



## 1. SCOPE

This SOP describes general safety procedures to be followed to minimize risk to both research volunteers and individuals working within and around the MRI system.

## 2. PROCEDURES

### a. Safety issues due to medical devices incompatible with magnet

- There are medical devices, implants and objects that are not compatible with the MRI environment. Anyone with the following devices, implants, or objects should indicate so before entering the facility, and may not proceed beyond the magnet room door unless it can be safely removed or identified to be MR safe:

- Pacemaker or Implanted Cardioverter Defibrillator (ICD)
- Aneurysm clip(s)
- Cardiac stent(s)
- Non-programmable/programmable shunt(s)
- Electronic implant or device
- Magnetically activated implant or device
- Neuro-stimulation system (ex. spinal cord stimulator)
- Implanted hearing device (ex. cochlear implant)
- Implanted drug infusion device (ex. insulin pump)
- Any type of prosthesis
- Any metallic fragment or foreign body
- Any external or internal metallic object
- Hearing aid(s)
- Lens implant(s)



- This is not a comprehensive list. Therefore, please complete the MR screening form and review with 3T MRI facility manager.

### b. Safety issues due to high static magnetic field strength

- High static magnetic field strengths are present in the 3T MRI facility. These strong magnetic fields pose potential risks to anyone entering the environment. Medical safety is very important; hence, everyone entering the environment must be aware of the potential dangers.
- There are specific medical devices, implants, and objects that are not compatible with the MR environment. Anyone with any of these (as listed above) should indicate so before entering the facility and may not proceed past the magnet room door unless it can be safely removed.
- All metallic objects have the potential to become projectiles in the MR environment, as they may contain ferrous components. As a result, objects entering the magnet room are restricted. The operator, or Level 2 MRI personnel is responsible for screening all objects entering the magnet room for ferrous components.

- No object should be brought into the magnet room unless it is necessary for the successful execution of an experiment. It must have been tested using a permanent magnet in the control room or have been viewed and permitted for entry by the 3T MRI facility manager or facility director.
- There are several metals that are non-ferrous. These metals include titanium, copper, gold, silver, aluminum, brass, and lead. It is extremely important to note that all metal objects must be tested before being permitted for entry by the 3T MRI facility manager or facility director, even if they are thought to have no ferrous components.
- It is mandatory to remove all personal metallic objects before crossing through the doorway into the magnet room. This includes the following list of articles:

- Hearing aids
- Cell phone/pager
- Keys
- Eyeglasses
- Hair pins/barrettes
- Jewelry (including body piercing jewelry)
- Watch/Fitbit
- Safety pins/clips
- Credit/Bank cards (any card with a magnetic strip)
- Coins
- Pocket knife
- Steel-toed boots/shoes
- Tools
- Any foil backed medication patches



- Any metallic object with ferrous components will gravitate toward the magnet and could potentially cause serious injury to anyone near the magnet and/or damage the system itself. All operators or Level 2 MRI personnel **must** complete the initial level one safety orientation, operator training, and conform to the yearly safety review as stated in *SOP # 220 Safety and Operator Training*. Level 2 MRI personnel are also encouraged to hold a level C CPR and Emergency First Aid certificate.
- It is extremely important that no large metal objects be brought into the magnet at any time. All large metal objects must not go beyond the magnet room doors unless specifically approved by the 3T MRI facility manager or facility director. A large metal object with ferrous components, placed too close to the magnet, will gravitate toward the magnet with excessive force and potentially cause serious injury to anyone near the magnet, and/or damage the system itself.
- In such an instance that a person is seriously injured or trapped as a result of a large ferromagnetic object being too close to the magnet, the operator, or if the operator is injured/trapped, one of the experimental support personnel must follow *SOP #215 Emergency Quench Procedure*.

## c. Safety issues due to hardware

- There exist dangerous and potentially lethal levels of electricity in the 3T MRI system. As such, it is important that all individuals working around the system be aware of the dangers and are therefore knowledgeable as to the safety issues concerning electricity. There is a risk of electric shock from extremely high voltages, possibly causing severe injury or death, and damage to the MRI system. Only trained personnel should handle hardware and cables in the magnet room.
- If a person is electrocuted in the 3T MRI facility and is not responding, breathing, and has no pulse, the operator, or if the operator has been electrocuted, one of the experimental support personnel must follow the procedure outlined in *SOP #205 Emergency Code Blue Procedure*.
- Current carrying cables, connections, and junction points in the vicinity of the main magnetic field are particularly susceptible to damage due to the extreme Lorentz forces created through the normal operation of the system. Periodically, the effects of the prolonged mechanical fatigue will result in breakage causing electrical arcing, sparking, and high heat levels before the system can shut down. Therefore, there is an increased risk of personal injury, and the possibility of a fire being ignited becomes more likely.
- In case of a fire, the operator, or if the operator is incapacitated, one of the experimental support personnel must follow the procedure outlined in *SOP #210 Emergency Fire Procedure*. The operator (or experimental support personnel) must keep their own safety in mind, as a priority, while removing the volunteer/patient from the magnet. If at this time the volunteer/patient is not responding, not breathing, and has no pulse, the operator (or experimental support personnel) must follow the procedure outlined in *SOP #205 Emergency Code Blue Procedure*. After all parties are safe, it is appropriate to seek to minimize damage to the system.
- If the fire cannot be contained by the operator or experimental support personnel using the non-magnetic fire-extinguisher, the operator must follow the procedure outlined in *SOP #210 Emergency Fire Procedure*.
- During certain types of MRI data collection, there exists high, and therefore potentially dangerous acoustic sound pressure levels (SPL). It is mandatory for the volunteer/patient and all others who will be present in the magnet room during the scan session to wear hearing protection either in the form of earplugs or headphones provided by the 3T MRI facility.
- Conductive components may also cause localized RF heating which may result in burns. The operator will ensure that current carrying cables are not looped or touching the volunteer's skin directly. The operator will also ensure that the integrity of the cables are checked prior to use. If there are any problems with cables, devices, or equipment (leads, coils, etc.) the operator will inform the 3T MR facility manager.

