MAGNETIC FIELD SAFETY MANUAL

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Table of Contents

Scope and Purpose 3
Abbreviations 5
Glossary of Terms / Definitions 6
Concordia University Administrative Structure 9
1. University Radiation Safety Committee (URSC) and MF Safety Responsibilities 10
2. The Chair of the URSC 12
3. The Radiation Safety Officer (RSO) 13
4. Internal Authorization Conditions 16
5. Responsible Users 17
6. Facilities Designated as MR Environments 19
7. Exposure Limits 20
8. Handling Cryogens for Superconducting Magnets 21
9. Emergency Procedures 22
10. Research Involving Laboratory Animals 25
11. Research Involving Research Participants 26
12. Facilities Management and External Services 30
Appendix I – Health Effects and Risk Considerations Associated With Magnetic Fields 31
Appendix II – Exposure Limits 34
Appendix III – Warning Signs 36
Appendix IV: Checklists 42

Scope and Purpose

Static and time-varying electromagnetic fields are generated by research and other equipment in various locations within Concordia University ("University") facilities. Although both static and time-varying magnetic fields and associated electromagnetic fields are not known to cause apparent long-term health effects, there are hazards, under some circumstances, which need to be recognized and controlled to avoid accidents or injury to equipment operators, researchers, support staff, students, visitors and Research Participants, as well as to the general public. Although there are no legislative, certification or licensing requirement, the University is committed to complying with all federal and provincial guidance documents concerning the safe operation of equipment generating significant magnetic and electromagnetic fields, as described in the University's *Magnetic Field Safety Policy* (VPS-54) and the present *Magnetic Field Safety Manual* (the "Manual").

This Manual applies to all persons working with or near strong magnetic fields or occupying University facilities with potentially elevated magnetic fields and all persons on University premises with potentially elevated magnetic fields., and/or all persons on University premises potentially exposed to, strong magnetic and electromagnetic fields, including but not limited to University faculty, staff, students, Research Participantsand authorized visitors.

This Manual should be read in conjunction with the *Magnetic Field Safety Policy* (VPS-54). In the event of a discrepancy between this Manual and the *Magnetic Field Safety Policy* (VPS-54), the latter shall prevail. Please note that this Manual will be revised on a regular basis and may be modified as circumstances require.

All persons working with magnetic fields (including, but not limited to, equipment used in MRI, NMR, and EPR), either static or time-varying, must comply with all rules and procedures detailed in this Manual. The purpose of this Manual is to describe the University's requirements for routine activities and emergency situations in order to ensure maximum safety in areas in which strong magnetic fields are being used. It should be noted that this Manual does not deal with ionizing electromagnetic radiation, which is dealt with in the University's *Radiation Safety Policy* (VPS-46) and the *Radiation Safety Manual*.

The rules and procedures described in this Manual are also intended to ensure compliance with the appropriate guidelines, including, but not limited to:

- *Guidelines on Exposure to Electromagnetic Fields from Magnetic Resonance Clinical Systems - Safety Code 26,* Health Canada

- *Technical Guide for Interpretation and Compliance Assessment of Health Canada's Radiofrequency Exposure Guidelines,* Health Canada (2009)
- *Guidelines on Limits of Exposure to Static Magnetic Fields.* Health Physics 96(4):504-514; 2009
- *Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz - 100 kHz)*. Health Physics 99(6):818-836; 2010
- *Exposure to high frequency electromagnetic fields, biological effects and health consequences (100 kHz-300 GHz) – Review of the Scientific Evidence and Health Consequences.* Munich: International Commission on Non-Ionizing Radiation Protection; 2009

All equipment capable of generating strong magnetic fields (> 0.5 mT or 5 G) at any distance must be registered, appropriately labelled and restricted to authorized persons within the 0.5 mT (5 G) field. Magnetic equipment generating static or time-varying fields greater than 0.5 mT will be subjected to the rules and operating procedures outlined in this Manual.

This Manual deals with the authority and responsibility related to the management of equipment generating significant magnetic fields, the health and safety of equipment operators, researchers and Research Participantss, routine maintenance and emergency situations.

All persons authorized to operate magnetic resonance equipment or who work in facilities where magnetic resonance equipment reside are issued a copy of the present Manual, which must be read and maintained in the principal location in which work in the vicinity of magnetic fields is carried out. These persons are responsible for communicating the guidelines, rules and operating procedures contained in this Manual to personnel in their laboratory and ensuring their compliance with these guidelines, rules and operating procedures. Copies of this Manual are provided to Faculty Deans, Department Chairs, and Center Directors if work with strong magnetic fields occurs in areas for which they are responsible. Service Area Directors who are either directly or indirectly involved in servicing laboratories with a potential magnetic field hazard will receive a copy of the Manual for distribution to appropriate individuals reporting to them.

Abbreviations

- ELF – Extremely Low Frequency
- EMF – Electrical and Magnetic Field
- EPR – Electron Paramagnetic Resonance Spectroscopy
- ESR – Electron Spin Resonance Spectroscopy
- G – Gauss
- MRI – Magnetic Resonance Imaging
- MRS – Magnetic Resonance Spectroscopy
- NMR – Nuclear Magnetic Resonance
- RF – Radio Frequency
- RSO – Radiation Safety Officer
- SAR – Specific Absorption Rate
- T – Tesla
- URSC – University Radiation Safety Committee

Glossary of Terms / Definitions

CGS
Units of measure based on centimetres, grams and seconds.

Electromagnetic Radiation (EMR)
A form of energy travelling through space at the speed of light with wave-like behaviour, with both electric and magnetic field components oscillating in phase, perpendicular to each other and with the same direction of propagation. EMR energy is a function of frequency and wavelength.

Electron Paramagnetic Resonance Spectroscopy (EPR)
Also known as Electron Spin Resonance (ESR); a technique for studying chemical species with unpaired electrons, which are excited by radiofrequency EMR and applied in conjunction with a static magnetic field.

Electron Spin Resonance Spectroscopy (ESR)
See EPR.

Functional Magnetic Resonance Imaging (fMRI)
A type of specialized MRI scan which measures change in blood flow related to neuron activity of the brain or spinal cord of humans or other animals.

Gauss (G)
Gauss is the CGS-derived unit of magnetic field strength (intensity) per unit area, also known as "magnetic flux density" and "magnetic induction". One G equals 0,0001 Tesla.

Human Research Studies Investigator
An individual authorized to conduct research who is the principal investigator (PI) or a co-investigator responsible for securing all necessary approvals for protocols and overseeing compliance with all regulations related to procedures involving use of magnetic fields in Research Participantss.

Magnetic Field
A force field created by a magnet or as a consequence of movement of electric charges.

Magnetic Resonance Imaging (MRI)
A technique using intense Magnetic Fields in combination with radiofrequency EMR to generate images of internal anatomical structures.

Magnetic Resonance Spectroscopy (MRS)
Also known as Nuclear Magnetic Resonance (NMR) spectroscopy; an *in vivo* technique using NMR properties of nuclei in molecules to identify chemicals in internal structures, e.g., the brain or muscles.

Medical Device
Includes internal/external electronic devices, metallic implants, surgical clips, prostheses, and hearing aids.

MR Environment
The volume within the 0.5 mT (5 G) line of an MR system, including the entire 3-dimensional volume of a space surrounding the MR scanner; for cases where the 0.5 mT (5 G) line is contained within the Faraday-shielded volume, the entire room shall be considered the MR Environment.

Nuclear Magnetic Resonance (NMR)
Nuclear Magnetic Resonance (NMR) spectroscopy is a technique that exploits the fact that magnetic nuclei of atoms in large static fields resonate with specific radiofrequency EMR to generate characteristic signals.

