

Acoustic Room Details

Preinstallation Requirements for MR Systems



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DOC0371395 - Global Language Procedure

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1 Introduction

1.1 Who Should Read This Manual

The following personnel must be aware of the contents of this manual:

Icon	Personnel
	Architect

1.2 Purpose

The purpose of this document is to provide the MR site contractor with the needed information on how to create an MR suite that will meet the acoustic requirements for the MR scanners. This information was previously located in the system Preinstallation Manual. Since acoustic requirements are similar for the different GE MR Systems, this manual will apply to all new production GE MR Systems. A building acoustics expert can be consulted during the design process, if needed.

2 Acoustic Specifications

2.1 MR Suite Acoustic Specifications

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

Table 2-1 Acoustic Specifications (Under Ambient Conditions)

Room	GE Equipment Acoustic Output
Control Room	≤ 62 dBA ¹
Equipment Room	≤ 83 dBA (For SIGNA Prime, SIGNA Victor, SIGNA Aviator AIR and SIGNA Star AIR) ≤ 83.6 dBA (For SIGNA Premier and SIGNA 7.0T) ≤ 80 dBA (For all other systems)
Magnet Room	See 2.2 Magnet Room Acoustic Specifications on page 7
1. For SIGNA Creator/Explorer/MR355/MR360/MR380 systems: when equipment room and control room are combined, refer to equipment room for Acoustic output.	

NOTE

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

1. The customer must use acoustic noise containment solutions to control leakage of acoustic noise from one room to the next. See *Chapter 3, Acoustic Background and Design Guidelines*, for guidance to contain the noise within the Magnet Room.
2. The level indicated for Equipment Room in [Table 2-1 Acoustic Specifications \(Under Ambient Conditions\)](#) is for GE equipment only. The Equipment Room acoustic level must not exceed 85 dBA.

2.2 Magnet Room Acoustic 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 2-2 Acoustic Specifications for the Magnet Room

Location	Maximum Sound Pressure Level ¹	Frequency Distribution ²
Magnet Bore	(For all 1.5T systems except Artist Evo) 122 dBA (For Artist Evo) 124 dBA (For all 3.0T systems) 128 dBA (For all 7.0T systems) 128 dBA	See the <i>Sound Pressure Spectral Distribution</i> figure below for the applicable system.
Front of Magnet - 800 mm from bore opening	Magnet Bore - 4 dBA	
Notes: 1. The magnet bore specification is based on the worst case or 20-second average acoustic noise. An 8-hour average will be much less. 2. The total energy, SPL, is derived through the log sum of each 1/3 band octave totaling 128 dBA (for 3.0T magnets) or 122 dBA (for 1.5T magnets). That is, the maximum single 1/3 band is lower than the published values at the front of the magnet.		

Figure 2-1 Sound Pressure Spectral Distribution (Normalized for 20 Hz SPL as 1 dBA) (For 3.0T: SIGNA Architect, SIGNA PET/MR, Discovery MR750w)

