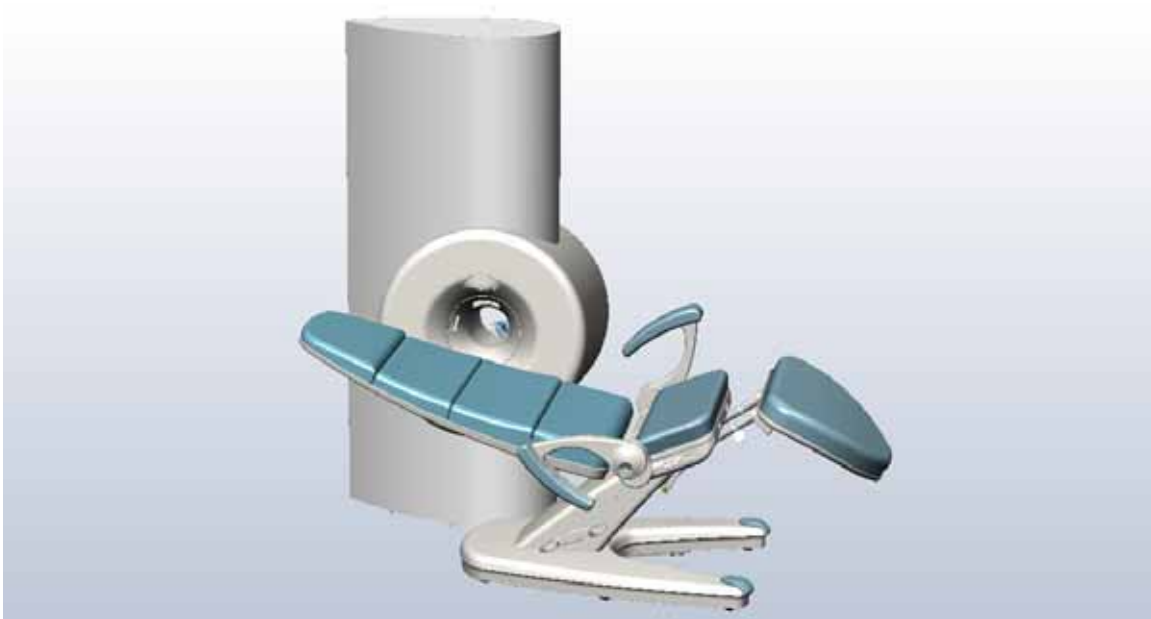




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## EXTREMITY SYSTEM SITE PLANNING GUIDE

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## Table of Contents

Chapter: 1	Introduction.....	1-1
	Overview.....	1-1
	Safety Considerations .....	1-4
	Limiting Access and General Site Considerations.....	1-4
Chapter: 2	Space Requirements.....	2-1
	Typical Imaging Suite Layout .....	2-1
	Floor Space and Clearance Requirements .....	2-1
	Cabling Considerations.....	2-2
	Floor Loading.....	2-3
	Magnet Anchoring .....	2-3
Chapter: 3	Magnetic Field Considerations .....	3-1
	Effects on the MRI Equipment .....	3-1
	Exclusion Limits .....	3-1
	Two or More Magnet Site Layout .....	3-5
Chapter: 4	Exam Room Physical & Electrical Requirements .....	4-1
	RF Shielding and Exam Room Finishing .....	4-1
	Sprinklers .....	4-6
	Electrical .....	4-6
	Lighting.....	4-6
	RF Shield Grounding Technique .....	4-6
Chapter: 5	Helium Venting.....	5-1
	Introduction.....	5-1
	Responsibilities .....	5-1
	Vent Tube Wave Guide Penetration through the RF Room .....	5-3
	Force on Vent Tube Penetration through the RF Room .....	5-4
	Specific Requirements for the Building's Helium Vent System .....	5-5
	Maximum Pressure Drop .....	5-5
	Vent Tube Materials .....	5-5
	Joints .....	5-6
	Vent Supports.....	5-7
	Fire Breaks .....	5-7
	Exhaust Vent.....	5-7
	Pressure Drop Calculations.....	5-8
	Internal Venting Criteria.....	5-8
Chapter: 6	Electrical Requirements .....	6-1
	Power Supply .....	6-1
	Exam Room Electrical Raceway .....	6-2
	Other Conduit or Raceway.....	6-2

Chapter: 7	Environmental Requirements.....	7-1
	Temperature and Humidity Specifications .....	7-1
	Heat Output and Cooling Requirements .....	7-1
	Moving Metal and Ambient Magnetic Fields.....	7-1
	50/60 Hz Stray Magnetic Fields .....	7-2
	Vibration .....	7-2
	Altitude Specification .....	7-2
	Audible Noise .....	7-3
	Reducing Air Pollution Effects .....	7-3
Chapter: 8	Network / Phone Connection Requirements.....	8-1
	Network Connection .....	8-1
	Phone Connection .....	8-1
Chapter: 9	Shipping and Delivery Information .....	9-1
	Transportation & Storage Requirements .....	9-2
Chapter: 10	Pre-Installation Checklist.....	10-1
Appendix A	Typical Layouts USA/60 Hz.....	A-1
Appendix B	Typical Layouts Europe/50 Hz .....	B-1
Index	.....	I-1

## Table of Figures

Figure 1-1. Typical Suite layout of system components.....	1-2
Figure 2-1. Magnet Stand base plate mounting anchor pattern and positioning of surface mount cable raceway and vent tube relative to magnet and exam room walls. See Figure 2-3 for section A-A. ....	2-4
Figure 2-2. Typical Floor Prep Detail for Hilti Anchor.....	2-5
Figure 2-3. Section A-A of Figure 2-1 showing detail of magnet base plate mounting anchors and floor preparation for “Grout & Copper” RF Floor.....	2-5
Figure 3-1. Magnet Near Fringe Field Top View (not to scale). ....	3-2
Figure 3-2. Magnet Near Fringe Field Side View (not to scale). ....	3-3
Figure 3-3. 1.0 T Magnet Fringe Field (not to scale).....	3-4
Figure 4-1a. Exam room elevation showing penetration panel horizontal opening & helium vent waveguide penetration. ....	4-2
Figure 4-2b. Exam room elevation showing penetration vertical panel opening & helium vent waveguide penetration. ....	4-3
Figure 4-3a. Pen Panel wall section. Typical shown. Shield wall/floor detail may vary with RF subcontractor.....	4-4
Figure 4-4b. Pen Panel wall section. Typical shown. Shield wall/floor detail may vary with RF subcontractor.....	4-5
Figure 5-1. Major Elements of a Cryogenic Venting System.....	5-2
Figure 5-2. Vent Tube Penetration Location Behind Magnet. Note: ONI site planning will provide specific location for vent pipe penetration. ....	5-4
Figure 5-3. Side View of Vent Tube Penetration through RF Room Wall.....	5-4
Figure 5-4. Force on Vent Tube Penetration through RF Room .....	5-5
Figure 5-5. Photograph of insulating Joint using a 2” DWV coupling. A coupling with metal shield and 4 clamps is required. Some RF room suppliers will provide a special insulating coupling for use outside of room. This item is supplied by your general contractor.....	5-6
Figure 5-6. Photograph of k-flange to 2” adapter provided by ONI. The adapter is to be soldered to 2” copper tube positioned at a location specified in Figure 5-1 and Figure 2-1. ....	5-7
Figure 7-1. Maximum Vibration Levels as a Function of Frequency.....	7-2

## List of Tables

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Table 1-1. EXTREMITY Major System Components .....	1-3
Table 2-1. Minimum Finished Room Size Requirements .....	2-2
Table 2-2. System Cable Properties for Two Available Lengths .....	2-2
Table 2-3. Floor Loading .....	2-3
Table 3-1. Maximum Magnetic Field Strengths .....	3-1
Table 3-2. Field and Proximity Limits of Various Equipment .....	3-6
Table 4-1. RF Shielding Requirements & Tests .....	4-1
Table 5-1. Copper Tube Dimensions .....	5-3
Table 5-2. Pressure Drop Table for Vent System Components.....	5-8
Table 6-1. EXTREMITY Electrical Power Requirements.....	6-1
Table 6-2. EXTREMITY Electrical Power Connection for USA and Canada (60Hz operation). ....	6-2
Table 7-1. EXTREMITY Environmental Requirements .....	7-1
Table 7-2. Maximum Equipment Audible Noise.....	7-3
Table 9-1. Shipping Data .....	9-1

# 1 Introduction

This guide outlines the various site requirements and special preparations for the proper installation of the MRI system. The customer and designated contractors are responsible for satisfying the requirements in this document.

The following is a summary of the major topics covered in this document:

- Placement of the components.
- Electrical service power and outlets.
- Exam room physical and shielding requirements.
- Helium gas venting.
- Environmental Control Requirements.
- Phone and computer network interfaces.

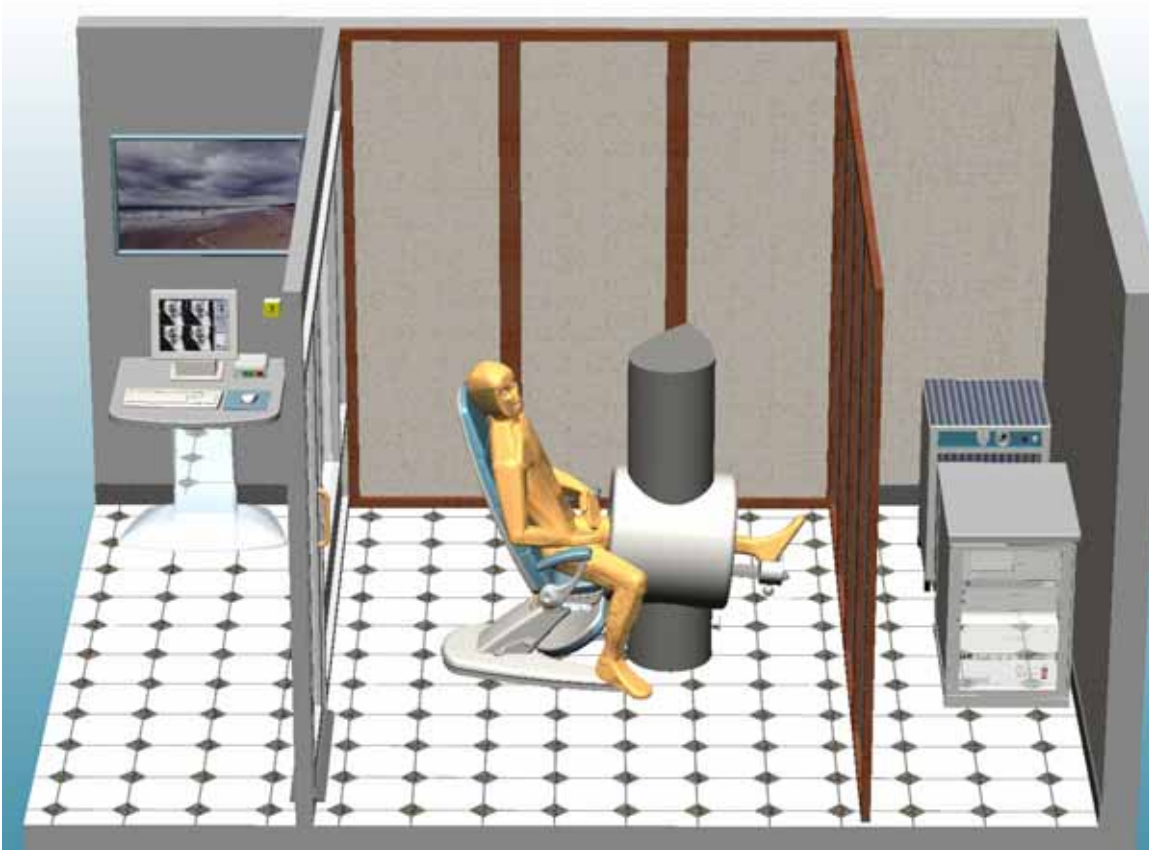
In preparing the site for installation, a variety of contracting trades will be required. Installation is normally coordinated through a single individual responsible for the project; sometimes this person is the customer, but usually it is a contractor or building facility coordinator retained by the customer who provides expertise in facility modifications.

During the course of preparing the site an ONI site planning coordinator is available to assist the customer's representatives in properly interpreting the contents of this document. The cost of this service is included in the purchase price of the equipment. ONI will generally provide a standard summary of the requirements tailored to site specific installation needs. Appendices A & B show examples of the information and the format to expect.

## Overview

**THE EXTREMITY** System is a Magnetic Resonance Imaging (MRI) system designed specifically for imaging human extremities. Its operating principle is similar to that of a whole-body system. With the exception of its smaller size and field-of-view, the resultant image quality and overall performance is similar to a conventional whole-body system. Figure 1-1 shows a typical suite layout of the system components.

The **EXTREMITY** system components provided by ONI are summarized in Table 1-1 below. The codes are used on various site-planning layouts when referring to equipment. Page 4 of Appendices A & B contain a summary of the equipment dimensions.



**Figure 1-1.** Typical Suite layout of system components.



**Table 1-1. Major System Components**

Code	Description	Rendition	Code	Description	Rendition
<b>OC</b>	Operator's Console Equipment consisting of an LCD monitor, keyboard, mouse and power control unit.		<b>PS</b>	Patient Support Chair.	
<b>EQ</b>	Emergency Quench Button.		<b>HC</b>	Air cooled Helium Compressor as part of the magnet refrigeration system.	
<b>MA</b>	1.0 Tesla Magnet Assembly.		<b>SE</b>	System Electronics Cabinet.	
<b>PP</b>	Penetration Panel that mounts on the RF shield wall.			Warning Signs. (QTY-2)	
<b>PC</b>	Penetration Panel Cover	N/A		Cables	N/A

## Safety Considerations

### Limiting Access and General Site Considerations

The controlled access area is established to prevent potential harm to equipment and individuals due to implants or other ferrous objects interacting with the magnetic field. Concern is for anyone in the area (e.g. patient, operator, maintenance worker) defined by the three dimensional 5 Gauss (0.5 mT) fringe field contour around the magnet. This exclusion zone extends six feet (1.8 meters) in the axial direction (front and back), and four feet (1.2 meters) in the radial direction (side to side, up and down), from the centerline of the magnet. Refer to Figures 3-1 and 3-2 for the detailed locations of the 5 Gauss contour, and those of other fringe field levels relative to the magnet's center point.



**DANGER:** Any ferrous object, e.g. paper clips, pocket knife, pen, keys, vacuum cleaner, oxygen bottles, tools, cordless drills, etc., brought within three feet (0.9 meter) of the magnet has the potential of becoming a projectile and causing harm to the system and anyone around the imaging system. With larger metal objects, the force can be very great and serious damage to equipment and serious personal injury can result, even death.



**DANGER:** Pacemaker implants, neurostimulators, and other biostimulation devices may fail to operate properly in static magnetic fields greater than 5 Gauss. Therefore, individuals with these devices must not enter the controlled access area. All entries to the controlled access area are to be labeled by a warning sign of the type shown below.

**CAUTION:** It is the responsibility of the user to follow local statutory requirements in regard to entering a controlled access area. Notification of maintenance personnel (especially those that might enter during off hours) and emergency personnel such as the fire departments is strongly recommended.



## 2 Space Requirements

Use this section to plan the layout of the imaging suite. It provides information on overall space requirements for equipment, cabling and floor loading specifications.

### Typical Imaging Suite Layout

Page 2 and page 3 of Appendices A & B show two typical suite layouts. There are three main areas of the suite; the exam room, the control room, and the equipment room. Refer also to Table 1-1 for equipment references.

The operator's control room should have a work desk of sufficient area to place the Operators Console (OC) equipment, made up of the LCD monitor, keyboard, mouse and power control unit along with any desired additional work space. Minimum desk area recommended and provided by the customer or the contactor is 42"W x 24"D (1070 mm W x 610 mm D). The control room is also the location of the Emergency Quench (EQ) button, which is to be located within reach of the operator at the OC location.

The exam room, containing the Magnet Assembly (MA) and Patient Chair (PC), must be shielded from radio frequency interference and be large enough to allow adjustment of the patient chair into all necessary patient positions. Cabinets should be placed in the exam room to hold the RF coils, Daily Quality Assurance Phantom, and foam positioning pads. At least one non-ferrous wall hung cabinet provided by the contractor with minimum dimension of 30"W x 12"D x 36"H (760 mm W x 305 mm D x 914 mm H) is recommended. Steel cabinets cannot be used. The exam room shielded door should have a key lock for safety.

