UC DAVIS HEALTH | Imaging Research Center

MRI Safety Manual

4701 X Street
Sacramento, CA 95817
health.ucdavis.edu/irc/

Initially Prepared by the UC Davis MRI Safety Committee on February 21, 2024

MRI Safety Committee Contact Information

- Abhijit Chaudhari: ajchaudhari@health.ucdavis.edu
- Costin Tanase: ctanase@health.ucdavis.edu
- Greg Hodge: gchodge@ucdavis.edu
- Martha Forloines: mrforloines@health.ucdavis.edu
- Lindsey Mooney: lnmooney@ucdavis.edu
- Marjorie Solomon: marsolomon@ucdavis.edu
- Jerry Sonico: gjsonico@ucdavis.edu
- James Wallis: jmwallis@health.ucdavis.edu
- Charles Smith: chasmith@ucdavis.edu
- Sydney Huddleston: slhuddleston@ucdavis.edu

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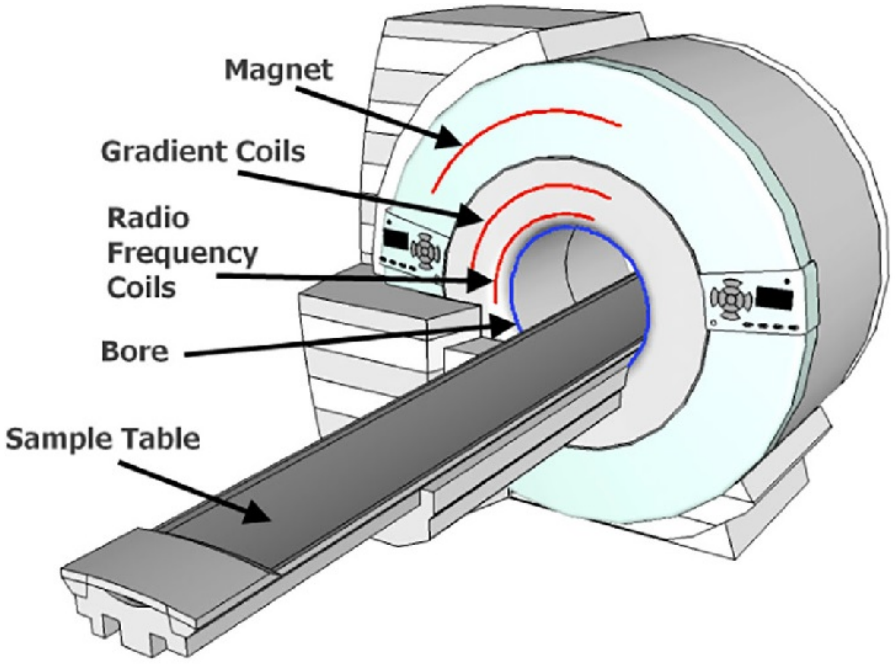
MRI Safety Guidelines for the UC Davis Imaging Research Center

Section 1

Introduction

The use of Magnetic Resonance Imaging (MRI) presents known safety hazards. MRI Safety Guidelines have been developed so that investigators, researchers, students, colleagues, study participants, and associated equipment remain safe in the magnetic environment. All personnel working within the magnetic environment are required to complete MRI safety training (see Section-4). The UC Davis Imaging Research Center (IRC) MRI Safety Committee has developed this guide of general MRI safety information for Research MRI Users.

Components of the MRI scanner system



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- The strong magnetic field is always present.
- The risk of the strong magnetic 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.
- Objects that are ferromagnetic may pin someone against the magnet in a life-threatening situation.
- Every individual must be screened for potential contraindication to safety PRIOR to entering the magnetic field.
- All equipment must be evaluated for potential risk PRIOR to being safely placed in the magnetic field.

The Radio Frequency (RF)

- Research participants and animals must be protected from potential heating and burns.
- The FDA sets limits to the amount of heating or the Specific Absorption Rate (SAR) that is allowed.
- Equipment and accessories must be used properly and safely to prevent heating or burns to the research participant or animal.

The Gradients or Time Varying Magnetic Fields

- Rapidly changing gradient fields used in MRI have the potential to cause peripheral nerve stimulation (PNS).
- Gradients produce excessive acoustic noise levels for which hearing protection must be provided and worn.

Ancillary equipment used for experiments

- All equipment placed in the magnetic environment must be considered for heating or any other potential safety risk.