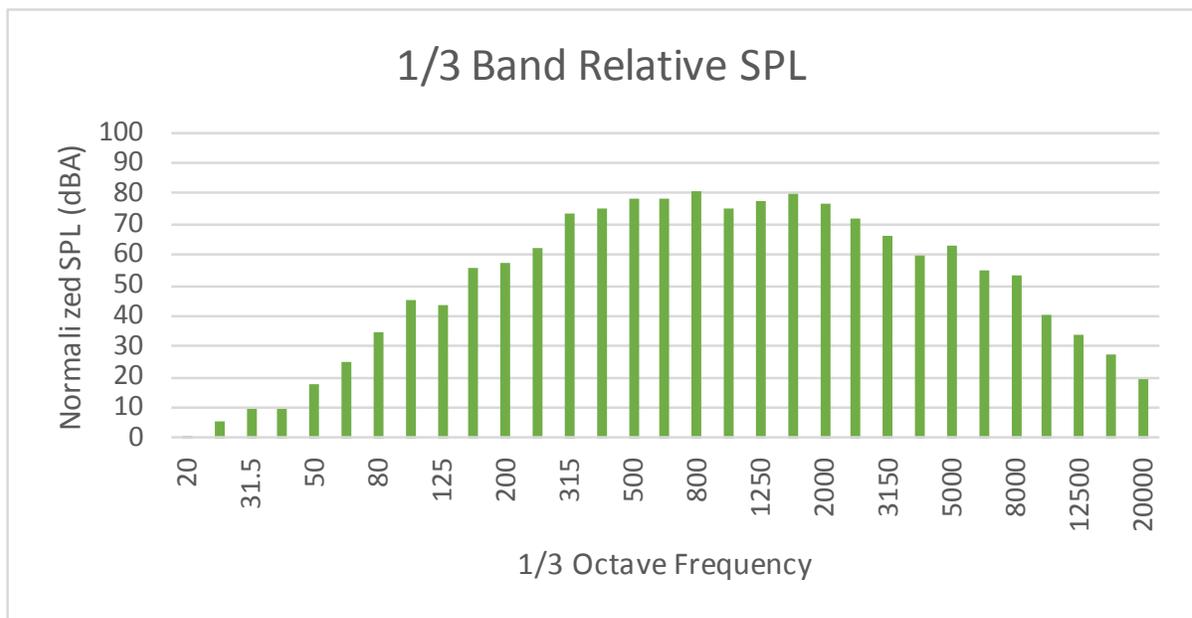


Figure 2-2 Sound Pressure Spectral Distribution (Normalized for 25 Hz SPL as 1 dBA) (For 3.0T: SIGNA Pioneer, SIGNA Hero)

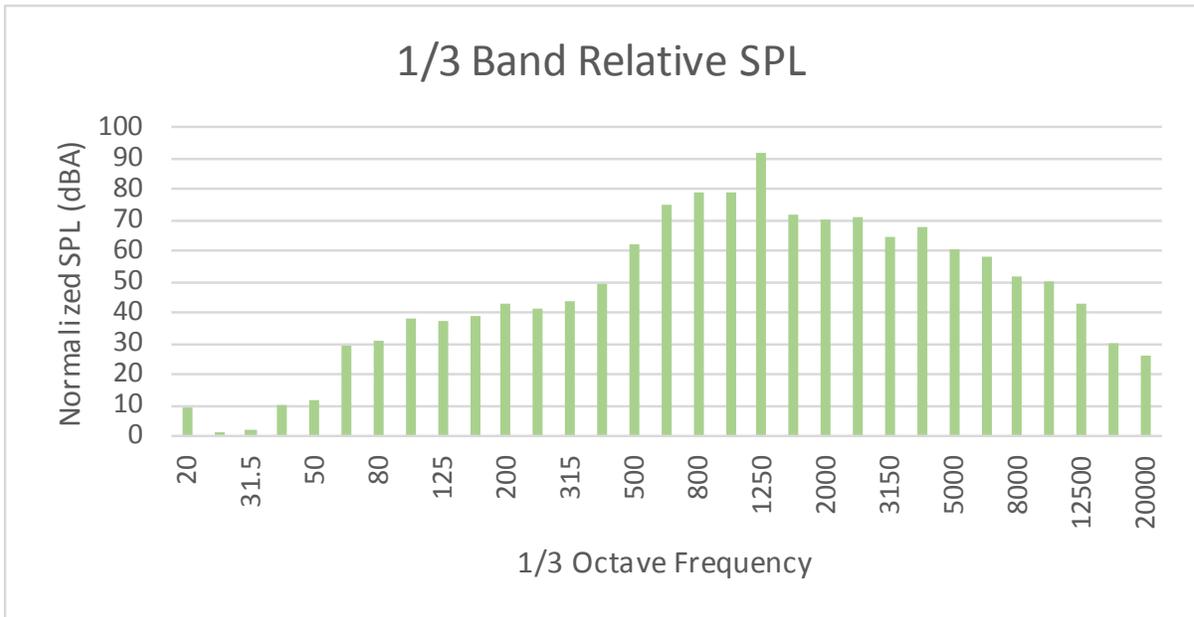


Figure 2-3 Sound Pressure Spectral Distribution (Normalized for 20 Hz SPL as 1 dBA) (For 3.0T: SIGNA Premier and 7.0T: SIGNA 7.0T)