The equipment room contains the Helium Compressor (HC) and the System Electronics (SE) to operate the imaging system and should have enough space for a service person to access the equipment.

Numerous alternative layouts are possible allowing flexibility to conform to specific limitations of the site. It is advised that an ONI site planning coordinator be brought into the site planning process as early as possible so that tradeoffs can be fully explained and so that the space available is used in the most efficient and functional way.

### Floor Space and Clearance Requirements

Table 2-1 shows typical floor space and minimum clearances needed to install all components. The minimum dimensions of the exam room are necessary to open and manipulate the chair into all its necessary configurations for imaging the upper and lower extremities. All room sizes are highly dependent on the means of access and the arrangement of the MRI suite. Typical total square footage needed will vary between 165 sq. ft. (15.3 m<sup>2</sup>) and 250 sq. ft. (23.2 m<sup>2</sup>).

After renovation, there are minimum hallway and ceiling clearances required to allow servicing of the equipment. Helium dewar transport requires 36" (915 mm) wide doors from the receiving entrance, through the facility into the exam room.

**Table 2-1.** Minimum Finished Room Size Requirements

Room	Width	Depth	Height	Door
Control Room	24 to 30 Sq. Ft. (2.2 to 2.8 m <sup>2</sup> )		Per code	36"x84" (915 x 2134 mm)
Exam Room <sup>1,2</sup>	11'-0" (3350 mm)	9'-6" (2896 mm)	7'-8" (2340 mm)	36"x84" (915 x 2134 mm)
Equipment Room	36 to 40 Sq. ft. (3.3 to 3.7 m <sup>2</sup> )		Per code	32"x84" (915 x 2134 mm)

<sup>1</sup> Minimum finished floor to ceiling height required for helium fill

<sup>2</sup> Minimum door opening of 36"(915 mm) required to fit standard 250 liter helium dewar. A 32"(813 mm) door is required to fit a standard 100 liter dewar.

## Cabling Considerations

There are numerous cables connecting the components located in the control room, the exam room, and the equipment room. All cables must be installed through conduits/raceways in a safe manner so as not to endanger foot traffic. A pull line must be left in all conduits. Table 2-2 summarizes the cabling requirements.

**Table 2-2.** System Cable Properties for Two Available Lengths

From	To	Cable Lengths ft(m)	Conduit/ Raceway <sup>1</sup>
System Electronics (SE)	Operators Console (OC)	24 (7.3) 49 (14.9)	3 in (76 mm) Min Diameter conduit or raceway
	Emergency Quench <sup>2</sup> (EQ)	24 (7.3) 49 (14.9)	
	RF Shield Penetration Panel (PP)	24 (7.3) 49 (14.9)	4 in (101 mm) conduit or raceway if required <sup>4</sup>
Helium Compressor (HC)	RF Shield Penetration Panel (PP)	24 (7.3) 49 (14.9)	4 in (101 mm) conduit or raceway if required <sup>4</sup>
Compressor Hoses <sup>3</sup>	Magnet Assembly (MA)	32 (10) 65 (20)	
RF Shield Penetration Panel (PP)	Magnet Assembly (MA)	24 (7.3)	3.5 in. x 10 in. Aluminum surface mount raceway

<sup>1</sup> Conduit/Raceway run length will necessarily be less than the cable length by 10 ft (3050 mm) or more to allow cable to be attached to equipment. The precise length will depend on location of components relative to conduit/raceway inlet/outlet location. All conduit and raceway supplied & installed by the customer or their contractor.

<sup>2</sup> The Magnet Emergency Quench Unit must be located in the same suite as the operator's console and out of the controlled area so that emergency personnel have access to it.

<sup>3</sup> The compressor Helium gas hoses form a single continuous connection that cannot be broken. As a result, the total length from the compressor to the magnet is a controlled length.

<sup>4</sup> The equipment room does not normally require raised computer floor, conduit, or raceway. Cables are positioned out of the way of foot traffic in this room by ONI's field engineer at installation.

## Floor Loading

The flooring of the site must be adequate to handle the additional weight of the EXTREMITY System. Table 2-3 lists the gross weight of the larger components along with additional information regarding anchoring of the equipment. Page 4 of Appendix A also lists the weights of the components. It is the responsibility of the customer or their consultants to verify the adequacy of planned or existing floors for delivery and installation of the System.

**Table 2-3.** Floor Loading

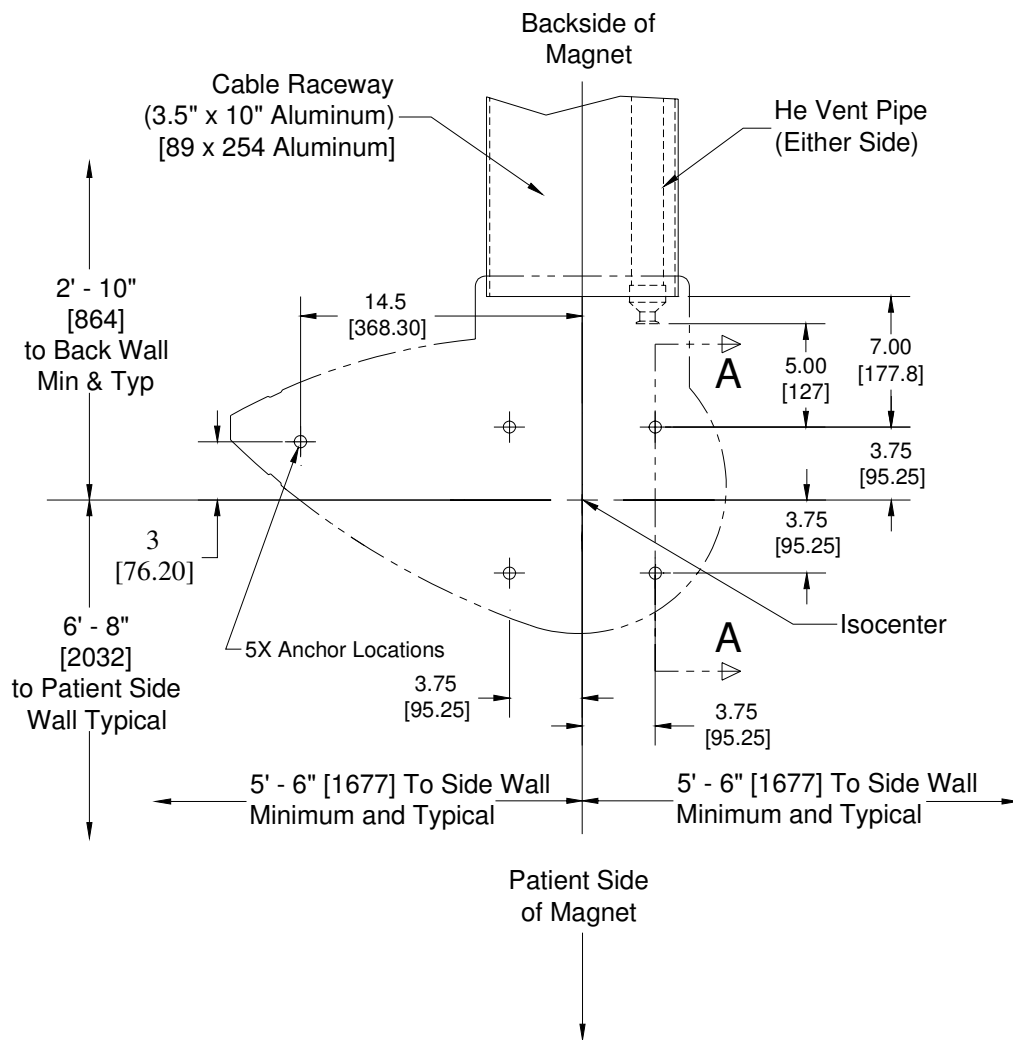
<b>Component</b>	<b>Net Weight Lbs. (Kg)</b>	<b>Normal Mounting Methods</b>
Magnet Assembly (MA)	1400 (638)	Bolted to the floor in a manner consistent with local earthquake and building codes. <sup>1</sup>
System Electronics (SE)	480 (218)	Free moving on casters, but could be attached to the floor if required by local earthquake requirements.
Patient Chair (PC)	170 (77)	Free moving on casters.
Helium Compressor (HC)	309 (140)	Free moving on casters, but could be attached to the floor if required by local earthquake requirements.

<sup>1</sup> The magnet assembly weight is distributed over an area of 1.0 square foot (92900 mm<sup>2</sup>) for a local floor loading of 9 psi (62 kPa).

## Magnet Anchoring

The Magnet is to be anchored to the floor for safety and for proper operation. Figure 2-1 shows the location of 5 anchor points for the magnet along with the proper positioning of a surface mount raceway at the back of the magnet assembly. Also shown are the minimum distances to the wall required for adequate patient and operator space and for service of the magnet system. A full size anchor template can be requested from ONI site planning.

Anchoring of the magnet must be done in such a way as to not compromise the integrity of the radio frequency shield. RF shielding manufacturers are familiar with the proper anchoring methods. Failure to properly mount the magnet could result in RFI artifacts in the images. Figure 2-2 and Figure 2-3 shows the typical details of how the magnet stand is to be anchored. Anchoring must be done in accordance to local earthquake requirements. If seismic compliance is a requirement, a structural engineer should review and approve anchoring details and weight distribution for the particular floor construction.

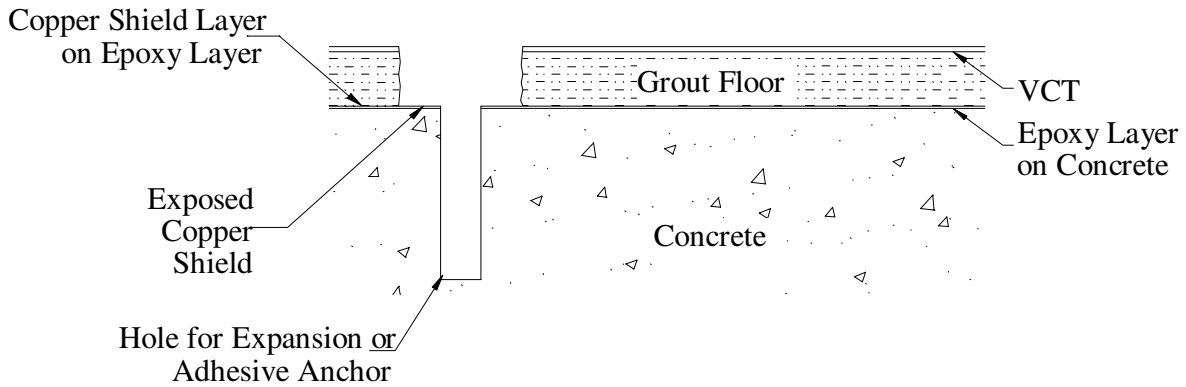


## MOUNTING PATTERN

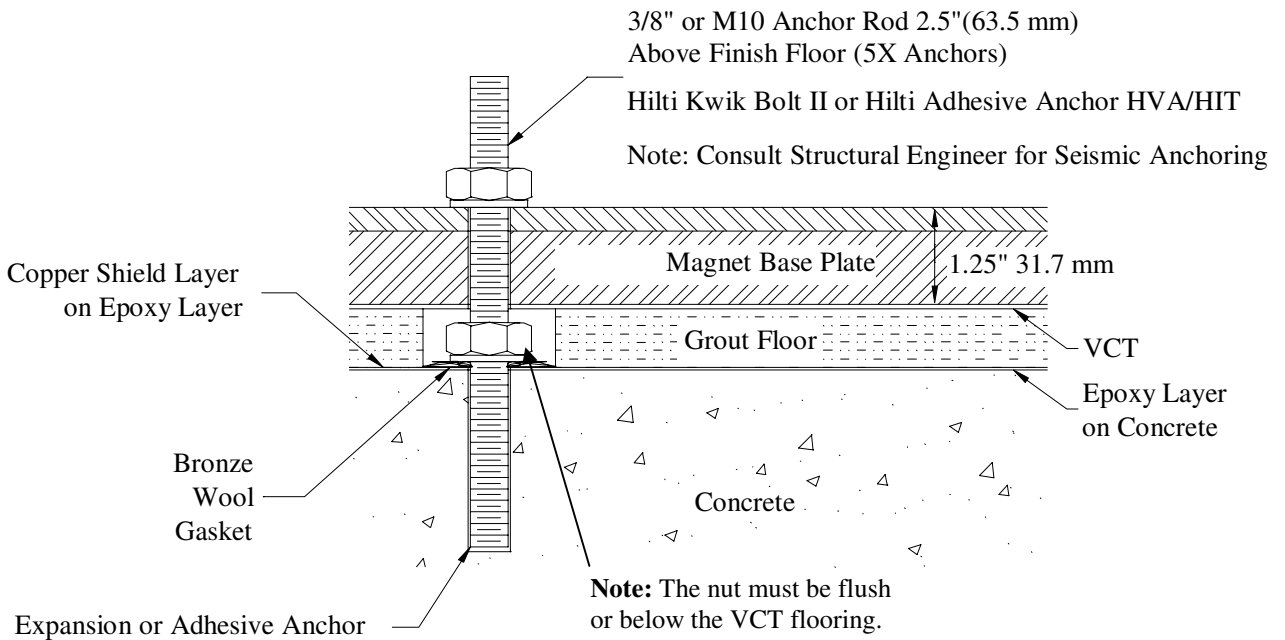
**Figure 2-1.** Magnet Stand base plate mounting anchor pattern and positioning of surface mount cable raceway and vent tube relative to magnet and exam room walls. See Figure 2-3 for section A-A.

**Note:** Helium vent pipe and cable raceway provided and installed by customer or their contractors.

**Note:** Distances to wall are typical only for those configurations where the magnet is oriented square to a four wall room. If the magnet is to be rotated out of square, or the room is a complex shape, contact ONI site planning for assistance.



**Figure 2-2.** Typical Floor Prep Detail for Hilti Anchor



## SECTION A-A

**Figure 2-3.** Section A-A of Figure 2-1 showing detail of magnet base plate mounting anchors and floor preparation for "Grout & Copper" RF Floor.





### 3 Magnetic Field Considerations

#### Effects on the MRI Equipment

The magnetic field can affect the operation of the components in the EXTREMITY MRI System. Consequently, the exact location of the components can be critical. Table 3-1 lists the maximum magnetic field strength that the system components (or group of components) can be subjected to without adverse effects. Figures 3-1 and 3-2 show the magnet near and far fringe field lines (shown in meters), respectively.