Section 2

Purpose

The purpose of this MRI Safety Guidelines is to provide a resource for continued safe MRI practices within the UC Davis Imaging Research Center community. The UC Davis Imaging Research Center MRI Safety Committee developed the MRI Safety Guidelines based on locally accepted standards and the internationally accepted recommendations of the American College of Radiology (ACR). The initial Blue Ribbon Panel of the ACR, led by Emanuel Kanal, M.D., FACR, first published recommendations in 2002 with revised information in 2004, 2007, and 2013 white paper. The *ACR Manual on MR Safety 2024* is used as the primary reference for the MRI Safety program at UC Davis Imaging Research Center.

The 2025 recommendations are incorporated into daily practice and policy here in light of continuing reports of accidents in the magnetic environment involving both equipment damage and serious personal injury, including death within the MR community. The MRI Safety Guidelines are reviewed on a regular basis, modified as needed and posted on the UC Davis Imaging Research Center website.

The *ACR Manual on MR Safety 2024* recommends that:

- All MRI sites should maintain MR safety policies.
- The MRI Safety Guidelines should be reviewed concurrently with the introduction of any significant changes in safety parameters of the MR environment and updated as needed.
- Site administration is responsible to ensure that the MRI Safety Guidelines are always implemented and adhered to by all site personnel.
- All adverse events, MR safety incidents or “near incidents” are reported to the UC Davis Imaging Research MRI Safety Committee and used in continuous quality improvement efforts.

UC Davis Imaging Research Center suggests action consistent with the ACR recommendations to prevent accidents and injuries in the MRI suite. The risk reduction strategies include reference to the ACR guidelines.

Standard of Practice at UC Davis Imaging Research Center

It has been reported by other facilities that any of the MRI related injuries and the few fatalities that have occurred were the apparent result of failure to follow safety guidelines or the use of inappropriate or outdated information. It is required that all UC Davis Imaging Research Center MRI researchers complete safety training prior to obtaining access to the MRI environment. It is expected that all MRI researchers should execute proper and orderly procedures every time studies and/or developmental work are performed. UC Davis Imaging Research Center researchers and support staff assigned to work in the MRI area(s) are required to complete safety training and adhere to the MRI Safety Guidelines.

To maintain safe laboratory practice, at least two UC Davis MRI researchers, student or faculty member that are MRI safety trained must be present with the research participant for all MRI scanning during normal work hours, Monday through Friday, 8am to 5pm. After normal work hours, weekends, and holidays a minimum of two MRI safety trained individuals besides the research participant being scanned must be present. This means the scanner operator and the safety monitor who have both completed MRI safety training. A one-to-one ratio of safety monitors to non-safety monitors must be in the MRI scanning environment at all hours, holidays, and weekends that are in the control room (Zone 3) or scanner room (Zone 4) e.g. three MRI safety monitors for three non-safety monitors. For animal studies a minimum of two MRI safety trained individuals should always be present. This applies to all scanning hours including the evenings, weekends and holidays.

Section 3

Definitions

MRI Safety Committee

The MRI Safety Committee is the official committee of the UC Davis Imaging Research Center (IRC) that reviews, develops, and implements MRI Safety. The MRI Safety Committee meets on a quarterly basis. Members are appointed by the Director of the UC Davis Imaging Research Center. Meetings are conducted by the MRI safety officer.

MRI Medical Director or Research Director

The MRI Medical Director or Research Director is responsible for overseeing overall MR facility operational safety. The MRMD/MRRD or MRRD responsibility is to ensure policies and procedures are in place for the safe performance of MR procedures. These include:

- The appointment of an MRSO and advisory MRSE.
- The development, implementation, and maintenance of specific policies and procedures pertaining to the safe operation of MR services.
- The implementation and maintenance of appropriate MR safety and quality assurance programs.
- Appropriate ongoing assessment of risk for the facility.
- An appropriate system for record keeping and analysis of adverse events (with the MRSO and MRSE as needed).
- Appropriate investigation and recording of all reported MR safety adverse events.
- Site-specific MR Safety training requirements for MR Personnel and others accessing the MR environment.

MRI Safety Officer

The MRI Safety Officer is an American Registry of Radiologic Technologists (ARRT) registered professional with the knowledge and experience to oversee day-to-day operations of the MRI Suite and implement UC Davis Imaging Research Center MRI Safety Program. The MRI Safety Officer is appointed by the MRMD/MRRD. The MRI Safety Officer's primary function is to support the research activities conducted within the MRI Suite by MRI research users while overseeing the safe operation of the MR Scanner and compliance with all relevant regulations, and UC Davis Imaging Research Center policies and procedures. The MRSO responsibilities include:

- Ensuring accessibility at all times, if the MR facility is in use, to the operators of MR scanners.
- Ensuring that policies and procedures of the MRMD/MRRD are implemented and always enforced.
- Development, documentation, and execution, in conjunction with and under the authority of the MRMD/MRRD, of safe working procedures for the MR environment.

