extends in a three-dimensional space around the magnet isocenter. Environmental steel within the static magnetic field affects the uniformity (or homogeneity) of the field. Field uniformity is critical to both image quality and chemical shift analysis (spectroscopy). An analysis of the environmental steel is required within a 5 feet (1.524 meters) spherical radius of the magnet isocenter. Environmental steel includes ferrous pipes, beams, concrete rebar, or any other structural steel in the floors, walls, or ceiling.

The following floor items must be limited per [Table 3-2](#).

1. Non-movable steel construction material such as rebar and metal decking
2. Existing or proposed RF/magnetic shielding or shim plates
3. [Table 3-2](#) defines the limits of use as a guideline to help the customer understand allowable amounts of ferrous rebar, steel decking, or other components as they design the MR suite and magnet room floor structure
4. The customer must provide detail defining ferrous material below the magnet to the Project Manager so the GE Healthcare MR Siting and Shielding team can review for compliance.

Table 3-2: Steel Mass Limits to Magnet Isocenter (10 ft. x 10 ft. Area Under Magnet)

Limits Of Steel Mass lbs/ft ² (kg/m ²)	Distance From Magnet Isocenter in. (mm)	Distance Below Top Surface Of Floor in. (mm)
0 (0)	0-45 (0-1143)	0-3 (0-76)
2 (9.8)	45-47 (1143-1194)	3-5 (76-127)
3 (14.7)	47-52 (1194-1321)	5-10 (127-254)
8 (39.2)	52-55 (1321-1397)	10-13 (254-330)
20 (98.0)	55+ (1397+)	13+ (330+)

2.3 Vibration Requirements

Excessive vibration can affect MR image quality. Vibration testing must be performed early in the site planning process to ensure vibration is minimized. Both steady state vibration (exhaust fans, air conditioners, pumps, etc.) and transient vibrations (traffic, pedestrians, door slamming, etc.) must be assessed (see [Illustration 3-2](#)). Specific requirements for vibration mitigation, include:

1. The Magnet (MAG) cannot be directly isolated from vibration. Any vibration issue must be resolved at the source
2. MR Suite HVAC must have vibration isolation
3. A vibration analysis must be performed at the proposed site with the results (and any mitigation) forwarded to the GE Healthcare Project Manager of Installation (PMI). See the [Chapter 7, MR Site Vibration Test Guidelines](#)
4. A transient vibration test must only be performed after a steady-state test has been performed and all steady-state sources of vibration have been mitigated
5. Transient vibration levels above the specified limits in the [Chapter 7, MR Site Vibration Test Guidelines](#) must be analyzed
6. Any transient vibration that causes vibration to exceed the steady-state level must be mitigated
7. Vibration test consultant must account for non-mechanically induced signals such as test equipment instabilities, thermal drift or RF interference

Illustration 3-2: Magnet Steady State Vibration Specifications

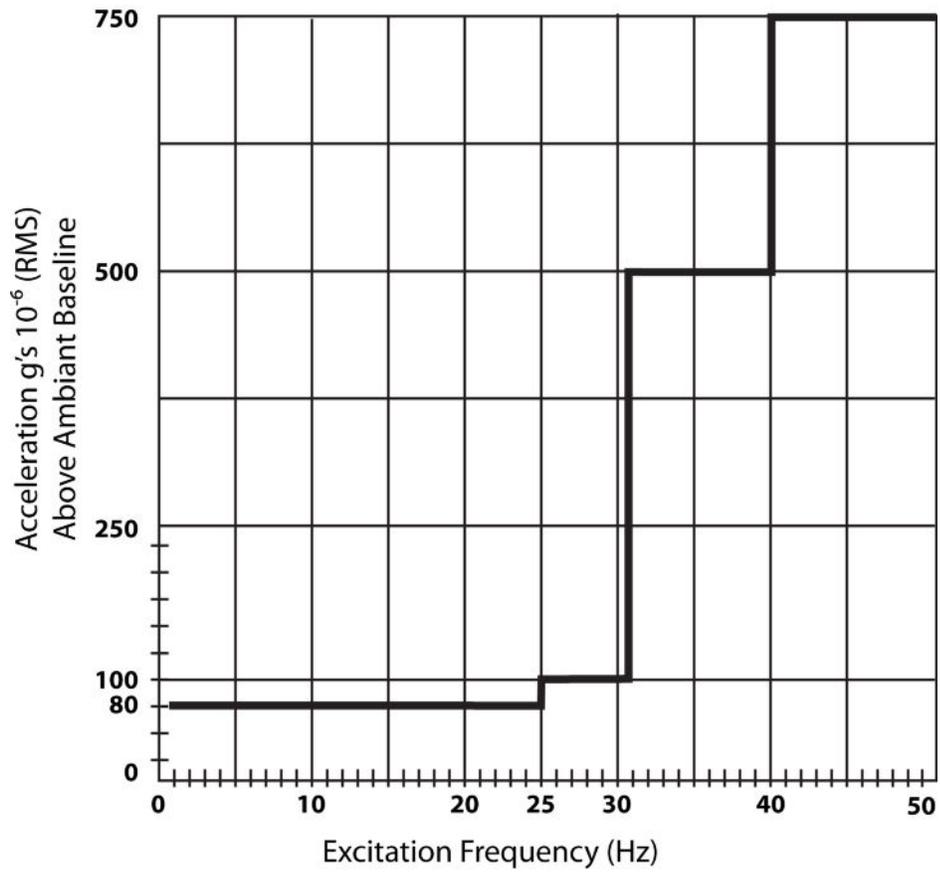


Table 3-3: Magnet Steady State Vibration Specifications

Acceleration (g) 10^{-6} (RMS) above ambient baseline	Excitation frequency (Hz)
65	5 – 8
70	8 – 25
100	25 – 29
300	29 – 33
500	33 – 40
750	40 – 45

3 Magnetic Shielded Room Requirements



NOTICE

All sites, including upgrade sites, must be evaluated for magnetic shielding requirements. Existing magnetic shielding at an upgrade site may not be sufficient for the new system. Contact the GE Healthcare Project Manager of Installation (PMI) to request a site evaluation.

Magnetic shielding prevents interaction between the magnet and nearby sensitive devices. Because of the added cost of magnetic shielding, room location should be carefully considered (not all sites require magnetic shielding). See [Chapter 2, MR Suite Magnetic Field Specifications](#) for detailed magnetic proximity limit information.

1. The GE Healthcare Project Manager of Installation (PMI) works with the customer to coordinate the magnetic shielding site evaluation
2. If required, the GE Healthcare Project Manager of Installation (PMI) coordinates the delivery of the magnetic shielding design
3. The customer is responsible for installation of all magnetic shielding

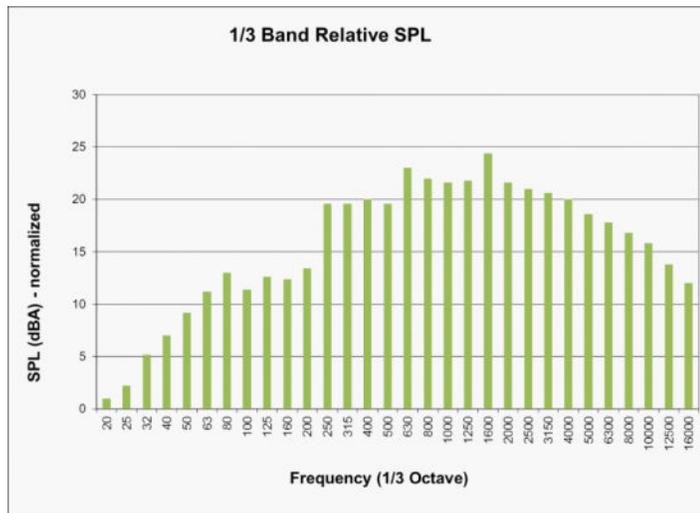
4 Acoustic Room Specifications

The acoustic room is a layer used to help contain the noise (within the Magnet Room) which is produced during clinical scanning. The following information is provided for the acoustic engineer to design for acoustic noise containment within the Magnet room.

Table 3-4: Acoustic Specifications

	Maximum Sound Pressure Level ¹	Frequency Range
Magnet Bore Isocenter	127 dBA ²	See Illustration 3-3
Front of Magnet - 800 mm from bore measurement	120 dBA	
Notes:		
1. Maximum Sound Pressure Levels is defined as the maximum allowable level any MR scanner can produce while protecting the patient to the IEC 60601-2-33 code.		
2. The total energy, SPL, is derived through the log sum of each 1/3 band octave totaling the 127 dBA. That is, the maximum single 1/3 band is lower than the published values at both the isocenter and at the front of the magnet		

Illustration 3-3: Sound Pressure Spectral Distribution (1/3 Band Relative SPL)



NOTE: The MR product clinical operation will generate sound pressure proportional to the specific clinical application. The entire spectra (envelope) shown above ([Illustration 3-3](#)) represents the relative 1/3 band octave sound pressure the MR scanner may transmit into the air. The acoustic room will best suit the customer when the 127 dBA proportionally distributed as defined by the Illustration

Refer to [Chapter 7, Acoustic Background and Design Guidelines](#) for acoustic design information.

5 RF Shielded Room Requirements

5.1 RF Shielded Room Purpose

The RF shielded room is critical to the proper clinical operation of the MR system. RF shielding attenuates the external RF electromagnetic fields. Low RF environments present lower risk to RF impacts to image quality. The RF shielding must also prevent the MR system RF emissions from interfering RF receiving systems such as other MR systems, aircraft control and communication systems.

RF shielding requirements consider the current RF environment at the site as well as future conditions, such as expansion, with the addition or upgrade of multiple MR systems, as well as changes to the RF environment at the time of installation. The RF shielding requirement also considers the expected degradation over time from the RF shielded room from corrosion and use.

The overall RF shielding performance aims to address:

1. IEC EMC Regulatory Compliance
2. MR Clinical image quality for the life of the product

5.2 RF Definitions

Broadband Interference

Broadband interference is caused by electrical discharge within the Magnet room. Potential sources of interference can be reduced by limiting static discharge, ensuring all metal-to-metal contact is tight and secure, and ensuring all electrical and grounding requirements are met.

Discrete Interference

Discrete interference is fixed-frequency, narrowband RF noise. Potential sources of discrete interference are radio station transmitters and mobile RF transmitting devices. Magnet room RF shielding prevents external RF energy from entering the room and degrading the MR system RF receivers.

Electromagnetic Environment

The totality of electromagnetic phenomena existing at a given location.

Plane Wave

An electromagnetic wave which predominates in the far-field region from an antenna (or source), and with a wave front which is essentially a flat plane.

Penetration

The passage through a partition or wall of an equipment or enclosure by a wire, cable, pipe, waveguide, or other conductive object.

Shield

A housing, screen, or cover which substantially reduces the coupling of electric and magnetic fields into or out of circuits or prevents the accidental contact of objects or persons with parts or components operating at hazardous voltage levels.

Shielding Enclosure (Faraday Cage)

An area (box, room, or building) specifically designed to attenuate electromagnetic radiation, or electromagnetic radiation and acoustical emanations, originating either inside or outside the area.

Shielding Effectiveness (SE)

A measure of the reduction or attenuation in the electromagnetic field strength at a point in space caused by the insertion of a shield between the source and that point.

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

Secondary Ground

Other grounds that connect the outside of the RF Shield room to earth grounds are called secondary grounds

5.3 Customer Responsibilities

The Customer is responsible for:

1. The selection of a quality RF shielded room vendor who understands the RF shielding room purpose described in [Section 5.1](#).
2. Contracting with a RF shielded room vendor to design and install (including installation of dock anchor) the RF shielded room to meet requirements in [Section 5.4](#).
3. Maintenance and repair of RF shielded room, to include, but not limited to, shielding effectiveness (SE), door threshold and door seal, pressure equalization vent operation for the life of the MR System.

- NOTE:**
- On request, the GE Healthcare Project Manager of Installation (PMI) can supply a list of RF shielding room vendors.
 - The RF shielded room may not be in a temperature or humidity controlled environment, the customer must take local measures to prevent RF shield effectiveness degradation.
 - Special care should be used when installing all fixtures penetrating the RF shield (e.g., vents, electrical conduit, penetration panels, etc.) to ensure the integrity of the RF shielded room is maintained.

5.4 Requirements

5.4.1 RF Shield Requirements

1. The RF shielded room with installed blank penetration panels shall provide a minimum of 100 dB of shielding effectiveness (SE) for the entire room at the following frequencies:
 - a. 127.72 MHz +/- 0.5 MHz
 - b. 102.20 MHz +/- 0.5 MHz
 - c. 153.30 MHz +/- 0.5 MHz

- NOTE:**
- The RF shielded room is designed and installed to meet or exceed the 100 dB of SE. Acceptance of lower SE performance is a customer responsibility with an absolute lower limit of 90 dB. The Customer must recognize the risk to accepting a lower quality RF shielded room. The RF shielded room performance degrades over time. Accepting a RF shielded room of low performance will result in additional cost to the customer on repairs after room construction is complete impacting clinical use of the product.
 - The final shielding effectiveness performance of the RF shielded room is determined based on the lowest measurement of all test point locations.
2. The RF shielded room must be isolated from earth ground by more than 1000 ohms DC resistance during construction (before electrical installation)
 3. The RF shielded room must be grounded to the RF common ground stud (which is grounded back to the Power Distribution Unit in the Power, Gradient, RF cabinet)
See [Grounding Requirements](#) for RF Shield room grounding details
 4. RF shielded room installation materials must meet steel mass limits listed in Magnet Room Structural Requirements to keep magnetic field homogeneity
 5. Any moving part (such as doors) must not contain magnetic materials

5.4.2 RF Shield Test Requirements

1. The minimum tests points for shielding effectiveness must be the following locations:
 - a. Walls
 - b. Penetration panels
 - c. Doors
 - d. Blower box removal hatch
 - e. All windows, including patient viewing window
 - f. Skylights
 - g. Penetration waveguides installed for GE Healthcare and Non-GE Healthcare options
 - h. Power filters
2. [Chapter 7, RF Shielding Effectiveness and Ground Isolation Test Methods](#) provides details for shielding effectiveness measurement based on IEEE Std 299-2006
3. When measuring shielding effectiveness (SE), the following must be installed for the RF shielded room:
 - a. All floor mounting bolts (including dock anchor bolt)
 - b. RF shielded door(s)
 - c. Waveguide penetrations, HVAC, cryogen vents, medical gas lines, system options (including FUS, MRE, etc.)
 - d. AC power supplied through low-pass filters

- e. Patient view window, skylights, windows, hatches, etc.
 - f. PEN Panel frames and blank penetration panels installed, dimensionally equivalent to the GE panel and the same mounting hardware to be used with the GE penetration panels
4. GE Healthcare Field Engineer must be present during RF SE testing and a test report must be delivered to the PMI
 5. Shielding Effectiveness (SE) test equipment must be calibrated

NOTE: The calibration cycle of equipment must be no greater than 2 years.

5.4.3 RF Shield Test Report

A test report must be prepared by the testing organization performing the shielding effectiveness and ground isolation resistance tests for the RF shielded room. The test report includes data necessary for the evaluation of the shielding effectiveness performance and ground isolation of the RF shielded room. The test report must contain as a minimum the following information:

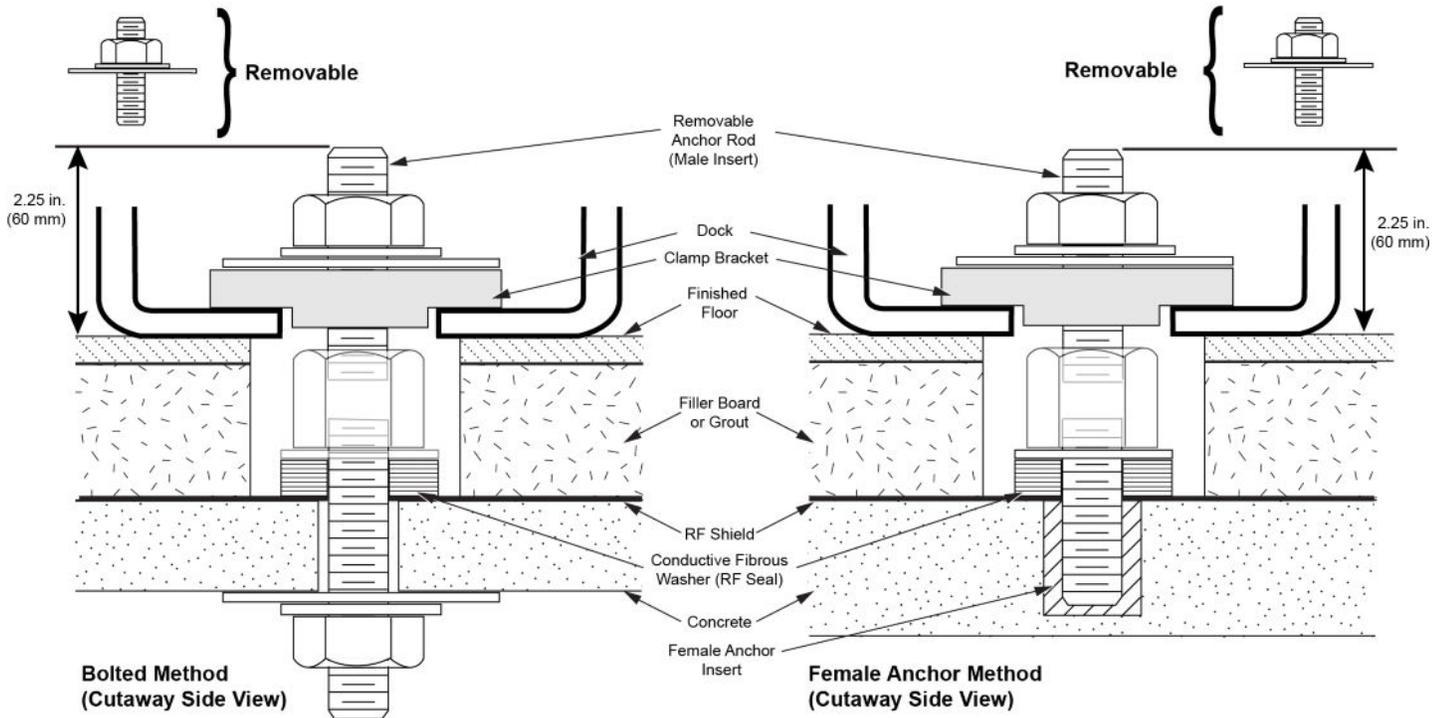
1. Name of the owner organization or hospital
2. Name of testing organization
3. Identification name for the RF shielded room being tested
4. Name of test personnel
5. Date of test
6. Frequencies tested
7. Shielding effectiveness measured for each test point location (each test point location must be identified in the test report)
8. RF shielded room drawing showing each test point location
9. List any changes pertinent to the test setup or SE results (e.g., limited separation distance of antennas, limited access to test points, etc.)
10. Perform a dock anchor pull test that is greater than 600 lbs.
11. Ground isolation test results and the condition of the room when tested (e.g., RF room completed without internal finishes and no electrical connections). This test must be performed before the site is turned over to the general contractor for electrical installation
12. Blank Pen Panel is installed
13. Pass/Fail conclusion
14. The following information for each piece of all calibrated equipment used for measurement:
 - a. Manufacturer
 - b. Model
 - c. Serial number

d. Current calibration date and calibration due date

15. Results of the dock-table anchor pull test.

5.4.4 Dock Anchor Mounting Requirements

Illustration 3-4: Dock Anchor Mounting Options



1. The RF Shield vendor must design and install the dock anchor bolt
2. The dock anchor hole must be drilled after the Magnet is installed
3. The dock anchor must not contact floor rebar or other structural steel
4. The dock anchor must electrically contact the RF shield at point of entry
5. The dock anchors must have the following properties:
 - a. Anchors must be two-part assembly (male/female)
 - b. Female side must be expansion- or epoxy-type
 - c. Male side must be a bolt or threaded rod with appropriate-sized nut (bolt or rod must be removable--not epoxied or cemented in place)
 - d. Anchors must be electrically conductive
 - e. Anchors must be non-magnetic
 - f. Anchors must not induce galvanic corrosion with the RF shield
 - g. Anchors must be commercially procured

- h. The anchor rod hole clearance in the dock anchor base is 0.43 in. (11). The anchor rod diameter must be sized appropriately
 - i. Anchors must meet the following clamping force: 600 lbs (2,669 N)
 - j. The anchor rod must extend 2.25 in. ± 0.5 in (60 mm ± 13 mm) above the finished floor
 - k. The anchor rod must be less than 6 in (152 mm) in total length (length above the floor plus embedded length)
 - l. If underside of deck is metallic, then insulating bushing must be added to through bolt hardware to prevent grounding of shield at this point.
- 6. The RF shield vendor must perform a pull test on the anchor (equal to the clamping force). Results must be provided to the GE Healthcare Project Manager of Installation (PMI)
 - 7. The RF shield vendor must provide instructions for removal / replacement of the table anchor without using a torque wrench. Instructions must be given to the GE Healthcare Project Manager of Installation (PMI).

5.4.5 RF Shielding Integrity Reliability Requirements

- 1. Ensure all joints and mechanical connections remain secure:
 - a. All solder joints clean and properly prepared
 - b. All mechanical fasteners sufficiently tightened and secured
 - c. Do not use rivets or self-tapping screws (as these tend to loosen over time due to vibration)
- 2. Prevent RF shield corrosion:
 - a. Avoid contact between dissimilar metals
 - b. Ensure all joints and seams are properly dressed using proper materials

NOTE: Sacrificial anodes are recommended
- 3. Doors and door frames must be structurally stiff to prevent physical changes to the RF shield

6 Finished Room Requirements



CAUTION

Personnel Injury or Equipment Damage

Metallic objects may become projectiles if not properly secured.

Remove or properly secure any metallic objects within the finished room.

1. Non-ferrous/non-metallic materials or components should be used in the Magnet room
2. Ferrous components or material in the Magnet room that could be removed for servicing, cleaning, or replacement must be secured to prevent the ferrous material from becoming a projectile (ferrous components or material must also be identified as ferrous to prevent untrained personnel from working on the ferrous material while the magnet is energized)

6.1 Walls

See Acoustic Room Specifications. Hard, bare wall surfaces may create a harsh scan room environment. Finished walls with acoustic detailing can reduce reflected noise.

1. GE Healthcare recommends finished walls to protect the RF shielding
2. Walls and any millwork, cabinets, storage areas, acoustic coverings, etc. must remain outside the minimum service area
3. Metallic electrical conduit inside walls and ceilings may be used. Conduit for receptacles must be metallic

6.2 Penetration Panel Closet

1. An enclosure (i.e., PEN closet) must be provided to restrict access to the PEN panels and for storage of excess interconnections
 - a. The PEN closet must have a mechanical locking mechanism to restrict access to the PEN panels
 - b. The PEN closet must maintain the minimum service area outside 200G in the Magnet room as shown in [Chapter 4, PEN and SPW Wall Opening Requirements](#).
 - c. The PEN closet may be expanded to provide an area for excess cable storage with the following requirements:
 - i. Excess cable must not be stored within the minimum closet service area
 - ii. Excess cable must not interfere with access or servicing of the PEN panel or SPW
 - iii. The area within the PEN closet to store the cable should be sized to accept a 28 in (711 mm) cable loop (2x the minimum bend radius of the largest cable)
 - d. PEN closet must allow free air exchange of 400 cfm (680 m³/hour) between the Magnet room and PEN closet for MR system blowers. Airflow may be achieved through door louvers or other openings in the PEN closet that meet all other PEN closet requirements

NOTE: The primary source of airflow must be from the Magnet room. Openings into the area above a false ceiling or other storage areas should be minimized.

- e. The penetration panel and SPW may be enclosed by separate closets with the following requirements:
 - i. The maximum distance between the PEN panel and SPW is 108 in. (2743 mm)
 - ii. The separate closets must meet all other service area requirements for each penetration panel
 - iii. Airflow as listed above must be provided for both closets
 - iv. Both closets must have mechanical locks
2. A closet service hatch must be provided if the room does not allow the PEN panel blower box removal path to remain completely outside the 200 Gauss line (see [Chapter 4, PEN and SPW Wall Opening Requirements](#) for location and service area requirements).

NOTE: If the room size is sufficiently large so the SPW blower box can be removed without entering the 200 Gauss line, a closet service hatch is not required.
3. The closet service hatch must meet the following requirements:
 - a. Must be located within the PEN closet on the RF wall allowing access to the Equipment room
 - b. May be located anywhere within the PEN closet with unobstructed pass-through. See [Chapter 4, PEN and SPW Wall Opening Requirements](#).
 - c. Must be minimum 20 in. x 20 in. (508 mm x 508 mm)
 - d. Must maintain RF shield integrity for all service access
 - e. May use any design (quick disconnect RF panel, blanker panel, hinged door, etc.) as long as all other requirements are met
 - f. The closet service hatch removal must take less than 15 minutes (replacement must also take less than 15 minutes)
 - g. If two penetration panel closets are used, the closet with the SPW panel must contain closet service hatch

6.3 Doors and Magnet Access Openings

1. The finished opening of the Magnet room main door must be at least 43 in. (1092 mm) wide to allow for helium dewars and patient tables
2. The customer must select the location of the Magnet room main door to allow for efficient clinical patient flow and service procedures
3. Threshold height must not exceed 1 in. (25 mm) on both sides of the door with a maximum 10 degree threshold inclination
4. Patient viewing windows recommended dimensions are 48 in. wide by 42 in. high (1219 mm x 1067 mm) and 72 in. (1829 mm) above the finished floor

NOTE: IEC requires the patient, while in the bore, be in full view of the operator. GE Healthcare recommends using a window, although other means (e.g., camera and video display) may be used as long as all IEC requirements are met

5. The magnet delivery requires opening into the room to allow access for the magnet delivery, rigging, and personnel access

6.4 Finished Ceiling

1. The customer is responsible for the finished ceiling
2. Finished ceiling grid must be non-magnetic
3. An optional curtain kit is available from GE Healthcare. Contact the GE Healthcare Project Manager of Installation (PMI) for more information

6.5 Magnet Room Floors

1. The finished floor must support the weight of all components (e.g., patient table, gradient coil replacement cart) throughout operation and service life
2. The finished floor must be water resistant to protect the subfloor and shielding from water damage
3. The customer is responsible for providing flooring to prevent the buildup to 8 kV
4. Magnet, Enclosure, and Patient Table areas must be flat and level within 0.125 in. (3 mm) within the shaded area shown in [Illustration 3-6](#)
5. The VibroAcoustic Dampening kit to calculate floor loading. Seismic Kit M1060MA. See the illustration below.
 - 2 pads per magnet, 255 lbs (116 kg) each
 - Nominal size: 24 in. x 65 in. (610 mm x 1651 mm) each
 - Magnet anchor option 1: Corner seismic anchor points (x4). Customer to address rebar free zone in those areas
 - Magnet anchor option 2: Seismic anchor holes (x4) (1.5 in., 38 mm)

NOTE: Seismic anchors shall have a 3 in. (76) rebar-free area around the anchor and shall install with assistance of the RF shield vendor.

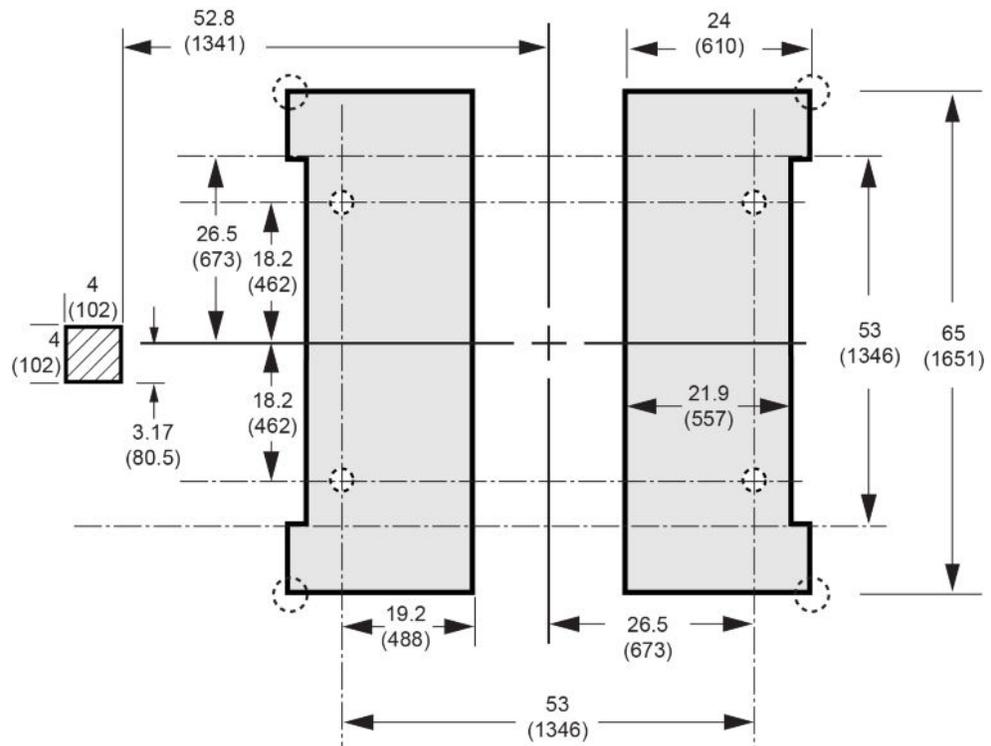
A 4 in. (102 mm) rebar-free area is necessary under the table dock anchor, in the position shown in the illustration below.



NOTICE

Table dock anchor hole is drilled only after magnet installation

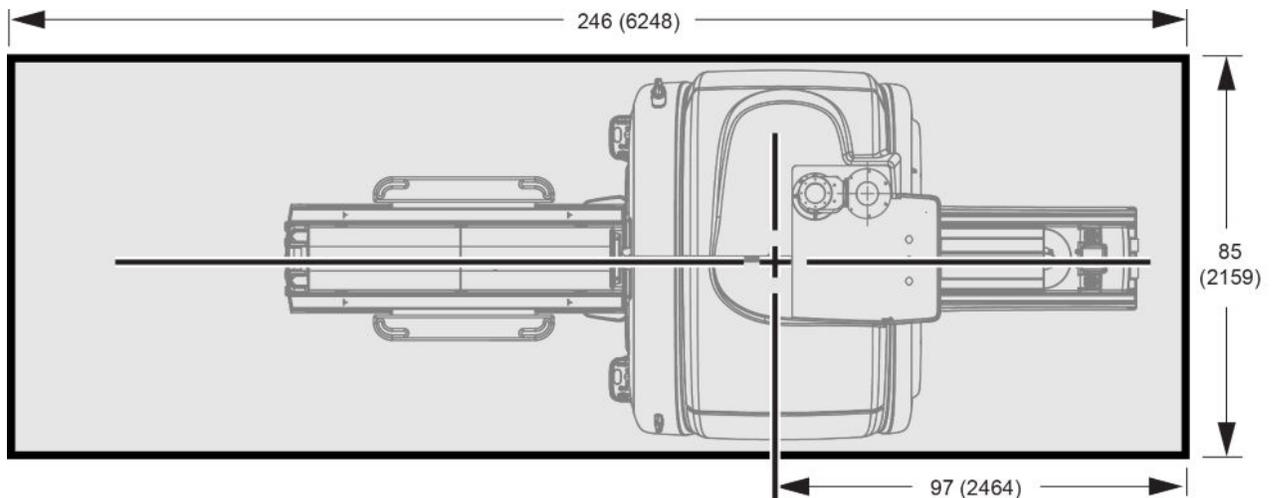
Illustration 3-5: Magnet Mounting Detail (seismic)



6. RF shield seams, joints, or overlaps must not be located under the VibroAcoustic mats

NOTE: Contact GE Healthcare PMI for magnet mounting details.

