Information

Magnetic Resonance Imaging and Nuclear Magnetic Resonance Safety

Applicability

This policy applies to the University Community (administrators, faculty, staff, and students).

Administrative Authority

Senior Associate Vice President for Operations

Responsible Unit

Environmental Health and Safety
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History

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Categories

Reason for Policy:

The University of Louisville houses MRI and NMR units for research purposes. Risks from the units come from the strong magnetic field and release of the cryogens into the room. Due to these risks, personnel must follow safety and operational procedures to protect the safety and health of any persons that enter the rooms that house the MRI and NMR units.

Statement:

Personnel must follow Magnetic Resonance Imaging (MRI) and Nuclear Magnetic Resonance (NMR) safety and operational procedures.

METAL DETECTOR

There are metal detectors installed at the entrances to all of the MRI procedure rooms to detect any items that may have been missed during medical and personal screening. Employees must ensure they are cleared for access and have screened themselves for any ferromagnetic objects prior to entering the MRI suite. The metal detectors are not to be used in place of medical and personal screening. Employees must not use metal detectors in lieu of personal screening. Anytime a metal detector alarms, the employee must stop immediately and check their body for ferrous metal objects and remove them before proceeding to the MRI room. Metal detectors must be operational at all times. Metal detectors must not be shut off at the end of the work day. Staff responsible for the supervision of the MRI equipment must ensure this equipment is operational and functioning properly.

SIGNAGE

MRI and NMR facilities are required to have signage that identifies the hazards associated with the MRI equipment and ferrous metal objects. The signs shall be posted on the doors to the rooms with the MRI/NMR units. The signs are informational and warn of strong magnetic field prohibiting anyone with a pacemaker, metallic implants, from entering the MRI/NMR rooms.

Equipment may be labeled that is considered safe for use inside the MRI/NMR rooms.

ZONE SIGNS: MRI areas may be posted with Zone I, II, III, or IV signs:

- ZONE I: open to general public access; presents the least exposure to anyone in this area. This is generally the reception and waiting area for the MRI suite.
- ZONE II: this is the first interaction site for the persons with the technologist and nursing staff in the MRI suite. The purpose of this zone is to restrict further public access to the suite and provide direct supervision of patients and visitors by the MRI staff.
- ZONE III: this is the entry zone to the MRI machine room. At this point the entrance into the MRI room is restricted physically and by protocol.
- ZONE IV: this is the room where the MRI unit is locked.

CAUTION IN HANDLING OBJECTS NEAR MAGNETIC FIELD

- Iron or other magnetic objects must not be brought into the neighborhood of the magnet. Such objects will be attracted by the magnet and may injure the patient or employees.
- Information on magnetic carriers, such as floppy disks, disks, tapes and magnetic strips on credit cards will be erased by the magnetic field. Keep enough distances: maximum 5mT (=50 gauss) magnetic field strength is permitted. Magnetic shielding will reduce the distance.
- Do not allow nonferrous metallic objects to be brought into the magnetic field area, including jewelry, hairpins, buttons, prosthetics, etc. These nonferrous metallic objects may disturb the RF signal and may cause image artifacts.
- MRI safe patient care accessories, i.e., wheelchair, stretcher, O^2 tanks, are available and must be used when entering the scan room.

PRECAUTIONS FOR EMERGENCY EQUIPMENT

- Safe and effective use of electronic or other metallic emergency equipment may be impossible near the magnet.
- Precautions should be taken and an appropriate plan should be established for use of emergency equipment outside the magnetic influence of the MR device if needed, especially for the following patients:
    1. Those with an above average high potential for cardiac arrest.
    2. Those likely to develop seizures or claustrophobic reactions.
    3. Heavily sedated, confused or unconscious patients.
    4. Those with whom no reliable communication can be maintained.

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ELECTRICAL SAFETY

- Use the MR imaging system only in a location that complies with all relevant legislation and recommendations concerning electrical safety in rooms used for medical purposes, e.g., U.S. National Code, VDE or IEC Standards concerning provisions for an additional protective earth (ground) terminal used for equipotential connection.
- The MR imaging system may be operated on a continual 24-hour basis without adversely affecting its safety or performance.
- Allow only authorized service personnel to replace or repair any component in the system. Special nonferrous tools may be required in certain areas.
- Keep all covers and doors closed except for the door of the main cabinet, and allow only authorized service personnel to open them.
- Do not use equipment in the presence of flammable gases or vapors.
- Keep water and other liquids out of the equipment, as they may cause short circuits or corrosion.
- Remember that some disinfectants vaporize, forming potentially explosive mixtures. If such disinfectants are used, the vapor must be allowed to disperse before the equipment is returned to use.
- The hardware and software prevent operation above specified levels, as outlined by the manufacturer.