## d. MRI Safety Zones

- Due to the inherent hazards associated with the static magnetic field, access to the 3T MRI facility is restricted to ensure the safety of all patients, subjects, visitors, and staff. The facility is divided into four zones of increasing level of potential risk and increasing access restriction as shown in Figure 1 below.

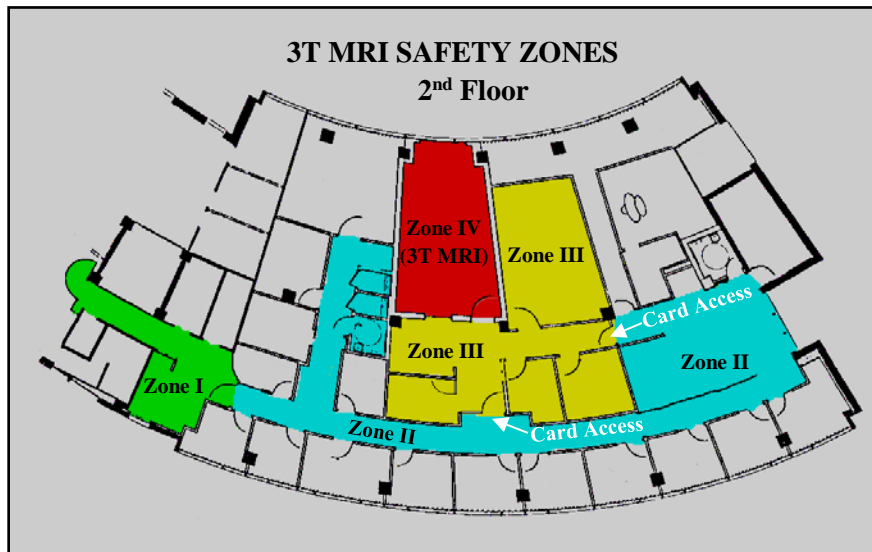


Figure 1.

### Zone I

- Consists of all areas freely accessible to the public. This zone includes the entrance to the Translational Imaging Research Facility (TIRF), and patient waiting room where the magnet poses no hazardous risk. It also includes all other areas of Robarts Research Institute excluding the other MRI facilities.

### Zone II

- Interface between Zone I and the more restrictive Zones III and IV. This zone begins at the TIRF reception desk, and extends into the patient change room area, and hallway leading to the secured 3T MRI suite doors.
- All non-MRI personnel in Zone II are to be accompanied by a TIRF staff member. This includes patients, volunteers, and visitors, accompanying research staff, and building service personnel.

## Zone III

- Region in which non-MRI personnel must be accompanied at all times by MRI safety trained personnel. Due to the strong magnetic field surrounding the MRI system, the existence of medical implants or ferromagnetic objects may result in serious injury, accident, or death, and therefore all access to Zone III is restricted.
- Zone III can be accessed through either of the two locked 3T MRI suite doors as shown in Figure 1. (Room 2245), and surrounds all areas beyond these doors, including the 3T control room, equipment room, DNP lab, animal prep room, and hyperpolarized gas lab.
- Access to Zone III is controlled by security keycard access. Only Level 1 and 2 MRI personnel may have security access to Zone III as outlined in SOP # 105 *Facility Access Approval Procedure*. All others may enter under the supervision and permission of level 1 or 2 MRI personnel.

## Zone IV (Magnet Room)

- Zone IV is synonymous with the magnet room itself and is the zone that causes the greatest potential risk due to extremely high magnetic fields. The magnet room door is to be secured and always locked when not in use.
- Only Level 2 MRI personnel may have access to Zone IV. All others may enter only with the permission and supervision of Level 2 MRI personnel after completing an “MRI Screening Form” (see Appendix 5). The 3T MRI facility manager must review and sign this form before visitors proceed into the designated high magnetic field area.
- All others who are permitted access to Zone IV, including patients, research staff, Level 1 MRI personnel, etc., must remain under constant observation by Level 2 MRI personnel.