Illustration 3-6: Magnet Room Floor Levelness Area



7 Magnet Room Equipment Specifications

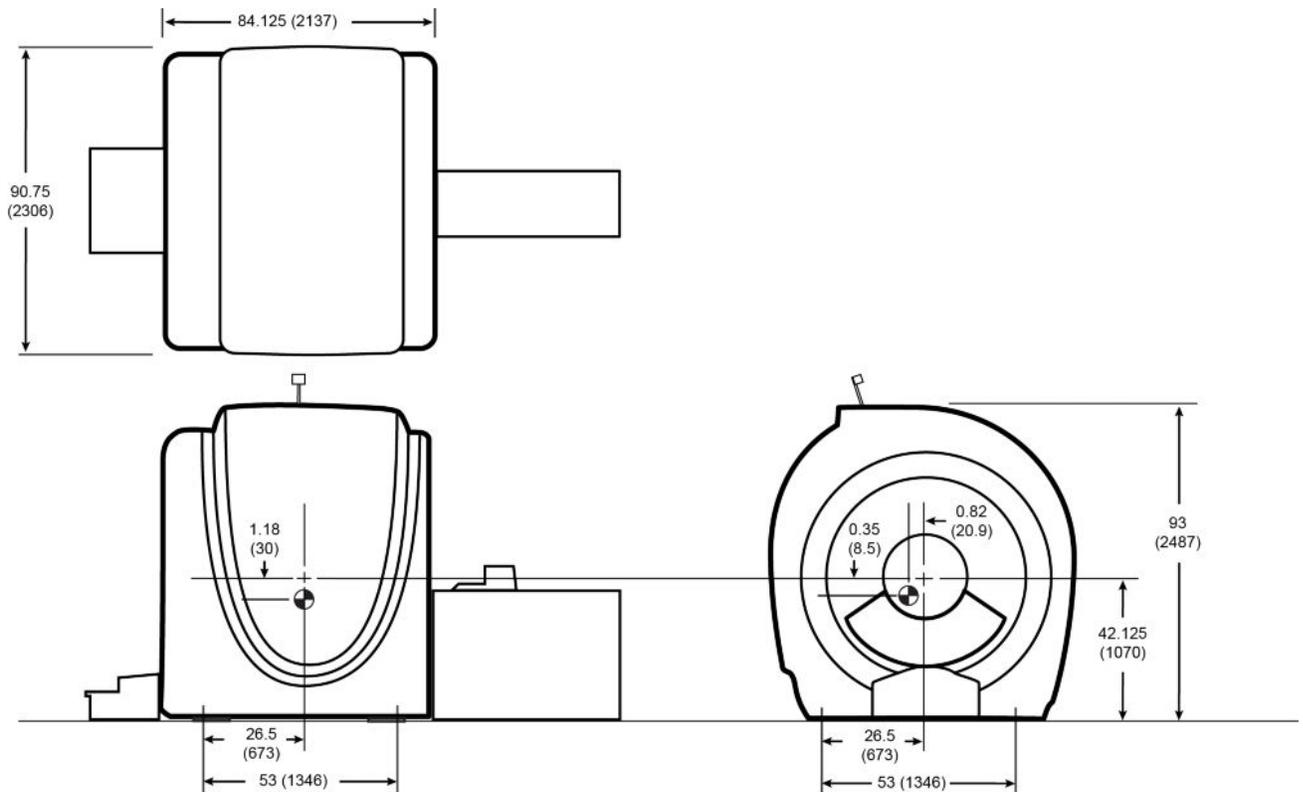
7.1 Magnet (MAG) Assembly Specifications

Rear Pedestal weight: 212 lbs (96 kg)

Table 3-5: Magnet Assembly Weight Table

Item Description	Actual Weight	Max Weight
Magnet (dry)	20970 lbs (9512 kg)	21495 lbs (9750 kg)
Cryogens	525 lbs (238 kg)	
Gradient Coil (XRMB)	2560 lbs (1164 kg)	2896 lbs (1314 kg)
Other components (RF coil, enclosures, interface parts, etc.)	510 lbs (232 kg)	
Lifting beams	335 lbs (152 kg)	
Total Weight as Shipped (Excludes crate/pallet and shipping collector items)	24900 lbs (11318 kg)	25763 lbs (11686 kg)
All dimensions are for reference and are controlled on the component level drawings.		
The replacement 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). The coil assembly outside diameter x length dimensions are 39.0 x 74.6 in. (991 x 1895 mm).		

Illustration 3-7: Magnet (MAG) and Rear Pedestal



7.2 Patient Table Specifications

7.2.1 Patient Table (PT)

Weight, empty: 418 lbs (190 kg)

Weight with maximum patient weight of 500 lbs (227 kg): 918 lbs (416 kg)

Illustration 3-8: Patient Table (PT)

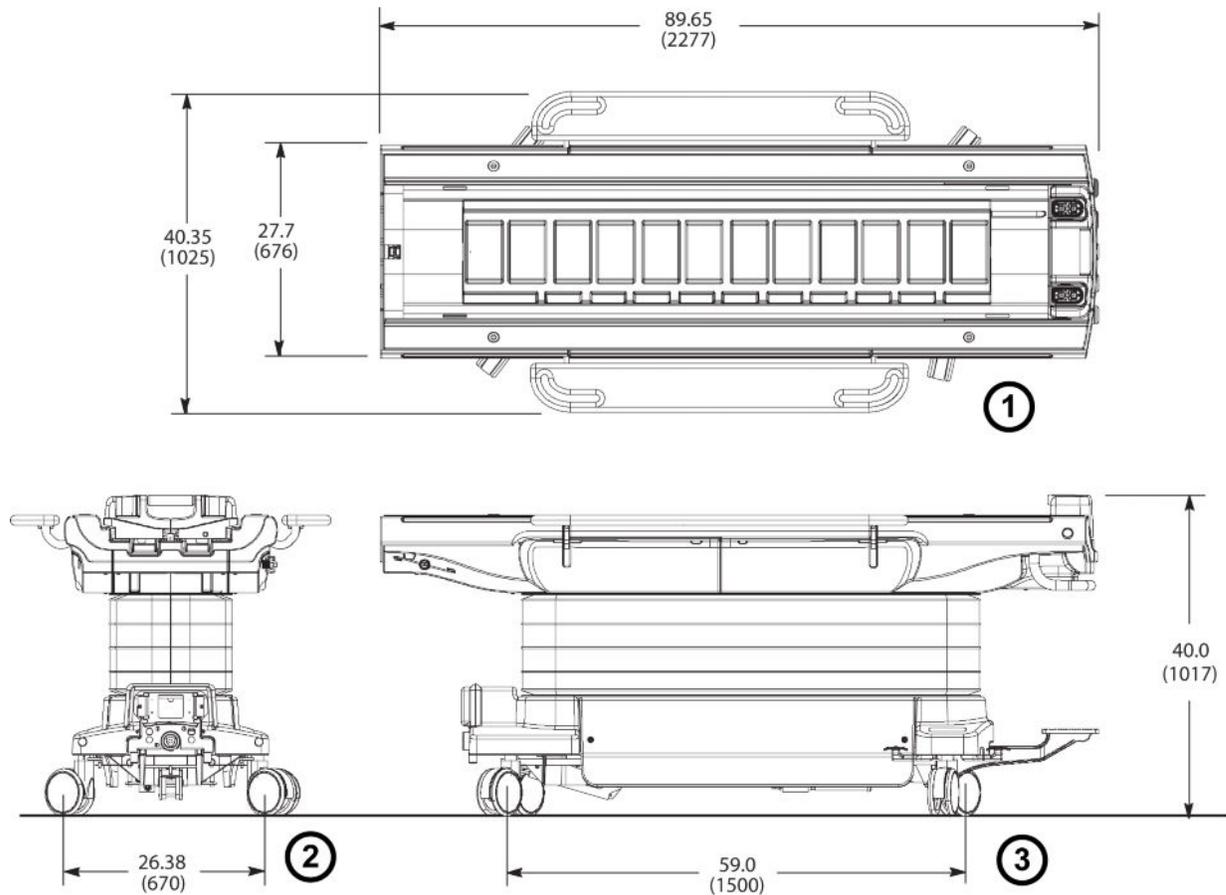


Table 3-6: Patient Table Notes

All dimensions are in inches; bracketed dimensions are in millimeters	
1	Top View
2	Front View
3	Side View

7.2.2 Optional Surgical Suite Transmobile Table

Weight, empty: 463 lbs (210 kg)

Weight with maximum patient weight of 300 lbs (136 kg): 763 lbs (346 kg)

Illustration 3-9: Optional Surgical Suite Transmobile Table

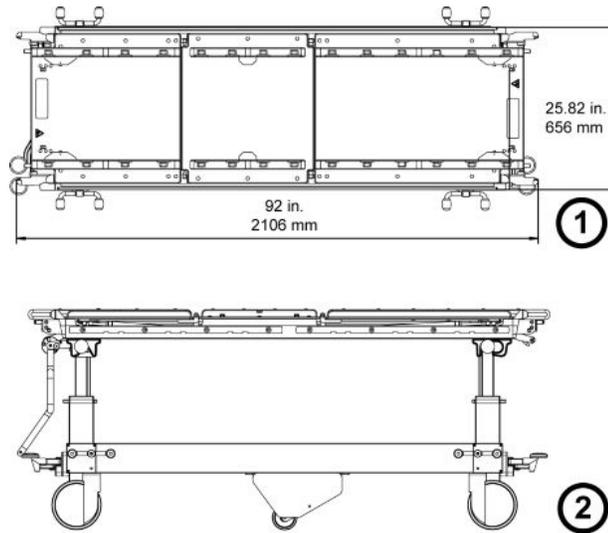


Table 3-7: Surgical Suite TransMobile Table Notes

All dimensions are in inches; bracketed dimensions are in millimeters	
1	Top View
2	Side View

7.3 Magnet Rundown Unit (MRU) Specifications and Requirements

1. Location: The bottom edge of the MRU must be mounted 60 in. (1524 mm) above the Magnet room floor near the front of the magnet enclosure
2. Weight: 7 lbs (3.2 kg)
3. Magnetic field limit: 200 gauss (20 mT)
4. The MRU is installed by the facility contractor
5. The MRU requires the following facility supplied power:

NOTE: Note: An optional remote MRU may be installed outside the magnet room. The remote MRU does not require facility power. For more information, refer to MRU vendor manual.

Table 3-8: MRU Facility Power Requirements

Parameter	Requirements	
Voltage / Frequency	100-120 VAC	50/60 Hz
	200-220 VAC	50/60 Hz
Phase	1	
Maximum Amps	1.0	
Connection type	Hard wired/permanently wired directly to facility power, no plugs or connectors allowed. 1/2 in. PVC Schedule 40 Conduit recommended	
Availability	Continuous	

Circuit Breaker	Dedicated AC disconnect required for both live and neutral connections
-----------------	--

Illustration 3-10: Magnet Rundown Unit (MRU)

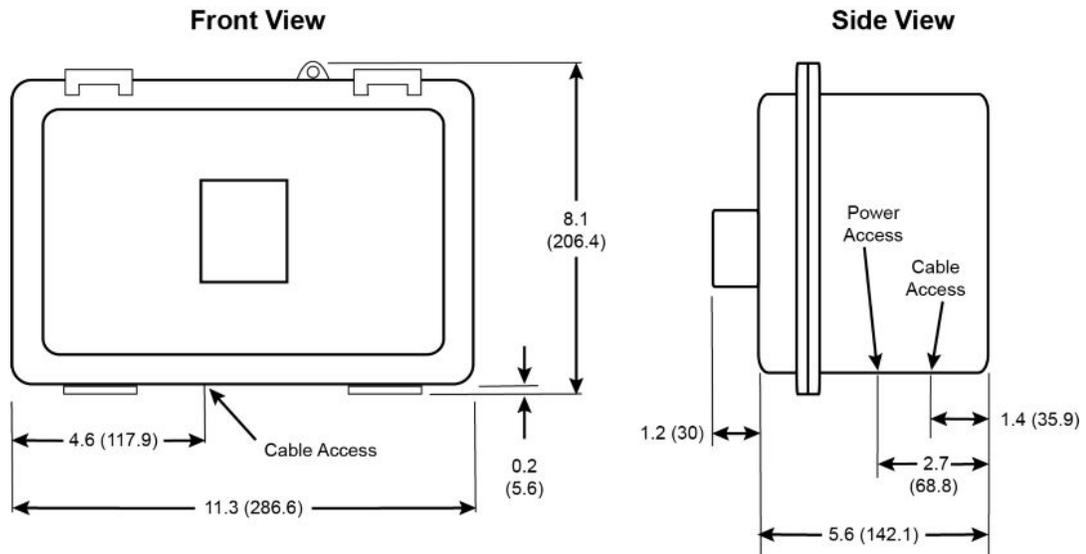
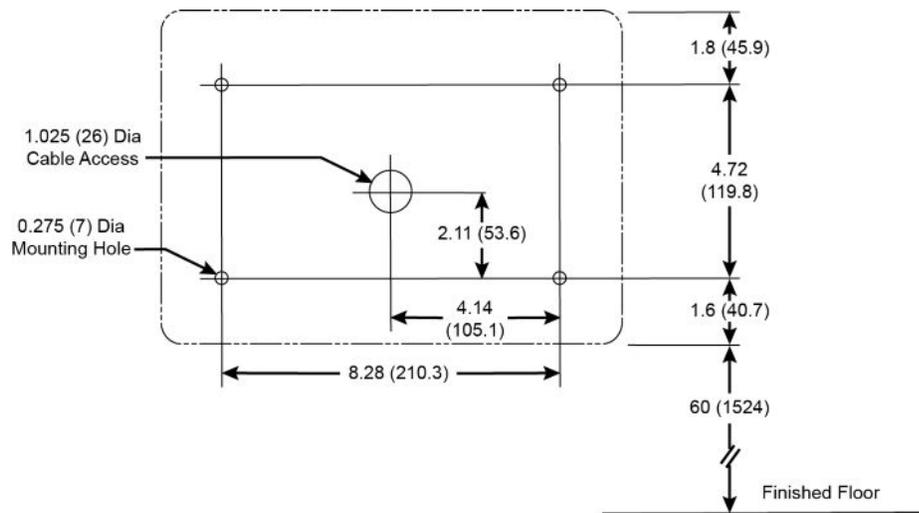


Illustration 3-11: MRU Mounting Pattern



7.4 Oxygen Monitor Option Sensor Specifications

See [Chapter 5, Oxygen Monitor \(OXY\) Option](#)

8 Magnet Room Venting Requirements

8.1 Venting System Requirements

The Magnet Room requires the following venting systems:

1. HVAC
2. Emergency Exhaust
3. Pressure Equalization
4. Cryogenic venting

8.2 HVAC Vent Requirements

1. HVAC vendor must comply with Magnet room temperature and humidity specifications and RF shielding specifications
2. RF Shield vendor must install open pipe or honeycomb HVAC waveguides
3. All serviceable parts in the Magnet room (e.g., diffusers) must be non-ferrous
4. Waveguides must be non-ferrous and electrically isolated
5. Incoming air must contain at least 5% air from outside the Magnet room (inside or outside the facility) to displace residual helium

8.3 Emergency Exhaust Vent Requirements

1. Exhaust vent system is supplied by the customer
2. All items within the RF enclosure must be non-ferrous
3. The exhaust vent system must be tested and operational before the magnet is installed
4. The exhaust intake vent must be located near the magnet cryogenic vent at the highest point on the finished or drop ceiling
5. Any space between finished ceiling and the RF ceiling must contain an additional exhaust intake vent (to prevent helium from pooling above the finished ceiling)
6. If there is no space between the RF ceiling and finished ceiling, the intake vent may be located on a side wall (must be on the coldhead side of the magnet, near the coldhead, with the top edge of the vent flush to the finished ceiling)

NOTE: If used, vent diffusers must not extend beyond the vent opening to prevent helium from pooling between the edge of the diffuser and the ceiling.

7. The Magnet room exhaust fan and exhaust intake vent must have a capacity of at least 1200 CFM (34 m³/minute) with a minimum 12 room air exchanges per hour
8. The exhaust fan must be installed outside of the RF shield and must remain fully functional in the magnetic field per the fan specification sheet
9. The exhaust fan must have appropriate waveguides and di-electric break to maintain the RF shield requirements (see *RF Shielded Room Requirements*)

10. The system must have a manual exhaust fan switch near the Operator Workspace (OW) and in the Magnet room near the door (the switches must be connected in parallel)
NOTE: If the Magnet room contains an optional oxygen monitor, the Magnet room switch is not required.
11. All system components must be accessible for customer inspection, cleaning, and maintenance
12. Electromechanical fire dampers must not be used. Fusible link fire dampers may be used (with annual inspection)

Illustration 3-12: Magnet Room Exhaust Fan Schematic

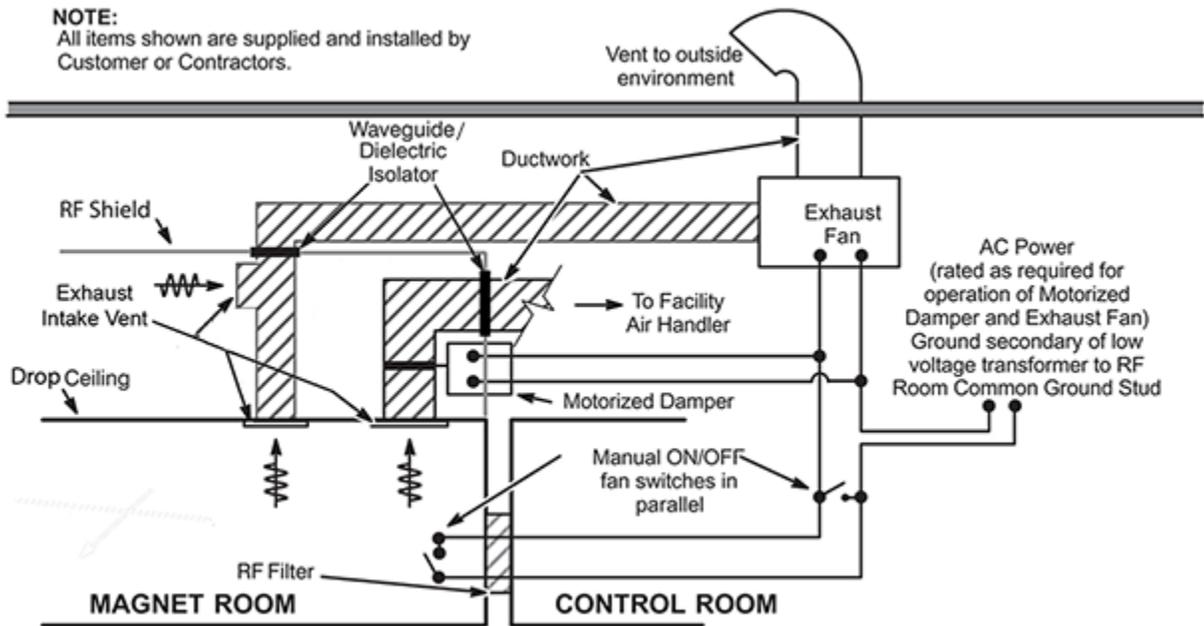
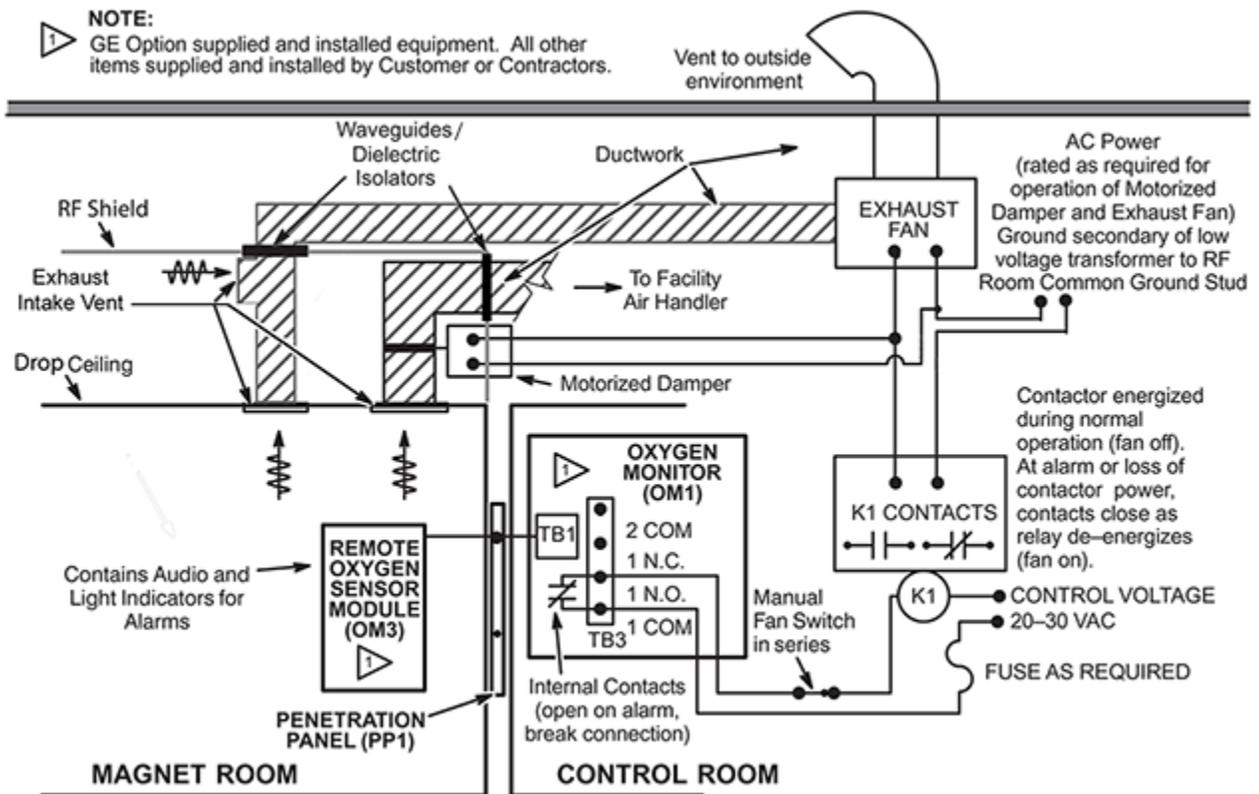


Illustration 3-13: Magnet Room Exhaust Fan Schematic with Optional Oxygen Monitor



8.4 Pressure Equalization Vent Requirement

1. A pressure equalizing vent is required in the magnet room ceiling or in the wall, at the highest point possible
2. The vent minimum size must be 24 in. x 24 in. (610 mm x 610 mm) or equivalent area
3. The pressure equalization vent must be located so any Helium gas is not vented into occupied areas

NOTE: Location may affect acoustic noise transmission into occupied spaces.

8.5 Cryogenic Venting



WARNING

CRYOGENIC BURNS OR ASPHYXIATION
 FAILURE OF THE CRYOGENIC VENT MAY CAUSE EXTREMELY COLD HELIUM GAS TO ENTER THE MAGNET ROOM OR OTHER OCCUPIED BUILDING SPACE. DIRECT CONTACT COULD CAUSE CRYOGENIC BURNS AND ASPHYXIATION COULD RESULT FROM OXYGEN DISPLACEMENT. THE CUSTOMER IS RESPONSIBLE CRYOGENIC VENTING. DESIGNERS AND INSTALLERS OF THE VENT MUST BE FAMILIAR WITH INDUSTRIAL PIPING SYSTEMS.

The MR System (magnet) requires a cryogenic venting system to direct helium gas to an unoccupied space if the magnet quenches. The cryogen venting system must direct all the helium gas outside the facility, and it must keep all helium out of all facilities. The helium in the magnet is a cold gas, which rapidly expands as it becomes warmer. The cryogen vent designer must adhere to the following requirements for the material, construction and maintenance of the vent. The customer is responsible for all of the cryogenic venting system.

Note the following:

1. All pipe or tube dimensions specified in this document are outside diameters unless otherwise noted
2. See [Chapter 7, Magnet Cryogenic Venting Pressure Drop Reference Tables](#) to calculate pressure drop for a specific system

Table 3-9: Magnet Cryogen Specifications

Magnet Types	Helium Volume gallons (liters)	Peak Helium Flow During Quench ft ³ per min (m ³ per min)	Magnet Vent Pipe OD inches (mm)
G3 (3.0T) Magnet	528.3 (2000)	141 (4.00) [Liquid]	8 (203.2)

8.6 Vent Requirements Inside the Magnet Room

8.6.1 General

Refer to

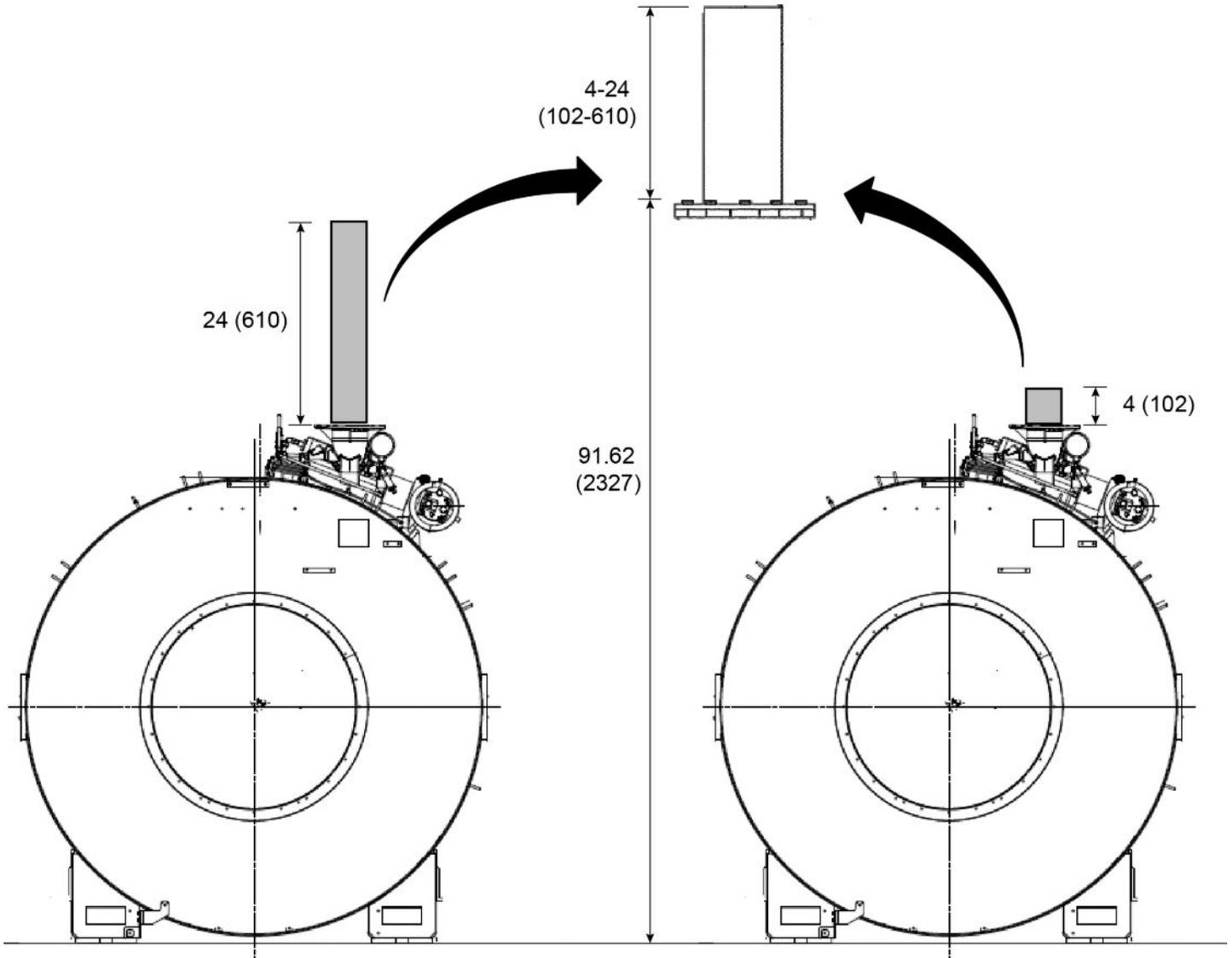
1. The customer is responsible for design, installation, and maintenance of all cryogenic venting materials inside the Magnet room
 - a. The cryogenic vent must be connected to the magnet within 24 hours of magnet delivery
 - b. Appropriate ventilation must be provided to evacuate the helium gas in the case of a quench before the magnet is connected to the cryogenic vent. See [Section 8.3](#)
2. The cryogenic vent must not transfer load to the magnet adaptor
3. GE Healthcare provides a flanged vent adapter that is 8 in. (203 mm) OD and 24 in. (610 mm) long. GE installs it straight up from the magnet (inline with the waveguide in the RF shield). The vent tube can be cut as short as 4 in. (102 mm). See [Illustration 3-14](#).
4. The customer must provide any additional vent tube (above the 1.0 ±0.25 in.gap) beyond the 24 in. (610 mm) provided
5. Other cryogenic venting systems are allowable (e.g., sidewall, ceiling offset) as long as all other cryogenic venting requirements are met
6. Do not remove or modify the vent adaptor bolted to the magnet

NOTE: The GE Healthcare supplied flanged adapter must be bolted directly to the magnet vent adaptor bolt flange

7. The vent must be located within 0.25 in (6.35 mm) of the location (in relation to isocenter) shown in [Illustration 3-19](#)

8. A 1.0 ± 0.25 inch (25.4 ± 6 mm) isolation gap must be included at the top of the GE Healthcare supplied vent tube

Illustration 3-14: Flanged Magnet Vent Adapter



8.6.2 Vent Size

The total pressure drop of the cryogenic vent system (from the magnet vent interface to, and including, the vent cap) must be less than 20 psi (138 kPa). The pressure drop of the RF shield waveguide must be included in the overall calculation.

