

ROBARTS RESEARCH INSTITUTE
CENTRE FOR FUNCTIONAL AND METABOLIC MAPPING:
3T/7T MRI FACILITY

Standard Operating Procedure #200-01
Last Updated: July 28, 2008

General Safety

1. Introduction

- 1.1 Research involving Magnetic Resonance Imaging (MRI) at high magnetic field strengths present unique hazards to both research subjects and individuals working within and around the MRI system. Consequently, the potential for serious personal injury is present due to the sheer size and strength of the static magnetic field along with the immense flexibility of the research system and associated peripheral hardware.
- 1.2 The static magnetic field in the 3T/7T MRI Facility is always present. It is important that all those entering the facility be aware of the presence of the field, as it cannot be detected by our person in any way, i.e. magnetic fields cannot be felt, seen, or smelt.
- 1.3 There exist dangerous and potentially lethal levels of electricity in both the 3T and 7T MRI systems. As such, it is important that all individuals working around the MRI systems be aware of the dangers and therefore knowledgeable as to the safety issues concerning electricity. Furthermore, 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 prolonged mechanical fatigue will result in breakage causing electrical arcing, sparking and high heat levels before the system can shut down. There therefore becomes a high potential for personal injury and the possibility of a fire being ignited.
- 1.4 During certain types of MRI data collection, there exists high, and therefore potentially dangerous, acoustic sound pressure levels (SPL). All those entering the facility must be made aware of this risk and be instructed as to the proper precautionary measures to be taken. Any patients, volunteers and/or research personnel present in the magnet room during an MRI experiment must wear appropriate hearing protection as outlined below.
- 1.5 As a result of the potential for serious injury, access to the 3T/7T MRI Facility is restricted, and requires permission. See SOP#100-01 "MRI Facility Access Approval Policy", and SOP#110-01 "MRI Facility Visitor Approval Policy".
- 1.6 Working within and around the high field MRI requires in depth training on safety and Standard Operating Procedures, and documented proof of other necessary training. See SOP#120-01 "Safety and Operator Training".
- 1.7 It is imperative that all personnel who are within and around the 3T/7T MRI Facility always keep in mind the potential safety risks, and act in accordance with the guidelines set out in the Standard Operating Procedures.

2. **Safety Issues – Medical Devices Incompatible with Magnet**

- 2.1 Aneurysm clips are incompatible with the MR environment. Anyone with an aneurysm clip should indicate so before entering the facility, and may not proceed beyond the 5 Gauss line.

3. **Safety Issues – Due to High Static Magnetic Field Strengths**

- 3.1 High static magnetic field strengths are present in the 3T/7T MRI Facility. These strong magnetic fields pose potential risks to those working, volunteering, or touring in the environment. Medical safety is very important; hence, everyone entering the environment must be aware of the potential dangers.
- 3.2 There are specific medical devices, implants and objects that are incompatible with the MR environment. Anyone with any of these, as listed above, should indicate so before entering the facility, and may not proceed beyond the 5 Gauss line unless the object can be safely removed. The 5 Gauss line is marked on the floor and on signs on the walls of the 3T/7T MRI Facility.
- 3.3 All metallic objects have the potential to become projectiles in the MR environment, as they may contain ferromagnetic components. As a result, objects entering the magnet room are restricted.
 - 3.3.1 The operator is responsible to screen all objects entering the magnet room for ferromagnetic components.
 - 3.3.2 All objects, not already in the magnet room, should not be brought into the magnet room, unless they are necessary for the successful execution of the experiment, and have been tested using a permanent magnet in the control room, or have been viewed and permitted for entry by one of the Facility Director, Manager or Head Technician.
 - 3.3.3 There are several metals that are not ferromagnetic. These metals include titanium, copper, gold, silver, platinum, aluminium, brass and lead. It is extremely important to note that all metal objects must be tested or permitted for entry by one of the Facility Director, Manager or Head Technician even if they are thought to have no ferromagnetic components.
- 3.4 It is mandatory to remove all personal metallic objects from your person before crossing the 5 Gauss line as marked on the floor and on signs in the 3T MRI Facility. This includes the following list of articles:
 - 3.4.1 Hearing aids
 - 3.4.2 Dentures
 - 3.4.3 Pager
 - 3.4.4 Cell phone
 - 3.4.5 Keys
 - 3.4.6 Eyeglasses
 - 3.4.7 Hair pins
 - 3.4.8 Wigs
 - 3.4.9 Barrettes
 - 3.4.10 Jewellery (including body piercing jewellery)
 - 3.4.11 Watch
 - 3.4.12 Safety pins
 - 3.4.13 Paperclips
 - 3.4.14 Credit cards

- 3.4.15 Bank cards
- 3.4.16 Magnetic strip cards
- 3.4.17 Coins
- 3.4.18 Pens
- 3.4.19 Pocket knife
- 3.4.20 Nail clipper
- 3.4.21 Steel-toed boots/shoes
- 3.4.22 Tools

- 3.5 Any metallic object with ferromagnetic components will fly toward the magnet and could potentially cause serious injury to anyone in or near the magnet, and damage to the MRI system. All operators must be first responders trained in Emergency First Aid, including first aid for impaled objects.
- 3.6 It is extremely important that no large metal objects be brought into or near the magnet room at any time. All large metal objects must not go beyond the 5 Gauss line as marked on the floor and on signs on the walls of the 3T/7T MRI Facility, unless specifically directed by the Director, Manager, or Head Technician. A large metal object with ferromagnetic properties, placed too near the magnet, will fly towards the magnet with great force, potentially causing serious injury to anyone in or near the magnet and damage to the MRI system.
 - 3.6.1 In such an instance, if someone is pinned to the magnet, trapped or potentially in a life-threatening situation as the result of a large ferromagnetic object coming too near the magnet, the operator, or if the operator is pinned, one of the experimental support personnel, must follow SOP#230-01 "Emergency Quench", and apply first responder principles.

4. **Safety Issues – Due to Hardware**

- 4.1 There exist dangerous and potentially lethal levels of electricity in both the 3T and 7T MRI systems. As such, it is important that all individuals working around the MRI systems be aware of the dangers and 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 set up hardware in the magnet room and plug in or change the placement of any cables.
 - 4.1.1 If someone is electrocuted in the 3T/7T MRI Facility and is not responding, breathing and has no pulse, the operator or, if the operator was electrocuted one of the experimental support personnel, must follow the procedure outlined in SOP#210-01 "Emergency Code Blue".
- 4.2 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 prolonged mechanical fatigue will result in breakage causing electrical arcing, sparking and high heat levels before the system can shut down. There therefore becomes a high potential for personal injury and the possibility of a fire being ignited.
 - 4.2.1 In the case of a fire, the operator, must follow the procedure outlined in SOP#220-01 "Emergency Fire". The operator must keep his/her 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 must follow the procedure outlined in SOP#210-01 "Emergency Code Blue". After all parties are safe, it is appropriate to seek to minimize damage to the

- system.
- 4.2.2 If the fire cannot be contained by the operator using the non-magnetic fire extinguisher, the operator must then call the fire department and follow the procedure outlined in SOP#230-01 "Emergency Quench". The fire department cannot enter the facility if the magnet is at field.
- 4.3 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/7T MRI Facility.