

3T/7T MRI FACILITY

SOP Number:	120.02
Title	General Safety

Revision Chronology		
Version Number	Date	Changes
120.01	28 July 2008	New
120.02	21 January 2013	Extensive updates to Sections 2, 3, 4

Facility Manager Signature: _____

Date: _____

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

Standard Operating Procedure #120.02

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 essential that everyone entering the facility is aware of the presence of the magnetic field, since we cannot otherwise detect it (i.e. magnetic fields cannot be seen or felt).
- 1.3 Dangerous and potentially lethal levels of electricity are used by both the 3T and 7T MRI systems. Therefore it is important that all individuals working around the MRI systems be aware of the dangers and understand the safety issues concerning electricity. 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 may result in breakage, thereby causing electrical arcing, sparking, and high heat levels before the system can shut down. In these instances there is a high potential for personal injury as well as the possibility of a fire being ignited.
- 1.4 During certain types of MRI data collection, high and potentially dangerous acoustic sound pressure levels (SPL) are generated. Everyone entering the facility must be made aware of this risk and be instructed as to the precautionary measures that must be taken. Any patients, volunteers, or other personnel present in the magnet room during an MRI scan must wear appropriate hearing protection as outlined in Section 4.4 below.
- 1.5 Due to the inherent hazards associated with the static magnetic field, access to the 3T/7T MRI Facility is restricted to ensure the safety of all patients, subjects, visitors, and staff. The 3T/7T MRI Facility is conceptually divided into four Zones of increasing level of potential risk and access restriction. See SOP#100a: "MRI Facility Safety Zones", SOP#100b: "MRI Facility Access Approval Policy", and SOP#110: "MRI Facility Visitor Approval Policy".
- 1.6 Personnel working within the 3T/7T MRI Facility require extensive training, see SOP#130: "MRI Personnel Training".

2. Safety Issues: Medical Implants and Devices

- 2.1 Many medical implants and devices are incompatible with the MR environment and may cause severe injury or death due to heating, movement, or malfunction when exposed to the static, gradient, and RF magnetic fields.

- 2.2 Many medical implants and devices have undergone extensive testing for safety within the MR environment and have been determined to be “Safe”, “Unsafe”, or “Conditional” at a particular magnetic field strength. Anyone with implants or devices deemed “Unsafe” will NOT be permitted to enter Zone IV (magnet room) or proceed beyond the 5 Gauss line of Zone III. Individuals with “Safe” or “Conditional” medical implants may be permitted to enter only upon the approval of authorized Level 2 MRI Personnel (i.e. Facility Manager or MRI Technologist) after they have reviewed all safety information available regarding the particular medical implant/device. Note that medical implants/devices’ safety is manufacturer and model specific, as well as field-strength specific. For further information, see www.mrisafety.com/list.asp.
- 2.3 Medical implants and devices known to be incompatible with the 3T/7T MR environment include aneurysm clips, certain cardiac pacemakers, and many others. All medical implants and devices must be individually researched to determine their compatibility in the MR environment.

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

- 3.1 High static magnetic fields are always present in the 3T/7T MRI Facility. These strong magnetic fields pose potential risks to those working, volunteering, or touring in the MR environment, therefore everyone entering must be aware of the potential hazards.
- 3.2 There are specific medical implants, devices, and objects that are incompatible with the MR environment. Anyone with these implants/devices (as outlined in Section 2 above), must inform facility staff before entering the 3T/7T MRI Facility, and may not proceed beyond the 5 Gauss line in Zone III or enter Zone IV unless the object can be safely removed.
- 3.3 Level 2 MRI Personnel are responsible for screening all objects and individuals before they enter Zone IV (magnet room) to ensure that all potentially hazardous objects have been removed.
 - 3.3.1 Any object has the potential to become a projectile in the MR environment, if it contains ferromagnetic components. All ferromagnetic objects are strictly prohibited from entering Zone IV.
 - 3.3.2 No equipment or object should enter or be brought into Zone IV (magnet room) unless it is necessary for the successful execution of the experiment, has been tested for magnetism using the permanent magnet in the control room, and has been approved for entry by Level 2 MRI Personnel.
- 3.4 All metallic objects must be removed from your person before crossing the 5 Gauss line in Zone III or entering Zone IV (magnet room). This includes, but is not limited to, the following objects:
 - 3.4.1 Hearing aids
 - 3.4.2 Dentures
 - 3.4.3 Cell phones
 - 3.4.4 Keys
 - 3.4.5 Coins
 - 3.4.6 Credit cards
 - 3.4.7 Bank cards
 - 3.4.8 Magnetic strip cards (including Western ID cards and LHSC parking tickets)
 - 3.4.9 Pagers
 - 3.4.10 Eyeglasses

