

# 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 .05mT. 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 metallic objects towards it 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 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 also 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.

There is a potential for burn hazards when the subjects skin has direct contact with transmit body radiofrequency (RF) coils (inside the magnet bore) or other transmit coils (CP Head). The use of sponges or pads at least 1 cm thick are used as insulation between the magnet bore and the body part to 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. Skin to skin contact should also be avoided.

# Emergency Procedures

## Medical Emergency

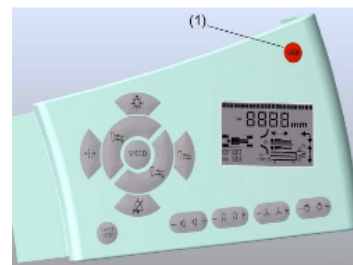
In case of a medical emergency, dial 13 to reach UR Security. State that you are in the Medical Center Annex Building, room 1B107 and report the nature of your emergency. Security will call 911.

Get the person out of the scan room as quickly as possible. We do have a MR safe stretcher located in the rear of the scan room if needed. If you need assistance there is an alarm switch located by the scanner door. When you flip this switch, an alarm goes off in the RCBI hallway and all available personnel will be there to offer assistance. This alarm stays on until someone arrives to help.



The fastest way for moving the table out of the scanner is to press the Home Position.

If you need to stop the motorized movement of the table there are two red stop buttons located by the table control panels of the scanner, one on either side of the table. By pushing this button, the table brakes are released and the table may be pulled out by hand. There is also a table stop button located on the top of the intercom in the control room.



Once activated, lights on the front panel of the scanner will flash until you reset the table stop. To reset, press the up/inward button, then the down/outward button and then the up/inward button. The flashing lights will stop. You will then be able to electronically move the table.

There is an emergency cart located in the control room behind the door if needed. The equipment on this cart is NOT MR safe. You MUST get the person out of the scan room first. Be sure to close the scan room door after removing the subject to prevent entry of unauthorized personnel.

Our emergency cart has the very basic items needed for CPR. We have an automatic external defibrillator, portable suction, oxygen tank, Ambu bag, suctioning, blood pressure cuff etc. There is a complete listing of items on the lower shelf of the cart.

## Fire Emergency

In case of a fire, stop the scan and remove the subject from the scanner. Call UR Security at ext. 13. State that you are in the Medical Center Annex Building, room 1B107 and explain the problem. Security will call 911. There is a fire alarm, which is located on the other side of the double doors (in the main hallway) just outside of the control room.

If it is an electrical fire (in the scanner or electronics cabinets) press the emergency stop button and pull the tab on the blue box located below the stop button to activate the sprinkler system. Be sure to close doors to contain fire before leaving the building.

We do have an MR safe fire extinguisher just outside of the control room. It is located on the wall opposite the sink. Use this only if the situation is appropriate.

Be sure to advise emergency personnel of the MR system. Local firefighters are aware of the safety issues concerning the magnet but they still need to be reminded and monitored.

Emergency stop button



If you smell smoke in the scanner or in the electronics cabinets, remove the subject from the area. If the situation is such that there is no immediate danger, shut down the computer first and then press the emergency stop button. Call UR Security at ext. 13. State that you are in the Medical Center Annex Building, room 1B107 and explain the problem. Security will send someone to investigate the cause. Be sure to close the magnet room door and monitor all personnel entering the area. Notify Siemens service and the director Dick Aslin immediately in the event of a fire or smoke.

## Emergency Shut-off Switches

### ***Emergency stop/shut-down switch (electrical supply only)***



By pushing this button all electrical supply to the magnet PDU (power distribution unit) is disrupted. It does not initiate a quench.

THE MAGNET REMAINS RAMPED UP (“ON”). MAKE SURE ALL FERROMAGNETIC OBJECTS REMAIN OUTSIDE OF THE SCAN ROOM.

Use this if there is a fire or electrical accident in the scan room or the electronics cabinets, or if the sprinkler system goes off in either of these rooms. Also, if you see or smell smoke coming from the magnet or a computer cabinet, use this button. Call UR Security at ext. 13. State that you are in the Medical Center Annex Building, room 1B107 and explain the problem.

There are three:

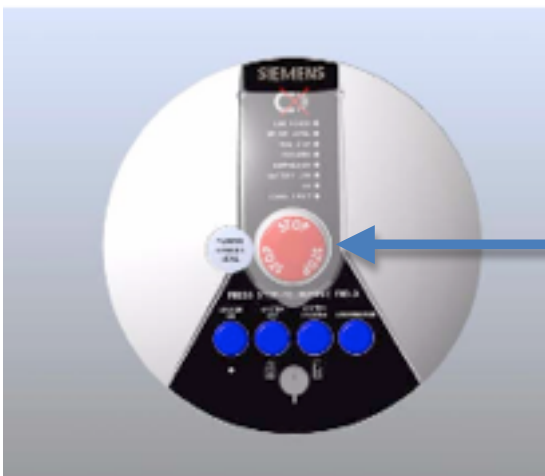
1. Inside the scan room, on the wall by the door
2. In the control room, to the left of the scanner monitor
3. In the computer cabinet room, on the wall by the door

### ***Magnet Stop / Quench switch***

There are two Magnet Stop buttons, both covered with a plastic flap.



This button is located in the magnet room.



This panel is located in the control room. Stop Button.

The only time this button can be pushed is if someone's life is at risk. Only an RCBI staff member can push this button.

By pushing this button you rapidly reduce the magnetic field strength. The helium coolant boils off suddenly during this process and is released through an exhaust vent. An alarm signal will sound when the magnet stop button is pushed.

Since a quench cost thousands of dollars and may damage the magnet, ONLY quench the magnet if a large metallic object pins or impales a person against the magnet and no other method will free them or prevent further injury.

Never attempt to pull large metallic objects from the magnet field. The object may change its magnetic polarity and re-align itself on the magnet and become a projectile, causing a serious or fatal injury.

If you need to quench the magnet, remove all personnel from the scan room as soon as possible. It takes about 20 seconds for the magnet to lose its power. Initiating a quench will release the helium through a vent to the outside.

Notify Siemens service and Dick Aslin immediately if this button is pushed.

### **Magnet Quench: Failure of vent**

During a quench, the liquid helium boils off through an exhaust vent and the magnet loses its super-conductivity. It takes only 20 sec. for the magnet to quench. When a quench occurs an alarm goes off (which can be silenced on the alarm box) and a hissing noise is heard as the helium is vented outside. Do not attempt to touch the vent during a quench due to the extremely cold temperature. Frostbite will occur. Large plumes of white fog appear outside as a result of the helium release.

One liter of liquid helium will quickly expand to about 800 liters of gaseous helium. If the exhaust vent fails, whereby the helium is vented into the scan room, it will quickly reduce the oxygen level in the scan room and cause asphyxiation. Frostbite and/or hypothermia will also occur.

If you need to quench the magnet, remove all personnel out of the room first! If someone is pinned to the magnet, be absolutely sure that you have propped the scan room door open with the doorstop. If the vent fails, the pressure caused by the expanding gas will slam the door closed and it will be impossible to open until the pressure of the gas is released. There is a passive vent in the ceiling of the magnet room to help alleviate the pressure.

Be sure to notify Siemens service immediately in the event of a quench. Also notify the director Dick Aslin. If he is not available notify Daphne Bavelier.

A copy of these procedures and contact personnel are kept in the control room.