**Note:** Ensure that components are placed in areas where magnetic fringe field strength does not pose a problem.

**Table 3-1.** Maximum Magnetic Field Strengths

Component	Magnetic Field Gauss(mT)
Helium Compressor (HC)	$G \leq 50$ (5)
System Electronics (SE)	$G \leq 10$ (1)

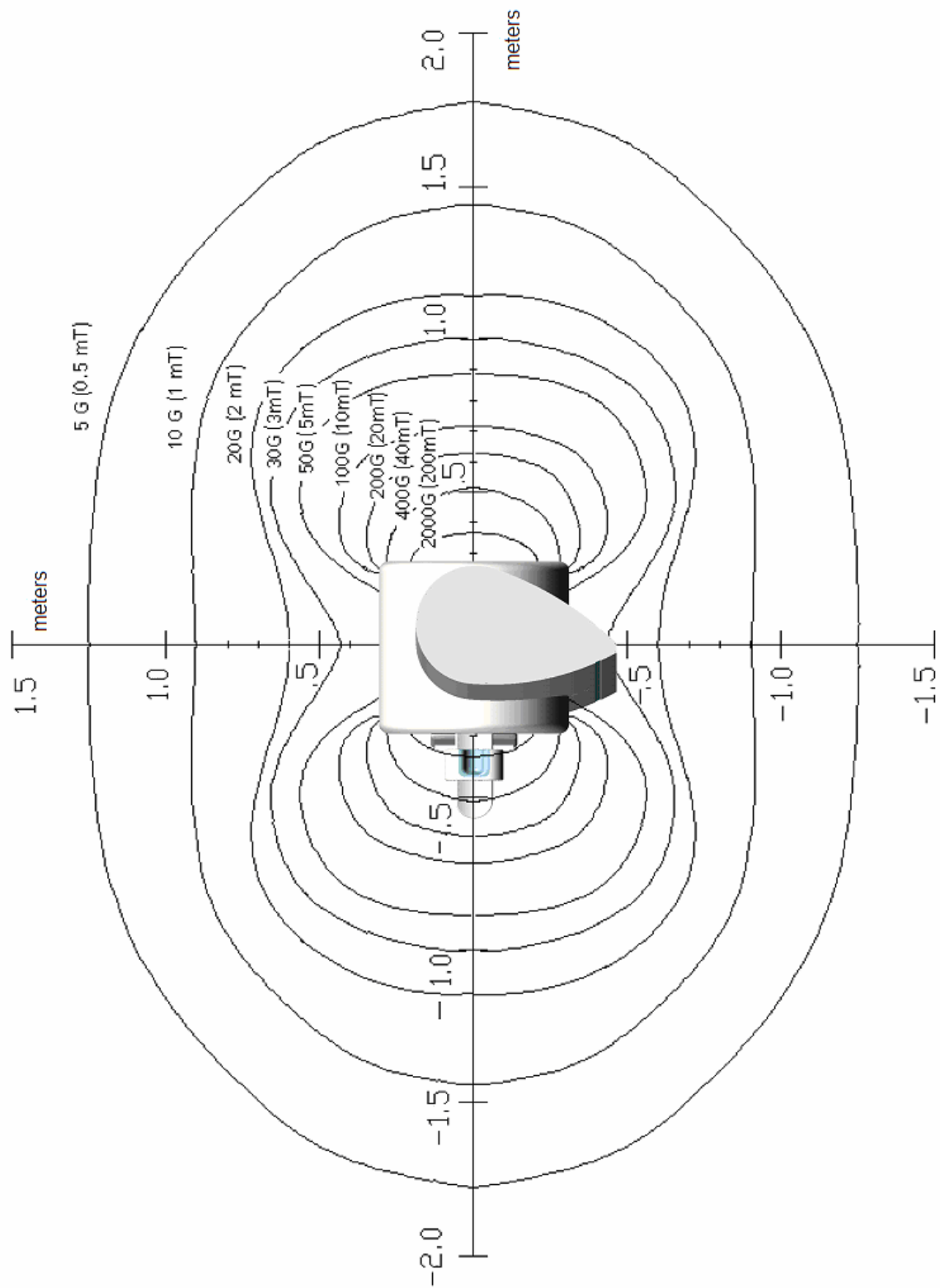
#### Exclusion Limits

When designing a floor plan, there are special considerations that must be taken into account in order to avoid interaction with or harm to certain medical implants (including cardiac pacemakers, neuro-stimulators, aneurysm clips, and bio-stimulation devices) due to the effect of the magnetic field. As a result, general public access must be limited to less than 5 gauss as discussed in the Safety Considerations section of Chapter 1.

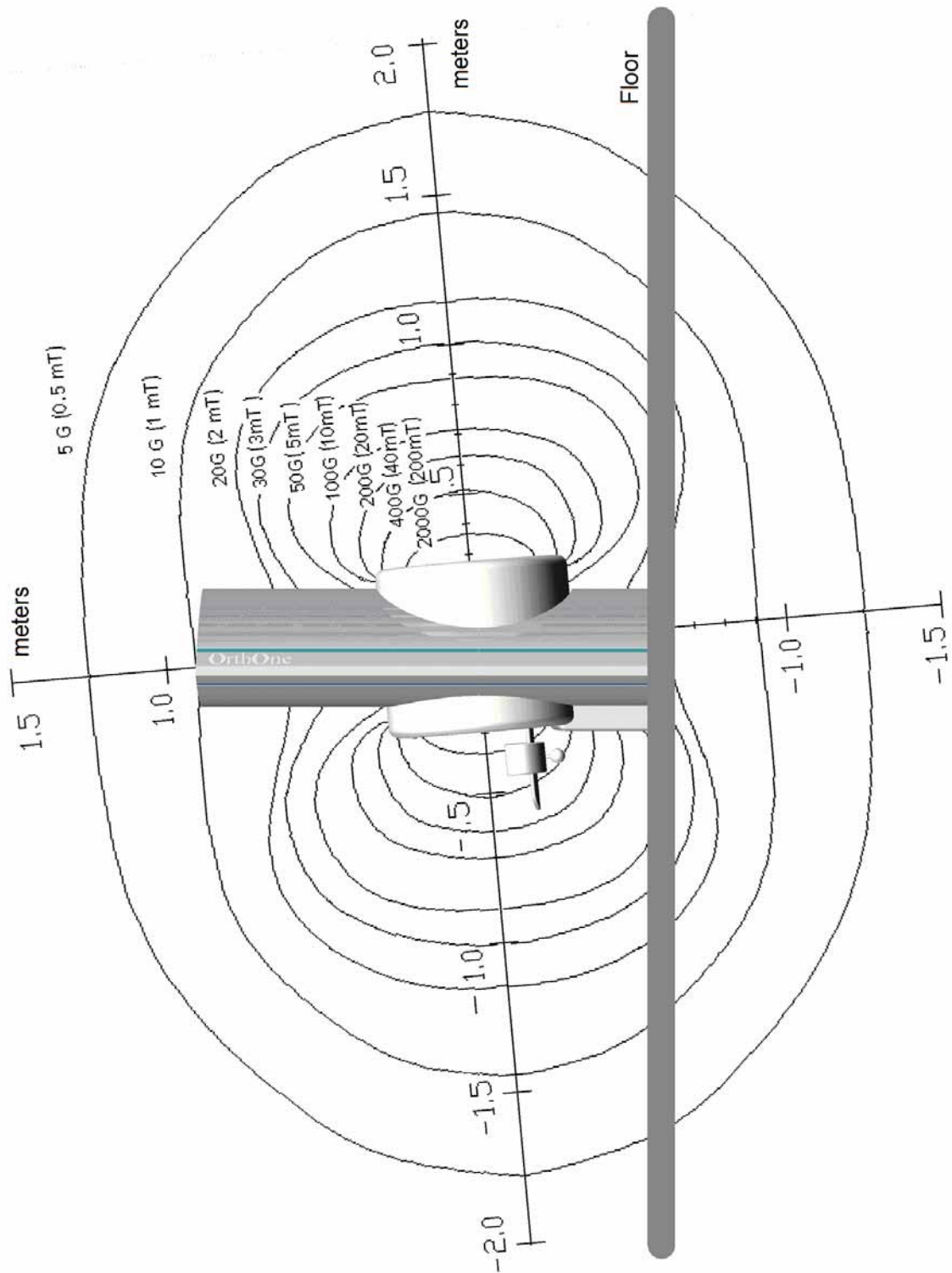
In addition to concern about physical safety, the fringe field of the magnet has the potential to damage sensitive surrounding equipment. A further consideration is the need to minimize the environmental effects of motors, steel, etc., that can adversely affect the magnet field homogeneity and stability, possibly adversely affecting image quality. Table 3-2, is a guideline for the proximity limits of the various equipment considering all these factors.

Recommended limits provided in Table 3-2 are based on general MR site planning guidelines. Actual susceptibility of specific devices may vary significantly. Any equipment such as that shown in the table should be brought to the attention of ONI site planning as early as possible in the process.

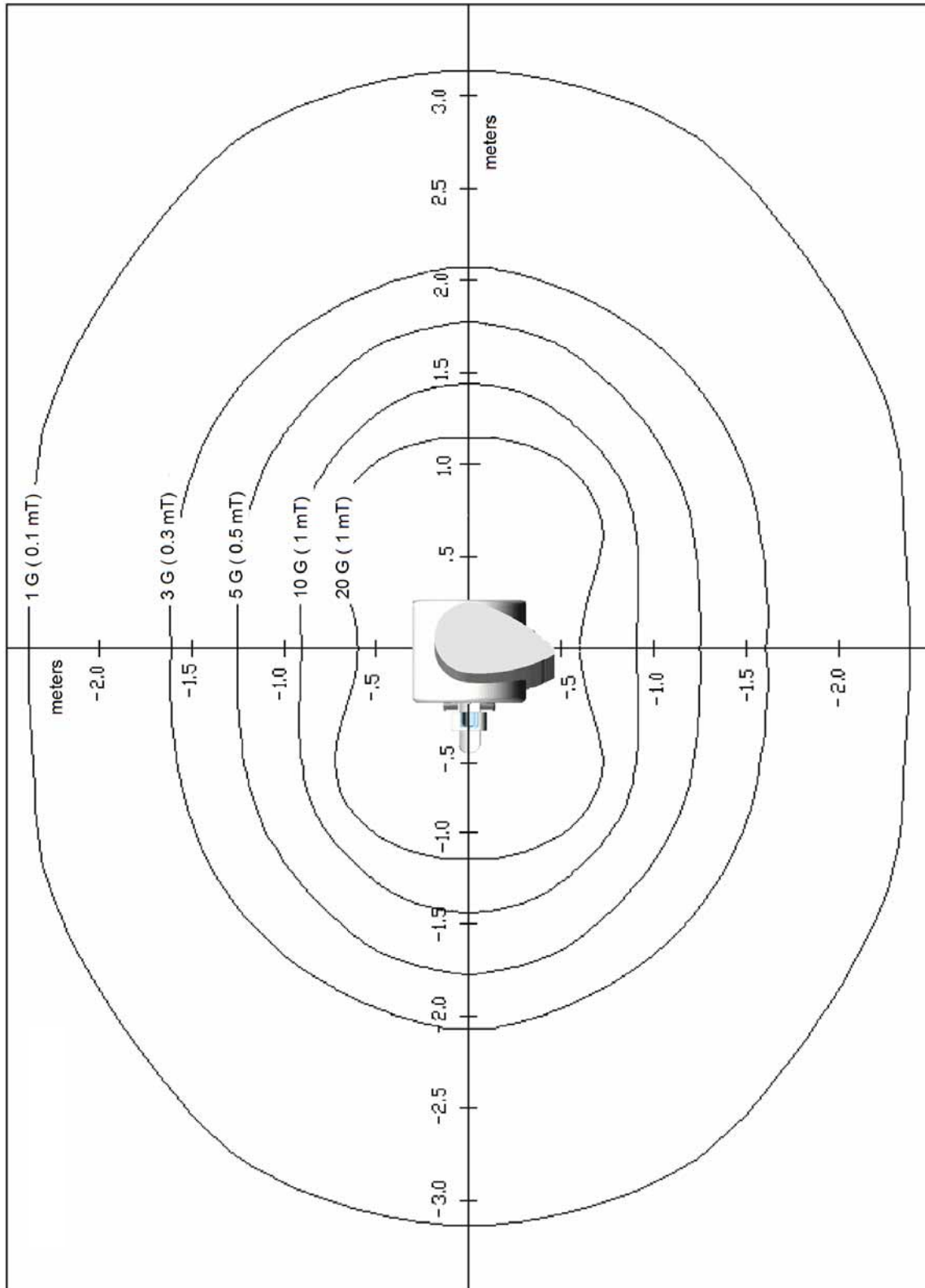
It is possible in some situations that large electrical equipment and moving metal is acceptable inside the exclusion zone. To make such a determination a site survey would normally be conducted (at the expense of the customer). The survey would include a measurement of the background magnetic field changes due to moving metal and stray 50/60 Hz magnetic fields emanating from motors, transformers power lines etc. ONI can provide the necessary survey or a qualified third party can perform it.



**Figure 3-1.** Magnet Near Fringe Field Top View (not to scale).



**Figure 3-2.** Magnet Near Fringe Field Side View (not to scale).



**Figure 3-3.** 1.0 T Magnet Fringe Field (not to scale).

## **Two or More Magnet Site Layout**

In some cases, there might be other magnets in close proximity to the EXTREMITY MRI System. Interaction will occur between the magnetic fields; therefore, a change in field strengths for either magnet may require re-shimming of both (or more) magnets. Accordingly, specific orientation of the two (or more) magnets may be necessary. It is recommended that the 5 Gauss contours of the two (or more) magnets do not overlap. Consult ONI Customer Service if you encounter this situation.

**Table 3-2.** Field and Proximity Limits of Various Equipment

Field Limit <sup>1</sup> (Gauss )	Minimum Distance from Iso-center of Magnet in any Direction ft (meters)	Equipment
Not Applicable	30 (9.2)	<ul style="list-style-type: none"> <li>• Moving Steel Equipment such as: <ul style="list-style-type: none"> <li>□ Vehicular Traffic.</li> <li>□ Fork Lift Trucks.</li> <li>□ Loading Dock (truck Traffic).</li> <li>□ Elevators.</li> <li>□ Movable Garbage Dumpsters</li> </ul> </li> <li>• Building Electrical distribution Equipment</li> <li>• Large Electrical Equipment with internal moving metal parts such as: <ul style="list-style-type: none"> <li>□ Emergency Generators.</li> <li>□ Rooftop Air Conditioning Chiller.</li> </ul> </li> </ul>
1 or less	10 (3)	<ul style="list-style-type: none"> <li>• Video Display (Color, B/W, Monochrome CRT based).</li> <li>• Power Transformers.</li> <li>• Main Electrical Distribution Panels and Transformers.</li> <li>• HVAC Blowers and Expansion Units.</li> </ul>
5 or less	5.3(1.6)	<ul style="list-style-type: none"> <li>• Cardio Pacemakers</li> <li>• Neuro-stimulators</li> <li>• Bio-stimulation Devices</li> </ul>
10 or less	5 (1.5 )	<ul style="list-style-type: none"> <li>• Magnetic Tapes and Floppy Drives.</li> <li>• VCRs.</li> <li>• Credit Cards, Watches and Clocks.</li> <li>• Telephone Switching Station.</li> <li>• LCD based monitors.</li> </ul>
200 or less	2 (0.6)	<ul style="list-style-type: none"> <li>• Electrical Line Filters.</li> </ul>

<sup>1</sup> Refer to magnetic fringe field plots in the prior section.

**Note:** Refer also to Chapter 7 for concerns related to environmental specifications related to time varying magnetic fields.

## 4 Exam Room Physical & Electrical Requirements

Ambient Radio Frequency Interference (RFI) can adversely affect the imaging performance of the MRI system. As a result RF shielding is required for all installations. There are several well qualified RF shielding contractors. ONI site planning can provide a contact list.

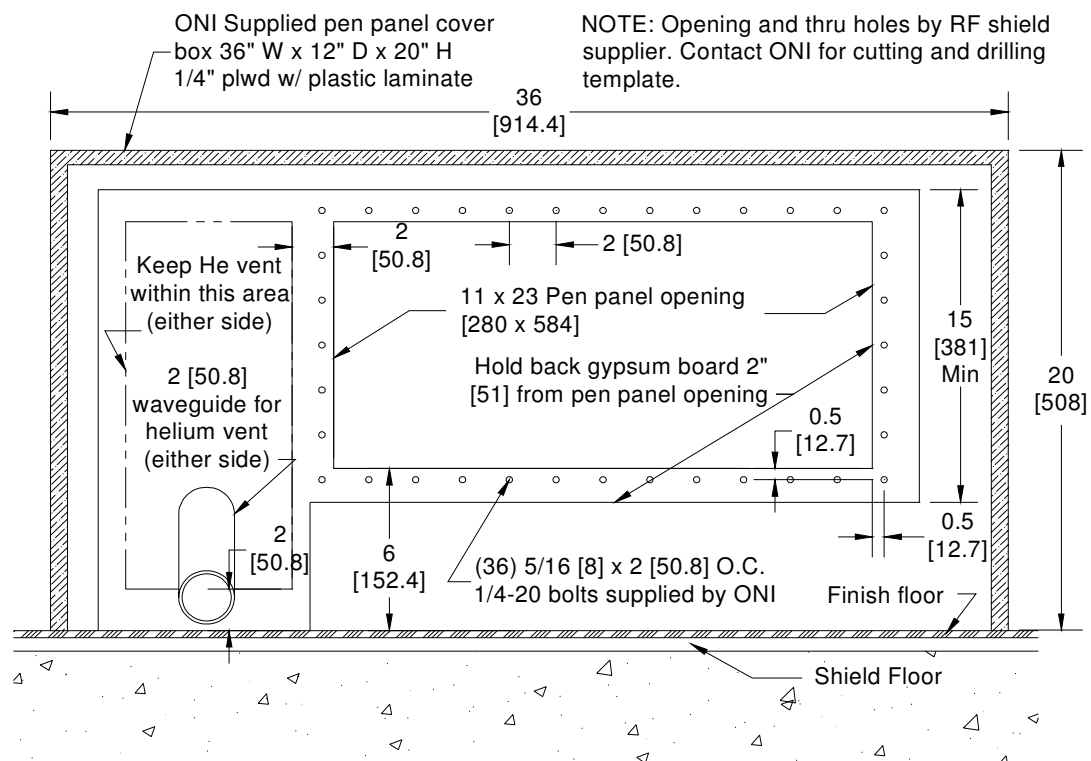
### RF Shielding and Exam Room Finishing

Table 4-1 summarizes the RF shielding and exam room finishing requirements. These requirements are to be used by the customer and the customer's contractors.