- Ensuring that adequate written safety procedures, emergency procedures, and operating instructions are issued, in consultation with the MRMD/MRRD and MRSE, as needed.
- Ensuring the implementation and monitoring of appropriate measures for minimizing risks to staff and patients in cooperation with the MRMD/MRRD.
- Managing hazards posed by the MR equipment and monitoring the measures taken to protect against such hazards.
- Ensuring, in cooperation with the MRMD/MRRD, that medical, technical, nursing, emergency, and all other relevant staff groups (including ancillary workers) who may be exposed to the MR environment are educated appropriately and updated as necessary as to MR safety requirements.
- Providing and/or ensuring the provision of MR safety education and training in cooperation with and as per the policies of the MRMD/MRRD and maintaining records of personnel education.
    - Ensure safety training to include understanding of the specific Instructions for Use (operator manual) for every MR system.
- Consult the MRMD/MRRD /MRRD and/or MRSE when further advice is required regarding MR safety.
- Reporting back to the MRMD/MRRD in a timely fashion all MR safety–related issues.
- Ensuring that there is a clear policy for purchasing, testing, and clearly marking of all equipment that will be taken into Zones III and IV.
- Providing safety advice on the modification of MR protocols (in cooperation with the MRMD/MRRD and/or MRSE) if/as needed.
- Maintaining regular contact with other relevant groups or committees responsible for the safety and welfare of personnel on-site.
- Providing expertise in root cause analyses, solutions meetings, etc., related to MR adverse events.

MRI Safety Expert

This individual is expected to serve as a resource for the MRMD/MRRD and MRSO for technical- and physics-related MR safety issues. The MRSE may be external to the organization. MRSE is often an MR physicist. It is expected that the MRSE will serve in an advisory role for the IRC. The MRSE responsibilities include:

- Providing advice on the engineering, scientific, and administrative aspects of the safe use of MR equipment, which includes quantification assistance for energy, force, and risk exposures.
- Providing advice on the development and continuing evaluation of a safety framework for the MR environment.
- Providing advice for the development of local rules and procedures to ensure the safe use of MR equipment.

- Providing safety advice regarding non-routine MR procedures, which includes advice regarding safety related to implanted devices and other similar issues.
- Providing advice on MR Safety and MR quality assurance programs, evaluations, and audits.
- Providing safety advice regarding equipment acceptance testing.
- Establishing and maintaining links with appropriate regional and professional bodies and reporting back to the MRMD/MRRD and MRSO on safety-related issues.
- Providing expertise in root cause analyses, solutions meetings, etc., related to MRI adverse events.

MRI Research User

The MRI Research User, hereafter *researcher*, is a Principal Investigator (PI) who has an IRB or IACUC approved protocol and utilizes one or more of the MRI scanners affiliated with UC Davis IRC for research purposes and/or a student, staff member or research assistant for whom the PI is responsible. Researchers must have approval via the UC Davis IRC Protocol Initiation form, and approved IRB or IACUC protocol. Only researchers with approved protocols are allowed to schedule MRI scanner time for research studies.

Research Participant

A research participant is a human subject who is placed into the MRI scanner for research purposes. The research participant must complete and sign both IRB consent and MRI pre-screening form prior to the MRI scan. The research participant must be treated and cared for within all institutional and federal guidelines and regulations.

MRI Scanner Operator

The MRI scanner operator is an individual who is an UC Davis affiliated personal that has completed the MRI safety training and is specially trained in the operation of one or more of the MRI scanners at the UC Davis IRC. Under grad students or volunteers are not eligible for MRI operator training. It should be noted that the trained UC Davis MRI scanner operators have authority by the MRI Safety Committee to stop any procedure they feel does not follow safe practices.

MRI Safety Monitor

The MRI safety monitor are individuals who are UC Davis affiliated personal that oversees the safety procedures during MRI scans to ensure the well-being of subjects, visitors and staff. They are responsible for enforcing guidelines, identifying potential hazards, and providing immediate assistance in case of emergencies related to MRI operations.

MRI Scanners

The available MRI scanners as of April 2026 at the UC Davis Imaging Research Centers are:

- Siemens 3T Prisma Fit (Sacramento)
- Siemens 3T Skyra (Davis)

Section 4

MRI Safety Training Procedure

Safety Training for all MRI Researchers is mandated by the MRI Safety Committee and has evolved to include the steps described below.

