



**Mason 3T MRI Core Facility**  
**MRI Safety Policies and Procedures Manual**  
*Environmental Health & Safety Office*  
**January 2019**

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## Acronyms

<b>ACR</b>	American College of Radiology
<b>AED</b>	Automated Emergency Defibrillator
<b>ARRT</b>	American Registry of Radiologic Technologists
<b>BLS</b>	Basic Life Support
<b>CPR</b>	Cardiopulmonary Resuscitation
<b>dB</b>	Decibel
<b>EHS</b>	Environmental Health and Safety
<b>FDA</b>	Food and Drug Administration
<b>G</b>	Gauss
<b>IRB</b>	Institutional Review Board
<b>MR</b>	Magnetic Resonance
<b>MRI</b>	Magnetic Resonance Imaging
<b>RDIA</b>	Research, Development, Integrity, and Assurance
<b>PI</b>	Principal Investigator
<b>RF</b>	Radio Frequency
<b>SAR</b>	Specific Absorption Rate
<b>SOP</b>	Standard Operating Procedure
<b>T</b>	Tesla
<b>W/kg</b>	Watt/kilogram

## Foreword

The purpose of the *Magnetic Resonance Imaging (MRI) Safety Policies and Procedures Manual* is to provide a resource for safe MRI practices at George Mason University. The safety policies and procedures outlined in this manual are based on recommendations of the American College of Radiology (ACR), guidance from the Food and Drug Administration (FDA), and best practices. The ACR publication, *ACR Guidance Document on MR Safe Practices: 2013*, was used as a primary reference for development of the MRI Safety Program at George Mason University.

The policies and procedures discussed in this manual were developed through the cooperative efforts of the Environmental Health and Safety Office (EHS), Research, Development, Integrity, and Assurance (RDIA), Office of Risk Management, and the Psychology Department.

This manual is available in the 3T MRI Core Facility located in Peterson Hall and is available on request from the EHS Office. The contents of this manual are reviewed periodically and revised as necessary to reflect changes in MRI safety and operations.

This manual supersedes all previous manuals regarding MRI policies and procedures at George Mason University.

## Document History

Version	Revision Date	Comments
1	January 2019	Initial <i>MRI Safety Policies and Procedures Manual</i>

## **1.0 Introduction**

The Mason 3T MRI Core Facility at Peterson Hall is dedicated to providing resources for the acquisition and storage of brain image data to the neuroscience community. George Mason University encourages collaborations between institutions and scientists, disseminates products of our research, and shares the resources of the imaging suite.

The Mason 3T MRI Core Facility contains a high field 3 Tesla Siemens MAGNETOM Prisma MRI scanner. This magnet is a full body scanner designed to accommodate high resolution structural scans of all body parts, and structural and functional imaging of the human brain. It has the capacity to resolve specific images of gray and white matter tissue and brain structures, vasculature, basic metabolic chemistry, and functional neural systems present in the human brain.

Because of the inherent risk associated with MRI, George Mason University follows strict safety and operational procedures to protect the health and safety of all personnel and participants who enter the MRI Suite. These procedures, as well as programmatic, maintenance, and operational requirements of the MRI Suite, are outlined in this manual.

### **1.1 Hazards Associated with MRI**

#### **1.1.1 Missile Effect**

The missile effect or projectile effect refers to the capability of the fringe field of the static magnetic field to attract a ferromagnetic object, drawing it rapidly into the scanner with considerable force. When this occurs, the missile effect can pose a significant risk to anyone in the path of the projectile, and cause significant damage to the scanner.

To guard against accidents from metallic projectiles, the 5 gauss line should be clearly demarcated and the area with that line kept free of ferromagnetic objects. Personnel and research participants must remove all metallic personal belongings (hearing aids, analogue watches, jewelry, belts, etc.) before entering the magnet room, as well as any clothing with magnetic fasteners.

All equipment to be taken into the scanner room, housekeeping supplies (bucket, broom, mop, etc.), research equipment (props), tools, and emergency equipment (litter, fire extinguisher, etc.) must be made of nonferrous material and be classified as MR safe.

#### **1.1.2 Rotational and Translational Forces**

Rotational force is a force that causes a ferrous object to turn and align along the magnetic field. Translational force is a force that causes a ferrous object to be pulled toward the center of the magnet.



Implants and devices that are not proven MR safe pose a serious health risk due to torque and heating. Implants tested to be safe at 1.5 T are not necessarily safe at 3 T. All implants and devices must be documented as MR safe before being permitted in the MRI Suite.

To prevent damage or injury due to torsion or translational forces, all individuals who enter the magnet room must be prescreened to determine if they have any ferrous material in their body. Comprehensive safety screening reviews potential injuries involving ferrous material and the presence of ferromagnetic devices or implants (clips, screws, shunts, etc.) as well as cosmetic concerns such as permanent eyeliner, tattoos, hair weaves or braids, and permanent retainers.

### **1.1.3 Cryogenic Liquids**

The coils of the superconducting magnet are immersed in liquid helium to prevent excessive heat buildup. Under normal operation, the helium slowly boils off and more liquid helium must be added. Risks associated with liquid helium include burns due to accidental direct contact with the cryogen or hypoxia as a result of a leak or quench.

A quench involves the rapid release of helium and results in loss or decrease of the magnetic field. A manual quench can be performed by trained personnel in the event of an emergency, such as a person being pinned to the magnet. In extraordinary circumstances, an uncontrolled quench can occur. In this circumstance, the oxygen level in the magnet room may significantly decrease, causing a hypoxic environment. To reduce the risk of hypoxia due to the rapid release of helium, the laboratory that houses the magnet has adequate ventilation and the doors open in the path of egress.

### **1.1.4 Magnetohydrodynamic Effect**

Magnetohydrodynamic effects are phenomena that arise from the motion of electrically conducting fluids (like blood) in the presence of electric and magnetic fields. These effects become more evident with an increase in static magnetic field strength. Within the MRI environment, magnetohydrodynamic effects may cause vertigo, nausea, or phosphenes (visual sensation from electrical stimulation of the eye).

### **1.1.5 Radiofrequency Fields**

The MRI signal is created by RF pulses through a transmit core. Conducting materials within the RF field may result in a concentration of electrical currents sufficient to cause excessive heating and tissue damage. Absorption of RF power by tissue is described in terms of Specific Absorption Rate (SAR) which is expressed in watts/kilograms (W/kg). According to the FDA, the SAR must be no greater than 4 W/kg averaged over the whole body for any 15-minute period, 3 W/kg averaged over the head for any 10-minute period, 8 W/kg in tissue in the head or torso, or 12 W/kg in tissue in the extremities for any period of 5 minutes.

### **1.1.6 Acoustic Noise**

Movement of the gradient coils due to switching of the gradient magnetic field is the main source of considerable acoustic noise within the scanner room, registering up to 140 decibels (dBA). The OSHA permissible exposure limit for noise is 90 dBA over an 8 hour workday, with a 50%

reduction in permissible exposure duration for every 5 dBA above the 90 dBA limit. Ear plugs or ear muffs can both reduce noise exposures by 20-30 dBA; used in combination, the noise exposure is reduced by an additional 5 dBA.

