UC Davis Imaging Research Center

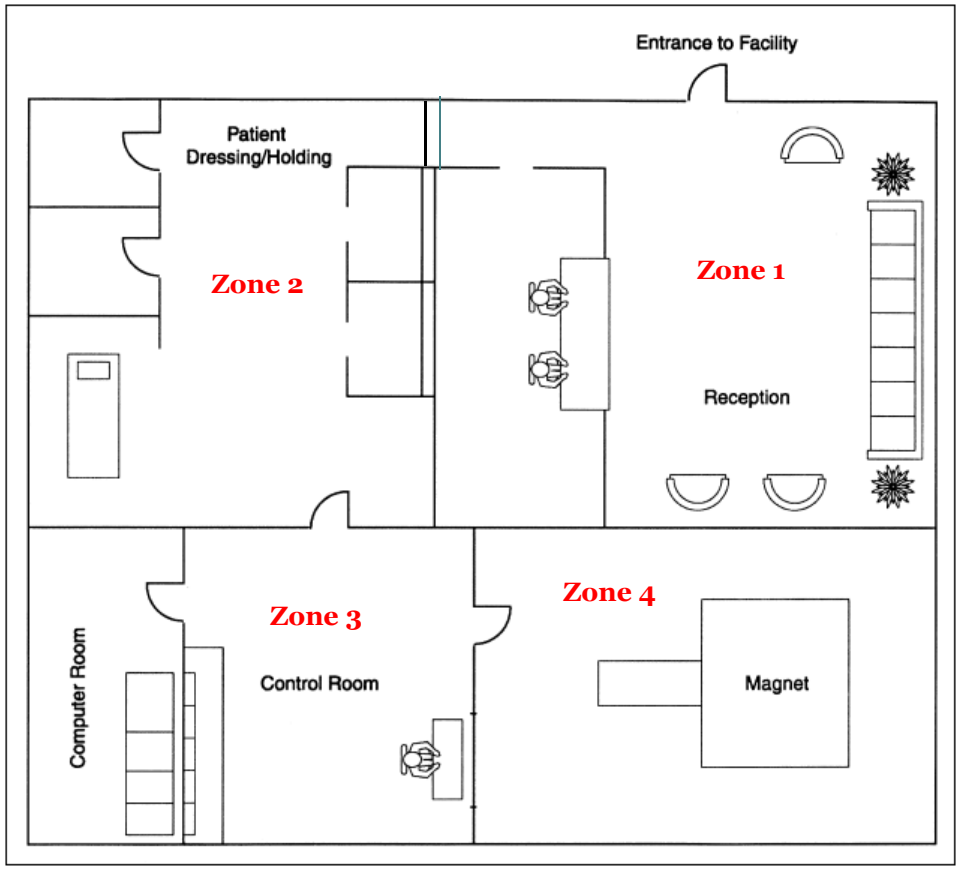
MRI Online Safety

Who should know MR Safety?

- All persons that have reason to enter the MR suite area should be trained in MR safety procedures. These include but are not limited to:
  - MR technologists, support personnel, researchers, research assistants
  - Research volunteers and test subjects
  - Maintenance and janitorial personnel

- Public safety forces (i.e. medical, law and fire personnel) that would respond to the MR suite for an emergency must also know the potential hazards of the MR equipment.

ACR Zone Recommendations



American College of Radiology Zone Recommendations

Zone 1: Is the unrestricted area. Anyone is free to move about. You will have the participant complete the MRI screening form in Zone 1.

Zone 2: Is restricted to card key access. All persons must be accompanied by Safety Trained Personnel.

Zone 3: Consists of the scanner control rooms. Two Safety Trained Personnel must be available after normal working hours.

Zone 4: Consists of the MRI scanner. MRI Screening Form must be completed before entering.

At UC Davis IRC you must follow the Zone recommendations

ACR Zone Recommendations

Compliance with the following protects you, subjects and guests:

- If you are the primary person responsible for the study remember that all subjects, family members or guests must be accompanied by a safety trained personnel.
- If you are having a guest observe your experiment and they will be entering the scan room, they MUST complete the MR screening form on each visit.
- The IRC receptionist is not allowed to open the electronic doors for your guest. Please, give your guest the phone extension of the scan room so your guest can call when they arrive. You will let them in, not the IRC receptionist.
- Always have a line of sight on your subject, guests and other personnel that are not safety trained to avoid potential accidents.