**Table 4-1.** Exam Room and Shielding Requirements and Tests

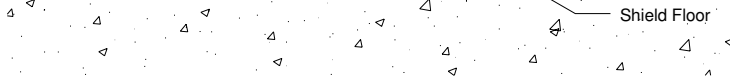
Parameters	Requirements
RF Shielding Effectiveness	80 dB of E field attenuation is required from 35 MHz to 50 MHz with a blank plate on the penetration panel opening.
Electrical Isolation	The RF shield must be electrically isolated from any point with a low impedance to ground, including non-ONI electrical equipment, plumbing, and the quench vent. The isolation required is > 1000 ohms before magnet anchoring.
Size	The exam room must not interfere with the patient handling. Minimum finished exam room dimensions per Table 2-1 are 11' wide x 9'6" (in direction of magnet axis) x 7'8" high (3.35 m x 2.9 m x 2.34 m).
Floor	The exam room floor must accommodate the floor loading from the ONI equipment, see Table 2-3 for specific requirements. The floor must be smooth to allow the patient chair to move freely with the heavy patient load. Commercial grade Vinyl Composition Tile (VCT) or commercial grade sheet flooring capable of withstanding heavy casters or rollers is required. <b>The maximum local floor pressure is estimated to be 1800 psi (12.4 MPa). Felt underlayment, textured or soft vinyl, or rugs are not acceptable.</b> The floor level must be $\leq 0.078''$ (2mm) between depressions and high spots over a 5' long (1524 mm) x 6' wide (1829 mm) (centered in front of magnet bore opening) floor area. Figure 2-1, 2-2 and 2-3 specifies anchor bolt type and shows the bolt pattern for mounting the magnet to the floor. This pattern must be accommodated in the floor to enable the magnet stand base to be installed flat on the finish floor. For sites that have earthquake mounting requirements, RF shielding should be installed accordingly.
Door	The finished door opening must be a minimum of 36" w by 84" h (915 x 2134 mm). It should not interfere with the patient chair access area. Any threshold should be minimized with a ramp and no gaps in the flooring according to requirements of local codes. The door should be provided with a key lock for safety.
Window	A screened window should be provided to allow continuous audio and visual contact between the operator and the patient. This window should not degrade the effectiveness of the RF shield. Sliding Glass over the screen window on operator side is recommended for privacy. A fully double glazed window may be used if the customer provides a 3 <sup>rd</sup> party MRI compatible intercom system. ONI site planning should be consulted.
Penetration Panel (PP)	An 11"x23" (279 mm x 330 mm) opening must be reserved for the penetration panel (PP) and it should be approximately 6" (155 mm) off the exam room floor. The room should be designed such that the penetration panel can be mounted anywhere on the back wall, or on the two sidewalls between the back wall and a perpendicular line out the side of the magnet from the iso-center. For the penetration panel mounting pattern see Figure 4-1 and Figure 4-2. ONI site planning will provide a drilling template/jig upon request.

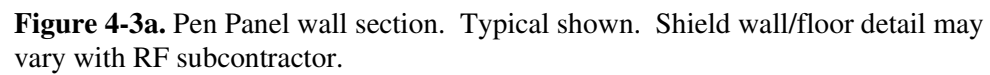
Parameters	Requirements
Helium Venting	A helium vent pipe penetration is required. The shield contractor is to supply a 2" (51 mm) waveguide section of tube and mechanically and electrically secure the tube to the shield. Refer to Chapter 5 for more details on helium venting.
Safety Vent Panel	A minimum 8" x 8" (203 mm x 203 mm) EMI-shielded ventilation panel with honeycomb construction should be installed in the ceiling. However, due to the presence of the window specified above (whose minimum area exceeds 64 square inches), a vent panel is not required.
Air Ventilation	RF room supplier to supply heating/air conditioning feed and return penetrations.
Shielding Material	Any typical non-ferrous RF shielding material may be used. Moving parts, such as a door or removable parts, must be non-ferrous.
AC power line filter	RF room supplier to supply AC power line filters for lighting and power outlets in the exam room. Two 20 AMP filters are recommended.
Structural Material	All structural material should comply with all architectural and safety regulations. Parts that can't be removed from the exam screen room can be ferrous, e.g., steel wall studs. Check with ONI for details.
Tests	The customer's RF shield vendor is responsible for conducting RF attenuation and ground isolation tests to verify that the shield meets ONI specifications. A statement of test with test data sheets should be provided to the ONI customer service representative before the installation commences.
Maintenance	Follow the RF shield vendor's recommended maintenance. Alert ONI customer service representatives of any RF shield defects since they could affect image quality.

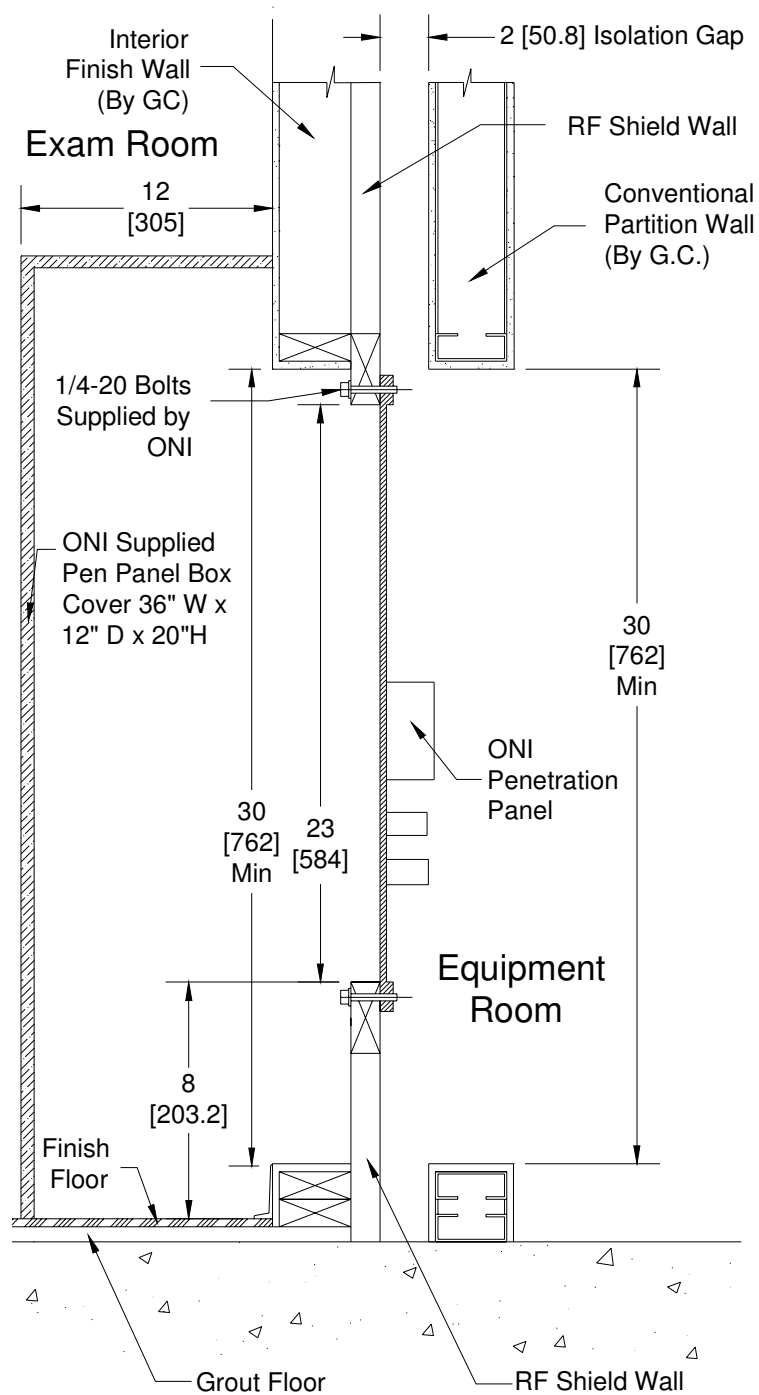


**Figure 4-1a.** Exam room elevation showing penetration panel horizontal opening & helium vent waveguide penetration.









**Figure 4-4b.** Pen Panel wall section. Typical shown. Shield wall/floor detail may vary with RF subcontractor.

## Sprinklers

If using sprinklers in the Exam Room, dry pipe systems have the advantage of reducing ground problems. However, all decisions regarding fire protection systems are the customer's responsibility.

## Electrical

The entry of any electrical or non-electrical (water, oxygen, air, floor drains) lines into the RF shield must be filtered and/or dielectrically isolated to ensure that the RF shield meets the minimum attenuation levels. The RF shield vendor must supply filters for all penetrations of the RF shielding, excluding the lines entering through the ONI-supplied RF penetration panel. All filters (for electrical lines) must be located outside the 200 Gauss line. The RF shield vendor should review with the electrical contractor the number of incoming power lines to the Exam Room in determining the number of filters needed for electrical requirements.

## Lighting

All lighting in the Exam room must be incandescent. *Fluorescent* lights are not permitted. Conventional dimmer switches must not be used; however, a selectable switch or special "inductive load" dimmers may be used to change the light intensity. Use of fluorescent lights and conventional dimmer switches will create unacceptable RF interference in the image. Consult with RF shielding supplier to determine the appropriate dimmer to use with their filters.

## RF Shield Grounding Technique

The usual practice in shielding construction is to build the shield so that it is electrically isolated from earth/building ground by greater than 1000 ohms. The shield is then intentionally grounded at a single point to make the shield electrically safe and to minimize circulating currents in the shield's metallic structure. This point is called the "common ground". The common ground usually takes the form of a ground stud and bus bar to which the RF shield's electrical filter grounds and the MRI's equipment grounds are all tied. For the Extremity system, there is no need for this type of common ground configuration. Instead, the single ground point will be the ground provided with the power wiring to the shield's electrical filters. Consult with your RF shielding supplier to determine the appropriate dimmer to use with their filters.

The electrical filters typically provided by the shield supplier are two 20 Amp units, one for lighting, the other for convenience outlets. They should be installed by the shield supplier immediately above the penetration panel (PP), either in the wall or the ceiling of the shield. If this is not possible, then they should be as close as is practical to this general area.

The electrical contractor must connect the branch circuit wiring directly to the filter assemblies *without* a dielectric break. That is, EMT conduit and fittings may be run directly to the metal filter units mounted on the shield. Although the bonded metallic conduit, fittings, and boxes used for this run may meet code requirements for electrical safety grounding, an insulated ground wire *must* be run along with the line and neutral wires from the bus bar of the distribution panel supplying the branch circuits. These ground wires must be fixed to the line-side ground terminals of the electrical filters.

**Note:** The RF shielding ground isolation test must be done **BEFORE** the connection of power to the filters is done. RF attenuation tests should follow power connection.



## 5 Helium Venting

### Introduction

The magnet system contains cryogenic helium necessary to maintain the magnet in a superconducting state. In case of a magnet quench, the helium boils and the resultant gas is expelled out of the magnet. This section describes the requirements necessary for safe venting of the cold helium gas.

During a quench, about 15 liters of liquid helium boils in approximately one minute. The resultant gas rapidly warms and expands as it travels out of the magnet and through the vent tube system. The 15 liters of liquid eventually expands to 800 times the original volume once the gas reaches room temperature. Thus 15 liters turns into 12 cubic meters (424 cubic feet) of gas once fully warmed.

The expanding gas from the magnet creates a number of potential hazards that proper venting avoids. The cold gas must be directed away from human contact to prevent possible injury in the form of cold burns. Additionally, the expanding gas can potentially increase the room pressure to levels that would make it difficult to open a door. Finally, in very confined spaces, the gas can potentially displace air and reduce the oxygen to unsafe levels.

In general, this gas must be vented to the outside. There are special cases outlined below where internal venting is permissible. In all cases, however, the venting must be done in a manner that prevents the cold gas from coming in direct contact with any person as well as electrical and plumbing devices while not reducing the oxygen to unsafe levels.

A warning sign should be placed at the outside vent with text similar to the following: “Warning. Freezing gasses and small objects may be discharged without notice. Stay at least two feet (60 cm) away from the opening.”

Figure 5-1 shows a pictorial representation of a typical vent system extending from the magnet through the wall of the Exam room and RF shield, to the outside of the building. The vent system consists of:

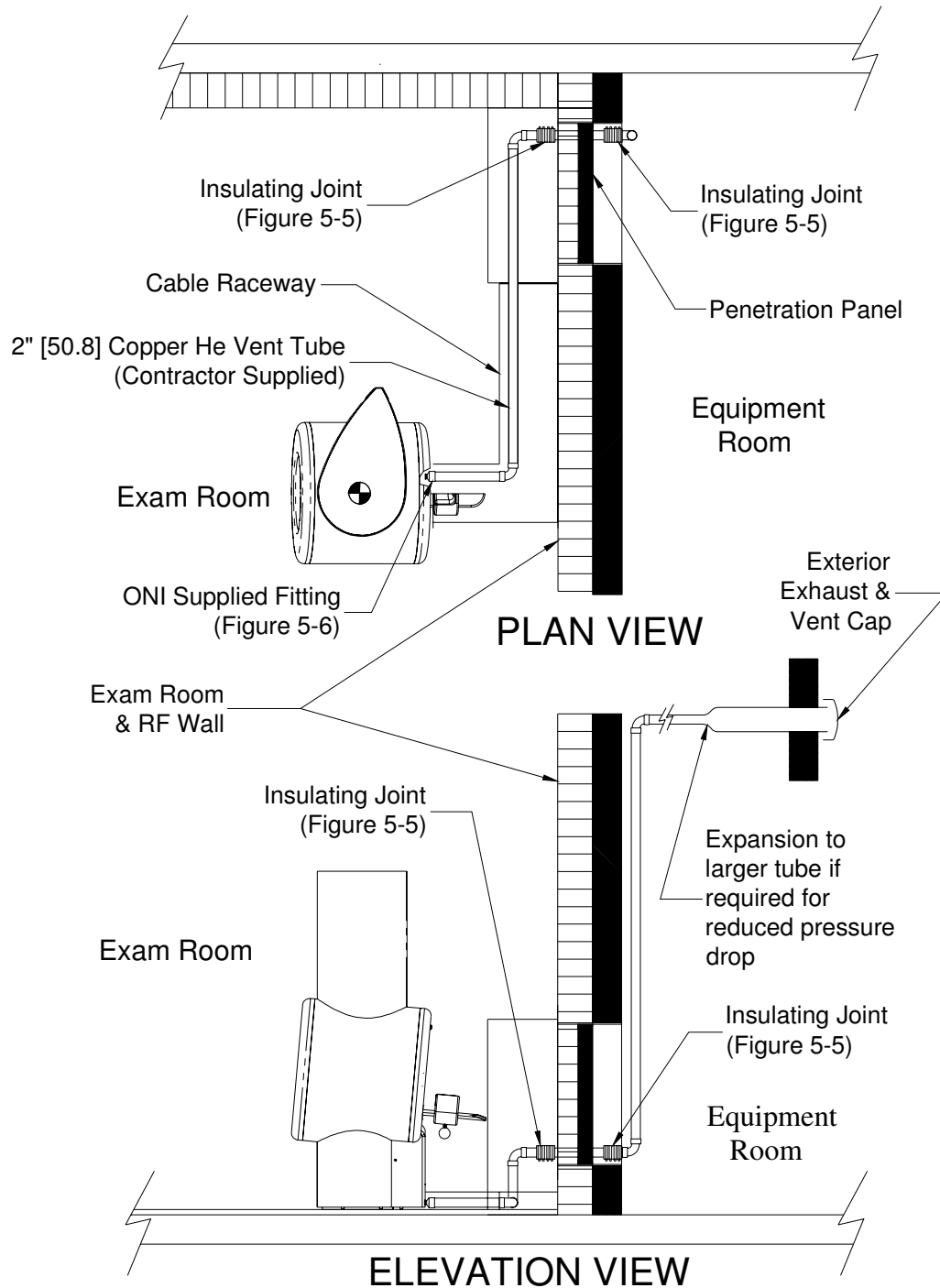
- Interior vent tubes between the magnet and the exam room wall.
- A tube penetrating through the RF shield wall.
- A building vent consisting of a set of tubes connecting the shield penetration to an exhaust external to the building.