All employees working in Zone 4 must be enrolled in the university Hearing Conservation Program, and are required to wear disposable ear plugs and/or headphones during Zone 4 activities.

Non-employee study participants and/or escorts involved in MRI studies are required to wear disposable foam ear plugs and/or headphones during Zone 4 activities.

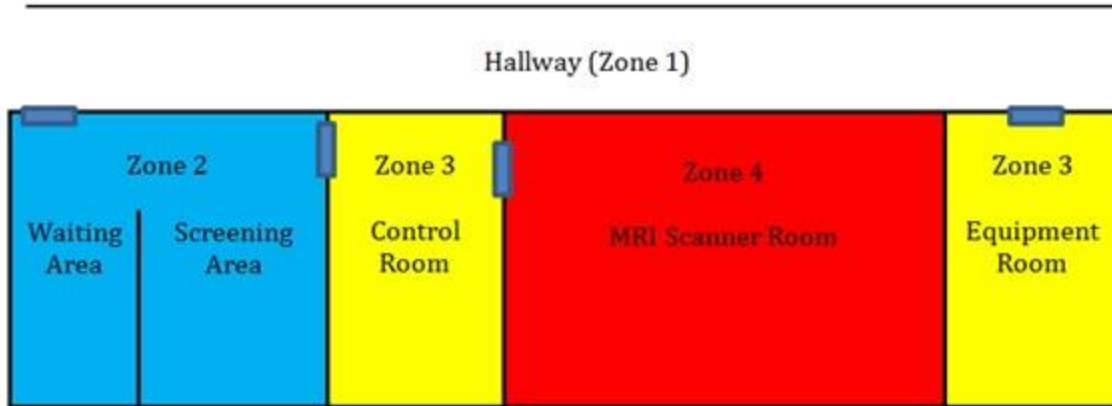
## **1.2 Facility Design**

### **1.2.1 Safety Zones**

The area surrounding the MRI scanner is divided into four safety zones:

- *Zone 1* includes all areas accessible to the general public (the corridor outside the MRI Suite, and the exterior of the building). There are no MRI hazards in Zone 1 areas.
- *Zone 2* is the interface between publicly-accessible Zone 1 and restricted Zones 3 and 4. There are no MRI hazards in Zone 2 areas. The MRI waiting area and screening room are Zone 2 areas.
- *Zone 3* is the region in which the MRI magnetic field may exceed 5 gauss, the level at which the magnetic field may interfere with the operation of cardiac pacemakers or other implanted medical devices. The MRI Console Room and MRI Equipment Room are Zone 3 areas.
- *Zone 4* is synonymous with the MRI scanner room. The magnetic field within *Zone 4* can be very dangerous. No ferromagnetic objects or equipment are permitted in Zone 4, and only individuals who have been properly screened may enter (this applies to employees, research participants, visitors, and participant escorts).

Each entrance to Zones 2, 3 and 4 is posted with a sign to indicate MRI level, any hazards that may be present, and any restrictions on access. Zones 3 and 4 are considered restricted access areas.



**Figure 1. 3T MRI Core Facility Safety Zones**

### 1.2.2 Shielding

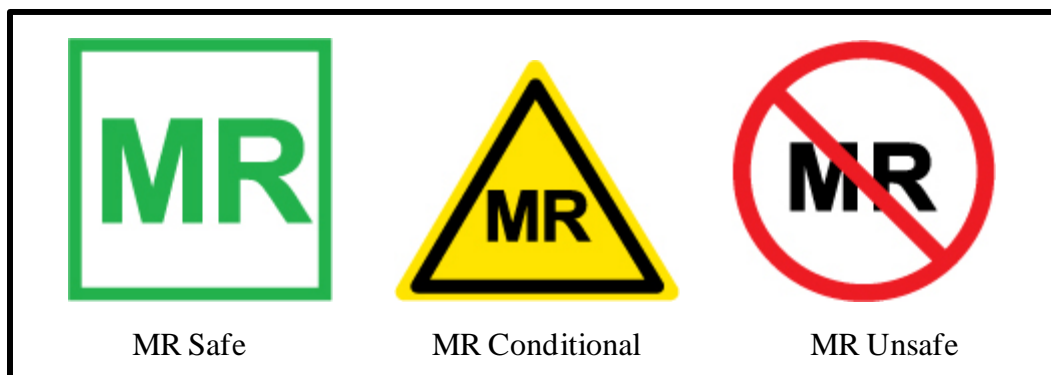
The scanner room (Zone 4) is shielded on six sides by copper and steel. The wave guides which permit functional imaging equipment to attach to the MRI are also constructed of copper. The copper shielding protects the magnetic environment from outside RF contamination. The steel shielding contains the magnetic field so that the hallway (Zone 1 – public access) is free of the magnetic field. The 5 gauss (0.5 mT) line extends several inches into the console room along the wall between the console room and the scanner room. Therefore, anyone with a pacemaker or other implanted medical device is not permitted entry to the console room. The presence of this field poses no risks to others who enter the console room.

### 1.2.3 Ventilation

The MRI Suite has unidirectional laboratory ventilation. In the event of a quench, released helium is vented to the building exterior to prevent the creation of a hypoxic environment. A quench is accompanied by a loud noise, which will startle persons in the facility and in the surrounding area, but the helium released to the outside is lighter than air, is inert, and is not harmful to the environment.

### 1.2.4 Labeling Requirements

Equipment, instruments, and devices must be clearly labeled to indicate their safety for use in the MR environment. Three types of labels (Figure 4) can be used to indicate if an object is safe for the MR environment (MR safe), safe under specific conditions (MR conditional), or unsafe (MR unsafe).



**Figure 2. ASTM Labeling**

*MR safe* is defined as an object that poses no known hazards in all MR environments. MR safe can only be applied to objects that are 100% safe to be taken, used, or placed within all MR environments without any risk or potential harm.

*MR conditional* is defined as an object that is safe when used in a specific manner within specific MR environments. Most objects will receive this rating. An object with this label warns the user that there are limitations to the usability or to the testing that was performed on it. In other words, the object may have been tested for a 1.5 Tesla system, but not for a 3-Tesla system. The conditions should be included on the object, in its packaging, or its accompanying instructions.

*MR unsafe* is defined as an object that poses a known threat or hazard in all MR environments.

### **1.2.5 Equipment and Supplies**

The MRI Suite is equipped with MR safe supplies for housekeeping, an MR safe ladder, a MR safe fire extinguisher, and an MR safe stretcher in case of a medical emergency. All equipment in the MRI Suite is labeled regarding suitability for the MR environment.

The closest portable Automated External Defibrillator (AED) is located in the second floor of the Peterson Hall main Building, in the elevator lobby. The AED is not MR safe and, therefore cannot be brought into the MRI Suite.