“Zone 2” Security and Safety

Entrance into “Zone 2” is secured by electronic locking doors. There are two electronic locking doors: 1) from the lobby and 2) from the back entrance hallway. All visitors and subjects must be accompanied by MRI Safety trained personnel into “Zone 2”. These doors are locked for your protection and must never be left open as unauthorized personnel may enter jeopardizing you or your subject’s safety. Violations will be subject to review by the UC Davis IRC Safety Committee with possibility of, but not limited too, additional MRI Safety training and/or suspension.

Entrance from lobby

Entrance from back hallway

"Zone 3" Security and Safety

- Final preparations and instructions are given to your participant in Zone 3.
- All metal items must be removed in Zone 3 prior to entering Zone 4.
- Eating and drinking is not allowed in Zone 3 or Zone 4.

“Zone 4” Security and Safety

- The MRI scan operator or PI onsite is ultimately in charge, and must monitor all actions going into Zone 4 to ensure that all lab members and subjects comply with UCD IRC safety policies.
- If you have a subject or a subject’s guest in Zone 4, never leave them unattended without a safety monitor present. This is a very dangerous safety violation which will result in immediate suspension.
- Never bring any unapproved equipment or objects into Zone 4. All equipment or objects that are not approved will need to be submitted to the MRI safety committee for approval.
- Never leave the door open after you have completed your study. Confirm that the door is closed and sealed (toggle switch is in up position). In addition, at the Skyra MRI scanner, when the study is completed, lock the door going into Zone 4.

"Zone 4" Security and Safety

The following equipment must be MRI safe before bringing into "Zone 4" – MR scan room:

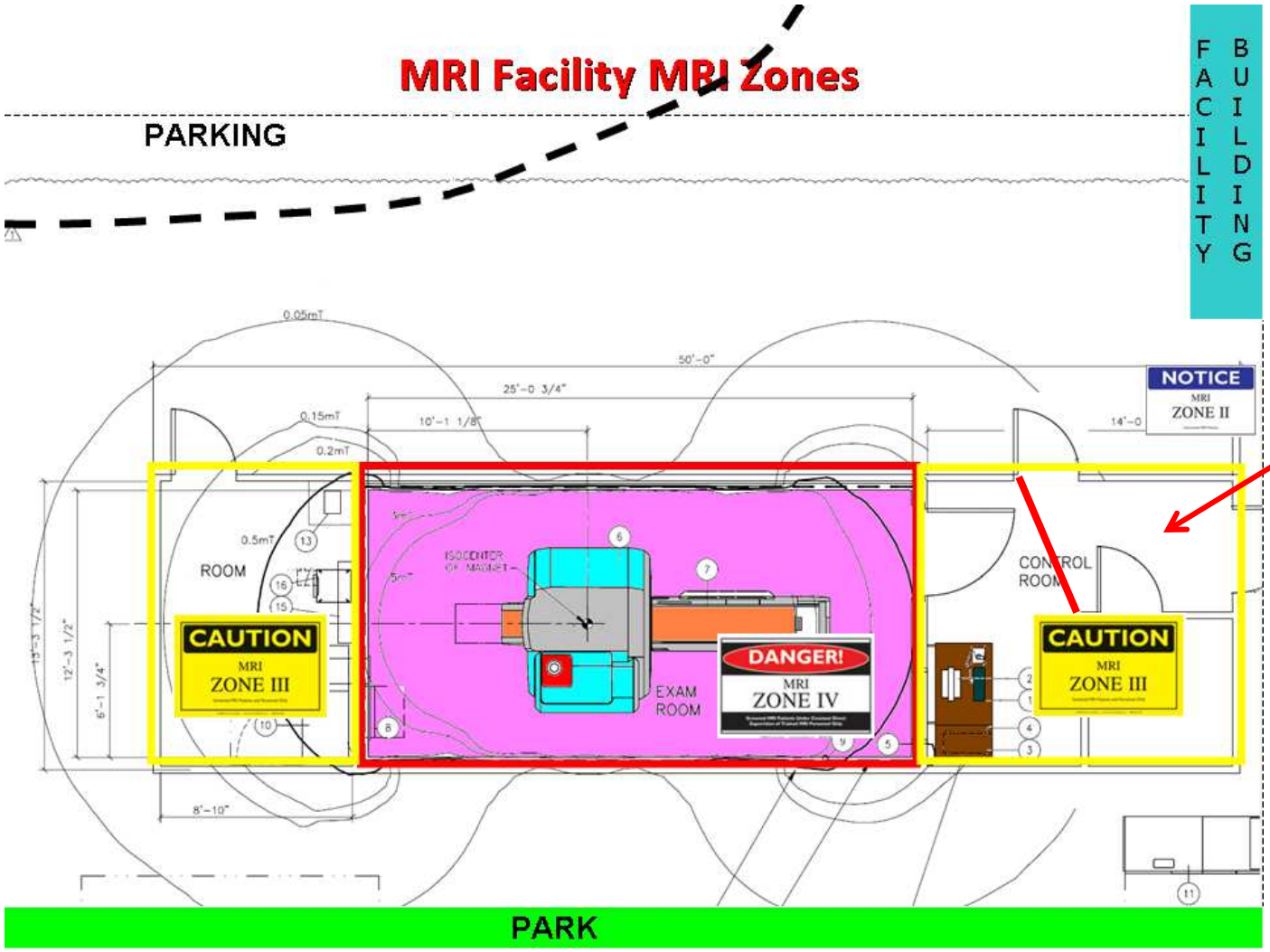
- Non-ferrous IV Poles, Wheelchairs, Oxygen Tanks, Medical supplies, Gurneys, etc.
- Monitoring Equipment
- Testing Equipment not onsite