Refer to [Chapter 7, Magnet Cryogenic Venting Pressure Drop Reference Tables](#)

8.6.3 Vent Materials

1. The 8 in. (203 mm) OD vent material must be one of the following materials with the wall thickness indicated:
 - a. SS 304: Minimum 0.035 in. (0.89 mm); Maximum 0.125 in. (3.18 mm)

- b. AL 6061-T6: Minimum 0.083 in. (2.11 mm); Maximum 0.125 in. (3.18 mm)
 - c. CU DWV, M or L: Minimum 0.083 in. (2.11 mm); Maximum 0.140 in. (3.56 mm)
2. Either tubes or pipes may be used and must be seamless or have welded seams
 3. Corrugated pipe or spiral duct must not be used
 4. If required, bellows pipe less than 1 ft (30 cm) in length may be used as a thermal expansion joint
 5. The vent pipe must withstand a maximum pressure of 35 psi (241.4 kPa)
 6. Waveguide vent material must match the outside diameter of the magnet flanged vent adapter

8.6.4 Cryogen Vent Support

1. The venting system (including supports) must be sized to withstand 2500 lbs (11125 N) helium flow reaction force at vent elbows
2. Any vent support connected to the RF shield must have a dielectric break
3. The Ventglas joint (GEHC-supplied) must not be used as a vent system support

8.6.5 Construction

1. A single dielectric break (i.e., Ventglas connection) in the vent system is required in the Magnet room
 - a. Gap between the RF waveguide and GEHC-supplied vent tube must be 1.0 ±0.25 inch (25.4 ±6 mm)
 - b. The outside diameter of the waveguide must match the outside diameter of the GE vent tube within ± 0.125 in. (3 mm)
 - c. The Ventglas connection inside the scan room must be accessible for maintenance and annual inspection
 - d. The distance between the bottom of the RF waveguide and the magnet room floor cannot be more than 116.9 in. (2969 mm)
2. The Ventglas connection may also serve as a thermal expansion joint
3. All pipe section connections must be welded or brazed
4. All isolation/thermal expansion elements (except the Ventglas joint) must be rated to 4.5 K (-451°F or -268°C) and 35 psi (241.4 kPa)
5. The vent system must be insulated with 1.5 inch (38 mm) thick flexible unicellular insulation to prevent condensation during magnet ramping. Exposed insulation must be covered with a white PVC jacket

Illustration 3-15: Waveguide

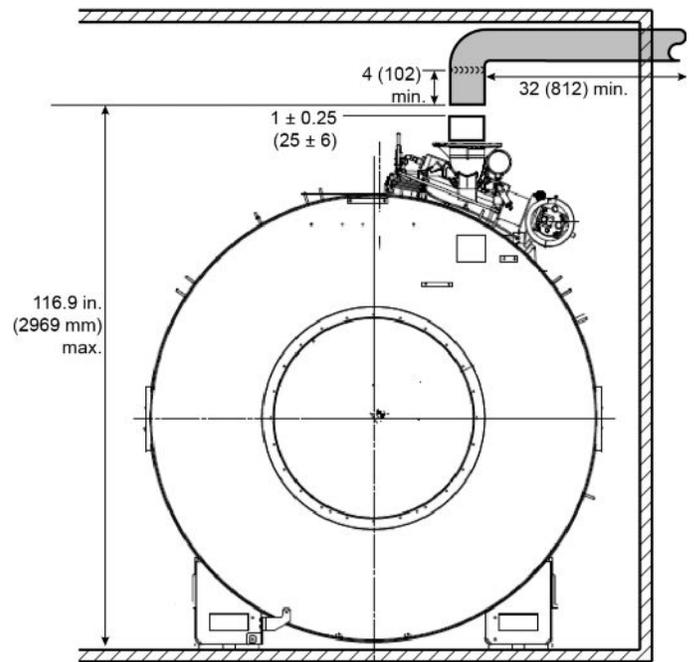
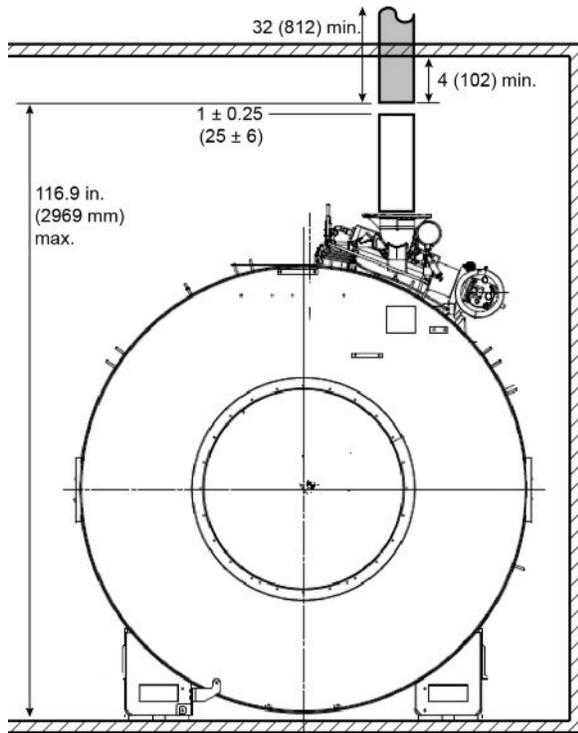
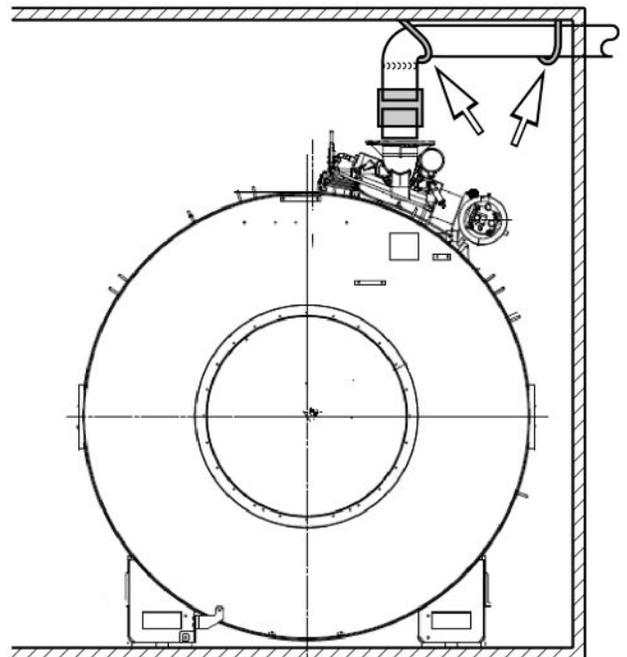
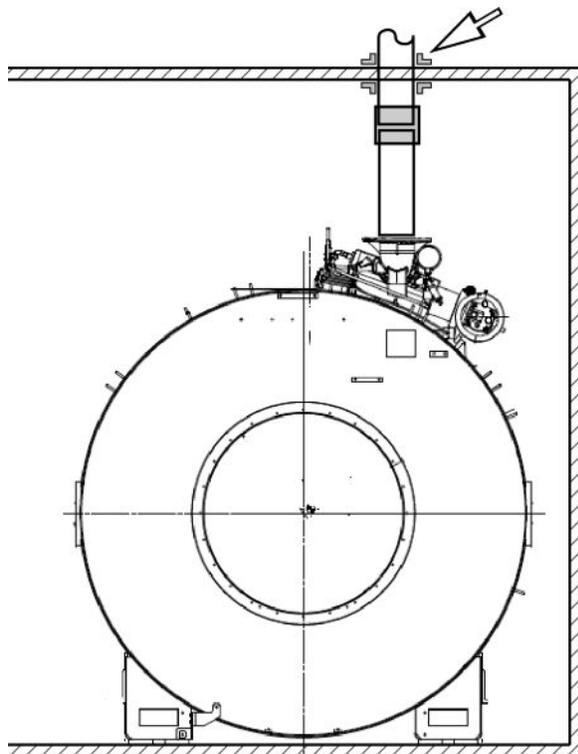


Illustration 3-16: Pipe Supports to Remove Vent Load from Ventglas Connection



8.7 Vent Requirements Outside the Magnet Room

The customer is responsible for design, construction, and maintenance of all cryogenic venting materials outside the Magnet room from the shielded room waveguide to the vent cap.

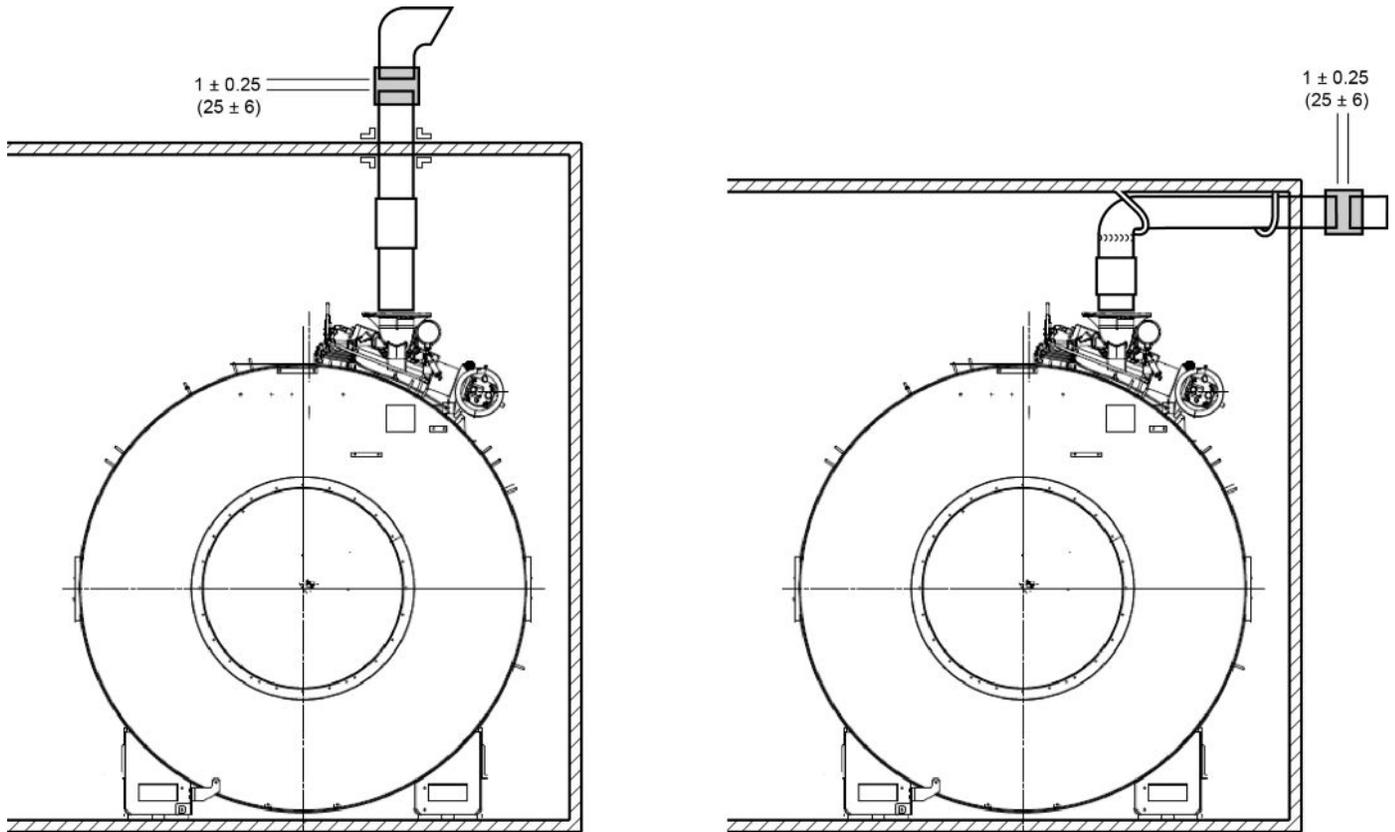
8.7.1 Cryogen Vent Support

1. The venting system (including supports) must be sized to withstand 2500 lbs (11125 N) helium flow reaction force at vent elbows
2. The customer supplied dielectric break must not be used to support the outside cryogenic vent pipe

8.7.2 Vent Construction

1. GE Engineering recommends that the cryogen vent be constructed to the same specification as required inside the Magnet Room.
2. The vent must be routed as directly as possible to the vent cap (i.e., venting system external protective cover)
3. Expansion/contraction elements must be provided for temperature decrease from ambient to 4.5 K (-451°F or -268 °C)
4. A dielectric break must be installed adjacent to the waveguide
 - a. The dielectric break gap must be 1.0 ± 0.25 inch (25 ± 6 mm)
 - b. A customer supplied clamp may be used to connect the dielectric break
 - c. The dielectric break must be accessible for inspection or maintenance
5. All components must be rated to withstand the helium flow reaction force at temperatures from ambient to 4.5 K (-451°F or -268°C)
6. Electromechanical fire dampers must not be used. Fusible link fire dampers may be used (with annual inspection)
7. Vent cap must prevent ingress of weather elements (e.g., rain, snow, hail, sand, etc.) and foreign material debris (e.g., leaves, bird nests, etc.)
8. Condensate must be prevented from pooling inside any section of the venting system (e.g., downward tilted vent system or local minima with weephole)

Illustration 3-17: Outside Dielectric Break (Customer-supplied)



8.7.3 Vent Exit



WARNING

CRYGENIC BURNS OR ASPHYXIATION DURING A QUENCH, EXTREMELY COLD GAS OR PARTICLES ARE RELEASED FROM THE CRYGENIC VENTING SYSTEM. A QUENCH MAY OCCUR AT ANY TIME. ENSURE ACCESS TO CRYOGEN VENT EXHAUST AREA IS RESTRICTED AND THE RELEASED GAS DOES NOT REENTER THE BUILDING. REFER TO THE SPECIFICATIONS BELOW.

1. An exhaust area in front of the vent 35 feet (10.7 m) long x 15 feet x (4.6 m) wide ([Illustration 3-18](#)):
 - a. The facility is responsible for any exhaust area barriers, restrictions, and warning signs
 - b. Must not include air intake vents to prevent cryogen exhaust from reentering the facility
 - c. Must not include any personnel, building components, or objects (movable or stationary)
2. For a rooftop exit:
 - a. Use either a horizontal exhaust vent with a 90° elbow and minimal pressure drop or other low pressure drop, high flow rate roof cap

- b. The bottom of the 90° elbow must be at least 3 feet (0.9 meters) above the roof deck (or higher if at risk of being blocked by drifting snow, sand, etc.)
 - c. The outlet must be covered with a 0.5 inch (12.7 mm) square screen mesh
 - d. The exhaust vent must be included in the pressure drop calculation
3. For a sidewall exit:
- a. You can use an exhaust vent with a 45° elbow (with a deflector rated for the helium reaction force), a 90° elbow, or vent cap with no restriction in gas flow
 - b. The exhaust exit must be at least 12 feet (3.66 meters) above the ground
 - c. The outlet must be covered with a 0.5 inch (12.7 mm) square screen mesh
 - d. The vent exit must be covered to prevent foreign material from entering or blocking the opening (e.g., louvers, etc.)
 - e. The exhaust vent exit must be included in the pressure drop calculation

Illustration 3-18: Cryogenic Exterior Venting Volume

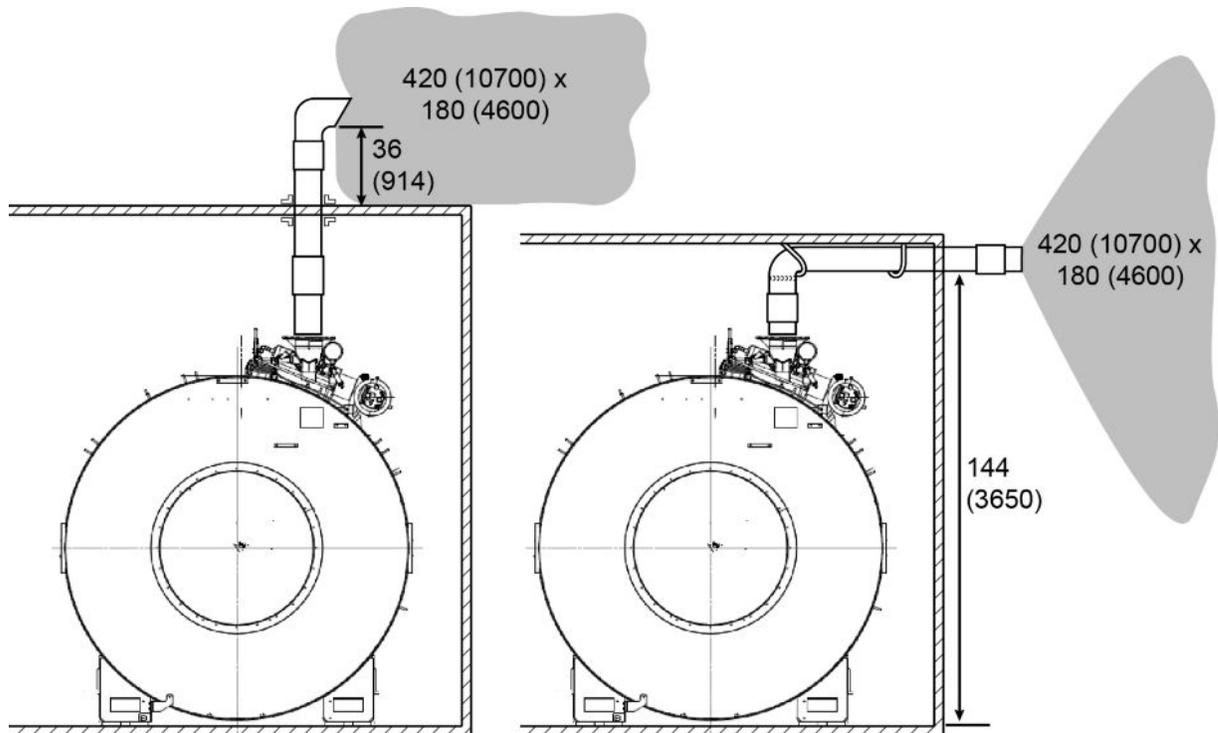
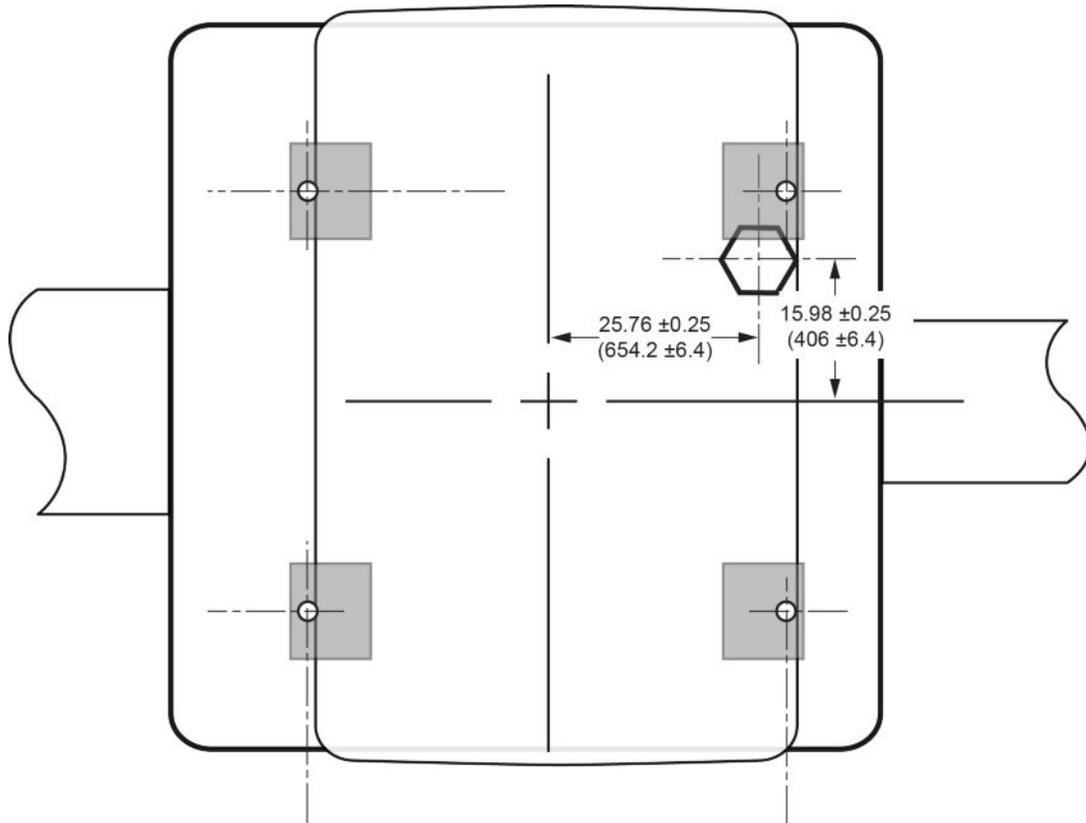


Illustration 3-19: Magnet Cryogenic Vent Location



8.8 Combined Vent

A site can combine cryogenic venting from two GEHC MR systems.

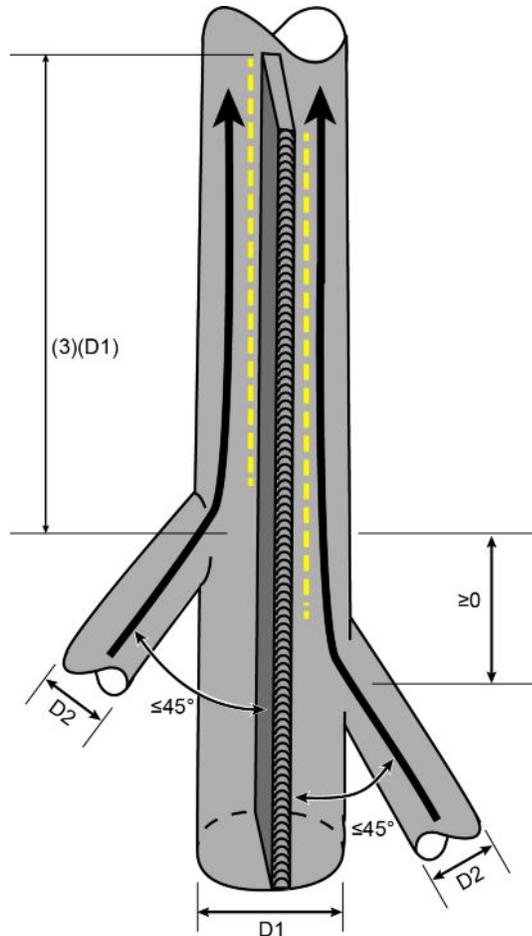
NOTE: The customer chooses this option with the risk that a magnet quench may quench the second magnet.

The waveguides of each system can connect via 45 degree elbow connectors to a 12 in. (305) pipe as shown in the illustration below. The pipe must be sealed at the bottom, and a plate must be fully welded to the inside of the pipe to correctly direct all cryogenics out of the magnet room. The plate and pipe used for the combined vent must be the same as the waveguide material.

1. The total pressure drop of the cryogenic venting system for each magnet (from the flanged vent adaptor to the vent exit including the vent exit) must be less than 20 psi (138.0 kPa).
2. The pressure drop in the shared section of the vent must not exceed 4 psig
3. The combined vent pipe diameter selected to maintain the pressure drop will require the combined pipe section diameter meet the back pressure and 35 psi internal pressure forces
4. The two magnet vents require a plate separating the entering pipes to prevent one magnet quench from imposing a back pressure to the other magnet
5. The separation plate must be able to withstand the quench up to 35 psi internal pressure caused by the impinging gas flow. Inspection/replacement of combined pipe section should the separation plate distort post quench.

- The venting system must have a structural support along any pipe section elbow and at the joining of the two (2) magnet vents to the combined vent.

Illustration 3-20: Combined Vent



Combined Vent Illustration Notes:

- The distance between the magnet and the tie-in point to the large diameter common pipe should be minimized as much as possible.
- The maximum pressure drop for each magnet between the magnet tie-in to the common pipe and the vent exit to outside shall be less than or equal to 4 psi.
- An additional pressure drop, equivalent to a standard 90 degree elbow, shall be added to each magnet branch due to the entrance effect to the common pipe section.
- Use the hydraulic diameter (instead of pipe diameter) when calculating the pressure drop after a magnet branch ties-in to common vent pipe until it leaves the edge of the splitter plate (yellow dashed lines in figure)
- For a circular cross section of diameter D_1 , with the divider of height D_1 :
Hydraulic diameter = $(\pi D_1) / (\pi + 2)$
- D_2 is typically 8(203) in diameter (Illustration 3-20 is not to scale).

9 Magnet Room Electrical and Grounding Requirements

9.1 Electrical Line and Filter Requirements

1. RF Shielded Room vendor and electrical contractor must design and install all electrical lines through the RF shielding
2. The RF Shielded Room vendor must supply electrical line filters for all lines through the RF shielding (excluding electrical lines through the GE supplied Penetration panels) to ensure compliance with the RF Shielded Room attenuation requirements
3. Electrical line filters must be located outside the 200 gauss (20 mT) line

9.2 Lighting Requirements

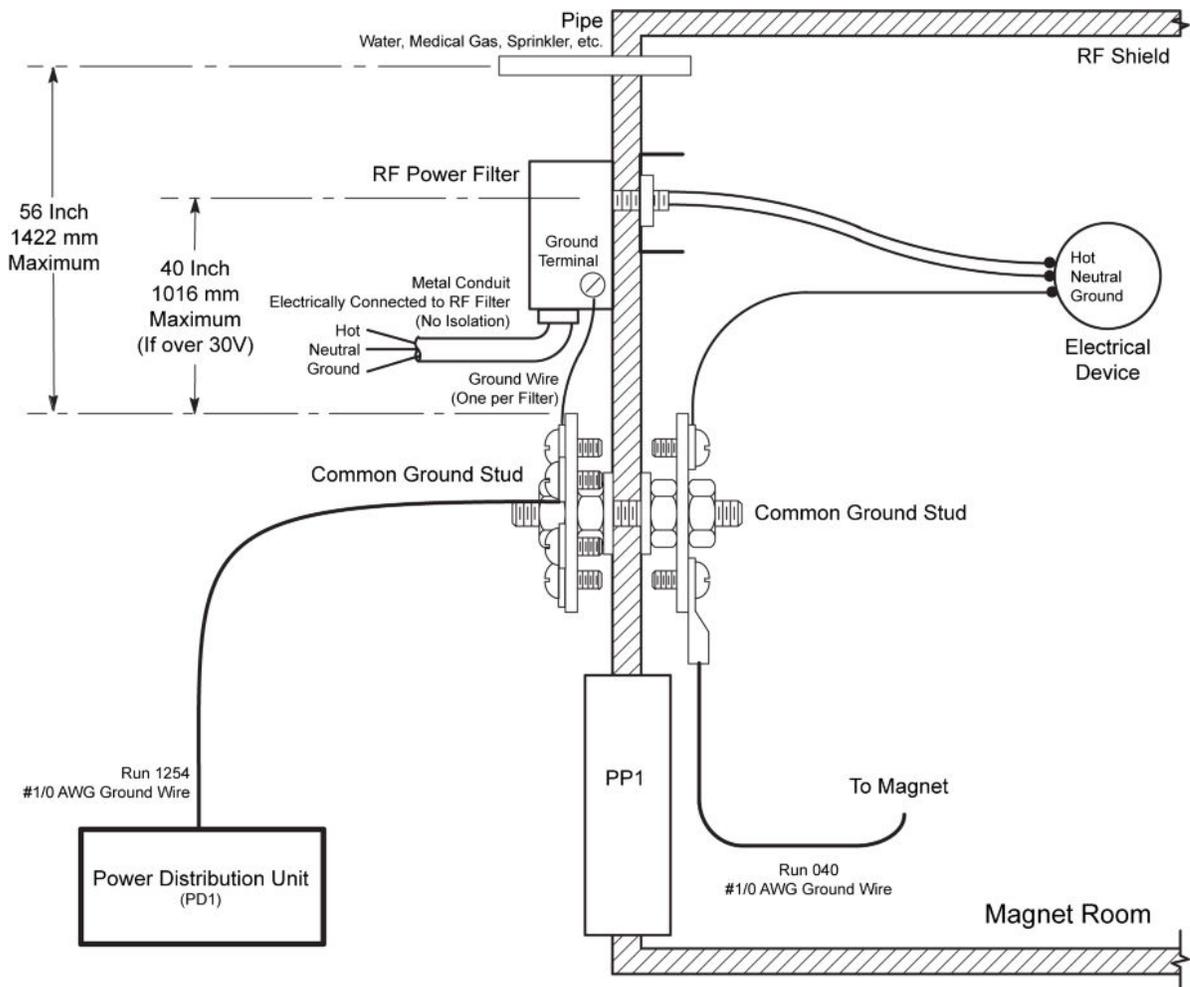
1. All lighting fixtures and associated components must meet all RF Shielded Room and RF Grounding requirements (e.g., track lighting is not recommended due to possible RF noise)
2. All removable lighting fixtures and associated components must be non-magnetic
3. All lighting must use direct current (the DC must have less than 5% ripple)
4. 300 lux must be provided at the front of the magnet for patient access and above the magnet for servicing
5. Fluorescent lighting must not be used in the Magnet Room
6. Lighting must be adjusted using a discrete switch or a variable DC lighting controller
7. SCR dimmers or rheostats must not be used
8. DC LED lighting may be used if the DC power converter is located outside the Magnet Room RF Shield
9. Battery chargers (e.g., used for emergency lighting) must be located outside the Magnet Room
10. Short filament length bulbs are recommended
11. Linear lamps are not recommended due to the high burnout rate

9.3 Grounding Requirements

1. The Penetration Panel Pen Wall and Secondary Pen Wall (SPW) are connected to the RF Common Ground Stud with the GE Healthcare supplied ground cable (refer to [Illustration 3-21Chapter 4, PEN and SPW Wall Opening Requirements](#))
2. All RF Power Filters over 30V (incomming) must be located within 40 in. (1016 mm) of the RF Common Ground Stud
3. All power lines into the RF shielded room require an RF filter
4. All electrical devices (e.g., outlets, light fixtures, etc.) must have a ground wire from device power source and be grounded to the RF Shield at the RF Common Ground Stud
5. Resistance between any two grounded devices must not exceed 0.1 ohm to ensure equal potential ground system within the Magnet Room (e.g., MGD to PDU)

6. Do not ground non-MR equipment to the MR ground system
7. All metallic pipes (including water, medical gas, sprinklers, etc.) entering the RF Shield, excluding the Cryogenic Vent and floor drains, must be located within 56 inches (1422 mm) of the RF Common Ground Stud
8. The illustration below shows a typical ground layout

Illustration 3-21: Typical Magnet Room Grounding



NOTE: See [Chapter 6, MR System Interconnects Specifications](#) for usable cable lengths.

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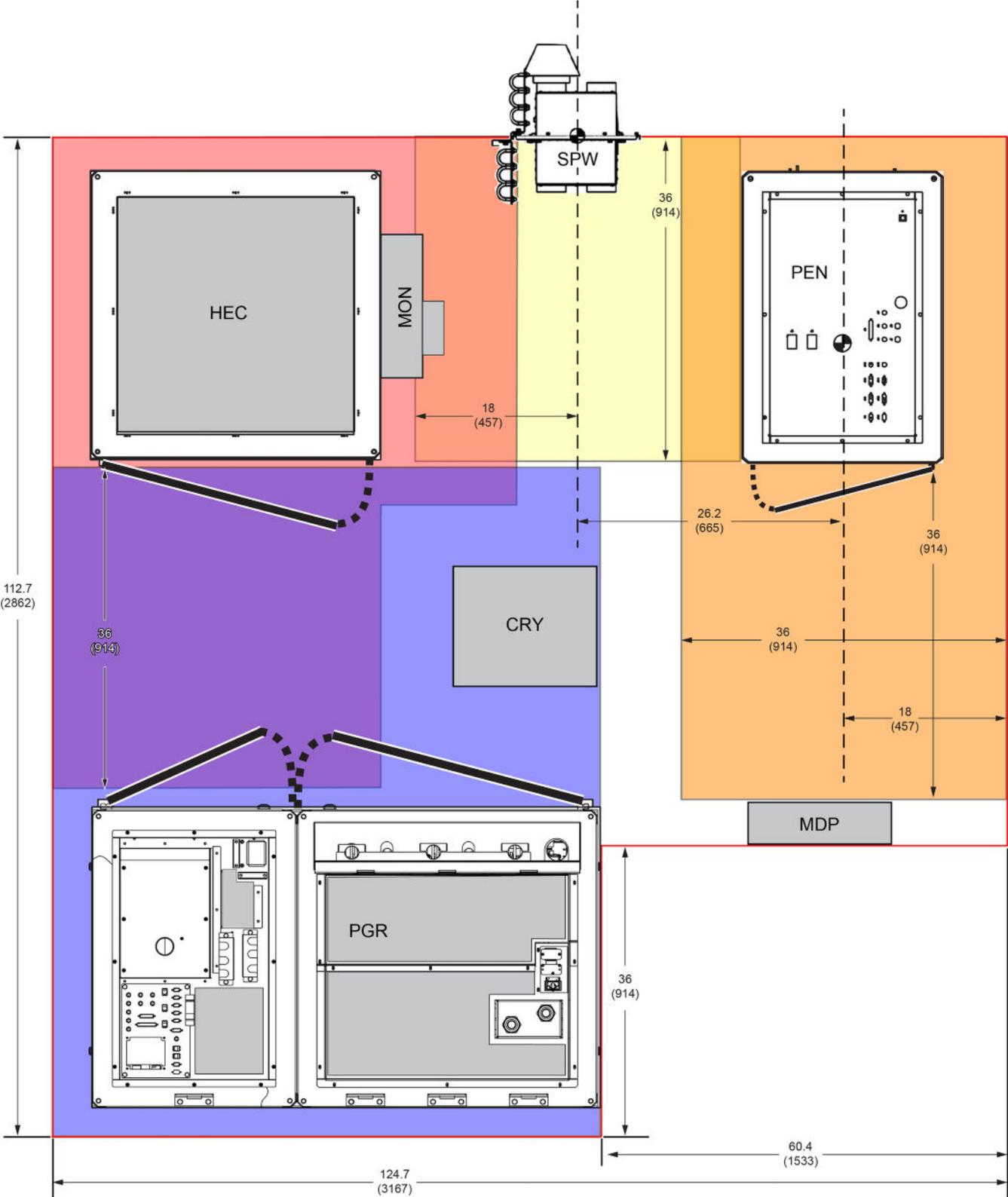
Chapter 4 Equipment Room

1 Equipment Room Overview

The illustration below shows an Equipment room layout example.