## **2.0 Roles and Responsibilities**

It is the responsibility of all employees, students, and visitors to conduct activities in a manner that will not adversely impact themselves, other laboratory personnel, George Mason University property, the surrounding community, or the environment. The implementation of a comprehensive MRI safety program relies on the support and cooperation of all entities listed in this section.

### **2.1 Vice President for Research**

The President delegates authority to the Vice President for Research, who is charged with overseeing all aspects of George Mason's research programs. Specific responsibilities of the Vice President for Research with regard to MRI safety are to:

- Provide operational funding, guidance and administrative support as required to maintain MRI research operations to meet all established safety, legal, and ethical regulations or guidelines applicable to MRI research operations. at George Mason University.
- Oversee the EHS Office, the Institute for Biohealth Innovation (IBI), and RDIA.

### **2.2 Associate Director, Institute for Biohealth Innovation**

The Associate Director, IBI provides programmatic oversight and administrative support to the Peterson MRI.

- Supervise the MRI Technologists with respect to operation of the MRI Suite.
- Provide the necessary support for proper management of maintenance and operations of the MRI Suite.
- Ensure compliance with George Mason University policies, procedures, and IRB protocols.
- Negotiate and manage research contracts for research and development activities conducted in collaboration with vendors, as well as service and maintenance contracts.
- Serve as member of the MRI Policies and Procedures Committee.
- Oversee financial mechanisms for billing and purchasing.

### **2.3 MRI Scientific Director**

The Scientific Director provides scientific oversight and technical support for research operation of the 3T MRI Core Facility. Specific responsibilities with regard to are to:

### **2.4 Director of Environmental Health and Laboratory Safety**

The Director of Environmental Health and Laboratory Safety oversees development and implementation of safety and compliance programs for George Mason University's research and instructional laboratories, to include the MRI Suite. Specific responsibilities with respect to the MRI Suite are to:

- Provide necessary support for development and implementation of the MRI Safety Program.
- Serve as a member of the MRI Policies and Procedures Committee.
- Conduct routine review of the MRI Safety Program for compliance with policies and procedures.
- Coordinate with the MRI Scientific Director and the MRI Technologist on emergency response procedures.

## **2.5 Associate Vice President for Research Development, Integrity and Assurance**

The Associate Vice President for RDIA oversees compliance with all regulations regarding the use of research subjects or participants through administration of George Mason University’s Institutional Review Board (IRB). Specific responsibilities with regard to the MRI Suite are to serve as a member of the MRI Policies and Procedures Committee.

## **2.6 Director of Risk Management**

The Office of Risk Management administers the Commonwealth’s Risk Management Plan and supports George Mason University departments by assessing potential risks, recommending action to manage hazards, or suggesting controls to minimize certain risks. Specific responsibilities of the Office of Risk Management are to serve as a member of the MRI Policies and Procedures Committee.

## **2.7 MRI Safety Policies and Procedures Committee**

The MRI Safety Policies and Procedures Committee will be comprised of six standing members and a up to four at-large members. At-large members will be nominated by standing members of the Committee, and will be selected based on individual expertise and experience relevant to the safe operation of a research MRI facility.

Standing members of the Committee will be:

- MRI Scientific Director
- Associate Vice President, RDIA
- Associate Director, IBI
- Director, EH&LS
- Director, Risk Management
- MRI Technologist (non-voting)

Specific responsibilities of the committee are to:

- Review and approve policies and procedures regarding safe operation of the MRI Suite as necessary.
- Conduct periodic review of the MRI Safety Policies and Procedures Manual.
- Participate in incident investigations for incidents taking place at the MRI Suite.
- Consult on device and implant review, upon request.

## 2.8 MRI Technologist

The MRI Technologist is an American Registry of Radiologic Technologists (ARRT) registered professional with the knowledge and experience to manage day-to-day operation of the 3T MRI Core Facility. The MRI Technologist's primary function is to support the research activities conducted within the MRI Suite by Principal Investigators (PI), overseeing the safe operation of the MRI Scanner in compliance with all relevant regulations, policies and procedures.

The MRI Technologist has the authority to immediately cease or suspend unsafe activities, or activities that are out of compliance with George Mason University policies and procedures and applicable regulations. Any such activities shall be reported and reviewed by the MRI Scientific Director, the Director of Environmental Health and Laboratory Safety, and the Associate Director, IBI. Specific responsibilities include:

- Maintain safe operations within the MRI while on shift at the university.
- Maintain appropriate certifications to include ARRT certification and Basic Life Support (BLS).
- Maintain current knowledge of functional MRI protocols utilized in the MRI Suite and be able to assist investigators in setting up new protocols.
- Monitor and implement policies and procedures for safety and operations of the MRI Suite.
- Conduct MRI safety and operational training for George Mason University personnel in cooperation with EHS and the MRI Policies and Procedures Committee.
- Conduct routine instrument testing and calibration, in consultation with the equipment manufacturer..
- Report any identified incidental findings to the PI, and assist the PI with radiologist consultation as requested.
- Maintain documentation and records for safety and compliance, operator training and service and maintenance, participant screening, quality assurance data, as required.
- Cease or suspend unsafe activities and instances of noncompliance until the issues can be resolved and corrective actions taken.
- Report unsafe activities and issues of noncompliance to the Director of Environmental Health and Laboratory Safety and the MRI Scientific Director.
- Conduct safety screening of all users of the MRI Suite as a component of MRI safety training, and approve or deny access to the suite based on training proficiency and screening results.
- Maintain a participant database.
- Manage supply inventory and procurement.
- Enforce access restrictions to the MRI Suite.
- Respond to after-hours emergencies as needed.
- Perform or coordinate routine cleaning and maintenance of the MRI facility (includes cleaning floors and surfaces, replacing light bulbs in the ceiling of the MRI scanner room, leaving the trash can outside of the facility in the main hallway to be emptied by housekeeping staff, etc.)

- Operate the MRI scanner to include routine and experimental setup, modification of scanning parameters to optimize data, daily quality assurance testing, and basic troubleshooting of scanner malfunction.
- Greet and interview research participants, document screening interviews, prepare subjects for scanning, converse with subjects during scanning, remove subjects from the scanner after scanning, and conduct follow-up interviews with subjects after scanning.
- Support users of the MRI scanner with paradigm implementation and other needed assistance.
- Organize, archive, and facilitate the transfer of acquired imaging data.
- Monitor and maintain temperature requirements for the scanner (water and helium levels).

## **2.9 Principal Investigators (PI)**

PIs, as defined in University Policy 4012, are responsible for overseeing the activities of all Research Assistants assigned to execute their MRI experiments. It is the responsibility of the PI to follow MRI policies and procedures and to ensure that all required training is completed. Specific responsibilities of PI are to:

- Require that all projects for which they are responsible comply with relevant regulations, policies, and procedures for use of the MRI and for human subject research.
- Obtain the appropriate approval from the IRB for conducting research in the MRI scanner.
- Require that all MRI operators involved in their research maintain training requirements, and follow all relevant MRI policies and procedures and IRB requirements.
- Communicate instances of accidents and unsafe work conditions to the MRI Scientific Director and the IRB.
- Notify research subjects of incidental findings and report findings to the IRB in accordance with George Mason University procedures.
- Implement and ensure compliance with the George Mason University Data Stewardship Policy #1114 regarding the transfer, use, and archiving of sensitive data.
- Inform personnel of potential hazards associated with MRI research and provide access to the MRI Policies and Procedures Manual.
- Follow additional MRI Operator responsibilities as outlined below.