Operator
An authorized and qualified user of equipment involving strong Magnetic Fields; normally specially trained technicians, certified radiology technologists or equipment supplier technicians.

Quenching
Refers to the loss of liquid nitrogen or helium cooling of superconducting coils in magnets present in NMR or MRI equipment and reverting to a resistive state, with total loss of Magnetic Field.

Radiofrequency (RF) Field
An electromagnetic field oscillating in the range of 30 KHz and 300 GHz.

Research Participant
A human research subject who is placed in the bore of the MRI scanner for research purposes in compliance with all institutional, provincial, and federal guidelines, regulations and standards of care.

Resistive Magnet
A simple electromagnet, in which electricity (AC or DC) passing through a conducting wire produces a Magnetic Field.

Responsible User
Includes Radiology Facility Managers, Operators (certified radiology technologists), Principal Investigators, and Human Research Participant Investigators who are authorized to operate or supervise operation of equipment in facilities and ensuring compliance by those working under their supervision.

Site RSO
A person at a specific location who, under the direction of the RSO, provides day-to-day assistance with respect to Magnetic Field safety and compliance as well as initial response to emergencies in controlled areas.

Specific Absorption Rate
A measure of the rate at which energy is absorbed by the body when exposed to a RF electromagnetic Field in W/kg tissue.

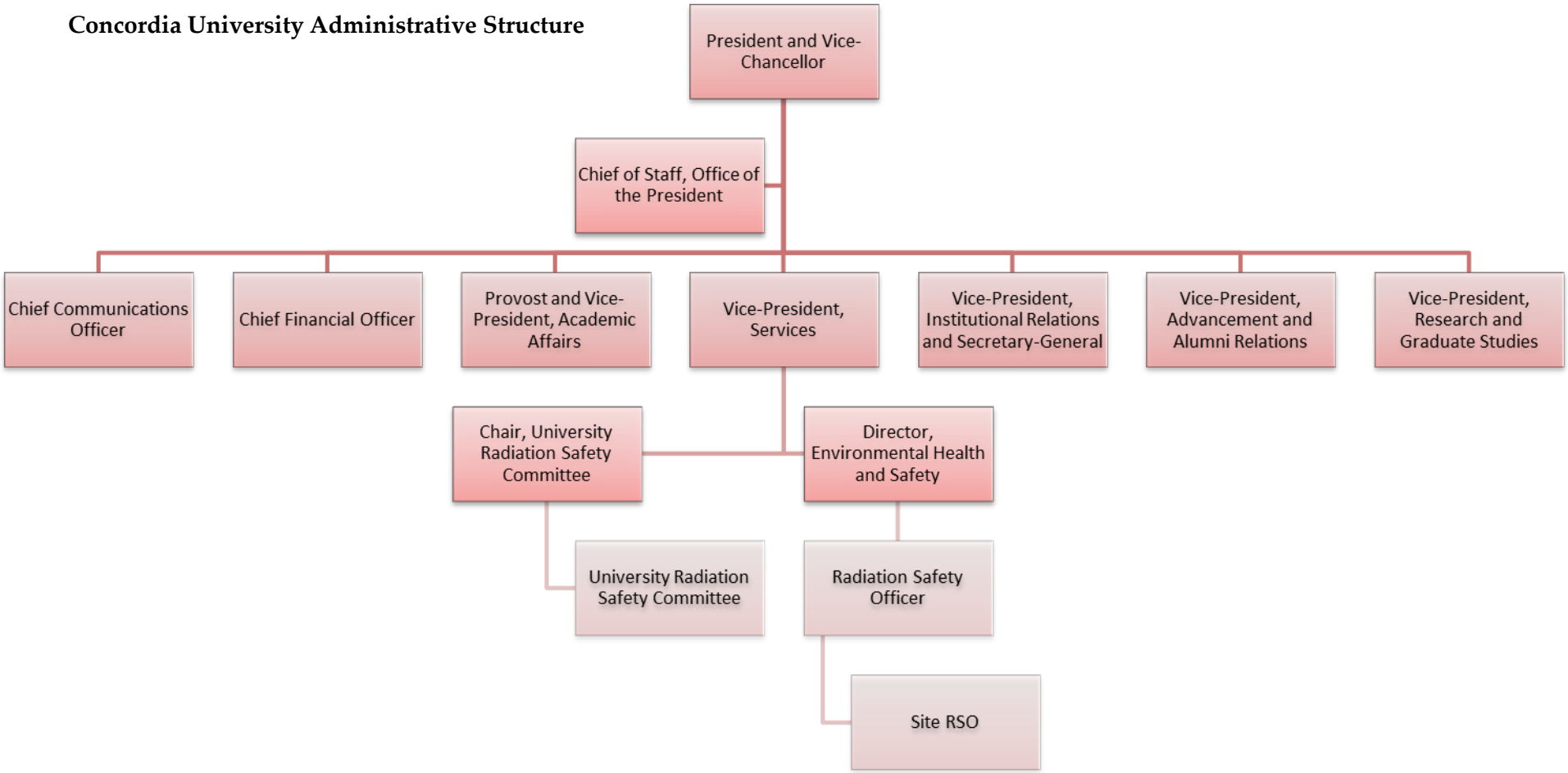
Static Magnetic Field
Magnetic Field that does not vary with time, created by a permanent magnet or a direct current electromagnet.

Superconducting Magnet
An electromagnet made from coils of superconducting wires, pure metals exhibiting zero resistance to electrical flow at cryogenic temperatures, producing very strong Magnetic Fields.

Tesla (T)
Tesla is the SI-derived unit of Magnetic Field strength per unit area, also known as “magnetic flux density” and “magnetic induction”. One T equals 10,000 G.

Time-Varying Magnetic Fields
Time-Varying Magnetic Fields are produced by alternating currents of various frequencies from 0 to the high GHz range.

Concordia University Administrative Structure



1. University Radiation Safety Committee (URSC) and MF Safety Responsibilities

1.1 The Vice-President, Services has authorized the URSC to establish policies and safe operating procedures for the use of equipment generating strong Magnetic Fields in research and teaching activities on behalf of the University. Such policies and operating procedures shall be enforced through the activities of the Chair of the URSC and the Radiation Safety Office (RSO), Site RSO or by a delegated staff member, as per terms of the University's *Magnetic Field Safety Policy* (VPS-54).

1.2 The composition and mandate of the URSC is established by the University's *Radiation Safety Policy* (VPS-46) and further elaborated in the *Radiation Safety Manual*.

In matters dealing with Magnetic Fields, the URSC shall include at least one (1) member from each department that operates large magnets and at least one (1) member with theoretical and practical expertise in Magnetic Field safety.

The URSC will:

1.3 Advise the Vice-President, Services regarding policies, procedures and guidelines on Magnetic Field safety, particularly with respect to operating large magnets in human research studies.

1.4 Review University policies, procedures and practices to ensure compliance with applicable regulations, and accepted 'best practices' and safety standards.

1.5 Establish and oversee Magnetic Field protection and training programs.

1.6 Advise its Chair regarding approval of facilities (magnetic and RF shielding), acquisition, modification or relocation of magnetic resonance equipment.

1.7 Review all standard operating procedures and protocols ("SOPs") for Operators, workers, researchers, students and Research Participantsexposed to strong Magnetic Fields.

1.8 Review SOP's for routine cleaning, maintenance of facilities with continuous Static Magnetic Fields and all emergency access requirements.

1.9 Review security systems and access controls to strong Magnetic Fields.

1.10 Approve human research studies protocols after scientific merit review and prior to human ethics review to ensure safety of Operators, researchers and Research Participants.