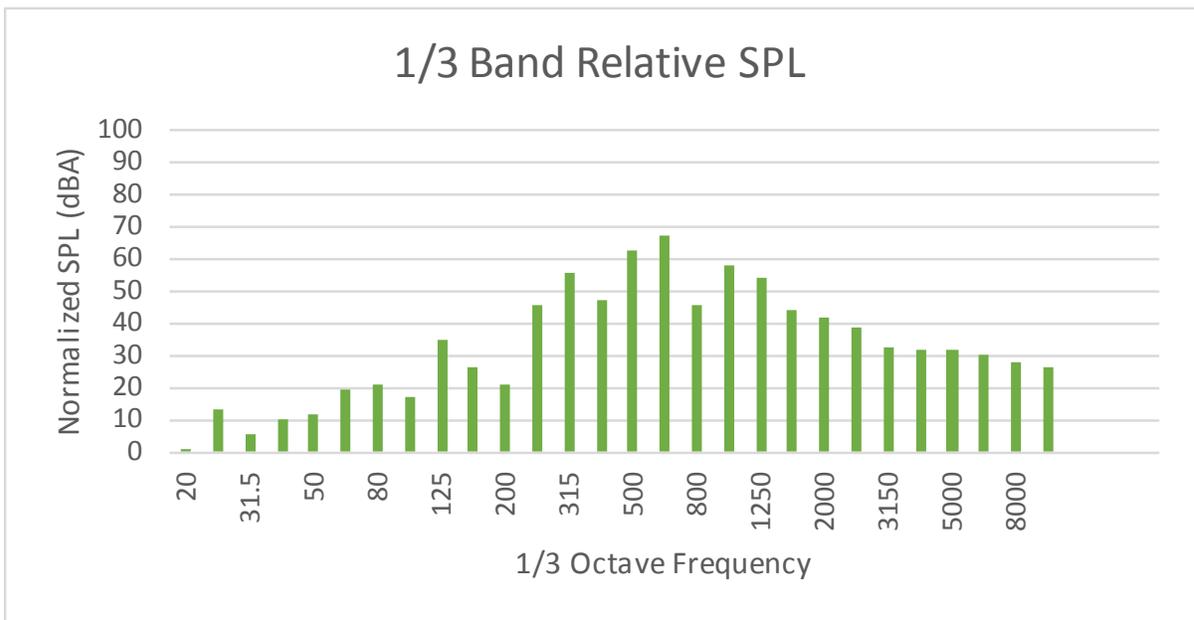


Figure 2-4 Sound Pressure Spectral Distribution (Normalized for 25 Hz SPL as 1 dBA) (For 1.5T: SIGNA Creator/Explorer/MR355/MR360/MR380)

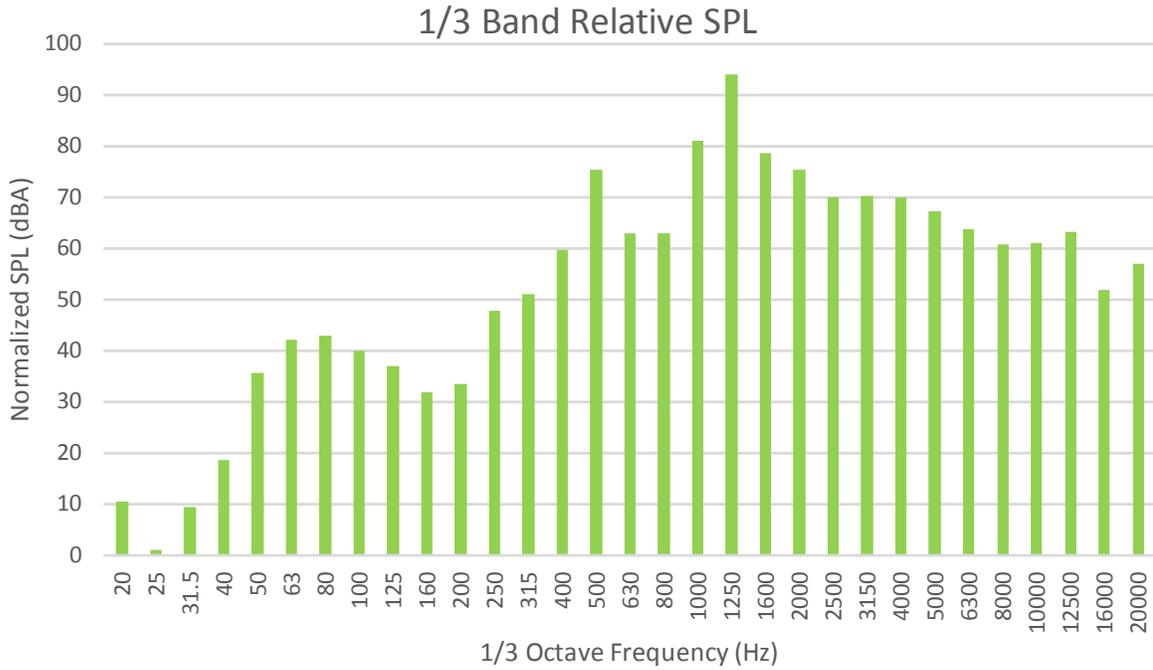


Figure 2-5 Sound Pressure Spectral Distribution (Normalized for 20 Hz SPL as 1 dBA) (For 1.5T: SIGNA Prime)