### Responsibilities

It is the responsibility of the customer’s mechanical/HVAC contractor to provide the vent tube between the base of the magnet and the RF shield penetration. The mechanical/HVAC contractor must coordinate the means of connection and routing of the tube with ONI and the shielding supplier. ONI will provide specific location information for magnet and helium vent penetration.

It is the responsibility of the customer’s RF shielding contractor to provide a tube that penetrates the RF room in accordance with the specifications described in this document and to coordinate the location of the tube with the customer’s HVAC contractor.

It is the responsibility of the customer's HVAC contractor to route the vent tube external to the RF shield and to make the connection between the RF shield and the external vent tubing in accordance with the requirements cited in this document.



**Figure 5-1.** Major Elements of a Cryogenic Venting System.



## Vent Tube Wave Guide Penetration through the RF Room

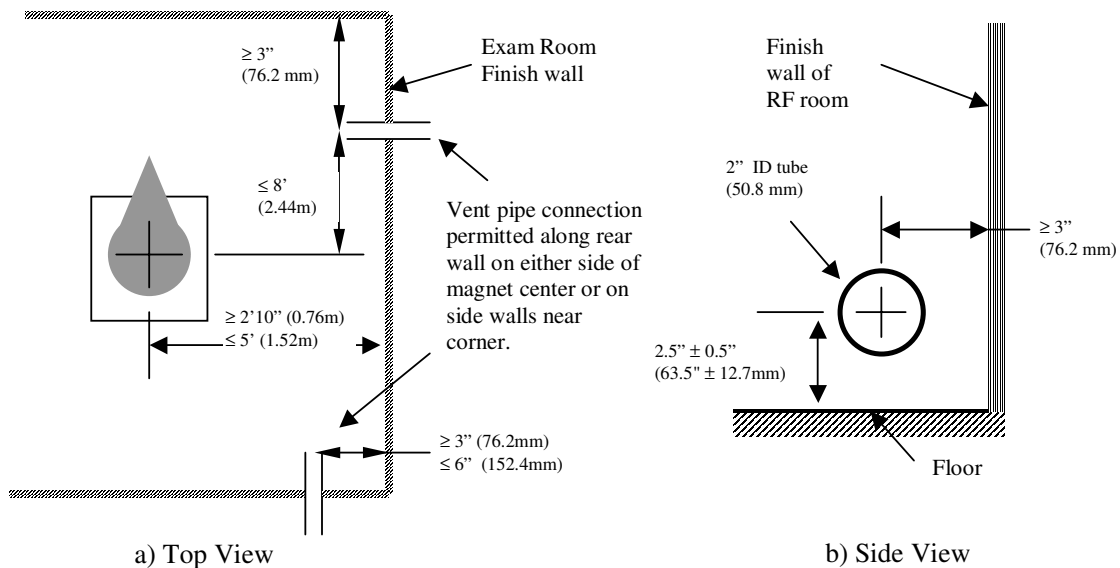
The vent tube wave guide penetration through the shield must be electrically-conducting to provide RF shielding. The shield contractor is to supply a 2”(51 mm) diameter waveguide section of tube and mechanically and electrically secure the tube to the shield. Adequate clearance and tube lengths must be maintained on both sides of the wall to permit electrical insulating connections.

The vent tube penetration is to be located on the lower portion of the wall on the rear side (non-patient side) of the magnet. Figure 5-2 shows the permitted locations for a wall vent tube. Figure 5-2a shows the top view of the permitted location of vent tube penetration, along the lower portion of the rear wall, and on the walls (near the corners). The maximum distance from the magnet center to the tube center is 8 feet (2438 mm). Maximum distance from the rear wall to the tube center is 6 inches (152 mm). Figure 5-2b shows the side view of the tube location relative to floor and wall. Floor and wall clearance is required to permit connection by the HVAC or plumbing contractor.

The outside and inside diameters of the copper tubes through the shielded room are shown in Table 5-1. These dimensional tolerances must be maintained so a proper seal can be made when making the electrical insulating connections.

**Table 5-1. Copper Tube Dimensions**

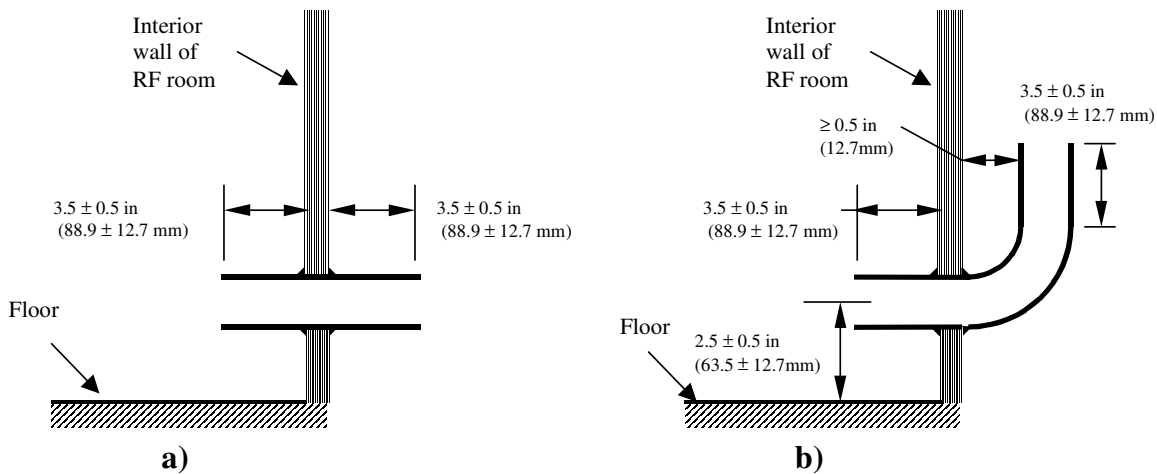
Copper Pipe Type	Standard size Inches (mm)	Outside Diameter Inches (mm)	Inside Diameter Inches (mm)	Wall Thickness Inches (mm)
K	2 (51)	2.125 (54 )	1.959 (49.76 )	0.083 (2.11 )
L	2 (51)	2.125 (54 )	1.985 (50.42 )	0.070 (1.78 )
M	2 (51)	2.125 (54 )	2.009 (51.03 )	0.058 (1.47 )
DWV	2 (51)	2.125 (54 )	2.041 (51.84 )	0.042 (1.07 )



**Figure 5-2.** Vent Tube Penetration Location Behind Magnet. Note: ONI site planning will provide specific location for vent pipe penetration.

Figure 5-3 shows the side view of the vent tube penetration through the wall, and the required length for adequate attachment of an insulating joint.

Figure 5-3a shows the required clearance for a wall configuration (straight through vent tube). Figure 5-3b shows a permitted variation of the wall configuration where a vent tube exit from the RF room is through a 90-degree bend. This configuration is useful where a wall vent is desired but the space outside the room for routing the vent tube is limited. Note that the pressure loss of the bend must be included when calculating the total pressure drop of the vent system (see Table 5-2).

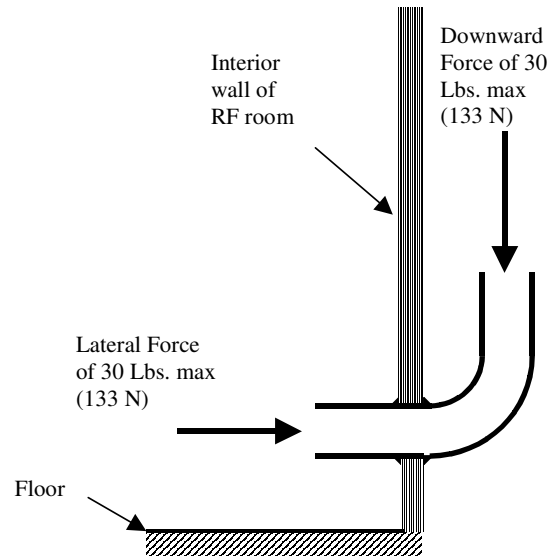


**Figure 5-3.** Side View of Vent Tube Penetration through RF Room Wall

## Force on Vent Tube Penetration through the RF Room

Each of the two joints will experience a maximum separating force of 30 Lbs(133 Nt). (corresponds to the total force of 5 psi on the cross-sectional area of a 2 in. diameter tube) during a quench. The force is parallel to the direction of the tube at the joint. The mechanical strength of the connection between the penetration tube and the shielded room must be sufficient to handle these forces, assuming the worst case that one or both of the joints cannot support the force directly.

Figure 5-4 shows the side view of vent tube penetration through RF room wall with 90-degree bend. During a quench, the penetration tube experiences a maximum force of 30 Lbs(133 Nt) in two directions (as shown) under the worst-case assumption that the electrical insulating joints provide no support in the direction parallel to the pipe.



**Figure 5-4. Force on Vent Tube Penetration through RF Room**

## Specific Requirements for the Building's Helium Vent System

This section describes permitted vent materials, types of connections, pressure drop requirements for the vent, and pressure drop tables for the vent system components.

### Maximum Pressure Drop

The pressure drop of the entire venting system, including the RF penetration and internal room piping, must be less than 5 psi (34.5 kPa). When planning the route for the vent, the general rule to follow is to identify the shortest distance to a safe exhaust location with as few bends as possible.

### Vent Tube Materials

Permitted vent tube material inside the exam room is smooth-walled copper, aluminum, or stainless steel tubing. Outside the exam room conventional steel tubing can be used as well. The tubes must be continuous or have a smooth-welded seam. Drawn or annealed copper tubes are preferred; Drain Waist Vent (DWV), Type K, Type L, or Type M pressure ratings are acceptable because of availability and ease of soldering.

Under quench conditions, the internal pressure is designed to be less than 5 psi over atmospheric pressure. The vent tube pressure rating must be greater than 10 psi to provide a factor of 2 safety margin.

PVC or ABS pipe are not permitted. Their interior surface is too rough – it creates too great a pressure drop. The integrity of the pipe (when exposed to cold gas) cannot be guaranteed.

## Joints

Joints must be soldered, braised, or welded, as appropriate for the vent material used. The only exception to this is the electrically-insulating connections between the RF shield and the vent tubing.

One method used to make the insulating joints between the RF shield and the vent tube is to wrap the tube with a thin sheet (1/32 inch, 1.3 mm or greater) of fiberglass to provide a primary barrier to the gas and to provide electrical insulation. This is followed by a wrap of thin stainless steel or aluminum (1/32 inch, 1.3 mm or greater) followed by 4 stainless steel clamps. In order to ensure an adequate insulating joint, the gap between the two pipes must be maintained between 0.5 inch and 1 inch, as shown before wrapping. The wall thickness of the vent tube must be chosen such that the outside diameter of the vent tube matches the outside diameter of the RF room penetration to within  $\pm 1/8$  inch (5 mm).

An alternative method to make the joint is to use an off-the-shelf DWV 2" to 2" connector. A coupler with a metal shield and 4 clamps is required. Figure 5-5 is a photograph of a permitted type to be used.

The connection of the EXTREMITY system to the vent tube is done via a special k-flange to 2" adapter as shown in Figure 5-6. This adapter is provided by ONI and is to be soldered to a 2" vent tube positioned at the base of the magnet as shown in Figure 5-1 and on the floor template in Figure 2-1.



**Figure 5-5.** Photograph of insulating Joint using a 2" DWV coupling. A coupling with metal shield and 4 clamps is required. Some RF room suppliers will provide a special insulating coupling for use outside of room. This item is supplied by your general contractor.



**Figure 5-6.** Photograph of k-flange to 2” adapter provided by ONI. The adapter is to be soldered to 2” copper tube positioned at a location specified in Figure 5-1 and Figure 2-1.

### Vent Supports

The electrical insulating joint on the 2”(51 mm) tube at the exit of the shield experiences a maximum separating force of 30 Lbs(133 Nt) during a quench. The insulating joint must be sufficiently strong to prevent a separation of the joint during a quench. A support bracket can be placed on the pipe, near the insulating joint, to prevent a separation. The support bracket must not be attached to, or make contact with, the shielded room electrical surfaces. Other supports are required by the HVAC contractor to handle the weight of the vent system.

### Fire Breaks

A Fire-Tite UL-approved fire damper may be required by local codes. It typically should have a replaceable fusible link with 165 °F(74 °C) standard.

### Exhaust Vent

A low-pressure drop exhaust vent and cap must be used. The pressure drop must be included in the calculation of the total vent system pressure drop. For purposes of choosing an appropriate vent, a maximum airflow rate of 318 Cubic Feet Per Minute (CFM) or 0.15 m<sup>3</sup>/sec at atmospheric outlet pressure and room temperature can be assumed. This will result in a conservative estimate since the actual exhaust pressure drop for helium gas is lower than room temperature.

Choose the location of the exhaust vent so as not to cause possible injury to any person. If there is potential for human contact, warning signs must be placed near the exhaust, indicating a possible hazard due to cold gas for persons within 2 feet(610 mm) of the exhaust.

Aluminum, copper or other metal flashing material should be used to protect any nearby surfaces that have the potential of coming in direct contact with the exhaust gas stream. In addition, there should be no snow or ice blockage.

## Pressure Drop Calculations

Table 5-2 below is used to calculate the pressure drop of the vent system components. For tube diameters other than those shown, the pressure drop can be assumed to scale as the reciprocal of the fifth power of the tube's inside dimension. Under no circumstances shall a tube diameter less than 2 inches (51 mm) be used.

When making the pressure drop calculation, the vent components inside the exam room must be included. If this is unknown at the time, assume a worst case of 15 feet (4570 mm) and two 90 degree bends of 2 inch (51 mm) ID tube.

**Table 5-2.** Pressure Drop Table for Vent System Components

Pressure Drop <sup>1</sup>	Distance of Vent System Component From Magnet			
	0-6.6 ft (0-2 m)	6.6-16.4ft (2-5 m)	16.4-32.8 ft (5-10 m)	32.8-65.6 ft (10-20 m)
2 inch (51 mm) DIA straight tube	0.0031psi/ft (70 Pa/m)	0.0061 psi/ft (138 Pa/m)	0.0091 psi/ft (206 Pa/m)	0.0121 psi/ft (274 Pa/m)
2 inch (51 mm) DIA std. sweep 45 degree bend	0.14 psi (965 Pa)	0.28 psi (1931 Pa)	0.42 psi (2896 Pa)	0.56 psi (3861 Pa)
2 inch (51 mm) DIA std. sweep 90 degree bend	0.28 psi (1931 Pa)	0.56 psi (3861 Pa)	0.84 psi (5792 Pa)	1.12 psi (7722 Pa)
3 inch (76 mm) DIA straight tube	0.00031 psi/ft (7 Pa/m)	0.00061 psi/ft (13.8 Pa/m)	0.00122 psi/ft (28 Pa/m)	0.00152 psi/ft (34.4 Pa/m)
3 inch (76 mm) DIA std. sweep 45 degree bend	0.019 psi (1310 Pa)	0.037 psi (255 Pa)	0.056 psi (3861 Pa)	0.074 psi (510 Pa)
3 inch (76 mm) DIA std. sweep 90 degree bend	0.037 psi (255 Pa)	0.074 psi (510 Pa)	0.111 psi (765 Pa)	0.148 psi (1020 Pa)

<sup>1</sup> The pressure drop is for a smooth inside wall. The inside dimension of the tube is the reference dimension. The pressure drop is for 15 liters/min of liquid vaporizing in the magnet. Std. sweep type elbows were used to calculate the pressure drops in this table; however, using long sweep type is acceptable and the pressure drops would be reduced.

## Internal Venting Criteria

If interstitial space is sufficient between the ceiling of the RF shield and the immediate floor above then helium can be vented in that space provided that:

1. There are no electrical or plumbing fixtures within 2 feet (610 mm) of the exhaust vent.
2. The space is interconnected to the adjacent offices' hallway ceiling space such that the minimum total volume exceeds 5,000 cubic feet (140 m<sup>3</sup>) which will allow the gas to expand into a confined space at less than 1 psi (6895 Pa) maximum pressure.
3. A sign indicating warning for the exhaust to be supplied and installed by the client.
4. The space is not used as a return air plenum.