1.11 Receive:

1.11.1 Results of periodic inspection of facilities, premises, equipment and work practices to assess that Magnetic Field generating equipment is used safely;

1.11.2 Reports concerning any incidents or unusual occurrences (security breaches, cryogen spills, magnet Quenching) on University facilities involving strong Magnetic Fields;

1.11.3 Any calibration, routine maintenance or emergency repairs of Magnetic Field generating equipment;

1.11.4 Any renovations to facilities, potentially affecting Magnetic Field or RF shielding integrity.

1.12 Recommend corrective measures or improvements:

1.12.1 When review or assessment identifies deficiencies in a proposal, protocol, SOP, program, practice, procedure, equipment operation, record or report;

1.12.2 To prevent recurrences of any incidents that exposed persons to risks or injury, or to prevent recurrence of any other unusual incidents (e.g., unauthorized access, improper screening of Research Participant, etc.).

1.13 Maintain written records of activities, decisions, advice and recommendations concerning Magnetic Field safety, including minutes of meetings and reviews of data, reports, programs, procedures, circumstances, incidents or unusual occurrences.

1.14 Advise senior administrators of any need for additional resources to establish, maintain or improve Magnetic Field safety programs or to fulfill compliance requirements.

2. The Chair of the URSC

In addition to duties outlined in the *Radiation Safety Policy* (VPS-46) and further described in the *Radiation Safety Manual*, and in respect to Magnetic Field safety, the Chair of the URSC shall be responsible for the following and will:

2.1 Correspond with federal, provincial and municipal departments and agencies on behalf of the University with respect to activities involving strong Magnetic Fields.

2.2 With approval of the URSC, authorize the operation of equipment generating strong Magnetic Fields and related SOPs.

2.3 With approval of the URSC, authorize SOPs involving human research studies.

2.4 Authorize the closing of University facilities, restricting access or suspending operation of equipment if Magnetic Fields in the facility or adjacent occupied areas (including public corridors) are deemed excessive by the RSO or the URSC or in emergency situations; immediately informs the Director of Security, the Director of Environmental Health & Safety (EH&S), the appropriate facility manager(s) about such closing and requests the RSO to change or post appropriate signs.

3. The Radiation Safety Officer (RSO)

In addition to duties and responsibilities listed in Section 3 of the *Radiation Safety Policy* (VPS-46) and the *Radiation Safety Manual*, the RSO:

3.1 Ensures the day-to-day administration of the Magnetic Field safety and training program on behalf of the University; training commensurate with activities may include MRI safety video and online or in-person training sessions.

3.2 Advises and consults the Chair of the URSC regarding issues related to the University's use of magnetic resonance equipment so as to ensure that such use is carried out in accordance with all applicable legislation and health and safety guidance documents.

3.3 Ensures that records and reports required by the University and external agencies are prepared, maintained and submitted as required. These records and reports include the following:

- 3.3.1 Names of all persons involved in the supervision and operation of equipment generating Magnetic Fields;
- 3.3.2 Names of persons who have undergone training on Magnetic Field safety;
- 3.3.3 Locations of equipment generating external Magnetic Fields greater than 0.5 mT (5 G);
- 3.3.4 Records of RF shielding testing and Magnetic Field strength measurements within facilities and adjacent rooms and public corridors;
- 3.3.5 Details of incidents involving magnetic resonance generating equipment;
- 3.3.6 Records of equipment repair, modification, calibration, re-configuration or re-location.

3.4 Provides safety warning signs, information bulletins and guidelines for those requiring such materials.

3.5 Maintains copies of all relevant regulations, guidelines and contingency plans in the event of an emergency.

3.6 Routinely inspects authorized facilities in order to review compliance with University policies and approved SOPs, and adequacy of access control and personnel training.

3.7 Notifies Operators, facility managers, researchers and unit heads of any remedial actions required to correct deficiencies in the inspection program.

3.8 Reviews and approves requests for authorization to purchase, modify or relocate magnetic

resonance equipment.

3.9 Assesses the qualifications and competence of persons operating magnetic resonance-generating devices to determine whether they can do so safely and in compliance with the *Magnetic Field Safety Policy* (VPS-54) and applicable guidelines.

3.10 Posts, in a readily visible location, safety signage and hazard warning and access restrictions.

3.11 Maintains a complete and up-to-date list of all designated areas, rooms and enclosures within which magnetic resonance-generating equipment is located and where fields greater than 0.5 mT (5 G) are present.

3.12 Develops, implements and maintains administrative controls or procedures to ensure Magnetic Field safety and compliance.

3.13 Ensures that persons (faculty, staff, students, Research Participants, visitors) who may be exposed to Magnetic Fields greater than 0.5 mT (5 G) are adequately screened and trained in relevant safety practices and procedures.

3.14 Ensures that persons who may be exposed to Magnetic Fields in the course of their duties (such as custodial, clerical, security and distribution staff) are screened and receive Magnetic Field safety training.

3.15 Reports any accident or incident involving personal injury or potential health consequences to the Chair of the URSC, Director of EH&S, appropriate facility manager(s) and supervisor(s), and reports same to CSST, if required.

3.16 Recommends appropriate actions to mitigate consequences of, or to prevent, the occurrence of accidents or incidents outlined in Section 3.15 above.

3.17 Assesses the adequacy to security and controls in managing unintended exposure of persons to excessive Magnetic Fields.

3.18 Every six (6) months, carries out inspection and monitoring of magnetic resonance facilities to confirm RF shielding adequacy, 0.5 mT (5 G) safety delineation, and reviews Operator logbooks, as well as repair and maintenance records.

3.19 Carries out (or requests) monitoring of Magnetic Fields after any room modification or relocation

of equipment.

3.20 Ensures that the Directors of EH&S and Security are informed and appropriate signs are posted in emergency situations in magnetic resonance facilities.

4. Internal Authorization Conditions

4.1 The URSC must be advised by the Responsible User of the location, access controls, security and shielding required for safe operation of magnetic resonance equipment.

4.2 The URSC must be informed by the Responsible User of the training and qualifications of persons authorized to operate magnetic resonance equipment (Operators) and work within the 0.5 mT (5 G) zone.

4.3 The authorization to operate magnetic resonance equipment will be issued by the Chair of the USRC for a maximum period of two (2) years and may be withdrawn in the event of non-compliance with the *Magnetic Field Safety Policy* (VPS-54) or serious health and safety violations.

4.4 Operation of magnetic resonance equipment (MRI, MRS) involving Research Participants must be carried out by qualified radiology technologists under the supervision of a qualified medical practitioner.

4.5 The RSO must be immediately informed regarding any changes to equipment, its location, operating procedures, Operators, or Responsible Users.

5. Responsible Users

The following requirements apply to individuals authorized to operate or work within MRI Environments, including facility managers, certified technologists, researchers, research support staff and graduate students.

The failure by Responsible Users to comply with the rules and regulations set forth throughout this Manual may lead to disciplinary action. The RSO and/or the URSC may terminate any magnetic resonance operations if deemed necessary by virtue of situations jeopardizing health, safety or the environment or failing to comply with any conditions stipulated in the appropriate authorizations.

A Responsible User:

5.1 Ensures that all persons working or accessing magnetic resonance equipment under their supervision or in facilities under their jurisdiction, fully comply with all applicable legislation, regulations and guidelines set forth in this Manual. Any exposure of Research Participants to Magnetic Fields greater than 0.5 mT (5 G) shall be carried in strict compliance with approved SOPs and the Responsible User must ensure Research Participant screening to eliminate any risks posed by internal or external ferromagnetic materials.

5.2 Possesses knowledge of potential hazards inherent in the operation of, or working in proximity to, magnetic resonance equipment.

5.3 Makes certain that individuals working under their supervision are properly trained, supervised and made aware of the potential risks, safety procedures, emergency procedures and proper operation of equipment to prevent unintended exposure to themselves and others.