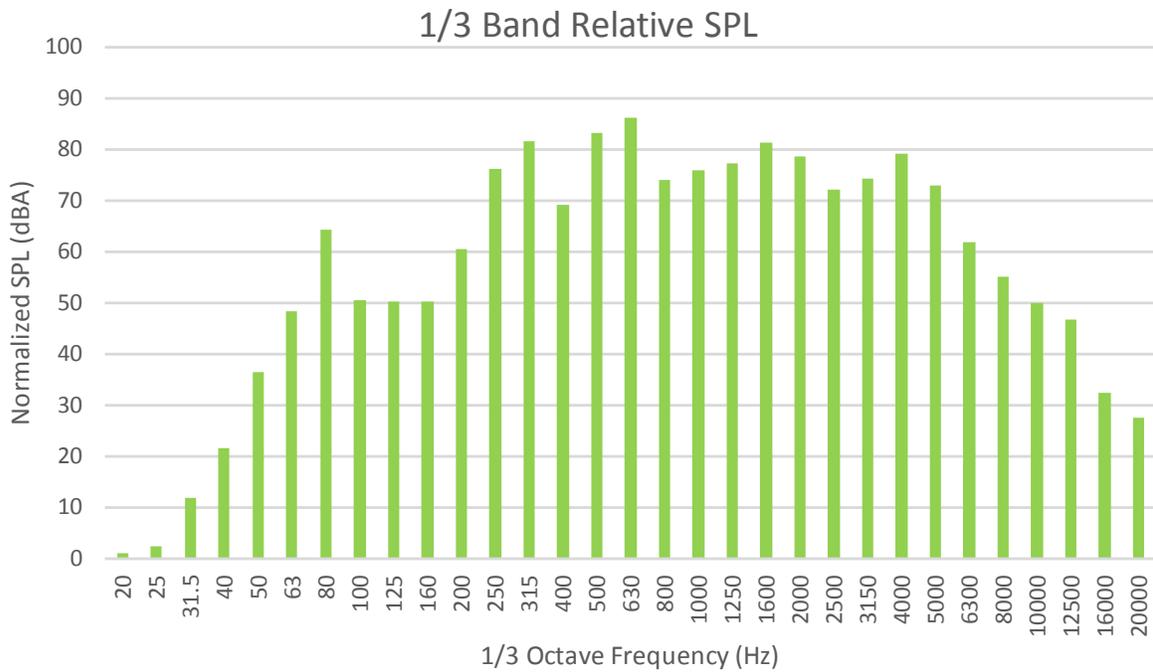


Figure 2-6 Sound Pressure Spectral Distribution (Normalized for 20 Hz SPL as 1 dBA) (For 1.5T: SIGNA Victor/SIGNA Aviator AIR/SIGNA Star AIR)