## **2.10 MRI Operators**

It is the responsibility of all MRI Operators to conduct MRI research in a manner that will not adversely impact themselves, other personnel, the surrounding community, or the environment. Specific responsibilities of MRI Operators are to:

- Be familiar with the contents of this manual.
- Maintain appropriate training status and certifications.
- Limit operations within the MRI Suite only to those protocols or operations for which they have been approved.
- Report incidents, accidents, and near-miss events occurring within the MRI Suite to their PI, the MRI Technologist, and EHS.



- Follow all policies and procedures for MRI safety and operations and human subject research.
- Understand and follow suite-specific emergency procedures, contact information, and evacuation procedures.
- Understand and follow suite-specific procedures for managing participants, operating the scanner, recordkeeping, data management, housekeeping, and maintenance reporting.
- Understand the location, use, storage, and maintenance of personal protective equipment and operational supplies.

### 3.0 Security and Access

Unauthorized access to the MRI Suite and scanner magnet can result in injury to those who may have conditions that are unsafe for the MR environment, damage to personal items that can be affected by the magnetic field, and damage to the scanner resulting from a ferromagnetic object being pulled into the bore of the magnet. For this reason, the MRI Scanner, Equipment Room and Console Room are *Restricted Rooms*.

**Access to the MRI Suite is controlled by electronic swipe card access. Anyone requesting access to the MRI Suite must receive approval from the Associate Director, the MRI Scientific Director, and the Director of EH&LS.**

Access to the scanner room is controlled by manual key access. The door locks to the MRI Suite (screening room, console room, equipment room, and scanner room) are not included the grand master or facilities master keys for the university. Unsupervised access is restricted to those individuals certified to operate the scanner; those who may need to enter the console, equipment, or scanner rooms in the event of an incident or emergency; and authorized individuals who may need to provide access to service personnel or conduct VIP tours of the facility. No one is permitted supervised or unsupervised access without appropriate notification of the potential risks associated with the magnet. Keys and access cards to the MRI Suite must be kept in a secure location and may not be shared or loaned to other personnel.

For research study, there must be a minimum of two qualified individuals present in the control room at all times during an MRI scan procedure. At least one of the individuals must be an MRI Technologist or approved Operator for the research scan being conducted. The second individual must be qualified and physically able to respond as necessary during an MRI emergency situation, and must have completed Level 1 MRI Safety Training and have current certification in cardiopulmonary resuscitation (CPR.)

Personnel who enter the MRI Suite must be involved in an approved MRI research study or be involved in authorized administrative or maintenance activities.

### 3.1 Visitors and Tour Groups

Visitors who wish to tour the MRI Suite must be escorted at all times by appropriately trained personnel. Prior to entry into the console room, visitors must be briefed regarding hazards associated with the MRI and must sign a *MRI Visitor Safety Screening Form*. Visitors may not enter the MRI scanner room. At no time should a visitor be left unattended while in the MRI Suite.

To protect the privacy of research participants and to limit the potential distractions for operators, tours should be conducted when the scanner is not in use. If a tour is conducted during a participant scan, the participant or his or her guardian must give verbal authorization before visitors are allowed into the Console Room.

### **3.2 Research Participants**

Research participants must be escorted in the MRI Suite at all times by qualified personnel.

### **3.3 Ancillary Personnel**

Housekeeping staff are not permitted to enter Zone 2 without an escort, and may not enter Zones 3 or 4. Trash and recycling containers should be placed in the hallway for pickup by evening housekeeping staff.

Service contractors and Facilities Management employees must be escorted at all times while working in Zones 3 or 4, and must have completed Level 1 MRI Safety training and been properly screened before entering those spaces.

### **3.4 Level 1 MRI Personnel**

PIs, postdoctoral fellows, undergraduate students and graduate students, and non-research employees who have completed Level 1 MRI Safety and have been properly screened are authorized to access Zones 2 and 3 in the MRI Suite, and are authorized to enter Zone 4 when escorted or in an emergency. Level 1 MRI Personnel may not operate the scanner, but may provide assistance in the event of an emergency.

### **3.5 Level 2 MRI Personnel**

PIs, postdoctoral fellows, undergraduate students and graduate students, and non-research employees who have completed Level 2 MRI Safety training and have been properly screened are authorized to access Zones 2, 3 and 4 in the MRI Suite. Personnel at this level may observe and assist a MRI Technologist or MRI Operator within Zone 4 during a scan, and may serve as a primary backup if they have current CPR certification. Personnel at this level are permitted access to the MRI Suite to conduct scans of inanimate objects or phantoms, with approval from the MRI Technologist.

### **3.6 Pregnant Staff, Researchers, and Participants**

Women who are pregnant will not be scanned as part of research protocols, and no pregnant woman (i.e., staff, technologist, family member, or participant) will be allowed to remain in the scanner room or magnet bore while the scanner is in operation. Female researchers or technologists who are pregnant may enter the scanner room to attend to participants while they are pregnant, regardless of their trimester.

### **3.7 Minors and Volunteer Adult Research Assistants**

Other than study participants, no individuals under the age of 18 are permitted in the MRI Scanner room. Non-participant minors who have completed Level 1 MRI Safety Training may observe and assist with research activities in Zones 2 and 3.

Adult research assistants who are not affiliated with George Mason are not permitted in the MRI Scanner room. Adult volunteers who have completed Level 1 MRI Safety Training may observe and assist with research activities in Zones 2 and 3.

## **4.0 Training**

### **4.1 MRI Awareness Training**

This training provides an overview of the 3T MRI Core Facility, a brief description of MRI hazards and emergency situations, and appropriate notifications and procedures for access authorizations or emergency response. This training is mandatory for University Police and Facilities Management personnel, and for any other ancillary personnel who may enter level and may be offered to other groups upon request. Personnel who complete this course may enter MRI Zone 2. EHS is responsible for developing and delivering this training, which may be incorporated into other training courses

### **4.2 MRI Level 1 Safety Training**

This training is required for all personnel who will work in MRI zones 3 or 4. The course may be offered on a scheduled or ad-hoc basis, and provides an understanding of MRI hazards and safety zones, safety policies and procedures for working in the MRI Suite, general operating procedures for the MRI, and response procedures for emergencies within the MRI Suite. Individuals who complete this course are categorized as Level 1 MRI Personnel, and may serve as a backup emergency responder during MRI scans, but may not operate the MRI or conduct non-emergency support activities in Zone 4.

The MRI Technologist is responsible for delivering this training course. MRI Level 1 Safety Training is a pre-requisite to attend MRI Level 2 Safety Training.