NOTE: Colored areas indicate service/installation areas. These areas can overlap as necessary as shown below. See individual component descriptions and room requirements for service area details. Magnet Monitor (MON) can be mounted on the side of the wall near the HEC. Optional equipment is not shown; additional space is required for options such as BrainWave, MNS, DC lighting, etc. If you use the minimum service area, it will be necessary to use riggers to install the equipment.

Illustration 4-1: Equipment Room Layout Example

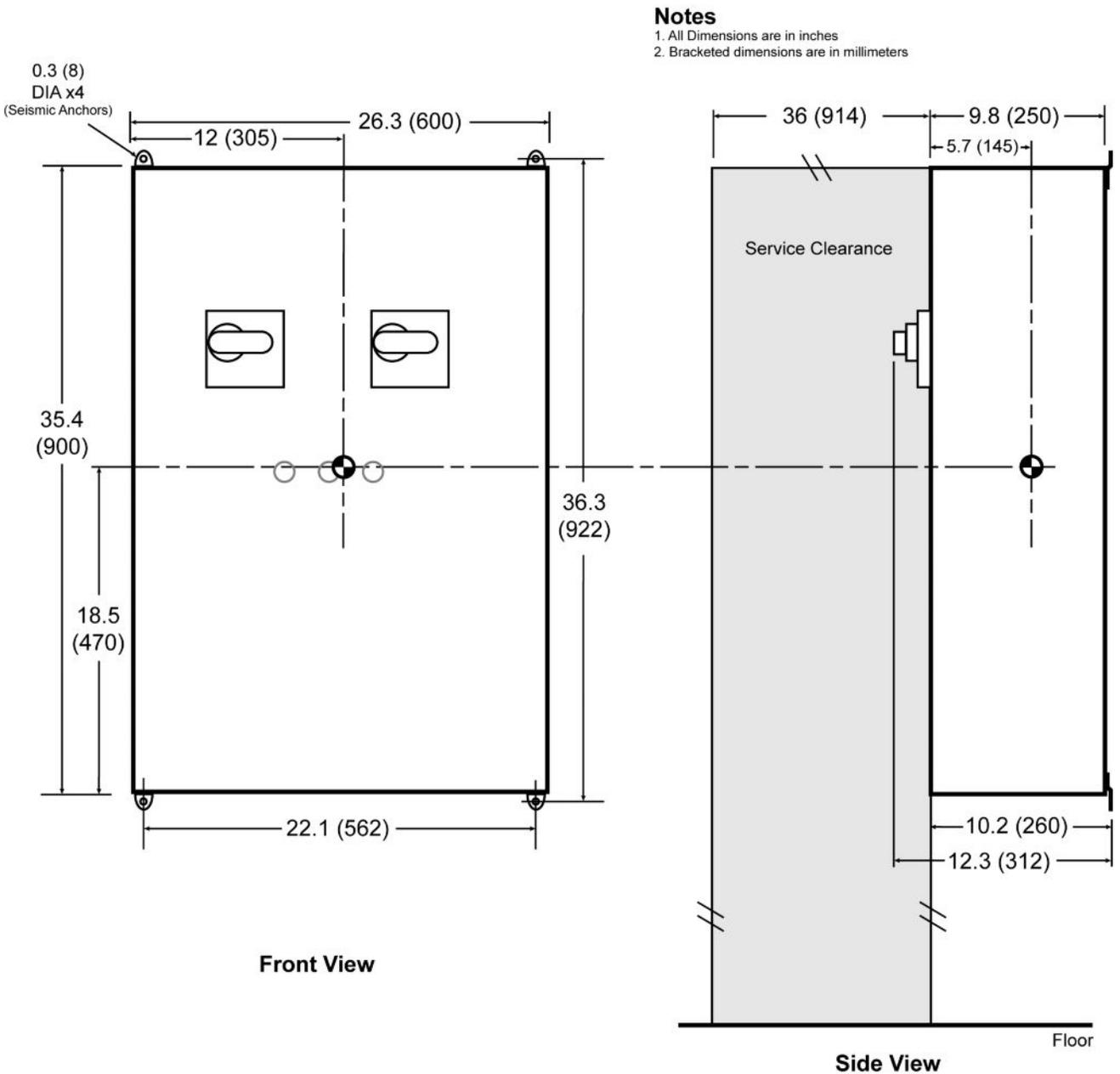


2 Main Disconnect Panel (MDP) Specifications

The Main Disconnect Panel (MDP) is optionally provided with the MR system.

1. Weight: 130 lbs (59 kg)
2. Magnetic Field Limit: 50 Gauss (5 mT)

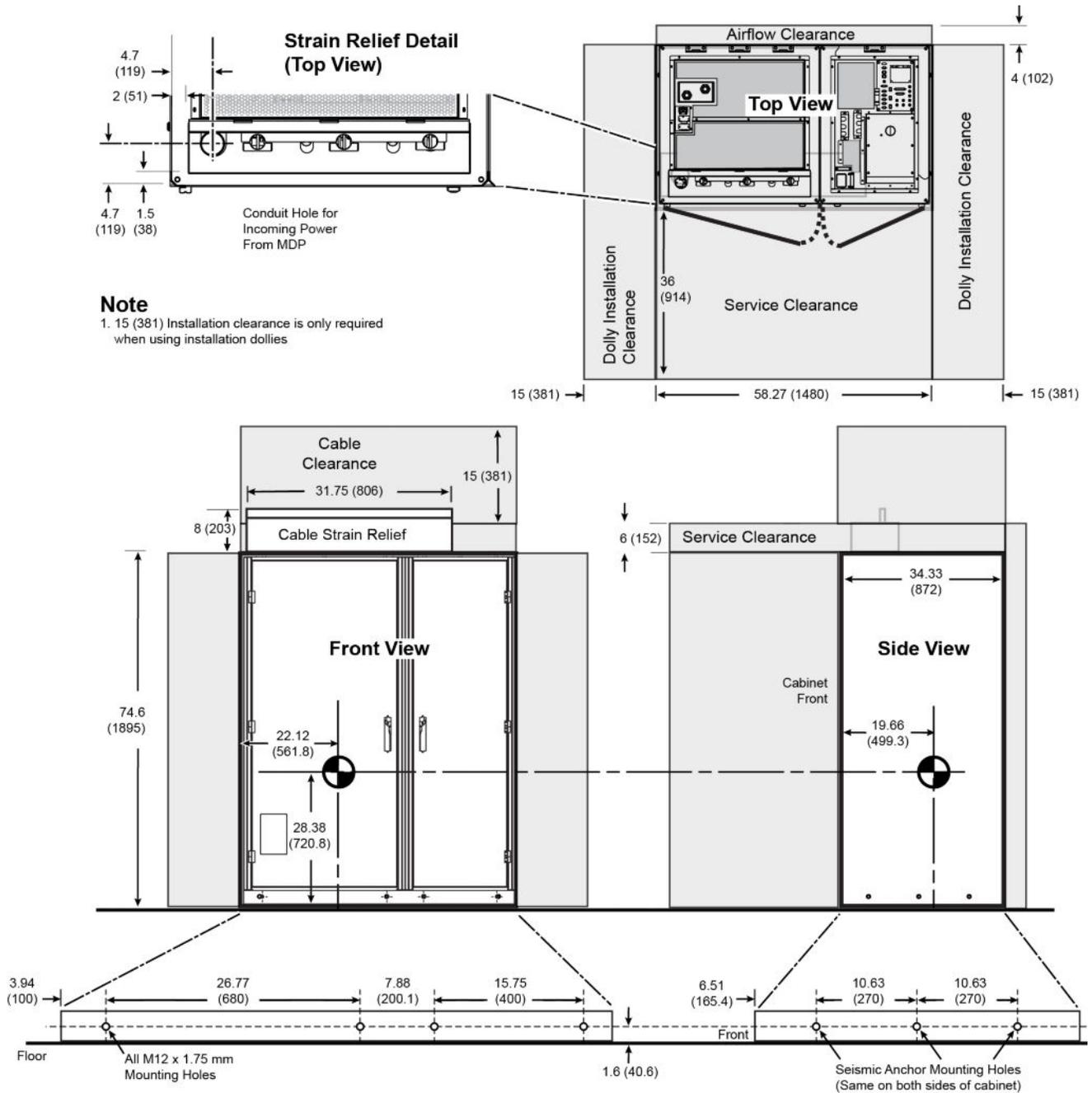
Illustration 4-2: Main Disconnect Panel



3 Power, Gradient, RF Cabinet (PGR) Specifications

1. Weight (GEM or non-GEM): 3279 lbs (1487 kg)
2. Magnetic Field Limit: 50 Gauss (5 mT)

Illustration 4-3: Power, Gradient, RF (PGR) Cabinet

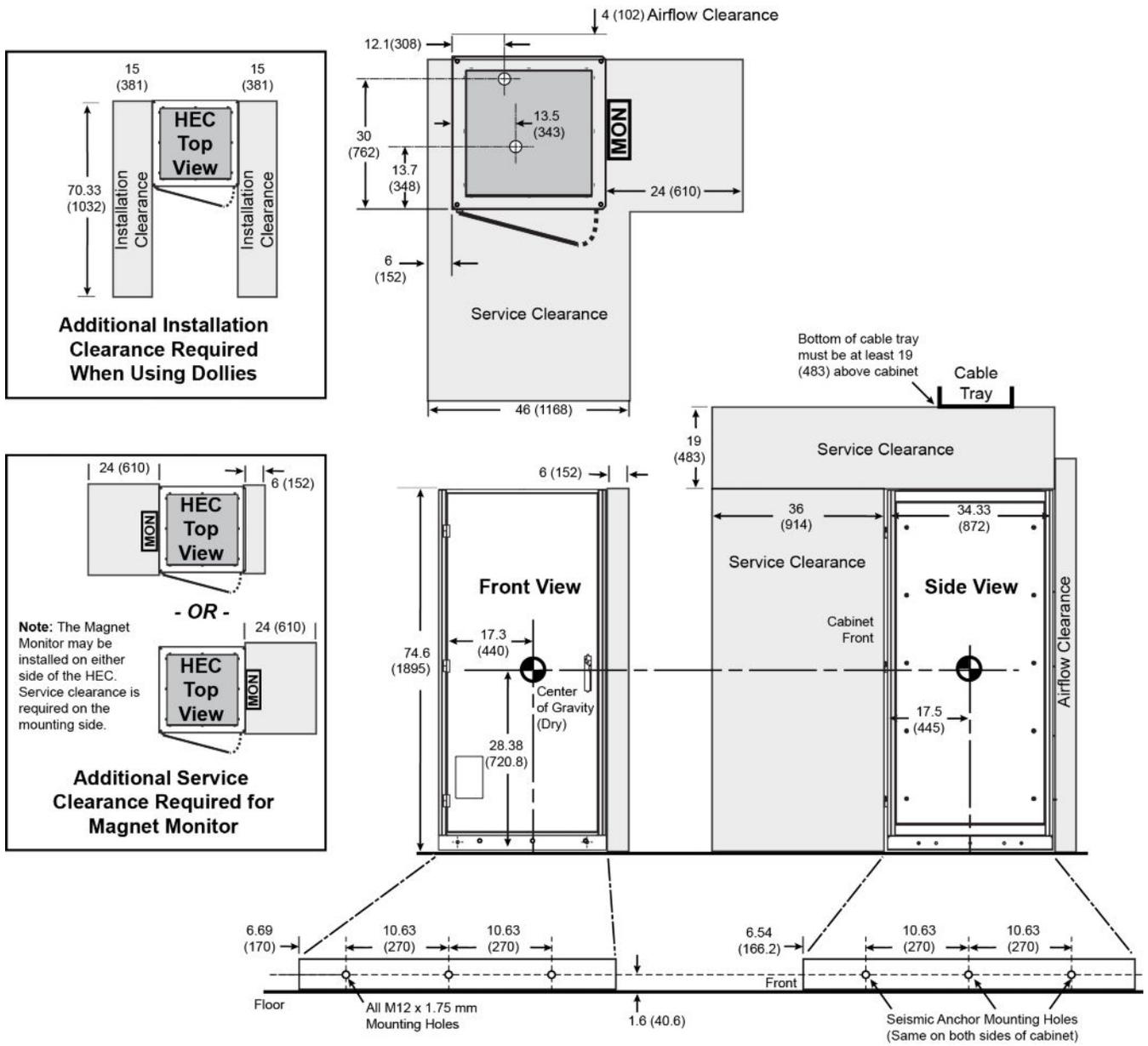


4 Heat Exchanger Cabinet (HEC) Specifications

Facility coolant is supplied to the Heat Exchanger Cabinet (HEC). The HEC provides closed loop chilled water circuits for the Power, Gradient, RF (PGR) Cabinet in the equipment room and the Gradient Coil inside the Magnet Enclosure. The HEC also routes facility chilled coolant to the Cryocooler Compressor (CRY).

1. Weight (approximate):
 - a. Dry (shipping – no fluid): 950 lbs (431 kg)
 - b. Wet (with cooling fluid): 1350 lbs (612 kg)
2. Magnetic Field Limit: 50 Gauss (5 mT)

Illustration 4-4: Heat Exchanger Cabinet (HEC)



5 Penetration Panel Cabinet (PEN) Specifications

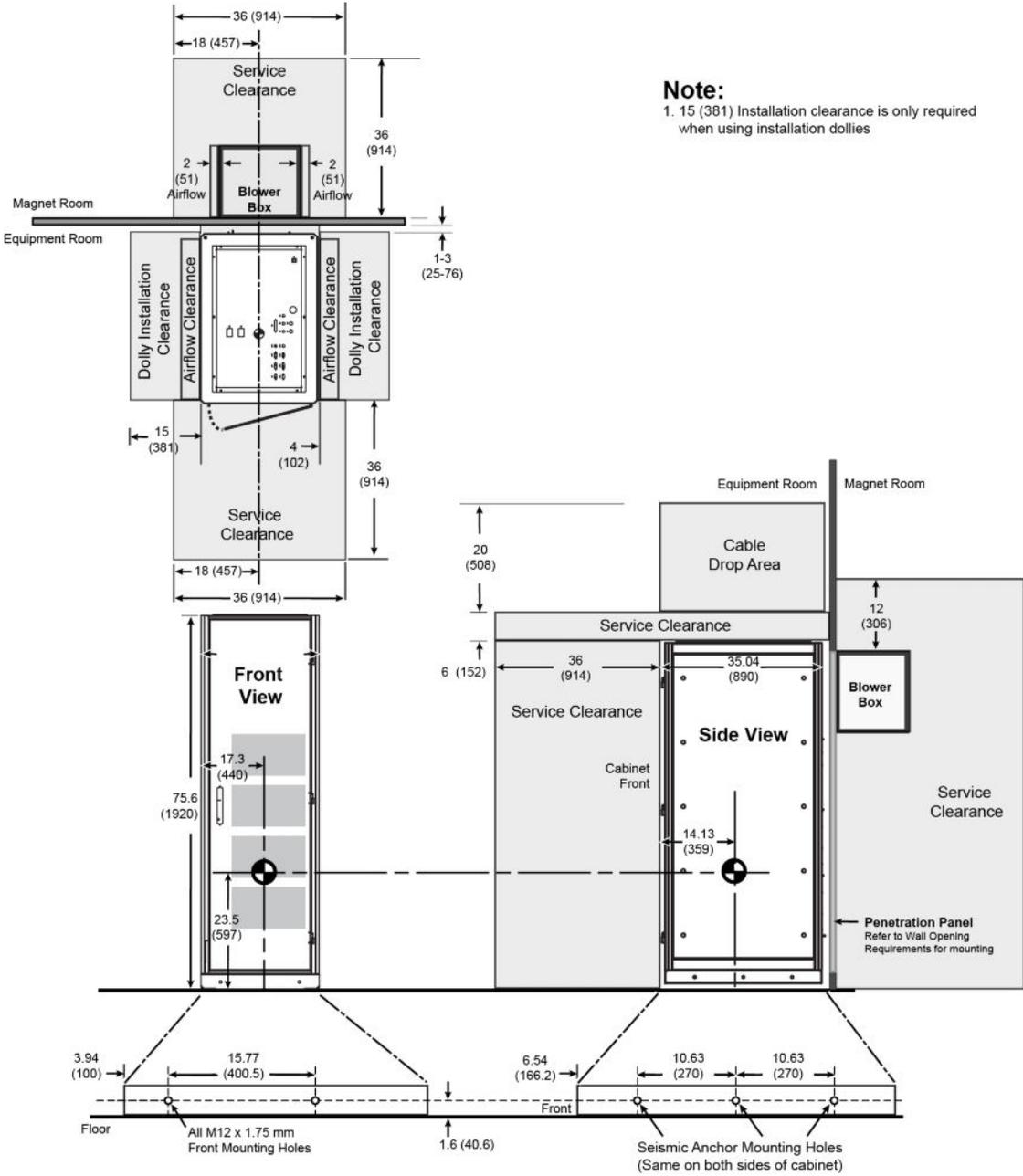
The Penetration Cabinet Penetration Panel provides interconnects from the PEN Cabinet through the Magnet Room RF Shield.

1. Weight: 639 lbs (290 kg)
2. PEN Panel Magnetic Field Limit: 200 Gauss (20 mT) for the entire PEN Panel (i.e., the blower box must be outside the 200 Gauss line)

PEN Cabinet Magnetic Field Limit: 50 Gauss (5 mT)

3. The PEN cabinet must be positioned directly in front of the PEN Panel. See [PEN and SPW Wall Opening Requirements](#) for PEN panel mounting and location requirements

Illustration 4-5: PEN Cabinet



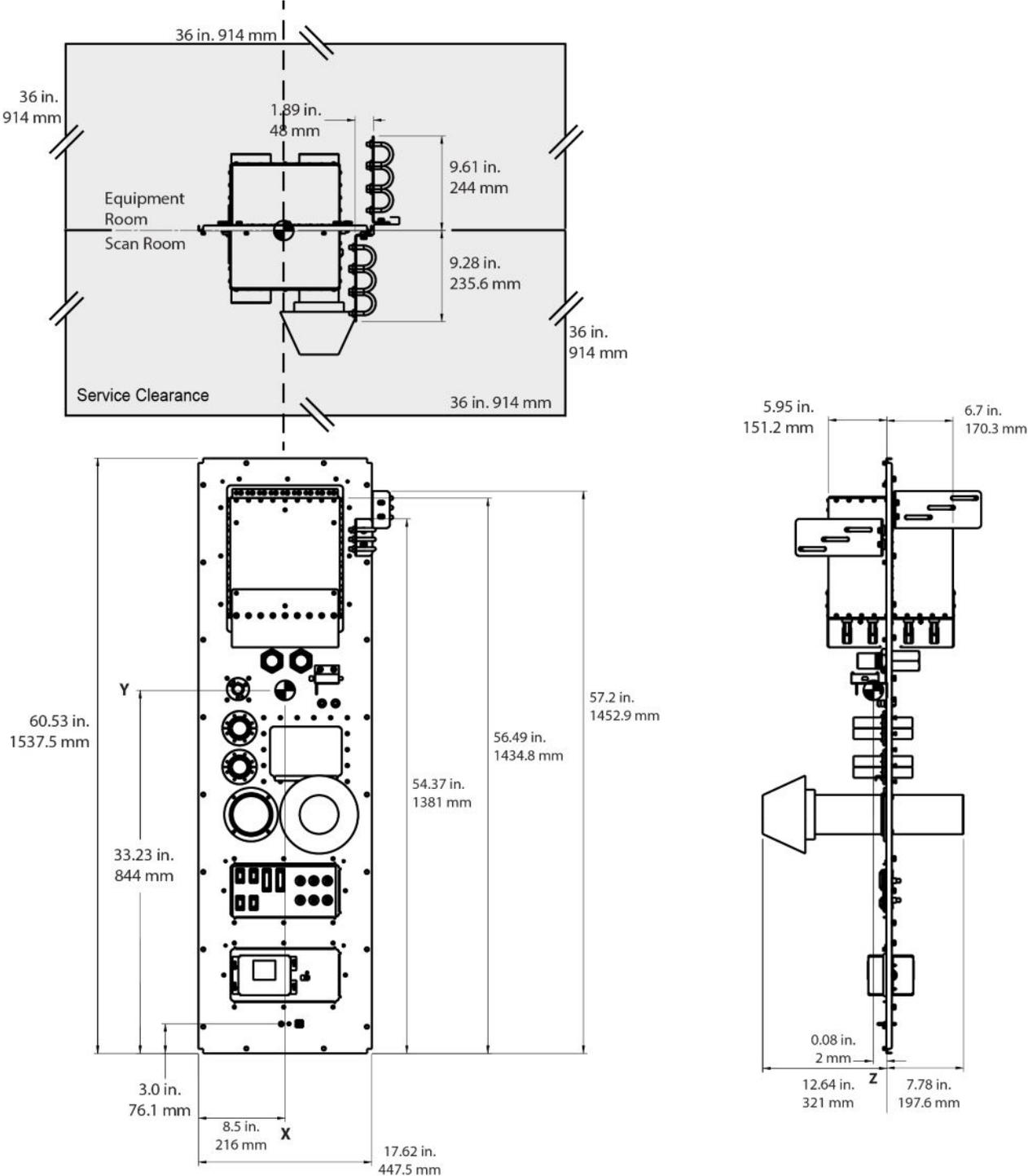
Note:
 1. 15 (381) Installation clearance is only required when using installation dollies

6 Secondary Penetration Wall (SPW) Specifications

The Secondary Penetration Wall (SPW) provides interconnects from the Equipment Room through the Magnet Room RF Shield.

1. Maximum Magnetic Field: 200 Gauss (20mT)
2. See [PEN and SPW Wall Opening Requirements](#) mounting and location requirements
3. The service area for the SPW is 36 in (914mm) from both sides the RF wall, and from floor to cable trays.

Illustration 4-6: Secondary Penetration Wall (SPW)



7 PEN and SPW Wall Opening Requirements

1. The Equipment Room and the Magnet Room must share at least one common wall to mount the PEN panel and SPW
2. Penetration panel frames must be installed on the Equipment Room side of the RF shield by the RF Shield vendor
3. The penetration panel opening requirements are shown below (see [Illustration 4-7](#) and [Illustration 4-8](#)).
4. See [Illustration 4-10](#) for Closet Service Hatch location

The closet service hatch may be located to the left, right, or between the PEN and SPW openings with the minimum spacing shown below.

Magnet room service areas for PEN and SPW must not overlap 200 G in magnet minimum service area

Service area clearance for PEN cabinet: See [Penetration Panel Cabinet \(PEN\) Specifications](#) for detailed dimensions

Illustration 4-7: PEN and SPW Panel Openings and Service Clearance (Top View), Example 1

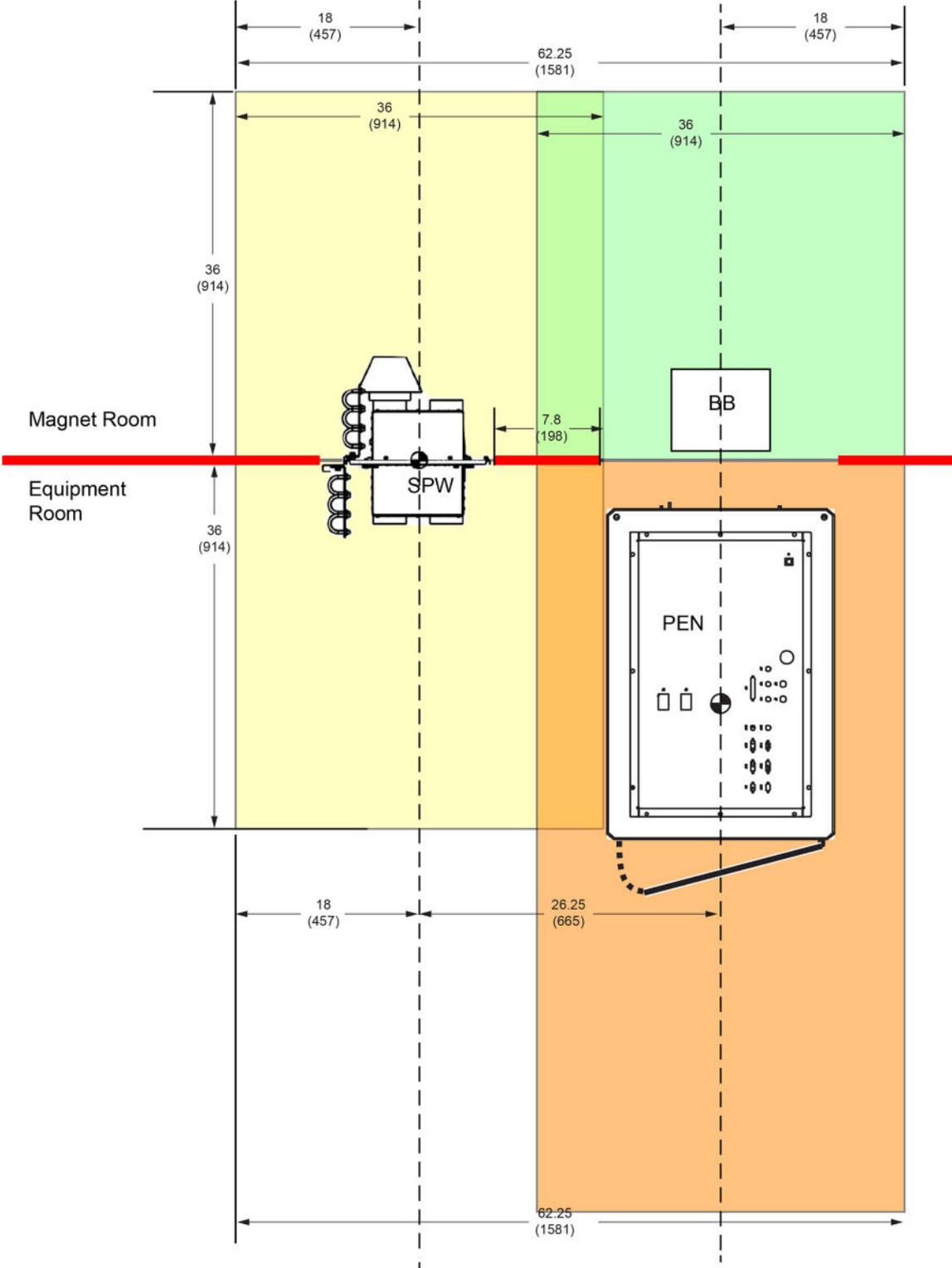


Illustration 4-8: PEN and SPW Panel Openings and Service Clearance (Top View), Example 2