You may see these stickers on some equipment. The green sticker indicates it is safe in the magnet room the red sticker indicates that it is not safe in the magnet room.

Skyra 3T MRI: ACR Zones

- Zone 1 and Zone 2 are outside the Skyra MR scanner building. The MR screening form must be completed before entering Zone 3.
- When you enter the Skyra MR scanner building you will be in Zone 3. Every precaution must be observed when bringing non-MR Safety individuals into Zone 3.
- No one that has electronic implants is allowed in Zone 3 in the Skyra MR scanner.
- Zone 3 is separated by a red line on the floor. Go to the left of the red line and remove any metal on you and do not cross the red line to the MR console with any metal brought with you (i.e. pens, paper clips, binders, clip boards etc.).

ACR Zone Recommendations Skyra



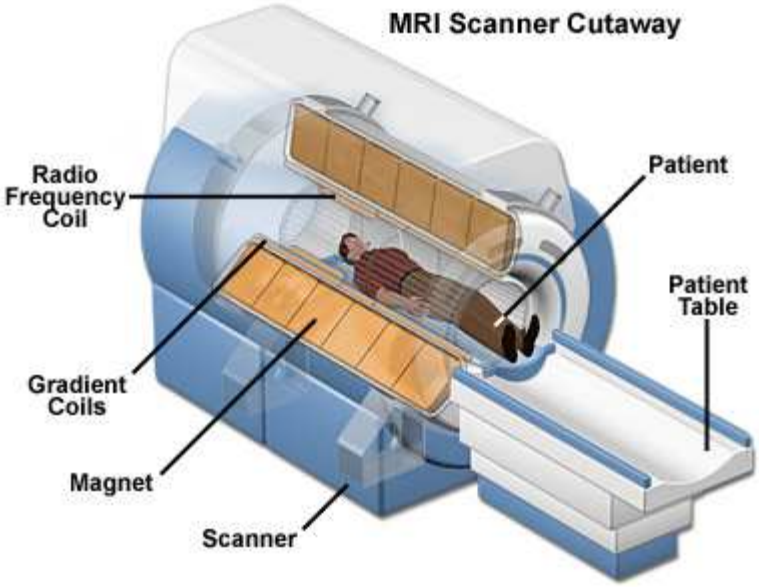
All metal items must be removed in this section to allow safe crossing of the red line, to prevent any metal becoming projectile in Zone 4.

The Magnetic Field of the MRI Scanner

- Is always on, 24hrs/day, 365 days/year.
- The magnetic field is on even when the magnet is NOT in use.
- Even if the electrical portion of the machine is off or a power outage occurs, the magnetic field is still up.
- Anyone operating the MRI scanner and or acting as a safety monitor must be trained in MRI safety.
- The MRI Safety Officer has the final say in who may be allowed to go into the scanner room.