MAGNET SAFETY

MR imaging systems are provided with a magnet emergency stop button, which should be used only under the following conditions:

- Forces due to the magnetic field are causing patient or personnel injury, requiring an immediate shutdown of the magnetic field.
- A fire or other unexpected occurrence demands immediate action and entry to the examination room by emergency personnel.
- Any other situation requires an immediate relief from the magnetic field effect as an alternative to the normal, controlled "ramp-down" of the magnetic field.

CRYOGEN SAFETY

- The superconducting magnet used with the magnetic resonance imaging system requires cryogenic gases for cooling. The principle of the superconducting magnet is to create an environment that does not require a continuous electrical energy source. The windings in the core of the superconducting magnet must be cooled to less than 9.5 K or -440 degrees Fahrenheit. This is accomplished by surrounding the windings with a dewar, a sophisticated thermos bottle, and filling it with liquid helium, which has a boiling point of 4.2 K. Liquid nitrogen has a boiling point of 77 K and is also used to cool the magnet.
- Cryogens require replenishment because of boil-off. This operation must be performed only by fully trained personnel following proper safety procedures. Safety glasses and heavy gloves are required. Refer to the safety documentation from the systems vendor.
- A quench of a magnet refers to the rapid loss of magnetic field. This can happen if the temperature of the magnet windings rises above 9.5 K and the windings become electrically resistive. The magnet windings heat up and can cause vaporization of 100 to 150 L of helium and nitrogen in less than one minute. These gases must vent directly to the outside.

SAFETY SCREENING FOR MRI

MRI staff will screen patients, employees and other visitors for potential injury or risk from exposure to the magnetic field prior to entry to the MRI area.

- Technologist or Tech Assistant will screen using a MRI Screening Sheet form using oral inquiry/observation. This form will be maintained as part of the patient's permanent medical record.
- No one with a pacemaker or other implanted device is allowed to enter restricted magnetic field area. Warning signs and the establishment of a controlled area are posted where magnetic field exceeds 5 gauss 3. No metal (ferrous or magnetism sensitive) objects are permitted to be in or on a person when entering the restricted magnetic field.
- Approval of technologist, radiological engineer, radiologist, or radiology nurse must be met before patient, personnel or visitor is to enter scan room.
- Patients are screened for pregnancy prior to being scanned.

ENVIRONMENTAL SERVICES

The magnetic resonance area should be closed according to normal research area procedures, except for the magnet room itself.

- No person shall enter the room without permission of the technologist.
- The technologist will question each person as to the presence of a cardiac pacemaker, cerebral aneurysm clips or other surgically implanted metal devices.
- The person shall be asked to remove jewelry, hairpins, and all loose objects in their pockets.
- The cleaning person should be made fully aware of the danger of taking any metal object into the room:
    1. That the magnet is on at all times.
    2. The dangers involved to themselves and the equipment if these safety guidelines are ignored.
    3. The expense of the repairs.
- Only an all-plastic vacuuming unit can be taken into the room.
- The cleaning of the magnet is the responsibility of the technologists.

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PRECAUTIONS TO BE ENFORCED BY POLICE OR SECURITY PERSONNEL

- Police and security personnel are to admit only designated service personnel and designated hospital employees to the MRI scan room(s) unless prearranged by medical imaging management.
- In the case of fire or other threat to safety, the power supply should be turned off and the magnetic field removed before anyone enters the scan room(s).
- Police and security personnel must remove firearms before entering the scan room(s).

Related Information:

NMR and MRI equipment produces a strong magnetic field that will pull ferromagnetic objects to the machine with great force. Additionally, the units use

cryogens (helium and nitrogen) for the use of superconduction and cooling of the magnet and other internal components.

Links to additional information:

MRI Safety Presentation (PDF)

MRI Fire and Cryogen Safety (PDF)

Radiation Safety Manual for Research Use (PDF)

Definitions:

Ferromagnetic Object - Ferrous is from the Latin term meaning iron. Ferrous materials are magnetic; objects vary in their magnetic attraction due to the amount of iron in the alloy. Some examples of ferrous metals are steel, stainless steel (some), and all types of iron. The NMR and MRI units are large magnets, so ferromagnetic objects can be highly dangerous as they get close to the magnets.

Magnetic Resonance Imaging (MRI) - uses the NMR principle to produce images of the inside of the body.

Nuclear Magnetic Resonance (NMR) - is a physical phenomenon in which magnetic nuclei in a magnetic field absorb and re-emit electromagnetic radiation.

Restricted Magnetic Field Area - this area includes the magnet room, control room and computer room for the MRI unit. For the NMR unit, this includes the room with the NMR unit.

Responsibilities:

MRI technologist shall control access to the area around the magnet with magnetic fields in excess of established safety guidelines (e.g., 5 gauss for a 0.5 millitesia unit).

Laboratory technologist or the principal investigator shall control access to the area with the NMR unit.