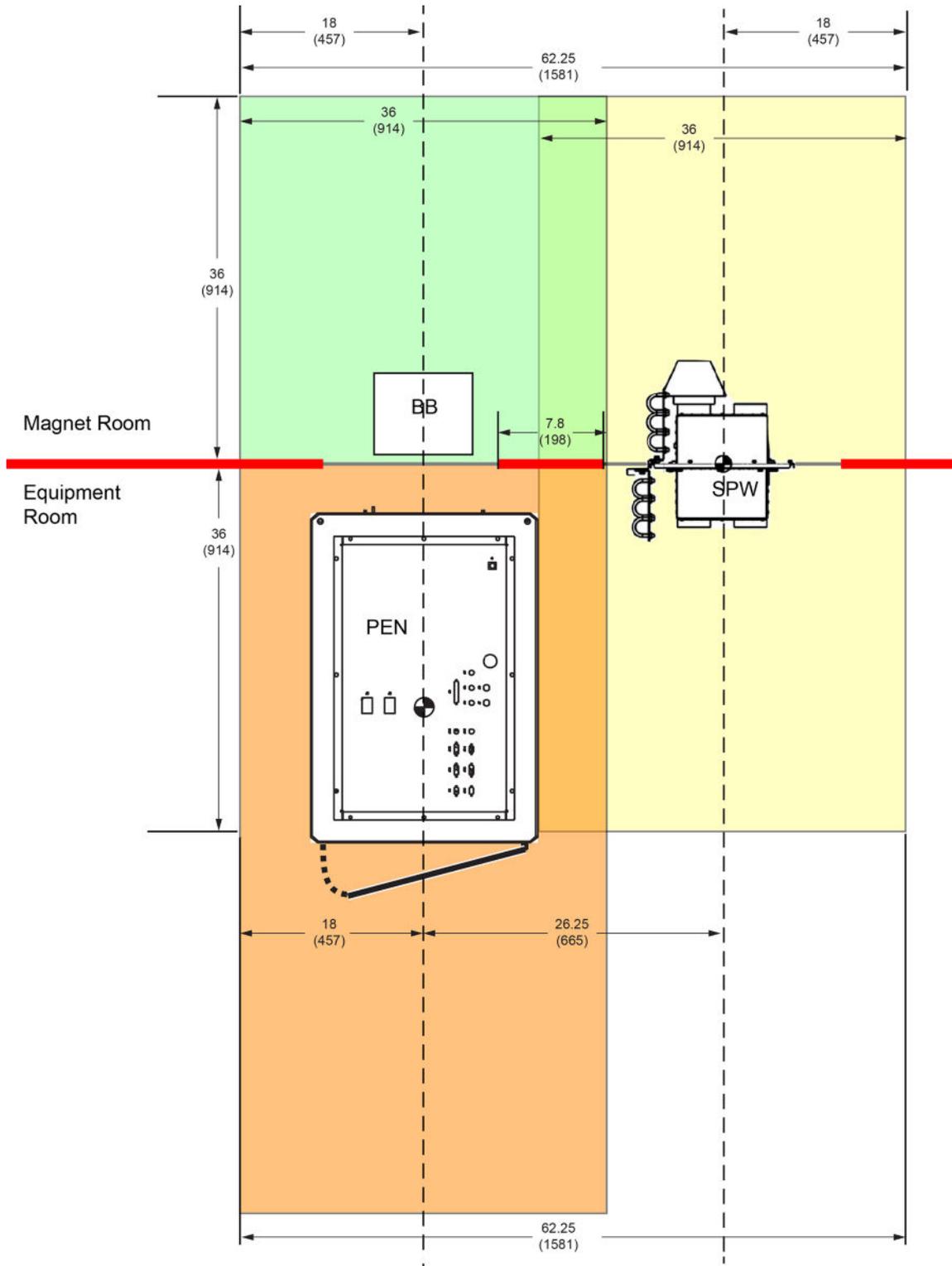


Illustration 4-9: Pen Panel and SPW Wall Openings

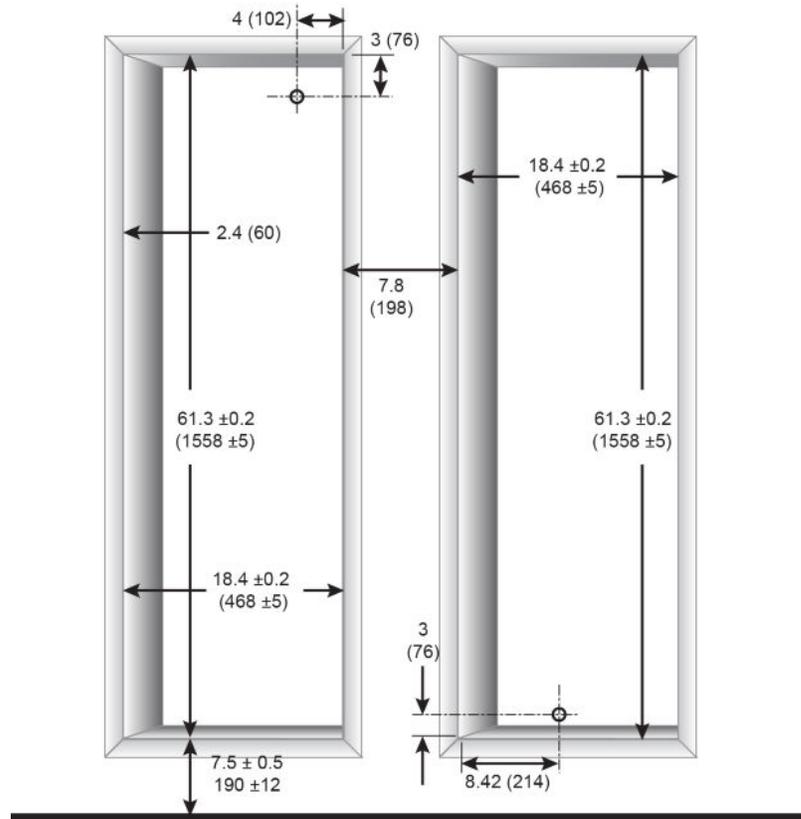


Illustration 4-10: Hatch for Blower Box

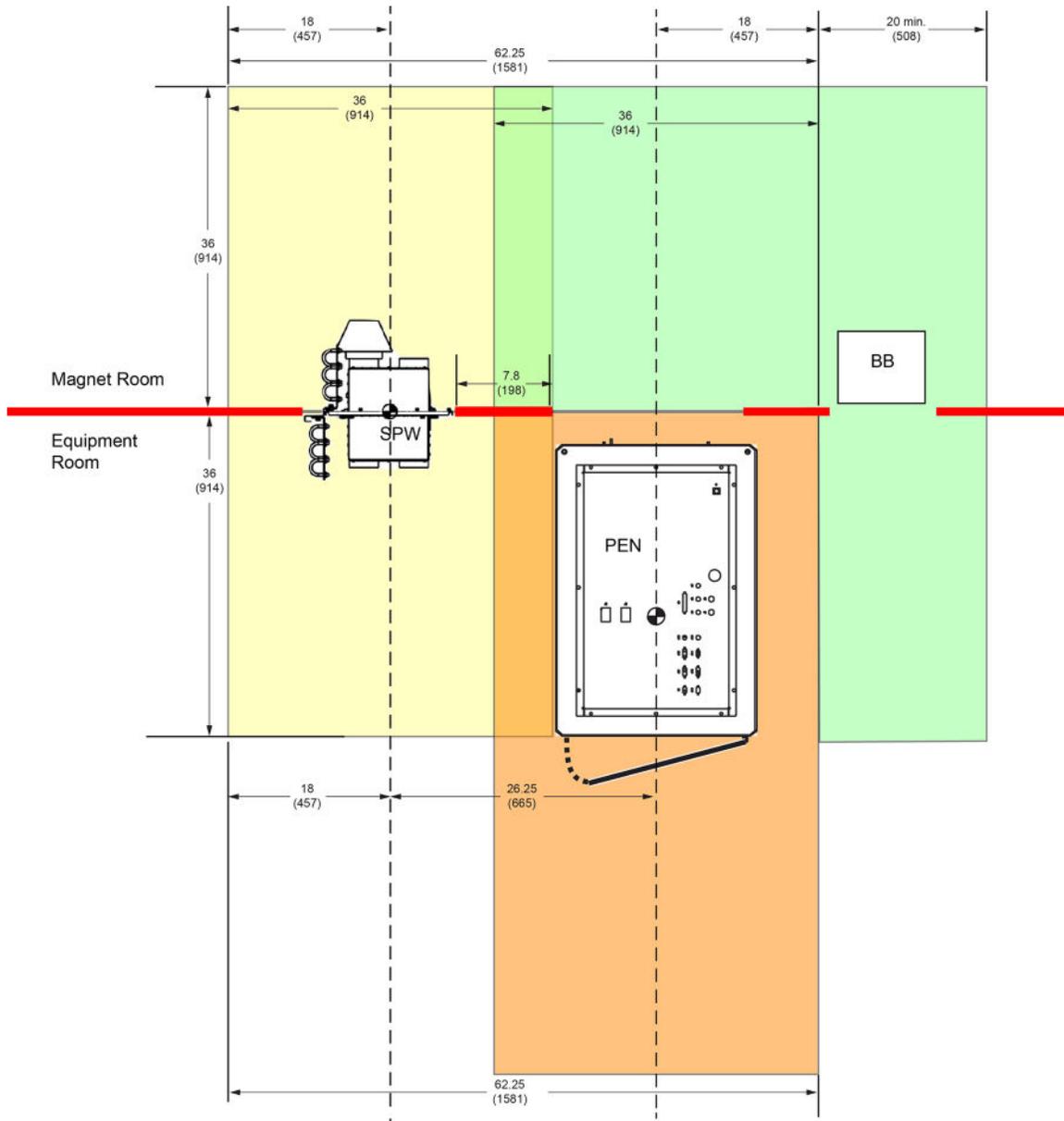


Illustration 4-11: PEN Frame Detail (Top View) Notes

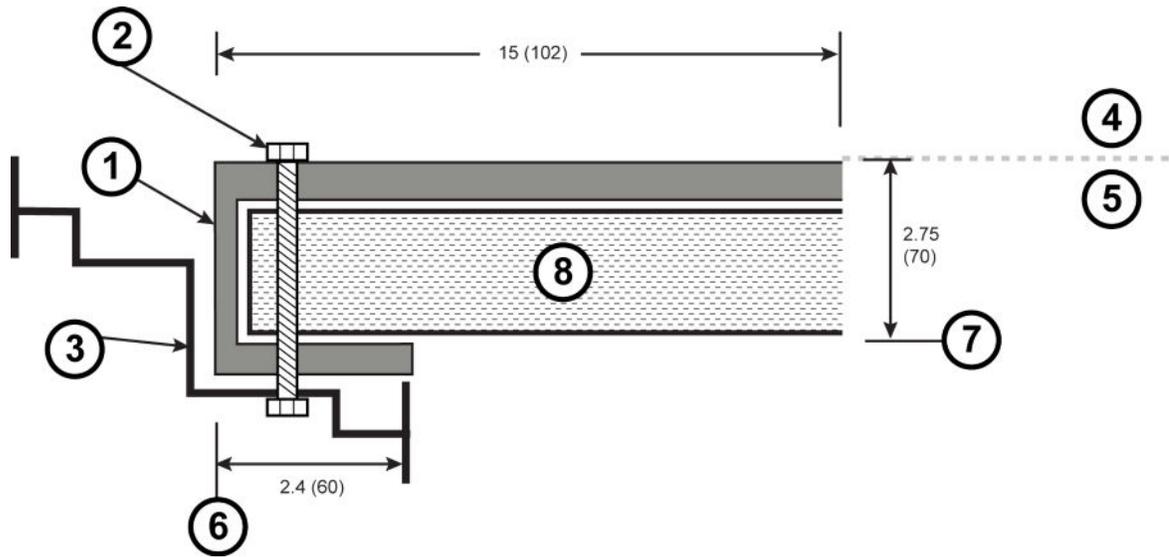


Table 4-1: PEN Frame Detail (Top View) Notes

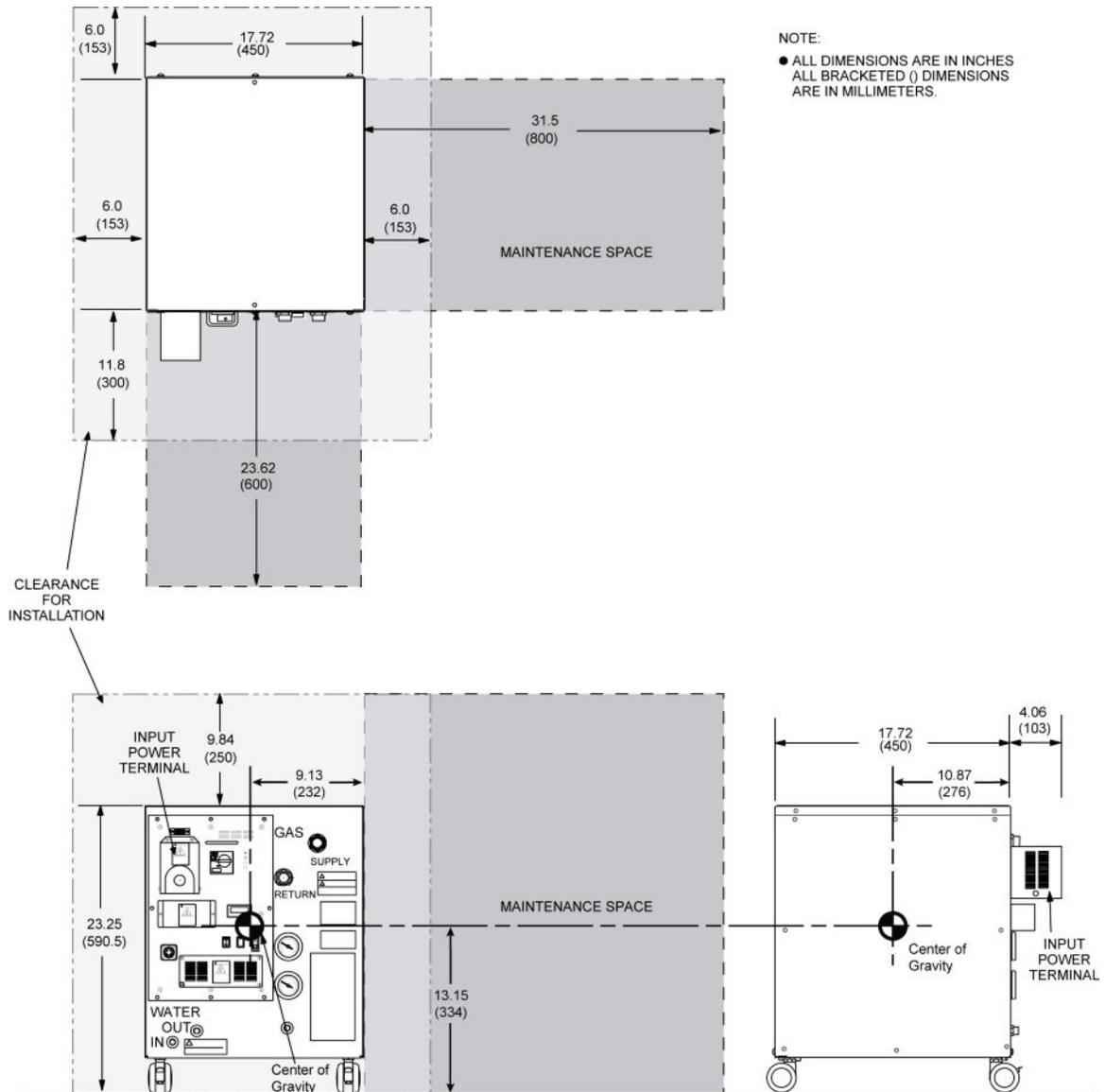
All dimensions are in inches; bracketed dimensions are in millimeters	
Wall Detail cross section is not to scale	
1	RF Shield Material
2	Bolts are provided by screen room vendor and bolt holes are drilled at installation. Bolt length varies by wall thickness
3	PEN Frame
4	Magnet room side
5	Equipment room side
6	Minimum exposed RF shield material (all around)
7	Maximum wall thickness
8	RF shield supporting structure (wall or double-sided galvanized panels, etc.)

8 Cryocooler Compressor (CRY) Specifications

Water cooling for the F-50 Cryocooler Compressor (CRY) is provided from the Heat Exchanger Cabinet (HEC) or facility supplied emergency backup water supply.

1. Weight: 264 lbs (120 kg)
2. Magnetic Field Limit: 100 Gauss (10 mT)

Illustration 4-12: Cryocooler Compressor



9 Magnet Monitor (MON) Requirements and Specifications

9.1 Requirements

1. Customer must supply T100 network connection with RJ45 connector to the Magnet Monitor (MON)
2. The network connection must not be routed through the Ethernet switch in the Global Operator Cabinet (GOC)
3. The Magnet Monitor requires a 110/220 VAC, 50/60 Hz, 2.0 A facility supplied outlet. Power at the outlet must be continuously available

9.2 Specifications

1. Mounting location: On either side of the Heat Exchanger Cabinet (HEC)
2. Weight: 10 lbs (4.5 kg)
3. Maximum gauss limit: 200 gauss (20 mT)
4. Power cord length: 72 in. (1829 mm)

Table 4-2: MNS Amplifier Cabinet (MNS) for 8 kW MNS Option Notes

All dimensions are in inches. All bracketed dimensions are in millimeters.

Graphic is not to scale.

The maximum magnetic field in which the cabinet can be located is 50 Gauss (5 mT),

The cabinet weights approximately 1150 pounds (523 kg).

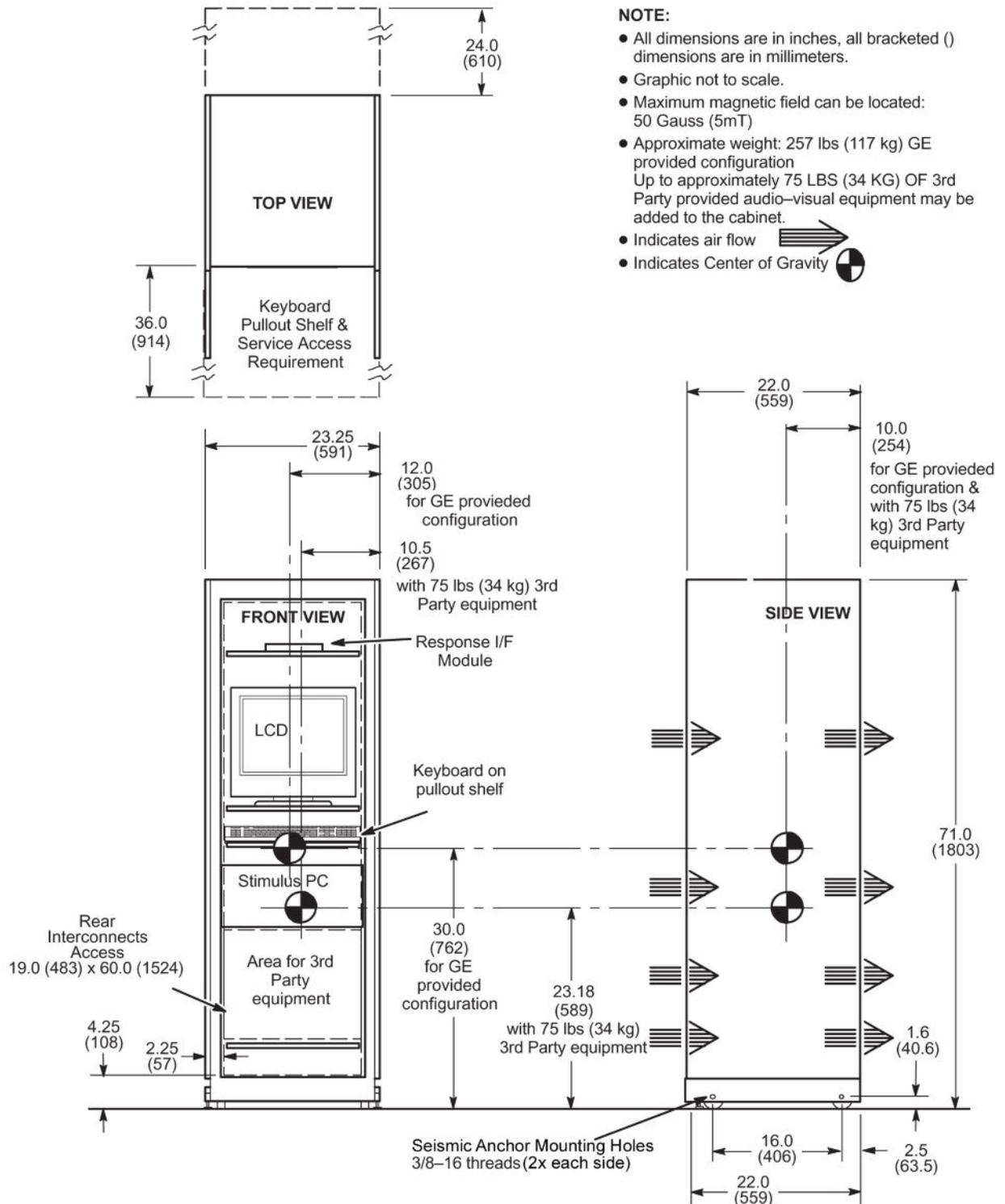
This symbol indicates the direction of air flow:



A	Top view
B	Front view
C	Side view
1	Service door
2	Service access requirement
3	Rear interconnect cable access
4	Service anchor mounting holes 3/8 – 16 threads
5	Center of gravity

11 Brainwave Lite (BW) Specifications

Illustration 4-15: Brainwave Lite Cabinet (BW)



Chapter 5 Control Room

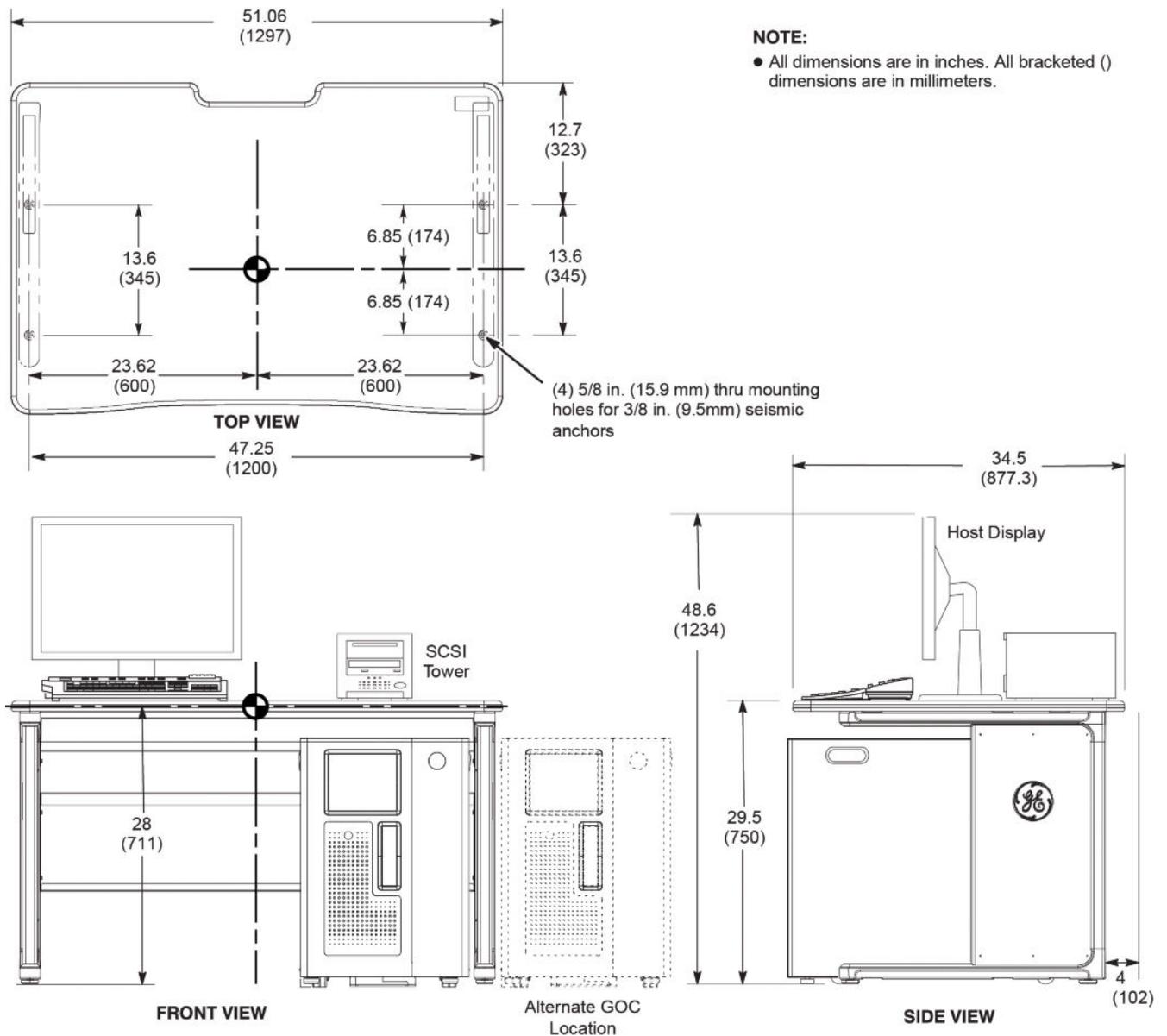
1 Operator Workspace Equipment Specifications

The operator seated at the Operator Workspace must have an unobstructed view of the patient on the Patient Table docked to the Magnet.

1.1 Operator Workspace (OW)

NOTE: The Operator Workspace table is optional.

Illustration 5-1: Operator Workspace (OW)



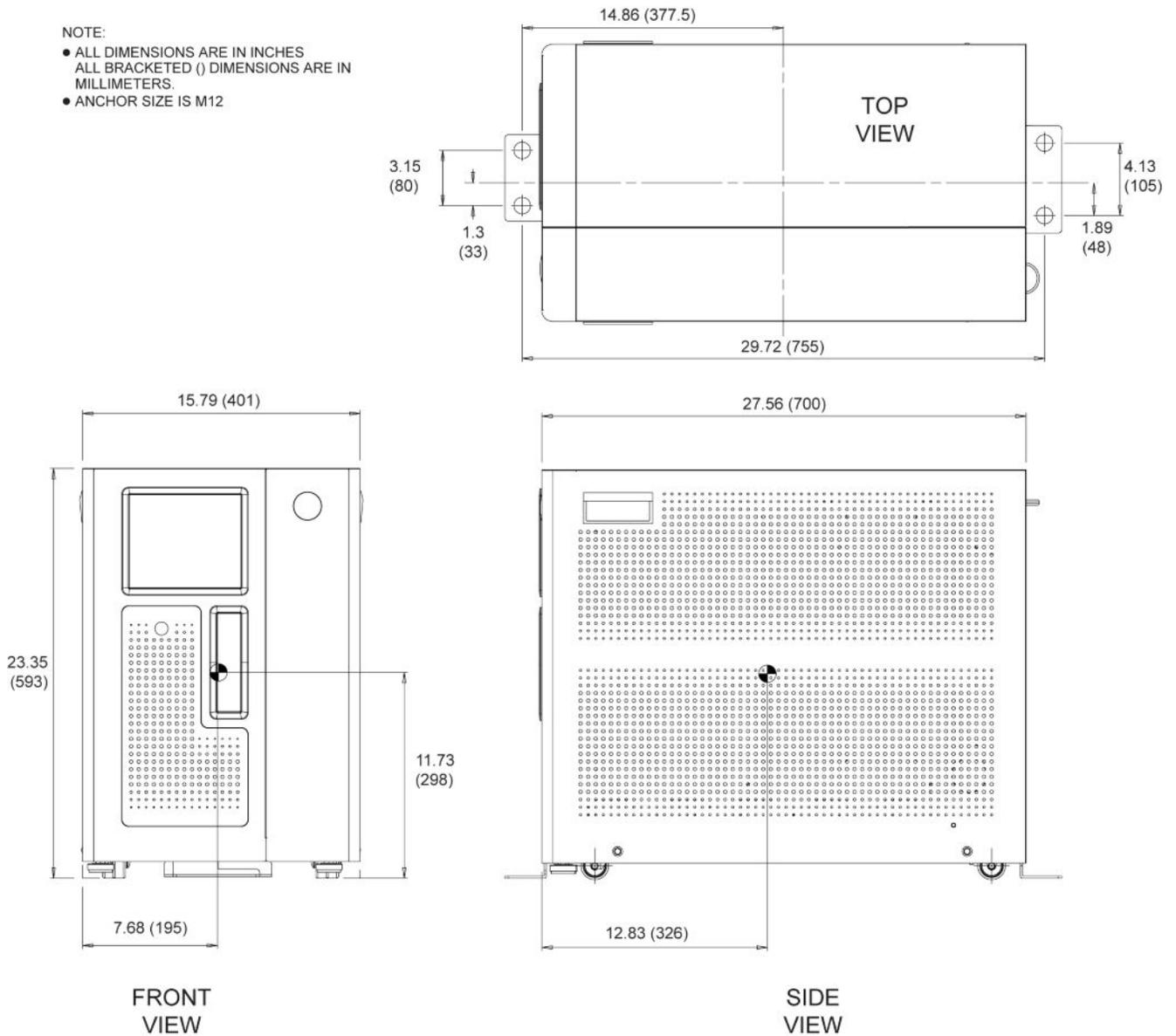
1.2 Global Operator Cabinet (GOC)

1. Weight: 141.75 lbs (64.3 kg)

2. Magnetic Field Limit: 50 Gauss (5 mT)

Illustration 5-2: Global Operator Cabinet (GOC)

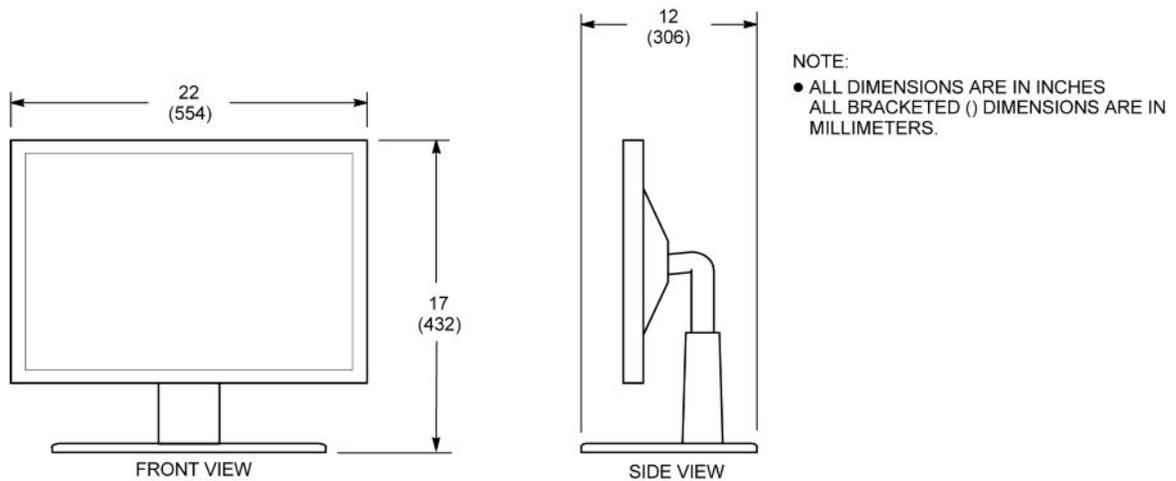
NOTE:
 • ALL DIMENSIONS ARE IN INCHES
 • ALL BRACKETED () DIMENSIONS ARE IN MILLIMETERS.
 • ANCHOR SIZE IS M12



1.3 Host Display

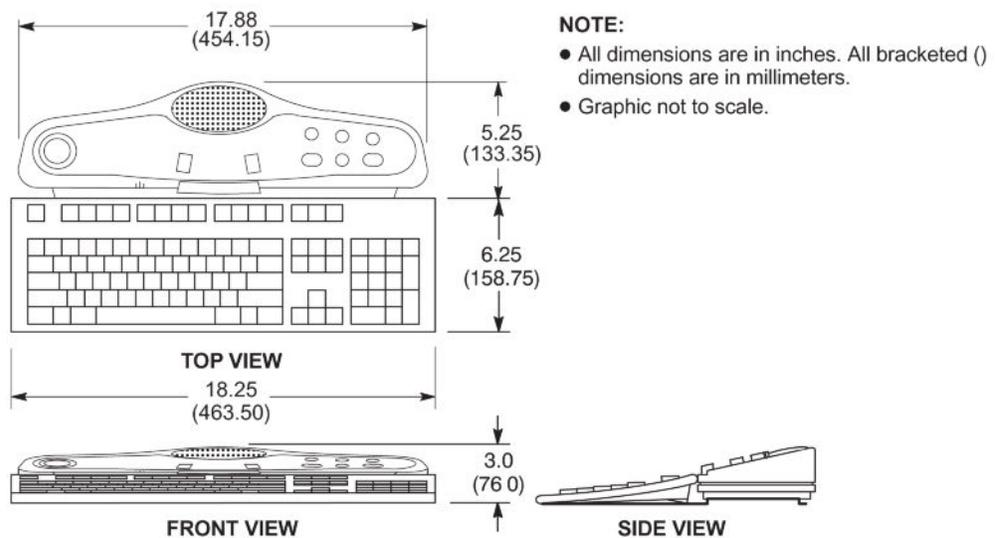
1. Weight 26 lbs (11.8 kg)
2. Magnetic Field Limit: 50 Gauss (5 mT)

Illustration 5-3: Host Display



1.4 Host Keyboard

Illustration 5-4: Host Keyboard

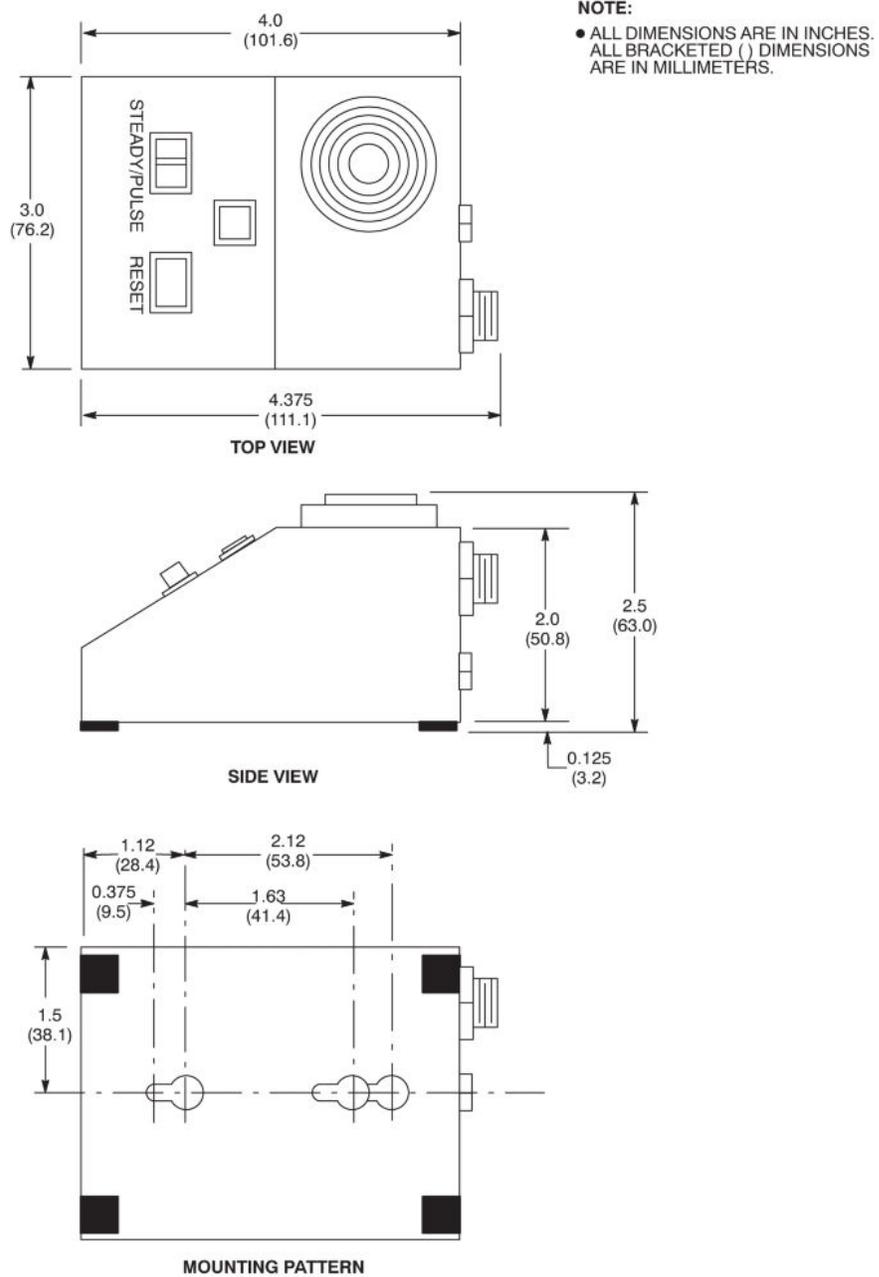


1.5 Pneumatic Patient Alert

The Pneumatic Patient Alert system allows the patient to contact the operator. 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.

