MRI Safety and Training

Special thanks to the University of Utah for allowing us to adapt their materials
Magnet Safety at **ALL TIMES**

**Outline**

Understanding Magnets
- Your role in MR Safety
- Metallic Screening

What to do in Emergencies
Preview MRI Safety Videotape
Magnetism / Magnets

- All substances possess some form of magnetism.
- The degree of magnetism exhibited depends on the atoms that make-up the substance.
- Magnetic susceptibility is the ability of a substance to become magnetized.
- Ferromagnetic substances, such as iron have a large magnetic susceptibility, it is easily magnetized permanently and becomes a magnet itself.
- All magnets have a North and a South pole.
- All magnets have a “fringe” magnetic field which exists in the vicinity surrounding the magnet.
Magnetic Fringe Fields

- The fringe magnetic field is the magnetic field which exists in the vicinity surrounding the magnet.
- This field may extend many meters from the magnet itself.
- These imaginary lines of force demonstrate the pattern of the magnetic field.
- Safety and operational concerns make it necessary to contain the fringe field to a small area.
- Magnetic fields are measured in units of Gauss or Tesla.
  
  (1T = 10,000G)
MRI Safety at \textbf{ALL TIMES}

\textbf{UGA BIOIMAGING RESEARCH CENTERS}

\textbf{STATIC MAGNETIC FIELD IS \textit{ALWAYS}}
PRESENT 24hrs/day, 365 days/yr. EVEN WHEN NOT IN USE.
MRI Safety - Projectiles

• Projectile effects of metal objects seriously compromise safety. *The potential harm cannot be over emphasized.*
  – Paper clips, hair pins’ velocity 40mph @ 1.5T, UGA has a 3T magnet, which will result in greater velocities.
  – Larger objects (scissors, etc.) have higher velocities and may be fatal.

• Many types of clinical equipment are ferromagnetic and should never be brought into the scan room.

• Items may be tested for magnetic susceptibility with a hand-held magnet located at the MR station.
Metal Objects Becoming Projectiles
Fatal Accidents *CAN* Happen!

**Hospital Nightmare**

*Boy, 6, Killed in Freak MRI Accident*

July 31 — A 6-year-old boy died after undergoing an MRI exam at a New York-area hospital when the machine’s powerful magnetic field jerked a metal oxygen tank across the room, crushing the child’s head.

Employees of the Westchester Medical Center in Valhalla, N.Y., gather outside after learning of the deadly MRI incident.

(ABCNEWS.com)
Controlled Access Area

• Although not detectable by the human senses, a magnetic field can be dangerous to equipment and to people.
• Since a magnet is always “at field,” safety procedures must be followed to prevent accidents.
• For the safety of patients and personnel, controlled access areas are established.
Controlled Access Area

- These areas are established for the safety of patients and personnel.
- These areas are clearly marked on the floor entering the MRI room.
- No emergency personnel should cross these boundaries with any form of metal.
Patients with the following should never enter the MRI room

- Cardiac Pacemakers
- Cochlear (inner ear) implants
- Ferromagnetic or unidentifiable aneurysm clips
- Implanted neuro stimulators
- Metal or unidentifiable foreign bodies in the eyes
- Shrapnel near a vital organ
If an emergency situation arises, you may need to quickly bring down the patient systems and remove power from the MR system.

The nature of the emergency will dictate which procedure you follow. Each procedure has a distinct and specific purpose.
Magnetic Field / Scan Room
Emergencies

Each magnet is equipped with two emergency buttons:

• Emergency Stop / Shut Off
  – Turns off all incoming electrical power to the magnet Power Distribution Unit (PDU)

• Quench or Emergency Run Down
  – Causes immediate collapse of the superconductive magnetic field within minutes
Emergency Stop / Shut Off Button

Shutting power to the PDU may be required for life threatening situations such as:

- Fire in the computer room
- Fire, sparks, loud noises emanating from the scan room
- Flooding or sprinkling system goes off
- Catastrophic equipment failure

***Keep in mind that when this button is pushed, it does not initiate a quench, the magnet remains “at field.” Exercise caution, make sure that all ferromagnetic materials remain outside of the scan room***
Quench / Emergency Run Down Button

The following situation is **THE ONLY TIME** that may require quenching of the magnet:

- **Large magnetic object pins or impales a person against the magnet and no other method can prevent further injury or free the person**

  - Do not attempt to pull large magnetic objects (oxygen tanks) from a 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.

  - *Do not* touch a quenched magnet. Under certain conditions, an electrical potential of >1,000 volts could exist on the surface of the magnet.
Quenching

Definition: A loss of superconductivity of the magnet coil due to a local temperature increase in the magnet as it becomes resistive, resulting in rapid evaporation of liquid helium in the cryostat and quickly reducing the magnetic field strength.

• A quench may happen spontaneously or can be manually instigated in case of an emergency.
• Quenching may cause severe and irreparable damage to the superconducting coils (magnet).
• A magnet quench will result in several days’ downtime, so do not press the button except in a true emergency.

Do not attempt to test this button!
CRYOGENS-LIQUID HELIUM/NITROGEN

• USED TO COOL SUPERCONDUCTING
• \(-269 \, ^\circ\text{C}/-452\, ^\circ\text{F}\)
• DURING QUENCH- EVAPORATE AND EXPAND TO 760 TIMES THEIR LIQUID VOLUME- 700 LIQUID LITERS PER SYSTEM ON AVERAGE
• O2 alarm will set off when O2 level is below 20.9\%
Summary

• MRI scanners are powerful magnets with the ability to attract ferromagnetic objects.

• Any personnel around the MRI suite must be adequately screened for metallic implants and personal items before entering the scan room.

• Become familiarized with E-Stop vs. Quench buttons at each scanner.

• Review UGA Policies and Procedures Manual for the BiolImaging Research Center
MRI system overview

Major systems of a MRI machine\(^2\) - Figure 1