- 3.4.11 Hair pins (including bobby pins, barrettes, clips, hair elastics)
- 3.4.12 Jewellery (including body piercings)
- 3.4.13 Watches
- 3.4.14 Safety pins
- 3.4.15 Paperclips
- 3.4.16 Pens
- 3.4.17 Pocket knives
- 3.4.18 Nail clippers
- 3.4.19 Steel-toed boots/shoes
- 3.4.20 Tools

3.5 Any object with ferromagnetic components will be pulled toward the magnet with strong force and has the potential to cause serious injury to anyone in or near the magnet, damage to the MRI system, and/or destroy the object.

3.5.1 Note that several metals are not ferromagnetic, including titanium, copper, gold, silver, platinum, aluminium, brass, and lead. Although these metals are non-magnetic, their presence in the magnet room may interfere with the normal operation of the MRI scanner. All metallic objects must be properly tested and approved for entry by Level 2 MRI Personnel even if they are thought to have no ferromagnetic components.

3.6 No large metallic objects may be brought into or near Zone IV (magnet room) at any time. All large metallic objects must remain beyond the 5 Gauss line as marked on the floor in Zone III, unless specifically directed by authorized Level 2 MRI Personnel. Any large metallic object with ferromagnetic properties will fly towards the magnet with great force if allowed too near to the magnet, potentially causing severe injury or death to anyone in or near the magnet and damage to the MRI system.

3.6.1 If an incident should occur, and someone is pinned to the magnet, trapped, or in a potentially life-threatening situation as the result of a large ferromagnetic object coming too near to the magnet, the Level 2 MRI Personnel (or if this person is pinned, any other MRI Personnel or Research Personnel present) must follow SOP#160: “Emergency Quench”, and apply first responder principles.

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

4.1 Dangerous and potentially lethal levels of electricity are used by both the 3T and 7T MRI systems. Therefore there is always a potential risk of electric shock, fire, or personal injury.

4.1.1 If someone has suffered a life threatening electric shock in the 3T/7T MRI Facility, is not breathing, and has no pulse, the MRI Personnel present must follow the procedure outlined in SOP#140: “Emergency Code Blue”.

4.1.2 In the case of a fire, the MRI Personnel present must follow the procedure outlined in SOP#150: “Emergency Fire”. The MRI Personnel must keep his/her own safety in mind while removing the volunteer/patient from the magnet. If at this time the volunteer/patient is not responding, is not breathing, and has no pulse, the operator must follow the procedure outlined in SOP#140: “Emergency Code Blue”.

4.1.2.1 After all parties are safe, and if it is safe and appropriate to do so, the MRI Personnel may attempt to contain or extinguish the fire.

4.1.2.2 The MRI Personnel must call the fire department, and if the fire cannot

be extinguished or contained outside Zone IV, follow the procedure outlined in SOP#160: "Emergency Quench". The fire department cannot enter Zone IV if the magnet is at field.

- 4.2 During certain types of MRI data collection, high and potentially dangerous acoustic sound pressure levels (SPL) are generated. It is mandatory for the volunteer/patient, and all others who will remain present in Zone IV (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.