

The exposure of MR team members and other healthcare workers is also concerning. Accordingly, if they remain in the scanner room for patient management reasons, they should routinely wear hearing protection.

Passive Noise Control

The simplest and least expensive means of preventing any hearing problems associated with the acoustic noise during MR procedures is to use disposable earplugs or headphones. Earplugs are required for patients undergoing exams and typically provide a sufficient decrease in acoustic noise (10- to 30-dB).

Unfortunately, passive noise control methods suffer from a number of limitations, like hampering verbal communication with patients during the operation of the scanner. In addition, standard earplugs are often too large for the ear canal of adolescents and infants. Most importantly, passive noise control devices provide non-uniform noise attenuation over the hearing range – while high frequencies may be well attenuated, attenuation is often poor at low frequencies. This is problematic because, for certain pulse sequences, the low frequency range is where the peak MR imaging-related acoustic noise is generated.



1. Always provide hearing protection to the patient and make sure the patient is properly educated with regard to the proper usage.
2. Before starting the MR exam, confirm that the hearing protection is in place and is functional.



Headphones may not provide adequate hearing protection. Always provide earplugs in addition to the headphones.

SITE ACCESS RESTRICTION – MR SAFETY ZONES

To manage safety issues related to the static magnetic field, each facility must restrict access to the MR site. Accordingly, as recommended by the ACR, the site must be conceptually divided into four distinct safety zones. **The term “MR environment” refers to Zones III and IV.**

Zone I includes all areas and corridors adjacent to the MR Department that are accessed freely by the general public. For mobile MR scanners, it includes the lot where the trailer is parked.

Zone II is the interface between freely accessible, uncontrolled Zone I and strictly controlled Zones III and IV. Here is where MR personnel obtain answers to questions related to patient screening, patient histories, and medical insurance. While patients may be



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greeted and prepared in Zone II, they are not allowed to move freely through Zone II without supervision by MR personnel.

Zone III is the area where free access by unscreened non-MR personnel or ferromagnetic objects or equipment could result in serious injury or death resulting from the interactions between the individual or equipment and the MR scanner's static and time varying magnetic fields.

Zone III should be physically restricted from general public access by, for example, ID badge readers, key locks, or any other reliable, physically restricting method that can differentiate between MR personnel and non-MR personnel. *The use of combination (push button or otherwise) systems is discouraged by the ACR and TRA because combinations are simply too easily distributed amongst personnel.*

Without exception, only MR personnel shall be provided free access to Zone III. Furthermore, all access to Zone III must be stringently restricted and controlled by and entirely under the supervision of MR personnel.

The controlled area Zone III is generally large enough to contain the 0.5 mT (5 Gauss) magnetic field contour. Because magnetic fields are three-dimensional volumes, the Zone III controlled access areas may project through floors and ceilings of MR suites, thereby imposing hazardous magnetic fields on floors other than that of the MR scanner. Accordingly, magnetic field plots for all MR systems should be analyzed vertically as well as horizontally. Access to these Zone III areas (that might include typically non-occupied rooftops) must be similarly restricted from non-MR personnel as they would be inside any other Zone III area associated with the MR suite.

Zone IV consists of the MR scanner room itself. By definition, it is located within Zone III and must be demarcated and clearly marked as being potentially hazardous due to the presence of very strong magnetic fields. Access to Zone IV is **strictly** limited to MR technologists, MR operations assistants, patients, accompanying family members, and *necessary* medical personnel who have undergone the thorough screening procedure. Access to this area is restricted *even during an emergency code situation*.

As a means to restrict Zone IV, MR technologists should be able to observe directly and control directly (by means of "line of sight" or by means of video monitors) the entrances to Zone IV from their normal positions in the Control Room.

Zone IV should be clearly marked with a red light and lighted sign that states "MAGNET IS ON." This light and sign must be illuminated at all times and should be provided with a battery backup energy source so that, in the event of loss of power to the site, the light and sign will remain illuminated.