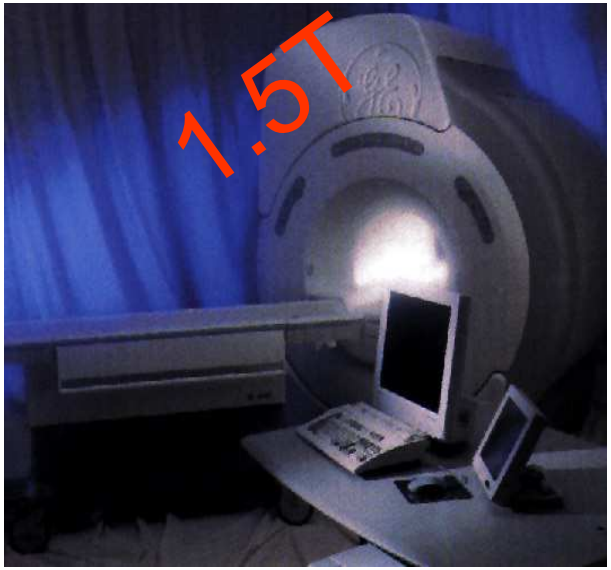
Types of Magnetic Fields in MRI

- Static (magnet) Field
- Gradient (time-varying) Field
- Radiofrequency (RF) Field



Magnetic Field Strength

- Proportional to system field strength
- Less with lower field systems greater with higher field systems



3Tesla MRI Scanners

- The main magnetic field of a 3T system is **60,000** times the earth's magnet field.
- It is double the strength of a 1.5T operating system.
  - It is important to remember that implants (i.e. orthopedic implants, etc.) that are clear for a 1.5T magnet may not be safe for a 3T magnet unless it has been cleared for a 3T machine.
- Mrisafety.com has the largest database of items that are cleared for the 3T environment
- The acoustic noise in a 3T system approaches twice that of the 1.5T system as well. It can reach excess of 130 dBA, ear protection and/or headphones must be used properly. Always check proper use of your participant ear plugs.

Forces in the MR Environment

- There are two types of effects the magnet will have on Ferromagnetic substances
  - Translation: The “Missile Effect”
  - Rotation/Torque: The “Rotational Effect”

Translational Force: The Missile Effect

- Also referred to as the "Projectile Effect" and is used to describe the attraction of the object to the center of the magnetic field
- This transforms objects into projectiles as they accelerate toward the magnet
- These items can become airborne, accelerating at speeds of up to 40 miles per hour.
- This effect has repeatedly resulted in accidents jeopardizing the safety of patients and staff, as well as the MRI equipment itself.

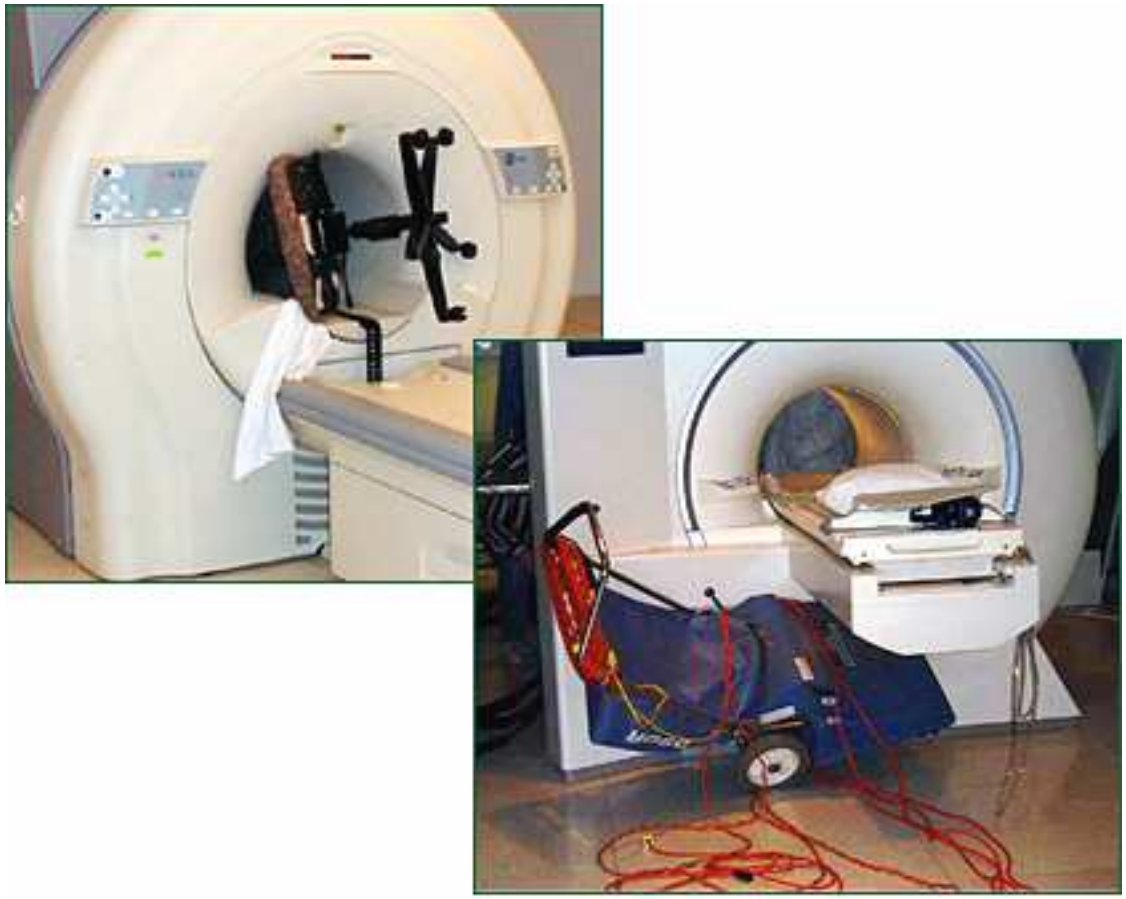
Rotational/Torque Force: Rotational Effect