## 6 Electrical Requirements

### Power Supply

Table 6-1 describes the electrical power requirements under normal conditions. Installation of a power conditioner may be required if the customer site is located in an area susceptible to brown outs, outages, surges, swells, and lightning storms. Such conditions could prove damaging and increase the downtime of the system. Power surges should be limited to a range 10% above and 10% below nominal operating voltages given in Table 6-1.

The location of electrical junction boxes and power outlets will be decided after ONI and the customer agree on the equipment layout.

Supplying the Helium Compressor and the equipment room air conditioner with emergency back-up power is desirable if the extra capacity is available in an existing emergency power system.

**Table 6-1.** Electrical Power Requirements

Equipment Item	Power Feed	Frequency (Hz)	Voltage (volts)	Maximum Current Draw (amps)	Minimum Supply Capacity (kVA)	Steady Power Demand (kW)	Maximum Power Demand (kW)
Helium Compressor (HC)	Three-phase 3W+GND (PE) Dedicated Circuit. Permanently connected.	50	380, 400, 415 ( $\pm 10\%$ )	7.5	6.5	3.8	4.7 <sup>1</sup>
		50/60	200 ( $\pm 10\%$ )	16	6.5	4.8	5.6
System Electronics (SE)	Single-Phase 2W + GND (PE) Dedicated Circuit. Permanently connected.	50/60	100,120, 220-240 ( $\pm 10\%$ )	13,11,7	1.25	.325	1.0 <sup>3</sup>
RF Shielding (RFS)	Two single phase branch circuits, one for lighting, one for receptacle, RF filtered.	50/60	Per local country requirements	Per local country requirements	--	--	--
Operator's Console (OC)	Single-Phase with 2W+GND (PE). Dedicated Circuit not Required	50/60	100-240 ( $\pm 10\%$ )	0.7	--	--	41 W
Convenience Power Outlet	2-Wire Plus Ground	50/60	Per local country requirements	Per local country requirements	--	--	--

**Notes:** 1. At time of magnet cool-down, approximately 48 hours during installation.  
 2. During Overnight mode  
 3. During high duty cycle scanning

The power connections to the electronics cabinet and the compressor are to be as defined by IEC 60601-1-1 for permanently connected equipment and in accordance with local

and national electrical code requirements. The customer and the customer's contractors must ensure that the connections meet these "permanently connected" requirements.

In the USA and Canada, the use of twist lock connections (as listed in Table 6-2 below) is the required equipment connection method. The twist lock connections defined in this table satisfy the requirements for permanently connected equipment.

**Table 6-2.** System Electrical Power Connections for USA and Canada  
(60Hz operation).

Equipment Item	Power Feed	Ground Wire	Connection Means
Helium Compressor (HC)	3 phase, 208 VAC, 30 Amp, 3W + GND (PE) Dedicated Circuit.	Ground wire size equal to phase wire size	NEMA L15-30R, 3 $\phi$ , Twist-Lock Receptacle on wall
System Electronics (SE)	1 phase, 115 VAC, 20 Amp, 2W + GND (PE) Dedicated Circuit.	Ground wire size equal to phase wire size	NEMA L5-20R, 1 $\phi$ , Twist-Lock Receptacle on wall
Operator's Console (OC)	1 Phase, 115 VAC, 15 Amp, 2W + GND (PE). Shared Circuit OK	Per local country requirements	NEMA 5-15R, 1 $\phi$ , Standard duplex wall receptacle
Exam Room / RF Shielding (RFS)	Two 115VAC, 20 Amp branch circuits, one for lighting, one for receptacle, RF filtered.	Insulated Ground wire to be run along with line and neutral wire.	Hard wire to RF filters and ground lug
Convenience Power Outlet	1 Phase, 115 VAC, 15 Amp, 2W + GND (PE). Shared Circuit OK	Per local country requirements	NEMA 5-15R, 1 $\phi$ , Standard duplex wall receptacle

## Exam Room Electrical Raceway

The customer or their electrical contractor is required to supply a floor (surface) mounted lay-in type aluminum electrical raceway in the exam room. This raceway runs from the back of the magnet to the penetration panel as shown in Fig. 2-1, Fig. 5-1, and in the example drawings of sheets 2 and 3 of Appendices A and B. The size of the raceway is 3.5" (89mm) high by 10" (254mm) wide. See also Table 2-2.

**Note:** Wiremold's 'Walker Duct' product (or equivalent) is suitable for this application. Check with ONI Site Planning if additional information is required. ONI engineers will lay-in cables and hoses. The mechanical contractor is responsible for installing the helium quench pipe in this raceway. There is a six to eight week lead time for delivery.

## Other Conduit or Raceway

See Table 2-2 for sizes and run lengths for other possible conduit or raceway needs. Always check with ONI Site Planning on the routing of conduits and raceways as run lengths are critical. ONI engineers will require customer/contractor supplied assistance in pulling cables and hoses in situations where runs are lengthy.



## 7 Environmental Requirements

Optimum performance of the EXTREMITY System depends on abiding by the environmental conditions described in this section. Use this section to determine the required ambient environmental conditions.

### Temperature and Humidity Specifications

Table 7-1 lists the specifications that the Heating Venting and Air Conditioning (HVAC) system must meet for the EXTREMITY System operation. This table is duplicated on page 4 of Appendices A & B. Note that these specifications must be maintained 24 hours per day, seven days per week, 365 days per year. *NO energy conservation setbacks are allowed* in either the Exam Room or the Equipment room.

**Table 7-1.** System Environmental Requirements

<b>Room</b>	<b>Temperature Range 24 x 7 x 365 F (C)</b>	<b>Temperature Set Point Regulation 24 x 7 x 365 F (C) [Within the range]</b>	<b>Humidity 24 x 7 x 365</b>
Control Room	As required for Comfort	As required for Comfort	Non-Condensing
Exam Room	64-77 (18-25)	$\pm 2.5$ $\pm (1.4)$	Non-Condensing
Equipment Room	60-80 (15-27)	$\pm 5$ $\pm (2.8)$	Non-Condensing

### Heat Output and Cooling Requirements

The System components generate heat in their respective locations. Page 4 of Appendices A & B list the maximum heat output in the room from the EXTREMITY System components *only*. At sea level, a 2 Ton (7.0 kW) dedicated air conditioning unit will generally be adequate for the equipment room if there are no other heat loads, including those cooling needs caused by outdoor temperature and/or direct sun.

The small rooms typically used for this equipment require adequate air flow and proper location and sizing of the supply and return ducts for cooling of the components. The thermostat for this room must be located so as to prevent the possibility of short cycling the air conditioning unit. It is suggested that the return duct be placed above the Helium Compressor (HC) and the supply duct over the System Electronics (SE).

### Moving Metal and Ambient Magnetic Fields

Large moving metal objects such as elevators, cars, fork lifts, trains, subways, dumpsters, etc. interact with the earth's magnetic field and/or create a small time-varying magnetic field. Sufficiently large changes in the magnetic field can adversely impact image quality in the form of

ghosting or artifacts. The field produced by moving objects should be maintained at less than 2 milli-Gauss peak-to-peak at the proposed location of the magnet to minimize the possibility of artifacts.

## 50/60 Hz Stray Magnetic Fields

Transformers, power conduits, motors and other 50/60 Hz electrical equipment can create stray magnetic fields. If too high, these fields can create ghosting or artifacts in the images. The 50/60 Hz stray magnetic fields should be less than 10 milli-Gauss RMS at the proposed location of the magnet to minimize the possibility of artifacts.

## Vibration

Air conditioners, motors, pumps, cooling towers and other equipment can cause mechanical vibrations. These vibrations, if large enough at the proposed location of the magnet, can produce magnetic field instabilities that adversely affecting image quality. Figure 7.1 is the recommended vibration limit for continuous vibrations at the proposed location of the magnet.

If there is any concern about vibration levels, a site vibration survey can be conducted to determine the levels of vibration present and the possible source. A qualified third party should conduct the study. ONI site planning can arrange for the survey to be conducted and to assist in the interpretation of any results.

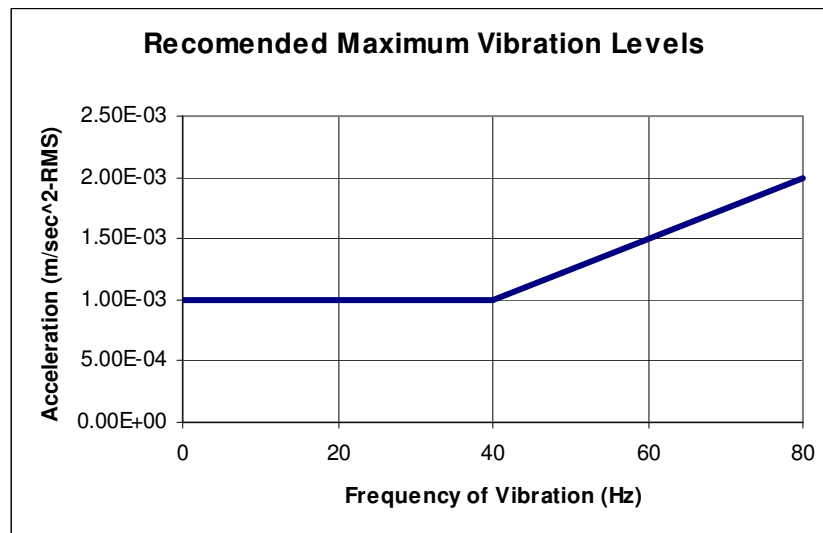


Figure 7-1. Maximum Vibration Levels as a Function of Frequency.

## Altitude Specification

The EXTREMITY system will operate in the range of 100 feet (30.5m) below to 6500 feet (2000m) above sea level. Operating at altitudes greater than 6500 feet (2000 Mm) is possible with additional air conditioning in the equipment room or the use of a water cooled helium compressor. Contact ONI site planning for more detail.

## Audible Noise

Table 7-2, lists the typical noise level readings produced by the System components. OSHA and the FDA maintain safe operating guidelines for audible noise. Hearing protection is not required by the operator or the patient at these levels of noise.

**Table 7-2.** Maximum Equipment Audible Noise

Room	Location	dB (A)
Imaging Suite	Operator's Console	Less than 70
Exam Room	Patient Position	Less than 90

## Reducing Air Pollution Effects

All components of the EXTREMITY system that are air-cooled have their own filters; however, if the facility is located in a particularly dusty environment, then a more sophisticated air filtration system should be installed.



## 8 Network / Phone Connection Requirements

This section describes the network and telephone connections that are required to remotely access the EXTREMITY Imaging system.

### Network Connection

A 10Base-T or a 100Base-TX/100Base-T4 network port is required via a RJ-45 port. Placement of the outlet will be decided after ONI and the customers agree on the site layout. It is typically located, with the phone connection below, adjacent to the system electronics power receptacle.

### Phone Connection

A dedicated standard modular telephone jack is required (type RJ-11). The type of phone connection should be a standard analog telephone line that would be provided for a dedicated FAX or PC modem. RJ-11 is the standard analog type phone line jack found in the office or home environment. Placement of the outlet is at the same location as for the network connection.

**Note:** The telephone line must have long distance calling privileges.



## 9 Shipping and Delivery Information

The delivery route for magnet and other components should be planned within the facility. The width of all corridors and doorways should be at least 36 inches wide with no obstructions. Elevators should have sufficient capacity and size for the equipment. See table 9-1 for the size of the individual boxes/crates.

A staging area of a minimum of 150 square ft is required for storing and unpacking the equipment during installation. This space would be required for approximately 2 to 3 days at the start of system installation.

**Table 9-1.** Shipping Data

<b>Component</b>	<b>W x D x H in. (meters)</b>	<b>Shipping Weight lbs (Kg)</b>
Magnet & Gradient Coil	26" x 30" x 58" (.660 x .762 x 1.47)	1400 lbs (635.0 Kg)
Compressor	26" x 44" x 31" (.660 x 1.11 x .78)	309 lbs (140.1 Kg)
Cold Head Assembly	11" x 26" x 15" (.279 x .660 x .381 )	56lbs (25.4 Kg)
Electronics Rack	29" x 39" x 52" (.736 x .99 x 1.32)	480 lbs (217.7 Kg)
Patient Chair Assembly	33" x 41" x 63" (.838 x . 1.04 x 1.6)	348 lbs (157.8 Kg)
Helium Lines & AC Power Cord	27' x 28" x 9" (.685 x .711 x .228)	50 lbs (22.6 Kg)
Pen Panel Cover	13" x 39" x 22" (.330 x .990 x .558)	21 lbs (9.52 Kg)
Magnet Front, Rear Covers & Foam wrap.	26" x 26" x 26" (.660 x .660 x .660)	65 lbs (29.4Kg)
Magnet Cylindrical Cover, Heel Support Platform, Pad & Lock Knob, Extremity Support Bracket, Teardrop Cable Cover & Ottoman.	24" x 24" x 24" (.609 x .609 x .609)	95 lbs (43.0 Kg)
LCD Monitor, Keyboard, Mouse & Host Computer Drive CDs, Power Control Unit, Pressure Control Module, Phantom Kit, Operators Guide, Viewer's Guide, Patient Log Books, SW Release Notes, MRI Exclusion Warning Signs & Health Effects Text, DVD & Power Cable.	26" x 26" x 26" (.660 x .660 x .660)	65 lbs (29.4Kg)
Right & Left Enclosures	24" x 24" x 36" (.609 x . 609 x .914))	65 lbs (29.4Kg)
Upper Tear Drop Enclosure	24' x 24" x 48" (.609 x .609 x 1.219)	65 lbs (29.4Kg)

<b>Component</b>	<b>W x D x H in. (meters)</b>	<b>Shipping Weight lbs (Kg)</b>
RF Coils	36" x 20" x 13" (.914 x .508 x .330)	95 lbs (43.0 Kg)
Penetration Panel, RF Front End & Labeling Kit.	26" x 20" x 11" (.660 x .508 x .279)	95 lbs (43.0 Kg)
Spare Cables, RF Room Cable & Rack to Console Kits, Optional 50' Rack to Console & Rack to Pen Panel Kits.	26" x 20" x 11" (.660 x .508 x .279)	95 lbs (43.0 Kg)
Magnet Saddle Stand, Cold Head Stand, Flexible tube, Cold Head Support Plate, Pressure Transducer, RF Coil Intf Plate, Laser Light Assy, Sensaphone Kit, Misc parts for Enclosure Kit, Magnet & Hardware Kits.	60" x 32" x 16" (1.524 x .812 x .406)	500 lbs (226.7 Kg)

## **Transportation & Storage Requirements**

The system components can be transported and shipped in temperatures ranging from -40°F (–40°C) to 150°F (65°C) and altitudes of up to 35,000 feet (air cargo). Dry heated storage is required for any extended period of storage, more than a few days.



## **10 Pre-Installation Checklist**

Use this section as a reminder of items that need to be coordinated. Some are frequently overlooked. A similar list will be used by an ONI service or site planning coordinator to review the site readiness before shipment.

### **Suite Layout and Details -(Per ONI provided site specific layout drawing)**

#### **Exam Room**

- ☐ Dimensions, L x W x H, "finish to finish"
- ☐ Door location, size, and swing direction
- ☐ Pen panel location and accessibility
- ☐ Storage cabinet location and min size 30"W x 12"D x 36"H (760 mm W x 305 mm D x 914 mm H)

#### **Equipment Room**

- ☐ Dimensions, L x W x H, "finish to finish"
- ☐ Door location, size, and swing direction
- ☐ Pen panel location and accessibility

#### **Control Room**

- ☐ Dimensions, L x W x H, "finish to finish"
- ☐ Door location, size, and swing direction
- ☐ RF window size and location. Screen, bypass glass, or glazed. (Note, customer supplied intercom needed, if glazed.)
- ☐ Countertop and casework to support ops console equipment 42"W x 24"D (1070 mm W x 610 mm D)

### **RF Shielding Installation Details**

#### **Exam Room**

- ☐ Copy of shield proof-of-performance test results
- ☐ Pen panel hole prepared for ONI pen panel, 11" x 23" (279 mm x 330 mm) with perimeter holes drilled
- ☐ Floor anchors installed in the right locations (see anchor layout drawing, verify magnet orientation)
- ☐ Door complete with all "fingers" intact (if used)
- ☐ Lockable exam room door, with keys
- ☐ HVAC diffusers installed -- feed and return
- ☐ He vent penetration ready for connection to pipe from magnet
- ☐ Convenience outlets in room (check function -- may be wired to light circuit)

#### **Equipment Room**

- ☐ Electrical filters installed near (usually above) pen panel, including any needed for a thermostat.
- ☐ He vent penetration properly connected outside the shield

### **Electrical Requirements**

#### **Exam Room**

- ☐ Incandescent AC lighting -- no fluorescent lamps, no conventional dimmers in room however a selectable switch or special "inductive load" dimmer may be used to change light intensity. Check with your RF shielding supplier for suitability of specific dimmers.