### **4.3 MRI Level 2 Safety Training**

This is advanced training required for personnel who are planning to train as an MRI Operator, or are planning to routinely conduct non-emergency support activities in Zone 4. The course will be scheduled on an ad-hoc basis, and provides an increased level of safety and operational training, including participant screening, MRI operating procedures and instruction, medical device and implant safety, and other safety issues related to the potential for thermal loading or burns and direct neuromuscular excitation from rapidly changing gradients. Individuals who complete this course are categorized as Level 2 MRI Personnel,

The MRI Technologist is responsible for delivering this training course. MRI Level 2 Safety Training is a pre-requisite for beginning MRI Operator Hands-On Training.

### **4.4 CPR Training and Certification**

The MRI Technologist, MRI Operators, and individuals trained in MRI Safety at Level 1 or 2 who will serve as secondary operator for scans of research participants, or personnel who trained at MRI Level 2 Safety with unescorted access to level 3 or 4 zones within the MRI Suite, must have current CPR certification through either the Red Cross or the American Heart Association. This training is periodically offered by the Environmental Health and Safety Office, or the trainee may obtain training from a certified outside instructor. A copy of CPR certification must be provided to EHS Office.

#### **4.5 MRI Operator Training**

Level 2 MR personnel who are interested in becoming an MRI Operator for specific research protocols must first receive operator training on the Siemens MAGNETOM Prisma 3T MRI. Operator training will be conducted by the MRI Technologist, and will include hands-on training of scanner operation procedures, review of specific procedures for incident and emergency response, identification and evaluation of incidental findings, and techniques for managing participants before, during, and after scanning.

Upon completion of Hands-on Operator training, a trainee is eligible for supervised scan time under the direct supervision of either the MRI Technologist or an approved MRI Operator scan. During this time, the trainee receives additional hands-on training from the supervisor until they are able to confidently operate the scanner for the specific protocol or protocols for which they are seeking Operator approval. Trainees who require additional hours of scan time prior to taking the proficiency practicum are encouraged to continue to scan with supervision until they are proficient and the supervisor is confident in their abilities to operate the scanner independently. However, trainees may not take the proficiency practicum before they have completed a minimum number of ten (10) supervised scanning hours.

#### **4.6 MRI Operator Proficiency Practicum**

Trainees who have completed supervised scan time or provided acceptable documentation of approved scan time at a previous institution are eligible to take the proficiency practicum for the level of access they wish to attain. The practicum is administered by an MRI Technologist and tests the trainee's competency, ability to operate the scanner independently, and ability to respond appropriately to emergencies.

If a trainee fails the proficiency practicum, they may require additional supervised scan time before retaking the practicum. It should be noted that some individuals may not have the appropriate skills or ability to operate the scanner independently. While every effort will be made to provide adequate training for all trainees, operator status will not be given to individuals who do not demonstrate competency and proficiency in scanner operations and safety.

Trainees who feel they were unjustly denied Operator status may appeal the decision to the MRI Safety Policies and Procedures Committee. Appeals will be assessed on a case-by-case basis.

## **5.0 Project Review and Approval**

All research involving research participants must be approved by the Institutional Review Board (IRB) prior to commencement of work. All research involving research participants proposed by non-George Mason University investigators must be approved by their own organization's IRB, and a copy of that approval and protocol must be provided to the MRI Scientific Director and the George Mason University IRB prior to commencement of work.

### **5.1 IRB Approval**

The IRB reviews all research projects involving research participants prior to initiation of the project. *The Human Subjects Application Form* and instructions are available through the online protocol management system. Details are available on the [RDIA website](#). PIs must make sure that the IRB protocols list all personnel who will be conducting MRI research and that each person who will conduct research has successfully completed IRB-required *CITI Training*.

### **5.2 Validity Testing**

Validity testing is defined as testing a task and/or sequence in the scanner to determine whether the proposed work is feasible before developing a pilot study or finalizing a proposed study for IRB approval. The nature of validity testing may require a researcher to be scanned. Because the scan itself will not be used as scientific data, and because participants will not be scanned, IRB approval is not required. All individuals who are scanned as part of validity testing must sign a *MRI Nonparticipant Consent Form* prior to the scan. The signed consent form will be kept on file by the PI and a copy will be given to the individual.

## **6.0 Participant Safety Screening**

Research participants are screened a minimum of two times. Safety screening may be performed in person or over the phone. Safety screens must be completed every time a research participant prepares to undergo an MRI scan.

The preliminary screening is conducted prior to scheduling the participant for a scan. The individual conducting the screening must be on a current IRB protocol and have completed IRB-approved research ethics training and attended the MRI Screening seminar.

If the research participant has any conditions listed in Section 6.3, *Mandatory Exclusionary Criteria*, they are automatically excluded from participating in an MRI study at George Mason University. The PI may also decide to exclude a participant who experiences claustrophobia or has a condition that makes it difficult for the participant to lie still for the duration of the scan.

If the research participant has had any type of surgery, or has any of the implants or devices listed in Section 6.4, *Criteria that May Exclude Research Participants*, the MRI Technologist must make a recommendation, in consultation with the MRI Scientific Director or other members of the MRI P&P Committee, as appropriate, to approve or exclude the research participant. All implants and devices, whether MR safe or not, must be documented on the screening form, and the following information must be collected for each device or implant:

- Type.
- Manufacturer.
- Make or model.
- Serial number.

For surgical implants, this information may be provided in a Material Identification Card. If the research participant is willing to provide a surgical report, this information may also be collected. Information must be sufficient to verify the compatibility of the implant with the MR environment. The PI is responsible for forwarding the necessary information for review.

The second screening is conducted by the MRI Technologist or qualified MRI operator within 48 hours of the participant's scheduled scan time. The MRI Technologist or qualified MRI operator may cancel or postpone a scan if the research participant's second screening raises suspicion about the suitability of the participant for the MRI environment. A file of the second screening of each participant will be maintained.

### **6.1 Screening a Minor as a Participant**

Anyone under the age of 18 who requires a screening must have a parent or legal guardian present at time of screening and signature required on the screening form.



## **6.2 Pregnancy and Female Participants**

Even though there are no known effects of MRI on the unborn fetus, there is no data on the effects on fetal development. Therefore, participants who think that they might be pregnant cannot be scanned.

## **6.3 Mandatory Exclusionary Criteria**

Participants with any of the following implants or conditions are excluded from participating in MRI studies:

- Metal in the eyes or an injury to the eyes involving a metal object or fragment (such as metallic slivers, shavings or a foreign body).
- A pacemaker or implanted cardioverter defibrillator.
- Eye implants (prosthesis, retinal tack, eyelid wire or spring).
- Electronic implant or device.
- Magnetically-activated implant or device.
- Internal electrodes or wires.
- Tissue expander (e.g., to expand tissue prior to a breast implant. Breast implants themselves are not exclusionary.)
- Shunts (spinal or intraventricular).
- Vascular access port and or catheter.
- Neurostimulator system, spinal cord stimulator, bone growth/bone fusion stimulator.
- Aneurysm clips.
- Any type of nonremovable pump (pain, drug infusion, insulin, etc.).
- Tattoos above the neck to include permanent cosmetics (e.g., eye or lip liner, etc.).
- Ear surgeries, implants (cochlear and otologic), stapes, prosthetic ear bone.
- For females, IUD.
- For males, penile implant.
- Any implant labeled MR unsafe.
- Any implant labeled MR conditional that is not deemed safe at 3T.
- Any implant for which clear and unambiguous documentation cannot be provided to verify the implant is MR safe at 3T.