- This force relates to the North and South pole orientation of the scanner's magnetic field
- Ferrous objects will attempt to align their long axes with this orientation
- This force will rotate objects until they are aligned with the magnetic field.
- Translational and Rotational Force happen at the same time making objects projectiles and dangerous!

MRI Safety - Projectiles

- Projectile effects of metal objects seriously compromise safety.
- **This potential harm cannot be over emphasized.**
  - For example, paper clips can travel at a velocity of 40mph @ 3T.
  - Larger objects travel at a higher velocity and may be fatal.
- *Do not bring any type or objects, especially metal objects, into Zone 4 unless approved by the MRI Safety Officer *

Metal Objects Becoming Projectiles



Metal Objects Becoming Projectiles

U.S. abcNEWS.com

Employees of the Westchester Medical Center in Valhalla, N.Y., gather outside after learning of the deadly MRI incident. (ABCNEWS.com)

Hospital Nightmare

Boy, 6, Killed in Freak MRI Accident

abcNEWS

July 31 — A 6-year-old boy died after undergoing an MRI exam at a New York-area hospital when the machine's powerful magnetic field jerked a metal oxygen tank across the room, crushing the child's head.

The force of the device's 10-ton magnet is about 30,000 times as powerful as Earth's magnetic field, and 200 times stronger than a common refrigerator magnet.

The canister fractured the skull and injured the brain of the young patient, Michael Colombini, of Croton-On-Hudson, N.Y., during the procedure Friday. He died of the injuries on Sunday, the hospital said.

Accidents *CAN* Happen!

- In 2003, a New Mexico woman sued claiming the magnetic pull of an MRI scanner caused an oxygen tank to hit her in the back.
- In 2001, a 6 year old boy, was killed while undergoing an MRI when an oxygen tank flew out of the hands of a nurse toward the machine, hitting him in the head.
- In 1992, a woman hemorrhaged and died after an aneurysm clip in her brain shifted while she was on a table preparing for an MRI procedure.

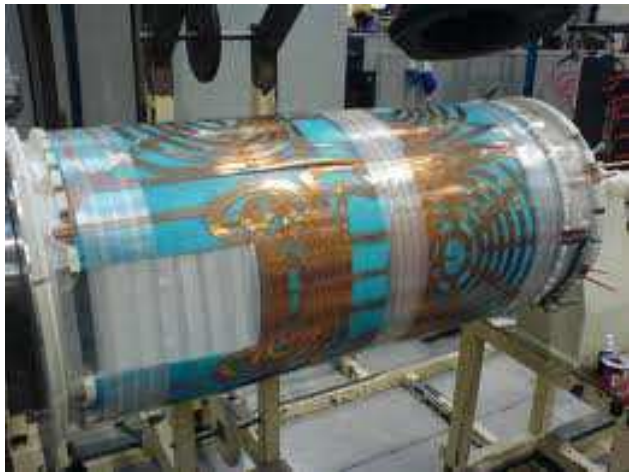
Items that can be damaged by the magnet

- The magnetic field can seriously damage or impair the following personal items:
  - Cell Phones
  - Watches
  - Credit /Bank cards
  - Hearing Aids
  - Hair Accessories, Belt Buckles, Shoes
  - Pocket Knives, Cigarette Lighters, Tie Clip

- Please remember to empty ALL pockets before entering the scanning room.

Gradient Magnetic Fields

- Gradient Magnetic Fields vary in intensity over distance, used for spatial localization. The loud banging noise is the gradient magnetic field.
- Rapid switching of the gradient fields can induce current in a conductor (Faraday's Law of Induction).