Overview

Safety training is required for all scanner operators and safety monitors. This involves an initial online safety training (https://health.ucdavis.edu/irc/content/start/safety.html). After passing the online MRI safety training, you will need to schedule an onsite MRI safety training with James Wallis (MR Safety Officer). **Safety training must be renewed annually by all active scanner operators and safety monitors. If your MRI Safety training has expired, you will not be allowed to operate the MRI scanner or serve as an MRI Safety monitor until completed. If you are a PI and your MRI safety certification has expired, you will not be able to conduct your MRI study until the MRI safety training is completed.**

Onsite MRI Training includes discussions on, but are not limited to the following:

- Indications for use of the MRI system
- Restrictions on use of the MRI system
- Contraindications for use of the MRI system
- Use of visual hazard warning signs
- Burn hazards (including precautions on patient positioning, precautions for larger patients, effective use of patient comfort monitor, precautions on using surface coils, warnings associated with using EKG pads and electrodes, and warnings associated with using peripheral pulse hemodynamic gating)
- Radiofrequency (RF) heating
- Warnings associated with body temperature increases during scanning
- RF power deposition considerations, including face and eye hazards associated with cosmetics and exposure to metal slivers
- Magnetic fringe field warnings and hazards
- Acoustic noise hazards during scanning
- Psychological hazards associated with MR scanning (e.g. claustrophobia)
- Precautions associated with scanning pregnant or infant patients
- Bio magnetic hazards such as subtle genetic or molecular changes,
- Precautions associated with scanning high risk participants (such as those likely to develop seizure or claustrophobic reactions, participants greater than normal risk of cardiac arrest, unconscious, heavily sedated, or confused participants with whom no reliable communication can be maintained)
- Problems associated with the operators limited view of the participant while the participant is in the MRI system.

Additional training is provided in MRI emergency treatment and prevention, such as how to inform the participant about the risks of the procedure, how to explain to the participant the use of the alert system within the MRI system, reviewing the procedures to follow in the event that the participant requires medical emergency attention during the scanning session, reviewing the procedures in the event that the magnet quenches or that the cryogen venting system fails. The call button alert system, and the magnet bore temperature monitor within the system, are provided to aid the researcher in the assessment of acute participant distress. Finally, a review is done of situations requiring immediate action on the part of the researcher, e.g. an MRI system failure that risks participant well-being, an acute medical condition of the participant such as a heart attack, or a life threatening situation such as the participant becoming pinned against the magnet by a ferromagnetic object, requiring an emergency “controlled rundown” of the main magnetic field known as a quench.

Section 5

MRI Safety Screening

General Procedure

Everyone must be checked for safety and pre-screened prior to entering the magnetic environment of the scanner room. A standardized MRI pre-screening form is used for evaluating the safety of an individual BEFORE that individual is permitted within the magnetic environment. MRI Safety Screening Training is a segment of the requirement for MRI researchers (see appendix for MRI pre-screening form).

The MRI environment

The MRI environment is that area passed the security doors requiring an electronic key card. The establishment of thorough and effective screening procedures for research participants and other individuals is one of the most critical components of a program to guard the safety of all those preparing to undergo MRI procedures or to enter the MRI environment. An important aspect of protecting individuals from MRI system-related accidents and injuries involves an understanding of the risks associated with the various implants, devices, and accessories which may be present within or adjacent to the individual. The risks of other objects that may cause problems in this setting must also be evaluated. This requires obtaining information and documentation about these objects to provide the safest MRI environment possible. In addition, because many MR related incidents have been due to deficiencies in screening methods and/or lack of proper control of access to the MRI environment, (especially with regard to preventing personal items and other potentially problematic objects from entering the MRI room) it is crucial to establish procedures and guidelines to help prevent such incidents from occurring.

Exclusions of Individuals and Research Participants

Individuals and research participants with cardiac pacemakers, implanted neural stimulators, or with attached or implanted electronic devices, with brain aneurysm clips, are specifically excluded from having MRI scans. All participants that have other types of implanted devices must have approval by the safety officer and/or the MRI safety committee even if a medical doctor approves the implanted device safe for MRI scanning. The MRI operator must notify the PI of a participant's implanted device prior to scheduling for further evaluation of a participant's compatibility to be scanned. **(Refer to Appendix: Procedure for approval of MRI scanning with implants.)**

Personnel

All personnel, including researchers, employees and students, who work within the magnetic environment, must be trained according to UC Davis IRC safety policy and screened for personal safety prior to entering the magnetic field. In addition, employees and researchers who have responsibility to recruit subjects, and/or screen subjects for MRI safety who are not

MRI safety trained are required to have an MRI safety trained individual involved with the specific MRI research study to verify that the participant is safe to scan. MRI Safety trained individuals must participate in an Annual Renewal of MRI Safety.