5.4 In the case of exposure of Research Participants, ensures that thorough medical screening and a full explanation of procedures and associated risks are explained to the Research Participantss.

5.5 In the case of exposure in facilities used for human research (MRI/MRS), possesses operational Magnetic Field monitoring and ferromagnetic materials detection equipment (e.g., hand-held magnet).

5.6 Posts warnings and restricts entry to areas with MR Environments; labels equipment and areas with any associated hazards.

5.7 Provides the RSO with twenty-four (24) hour contact numbers of individuals able to respond to

emergency situations.

5.8 Notifies the RSO of any personnel changes, including the addition or removal of students and employees on authorization lists.

5.9 Notifies the RSO of the designation of a responsible individual to oversee work involving magnetic resonance during short absences, and of a stand-in principal investigator during absences greater than forty-five (45) days.

5.10 Maintains an up-to-date logbook, listing all procedures carried out, standard operating parameters and names of Operators, as well as approved protocols for work involving Research Participants.

In addition to this logbook, the MRI/MRS facility manager and/or Human Research Studies Investigator(s) are required to keep confidential records regarding research on Research Participants involving radiology procedures, consent forms, human research ethics approvals, URSC authorization(s), and other documents in accordance with applicable regulations.

5.11 Maintains up-to-date records for a minimum of three (3) years which may be inspected at any time by the RSO and/or government inspectors. Documents pertaining to research using MRI/MRS in humans will be maintained for the period required by applicable legislation and regulations.

5.12 Makes the logbook as well as a copy of this Manual readily accessible to all workers in the controlled areas of the facility, and to the RSO.

5.13 Posts, in a readily visible location, a copy of the facility authorization from the URSC, laboratory facility safety guidelines, and emergency procedures. In facilities where individuals are working with MRI/MRS involving humans, emergency resuscitation equipment must be readily available and suitably trained personnel must be on duty.

5.14 Is accountable for the safety of all individuals within the MR Environment while under their supervision.

6. Facilities Designated as MR Environments

6.1 All rooms used for operation of equipment generating Magnetic Fields greater than 0.5 mT (5 G) external to the magnets shall require the authorization of the URSC.

6.2 All rooms authorized for operation of equipment generating significant Magnetic Fields shall bear warning signs in both English and French with accepted pictograms. All such room must have sufficient RF shielding in order to reduce Magnetic Fields to less than 0.1 mT (1 G) in adjoining rooms and public corridors. Furthermore such rooms:

- 6.2.1 Must be locked at all times with safety interlocks and/or warning lights and an alarm when Magnetic Fields are present;
- 6.2.2 Shall have zones exceeding 0.5 mT (5 G) and 5 mT (50 G) clearly delineated on the floor or by barriers;
- 6.2.3 Shall have only non-ferromagnetic equipment, furnishing and accessories within the MR Environment;
- 6.2.4 Shall have provisions for the safe transport and storage of cryogens;
- 6.2.5 Shall have emergency ventilation and pressure control in the event of Superconducting Magnet failure (Quenching);
- 6.2.6 Shall be restricted to authorized persons only; all other persons must be accompanied by an authorized person;
- 6.2.7 Shall have an emergency '*kill switch*' which must be wall-mounted or highly visible on the equipment.

6.3 Magnetic resonance equipment (magnet) rooms for MRI/MRS on Research Participants must be accessed via a separate control room with a viewing window for continuous observation of participants, attending personnel, researchers or research personnel. The control room shall link the magnet room with the participant preparation room, which in turn is linked to the waiting room. Only authorized persons may enter the control room or magnet room.

6.4 Only non-ferromagnetic equipment, tools and hardware accessories may be used within MR Environments. In particular, non-magnetic stainless steel Dewar flasks must be used to transport liquid nitrogen or helium.

7. Exposure Limits

7.1 Limits of Magnetic Field exposures are based on guidelines established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) described in the following table. Intervention levels at the University are established at 1/5th of these values, except for Medical Device wearers, for whom the Static Magnetic Field remains at 0.5 mT (5 G).

Exposure	ICNIRP Ceiling Value
Whole body (general workplace)	2 T (20,000 G)
Whole body (special training controlled area)	8 T (80,000 G)
Limbs	20 T (200,000 G)
Medical Device wearer	0.5 mT (5 G)
General public (any part of the body)	0.4 T (4,000 G)
Public corridors	0.1 mT (1 G)

7.2 Exposures exceeding intervention levels will require the review of shielding, work practices and personnel training to ensure exposures are as low as possible.

7.3 Time-Varying (RF) Magnetic Field exposure can induce electrical currents in conducting materials causing localized heating effects and may affect neurological activities, which must be carefully monitored in Research Participantss undergoing MRI scans.

7.4 Exposures must be kept to the absolute minimum for pregnant workers, Research Participants and children under the age of 18 years.

7.5 Given the difficulty of detecting individual exposures, routine monitoring of Magnetic Field facilities and adjoining areas must be carried out regularly.

8. Handling Cryogens for Superconducting Magnets

It may be necessary to periodically replenish liquid nitrogen or liquid helium which may involve several hundred litres. Careful planning of the delivery route of such liquids, which must be in Dewar flasks, to equipment and the careful transfer of such liquids to magnets is needed.

The following applies to the handling of cryogens for Superconducting Magnets:

8.1 Cryogens shall not be transferred via passenger elevators.

8.2 Freight/service elevators shall not be shared with other persons or materials when cryogens are present.

8.3 Cryogens shall be received, transported, and transferred in non-ferromagnetic stainless steel Dewar flasks.

8.4 The transfer of cryogens and filling magnets shall be carried out by trained personnel.

8.5 Dewars containing cryogens should not be stored in a magnetic resonance facility or poorly ventilated rooms.

9. Emergency Procedures

Work involving magnetic resonance at high Magnetic Field strengths presents unique hazards to both Research Participantsand individuals working within an MR Environment. Consequently, the potential for serious personal injury is present due to the size and strength of the Static Magnetic Field, along with peripheral research hardware.

The following emergency procedures must be adhered to when working in an MR Environment:

9.1 All persons entering the facility must be aware that the Static Magnetic Fields of Superconducting Magnets are always present and are not detected by human senses.

9.2 Access to magnets must be restricted to authorized, knowledgeable staff or those under their supervision.

9.3 Those authorized to work within and around an MR Environment must have completed appropriate checklist (see ***Appendix IV***), safety training and must comply with all approved SOPs.

9.4 Emergencies are situations in which one or more persons require medical attention, evacuation, or immediate interruption of work to prevent injury or damage to equipment (e.g., magnet Quenching).

9.5 The magnetic resonance equipment Operator on duty at the time of the incident is responsible for following emergency procedures.

9.6 Emergencies which require medical attention may arise from Magnetic Fields, flying objects, cryogen spills, implanted Medical Device issues, magnet Quenching or, in cases of participants exhibiting change of behaviour or responsiveness.

9.6.1 Signs of cardiac arrest include all of the following:
- person is non-reactive;
- person is not breathing;
- person has no pulse.

9.6.2 If a person exhibits a change of behaviour or responsiveness, the Operator must:
- stop scan if in progress;
- assess the participant's condition;

- if emergency response is required, call 911 and University Security (extension: 3717);
- extract person from magnet room on magnetic resonance bed;
- close magnet room door;
- start life-saving measures, as needed;
- request support staff to meet emergency responders at elevator and guide to control room.

9.6.3 Accidental, significant or major release of water (spill or leakage) into the magnet or control room must be reported to the facility manager, Security and Facilities Management, and followed by aborting any scan in progress and shutting down the electrical power to the magnetic resonance equipment (red Magnet Stop button '*kill switch*') in the magnet room and the control room. Any participants and research personnel must be evacuated to the waiting room area or another suitable area.