1. Weight 0.5 lbs (0.2 kg)
2. Magnetic Field Limit: 50 Gauss (5 mT)
3. The Control Box must be mounted within sight of operator and within 5 ft. (1.5 m) of an electrical outlet

Illustration 5-5: Pneumatic Patient Alert (PA)



2 Oxygen Monitor (OXY) Option Specifications

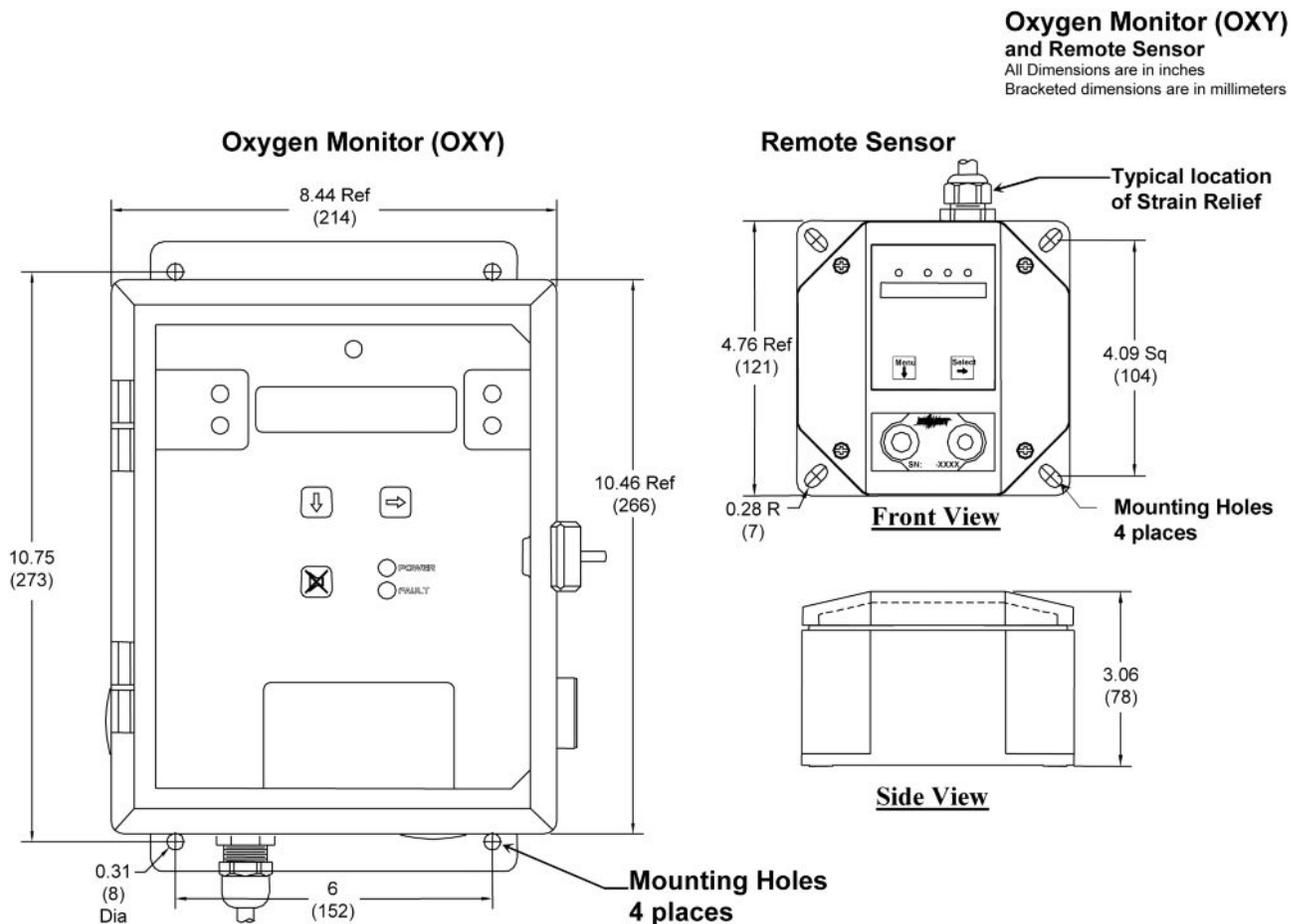
The optional Oxygen Monitor system consists of the Oxygen Monitor, the Remote Oxygen Sensor Module, and interconnects through the Secondary Penetration Wall (SPW). The Oxygen Monitor alarm is located near the Operator Workspace is activated by the Remote Oxygen Sensor Module in the Magnet Room.

1. Oxygen Monitor Weight: 8 lbs (3.6 kg)
2. Oxygen Sensor Module Weight: 2 lbs (0.9 kg)
3. The Oxygen Monitor requires facility supplied power:

Table 5-1: Oxygen Monitor Facility Power Requirements

Parameter	Requirements
Voltage / Frequency	100-240 VAC, 50/60 Hz
Phase	1
Maximum Amps	0.9
Connection type	Hard wired in unit

Illustration 5-6: Oxygen Monitor and Remote Sensor



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Chapter 6 MR System Interconnects

1 MR System Interconnects Specifications

1.1 Component Designator Definitions

GE Healthcare uses Component Designators to identify system components. All subsystem cabinets and other components are referred to by their component designators in the Interconnect Data diagrams and tables.

Table 6-1: MR System Component Designators

Component Designator	Description
CRY	Cryocooler Compressor Cabinet
E01, E02, etc.	Emergency Off Buttons
MDP	Main Disconnect Panel
HEC	Heat Exchanger Cabinet
MAG	Magnet and Enclosure (all magnet enclosure components in Magnet Room)
Modem	Modem for Magnet Monitor
MON	Magnet Monitor
MRU	Magnet Rundown Unit
OW	Operator Workstation
PA1	Pneumatic Patient Alert Control Box
PDU	Power Distribution Unit (PDU) is a module in the PGR cabinet
PED	Magnet Rear Pedestal
PEN	Penetration Panel Cabinet
PGR	Power Gradient RF Cabinet
PT	Patient Transport Table
DS, DS1	Door Switch
SPW	Secondary Pen Wall

Table 6-2: MR System Options Component Designators

Component Designator	Description
BW	Brainwave Lite Cabinet
MNS	MNS Cabinet
OXY	Oxygen Monitor
OM2	Remote Oxygen Sensor Module

1.2 Usable Cable Lengths

Three configurations of cable lengths are available for order. Measure the distances between the equipment and compare them to the distances specified in the tables. If the your distance is less than the shortest distance specified, the Site Option is “Short”; if your distance is longer

than the longest distance specified, the Site Option is “Long.” If all of your Site Options are “Long-Long,” the configuration of the equipment will have to change.

Table 6-3: Order Configuration Options

Configuration	Equipment Room — Site Option	Magnet Room — Site Option
A	Short	Short
B	Long	Short
C	Short	Long

Table 6-4: Usable Cable Lengths

Point A	Point B	Site Option A: Short ER, Short SR	Site Option B: Long ER, Short SR	Site Option C: Short ER, Long SR
		in. (mm)		
Equipment Room				
CRY	Magnet Monitor	370.1 (9400)		
Magnet Monitor	SPW, bottom edge	661.4 (16800)		
HEC, top panel	CRY	354.3 (9000)		
HEC, top panel	Customer-Supplier Network	1102.4 (28000)		
PEN cabinet, top panel	GOC, rear panel	141.7 (29000)		
PEN cabinet, top panel	Magnet Monitor	645.7 (16400)		
PEN Ground stud	RF common ground stud	86.6 (2200)		
SPW Ground stud	RF common ground stud	85.6 (2200)		
PGR, top panel	GOC, rear panel	1133.9 (28800)		
PGR, top panel	HEC, top panel	346.5 (8800)		
PGR, top panel	Magnet room door switch	960.6 (24400)		
PGR, top panel	PEN cabinet, top panel	370.1 (9400)	645.7 (16400)	370.1 (9400)
PGR, top panel	SPW, bottom edge	385.8 (9800)	661.4 (16800)	385.8 (9800)
SPW, bottom edge	CRY	551.2 (14000)		
SPW, bottom edge	E-off switch, Control room or Equipment room	385.8 (9800)	661.4 (16800)	385.8 (9800)
SPW, bottom edge	GOC, rear panel	1149.6 (29200)		
HEC, top panel	SPW, bottom edge	244 (6200)	677 (17200)	244 (6200)
Magnet Room				
GOC, rear panel	MAG, gradient cable clamp block	1496.1 (38000)		1653.5 (42000)
PEN panel, bottom edge	MAG, gradient cable clamp block	307.1 (7800)		464.6 (11800)
SPW, bottom edge	E-off switch, Magnet Room	1173.2 (29800)		
SPW, bottom edge	MAG, gradient cable clamp block	338.6 (8600)		488.2 (12400)
Notes: All cable lengths include a 24 in. (600 mm) service loop				

1.3 Multi-Nuclear Spectroscopy Option

Table 6-5: MNS Option Usable Cable Lengths

Cable Part number	Point A	Point B	Site Option A: Short ER, Short SR	Site Option B: Long ER, Short SR	Site Option C: Short ER, Long SR
			in. (mm)		
	PGR, top panel	MNS Cabinet	383.9 (9750)		
5169804-15	J200	J5			
5169804-16	J201	J6			
5169804-17	J202	J7			
5169804-18	J203	J8			
5169227-4	J204	J1			
5310317	J205	J12			
	PEN cabinet, top panel	MNS Cabinet	622 (15800)		
5169804-19	J4	J11			
5270425	J16	J3			
	PEN cabinet	PGR cabinet	653.5 (16600)		
5265483	MNS BB Exciter H1	J12			
	PEN cabinet	SPW	551.2 (14000)		
5265976	J4	J129			
Note: All cable lengths include a 24 in. (600 mm) service loop					

1.4 Brainwave Option

Table 6-6: Brainwave Option Usable Cable Lengths

Cable Part number	Point A	Point B	Site Option A: Short ER, Short SR	Site Option B: Long ER, Short SR	Site Option C: Short ER, Long SR
			in. (mm)		
	PEN Wall/Cabinet	Brainwavew Cab- inet			
LG408	Empty 9 pin D-sub	Lumina Controller	720 (18,288)		
LU001-60	J16 in PEN Cab- inet	Lumina Controller	720 (18,288)		

2 MR System Interconnects Routing Requirements

2.1 General Requirements

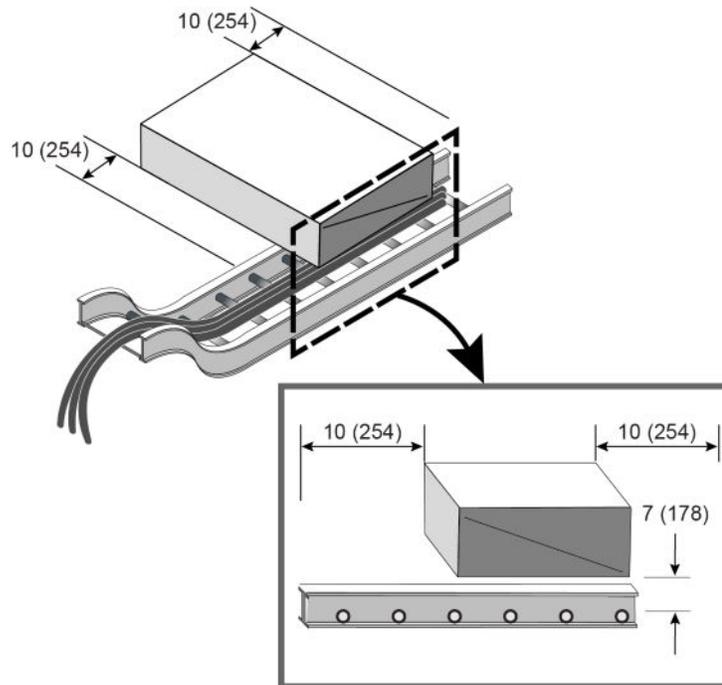
1. The customer is responsible for the purchase and installation of all cable support mechanisms
2. Any type of nonferrous cable support may be used, such as commercially available ladder or wire rack style cable trays, provided the cable trays meet all MR system requirements
3. The distance between cable supports must be less than 12 in. (305 mm). For example, the distance between rungs on a ladder tray, or the distance from the end of a cable tray to a final nonferrous cable support must be 12 in. (305 mm) or less
4. The cable supports must have the minimum cable bend radius per [MR System Cable Specifications](#). For example, the vertical and horizontal bends of the gradient cables must have a bend radius of 13 in. (330 mm)
5. Cable supports may be stacked or side-to-side
6. Cables must be accessible on at least one side of the cable support and require a minimum of 10 in. (254 mm) from the top of the tray. (For example, see [Illustration 6-4](#).) If this is not possible due to obstructions, see the exceptions below
7. All individual cable supports (e.g. rungs) require lateral support to maintain the positions specified in the illustrations both during installation and after installation of the interconnects (e.g. cables).

Exceptions for Obstructions:

1. The top of the cable tray must not touch an obstruction. A minimum of 10 in. (254 mm) of clearance is required on either side of the obstruction. See [Illustration 6-1](#).
2. A minimum of 7 in. (178 mm) of clearance is required from the top of the tray rung to the lowest point of any obstruction. The illustration below.

NOTE: The illustration below shows how to route cable trays around HVAC ducts, light fixtures, medical gases, structural beams, and other obstructions. If local code permits, a tray with a bend can route the cables underneath an obstruction. At the rear of the magnet, the cable tray must be installed at the minimum height. The part of the cable tray that is under the obstruction can be installed at a lower height. The tray bend must provide the minimum cable bend radius.

Illustration 6-1: Obstruction Example



2.2 Magnet Room Requirements

1. Two cable trays must be used, each at least 18 in. (457 mm) wide
2. Installation and routing of cable trays must be coordinated with the RF shield vendor
3. Side-to-side trays in the Magnet room must not touch to prevent RF broadband noise caused by metal-to-metal sidewall contact
4. If trays are stacked, the air, water, and cryogen lines must be run in the lower support (see [Illustration 6-2](#))
5. Each cable tray must support a weight of at least 50 lbs/ft (74.8 kg/m)

NOTE: If stacked, each cable tray must support the weight of both cable trays: i.e., 100 lbs/ft (149.6 kg/m)

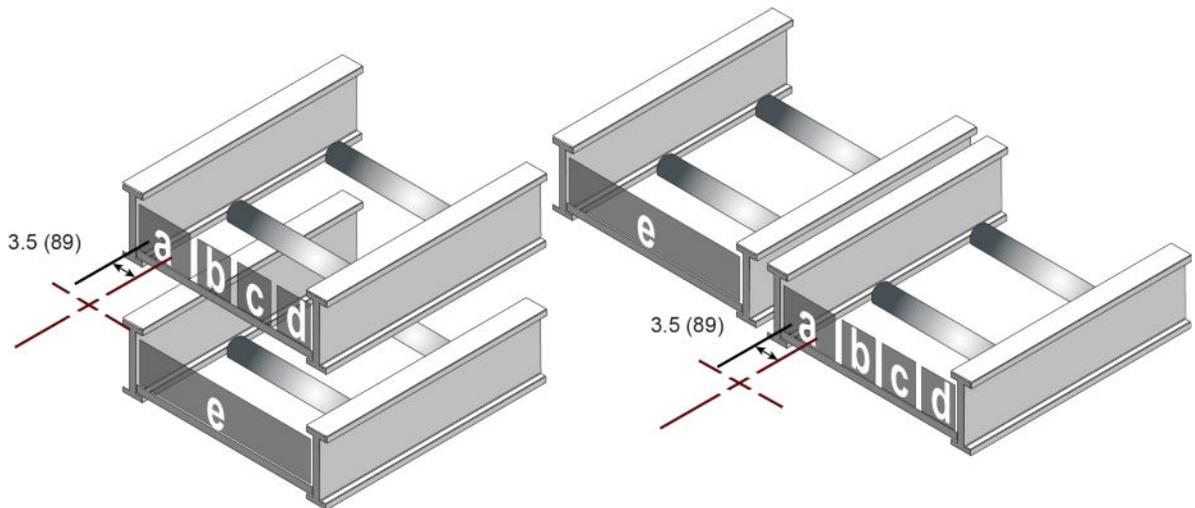
6. Ceiling grid work, medical gas lines, lighting fixtures, etc. must not touch MR system cabling or cable supports
7. Excess cable length in the Magnet room must be stored in either:
 - a. Penetration Panel closet
 - b. Magnet room cable trays (excess cable must be at least 36 in. (915 mm) from the magnet end of the tray)

2.2.1 Recommended Cable Groupings

We recommend the grouping order shown below. The cable groups must not touch. Local code may require dividers, channeling, bundling, etc.

- Group a — Gradient and RF common ground cables. In the Magnet room, the gradient cable group must be laid in a single layer. The center of cable group “a” is 3.5 in. (89 mm) from the inside edge of the tray, in line with the magnet center. See [Illustration 6-2](#).
- Group b — Coax, RF, and AC power cables with jacket rating of 600V and above
- Group c — Data and fiber optic and 300V coax or RF clock cables
- Group d — 300V signal, 300V power, and 300V power/signal cables
- Group e — Air, water, and cryogen lines

Illustration 6-2: Cable Groupings



2.2.2 Cable Tray Requirements and Examples

1. The gradient cable support must end at the back of the magnet 49 ± 0.5 in. (1245 ± 12 mm) from geometric isocenter. See [Illustration 6-3](#), [Illustration 6-4](#), and [Illustration 6-5](#).
2. Supports for all other cables and hoses must end at the back of the magnet 34 ± 0.5 in. (864 ± 12 mm) from geometric isocenter.
3. Cable supports must have a minimum height of 101.5 in. (2581 mm) at the back of the magnet measured from the floor. See [Illustration 6-3](#).

NOTE: Supports may be lower at other points along the route to clear obstructions as long as all other requirements are met

4. The top of the cable tray must be less than 128 in. (3251 mm) above the finished floor. See [Illustration 6-3](#).

Illustration 6-3: Cable Tray Requirements Example (Side-By-Side)

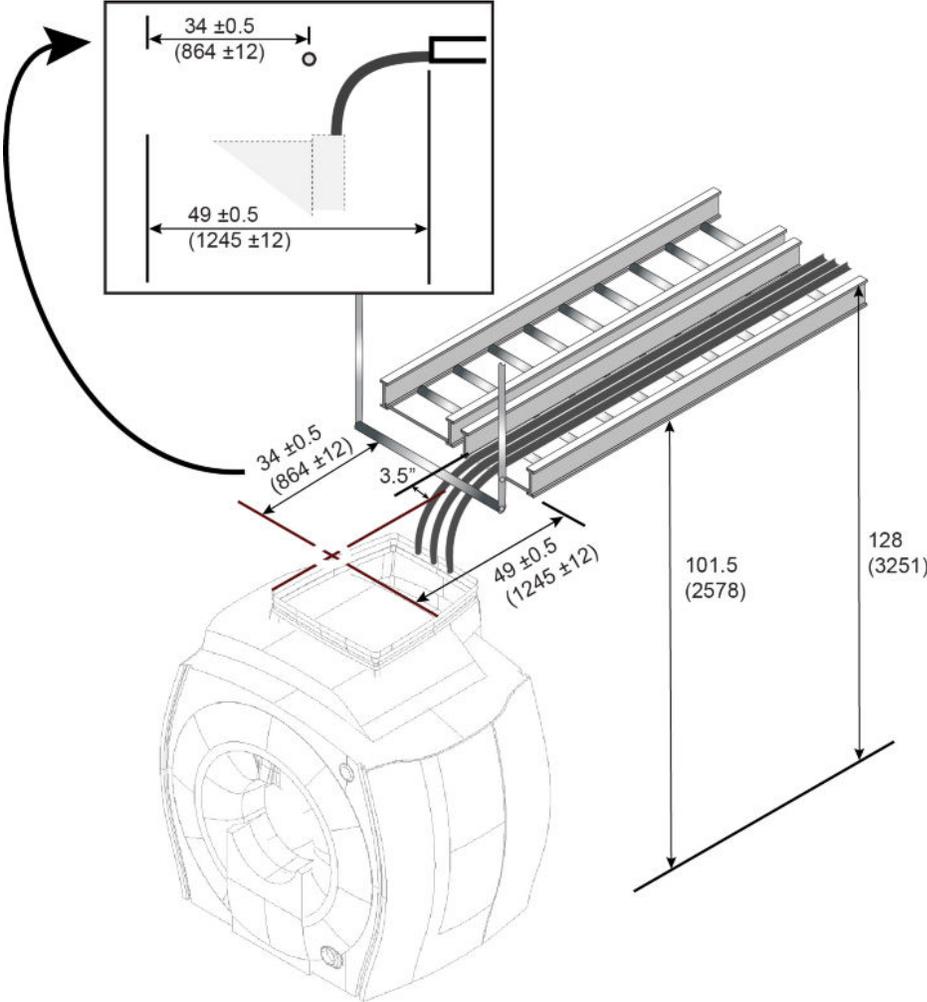


Illustration 6-4: Cable Tray Requirements Example (Stacked)

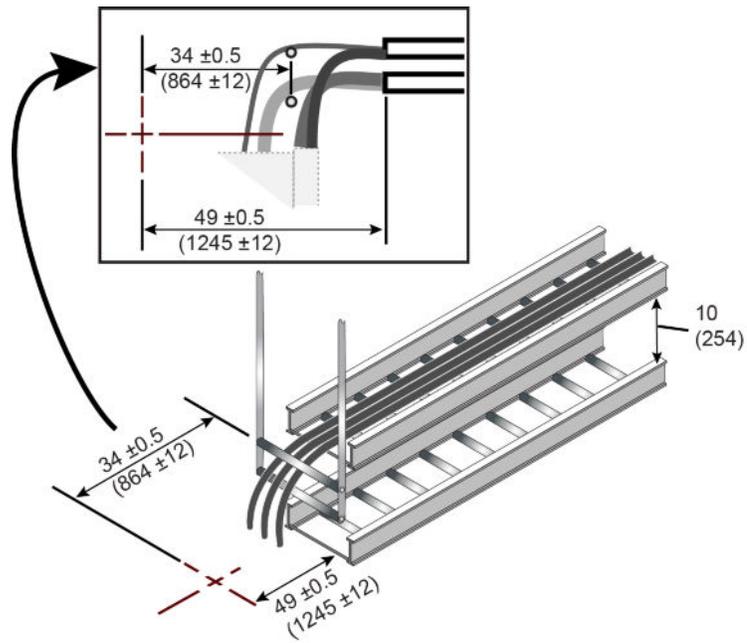
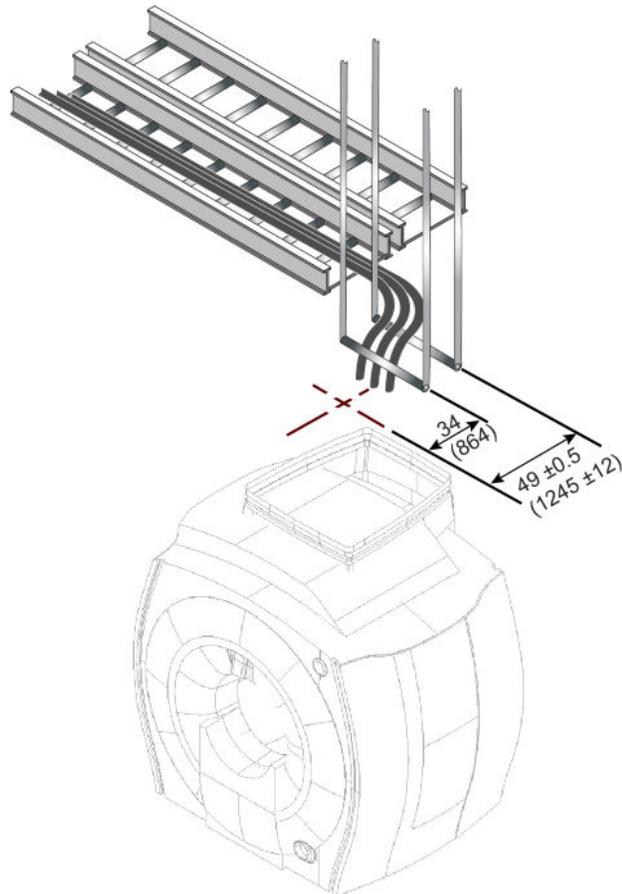


Illustration 6-5: Cable Tray Requirements Example (90° Magnet Interface)



2.3 Penetration Panel Closet Requirements

1. The end of the cable support must be contained within the Penetration Panel closet (see [Illustration 6-6](#))
2. The end of the gradient cable support must be parallel to the Secondary Pen Wall (SPW)
3. The gradient cable support height and distance from the SPW must support a minimum cable bend radius of 13 in. (330 mm) to accommodate gradient cables

Illustration 6-6: Gradient Cable Drop to SPW (Side View)

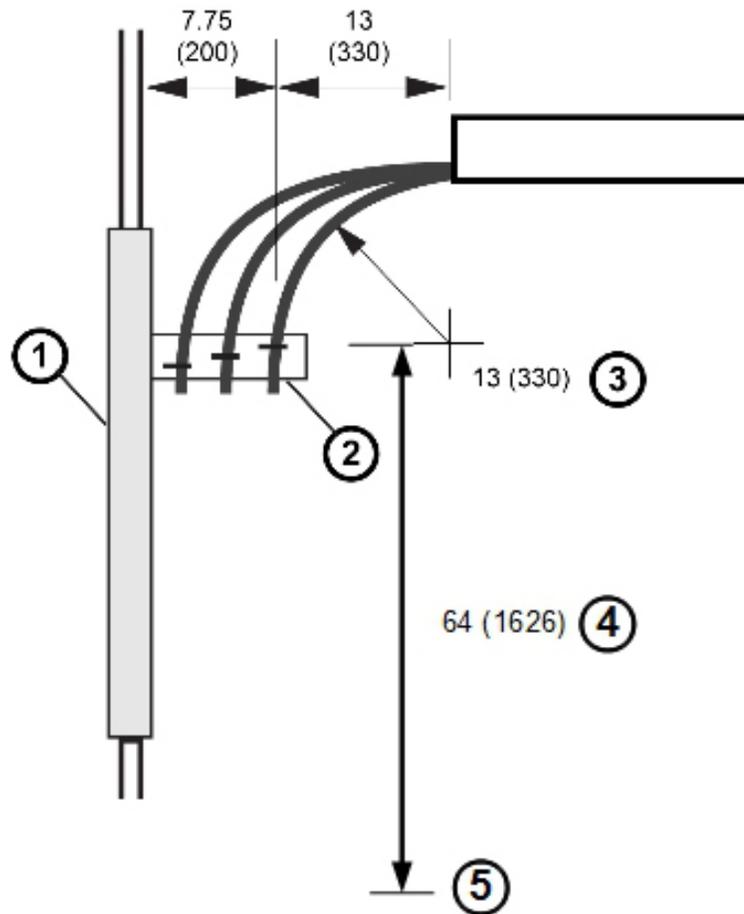


Table 6-7: Gradient Cable Drop to SPW (Side View) Notes

All dimensions are in inches; bracketed dimensions are in millimeters	
1	Secondary Pen Wall (SPW)
2	Gradient Cable Clamps
3	Gradient Cable drop nearest to the cable tray must have a minimum bend radius of 13 (330).
4	Drop from bottom of cable tray to floor

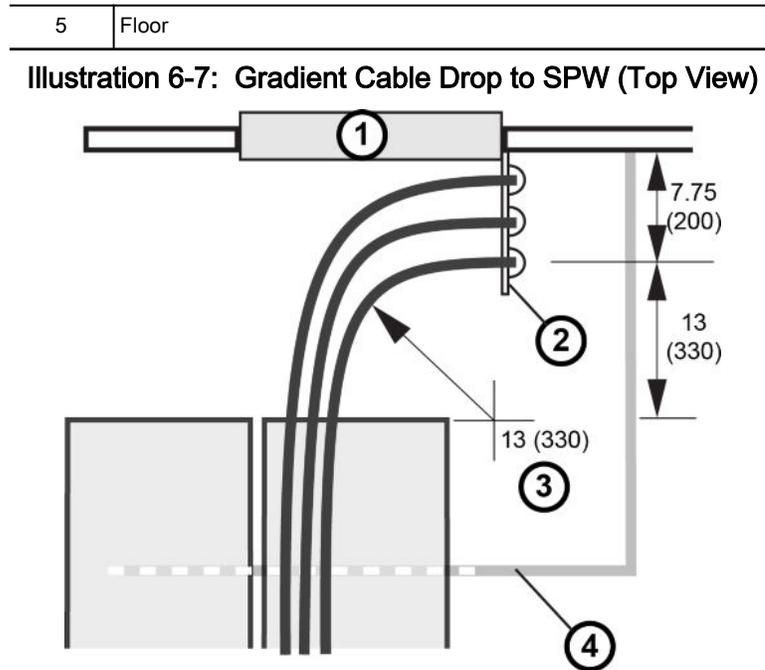


Table 6-8: Gradient Cable Drop to SPW (Top View) Notes

All dimensions are in inches; bracketed dimensions are in millimeters	
Cables must drop through the bottom or from the end of the tray	
1	Secondary Pen Wall (SPW)
2	Gradient Cable Clamps
3	Gradient Cable drop nearest to the cable tray must have a minimum bend radius of 13 (330).
4	The end of the cable tray must be contained in the PEN closet (cables must not rest directly on the wall opening)

2.4 Equipment Room Requirements

1. All equipment interconnects must route overhead (except helium hoses)
2. Cables/hoses must drop through the bottom or off the end of the cable support directly to the top of the cabinets (see individual components in Chapter 4 for height requirements)
3. Cable supports do not have minimum height restrictions except above Equipment room components (to maintain the 13 in. (330 mm) bend radius drop to the cabinet)
4. The end of the gradient cable support must be parallel to the Secondary Pen Wall (SPW)
5. The gradient cable support height and distance from the SPW must support a minimum cable bend radius of 13 in. (330 mm) to accommodate the gradient cable bend radius
6. Excess cable length must be stored in the Equipment room
7. For multiple MR system installations, cables from different MR systems must not share the same cable support

8. The table below lists the minimum width for cable trays between Equipment Room (and Operator Workspace) components

Table 6-9: Minimum Cable Tray Width

	PEN	SPW	PGR	HEC	OW
PEN		N/A	6 in. (150 mm) Electrical	6 in. (150 mm) Electrical	6 in. (150 mm) Electrical
SPW	N/A		12 in. (300 mm) Electrical	6 in. (150 mm) Electrical	6 in. (150 mm) Electrical
PGR	6 in. (150 mm) Air/Water	N/A		6 in. (150 mm) Electrical	6 in. (150 mm) Electrical
HEC	18 in. (450 mm) Air/Water	N/A	6 in. (150 mm) Air/Water		N/A
OW	N/A	N/A	N/A	N/A	

3 MR System Cable Specifications

MR750 cables are marked with an X in the column titled 750. The other cables are not used with the MR750 system.