To work unescorted in the magnetic environment, it is mandatory to complete the required MRI safety training. This includes all scanner operators and individuals who are assisting as MRI safety monitors with MRI research studies. Operators who will be scanning research participants or animals must complete operator on-site training. Non-UC Davis personnel may not be trained to operate the MR scanner, without specific approval of the Director. **Undergrads or volunteers are not eligible for MRI operator training.** Any individual who has a need to enter the magnet room, i.e. facility maintenance employees, site visitors, etc., must be screened on a case-by-case basis.

Pregnancy

Individuals who are or may be pregnant are not allowed to remain in the MR scanner room while the RF and gradients are operating. Pregnant individuals may remain in the control room (Zone 3) and enter the magnet room (Zone 4) between scans, during the study. This includes staff or individuals accompanying the research participant.

Female research participants that are pregnant are not eligible to participate in an MRI scan. If a research participant suspects pregnancy, the MRI scan will be postponed until the research participant is able to confirm that she is not pregnant.

Research Participants

The preservation of a safe MRI environment requires constant attention to the care of research participants and individuals with metallic implants and devices, because the variety and complexity of these objects constantly changes. With the continued advances in MRI technology and the development of more sophisticated implants and devices, there is an increased potential for hazardous situations to occur in the MR environment. Therefore, to prevent incidents and accidents, it is necessary to be aware of the latest information pertaining to MR biological effects, to use current evidence-based guidelines to ensure safety for research participants and staff members, and to follow proper recommendations pertaining to biomedical implants and devices.

Preliminary screening of research participants for MRI procedures should take place during the scheduling process. This must be conducted by an individual who is involved with the research study and able to recognize:

- The potential hazards and issues associated with the MRI environment and MRI procedures.

- The information contained on the screening form for research participants and individuals that are contraindications for MRI.
- When to contact an MRI safety trained individual, MRI safety officer, or the UC Davis IRC MRI Safety Committee for further evaluation of a participant's compatibility to be scanned.

Preliminary screening helps to prevent scheduling of research participants who may be at risk for safe MR imaging.

At the UC Davis Imaging Research Center, it is mandatory for every research participant to undergo comprehensive MRI screening in preparation for the MRI study. Comprehensive MRI screening involves the use of the approved UC Davis IRC MRI pre-screening form to document the screening procedure, a review of the information on the screening form, and an oral interview to verify the information and allow discussion of any question or concern that the research participant may have. All sections of the UC Davis IRC MRI pre-screening form must be completed and include date and signatures of the reviewer and research participant. An individual who has completed MRI safety training must conduct this aspect of research participant MRI screening.

It should be noted that having undergone a previous MRI procedure without incident does not guarantee a safe subsequent MRI examination. Various factors (e.g., static magnetic field strength of the MR scanner system and orientation of a metallic implant or object) can substantially change the scenario. Therefore, a comprehensive screening procedure must be conducted every time a research participant prepares to undergo an MRI procedure. This is not an inconsequential matter, because a seemingly unrelated event may have occurred that could affect the safety of the research participant entering the MRI environment.

To summarize, each research participant considered for an MRI procedure should be screened a total of three times:

- By the individual scheduling the procedure.
- By the individual greeting the subject upon arrival at the site.
- By the individual who is conducting the study or operating the MR scanner.

Implants and devices

Implants and devices are evolving rapidly and must be thoroughly investigated if potential participants or individuals who will enter the magnetic environment indicate their presence. Implants that are approved to scan at 1.5T are not necessarily safe to scan at 3T. Before scheduling a participant that has an implanted device, both the PI and the MR safety officer must be notified to confirm compatibility of the implanted device with the magnetic field strength

that will be used to perform the MR scan. If the individual knows or has documentation as to the specific manufacturer and type of device, then the following steps are implemented:

- Look up the item by the manufacturer in the current ***Reference Manual for Magnetic Resonance Safety, Implants, and Devices*** by Frank G. Shellock, Ph.D. or on the web site: http://www.mrisafety.com.

If the device or object is not listed in the above reference manual or has not been tested at 3 Tesla, then contact the manufacturer for the following information and written documentation:

- Have the manufacturer fax the text that states the device is MRI compatible and at which magnetic field strength(s), and conditions, it is safe.
- The manufacture's MR safety statement must verify the device is MRI compatible and/or state the specific conditions which must be adhered to for the field strength the individual will be entering.

The assurance of safety needs to be verified BEFORE the participant or individual is brought to the MRI scanner so that the operator has adequate information to ensure the safety of the individual they are placing or leading into the magnetic environment.