9.6.4 In the event of fire, smoke or odour, proceed as follows:

- ensure your safety and that of any Research Participant in the magnet bore;
- abort scan and withdraw Research Participant from magnet (activate emergency release if necessary);
- turn off electrical supply to magnet and control;
- evacuate magnet and control room;
- contain fire with fire-blanket and/or by using non-magnetic extinguisher;
- activate the fire alarm (Stage I);
- wait for Security to confirm uncontrolled fire and activation of Stage II alarm;
- follow standard evacuation procedures, if instructed by Security, and close magnet room door after quench procedure (red button '*kill switch*');
- contact emergency response team and file incident report with Security;
- the magnet must be quenched before firemen can enter the magnet room.

9.6.5 In emergency situations, the electrical power can be turned off suddenly *without losing the Static Magnetic Field generated by cooled Superconducting Magnets*. Quenching (loss of Magnetic Field) occurs when there is a loss of superconductivity, resulting in an increase in resistivity of magnet coil windings, which generate heat and causes rapid evaporation of magnet coolant (liquid helium). This evaporated coolant is hazardous (pressure build-up, asphyxiation) and requires emergency venting systems to protect personnel and Research Participantss. Quenching can damage the magnetic resonance magnet, with significant down-time and expensive repair, and as such should only be executed (by pressing the red Magnet Stop *'kill switch'* button).

Summarized below are the steps that must be followed when:

- there is a fire in the magnet room which cannot be contained, the fire department must be contacted immediately, or
- an individual is pinned to the magnet, trapped or in a potentially life-threatening situation by a non-removable ferromagnetic object.

When in any one of the conditions above occurs, the following steps must be followed in the order that they appear below.

1. After evacuating the room, depress the red Magnet Stop *'kill switch'* button in the control room or the magnet room, which causes an audio alarm and activates the warning light.
2. Respond to any injury to Operators, research personnel or participants in the room at the time of the Quench and inform Security, Facility Manager(s) and EH&S immediately.

10. Research Involving Laboratory Animals

10.1 All research projects in magnetic resonance facilities involving live animals must have the prior approval of the Concordia Animal Research Ethics Committee.

10.2 All animals brought into magnetic resonance facilities normally used for human research must be transported in sealed cages with filtered air exchange.

10.3 All animal waste (bedding, feces, and urine) must be removed from the sealed cages after procedures in magnetic resonance facilities.

10.4 All surfaces which were in contact with the live animals must be wiped down with a disposable cloth and must be receive a final wipe with 70% alcohol.

10.5 All equipment or materials in contact with the live animals at any stage must be removed or decontaminated prior to resuming research on human Research Participants.

11. Research Involving Research Participants

During magnetic resonance data acquisition, the Research Participant being imaged is exposed to rapidly changing Magnetic Field gradients and Magnetic Fields oscillating in an RF range (128 MHz). These Time-Varying Magnetic Fields are much weaker than the Static Magnetic Fields (up to 10 mT or 100 G vs. 3T or 30,000 G) but do create additional safety hazards.

11.1 All Research Participants, Operators, and research personnel must wear appropriate hearing protection, since there may exist high acoustic sound pressure levels during certain types of data collection.

11.2 All research personnel and ResearchParticipants must have completed all required safety training and must have completed either the ***Magnetic Resonance Environment Safety Checklist for Individuals***, in the case of research staff, or the ***Magnetic Resonance Imagery Safety Checklist for Research Participants*** in the case of human participants (see ***Appendix IV***).

11.3 Static Magnetic Field Safety Issues:

11.3.1. Anyone with any of the following Medical Devices (internal or external) or external items should identify these before entering the facility and may not proceed beyond the 5 mT (5 G) line unless the Medical Device or item can be removed or safety deactivated:

- aneurysm clips
- implanted cardioverter defibrillator
- electronic implant or device
- magnetically-activated implant or device
- neuro-stimulation system
- spinal cord stimulator
- insulin or other drug infusion pump
- brachytherapy needles (seeds)
- any type of prosthesis
- any type of implant containing metallic components
- artificial or prosthetic limb
- any metallic fragment or foreign body
- any internal or external metallic object
- hearing aid
- eyeglasses
- stents
- metallic dental fillings.

11.3.2. All metallic objects have the potential to become projectiles in the magnetic resonance environment if they contain ferromagnetic elements.

11.3.3. The equipment Operator is responsible for screening all objects brought into the magnet room for ferromagnetic properties.

11.3.4. Only equipment and materials essential for the execution of experiments, which have been tested using the permanent magnet in the control room, may be brought into the magnet room.

11.3.5. Although there are several metals that do not have ferromagnetic properties, it is important that all are tested for purity before importing to the magnet room.

11.3.6. It is mandatory to remove all personal metallic objects before crossing the 0.5 mT (5 G) line. These include:

- hearing aids
- pagers, cell phones, communication devices
- keys
- hairpins, barrettes, clips
- loose jewellery
- watches
- safety pins, paperclips
- credit cards, bank cards, magnetic ship cards
- pens
- pocket knives, nail clippers
- steel-toed safety footwear
- tools
- eyeglasses
- cosmetics

11.3.7. All Operators of MRI scanners must be trained in first-aid to deal with potential injuries from objects moving at great speed toward the ferromagnetic magnet.

11.3.8. In the event of entrapment of a person on the magnet because of a large ferromagnetic object, the magnet will be quenched by the Operator or research support personnel.

11.4 Time-Varying Magnetic Field safety issues

Magnetic Fields that change quickly with time are present within magnetic resonance systems while data are being acquired. As Time-Varying Magnetic Fields can induce electrical currents and consequent heating in electrical conductors, these fields pose additional potential risks for Research Participantss and for personnel who are very close to the RF coils during data acquisition.

11.4.1. The potential for peripheral nerve stimulation (depolarization) due to rapid switching of Magnetic Field gradients must be monitored by magnetic resonance hardware and software and may not exceed Health Canada established limits.

11.4.2. To prevent the creation of large conducting loops, Research Participantss must be positioned without arms, hands, legs, and feet touching.

11.4.3. Before positioning in the Magnetic Fields for data acquisition, it is mandatory to remove all electric-conducting objects, including:

- eyeglasses
- underwire bra
- jewellery (including body piercings)
- clothing with metallic zippers
- belts
- buttons

11.5 Electrical safety issues

Dangerous and potentially lethal levels of electricity exist in a magnetic resonance system. It is therefore imperative that all individuals working in magnetic resonance facilities be aware of the such dangers and become knowledgeable regarding safety issues concerning electricity. There is a risk of electrical shock from extremely high voltage, possibly causing severe injury or death to a person and damage to the magnetic resonance equipment.

11.5.1. Only trained personnel should set up hardware in the magnet room, including the connection or placement of any cables.

11.5.2. Electrical breakers must be labelled and accessible for all high voltage (208 volts or greater) transformers and other high voltage equipment.

11.5.3. Only qualified service personnel and technicians shall carry out routine service and repair work on magnetic resonance systems. Such service and repair work must comply with the manufacturer's specifications and operating procedures.

11.5.4. Any electrical modifications to magnetic resonance equipment or support infrastructure must be carried out by qualified electricians, and subsequently tested or verified by the manufacturer.

11.5.5. All high voltage transformers or points of contact with high voltage sources shall be clearly labelled.

11.5.6. All abnormal leakage or spill of large quantities of water impacting the control room or magnet room will be reported to the Facility Manager and treated as an emergency situation with safe evacuation of Operator(s), research personnel and Research Participantss.