Gradient Safety Concerns

- Current Induction
  - Peripheral nerve stimulation
  - Caution should be used when using any type of wires in the MRI scanner.
- Acoustic Noise
  - Hearing protection always used
  - Greater with faster imaging sequences
  - Increases with gradient strength

Peripheral Nerve Stimulation

What Is It?

- Rapidly changing magnetic fields can, under certain conditions, cause nerves close to the skin surface to become stimulated.
- The point where 50% of the population experiences PNS is referred to as the PNS Threshold. Peripheral Nerve Stimulation has been described as a “involuntary muscle contractions”.
- The potential for Subjects experiencing PNS is very low-- but still possible.

Peripheral Nerve Stimulation

What To Do?

- Be sure that the subject does not have their extremities crossed. PNS maybe uncomfortable and more common with BOLD sequences.

Acoustic Noise

- The rapid alternation of current within the gradient coils causes the loud banging sounds
- Some patients may experience discomfort from the associated noise of the scanner.
- Prior to scanning it is mandatory to provide ear plugs and/or head phones are provided to the participant to reduce the noise level.

Radio Frequency

- Oscillating magnetic field
- Responsible for heating of tissues
- Amount of RF (heat) deposition dependent on many factors which include
    - Flip angle
    - Field strength
    - Pulse Sequence
- RF deposition is expressed by the Specific Absorption Rate (SAR)

Specific Absorption Rate

- The rate the subject absorbs the RF energy is described in terms of Specific Absorption Rate (SAR), measured in watts/kg.
- SAR is calculated by the patient's weight and expected increase in body temperature for each imaging pulse sequence. Remember to enter the correct weight when registering.
- The scanner will calculate how much heat will be absorbed by the patient per scan. If the SAR for the scan is too high the scanner will not let you run your scan.

Radio Frequency Safety Concerns

- The FDA limits the amount of SAR – equal to or less than 4.0 Watts/kg averaged over 15 minutes for whole body and equal to or less than 3.2 Watts/kg average over 10 minutes for the head.
- Communicate with your subject and listen for complaints of being to warm.
- Larger subjects have a tendency too get warmer quicker, avoid using blankets and use the fan too circulate air.

Radio Frequency Safety Concerns

Safety Concerns

Another potential problem is when using EKG cables or other conductive cables. Do not loop the cables because an induced current can occur causing the wires to get hot causing burns to your subject. Always, place a cloth material between the wires and skin to help prevent burns..

Who must be screened before entering the scan room?

- Participants and their guests
- Nurses, Physicians, all medical personnel
- Environmental and POM personnel
- Emergency personnel (fire and police)

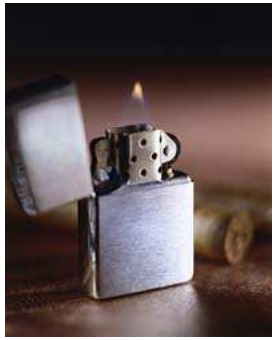
EVERYONE!!!

The Screening Process - Researcher

- Every person that enters the MRI room must be screened for possible contraindications that could affect their health and safety.
- As a PI, researcher, or research assistant you will need to initially be screened as well. If there is ever any changes in your health please notify the MRI Safety Officer or Technical Director.

MRI SAFETY PRECAUTION

- NEVER enter the magnet room with any metal whatsoever.
- No metal in your pockets, no metal in your hands, no jewelry
- No credit cards or ID cards – they will be erased
- No flash drives, pens, scissors, lighters, pocket knives, keys, stools, or other tools – EVER.
- No one should enter the magnet room unless they have been screened for metal and are well aware of this issue.



Subject Screening

All subjects involved with a research study must have the following two forms completed prior to any MRI scans:

- **IRB Consent or Animal Protocol -** An institutional review board (IRB), is a committee that has been formally designated to approve, monitor, and review biomedical and behavioral research involving humans with the aim to protect the rights and welfare of the research subjects.

- **MRI Screening** - The establishment of thorough and effective screening procedures for patients and other individuals is one of the most critical components of a program that guards the safety of all those preparing to undergo magnetic resonance (MR) procedures or to enter the MR environment. (Frank Shellock,Ph.D.) **MRI screening must be completed for each study or visit for all individuals (includes friends, family, and guests) that are not MRI safety trained before entering Zone 4.**

The screening form below is incomplete. Remember this is a legal document. All sections, dates, names, signatures must be completed before the subject enters the scan room. If it is incomplete it is not valid for a subject to be scanned and you could be liable for any damages or injury incurred by the subject. Do not modify or change the MRI screening form without the approval of the IRC MRI safety committee. Complete the screening form on each visit.