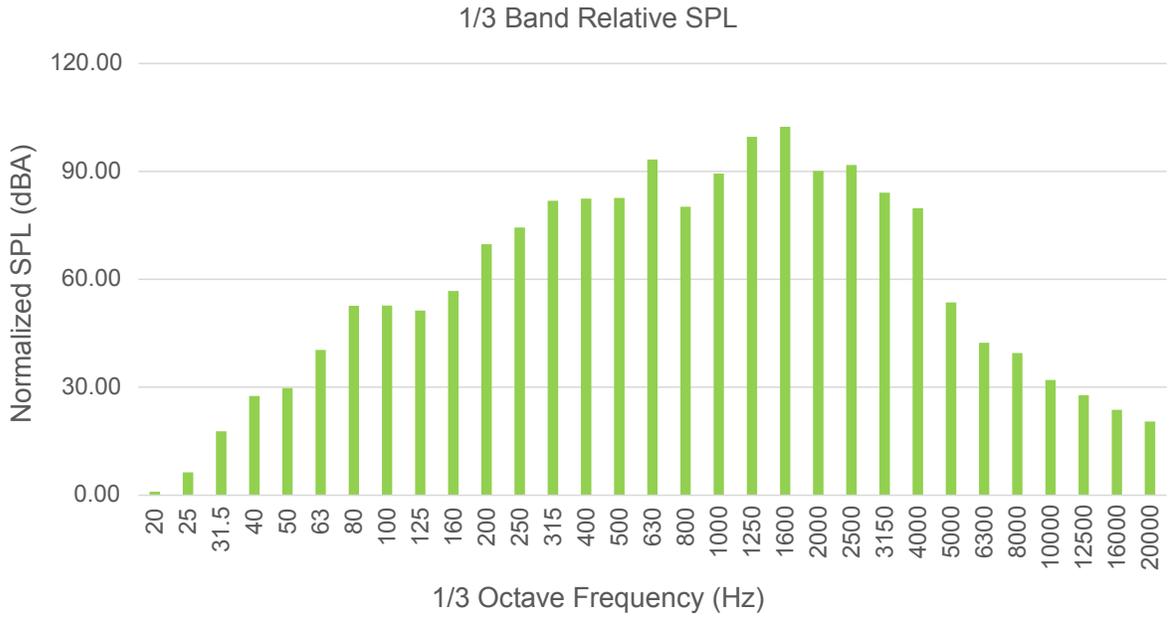


Figure 2-7 Sound Pressure Spectral Distribution (Normalized for 31.5 Hz SPL as 1 dBA) (For 1.5T: SIGNA Artist, Optima 450w)

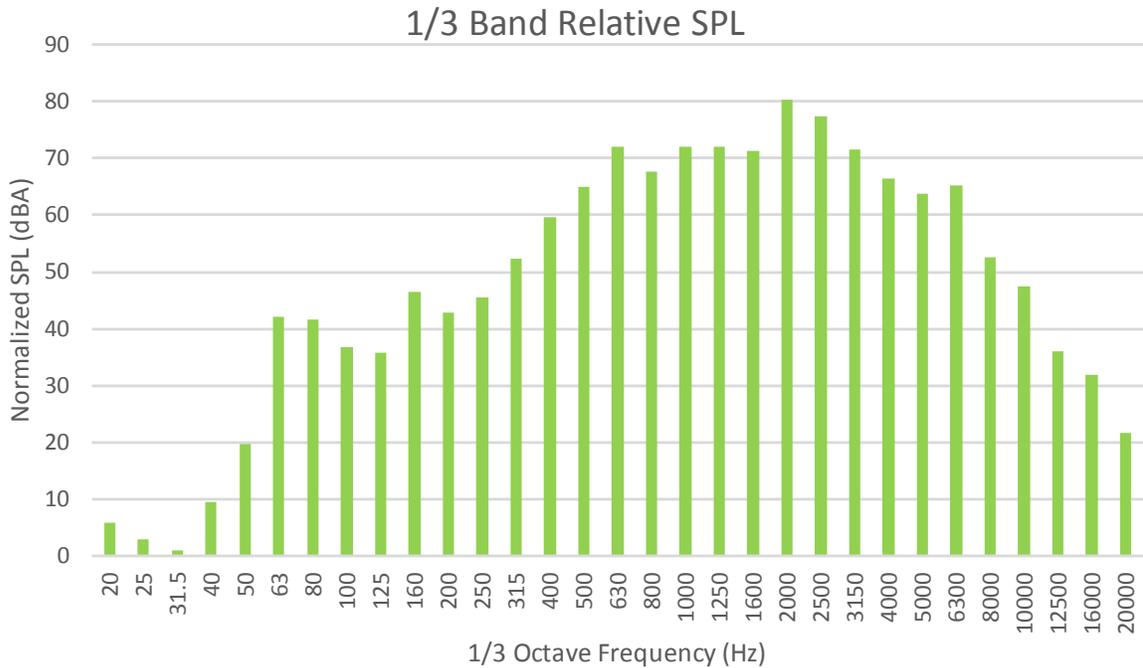


Figure 2-8 Sound Pressure Spectral Distribution (Normalized for 31.5 Hz SPL as 1 dBA) 1.5T: SIGNA Artist Evo