- ❑ Branch circuit receptacle (one OK) somewhere in room, 15 A, 115 VAC per local requirements (check function, may be wired to lighting circuit)
- ❑ Aluminum lay-in raceway between pen-panel and back of magnet (may not be in place at time of inspection)

### **Equipment Room**

- ❑ For compressor power verify three phase with ground, no neutral (four wires, verify phase line to line voltages, verify no voltage difference between receptacle ground and RF shield ground). In US/Canada verify NEMA L15-30R twist-lock receptacle, 30 A, 208 VAC. In other countries verify connection according to local or country voltage and code requirements. Phase rotation must be clockwise (L1, L2, L3).
- ❑ For electronics power verify voltage levels hot to neutral, verify no voltage difference between receptacle ground and RF shield ground. In US/Canada verify NEMA L5-20R twist-lock receptacle, 20 A, 115 VAC. In other countries verify connection according to local or country voltage and code requirements.
- ❑ 110 VAC 20A convenience receptacle for Service Engineer's (SE) use per local codes.
- ❑ Adequate lighting

**Note:** All electrical equipment must be installed prior to System installation.

### **Control Room**

- ❑ Verify 115 VAC, 15 amp standard duplex wall outlet 5-15R for console monitor if US/Canada or per local country standard outlet requirements.

**Note:** This must be from the same panel and phase as the system electronics.

- ❑ Identify location for quench button mounting.

### **HVAC Requirements**

**Note:** All HVAC equipment must be installed prior to System delivery and installation.

### **Exam Room**

- ❑ Verify thermostatic control of exam room temp. Note: thermostat control unit may be in control room with sensor in return air duct coming from Exam room. If mounted in-room, it should not be in a corner, or in sunlight, or other location where it will not be representative of average room conditions.
- ❑ Verify that room air feed and return is functional
- ❑ Confirm that there are NO energy conservation temp "set backs" -- must run 24 hours per day, 7 days per week, 365 days per year at nominal temp.
- ❑ Helium vent penetration properly located and dielectric breaks in position on both sides of the waveguide.
- ❑ Helium vent piping outside the exam room properly routed to vented attic or exterior of building. (Pipe to magnet will not be installed at this time.)
- ❑ Helium vent pipe termination safely located? Warning signs needed?

### **Equipment room**

- ❑ Perform functional check of A/C unit -- it should be able to get this room very cold without the equipment installed and running -- 65 F (18 C) should not be a challenge!
- ❑ In-room thermostatic control must be present, working, and in a logical location.
- ❑ Air feeds and returns in logical positions- return above HC, supply above SC.
- ❑ 24 hours per day, 7 days per week, 365 days per year operation required of A/C unit.
- ❑ Cable run lengths to other areas correct length for cable set on order.

### **Telecommunications Requirements**

#### **Equipment Room (Near location of Electronics Rack)**

- ☐ RJ-45 socket for "Ethernet" connection, 10Base-T or 100Base-T network.
- ☐ RJ-11 socket for dedicated analog type telephone line for computer modem with long distance dial out privileges.

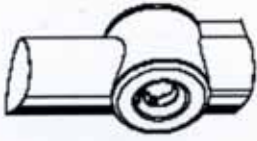
### **Miscellaneous Requirements**

- ☐ All ceilings, walls, and floors completely finished and cleaned up (dust free).
- ☐ Delivery route for magnet and other components planned-out -- no obstructions or other problems (tiny elevators, steep ramps, no dock, street level delivery, curbs, etc.)?
- ☐ Staging area available at time of delivery for unpacking and sorting materials (150 sq ft)?
- ☐ Means of disposing of packing material, crates, boxes, etc., provided ?
- ☐ Is it necessary to get permits for delivery? Parking problems (delivery truck size)? Restricted access in off hours?
- ☐ Have magnet safety and fringe field concerns been properly addressed?
- ☐ Have locations for warning signs (quantity-2) been identified?
- ☐ Has all required fencing been installed?
- ☐ Is a secure storage space available on site?
- ☐ Are first-aid kits and non-ferrous fire extinguishers available at the site?
- ☐ Have facility arrangements been made for refuse disposal during installation?



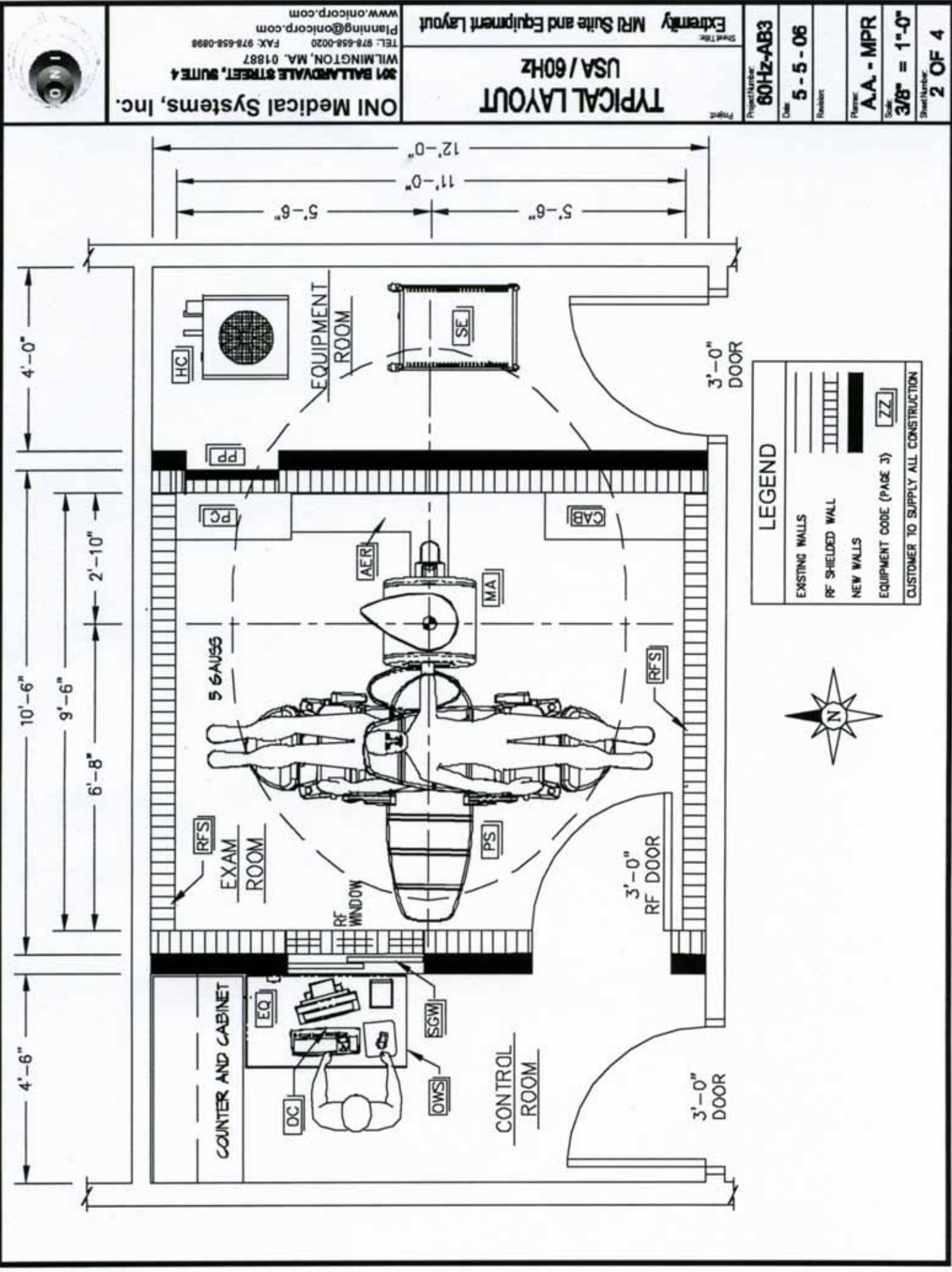
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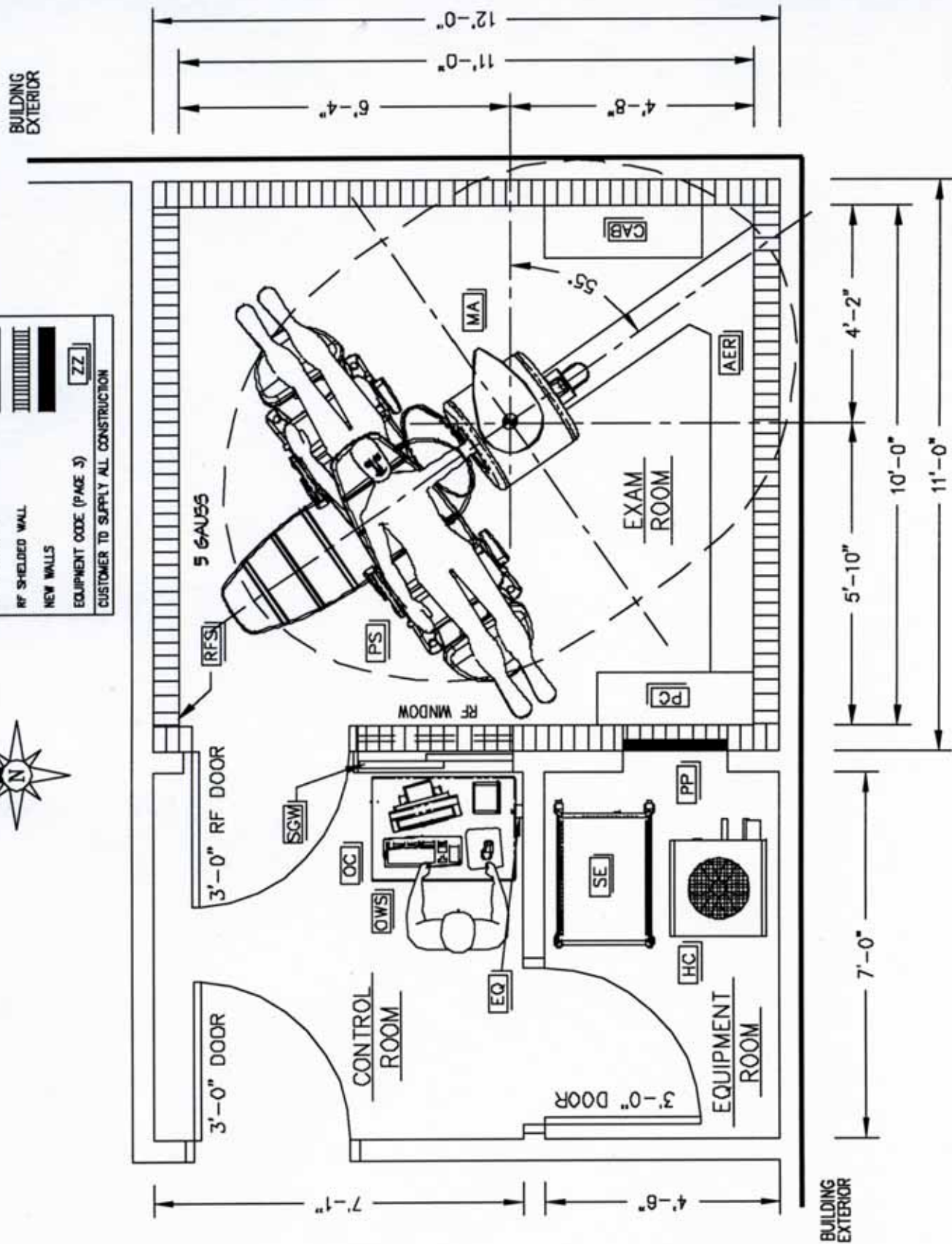
**Extremity**

PRELIMINARY SITE PLAN

**Customer:****TYPICAL LAYOUTS****USA / 60Hz****Project Number:****2006-TYP-60Hz-AB3****Date:****MAY 5, 2006****Revision:****Sheet****1 OF 4****Contract/Quota Number:****001****Account Executive:****MAB****Region:****USA****Plan Approval:****VINCE**







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Project: **TYPICAL LAYOUT**  
USA / 60Hz

Project Number: <b>60Hz-AB3</b>	Date: <b>5 - 5 - 06</b>	Revision:	Planner: <b>AA-MPR</b>	Scale: <b>3/8" = 1'-0"</b>	Sheet Number: <b>3 OF 4</b>
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## Extremity Equipment Legend

CODE	Description (comments)	Width inch (mm)	Depth inch (mm)	Height inch (mm)	Weight lbs. (kg)	Heat (cont.) btu/h (W)
OC	Operator's Console equipment (requires counter space, incl. LCD monitor keyboard, mouse, and power control unit)	32" (810 mm)	24" (610 mm)	20" (510 mm)	25 lbs (12 kg)	137 btu/h (41 W)
EQ	Emergency Quench button (kills magnetic field, wall mount)	3" (80 mm)	3" (80 mm)	3" (80 mm)	1 lbs (0.5 kg)	0 btu/h (0 W)
MA	Magnet Assembly	33" (840 mm)	30" (760 mm)	58" (1,470 mm)	1,400 lbs (638 kg)	1,000 btu/h (300 W)
PS	Patient Support (maximum extensions shown)	30" (760 mm)	65" (1,650 mm)	53" (1,350 mm)	170 lbs (77 kg)	0 btu/h (0 W)
HC	Helium Compressor (magnet cryo refrigeration)	22" (560 mm)	25" (640 mm)	35" (890 mm)	309 lbs (140 kg)	16,000 btu/h (4,800 W)
SE	System Electronics	22" (560 mm)	32" (812 mm)	30" (765 mm)	480 lbs (218 kg)	3,000 btu/h (900 W)
PT	Penetration Panel (mounts on RF shield wall)	25" (640 mm)	4" (100 mm)	13" (330 mm)	25 lbs (12 kg)	0 btu/h (0 W)
PC	Penetration Cover (slides pp and Cryovent)	30" (910 mm)	12" (310 mm)	20" (510 mm)	10 lbs (5 kg)	0 btu/h (0 W)
* * * Customer and/or Contractor Supplied and Installed Items * * *						
RFB	Radio Frequency Shielded room (80dB or better, incl door & win)	--	--	--	--	--
OWS	Operator's Work Surface (OC, phone, & writing surface)	42" (1,070 mm)	24" (610 mm)	32" (810 mm)	--	--
CAS	Storage Cabinet-Non Magnetic (storage of accessories & etc.)	30" (760 mm)	12" (310 mm)	36" (910 mm)	--	--
AER	Aluminum Electrical Raceway (surface mount, for MA wiring)	10" W (250 mm)	3-1/2" H (90 mm)	run length	--	--
SOW	Sliding Glass Window (in Partition wall)	36" W (910 mm)	36" H (910 mm)	--	--	--
INT	Intercom (if no sliding glass window)	--	--	--	--	--

## Extremity 60Hz USA &amp; Canada Electrical Power Requirements

Equipment Item	Power Feed	Minimum Power Supply	Connection Means	Continuous Power Demand	Peak Power Demand
HELIUM COMPRESSOR (HC)	Three-Phase, 208V, 3ØA, 3W+GND(PE) No neutral wire. Dedicated circuit	6.5 kVA	NEMA L1S-3ØR Twist-Lock Receptacle on wall	4.8 kW	5.6 kW
SYSTEM ELECTRONICS (SE)	Single-Phase, 115V, 20A, 2W+GND(PE) Dedicated circuit.	1.25 kVA	NEMA L5-2ØR Twist-Lock Receptacle on wall	325 W	1.0 kW
OPERATOR'S CONSOLE (OC)	Single-Phase, 115V, 15A, 2W+GND(PE) Power to be pulled from "SE" feed panel	50 VA	NEMA R-15R standard duplex wall receptacle.	--	41 W
RF SHIELDING / EXAM ROOM (NPS)	Single-Phase, 115V, 20A, 2W+GND(PE) For lighting & outlets, two dedicated circuits.	To meet lighting needs.	Hard-wired to RF filters per local codes	--	--
EQUIPMENT RM	Single-Phase, 115V, 20A, 2W+GND(PE) Shared circuit OK.	PER LOCAL CODE	NEMA R-3ØR standard duplex wall receptacle.	--	41 W

## Minimum Finished Room Size Requirements

Room	Width	Depth	Height	Door
CONTROL ROOM	24 to 30 Sq. Ft.		PER CODE	36" x 84"
EXAM. ROOM	11'-0"	9'-0"	7'-8"	36" x 84"
EQUIPMENT ROOM	36 to 40 Sq. Ft.		PER CODE	32" x 84"

Note: All room sizes highly dependent on the means of access and arrangement of the MRI suite. Typical total square footage needed will vary between 185 Sq. Ft and 250 Sq. Ft.