UCDAVIS IMAGING RESEARCH CENTER PRE-MRI SCREENING FORM

Date [redacted] / [redacted] / 09 | **Principal Investigator:** _____

Name [redacted] [redacted] [redacted] Height [redacted] Weight [redacted]

Last name First name M.I.

Birth Date [redacted]

Missing PI's name.

2. Have you ever had surgery or similar invasive procedure in which medical devices may have been implanted? No ☒ Yes ☐

If yes, please list:
Type: _____ Date: ___/___/___
Type: _____ Date: ___/___/___

2. Have you had any previous MRI imaging studies? No ☐ Yes ☒
If yes, please list:

Body part	Date	Facility Location
[redacted]	[redacted]	[redacted]

3. Have you ever worked with metal (grinding, fabricating, etc.) or ever had an injury to the eye involving a metallic object (e.g., metallic slivers, shavings, shrapnel, foreign body)? No ☒ Yes ☐
If yes, please describe: _____

For female subjects only:

4. Are you pregnant, or is there a possibility that you are pregnant? (if unsure, please notify MRI operator or Principal Investigator) No ☒ Yes ☐
5. Are you breast feeding? No ☒ Yes ☐ 6. Date of last menstrual period: [redacted] / [redacted] / [redacted]
7. Are you taking any type of fertility medication or having fertility treatments? No ☒ Yes ☐
8. Are you taking oral contraceptives or receiving hormone treatment? No ☒ Yes ☐

9. Are you currently taking or have you recently taken any medication? No ☐ Yes ☑
If yes, please list: [redacted]

10. Do you have anemia or any diseases that affect your blood, or a history of renal disease? No ☒ Yes ☐
If yes, please list: _____

11. Do you have a history of seizure disorder or epilepsy? No ☒ Yes ☐

12. Do you have any drug allergies? No ☒ Yes ☐
If yes, please list: _____

13. Have you ever had asthma, allergic reaction, respiratory disease, or any type of reaction to a contrast medium or dye used for an MRI or CT examination? No ☒ Yes ☐

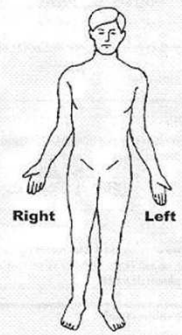
UC Davis Research Imaging Center
Version 1.1, February 23, 2004.

Some of the following items may be hazardous to your safety and some can interfere with the MRI examination. Please check the correct answer for each of the following. Do you have any of the following:

Yes ☐	No ☑	Cardiac pacemaker
Yes ☐	No ☑	Implanted cardiac defibrillator
Yes ☐	No ☑	Aneurysm clip(s)
Yes ☐	No ☑	Carotid artery vascular clamp
Yes ☐	No ☑	Neurostimulator
Yes ☐	No ☑	Insulin or infusion pump
Yes ☐	No ☑	Implanted drug infusion device
Yes ☐	No ☑	Bone growth/fusion stimulator
Yes ☐	No ☑	Cochlear, otologic, or implant
Yes ☐	No ☑	Any type of prosthesis (eye, penile, etc.)
Yes ☐	No ☑	Heart valve prosthesis
Yes ☐	No ☑	Artificial limb or joint
Yes ☐	No ☑	Electrodes (on body, head, or brain)
Yes ☐	No ☑	Intravascular stents, filters, or coils
Yes ☐	No ☑	Shunt (spinal or intraventricular)
Yes ☐	No ☑	Vascular access port and/or catheter
Yes ☐	No ☑	Swan-Ganz catheter
Yes ☐	No ☑	Any implant held in place by a magnet
Yes ☐	No ☑	Transdermal Patch Delivery System (e.g. Nicotine,) **(Remove before MRI)**
Yes ☐	No ☑	IUD or diaphragm
Yes ☐	No ☑	Tattooed makeup (eyeliner, lips, etc.)
Yes ☑	No ☐	Body piercing(s) **(Remove before MRI)**
Yes ☐	No ☑	Any metal fragments (including bullets, shrapnel)
Yes ☐	No ☑	Internal pacing wires
Yes ☐	No ☑	Aortic clip
Yes ☐	No ☑	Metal or wire mesh implants
Yes ☐	No ☑	Wire sutures or surgical staples
Yes ☐	No ☑	Harrington rods (spine)
Yes ☐	No ☑	Metal rods in bones
Yes ☐	No ☑	Joint replacement_____
Yes ☐	No ☑	Bone/joint in, screw, nail, wire, plate
Yes ☐	No ☑	Hearing aid **(Remove before MRI)**
Yes ☐	No ☑	Dentures **(Remove before MRI)**
Yes ☐	No ☑	Breathing disorder
Yes ☐	No ☑	Movement disorder
Yes ☐	No ☑	Claustrophobia
Yes ☐	No ☑	Anxiety

Other, please explain

Please mark on the figure below, the location of any implant or metal inside of or on your body.