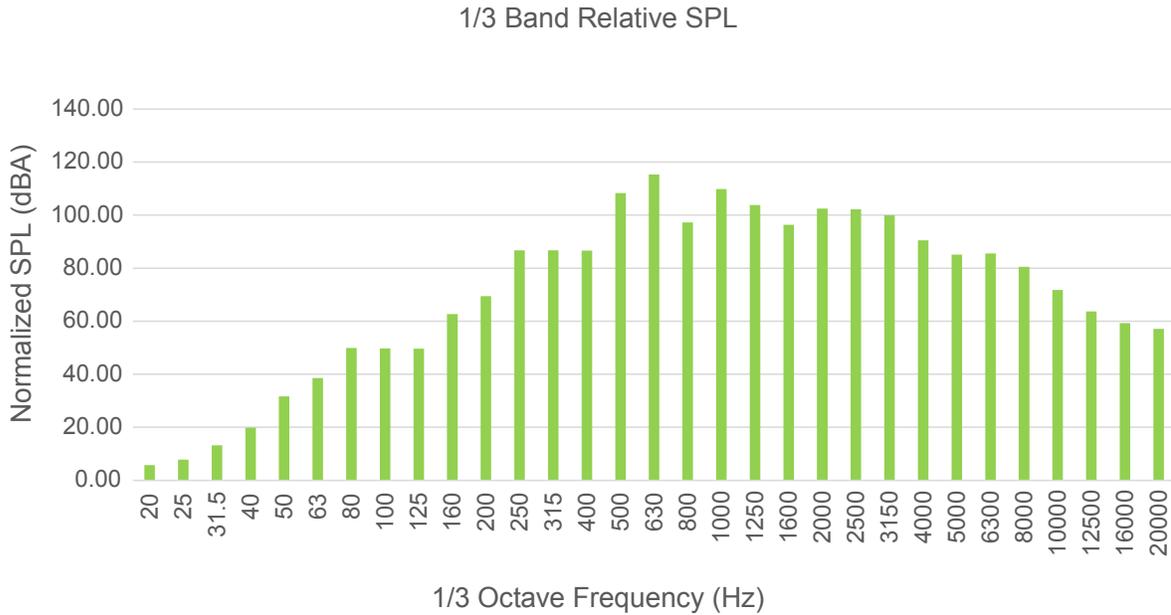
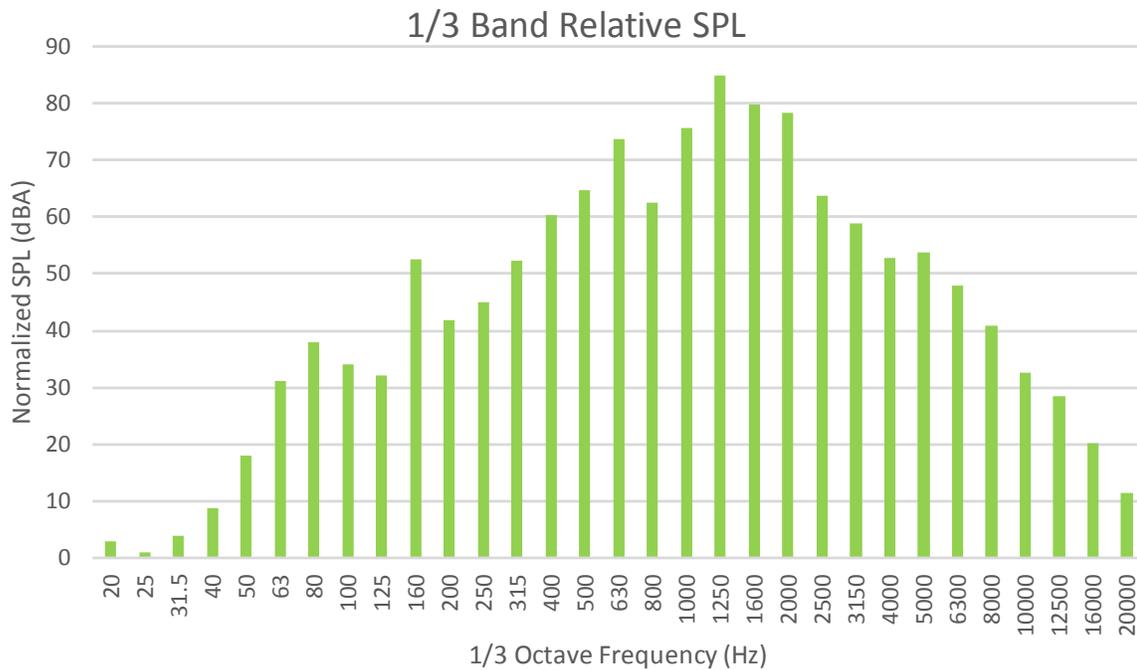


Figure 2-9 Sound Pressure Spectral Distribution (Normalized for 25Hz SPL as 1 dBA) (For 1.5T: SIGNA Voyager)



NOTE

The vertical axis does not represent the actual SPL. Use the dB difference between frequency as a reference.