11.5.7. In any emergency situation, electrical shutdown can reduce the risk of electrical shock. However, this does not eliminate risks of Static Magnetic Fields from Superconducting Magnets.

11.6 Use of Contrast Agents

There are potential adverse reactions of Research Participants to the injection of contrast agents and the following precautions must be taken:

- approved SOP for use of contract agent followed
- appropriate section of consent form completed
- medical questionnaire completed and reviewed by physician
- physician present during the procedure

12. Facilities Management and External Services

12.1 All persons entering the magnet room must be screened by the Operator (see ***Appendix IV***).

12.2 Routine cleaning of the magnet room should be done by facility staff or qualified users.

12.3 Emergency access (outside normal hours of operation) shall be restricted to the trained security and emergency response team and the RSO.

12.4 Maintenance work by Facilities Management staff will only be undertaken after screening and briefing by the Facilities Manager of qualified magnetic resonance equipment Operators.

12.5 Any electrical, mechanical or structural modification affecting or altering Magnetic Fields or RF shielding must be validated by qualified technicians.

Appendix I – Health Effects and Risk Considerations Associated with Magnetic Fields

There are three (3) considerations in evaluating health effects of Magnetic Fields: Static Magnetic Fields, Time-Varying Magnetic Fields, and RF Fields. All three (3) come into play with magnetic resonance technologies. The following has been derived from Health Canada's, *Guidelines on Exposure to Electromagnetic Fields from Magnetic Resonance Clinical Systems - Safety Code 26*.

Static Magnetic Fields

Static Magnetic Fields can interact with biological systems by exerting forces on molecules (e.g., DNA, RNA, proteins) and cells (neurons, blood cells) having diamagnetic susceptibility. They can also affect enzyme kinetics and act on moving charges (including moving fluids, e.g., blood). Some molecules and some molecular structures, such as retinal rods, DNA, and some red blood cells, are magnetically anisotropic, and therefore a force acts upon them in a Static Magnetic Field, which tends to orient them in a field. Fields of the order of 0.3 to 2 T have been reported to cause orientation of samples studied *in vitro*. Enzymatic reaction kinetics can be affected by strong Magnetic Fields in the range of 20 T.

A Static Magnetic Field exerts a force on a moving charge in the field. The force is directed perpendicular to the direction of motion and can affect nerve (decrease) action potential and conduction velocity), but fields greater than 20 T are required for this effect.

Another type of interaction involves moving conducting fluids such as blood flow and periodic movement of certain body parts, e.g., chest and heart muscle contractions. Motion of a conductor in a Magnetic Field results in the induction of a potential voltage across the conductor, e.g., across a blood vessel. The induced voltage depends on the magnetic flux density, blood vessel diameter, flow rate and orientation of the vessel with respect to the direction of the field. These potentials are detectable in ECG; however, they are physiologically insignificant until a threshold for depolarization of membrane potential of cardiac muscle fibres is reached. It is possible that 3 T could induce flow potentials in the range of 40 mV across aorta which approaches depolarization threshold for individual muscle fibres; however, potentials across individual cells will be much less. There is no evidence that Static Magnetic Fields up to 3 T affect any significant biological function. Some evidence has emerged, which indicates that occupational exposures of humans, up to 2 T for a few hours, do not seem to cause any adverse effects, and exposures up to 0.5 T for prolonged periods of time did not result in deleterious effects. See ***Appendix II*** for exposure limit guidelines.

Static Magnetic Fields are always present and field increases the closer an object is to the bore or opening of the magnet. Objects that are ferromagnetic may become projectiles with the potential to cause serious injury or may pin someone against the magnet in a life-threatening manner. Prior screening of personnel and equipment is essential before entering thbe MF Environment.

Time-Varying Magnetic Fields

Time-Varying Magnetic Fields interact with biological systems, primarily through induction of internal electric currents ('*eddy currents*'). The magnitude of the current depends on the time rate of change of the magnetic flux density and on the radius of the current loop. The current loops are in planes perpendicular to the direction of the Magnetic Field. The threshold effects have been established, including fibrillation, electroshock, induction of visual phosphenes (sensation of seeing light), and initiation of muscle and nerve impulses.

These thresholds are not attained in exposures up to 3 T/s and have been adopted as the U.S. standard. These Time-Varying EMFs are in the ELF range (1 Hz to 3 kHz).

Radiofrequency Field

Detrimental health effects from exposure to RF Fields are associated with high rates of energy deposition. Because the interactions of RF Fields depend on the field frequency, type of field (electric, magnetic, near field and far field behaviour) and body size/shape, a parameter called the Specific Absorption Rate (SAR) has been used to quantify the effects. The SAR is the dose rate, defined as the rate at which RF energy is imparted into a unit mass of the exposed biological body. SAR is usually expressed in Watts per kilogram. The SAR is not spatially uniform within the human body and also depends on equipment design and size/shape and tissue type of image object.

Exposure to RF Fields at sufficient SARs results in localized or whole-body temperature increases; whole-body temperature increase of about 1°C can be induced by exposures of 2-4 W/kg after one (1) hour.

Research Participants and animals must be protected from potential heating and burns. Precautions must also be taken to prevent over-heating of equipment and accessories.

Most RF effects can be explained on the basis of general or localized heating. However, some of the effects are due to non-thermal mechanisms. Prolonged whole-body average SARs for 1-3 W/kg have been reported to affect a number of biological systems; however, it is generally accepted that thresholds for deleterious biological responses are not attained with human exposures to 3 T/s.

Magnetic Resonance (MR) Fields

MR fields include simultaneous production of Static, and Time-Varying Magnetic Fields as well as RF Fields. Exposures in MR systems which do not exceed the following limits are considered of minimal, if any, health effects.

ii. The Static Magnetic Field: 2 T
iii. The rate of time change of the Magnetic Field: 3 T/s (rms)
iv. RF Field which does not cause an increase of body temperature of more than 0.5°C and of any part of the body of more than 1°C. This should be respected if SARs do not exceed 2 W/kg as averaged over any 25% of the whole-body mass for exposures up to 15 minutes and 1 W/kg for longer durations.

Rapidly changing gradient fields have the potential to cause peripheral nerve stimulation. The generation of RF gradients produces excessive noise levels, for which hearing protection must be provided.

Appendix II – Exposure Limits

Table 1 – Static Magnetic Field Limits*

Exposure	Magnetic Flux Density
Whole-body (general work place)	2 T (20,000 G)
Whole-body (special training and controlled area)	8 T (80,000 G)
General public (any part of the body)	0.4 T (4,000 G)
Medical Device wearer	0.5 mt (5 G)

** International Commission of Non-Ionizing Radiation Protection*

Table 2 – EMF Limits in the Range from 1 Hz to 3 kHz – Occupational

Frequency range	E electric field strength (V/m)	H Magnetic Field strength (A/m)	B Magnetic Field density	
			micro T	mGs
1 – 10 Hz	20 000	$2 \times 10^5 / f^2$	$2.5 \times 10^5 / f^2$	$25 \times 10^5 / f^2$
10 – 25 Hz	20 000	$2 \times 10^4 / f^2$	$2.5 \times 10^4 / f^2$	$25 \times 10^4 / f^2$
0.025 – 0.1 kHz	500/f	20/f	25/f	250/f
60 Hz	8333	333	417	4166
0.1 – 0.4 kHz	5000	200	250	2500
0.4 – 1 kHz	2000/f	80/f	100/f	1000/f
1 -3 kHz	2000	80	100	1000

f in Hz or kHz, as indicated in the frequency range column.