Illustration 6-12: System Cable List (Page 5)

Discovery MR750	Optima MR150W	Discovery 750W	MR750W 32CH GEN	MR750W 32CH non GEN	Description	Connector Size (in)	Connector Size (mm)	Cable Length (ft)	Cable Diameter (mm)	Cable Diameter (in)	Bend radius (ft)	Bend radius (mm)	Number of Conductors	AWG	Certification	Voltage Rating (volts)	Temperature Rating (Celsius)	Notes
X	X	X	X	X	Run M4005 RF-COM GND STUD to MAG-GND STUD, 13500mm	0.807	20	0.808	15	7.0	178	178	1	10	UL AWM 1284, TEW	600	105°	single conductor ground cable
X	X	X	X	X	Run M4005 RF-COM GND STUD to MAG-GND STUD, 17500mm	0.807	20	0.808	15	7.0	178	178	1	10	UL AWM 1284, TEW	600	105°	single conductor ground cable
X	X	X	X	X	Run E4008 RF-COM GND STUD to SPN-GND Run E4010 RF-COM GND STUD to PEN-GND STUD, 28000mm	0.807	20	0.808	15	7.0	178	178	1	10	UL AWM 1284, TEW	600	105°	single conductor ground cable
X	X	X	X	X	Run E4002 PEN-GND to PGR-GND, Ground Cable, 10000mm	0.531	13	0.18	5	5.0	127	127	1	10	CMG	300	80°	single conductor ground cable
X	X	X	X	X	Run E4002 PEN-GND to PGR-GND, Ground Cable, 17000mm	0.531	13	0.18	5	5.0	127	127	1	10	CMG	300	80°	single conductor ground cable
X	X	X	X	X	Run E4007 HEC-GND to PGR-GND, Ground Cable, 10000mm	0.531	13	0.18	5	5.0	127	127	1	10	CMG	300	80°	single conductor ground cable
X	X	X	X	X	Run E4008 HEC-GND to PGR-GND, Ground Cable, 10000mm	0.531	13	0.18	5	5.0	127	127	1	10	CMG	300	80°	single conductor ground cable
X	X	X	X	X	Run M3384 PEN-J72 to MAG-DTRSM-J7, 14000mm	0.75	19	0.195	5	2.0	51	51	1	N/A	CMR FT4	1000	100°	LMR-195 coaxial cable
X	X	X	X	X	Run M3395 PEN-J78 to MAG-DTRSM-48, 10000mm	0.75	19	0.195	5	2.0	51	51	1	N/A	CMR FT4	1000	100°	LMR-195 coaxial cable
X	X	X	X	X	Run M3395 PEN-J78 to MAG-DTRSM-48, 14000mm	0.75	19	0.195	5	2.0	51	51	1	N/A	CMR FT4	1000	100°	LMR-195 coaxial cable
X	X	X	X	X	Run M3378 PEN-J11T to MAG-J50, Enclosure LED Power, 10000mm	0.75	19	0.195	5	2.0	51	51	1	N/A	CMR FT4	1000	100°	LMR-195 coaxial cable
X	X	X	X	X	Run M3378 PEN-J11T to MAG-J50, Enclosure LED Power, 14000mm	0.75	19	0.195	5	2.0	51	51	1	N/A	CMR FT4	1000	100°	LMR-195 coaxial cable
X	X	X	X	X	Run M3384 PEN-J72 to MAG-DTRSM-J7, 10000mm	2.1	53	1.2	30	6.5	165	165	1	N/A	CMR FT4	6000	85°	Based on 6267796DDW
X	X	X	X	X	Run M3384 PEN-J72 to MAG-DTRSM-J7, 14000mm	2.1	53	1.2	30	6.5	165	165	1	N/A	CMR FT4	6000	85°	Based on 6267796DDW
X	X	X	X	X	Run M3395 PEN-J78 to MAG-DTRSM-48, 10000mm	0.75	19	0.195	5	2.0	51	51	1	N/A	CMR FT4	1000	100°	LMR-195 coaxial cable
X	X	X	X	X	Run M3395 PEN-J78 to MAG-DTRSM-48, 14000mm	0.75	19	0.195	5	2.0	51	51	1	N/A	CMR FT4	1000	100°	LMR-195 coaxial cable
X	X	X	X	X	Run M3378 PEN-J11T to MAG-J50, Enclosure LED Power, 10000mm	1.5	38	0.305	8	6.0	152	152	9	22	CL3, FT4	300	90°	
X	X	X	X	X	Run M3378 PEN-J11T to MAG-J50, Enclosure LED Power, 14000mm	1.5	38	0.305	8	6.0	152	152	9	22	CL3, FT4	300	90°	
X	X	X	X	X	Run M3380 PED-HUB-SLOT1-J48 to Table Body Gal. DTRSM and Body Preamp, HARAT Cable, Run M3381 PED-HUB-SLOT1-J48 to Body Cell. DTRSM and Body Preamp, HARAT Cable	1.5	38	0.305	8	6.0	152	152	9	22	CL3, FT4	300	90°	
X	X	X	X	X	Cable Fiber Optic, RUN P2003 ICE-J31 and ICE-J32 to RCVR-1, J4 and RCVR-2, J4, 20000mm	1.2	30	0.38	10	5.7	145	145	6	N/A	OFNR	N/A	85	optical fibers, 3 duplex connectors bundled on each end
X	X	X	X	X	Cable Fiber Optic, RUN P2003 ICE-J31 and ICE-J32 to RCVR-1, J4 and RCVR-2, J4, 20000mm	1.2	30	0.38	10	5.7	145	145	6	N/A	OFNR	N/A	85	optical fibers, 3 duplex connectors bundled on each end
X	X	X	X	X	Cable Fiber Optic, ICE to PEN Cabinet Exciter and CFE, 10000mm	2.4	61	0.82	21	7	178	178	6	N/A	LFNC	N/A	85	optical fibers, 2 duplex connectors bundled on each end
X	X	X	X	X	Cable Fiber Optic, ICE to PEN Cabinet Exciter and CFE, 17000mm	2.4	61	0.82	21	7	178	178	6	N/A	LFNC	N/A	85	optical fibers, 2 duplex connectors bundled on each end
X	X	X	X	X	Cable Terminal, RUN ET307 PGR-J300 to PEN-J23	0.57	14.5	0.28	6	2.5	63.5	63.5	2	20	MIL-DTL-17198	750RMS	85	twix cable Pretrak P23490LF
X	X	X	X	X	Run E3037 ISCT Top to PGR301 to GWHOST-USB, 30000mm	1.5	37.2	0.19	4.8	1.18	30	30	4.4	20	UL2725	30	80	USB cable

4 Facility Supplied System Interconnects Specifications

The following table lists the required facility supplied system interconnects. Refer to [Illustration 6-13](#) for additional information.

Table 6-10: Facility Supplied System Interconnects

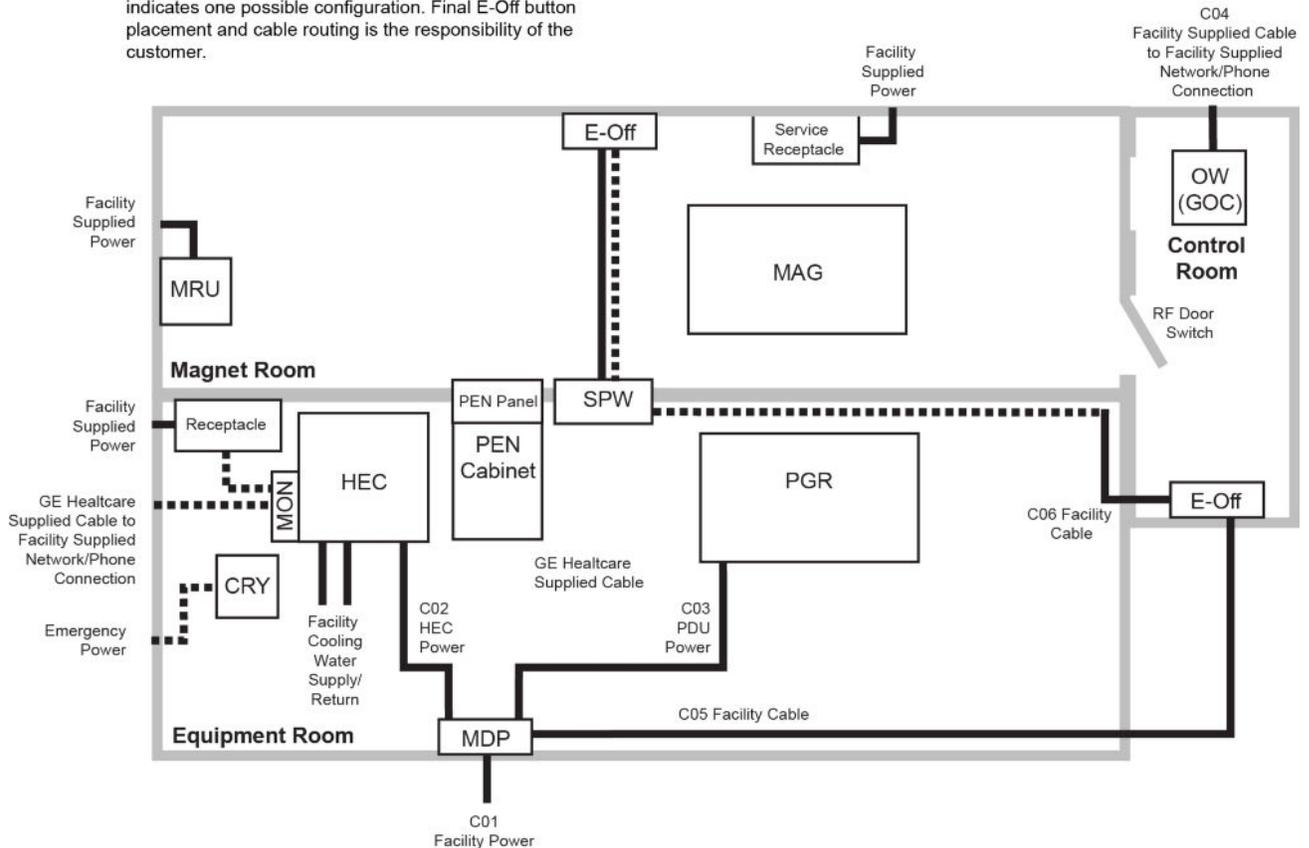
Group	Between Units		Comments	Requirements
	From	To		
C01	Facility Power	MDP	Facility Power and Ground	Chapter 2, MR Suite Electrical Requirements
C02	MDP	HEC	HEC Power	
C03	MDP	PGR	PDU Power	
	Facility Cooling Water	HEC	Cooling Water Supply	Chapter 2, MR System Facility Water Requirements
	Facility Cooling Water	HEC	Cooling Water Return	
C04	Facility Network	MON	Facility must provide network access for the Magnet Monitor (MON) and Global Operator Cabinet (GOC). The MON connection must be available at all times.	Chapter 4, Magnet Monitor (MON) Requirements and Specifications
	Facility Network	GOC		
C05	MDP	E-Off Switch	Facility must supply cable from MDP to E-Off Switch in Equipment Room	Chapter 2, MR Suite Electrical Requirements
	Facility Power	Outlet near MON	Facility outlet for MON power	Chapter 4, Magnet Monitor (MON) Requirements and Specifications
	Facility Power	MRU	Facility power to MRU	Chapter 3, Magnet Room Equipment Specifications
C06	GE Healthcare Supplied Cable from SPW	E-Off Switch in Control room or Equipment room	Facility must supply additional wiring between the GE Healthcare supplied cable and the E-Off switch if the length needed is greater than the usable length listed in MR System Interconnects Specifications	Chapter 2, MR Suite Electrical Requirements

Illustration 6-13: Facility Supplied System Interconnects

Facility Supplied System Interconnects

Notes:

1. Illustration is not to scale and component positioning/interconnect runs are typical
2. Solid lines are facility required interconnects; dashed lines are GE Healthcare supplied interconnects; both are shown where both are options.
3. Only GE Healthcare equipment interconnects are shown. Additional facility interconnects are required for non-GE Healthcare equipment (e.g., Magnet room DC Lighting)
4. E-Off button placement and cable routing shown indicates one possible configuration. Final E-Off button placement and cable routing is the responsibility of the customer.



NOTE: GE Healthcare recommends installing the RF Door switch on the outside wall of the Magnet room.

The 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 10V DC maximum and the switches must be in the open position when the doors are open (switch contacts close when the doors are completely closed).

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Chapter 7 Appendices

1 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.

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 Shielding

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

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..

Radio Frequency Shielding

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

Resonance

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

Security Zone

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

Shield Cooler Coldhead

An external refrigeration device which maintains the shields inside the cryostat at a constant temperature.

Shim Coils

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

Shimming

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

Superconducting Magnet

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

Superconductor

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

Tesla

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

2 MR Site Vibration Test Guidelines

2.1 Test Measurements

1. Vibration measurements must be in the range of 10^{-6} g. Test equipment must have the required sensitivity to these levels
2. Instrumentation must have a low tolerance to temperature effects since many times the low frequency thermal drift may influence the measurements
3. All measured data must be acquired real time. Recording of vibration data will not allow for a proper site survey, specifically when studying transient vibration and when searching for specific vibration sources
4. All analyses must be narrow-band Fast Fourier Transforms (FFT) over the frequency bands listed in [Table 7-1](#)
5. 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 that transient activity exceeds the trigger level, then expand the time history data to exhibit the structural response

Table 7-1: Frequency Bands for FFT

Frequency Band	Frequency Resolution
0.2 to 50 Hz	$\Delta f = 0.125$ Hz

2.2 Equipment (Spectral Analyzer) Set-Up

1. Frequency average should be a minimum of 20 linear averages (Do not use peak hold or 1/3 octave analysis)
2. Average and store should be a minimum of 20 plots steady state and 20 plots transient to support the consistency of the site vibrations
3. Hanning windows must be applied to the entire spectra
4. 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

NOTE: The equipment mentioned is for example only. It is the responsibility of the Engineering Test Firm to provide equipment that will allow measurements compliant with this guideline.

2.3 Data Collection

2.3.1 Ambient Baseline Condition

1. All of the measurements listed above must be made in a “quiet” environment--i.e., areas where excessive traffic, subway trains, etc. do not exist. 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
2. The source of any steady state vibration, whose level exceeds the magnet specifications found in [Chapter 3, Magnet Room Structural Requirements](#), must be identified. 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 the specific source of the vibration concern. The majority of steady state vibration problems can be negated by isolating the vibration source

2.3.2 Normal Condition

1. All of the vibration measurements listed above must be repeated during periods of “normal” environmental conditions, including the FFTs and time histories. The transient measurements must be provided to define the dynamic disturbances the MR system may be exposed to. Transient analysis is required for a true assessment of the site
2. 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 vibration must be identified and supported with vibration plots. If the source of any transient vibration is not locatable, it is recommended that the customer have an alternate location identified and the vibration studied
3. Transient vibration can be difficult to assess if the details are not understood. The **0.0005g, zero-to-peak trigger level** is a starting point to 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 of 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 Healthcare can help determine compliance with the vibration guidelines
4. The test consultant must provide site data to show the design recommendations for all sites/ building structures meet the Magnet specifications found in [Chapter 3, Magnet Room Structural Requirements](#)

2.4 Presentation/Interpretation of Results

1. The recommended format for site vibration data collection, presentation, and analysis is demonstrated in the examples in [Illustration 7-1](#), [Illustration 7-2](#), [Illustration 7-3](#), and [Illustration 7-4](#). Presentation of the data in any other format (linear units only) may result in incorrect interpretation and diagnosis of the site. Additional data collection or presentation methods are at the option of the vibration testing service
2. All plots must be properly annotated with:
 - a. Instrumentation setup including number of averages, frequency resolution, etc.

- b. Test location
- c. Test conditions:
 - i. Steady state
 - ii. Transient
 - iii. Heel drop
 - iv. Normal environment
 - v. Typical traffic
 - vi. Any other conditions necessary to demonstrate understanding of potential sources of vibration
- 3. The customer's vibration testing service is responsible for interpreting the results and determine if that site meets GE Healthcare specifications
- 4. If the vibration levels are too high, additional data acquisition may be necessary to:
 - a. Determine the source of the vibration
 - b. Propose a solution to the problem
 - c. Find an alternate site location
- 5. Any questions regarding test equipment requirements, test parameters, or general questions should be discussed with the GE Healthcare Project Manager of Installation (PMI)

Illustration 7-1: Example of Site Environmental Vibration Levels

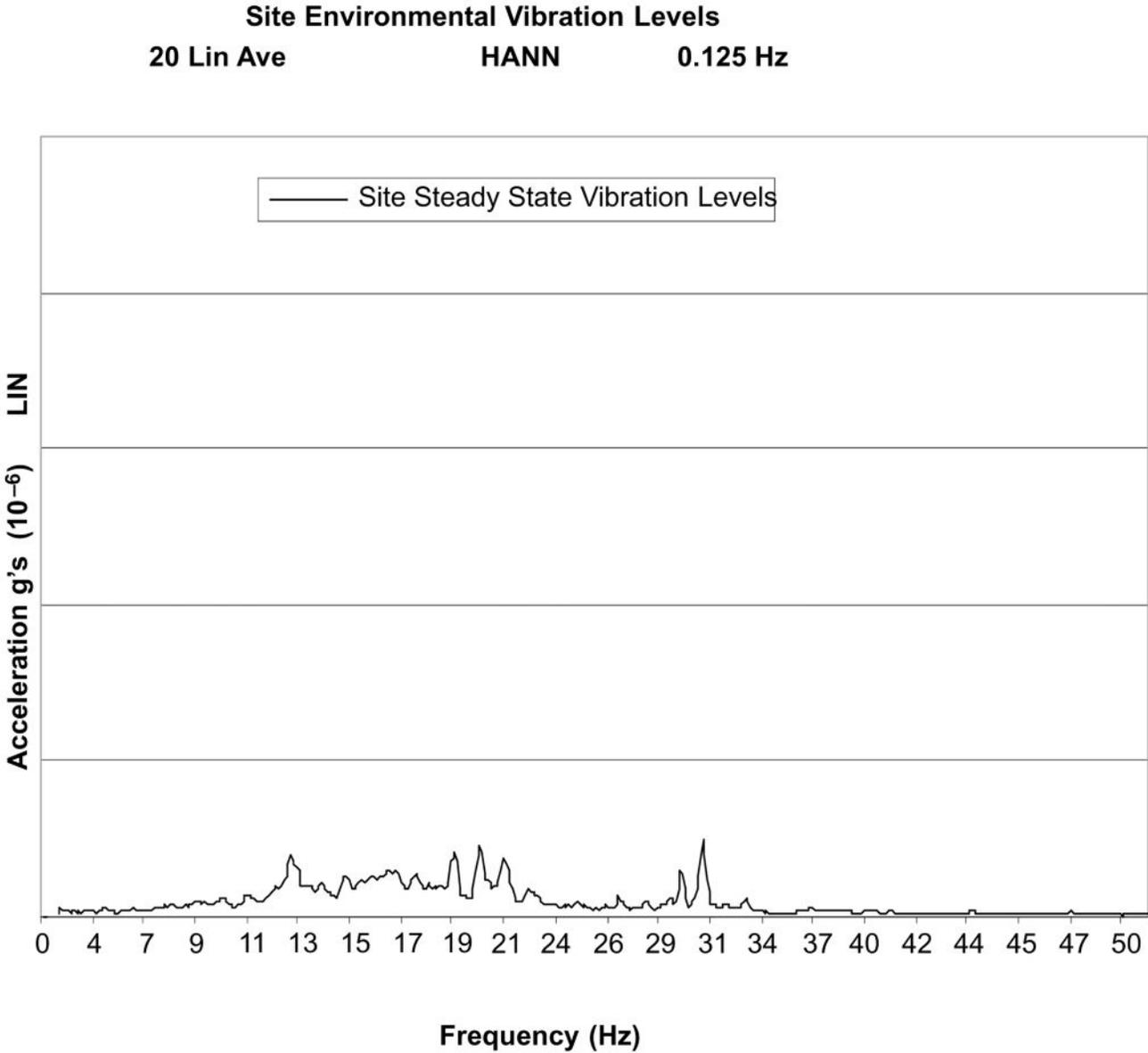


Illustration 7-2: Example Site Environmental Vibration

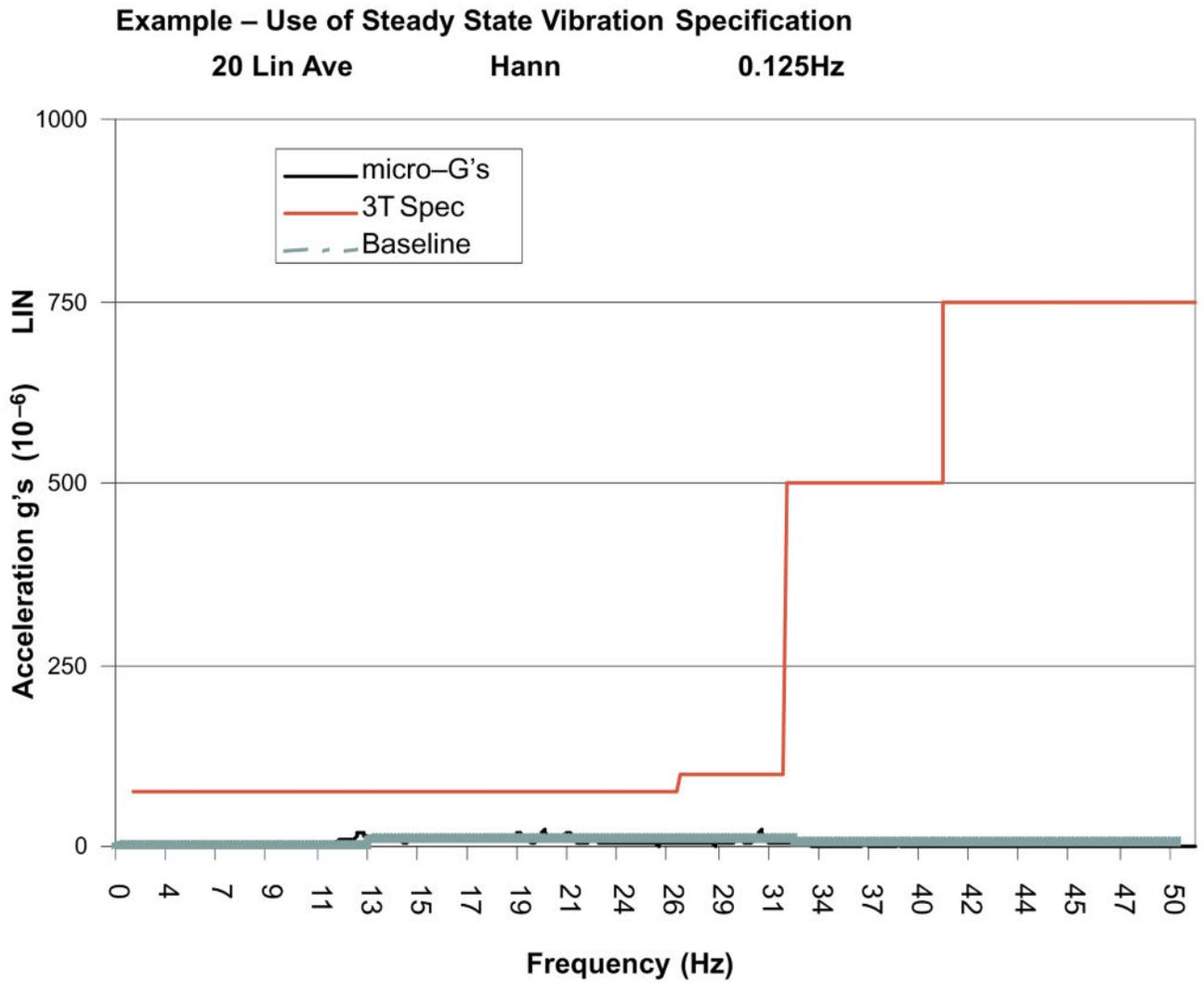


Illustration 7-3: Acceleration Time History

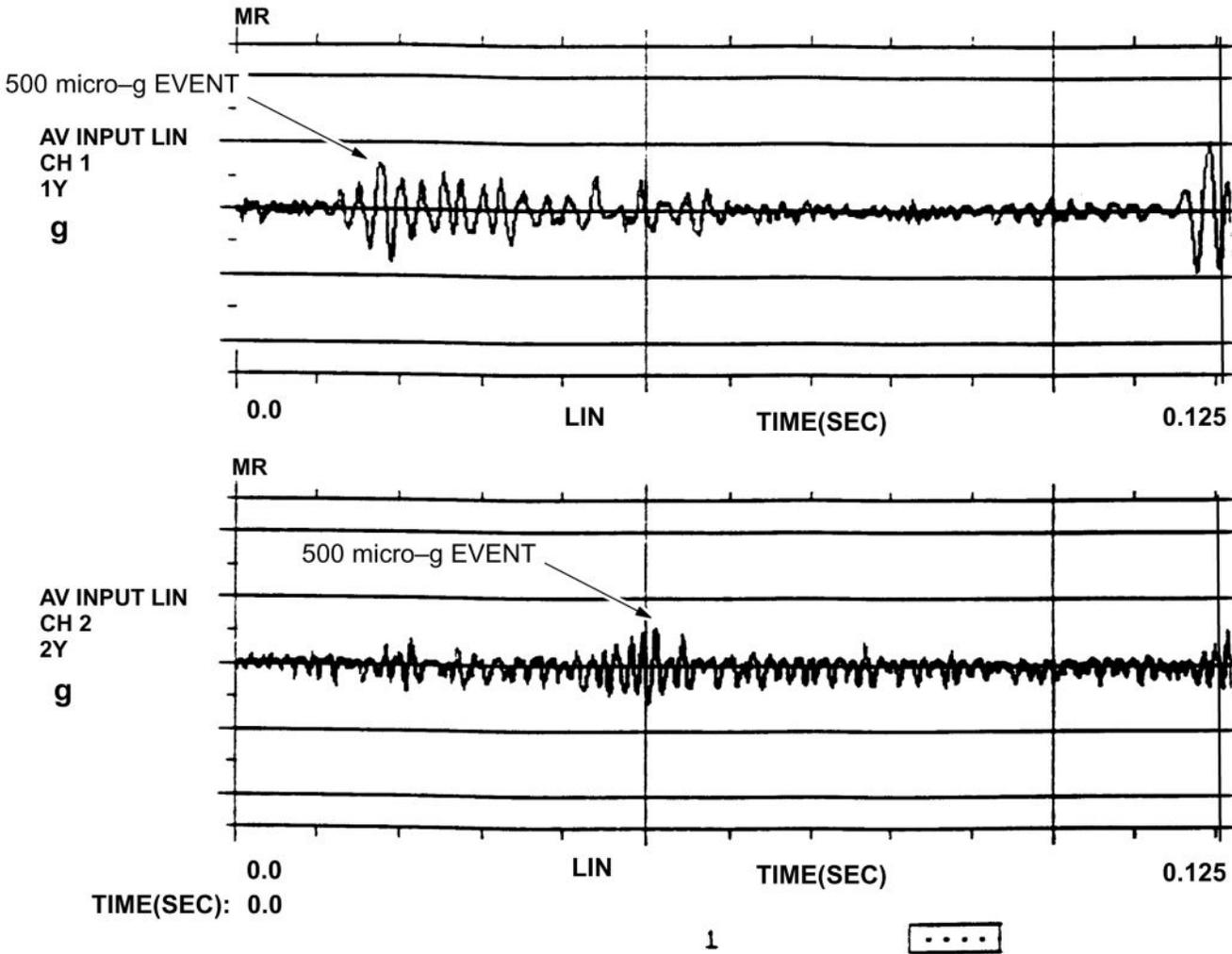
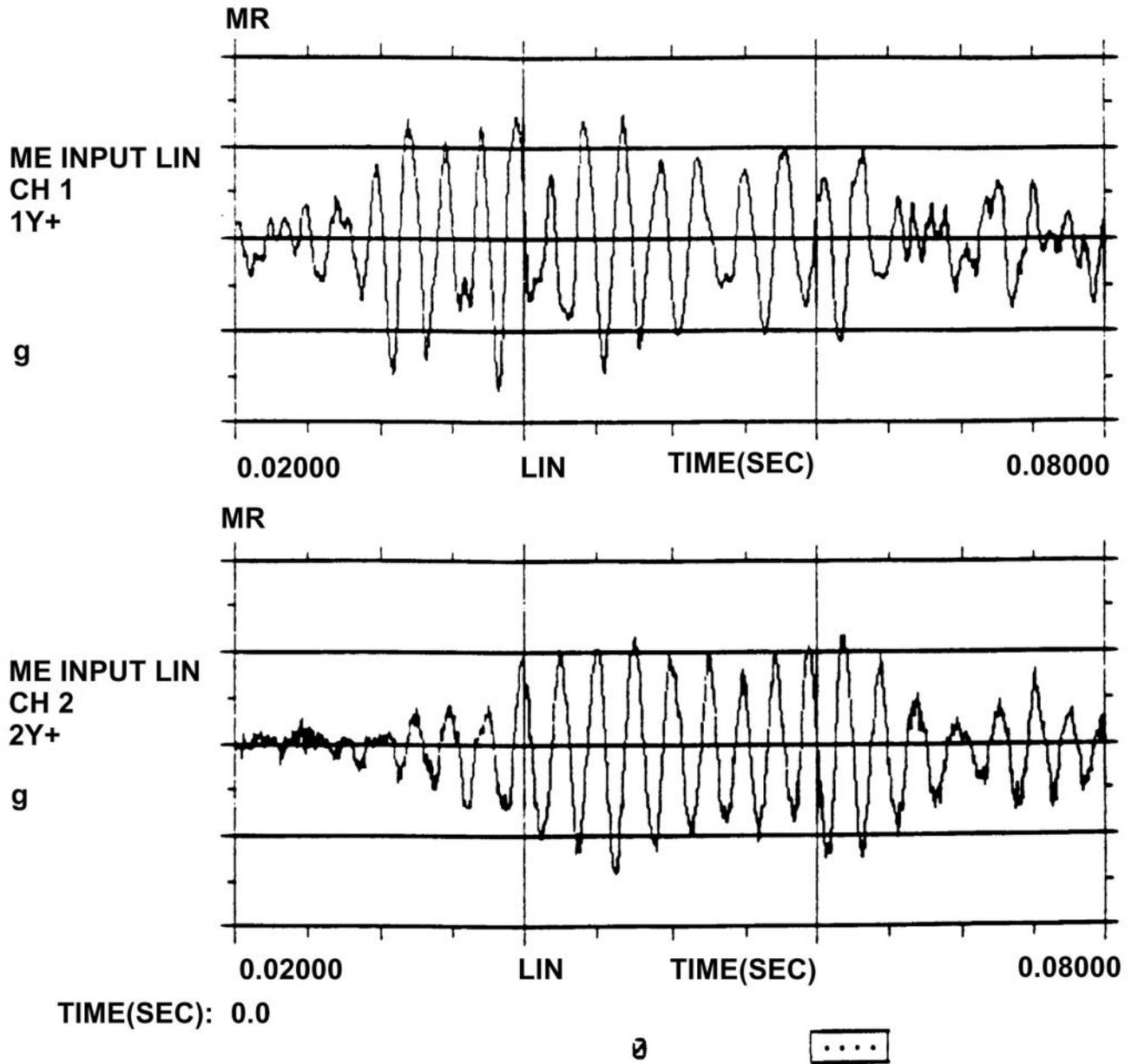


Illustration 7-4: Acceleration Time History (Zoomed In on Transient Event)



3 RF Shielding Guidelines

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

3.1 Discrete RF Interference

Discrete RF interferences are narrowband and are fixed frequency in nature. The Magnet Room must be RF shielded from RFI sources so external RF energy does not degrade the MR system RF receivers at the system imaging frequencies. Some potential sources for discrete frequency signals are radio station transmitters, mobile or hand-held RF transmitting devices, in general any intended RF transmitter or non-intended transmitters but with clocked digital electronic circuits.