For research participants, include the device information with the consent and MR safety screening form so there is documentation that the safety of the subject was investigated before the MRI study was performed.

Screening Patients and Individuals with Metallic Foreign Bodies (Frank Shellock)

All participants and individuals with a history of being injured by a metallic foreign body such as a bullet, shrapnel, or other type of metallic object should be thoroughly screened and evaluated prior to admission to the area of the MR system. This is particularly important because serious injury may occur because of movement or dislodgment of the metallic foreign body as it is attracted by the magnetic field of the MR system. In addition, heating may occur, although this tends to only happen if the object forms a resonant conductive loop.

The relative risk of injury is dependent on the ferromagnetic properties of the foreign body, the geometry and dimensions of the object, the strength of the static magnetic field, and the strength of the spatial gradient of the MR system. Additionally, the potential for injury is related to the amount of force with which the object is fixed within the tissue (i.e., counterforce or retention force) and whether it is positioned in or adjacent to a particularly sensitive site of the body. These sensitive sites include vital neural, vascular, or soft tissue structures.

The use of plain film radiography is the technique of choice recommended to detect metallic foreign bodies for individuals and research participants prior to admission to the MR

environment. The UC Davis IRC does not provide plain film radiography, and therefore a participant should not be admitted to the MR environment until they have had plain film radiography documenting that there is not any potential danger to the participant. This includes screening individuals and participants for the presence of metallic orbital foreign bodies. The inherent sensitivity of plain film radiography is sufficient to identify any metal with a mass large enough to present a hazard to a research participant in the MR environment.

Orbital foreign body screening guidelines

The procedure to follow regarding an individual or research participant suspected of having an orbital foreign body involves a clinical screening protocol that entails asking the individual or research participant if he or she has had an eye injury. If an eye injury from a metallic object was sustained, the individual or research participant is asked if they have had an MRI scan that was cleared by conventional radiography (x-rays) after the eye injury. If the individual or research participant indicates that they have had an MRI scan after the eye injury that has been cleared of metallic objects by x-rays, then the individual or research participant may proceed with the MRI scan. If the individual or research participant has had an ocular injury but has not been cleared of metallic objects sustained to the eyes, then the individual or research participant must have x-rays to confirm that there are not any metallic objects in the eyes. The MRI scan must be postponed until documentation has been received indicating that there are not any metallic objects in the eyes.

Hearing Protection

Anyone in the scanner room while the scanner is in operation must be provided with and must use hearing protection in the form of earplugs and/or headphones to avoid hearing injury from the acoustic noise generated by the scanner. According to the Siemens documentation, if you are using the Siemens headphones you **MUST** also provide the subject with earplugs for additional hearing protection.

Claustrophobia Screening

Statistics indicate that about 10% and up to 20% of the general population is claustrophobic to some degree. In many cases research participants who think they are claustrophobic can go through an MRI study with some reassurance.

Medical Status Screening

Research participants must be evaluated for medical status or issues that may prevent them from lying flat or holding still for long periods of time. Research participants who are dependent on continuous medication via external or internal devices should be excluded from research MRI studies. Research participants who do not understand directions or cannot cooperate with the researchers to ensure a successful study should be excluded. In addition, research participants

that are unable to ambulate on and off the MRI table with minimal assistances may be excluded from an MRI research study.

Exceptions may be evaluated on a case-by-case basis depending on the purpose of the MRI study.

Magnetic field-related issues and Screening

Magnetic field-related translational attraction and torque are known to present hazards to individuals and research participants with certain implants or devices. MR systems used in clinical and research settings operate with a static magnetic field that ranges from 0.2T and higher. Most previous ex vivo tests were performed to assess objects for MR safety used units with a static magnetic field of 1.5T or lower. Accordingly, this could present problems, insofar as it is possible that an object that displayed “weakly” ferromagnetic qualities in association with a 1.5T MR system may exhibit substantial magnetic field interactions with an MR system operating at a stronger static magnetic field strength. The magnetic field strength currently used for research participants at UC Davis Imaging Research Center are 1.5T and 3.0T. If implants or devices are safe for 1.5T, this does not necessarily mean that they are safe for 3.0T. Documentation must be obtained from the manufacturer as to the safety of a particular device at 3.0T before it is allowed or brought into the magnetic environment.

Equipment Screening

Any additional equipment to be used that is not currently in use within the magnet room must be approved by the UC Davis IRC MRI Safety Committee or the MR safety officer. Researchers are cautioned to NEVER take equipment into the magnet room without prior testing for magnetic attraction. Researchers are cautioned to NEVER implement the use of equipment with research participants before testing with a phantom or other method that will not potentially cause harm to a research participant or to related equipment. Equipment operating within the magnetic environment must be monitored for any spurious signals that may cause artifacts on images or acquired data.