Table 3 – EMF Limits in the Range from 1 Hz to 3 kHz – General Public

Frequency range	E electric field strength (V/m)	H Magnetic Field strength (A/m)	B Magnetic Field density	
			micro T	mGs
1 – 10 Hz	10 000	$4 \times 10^4 / f^2$	$5 \times 10^4 / f^2$	$50 \times 10^4 / f^2$
0.01 – 0.025 kHz	10 000	4/f	5/f	50/f
0.025 – 0.1 kHz	250/f	4/f	5/f	50/f
60 Hz	417	67	83	833
0.1 – 0.4 kHz	250/f	40	50	500
0.4 – 1 kHz	250/f	16/f	2/f	20/f
1 -3 kHz	250/f	16	20	200

f in Hz or kHz, as indicated in the frequency range column.

Table 4 – Exposure Limits for Controlled Environments from 3 kHz to 110 MHz

Frequency (MHz)	Electric field strength (V/m)	Magnetic Field strength (A/m)	Power density (W/m^2)	Averaging time (min)
0.003 – 1	600	4.9		6
1 – 10	600/f	4.9/f		6
10 – 30	60	4.9/f		6
30 – 300	60	0.163	10*	6
300 – 1 500	$3.54* f^{0.5}$	$0.0094* f^{0.5}$	f/30	6
1 500 – 15 000	137	0.364	50	6
15 000 – 150 000	137	0.364	50	$616\,000/f^{1.2}$
150 000 – 300 000	$0.354* f^{0.5}$	$9.4 \times 10^{-4} *f^{0.5}$	$3.33 \times 10^{-4} *f$	$616\,000/f^{1.2}$

f is frequency measured in MHz

**Power density limit is applicable at frequencies greater than 100 MHz.*

Table 5 – Exposure Limits for Uncontrolled Environments from 3 kHz to 300 GHz

Frequency (MHz)	Electric field strength (V/m)	Magnetic Field strength (A/m)	Power density (W/m^2)	Averaging time (min)
0.003 – 1	280	2.19		6
1 – 10	280/f	2.19/f		6
10 – 30	28	2.19/f		6
30 – 300	28	0.073	2*	6
300 – 1 500	$1.585*f^{0.5}$	$0.0042*f^{0.5}$	f/150	6
1 500 – 15 000	61.4	0.163	10	6
15 000 – 150 000	61.4	0.163	10	$616\,000/f^{1.2}$
150 000 – 300 000	$0.158*f^{0.5}$	$4.21 \times 10^{-4} *f^{0.5}$	$6.67 \times 10^{-5} f$	$616\,000/f^{1.2}$

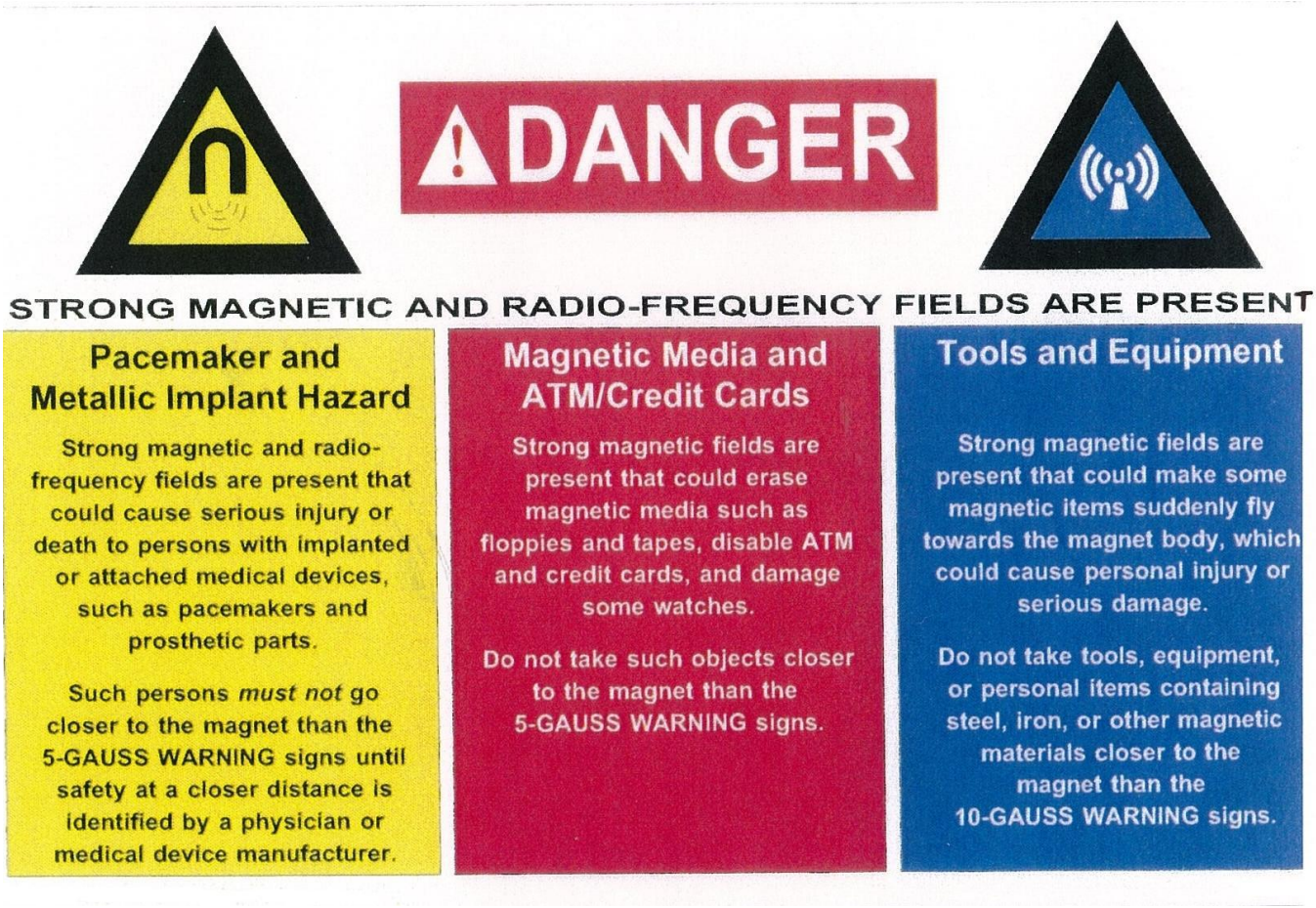
f is frequency measured in MHz

**Power density limit is applicable at frequencies greater than 100 MHz.*

Appendix III – Warning Signs


5-GAUSS
WARNING
STRONG MAGNETIC FIELD
Pacemaker, Metallic Implant Hazard
Strong magnetic and rf fields are present that can cause serious injury or death to persons with implanted or attached medical devices, such as pacemakers and prosthetic parts. Such persons must not go closer to the magnet than this sign until safety at a closer distance is identified by a physician or device
Magnetic Media, ATM/Credit Cards
Strong magnetic fields are present that can erase magnetic media, disable ATM and credit cards, and damage some watches. Do not take such objects closer to the magnet than this sign.


Extreme Caution!
IRON or other FERRO MAGNETIC OBJECTS must not be brought into the vicinity of the magnetic field as very strong attractive forces exist!
No Admission
for persons with PACE-MAKERS and other metallic implants


DANGER
STRONG MAGNETIC AND RADIO-FREQUENCY FIELDS ARE PRESENT
Pacemaker and Metallic Implant Hazard
Strong magnetic and radio-frequency fields are present that could cause serious injury or death to persons with implanted or attached medical devices, such as pacemakers and prosthetic parts.
Such persons *must not* go closer to the magnet than the 5-GAUSS WARNING signs until safety at a closer distance is identified by a physician or medical device manufacturer.
Magnetic Media and ATM/Credit Cards
Strong magnetic fields are present that could erase magnetic media such as floppies and tapes, disable ATM and credit cards, and damage some watches.
Do not take such objects closer to the magnet than the 5-GAUSS WARNING signs.
Tools and Equipment
Strong magnetic fields are present that could make some magnetic items suddenly fly towards the magnet body, which could cause personal injury or serious damage.
Do not take tools, equipment, or personal items containing steel, iron, or other magnetic materials closer to the magnet than the 10-GAUSS WARNING signs.