3.2 Broadband RF Interference

Broadband RF noise is a single transient or continuous series of transient disturbances caused by an electrical discharge. Low humidity environmental conditions will have higher probability of electrical discharge. 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:

1. Loose hardware/fasteners vibration or movement (electrical continuity must always be maintained)
2. Flooring material including raised access flooring (panels & support hardware) and carpeting
3. Electrical fixtures, including:
 - a. Lighting fixtures
 - b. Track lighting
 - c. Emergency lighting
 - d. Battery chargers
 - e. Outlets
4. Ducting for HVAC and cable routing
5. RF Shield seals (walls, doors, windows, etc.)

4 RF Shielding Effectiveness and Ground Isolation Testing

4.1 Ambient Radio Frequency Interference (RFI)

The MR System operates with a highly sensitive RF receiving front end to be able to capture the signal of an object scanned. A Limited level of RF interference (RFI) at the installation site is needed for the proper operation for the MR System. The RFI level will depend on the electromagnetic environment and the equipment installed at the vicinity of the installation site, some examples are radio stations, land mobile radio transmitter stations. RF sources which can adversely affect image quality may be generated by discrete frequency or broadband noise (RF) sources.

4.2 Introduction

4.2.1 Discrete RF Interference

Discrete RF interferences are narrowband and fixed frequency. The Magnet Room must be RF shielded from RFI sources so external RF energy does not degrade the MR system RF receivers at the system imaging frequencies. Some potential sources for discrete frequency signals are radio station transmitters, mobile or hand-held RF transmitting devices, in general any intended RF transmitter or non-intended transmitters but with clocked digital electronic circuits.

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 - b. Track lighting
 - c. Emergency lighting
 - d. Battery chargers
 - e. Outlets
4. Ducting for HVAC and cable routing
5. RF Shield seals (walls, doors, windows, etc.)

4.2.3 Ambient Radio Frequency Interference (RFI) Site Survey

When a RFI site survey is considered, it is recommended to be completed before the purchase and installation of the RF shielded room.

1. The ambient RFI measured should be less than 100 millivolt per meter (100 dB microvolt per meter)
2. The recommended centerband and bandwidth frequencies to be used when measuring RFI are listed in the table below. (This table includes frequency bands important for both imaging and spectroscopy):

Table 7-2: 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

3. RFI site surveys are to be performed by cycling through the preceding frequency bands and a broad band range up to 145 MHz ± 10 MHz . 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, the maximum field strength.

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

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

where: BW = Bandwidth (resolution)

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

4.3 RF Shielding Effectiveness (SE) and Ground Isolation Test Methods

The shielding effectiveness test method defined within this appendix is in accordance with methods and requirements from IEEE Std 299-2006 - IEEE STANDARD METHOD FOR MEASURING THE EFFECTIVENESS OF ELECTROMAGNETIC SHIELDING ENCLOSURES.

4.3.1 Introduction

This appendix provides details on shielding Effectiveness (SE) the test method. MRI scanner is highly sensitive to RF energy from sources outside of the RF shielded room. To ensure proper operation of the MRI scanner, the RF shielded room is installed to reduce the interaction of external RF electromagnetic fields with the MR scanner operation (it also prevents MR system RF radiation from interfering with external RF systems, such as aircraft control).

NOTE: Impinging Electromagnetic fields at the frequencies to test the RF shielded room may not be planar.

4.3.2 Test Set-Up for RF Shielded Room

The RF shielded room is set up for shielding effectiveness testing with a normal configuration consisting of:

1. Magnet installed including all floor mounting bolts (including dock anchor bolt)
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. Frames and blank penetration panels installed, dimensionally equivalent to the GE panel and the same mounting hardware to be used with the GE penetration panel.

NOTE: A GE Field Engineer is responsible for disconnecting cryocooler lines. For safety reasons, the enclosure will be electrically grounded during the shielding effectiveness test. Any variances from the normal configuration will be noted in the RF shield test report

4.3.3 Shielding Effectiveness (SE)

The final shielding effectiveness performance of the RF shielded room is determined based on the lowest measurement of all test point locations.

4.3.4 Reference Level and Dynamic Range

1. The reference level is the value of signal measured by the receiver equipment with the receiving antenna located at a prescribed distance from the transmit antenna and located outside of the shielded enclosure
2. The dynamic range (DR) is the range of amplitudes over which the receive system operates linearly. The dynamic range must be at least 6 dB greater than the SE to be measured. For SE measurement, the dynamic range is the difference of the reference level to the noise floor

4.3.5 Test Equipment

1. Test equipment must be selected to provide measuring capabilities as described in this test method
2. Any piece of equipment, whose operation directly affects the numerical value of the Shielding Effectiveness (SE), must be in calibration before any critical measurements are begun. Dates of calibration traceable to a national standard must be provided in the test report (see [Section 4.3.9](#) for test report requirements) and must be within the calibration cycle of the equipment. The calibration cycle of equipment must be no greater than 2 years.
3. All equipment must be verified for proper operation between and after each series of tests by repeating the reference readings at the specified frequency.
4. Required equipment for transmit chain of measurement system:
 - a. Frequency Synthesizer or Signal Generator.
 - b. RF Power Amplifier (if required)
 - c. DC Power Supply (if required)
 - d. Tuned $\lambda/2$ Dipole antenna at the test frequencies or broadband biconical antenna

NOTE: Considering the dimensions for the a tuned $\lambda/2$ dipole antenna at lower frequencies, it is more practical to use a broadband biconical antenna.

5. Required equipment for receive chain of measurement system
 - a. Spectrum analyzer
 - b. RF preamplifier (if required)
 - c. In-line attenuator (if required)
 - d. DC power supply (if required)
 - e. Tuned $\lambda/2$ Dipole antenna at the test frequencies or broadband dipole antenna

NOTE: Considering the dimensions for the a tuned $\lambda/2$ dipole antenna at lower frequencies, it is more practical to use a broadband biconical antenna.

6. The transmit and receive antenna must be of the same type for each measurement

4.3.6 Test Frequency

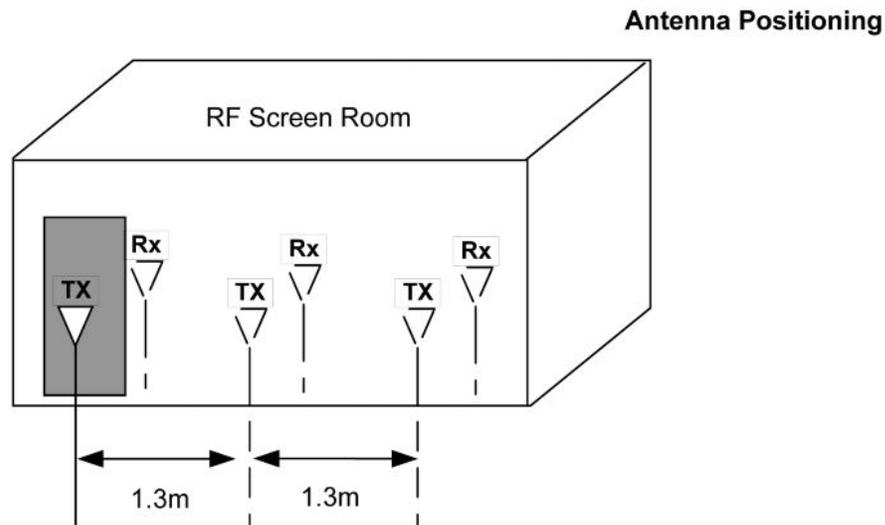
The test frequencies for shielding effectiveness (SE) measurement are defined in [Chapter 3, RF Shielded Room Requirements](#). Test frequencies used must be noted in the RF shield test report.

4.3.7 Measurement Procedure

NOTE: Except when specified, antenna distances are measured at the center of the antenna.

1. Each wall of the RF shielded room that is accessible for the measurement will be tested. For areas that are inaccessible for the direct location of the transmitting antenna, the inside of that area will still be scanned using the receiving antenna with the transmitting antenna positioned as close as possible to the intended test position, that position must be noted on the test report
2. Each accessible plane of the wall is subdivided so that the horizontal spacing is no more than 1.3 m (4 ft 3 in.) for the Transmit Antenna (TX) and Receive Antenna (RX) horizontal positions. See the illustration below:

Illustration 7-5: Antenna Positioning



3. Measurements are taken with horizontal and vertical antenna polarizations. Both Transmit (TX) and Receive (RX) antennas must be aligned with the same polarization, the measured polarization must be part of the test report
4. For localized testing of shielded room items such as doors, windows, filters, penetration areas, etc. the transmitting antenna (as well as receiving antenna) will be positioned in front of the items under test

4.3.7.1 Shielding Effectiveness Measurement

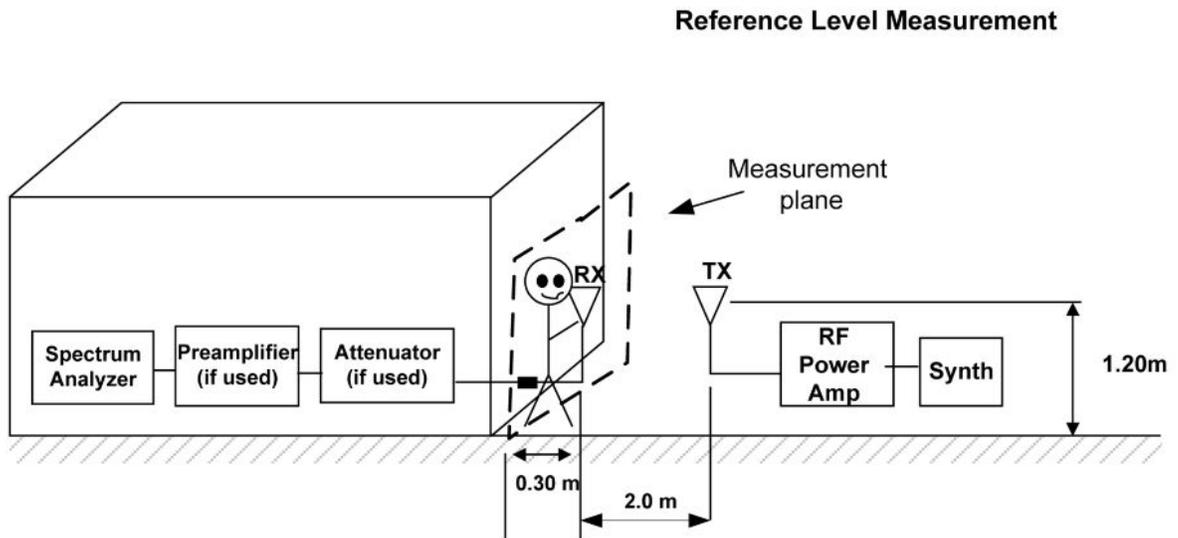
Three main steps are required to complete the Shielding Effectiveness measurement at each test position:

1. Take reference level measurement ([Section 4.3.7.2](#))
2. Take attenuated level measurement ([Section 4.3.7.3](#))
3. Calculate Shielding Effectiveness ([Section 4.3.7.4](#))

4.3.7.2 Reference Level Measurement

1. The reference level is the value of signal measured by the receiver equipment with the receiving antenna located at a prescribed distance from the transmit antenna and located outside of the shielded enclosure.
2. Measurement setup for the reference level is in accordance with the illustration below:

Illustration 7-6: Reference Level Measurement



3. The antennas must be separated by a distance of 2 m, minimum, unless physical spacing limitations for either the reference level or SE readings preclude maintaining that spacing. In that event, maximum available separation must be used, but must not be less than 1 m, and that separation must be noted on the test report
4. The coaxial cable from the receive antenna must be kept perpendicular to the axis of the antenna for a distance of at least 1 m
5. The cable from the receive antenna is preferably routed through the wall of the shield via a bulkhead type of coaxial connector. If this is not possible, it may be routed through a shield door that is opened only far enough to pass the cable. If the open-door method is used, a check for direct coupling to the receiving equipment must be made by putting a dummy load in place of the receive antenna and verifying that any signal present is at least 10 dB below the reference reading
6. Reference Level measurement is taken at each test location with antenna at both polarizations (horizontal and vertical)
 - a. Reference Level at Horizontal Polarization
 - i. The reference level measurement is taken over a plane area covered as described below.
 - ii. With horizontal polarization for both antennas, the receive antenna must be moved vertically up 1.0 m from the initial position, and then move it down from the initial position to 0.3 m above the floor. Then starting 1 m to the right of the initial position, move slowly vertically up 1 m and then down to 0.3 m above the floor. Repeat this at 1 m to the left of the original position
 - iii. Record the maximum measurement reading in this plane
 - b. Reference Level at Vertical Polarization
 - i. The reference level measurement is taken over a plane area covered as described below.

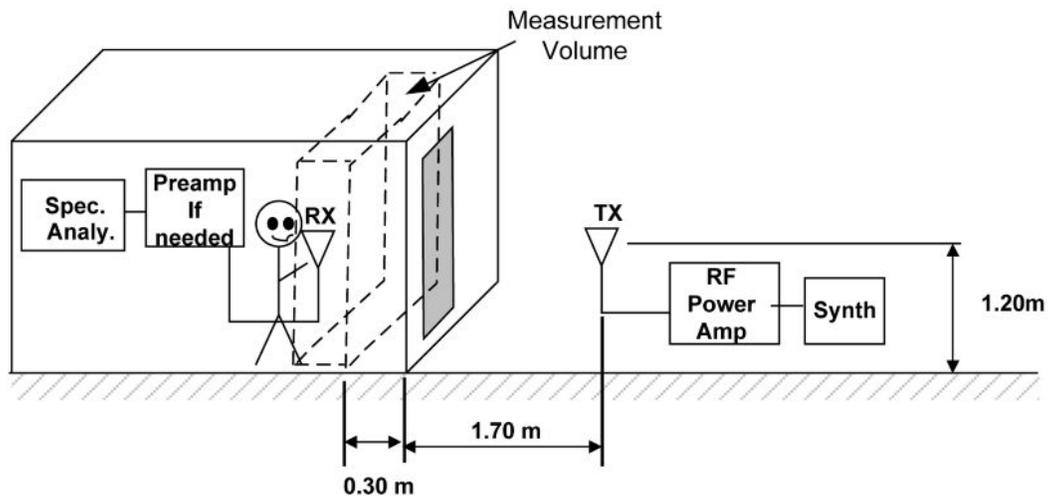
- ii. With vertical polarization for both antennas, the receive antenna must be moved horizontally right 1.0 m from the initial position, and then move it left from the initial position to 1.0 m. Then starting 1 m above the initial position, move slowly horizontally right 1 m and then horizontally left 1 m from initial position. Repeat this at 0.3 m above the floor (measure 0.3 m from the floor to the bottom of the antenna), move slowly horizontally right 1 m and then horizontally left 1 m
- iii. Record the maximum measurement reading in this plane

4.3.7.3 Attenuated Level Measurement

1. The basic measurement procedure consists of positioning the transmit antenna outside the RF shielded room and the receive antenna inside the RF shielded room and measuring the magnitude of the largest received signal
2. The Transmit Power for the shielded Room Measurement is the same as the power used to determine the Reference Level
3. If an attenuator was used in the Reference measurement, it would be taken out for the shielded Room measurement and the attenuator value added to the SE in the datasheet
4. Measurement setup for the attenuated level is in accordance with the illustration below:

Illustration 7-7: Attenuation Level Measurement

Attenuation Level Measurement



5. Attenuated Level measurement is taken at each test location with antenna at both polarizations (horizontal and vertical).
 - a. Attenuated Level at Horizontal Polarization
 - i. Both tuned Receive and Transmit Antennas are in Horizontal Polarization
 - ii. In all the following measurements the Receive Antenna is held in Horizontal Polarization and kept at a distance of 0.3 m from the inside shielded room wall
 - iii. Starting with the Receive Antenna directly parallel to the Transmit Antenna begin to slowly move the Receive Antenna in a Volume Parallel to the shielded room wall 1 m

above initial position and 0.3 m above the floor and 1m to the left and right of the initial position, see [Illustration 7-7](#)

- iv. Measure and record the highest power in this volume
- b. Attenuated Level at Vertical Polarization
 - i. Both Receive and Transmit Antennas are in Vertical Polarization
 - ii. In all the following measurements the Receive Antenna is held in Vertical Polarization and kept at a distance of 0.3 m from the wall
 - iii. Starting with the Receive Antenna directly parallel to the Transmit Antenna begin to slowly move the Receive Antenna in a Volume Parallel to the shielded room wall 1 m above the initial position and 0.3 m above the floor (measure 0.3 m from the floor to the bottom of the antenna) and 1 m to the left and right of the initial position
 - iv. Measure and record the highest power in this volume

4.3.7.4 Shielding Effectiveness calculation

The shielding effectiveness is calculated with the reference level measurement and the attenuated level measurement as defined in Equation 1:

$$SE (db) = V_{Ref_max} - V_{Att_max}$$

or

$$SE (db) = P_{Ref_max} - P_{Att_max}$$

Where:

SE : Shielding Effectiveness in dB

V_{Ref_max} , V_{Att_max} : Reference measurement in dBuV

P_{Ref_max} , P_{Att_max} : Reference measurement in dBm

4.3.8 RF shielded Room Ground Isolation Resistance Measurement Method



WARNING
ELECTRICAL SHOCK HAZARD

THE RF SHIELDED ROOM MUST BE PROPERLY GROUNDED.

Illustration 7-8: RF Shielded Room

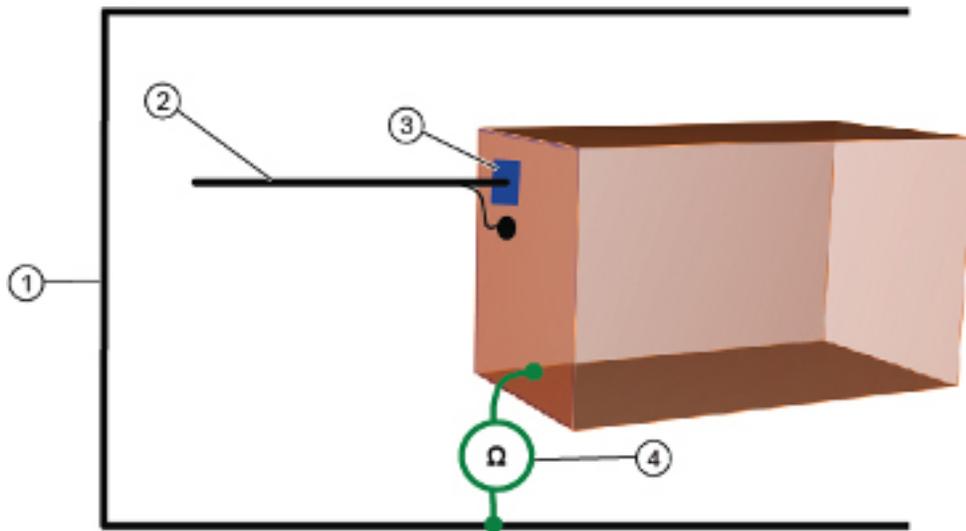


Table 7-3: RF Shielded Room

1	Hospital ground grid
2	AC lines and ground wire
3	Filter
4	Low resistance reading

1. This section does not apply to upgrades
2. This test must 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 must not be used
3. The ground isolation resistance measurement is performed by the following procedure:
 - a. All power to the enclosure is removed. For safety reasons, an AC voltage measurement will be made to verify that no power is connected
 - b. With electrical power and intentional ground disconnected, connect the test instrument between the shielded enclosure and AC power ground
 - c. Take a reading and record the value
 - d. Reconnect the lines to ground

4.3.9 RF Shield Test Report

A test report must be prepared by the testing organization performing the shielding effectiveness and ground isolation resistance tests for the RF shielded room. The test report includes data necessary for the evaluation of the shielding effectiveness performance and ground isolation of the RF shielded room. The test report must contain the following information:

1. Name of the owner organization or hospital
2. Name of testing organization

3. Identification name for the RF shielded room being tested
4. Name of test personnel
5. Date of test
6. Frequencies tested
7. Shielding effectiveness measured for each test point location (each test point location must be identified in the test report)
8. RF shielded room drawing showing each test point location
9. List any changes pertinent to the test setup or SE results (e.g., limited separation distance of antennas, limited access to test points, etc.)
10. Ground isolation test results and the condition of the room when tested (e.g., RF room completed without internal finishes and no electrical connections)
11. Pass/Fail conclusion
12. The following information for each piece of all calibrated equipment used for measurement:
 - a. Manufacturer
 - b. Model
 - c. Serial number
 - d. Current calibration date and calibration due date

Recommended additional information:

1. Location of RF shielded room relative to the whole building where it is installed
2. Pictures of RF shielded room shielding effectiveness test showing:
 - a. Overall view of RF shielded room
 - b. Window(s), door(s), filter(s), skylights, patient view window
 - c. Blank penetration panels
 - d. Installed additional penetration points (waveguides, vents, ducts, etc.)
 - e. Test set-up for reference level measurement
 - f. Test set-up for attenuated level measurement

5 Acoustic Background and Design Guidelines

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.

5.1 Acoustic 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.

5.1.1 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

5.1.2 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

5.2 Acoustic Design Guidelines

5.2.1 Magnet Room

Noise generated by the MR system is inherent to the operation of the system. 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 4 ft x 6 ft (1.2 m x 1.8 m) with a thickness of 4 inches (102 mm) 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.

5.2.2 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 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.

5.2.2.1 Wall Construction

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

- The preferred wall would have an ASTM Sound Transmission Coefficient (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 7-9](#) and [Illustration 7-10](#).

- 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 7-9: Example Of Wall Construction For Airborne Noise Control - Option 1

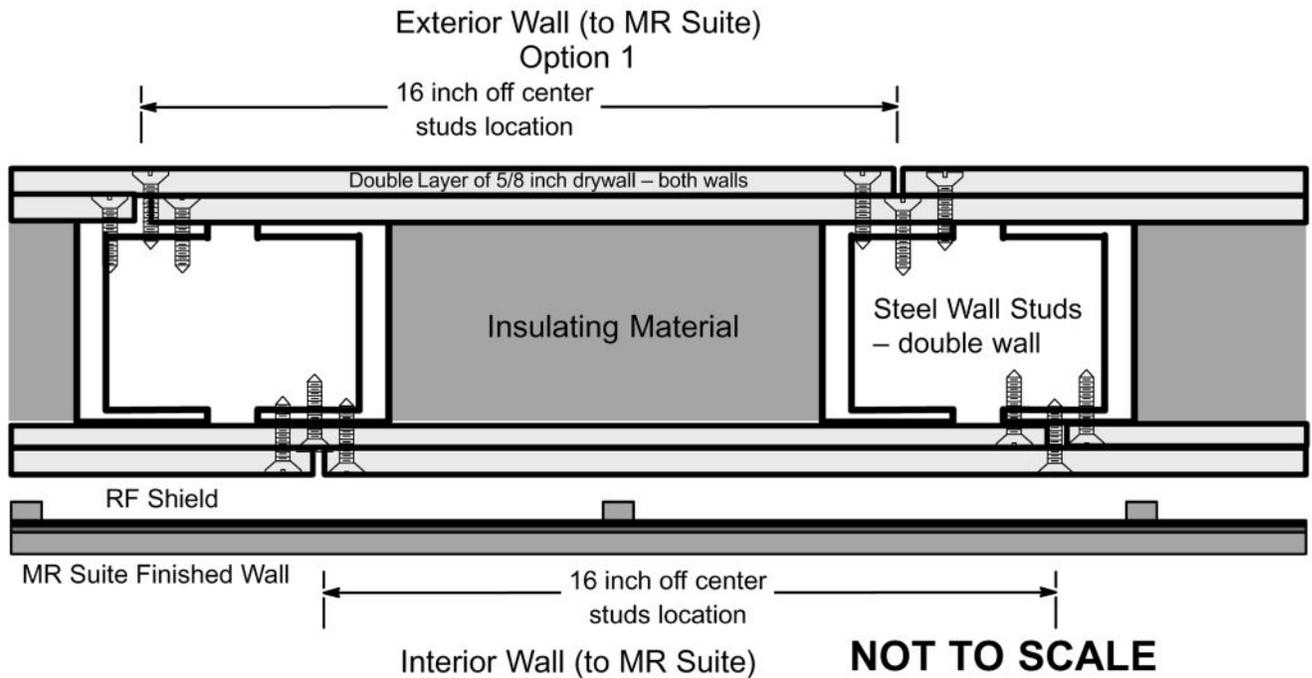
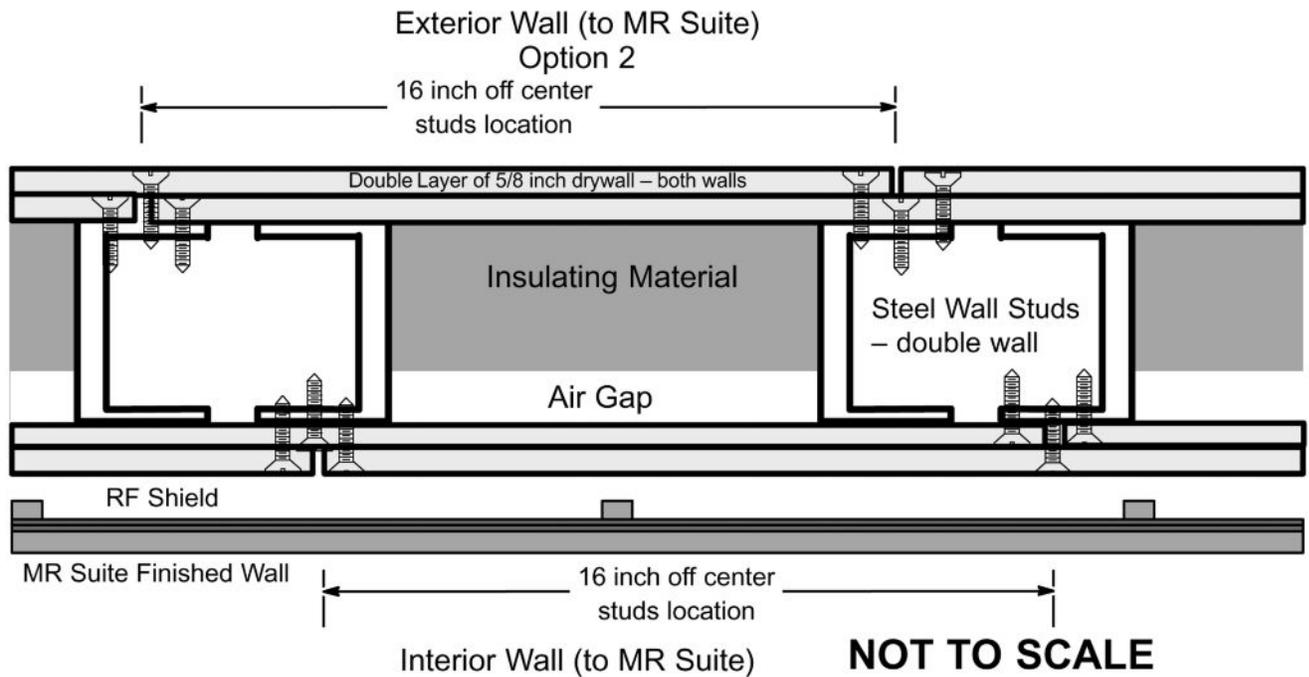


Illustration 7-10: Example Of Wall Construction For Airborne Noise Control - Option 2



5.2.2.2 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".

5.2.2.3 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.

6 Sample Calculation AC Power Equipment Minimum Distance

This is a sample calculation to determine minimum distance from a feeder, transformer, or other AC electrical source, using the Formula found in [Chapter 2, MR Suite Magnetic Field Specifications](#) Electrical Current subsection to determine minimum distance from a feeder, transformer, or other AC electrical source.

$$I \text{ (amps)} = 8.55X^2 \text{ (meters)} \div S \text{ (meters)}$$

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.

$$x^2 = \frac{I \times S}{8.55}$$

Rearranging:

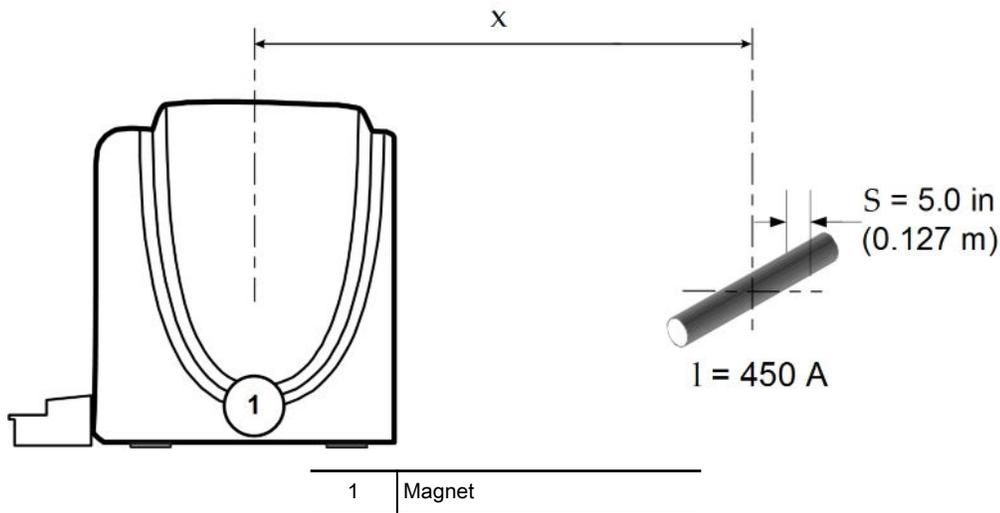
$$x = \sqrt{\frac{I \times S}{8.55}}$$

where:

x	Minimum distance (in meters) from the feeder lines to isocenter of the magnet
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

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.

$$S = 5 \text{ inches} = 0.127 \text{ meters}$$



$$x = \sqrt{\frac{450 \text{ A} \times 0.127 \text{ m}}{8.55}}$$

The conduit should be 2.6 meters or 8.5 feet from the magnet 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 worst 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.

7 Selecting Magnet Anchor Size

The following is an example to illustrate the selection of proper anchors to install a Magnet in a building with 2000 psi (13.8 MPa) concrete. For this example the area is not under seismic requirements.

1. Determine magnet clamping force (for the Magnet: 2500 lbs + 200 lbs = 2700 lbs or 11,100 N + 900 N = 12,000 N).
2. Refer to the examples of anchor vendor catalogs below 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.

Table 7-4: Allowable Anchor Loads in Concrete (English Units)

Anchor Diameter inches (mm) See note below	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)						
5/8 (15.9)	2 3/4 (70)	1250 (5.6)	2800 (12.5)	1600 (7.1)	3070 (13.7)	1810 (8.1)	3300 (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: All shaded values fail to meet the clamping force (tension), and are therefore not acceptable anchors.

Table 7-5: Allowable Anchor Loads in Concrete (Metric Units)

Anchor Diameter See note below	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)						
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: All shaded values fail to meet the clamping force (tension), and are therefore not acceptable anchors.

8 Magnet Cryogenic Venting Pressure Drop Reference Tables

Use the following tables to calculate the cryogenic vent pressure drop through the pipe used.

Table 7-6: 3.0T 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	68.87	--	--
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
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

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
	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	
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	

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



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 10 Kelvin
 - c. Gas temperature starting at 10 Kelvin and increase with length determined by thermal energy balance
 - d. 90% He is assumed to be evacuated within 30 sec. None left after quench.
 - e. Absolute roughness is assumed to be 0.25 mm.
 - f. R/D = 1.0 for standard sweep elbows, R/D = 1.5 for long sweep elbows where D = inside diameter of pipe; R = radius of bend

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