## **6.4 Criteria that May Exclude Research Participants**

Clearance by the MRI Technologist is required for research participants with any of the following conditions:

- History of surgical procedures that may or may not contain implants.
- Injury involving a metallic object or metallic foreign body, such as a BB, bullet, shrapnel, or shard of metal.
- Joint replacement (hip, knee, etc.).
- Bone/joint pin, screw, nail, wire, plate, etc.
- Surgical staples, clips, or metallic sutures.
- Artificial limb.

- Wire mesh implant.
- Heart valve prosthesis.
- Insulin pump.
- Metallic stents, filters, or coils.
- Other implants not listed above.
- A history of claustrophobia.
- Medication patches (nicotine, nitroglycerine, contraceptive, pain).
- Women who are pregnant will not be scanned as part of research protocols unless a specific protocol involving the scanning of pregnant women is approved by the IRB.

## **6.5 Clearance Procedure for Devices and Implants**

Research participants with implants or devices will not be permitted to participate in an MRI study at Peterson Hall unless clear and unambiguous documentation verifies that the implant is MR safe at 3T. The PI is responsible for forwarding the preliminary screening form and required documentation to the MRI Technologist. The MRI Technologist, in consultation with the MRI Scientific Director and other members of the MRI P&P Committee, as appropriate, will recommend whether to approve or exclude a research participant. If the MRI Technologist recommends that the device or implant is MR safe, the PI may continue to include the participant in the study. For a device to be recommended as safe for a scan, the following criteria must be met:

- Clear and unambiguous documentation exists verifying that the device or implant is MR safe at 3T.
- The implant is rated as MR safe at 3T according to the Reference Manual for Magnetic Resonance Safety, Implants and Devices, by Frank G. Shellock, PhD, or [www.mrisafety.com](http://www.mrisafety.com).
- A medical professional certifies that the implant is safe.

## **6.6 Removable Items**

The following items must be removed before entering into the MRI Suite. Any or all of the following items may result in either injury or damage to the item or the scanner.

- Insulin pumps. (An exception can be made when the pump is known to be MR compatible. In this case, the outer battery pack must be removed before entering the scanning room.)
- Prosthesis.
- Medication/birth control/pain patches. These patches may have a foil backing and can cause a burn on a participant's skin if placed in the scanner. The subject will need to contact his/her physician before agreeing to a scanning time to see if the patch can be removed for the duration of the scanning period. The decision to remove these patches is not to be made by the researcher/operator or MRI Technologist.
- Diaphragm and pessary (females).

- Body piercing jewelry/rings/necklaces. Any jewelry made of nonferrous or ferrous metal that is in the form of a loop can cause a burn due to the possibility that it may induce a current.
- Hearing aids. These contain a battery and may damage the hearing aid beyond repair.
- Colored contact lenses. Colored contacts worn in place of glasses may contain metallic dyes depending on the color of the lenses. There may be a slight risk that this could cause heating and irritation of the eyes while scanning. For this reason colored contacts must be removed prior to scanning. Clear contacts are acceptable and pose no risk.
- Eyeglasses. Eyeglasses must be removed prior to entering the scanner room. Metal components are almost always contained in the hinges of glasses and would cause an artifact even if the components were not made of ferrous material. Injury to the participant could occur and the glasses could be destroyed if they became attracted to inside of the bore of the magnet.
- Dentures, partial plates, and nonpermanent retainers. All dental work that is removable should be removed. All of the above items listed are to be removed even if no metal is visibly seen to ensure no artifact would be present on the images.
- Clothing made with metallic components. Participants may arrive with clothing made with metallic threads and/or metallic decorative artwork. This type of fabric may have a tendency to heat, smoke or potentially cause a burn to the participant if exposed to the skin. Such articles of clothing need to be removed before a participant is placed into the magnet. If the article of clothing is the participant's primary shirt or sweater, MRI provides laundered sweatshirts for the participant located in the screening room to wear for the duration of the scan.

## **7.0 Scheduling**

Scheduling for the MRI scanner is coordinated by the MRI Technologist using an online calendar request system. Scanning time may also be requested by sending an email to the MRI Technologist. Additional time may be added to each scanning time slot to allow for delays in participant's arrival, computer task setup, and room turnaround. A confirmation email will be sent to the PI or MRI User specifying the date and time of allotted scan time. Reminder emails will not be sent. Evening and weekend hours are available upon request.

The MRI Technologist should be notified as far in advance as possible of cancellations or the need to reschedule so that the calendar can be updated to reflect available scan times.

If a PI or MRI Operator wishes to secure an entire day on a consistent basis (e.g., one day specified each week), the PI or MRI Operator must confirm and/or verify need at least 48 hours in advance of the scheduled date and time; otherwise the reservation will be cancelled and the date will be made available for general use. Names of participants shall not be listed on the schedule, only the PI's last name and the name of the study.

## 8.0 Rules of the 3T MRI Core Facility

The 3T MRI Core Facility is a shared resource. Any action that inhibits or has the potential to inhibit the ability to utilize these resources will be considered a policy violation. Operators are expected to use good judgment in their use of the MRI Suite, and to follow the policies and procedures put forth in this manual and in the standard operating procedures (SOP) for the MRI Suite.

The following rules must be followed by all operators in the MRI Suite:

- Doors to the MRI Suite (console, scanner, and equipment rooms) must be kept closed and locked at all times.
- No eating, drinking, use of tobacco products, or storage of food and beverages is permitted in the Zones 3 or 4.
- Access to the MRI Suite is restricted to authorized individuals.
- Before entering the scanner room, personnel must remove the following items: hearing aids, keys, beeper, cell phone, hairclips, barrettes, pins, jewelry, watch, wallets, credit cards, bank cards, pens, pocket knife, nail clips, or any other objects that contain ferromagnetic material or that may be damaged by the magnetic field.
- Any equipment to be used in the scanner room must be approved by the MRI Technologist. All equipment must be tested for ferromagnetic properties with a handheld magnet before being brought into the scanner room.
- For scans involving research participants, at least one appropriately trained MRI operator and a qualified second attendee must be present to operate the MR scanner.
- The MRI Technologist has the authority to stop MRI procedures deemed unsafe. For scans involving human research participants:
  - Ensure participants sign a consent form before entering the scanner, and remove all items as listed in Section 5.8 and items that are not MR-compatible (keys, cards with magnetic strips, etc). The screening room should be used to secure participants' personal belongings and other removable items.
  - Instruct participants do not cross their arms or legs or in any way form a closed loop with their extremities. This will reduce or avoid peripheral nerve stimulation.
  - Instruct participants on how and when to use the emergency squeeze ball.
  - Instruct participants to inform the operator if they experience any of the following symptoms: excessive perspiration, rapid heart rate, difficulty breathing, tightness of chest, pain or discomfort to including warming of the skin, muscle tingling, etc.
  - Hearing protection must be worn by research participants and any other individuals who will remain in the scanner room during the scan. The MRI Technologist or Operator shall provide instructions on the proper use of hearing protection.
  - Maintain verbal contact with the research participant during the scan. Immediately investigate any research participant who does not respond verbally to contact.
  - Stop the scan if an individual becomes ill or injured. Remove the participant from the magnetic environment immediately and follow incident response procedures. All such incidents must be reported to the IRB within 5 business days.

