MR Safety issues

MRI has three types of fields: Static magnetic, gradient magnetic and radiofrequency (RF). There are potential risks associated with each field.

Static Magnetic field:
The potential hazard concerning the static field is the missile effect.

The static magnetic field is the main magnetic field created by the superconducting coils and is measured in Tesla. 10,000 gauss equals 1 Tesla. The earth’s magnetic field is .5 gauss or .5mT. So, a 1 Tesla magnet is 20,000 times stronger than the earth’s magnetic field. Therefore, our 3T scanner is alarmingly strong! The stray magnetic field, which is outside of the magnet bore, is known as the fringe field. Superconducting magnets use active shielding which confines the fringe field to the scan room. For our purposes we consider the threshold of the magnet room door as the .5 gauss line. (when speaking of this line it is a general practice to just refer to the line as 5 gauss). Electronic devices and ferromagnetic objects inside the 5 gauss line are strictly prohibited.

The magnetic field of an MR system has the capability to attract metal with a high velocity and force. The larger the object, the greater the velocity and force.
NOTE! Objects that do not appear to contain any metal may have ferromagnetic metal inside. Non-ferrous metals such as titanium, gold, silver, copper, brass, and aluminum are safe to go into the magnet but always test with the hand held magnet first since they may contain parts such as screws that are ferromagnetic. Therefore, prior to taking any object into the MRI scan room, you should test it with the 1000 Gauss test magnet (shown at right). Always test and verify! The test magnet is located just right of the MR console in the control room.

Ferromagnetic implants or fragments in the body may rotate or move causing internal injury. Therefore everyone must be carefully screened prior to entering the magnet room. Anyone inside the 5 gauss line MUST be screened and MUST be accompanied by authorized personnel. The control room is restricted to card access only. DO NOT prop the door open.

Gradient Magnetic field:
The two potential hazards associated with the gradient magnetic field are peripheral nerve stimulation and acoustic noise.

Peripheral nerve stimulation
Gradients vary slightly in magnetic field strength and are used to spatially encode information in the emitted RF signal. While data is being acquired these gradient
magnetic fields change quickly in time. This rapid switching of magnetic fields has the potential of inducing stimulation to the peripheral nerves. Sensations of tingling or twitching may be felt. Instruct the subject not to cross their arms or legs. If they do so, a conducting loop is formed and the potential for peripheral nerve stimulation is increased.

**Acoustic noise**

Certain types of pulse sequences will create a high and potentially dangerous level of acoustic noise. Therefore, everyone, including deaf subjects, is required to wear ear protection. Use either disposable earplugs or headphones. Anyone who stays in the scan room during the study is also required to have ear protection.

**RF field:**

The potential hazards from the RF field are tissue heating and burns.

During the MR scan a short intense burst of RF (radiofrequency) is introduced into the subject. The application of an RF pulse flips the protons and also results in nuclei absorbing energy. The principal effect of RF absorption on body tissues is the potential for a rise in body temperature. Localized heating is caused by RF energy absorption to a volume of tissue. The amount of absorbed energy depends on the static magnetic field and the type of sequence being used. A 180° pulse deposits more RF energy than a 90° pulse. There is more energy deposited using sequences that employ many RF pulses (such as fast spin echo) than those that use fewer RF pulses (such as gradient echo EPI).

Since MR systems are not able to measure RF exposure it is necessary to measure RF absorption. SAR (Specific Absorption Rate) is the measure of RF energy absorbed in the body (watts per kilogram). The FDA has set safety guidelines for this. MR systems calculate the SAR based on the pulse sequence and the participant’s weight. For this reason an accurate weight must be entered on the computer console.

RF pulses have the potential to heat non-ferrous metallic implants, mainly at the surface. Although unauthorized implants should never be present in a subject who is being scanned, an authorized implant may lead to unexpected heating. For this reason be sure to warn the subject of the potential for heating and instruct the subject to use the squeeze bulb if any unusual sensation (such as heating) is felt in the area of the implant.

RF pulses have the potential for burn hazards from an electrical current that is produced in conductive loops. Therefore when using surface coils be sure that no loops are created by the wires, nor allow the wires to touch the subject.

The current produced by the RF pulses has the potential to cause localized burns if a body part is touching the magnet bore. The use of sponges or pads as insulation between the magnet bore and the body part will minimize this risk. The potential is also increased if clothing is dampened by perspiration. Be sure the room temperature is 75 degrees or lower and if needed use the scanner’s internal fan to keep the subject cool.