NOTE

The MR product clinical operation will generate sound pressure proportional to the specific clinical application. The entire spectra (envelope) shown above in figures 1 through 9 represents the relative 1/3 band octave sound pressure the MR scanner may transmit into the air.

See [Acoustic Background and Design Guidelines on page 14](#) for acoustic design information.

3 Acoustic Background and Design Guidelines

3.1 Acoustic Background

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 Operator Manual.

A typical MR suite has two types of acoustic noise issues:

- Acoustics within the rooms in which the patients and technicians are impacted by the noise of the MR System as the system scans
- Noise transmitted to other spaces through airborne and structure-borne paths. Refer to the system Preinstallation Manual for details on structure-borne acoustic management.

3.2 Airborne Acoustic Background

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 through any openings (for example, 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 (For example, 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, and so on)
- Adjacent residential areas or spaces
- In-house library facilities

3.3 Structure-borne Acoustic Background

The structure-borne transmission path is the result of mechanical excitation of the floor or 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 structure-borne acoustic issues.

Examples of structure-borne acoustic 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, and so on)

- Adjacent residential areas or spaces
- In-house library facilities

3.4 Acoustic Design Guidelines for the 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 by absorbing sound energy at some frequencies, while not impacting the overall sound level.

- Use ceiling tiles with fiberglass panels having a 51 mm (2 in.) 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 1.2 m x 1.8 m (4 ft. x 6 ft.) with a thickness of 102 mm (4 in.) or equivalent. Panel 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 breathe 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.

3.5 Acoustic Design Guidelines for 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 through 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.

3.6 Wall Construction

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

- The preferred wall construction should have a Weighted Sound Reduction Index (R_w) rating of 46 or an ASTM Sound Transmission Coefficient (STC) of 50. This entails the use of standard wall construction of steel studs (typically 92 mm (3-5/8 in.)) with 2 layers of Type X drywall (typically 16 mm (5/8 in.)) on each side (a total of 4 layers) and fiberglass batt in the stud cavity. All drywall must be overlapped by 152 mm (6 in.) 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 [Figure 3-1 Example Of Wall Construction For Airborne Noise Control - Option 1](#) and [Figure 3-2 Example Of Wall Construction For Airborne Noise Control - Option 2](#).

- The top of the wall must join the ceiling or floor above so that no cracks or gaps occur. If metal pan is used on the ceiling or 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.