STRONG MAGNETIC FIELD

Pacemaker/Prosthetic Users

Pacemaker and metal prosthetic users are at risk of serious injury or death.

Such users must stay at least 4.6 meters (15 feet) away from the magnet until safety at a closer distance is identified by a physician and medical device manufacturer.

ATM/Credit Cards

The magnetic field can disable ATM and credit cards and damage watches.

Keep ATM and credit cards away from the strong magnetic field.

Labels to be used for portable objects taken into the magnet room:

MR safe:
An item which poses no known hazards in all MR Environments. Includes non-conducting, non-metallic, non-magnetic items, e.g. plastic or cotton.

MR Conditional:
An item demonstrated to pose no known hazards in a Specified MR Environment with specified conditions of use. Includes for static Magnetic Field strength, spatial gradient; For Time-Varying MF, radiofrequency fields and Specific absorption rate.

MR Unsafe:
An item known to pose hazards in all MR Environments, including magnetic items, e.g. ferro-magnetic scissors.

Appendix IV: Checklists

1. PERFORM Center MRI Facility: Magnetic Resonance (MR) Environment Safety Checklist for Workers
2. PERFORM Center MRI Facility: Magnetic Resonance (MR) Environment Safety Checklist for Research Participantss

PERFORM Center
MRI Facility

MAGNETIC RESONANCE (MR) ENVIRONMENT SAFETY CHECKLIST FOR WORKERS

This MR system has a very strong Magnetic Field (3 Tesla) that may be hazardous to individuals entering the magnet room if they have certain metallic, electronic, magnetic, or mechanical implants, devices or objects. Therefore, all individuals are required to fill out this form BEFORE entering the magnet room. Be advised, the magnet is ALWAYS ON.

This questionnaire must be completed accurately to ensure safety. An answer of "Yes" in a category may not necessarily exclude you from entry into the MRI or its vicinity.

Please circle

Have you had prior surgery or an operation (e.g., arthroscopy, endoscopy, etc.) of any kind?	Yes	No
Have you had an injury to the eye involving a metallic object (e.g., metallic slivers, foreign body)?	Yes	No
Have you ever been injured by a metallic object or foreign body (e.g., BB, bullet, shrapnel, etc.)?	Yes	No
Are you pregnant or suspect that you are pregnant?	Yes	No

WARNING: Certain implants, devices or objects may be hazardous to you in the MR Environment or the magnet room. DO NOT ENTER the MR Environment or the magnet room if you have any questions or concern regarding a mechanical implant, device or object.

Please indicate if you have any of the following:

Aneurysm clip(s)	Yes	No
Cardiac pacemaker	Yes	No
Implanted cardioverter defibrillator (ICD)	Yes	No
Electronic implant or device	Yes	No
Magnetically-activated implant or device	Yes	No
Neurostimulation system	Yes	No
Spinal cord stimulator	Yes	No
Cochlear implant or implanted hearing aid	Yes	No
Insulin or infusion pump	Yes	No
Implanted drug infusion device	Yes	No
Any type of prosthesis or implant	Yes	No

Please indicate if you have any of the following:

Artificial or prosthetic limb	Yes	No
Any metallic fragment or foreign body	Yes	No
Any external or internal metallic object (e.g., dentures,	Yes	No
Hearing aid (remove before entering the magnet	Yes	No
Tattoo	Yes	No
Body piercing	Yes	No
Other implant	Yes	No

IMPORTANT INSTRUCTIONS: Remove all metallic objects before entering the MR Environment or magnet room, including hearing aids, beeper, cell phone, keys, hairpins, barrettes, jewellery, watch, safety pins, paperclips, money clips, credit cards, bank cards, magnetic strip cards, coins, pens, pocket knife, nail clipper, steel-toed boots/shoes, and tools. Loose metallic objects are especially prohibited in the magnet room and MR Environment.

I attest that the above information is correct, to the best of my knowledge. I have read and understood the entire contents of this form and have had the opportunity to ask questions regarding the information on this form.

Person completing form:

Print name	Signature	Date

Form reviewed by:

Print name	Signature	Date	Position

PERFORM Center
MRI Facility

MAGNETIC RESONANCE (MR) IMAGING SAFETY CHECKLIST FOR RESEARCH PARTICIPANTS

This MR system has a very strong Magnetic Field (3 T) that may be hazardous to individuals entering the magnet room if they have certain metallic, electronic, magnetic, or mechanical implants, devices or objects. Therefore, all individuals are required to fill out this form BEFORE entering the magnet room. Be advised, the magnet is ALWAYS ON.

This questionnaire must be completed accurately to ensure safety. An answer of "Yes" in a category may not necessarily exclude you from entry into the MRI or its vicinity.

Full name: _____
Given / Middle / Family

DOB: _____/_____/_____

Weight: _____ **Height**: _____

Family Physician Name: _____

Address or City: _____

Please circle

Have you had prior surgery or an operation of any kind?	Yes	No
Have you had an injury to the eye involving a metallic object (e.g., metallic slivers, foreign body)?	Yes	No
Have you ever been injured by a metallic object or foreign body (e.g., BB, bullet, shrapnel, etc.)?	Yes	No
Are you pregnant or suspect that you are pregnant?	Yes	No

WARNING: Certain implants, devices or objects may be hazardous to you in the MR Environment or the magnet room. DO NOT ENTER the MR Environment or the magnet room if you have any questions or concern regarding a mechanical implant, device or object.

Please indicate if you have any of the following:

Aneurysm clip(s)	Yes	No	Body piercing	Yes	No
Cardiac pacemaker	Yes	No	Neurostimulation system	Yes	No
Implanted cardioverter defibrillator (ICD)	Yes	No	Spinal cord stimulator	Yes	No
Electronic implant or device	Yes	No	Cochlear implant or implanted hearing aid	Yes	No
Magnetically-activated implant or device	Yes	No	Insulin or infusion pump	Yes	No
Any type of prosthesis or implant	Yes	No	Implanted drug infusion device	Yes	No
Artificial or prosthetic limb	Yes	No	Metallic objects (e.g., permanent retainer, dentures, IUD, metal sutures)	Yes	No
Stents	Yes	No	Hearing aid (remove before entering the magnet room)	Yes	No
Any metallic fragment or foreign body	Yes	No	Tattoo	Yes	No
Medication patch (Nicotine, Nitroglycerine)	Yes	No	Other implant	Yes	No
Tissue expander (e.g., breast)	Yes	No	_____		
			_____		

IMPORTANT INSTRUCTIONS: Remove all metallic objects before entering the MR Environment or magnet room, including hearing aids, beeper, cell phone, keys, hairpins, barrettes, jewellery, watch, safety pins, paperclips, money clips, credit cards, bank cards, magnetic strip cards, coins, pens, pocket knife, nail clipper, steel-toed boots/shoes, and tools. Loose metallic objects are especially prohibited in the magnet room and MR Environment.

I attest that the above information is correct, to the best of my knowledge. I have read and understood the entire contents of this form and have had the opportunity to ask questions regarding the information on this form.

Person completing form:

Print name	Signature	Date	
Form reviewed by:			
Print name	Signature	Date	Position (MD, RN or RT)

For research study volunteers (to be completed at the end of the study)

Total time spent in magnet (minutes): _____

Time entered by (name): _____