- Properly clean all surfaces that have come into contact with a research participant before the next MRI scan is conducted.
- Report all incidents and near-misses, including equipment malfunctions, projectile accidents, security or safety breaches, or injury to personnel or research participants, to the MRI Technologist and EHS.

## **9.0 Housekeeping and Maintenance**

The MRI Technologist oversees scheduling of service and maintenance of the MRI Suite. Preventive maintenance on the scanner is conducted quarterly. Cryogenic liquid used to cool the magnet is replenished quarterly, or as otherwise needed. The chiller and HVAC system are serviced quarterly.

Housekeeping duties for the MRI Suite (cleaning, sweeping and mopping floors) is the responsibility of the MRI Technician. Floors should be swept and mopped weekly, or more frequently as needed. In addition, the scanner table must be cleaned and disinfected after every use. Blankets for research participants' comfort should be laundered as necessary to ensure proper hygiene.

## 10.0 Considerations for Research Participants

Research participants traveling to Peterson Hall should be provided directions to the campus and basic information regarding the following to facilitate their visit to George Mason University. A map and directions are available at <http://www.gmu.edu/resources/welcome/Directions-to-GMU.html>.

- **Parking:** Visitor parking is available in the campus parking decks, including nearby Rappahannock River Parking Deck. Additionally, PI may purchase and provide parking passes for research participants at his or her discretion.
- **Upon Arrival:** Participants should be instructed to wait in the lobby of Peterson Hall until they can be escorted to the MRI Suite. An investigator should meet the participant in the lobby to escort them through the building.
- **Arrival Time:** Research participants should be instructed to arrive with sufficient time to complete safety screening and to prepare for the scan. The amount of time required may depend upon the conditions of each particular study. If the participant is running late, consideration must be made for any studies scheduled after that participant. In some cases, the participant may need to be rescheduled.
- **Confidentiality:** Procedures regarding privacy for research participants must be clearly outlined by the researchers in the IRB application. It is the responsibility of each PI to ensure these procedures are followed. The names of research participants are not listed in imaging data acquired by the scanner.

Each investigator is encouraged to examine data collections to ensure that the contents of the collection do not violate explicit or implicit pledges of confidentiality given to research participants. Data items that could be used as identifiers should be removed, masked, or collapsed (according to the Health Insurance Portability and Accountability Act of 1996) unless the investigator has a limited data set agreement in place which provides for sharing of protected information. Investigators choosing to share limited data are encouraged to do so under a *Data Use Agreement*.



## **11.0 Incidental Findings**

All participant consent forms must clearly state the purposes of the MRI scanning that will be conducted, and that (1) the researchers are not medical personnel; (2) that the MRI scans are intended for research purposes only; (3) that the images produced by the MRI are not of sufficient quality for medical diagnosis; (4) the participant should not expect any clinical evaluation or review of MRI scans by medical personnel; and (5) if the researcher notices anything abnormal in a participant's scans, he or she will inform the participant of the incidental finding.

The Principal Investigator (PI) of each study has primary responsibility for the identification and communication of incidental findings. If the PI (in consultation with the MRI Technician) observes something in any scan that might be an indication of a significant abnormality, he or she should forward the scan(s) to a consulting radiologist for confirmation. If the radiologist agrees that the finding is potentially significant, the PI shall inform the participant that a potentially significant finding was observed during the scan, and the participant should follow-up with a health professional. Notification to the participant of an incidental finding shall be the responsibility of the PI. No diagnosis should be provided as part of the participant notice, and no copies of existing research scans are to be provided to the participant.

## 12.0 Recordkeeping

Records regarding MRI safety and compliance, scan QA, equipment maintenance and repair, operational hours, billing, are maintained by the MRI Technologist. A list of records is outlined below.

- Training Records: EHS maintains safety and compliance training records for all personnel. The MRI Scientific Director manages and maintains documentation of proficiency testing and copies of CPR certification for MRI Operators.
- Screening Forms: Preliminary safety screening forms for research participants are kept on file by the PI overseeing the study. The second safety screening form for each participant is kept on file by the MRI Scientific Director. The safety screening forms for MRI Operators, other George Mason University personnel, and visitors who enter the scanner room with research participants are also maintained by the MRI Director.
- Visitor Forms: Visitor Forms for tours of the MRI Suite are kept on file in the MRI Console Room and maintained by the MRI Technologist.
- Consent Forms: Signed consent forms for each research participant involved in a study are maintained by the PI in accordance with IRB requirements.
- Incidental Findings: Records of incidental findings and notifications shall be kept by the PI with the study files. These forms do not contain identifying information and will follow the naming convention for scanner files. These forms should be maintained in compliance with HIPAA requirements.
- Data: The naming convention for all imaging studies will not contain any identifying information and will be listed as follows: PI Name-Name of Study-Participant#.
- Per the rules and regulations of the George Mason University IRB, it is the jurisdiction and responsibility of the PI to keep their research participant's information protected and confidential. PIs will retain copies of their own participant's signed informed consents and assents, MRI prescreening, and any other documentation related to participation in their study. Once imaging data has been shared with the PI, it becomes their jurisdiction and responsibility to maintain and use the data in a confidential and appropriate manner
- Performance and Maintenance Logs: The following logs are kept by the MRI Technologist:
  - Quality assurance data.
  - Weekly temperature and humidity readings for the scanner and equipment rooms.
  - Weekly cryogen readings.
  - Scanner and equipment room filter change dates.
  - Scanner communication log with Siemens for maintenance and scanner errors.
  - IP addresses, port numbers, application entry titles.
  - Participant archive log of all participants scanned.
- Usage Logs: Accurate records regarding use of the scanner are required for proper billing and reporting to federal funding agencies. When using the scanner, MRI Operators must record the following information:
  - Date.
  - IRB number (when appropriate) and study name or description.
  - PI overseeing the project or study.

- Type of project or study (pilot study, research participant, phantom scanning, validation testing, etc.).
- Participant number (when appropriate).
- Funding or Org number.
- Start and end time of scanner use.