MRI safe equipment is developed for specific magnetic field strengths and MRI system configurations. Equipment that may operate safely within a magnet room is NOT necessarily safe to operate in another magnet room even if the magnets have the same static field strength. Routine inspection and maintenance of equipment must be performed. Broken or malfunctioning equipment must be identified and reported to the IRC Tech support team.

Incidental Findings

Incidental findings are described as abnormal anatomical structures displayed on the MRI images of the research participant’s MRI scan that is observed by MRI researchers. MRI researchers will report any incidental findings via email to the following: Director, Technical Director and Safety Officer.

Section 6

Emergency Safety Procedures

General Procedure

In an MRI environment emergency, orderly and proper procedures ensure the safety of individuals, researchers and the research participant. In the event of an emergency, call 911 and provide the reason for the emergency and the location. Furthermore, emergency personnel must be met at the locked electronic doors and advised that a strong magnet field is present, and precaution must be observed.

Research Participant Scanning

It is essential that there is constant communication between the research participant within the MRI scanner and the scanner operator. Each research participant receives a squeeze ball to alert the scanner operator if any difficulties occur, even when the scanner is running and producing loud noises. During the quiet times of the study the scanner operator should maintain verbal contact with the research participant. A research participant who does not respond verbally requires immediate investigation to ensure the research participant's wellbeing.

Medical Emergency

If the research participant has a medical emergency, they must be removed from the magnet room and into the control room to prevent a potential accident due to ferromagnetic projectiles in the event emergency personnel enter the magnetic room with equipment. If the medical emergency is due to the individual being trapped in or on the magnet and is in a life threatening situation, it may be necessary to quench the magnet to rescue the injured individual. The event must be reported to the Principal Investigator and the UC Davis IRC MRI Safety Committee.

Emergency Stop

If there is an emergency such as an equipment failure that could cause injury; sparking of equipment, a flood or a fire, the scanner operator or safety monitor should immediately press the emergency stop button.

Magnet Emergency

If an individual or research participant is restrained or pinned by a ferrous object to the magnet: Assess if the situation is life threatening. If YES, an emergency rundown to quench the magnet can be performed by an authorized person (see emergency quench below). If an individual or research participant is restrained by a ferrous object to the magnet and is NOT in a life-

threatening situation, call a member of the IRC tech support team during normal business hours or Siemens Online support to determine the optimal way of releasing the individual or research participant from the magnetic field. If a quench is necessary, proceed as above. It is the responsibility of the scan operator to document the accident within 24 hours and submit a written explanation of the accident to the MRI safety officer.

Emergency Quench

A quench includes the rapid release of cryogens and results in the loss or significant decrease of the magnetic field. A quench should ONLY be performed by authorized personnel in dire emergency that involves a serious personal injury or life-threatening situation. Sudden loss of the magnet field in a quench situation could cause debris and freezing gases to enter the room. Also, this rapid loss of cryogens could potentially damage the magnet or components of the system. There is a considerable cost related to quenching the magnet and re-implementing the magnetic field. The strong magnetic field will dissipate in about a minute, releasing the individual.

Note: in extraordinary circumstances such as an earthquake or explosion, resulting in an uncontrolled quench, the oxygen level in the magnet room may significantly decrease possibly making breathing difficult.

Section 7

MRI pre-screening form

The MRI pre-screening form for Human Subject Participants in use at UC Davis IRC is:

- A standardized form that will ensure the safety of UC Davis IRC research participants and individuals.
- The only approved MRI pre-screening form that will be used for screening of research participants or individuals at the UC Davis IRC. Any modification to the UC Davis IRC MRI pre-screening form without review and approval by the MRI Safety Committee is strictly prohibited.

Standard MRI pre-screening form

MR Safety Screening Forms written or electronic MR safety screening forms are essential in efforts to prevent unsafe exposures to the Zone IV MR environment for research participants, and other individuals as well as for MR Personnel, non-MR Personnel, and any others. The MRI pre-screening form can be accessed on the IRC website:
(https://health.ucdavis.edu/irc/content/start/documents.html).

Outdated MRI pre-screening forms are not acceptable. Different MR screening forms, including those with modifications or revisions, require approval of the MR Safety Committee. No empty responses are accepted, and each question must be answered with a yes or no, or specific further information must be provided as requested. The patient, guardian, or research participant and the screening MR staff member must each physically or electronically sign the completed form to acknowledge the accuracy of the information provided. If the research participant is a minor, the parent or guardian must complete the form. This form should then become part of the participant's personal research record. Additional written or verbal information for inclusion on a screening form must be provided by a lab member, scanner operator or PI or other reliable source (e.g., those knowledgeable about specifics related to an implanted device) and documented.