## Extremity 24 x 7 Environmental Requirements

Room	Temperature Range 24 x 7 x 245 F (C)	Temp. Regulation 24 x 7 x 245 F (C)	Humidity 24 x 7 x 245
CONTROL ROOM	As required for comfort	As required for comfort	Non - Condensing
EXAM. ROOM	64° - 77° ( 18° - 25° )	+/- 2.5° ( +/- 1.4° )	Non - Condensing
EQUIPMENT ROOM	60° - 80° ( 15° - 27° )	+/- 5° ( +/- 2.8° )	Non - Condensing

## Extremity Telecom Requirements

Systems Function	Data Service Type	Connection Means
Remote Service Access	Dedicated and/or telephone line Do Not Route Through Switch Board	RJ-11 socket
Network and Printer Access	10Base-T, 100Base-TX, or 100Base-T4	RJ-45 socket

TYPICAL LAYOUT  
USA / 60Hz

Project: **Extremity MRI Suite and Equipment Layout**

Sheet:

Project Number:  
**60Hz-AB3**

Date:  
**5-5-06**

Revision:

Power:  
**AA - MPR**

Scale:  
**NTS**

Sheet Number:  
**4 OF 4**

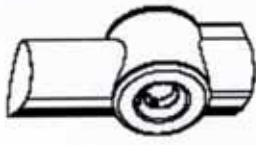
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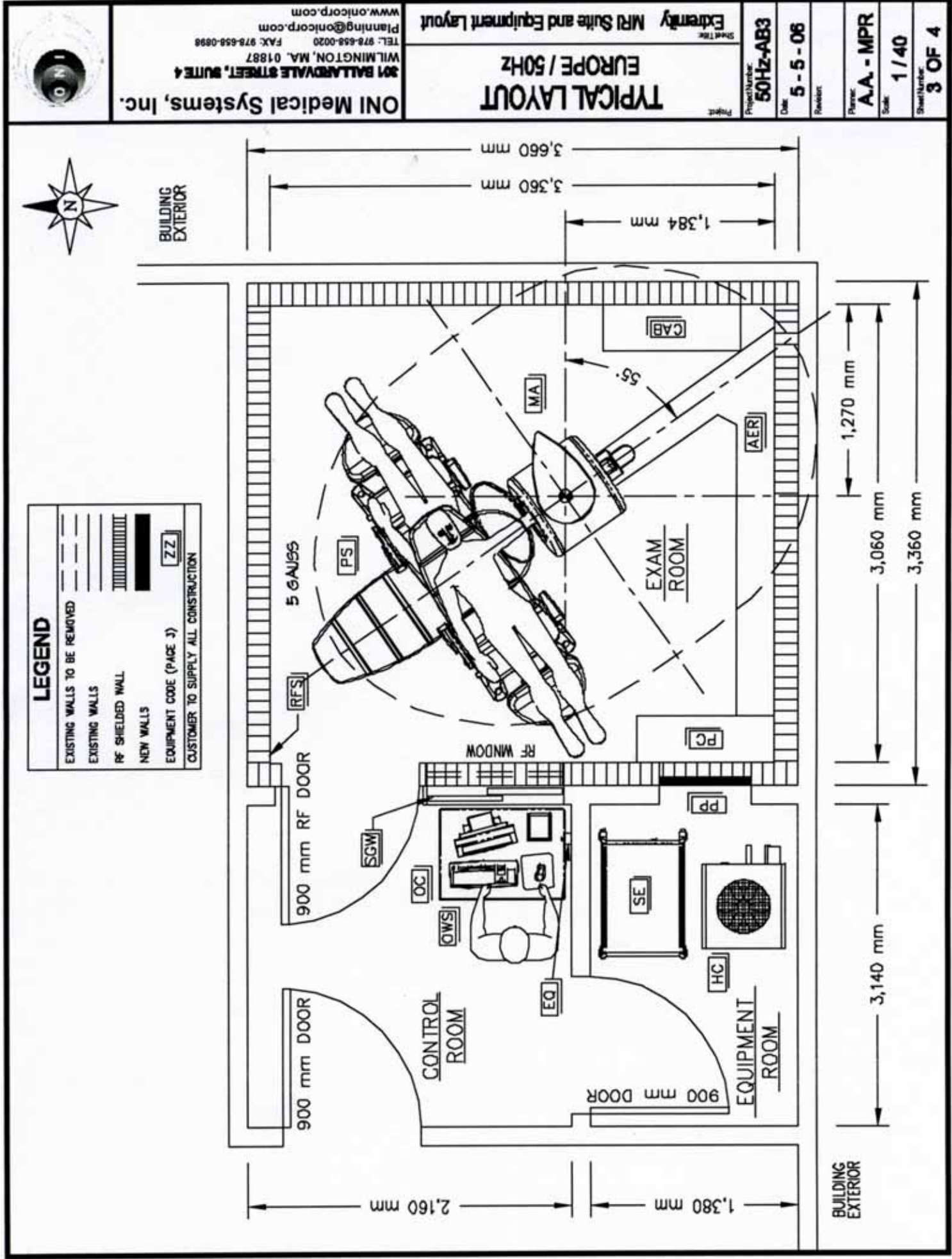
**Extremity**

PRELIMINARY SITE PLAN

**Customer:****TYPICAL LAYOUTS****EUROPE / 50Hz**

<b>Project Number:</b>  <b>2004-TYP-50Hz-AB3</b>	<b>Date:</b>	<b>Contract/Quota Number:</b> <b>001</b>
	<b>MAY 5, 2006</b>	<b>Account Executive:</b> <b>MAB</b>
<b>Revision:</b>	<b>Sheet</b>  <b>1 OF 4</b>	<b>Region:</b> <b>EUROPE / 50Hz</b>
		<b>Plan Approval:</b> <b>VINCE</b>





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**TYPICAL LAYOUT**  
EUROPE / 50Hz

Sheet Title: **Extremity MRI Suite and Equipment Layout**

Project: **50Hz-AB3**

Date: **5-5-08**

Revision:

Planner: **A.A. - MPR**

Scale: **1 / 40**

Sheet Number: **3 OF 4**



## Extremity Equipment Legend

CODE	Description (comments)	Width inch (mm)	Depth inch (cm)	Height feet (cm)	Weight lbs. (kg)	Heat (avg.) btu/h (W)
OC	Operator's Console equipment (requires counter space, ind. LCD monitor keyboard, mouse, and power control unit)	32" (810 mm)	24" (610 cm)	20" (510 cm)	25 lbs (12 kg)	137 btu/h (41 W)
EQ	Emergency Quench button (kills magnetic field, wall mount)	3" (80 mm)	3" (80 mm)	3" (80 mm)	1 lbs (0.5 kg)	0 btu/h (0 W)
MA	Magnet Assembly	33" (840 mm)	30" (760 mm)	58" (1,470 mm)	1,400 lbs (638 kg)	1,000 btu/h (300 W)
PS	Patient Support (maximum extensions shown)	30" (760 mm)	65" (1,650 mm)	53" (1,350 mm)	170 lbs (77 kg)	0 btu/h (0 W)
HC	Helium Compressor (magnet cryo refrigeration)	22" (560 mm)	25" (640 mm)	36" (910 mm)	309 lbs (140 kg)	16,000 btu/h (4,500 W)
SE	System Electronics	22" (560 mm)	32" (812 mm)	36" (915 mm)	480 lbs (218 kg)	3,000 btu/h (800 W)
PP	Penetration Panel (mounts on RF shield wall)	25" (640 mm)	4" (100 mm)	13" (330 mm)	25 lbs (12 kg)	0 btu/h (0 W)
PC	Penetration Cover (hides PP and Cryopent)	36" (910 mm)	12" (310 mm)	20" (510 mm)	10 lbs (5 kg)	0 btu/h (0 W)
* * * * * Cryopent and/or Cryopent Supplied and Installed House						
RFPS	Radio Frequency Shielded room (80dB or better, incl door & win)	--	--	--	--	--
OWS	Operator's Work Surface (OC, phone, & writing surface)	42" (1,067 mm)	24" (610 mm)	32" (810 mm)	--	--
GLS	Storage Cabinet—Non Magnetic (storage of accessories & etc.)	30" (760 mm)	12" (310 mm)	36" (910 mm)	--	--
AEF	Aluminum Electrical Raceway (surface mount, for MA wiring)	10" W (250 mm)	3-1/8" H (80 mm)	run length	--	--
SGW	Sliding Glass Window (in Partition wall)	36" W (910 mm)	36" H (910 mm)	--	--	--
INT	Intercom (if no sliding glass window)	--	--	--	--	--

## Extremity Europe / 50 Hz Electrical Power Requirements

Equipment Item	Power Feed	Minimum Power Supply	Connection Means	Continuous Power Demand	Peak Power Demand
HELIUM COMPRESSOR (HC)	Three-Phase, 380V-415V, 15A, 3W+PE No neutral wire. Dedicated circuit.	6.5 kVA	Power Cord w/2.5mm <sup>2</sup> flying leads.	4.8 kW	5.8 kW
EQUIPMENT RACK (RS)	Single-Phase, 220V-240V, 10A, 2W+PE Dedicated circuit.	1.25 kVA	Power Cord w/1.5mm <sup>2</sup> flying leads.	325 W	1.0 kW
OPERATOR'S CONSOLE (OC)	Single-Phase, 100V-240V, 2W+PE Power to be pulled from "SE" feed panel	50 VA	Standard wall receptacle	--	41 W
RF SHIELDING / EXAM ROOM (RFPS)	Single-Phase, 220V-240V, 10A, 2W+PE For lighting & outlets, 2 dedicated circuits.	To meet lighting needs.	Hard-wired to RF filters per local codes.	--	--
EQUIPMENT RM	Single-Phase, 100V-240V, 2W+PE Dedicated circuit.	PER LOCAL CODE	Standard wall receptacle	--	500 W

## Minimum Finished Room Size Requirements

Room	Width	Depth	Height	Door
CONTROL ROOM	2.2 to 2.8 Sq. M.		PER CODE	900 x 2,130 ( mm )
EXAM. ROOM	3,350 mm	2,690 mm	2,330 mm	900 x 2,130 ( mm )
EQUIPMENT ROOM	3.3 to 3.7 Sq. M.		PER CODE	810 x 2,130 ( mm )

Note: All room sizes highly dependent on the means of access and arrangement of the MRI suite. Typical total square footage needed will vary between 15.3 Sq. M. and 23.2 Sq. M.

## Extremity 24 x 7 Environmental Requirements

Room	Temperature Range 34 x 7 x 366 F (C)	Temp. Regulation 34 x 7 x 366 F (C)	Humidity 24 x 7 x 366
CONTROL ROOM	As required for comfort	As required for comfort	Non - Condensing
EXAM. ROOM	64° F - 77° F (18° C - 25° C)	+/- 2.5° F (+/- 1.4° C)	Non - Condensing
EQUIPMENT ROOM	60° F - 80° F (15° C - 27° C)	+/- 5° F (+/- 2.8° C)	Non - Condensing

## Extremity Telecom Requirements

System Function	Data Service Type	Connection Means
Remote Service Access	Dedicated analog telephone line Do Not Route Through Switch Board	Standard Wall Jack
Network and Printer Access	10 Base-T, 100 Base-TX, or 100 Base-T4	RJ-45 socket

TYPICAL LAYOUT  
EUROPE / 50Hz

Extremity MRI Suite and Equipment Layout

Project

Project Number

50Hz-AB3

Date

5-5-06

Revision

Planner

A.L. - MPR

Scale

NTS

Sheet Number

4 OF 4

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## Index

Access		Network connection.....	8-1
Limiting.....	1-4	Noise.....	7-3
Air		Phone connection.....	8-1
Reducing air pollution effects .....	7-3	Physical requirements.....	4-1
Air filtration system.....	7-3	Pre-Installation Checklist.....	10-1
Altitude specification .....	7-2	Pressure Drop	
Ambient EMI.....	4-1	Maximum .....	5-5
Ambient RFI.....	4-1	Pressure drop calculations .....	5-8
Building		Quench.....	5-1
Vent system requirements .....	5-5	Requirements	
Cabling .....	2-2	AC power .....	6-1
Checklist.....	10-1	Altitude.....	7-2
Clearance requirements .....	2-1	Building vent system.....	5-5
Common Ground.....	4-6	Clearance.....	2-1
Cooling requirements .....	7-1	Cooling .....	7-1
Delivery information .....	9-1	Environmental .....	7-1
Electrical requirements.....	4-1	Exhaust.....	5-7, 6-2
Electrical system.....	4-6	Fire breaks .....	5-7
EMI.....	4-1	Floor space .....	2-1
Environmental Requirements .....	7-1	Force on vent tube penetration .....	5-4
Exclusion limits .....	3-1	Heating .....	7-1
Exhaust .....	5-7, 6-2	Helium venting.....	5-1
Field homogeneity		Joints .....	5-6
Environmental effects .....	3-1	Pressure drop calculations .....	5-8
Fire Breaks .....	5-7	Responsibilities .....	5-1
Floor loading .....	2-3	RF Room .....	4-1
Floor space requirements.....	2-1	Space .....	2-1
Force		Sprinklers .....	4-6
Vent tube penetration .....	5-4	Temperature & humidity .....	7-1
Hazards		Vent supports.....	5-7
Fire breaks.....	5-7	Vent tube materials.....	5-5
Quench .....	5-1	Vent tube penetration .....	5-2
Heat output .....	7-1	Responsibilities.....	5-1
Helium Venting .....	5-1	RF Room	
Humidity.....	7-1	Common Ground.....	4-6
Imaging suite		Electrical requirements.....	4-1
Typical layouts.....	2-1	Electrical system .....	4-6
Internal Venting.....	5-8, 6-1	Force on vent tube penetration .....	5-4
Joints.....	5-6	Lighting .....	4-6
Lighting .....	4-6	Physical requirements .....	4-1
Magnet		Specifications .....	4-1
Others in proximity .....	3-5	Vent tube penetration .....	5-3
Magnet Anchoring.....	2-3	RFI.....	4-1
Magnetic field		Shipping information.....	9-1
Considerations.....	3-1	Shipping List.....	9-1
Effects on equipment .....	3-1		
Exclusion limits.....	3-1		
3-5, 7-1			
Network.....	8-1		

Siting .....	3-5, 7-2	Magnetic field effects .....	3-1
Cabling .....	2-2	Noise, audible .....	7-3
Environmental requirements .....	7-1	Proximity of other magnets .....	3-5
Exclusion limits .....	3-1	Telephone .....	8-1
Floor loading .....	2-3	Temperature .....	7-1
General considerations .....	1-4	Vent tube	
Magnet Anchoring .....	2-3	External .....	5-6
Magnetic Field .....	3-1	Venting	
3-5, 7-1		Building system .....	5-5
RF Room .....	4-1	Exhaust .....	5-7
Two or more magnets .....	3-5	Helium .....	5-1
Vibration .....	7-2	Internal .....	5-8, 6-1
Space requirements .....	2-1	Pressure drop .....	5-8
Sprinklers .....	4-6	Pressure drop, maximum .....	5-5
3-5, 7-2		Supports .....	5-7
Suite layouts .....	2-1	Tube materials .....	5-5
System		Vent tube penetration .....	5-3
Floor loading .....	2-3	Vibration .....	7-2