## **13.0 Emergency Procedures**

Emergencies, by their nature, are unpredictable and unexpected events that pose a potential threat to health and safety of personnel, property, and the environment. Each emergency event will be unique and will require assessment to determine the appropriate response. The MRI Suite poses a hazard for emergency response personnel in that they cannot safely enter the suite with typical emergency response equipment. Therefore, emergency response procedures for the MRI Suite must include MR safe equipment whenever possible, and procedures for removal of injured or ill individuals from the suite by the MRI Operators. University Police receive training regarding hazards associated with the MRI Suite and are aware not to enter the suite while the magnet is operational.

This section provides general emergency procedures for the MRI Suite. Additional emergency response information for the Prisma 3T magnet is available in the MRI Console Room.

### **13.1 Emergency Preparation**

All MRI personnel must know the appropriate procedures for emergencies involving research participants, the appropriate steps for safely shutting down the magnet, the location and use of any emergency equipment, emergency contact information, and any necessary follow-up procedures.

The required elements of emergency preparedness for the MRI Suite are:

- Emergency Response Procedures are posted in the MRI Console Room, along with a list of emergency contacts.
- MRI Operators and researchers are trained on Emergency Response Procedures and participate in routine drills and exercises in the MRI Suite.
- A first aid kit is stocked and available in Peterson Hall.
- A MR safe fire extinguisher is located in the console room.
- A MR safe stretcher is kept in the scanner room.
- Two individuals with Level 2 MRI Safety Training and current CPR certification must be present for use of the scanner.
- MRI Operators must be trained in the use of Fire Extinguishers
- A spill supply kit is located in the console room.

### **13.2 Emergency Notification**

When an emergency situation arises, contact University Police by dialing 911 from any George Mason University phone, or by dialing (703) 993-2810. Provide the following information to emergency responders:

- Name and telephone number of the caller.
- Nature of the emergency (e.g., medical emergency, technical problem, fire, etc.)
- Specify that this is Peterson Hall MRI Suite with magnetic hazards.

- Special considerations (e.g., hazardous gases present, people trapped, number of people injured and type of injuries, electrical hazards, property damage and access routes to the emergency).

### **13.3 Termination of Scanning and Participant Evacuation**

MRI Operators must be prepared at all times to handle an emergency involving a research participant, and must be able to identify signs that the participant is experiencing discomfort or distress.

MRI Operators should provide the emergency squeeze ball to participants and make sure the participant is comfortable with its use. Operators must also remain in verbal contact with the participant throughout the scan.

#### **13.3.1 Reasons for Terminating a Scan**

The MRI Operator should terminate the scan when any of the following occur:

- The research participant experiences any symptoms of claustrophobia, such as increased perspiration, increased heart rate, difficulty breathing, or tightness of the chest. Most participants experiencing these symptoms will ask to be removed from the scanner. However, they may not associate the symptoms with claustrophobia.
- The participant experiences pain or discomfort, to include warming of the skin, muscle tingling, etc.
- The participant feels ill or experiences dizziness or nausea.
- The participant experiences a medical emergency or becomes unresponsive.
- Technical issues such as the following occur:
  - Power outage.
  - Fire alarm.
  - Scanner console freezes (and problem is not resolved by rebooting the scanner).
  - Head coil malfunctions.
  - Gradient errors occur.
  - Cold head is not working.
  - Chiller malfunctions.

A research participant must never be asked to remain in the magnet when experiencing discomfort or distress and should never be kept in the scanner while technical concerns are evaluated.

#### **13.3.2 Emergency Evacuation Procedure for a Responsive Participant**

If the research participant is conscious and is able to communicate, follow these steps:

- Press the STOP SCAN button.
- Move the table out of the magnet using the toggle switch.
- Lower the table down to the floor as low as possible.
- Have the participant sit up, but do not have them get up off the table right away.

- Assess the research participant.
- If the participant is experiencing a medical emergency, call 911 and follow emergency notification procedures in Section 13.2.
- If the symptoms subside and the participant feels better, the participant may be escorted from the facility, and a recommendation made to the participant for follow-up with a medical professional if the symptoms recur.

### **13.3.3 Emergency Evacuation for a Nonresponsive Participant**

If the participant becomes unresponsive at any time during the procedure, scanning should be stopped immediately.

- Press the STOP SCAN button.
- Bring the table all the way out of the bore (do not lower the table).
- Slide the participant's head out of the coil and onto the table pad.
- Move the stretcher from against the wall next to the table.
- Roll the participant with the table pad to face the counter and cabinetry in the room and slide the white transfer board halfway under the subject and table pad.
- As one unit, slide the participant and table pad across the white board onto the stretcher. (The board is to be used as a bridge.)
- Wheel the stretcher, with the participant on it, out of the scanner room into the control room.
- Close the scanner door.
- Open the hallway door and wheel the participant out into the main corridor.
- Call 911 from a university phone and give the operator the location (Krasnow Building, lower level corridor outside Room 102) and instruct the other researcher to obtain the AED unit from the first floor.

## **13.4 Quench**

The MRI scanner is super-cooled with liquid helium. Quench is the rapid boiling off of this liquid either intentionally or unintentionally.

An intentional quench is performed in an extreme emergency to rapidly run the magnetic field to zero. A quench of the magnet should only be performed when:

- A person is pinned to the magnet and is unable to be removed from the scanner without harm.
- There is a fire in the MRI scanner, equipment, or console room.
- There is a fire in another area of the Peterson Building and fire, smoke, or water damage is a threat to the MRI Suite.

The MRI Suite is designed to exhaust gaseous helium directly outside the building. However, due to potential for displacement of oxygen and the creation of a hypoxic environment, the MRI Suite should be evacuated anytime a quench is performed.

## 13.5 Fire

If an electrical fire were to occur in any of the three MRI rooms console, magnet, or equipment room, two nonferrous water mist fire extinguishers are located within the MRI Suite to contain the fire. Personnel are not required to fight fires and should evacuate the building immediately in the event of a fire. University Police has the primary responsibility for managing emergencies and must be notified immediately of such situations by calling 911 from any campus phone or (703) 993-2810. Employees may use fire extinguishers to fight small, incipient fires (no larger than a waste basket) only if they have been trained in the proper use of a fire extinguisher and are confident in their ability to cope with the hazards of a fire. In such cases, firefighting efforts must be terminated when it becomes obvious that there is danger from smoke, heat, or flames. If a fire occurs in the MRI Suite or the building fire alarm sounds:

- Stop the scan and remove the research participant as described in Section 13.3.2.
- If the fire is within the MRI Suite, quench the magnet so that emergency responders can safely respond to the fire.
- Have all individuals in the MRI Suite evacuate the building in a calm manner and according to the building evacuation plan. Never use elevators.
- Congregate at the predesignated assembly area for the building.
- Notify emergency response personnel if you have specific information about the fire and whether or not the magnet was quenched





**Appendix B**  
**Participant Screening Form**

**Appendix C**  
**Radiologist Consultation Form**

**Appendix D**  
**Phantom Practicum**

**Appendix E**  
**Human Practicum**

**Appendix F**  
**Level 1 and Level 2 MRI Safety Training Objectives**