Required Signatures and Date

The last section of the MRI pre-screening form must have the printed name and signature of the individual that is completing the form and the safety trained individual that is reviewing the MRI pre-screening form. The date must be entered by the individual(s) that complete the form and review the form. The MRI pre-screening form is a medical-legal document and is invalid if printed name, signatures, or date are not included.

Section 8

Facility Design

Safety Zones

The UC Davis IRC building where the MR scanner is housed is divided into four safety zones in accordance with the *ACR Manual on MR Safety 2024*.

Zone 1: Includes all areas accessible to the public (the areas outside the electronic doors). The MRI screening room where participants are greeted and screened before entering the scanner environment

Zone 2: The interface between publicly accessible Zone 1 and the restricted Zones 3 and 4. Includes entrance through the electronic doors, behavioral testing room, rest room, and research participant screening including ferromagnetic detection.

Zone 3: Is the region in which free access by unscreened non-MR personnel or ferromagnetic objects or equipment can result in serious injury or death. Zone 3 is strictly controlled. The MRI Control Room and MRI Equipment Room are Zones 3a and 3b, respectively. Entrances to Zone 3 should be identified with appropriate signage denoting the Zone 3 space and appropriate access control utilized.

Zone 4: Is synonymous with the MR scanner room, that is, the physical confines of the room within which the MR scanner is located. Zone 4, by definition, will always be adjacent to Zone 3 as it is the MR magnet and its associated magnetic field that generates the existence of Zone 3. The 5-gauss line is at the door entrance of the Zone 4 (MR scanner room) for the 3T. “Magnet is Always On” signage must be visible under all conditions for superconducting systems. Zone 4 MR system room door will be always closed except for prepping for an MRI research study.

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. Quench is accompanied by a loud noise, which would startle persons in the facility and surrounding area. The helium released to the outside air is not toxic or harmful. In addition, there is an accessory quench door that is manually opened to release helium gas in the event of a quench.

Security Access to MRI Suite

Access to open the doors to enter the MRI Suite is controlled by electronic key card. The doors must not be left open at any time. If the doors are left open longer than 30 seconds, an audible alarm will be activated until the doors are closed as a reminder not to leave the doors open.

Restriction of food, beverages, tobacco products

No food, beverages, or tobacco products will be consumed or used in the MRI suites by participants or research personnel. These items may be stored in provided lockers or in the kitchen.

Section 9

Gadolinium Contrast

The American College of Radiology (ACR) guidelines on gadolinium contrast agents (2010) will serve as the standard of practice when administering gadolinium contrast agent for clinical trial participants or research participants requiring gadolinium. Please refer to link:

https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Contrast-Manual

Appendix:

Procedure for approval of MRI scanning with implants:

- If participants have any type of implants (i.e. orthopedic hardware, heart stents, surgery clips, electronic implants, etc.), you cannot proceed with the MRI scan until it has been approved by one or all the following IRC personnel: James Wallis, and/or Abhijit Chaudhari.
- If a participant has had an MRI with an implant, never assume that the participant is safe to scan. You must still have approval before scanning your participant.
- When approval of the implant is needed, have the name of the manufacture, name of the implant, model number of the implant, and physician's operative report.
- Always allow a minimum of seven days before an appointment to confirm the conditions needed to safely scan the participant with an implant.
- If unable to acquire written documents confirming the conditions to safely perform an MRI scan, the participant cannot be allowed to participate with the MRI scan.
- Violation of this policy is grounds for immediate suspension of the research lab and all scheduled MRI scans will be cancelled until violation has been resolved.

Approval of items to be used during MRI Scan sessions

- Items that are not already in Zone 4 (Scanner room) must **NOT** be brought into Zone 4 without being first approved for MRI safety by the MRI Safety Officer.
- The item will be stored at the respective MRI scanning facility (Davis or Sacramento) until the time of the scan session. This is to confirm that the item is not substituted for a similar item that has not been approved and brought into the MRI scanner.
- If an item is brought with the subject but has not been approved and is brought into Zone 4, this is a direct violation of this policy, and the lab will be suspended, and disciplinary action will be taken.

Service and support animals

- Service and support animals are restricted in Zone 4 due to screening challenges for their safety and the safety of research participants and MR Personnel. The service animals will remain in Zone 1 with supervision designated by the owner of the service/support animal that is not a research lab member.