Figure 3-1 Example Of Wall Construction For Airborne Noise Control - Option 1

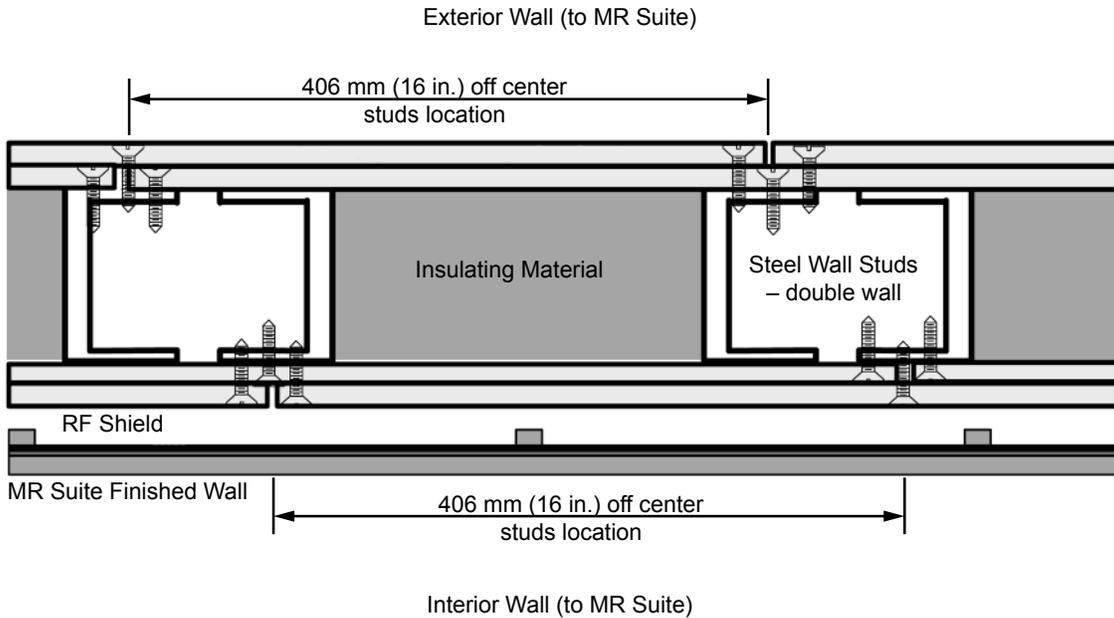
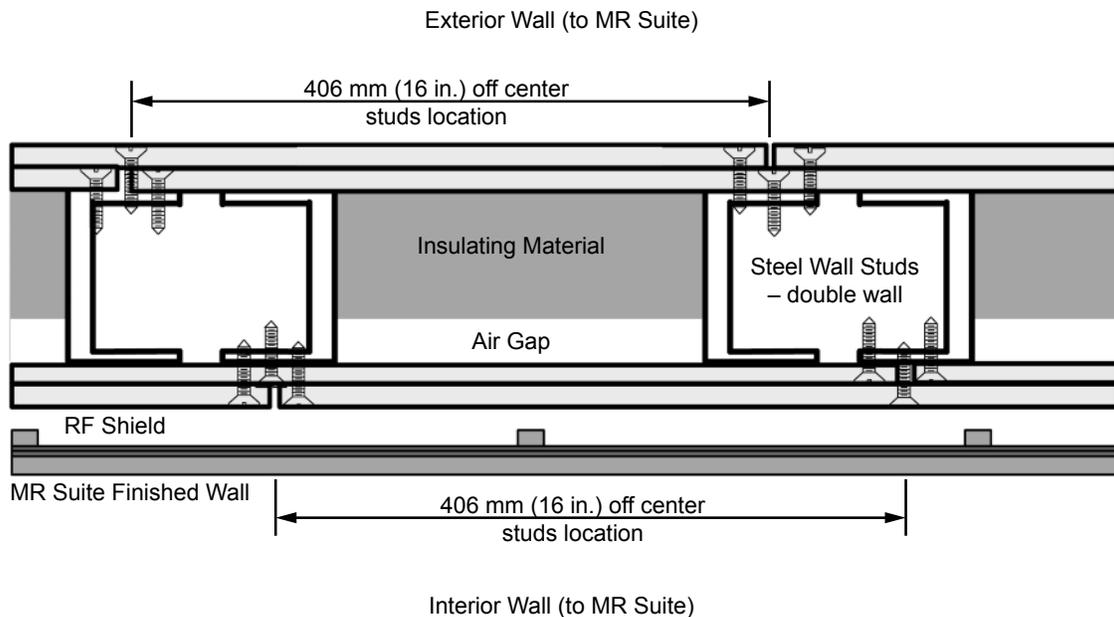


Figure 3-2 Example Of Wall Construction For Airborne Noise Control - Option 2



3.7 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 (a total of 4 layers) with fiberglass batt in the cavity.
- Penetrations should be avoided through 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."

3.8 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 or frame units with an STC rating obtained from laboratory testing per ASTM standards. Rw 46 (STC 50) windows are needed. The installation must include correct sealing to avoid sound leaks.
- RF doors should be selected to provide Rw 46 (STC 50) to quell the noise. Contact the 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.

Revision History

English Document review and approval per DOC2348786		
Rev	Date	Description
Rev 3	October 2022	Table 2-1: Added product "SIGNA Victor, SIGNA Aviator AIR and SIGNA Star AIR" Table 2-2: Added value for Artist Evo Added new Figure 2-6 for SIGNA Victor/SIGNA Aviator AIR/ SIGNA Star AIR Added new Figure 2-8 for SIGNA Artist Evo
Rev 2	August 2021	Added product "SIGNA Hero" to title of Figure 2-2 Added product "SIGNA 7.0T" to content of Table 2-1 and Table 2-2 Added product "SIGNA 7.0T" to title of Figure 2-4
Rev 1	July 2020	Initial Release of 5850262-1EN based on DOC2348786, Rev. 2

