

## **Centre for Neuroscience Studies**

### **fMRI Facility**

#### **Standard Operating Procedure #05**

##### **General Safety Procedures**

### **1. Introduction**

- i. 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 flexibility of the research system and associated peripheral hardware.
- ii. The static magnetic field in the 3T 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 smelled.
- iii. During MRI data acquisition the subject being imaged is also exposed to rapidly changing magnetic fields due to pulsed magnetic field gradients, and fields oscillating at radio-frequencies (around 128 MHz for 3 T). These time-varying fields are much weaker than the static field (up to 10 mT or 100 gauss) but create additional safety risks and all personnel working with the MRI equipment must be aware of these risks.
- iv. 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.
- v. As a result of the potential for serious injury, access to the 3T MRI Facility is restricted, and requires permission. See SOP# 01 "Authorization for Access to the 3T MRI Facility" and SOP# 02 "3T MRI Facility Visitor Approval Policy."
- vi. 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# 03 "Safety and Operator Training Procedures."
- vii. It is imperative that all personnel who are within and around the 3T MRI facility always keep in mind the potential safety risks, and act in accordance with the guidelines set out in the Standard Operating Procedures.
- viii. Any person who enters the Magnet Room must have completed the Safety Checklist: "MAGNETIC RESONANCE (MR) ENVIRONMENT SAFETY CHECKLIST FOR INDIVIDUALS", or alternatively anyone who will be entering the Magnet as a subject for imaging or spectroscopy must have completed the Safety Checklist:

“MAGNETIC RESONANCE (MR) IMAGING SAFETY CHECKLIST FOR RESEARCH SUBJECTS”

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

- i. There are medical devices, implants and objects that are incompatible with the MR environment. Anyone with any of the following should indicate so before entering the facility, and may not proceed beyond the 5 Gauss line unless the object can be safely removed:

Aneurysm clip(s)  
Implanted cardioverter defibrillator (ICD)  
Electronic implant or device  
Magnetically-activated implant or device  
Neurostimulation system  
Spinal cord stimulator  
Cochlear implant or implanted hearing aid  
Insulin or infusion pump  
Implanted drug infusion device  
Any type of prosthesis  
Any type of implant that may contain metallic components  
Artificial or prosthetic limb  
Any metallic fragment or foreign body  
Any external or internal metallic object  
Hearing aid

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

- i. High static magnetic field strengths are present in the 3T 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.
- ii. 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 by the threshold of the magnet room door and signs on the door.
- iii. 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.
- a. The operator is responsible to screen all objects entering the magnet room for ferrous components.
  - b. 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 the Facility Director.
  - c. 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 or permitted for

entry by the Facility Director, even if they are thought to have no ferrous components.

- iv. It is mandatory to remove all personal metallic objects from your person before crossing the 5 Gauss line as marked by the door threshold and on signs on the magnet room door. This includes the following list of articles:

- Hearing Aids
- Pager
- Cell Phone
- Keys
- Hair pins
- Barrettes
- Loose jewelry
- Watch
- Safety Pins
- Paperclips
- Credit Cards
- Bank Cards
- Magnetic Strip Cards
- Coins
- Pens
- Pocket Knife
- Nail Clippers
- Steel-toed boots/shoes
- Tools

- v. Any metallic object with ferrous components will fly toward the magnet and could potentially cause serious injury to anyone 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.
- vi. 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 door to the magnet room, unless specifically directed by the Director. A large metal object with ferrous properties, placed too near the magnet, will fly towards the magnet with great force, potentially causing serious injury to anyone near the magnet and damage to the MRI system.
  - a. 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 ferrous object coming too near the magnet, the operator, or if the operator is pinned, one of the experimental support personnel, must follow SOP# 8 "Emergency Shut-down and Quench Procedures", and apply first responder principles.

#### **4. Safety Issues –Due to Rapidly Changing Magnetic Fields**

- i. Magnetic fields that change quickly in time are present within the MRI system while data is being acquired. These fields pose additional potential risks for volunteers being studied, or for personnel who are very close to the radio-frequency coils during data acquisition. The risk is created because time-varying magnetic fields can induce electrical currents in electrical conductors.
- ii. The potential for peripheral nerve stimulation due to rapid switching of magnetic field gradients is monitored by the MRI hardware and software. Changing magnetic

fields (dB/dt levels) are not permitted by the system to exceed Health Canada approved limits. However, volunteers must be positioned without their arms or hands touching to avoid creating large conducting loops.

- iii. Objects with good electrical conductance must not be permitted to rest against the skin of the subject within the region spanned by the body coil, and should not be permitted within the body coil unless essential for the study being conducted. Acceptable exceptions are such as MR-compatible leads for ECG monitoring.
- iv. It is mandatory to remove electrically conducting objects from the volunteer before positioning in the magnet for data acquisition. This includes the following list of articles:

- Eyeglasses
- Underwire bra
- Jewelry (including body piercing jewelry)
- Clothing with zippers

## 5. Safety Issues – Due to Electrical Power

- i. 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 MRI system 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.
  - a. If someone is electrocuted in the 3T MRI Facility, the operator or, if the operator was electrocuted one of the experimental support personnel, must follow the procedure outlined in SOP# 06 “Emergency Procedure.”
  - b. In the case of a fire, the operator, must follow the procedure outlined in SOP# 07 “Emergency Fire Procedure”. 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# 06 “Emergency Procedure”. After all parties are safe, it is appropriate to seek to minimize damage to the system.
  - c. If the fire cannot be contained by the ceiling mounted fire suppression system, the operator must then call the fire department and follow the procedure outlined in SOP# 08 “Emergency Shut-down and Quench Procedure”. The fire department cannot enter the facility if the magnet is at field.
- ii. 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 and/or headphones provided by the 3T MRI Facility.