Before your MRI, please **remove all metallic objects** including keys, hair pins, barrettes, jewelry, watch, safety pins, paperclips, money clip, credit cards, coins, pens, belt, metal buttons, pocket knife, & clothing with metal in the material.

NOTE: YOU ARE REQUIRED TO WEAR EARPLUGS OR EARPHONES DURING THE MRI EXAMINATION.

[redacted] [redacted] Date [redacted] / [redacted] / 09
Signature/Printed name of Person Completing Form

Form completed by: ☒ Patient/Subject ☐ Relative: _____
Name & relationship to patient
☐ Physician or other: _____
Name & relationship to patient

_____ / _____ Date ___/___/___
Signature/Printed name of Person Reviewing Form

Missing reviewers signature

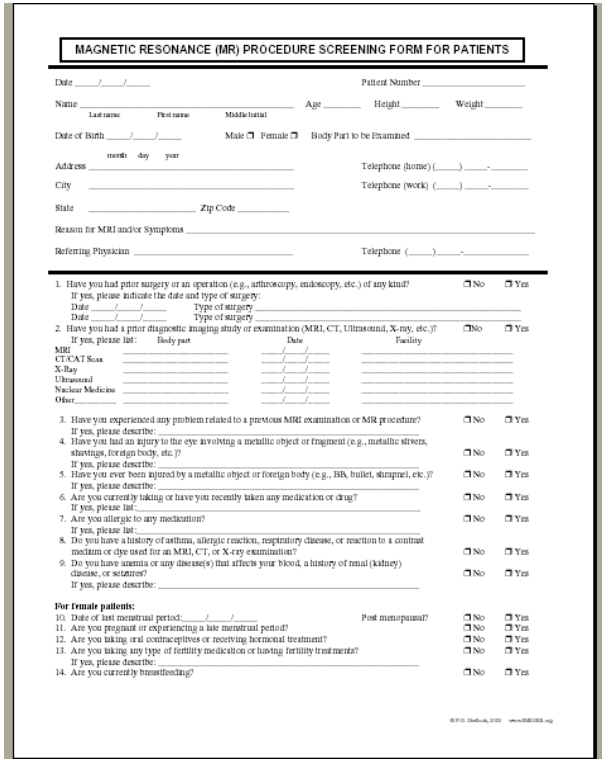
No date means it was never reviewed .

UC Davis Research Imaging Center
Version 1.1, February 23, 2004.

Subject Screening

The following are red flags for additional investigation of MRI compatibility prior to performing an MRI scan:

- Metallic Foreign Bodies
- Biomedical Implants and Devices
- Aneurysm Clips
- Electronic implants
- Catheters, Coils, Filters and Stents
- Heart Valves
- Pacemakers and Pacing Wires
- Intra-ocular Ferrous Foreign Body
- Personal belongings
- Pregnancy



MAGNETIC RESONANCE (MR) PROCEDURE SCREENING FORM FOR PATIENTS

Date ____/____/____ Patient Number _____

Name _____ Age _____ Height _____ Weight _____
Last name First name Middle Initial

Date of Birth ____/____/____ Male ❒ Female ❒ Body Part to be Examined _____
month day year

Address _____ Telephone (home) (____) ____-_____

City _____ Telephone (work) (____) ____-_____

State _____ Zip Code _____

Reason for MRI and/or Symptoms _____

Referring Physician _____ Telephone (____)____-_____

1. Have you had prior surgery or an operation (e.g., arthroscopy, endoscopy, etc.) of any kind? ❒ No ❒ Yes
   If yes, please indicate the date and type of surgery:
   Date ____/____/____ Type of surgery _____
   Date ____/____/____ Type of surgery _____
2. Have you had a prior diagnostic imaging study or examination (MRI, CT, Ultrasound, X-ray, etc.)? ❒ No ❒ Yes
   If yes, please list:

	Body part	Date	Facility
MRI	_____	____/____/____	_____
CT/CAT Scan	_____	____/____/____	_____
X-Ray	_____	____/____/____	_____
Ultrasound	_____	____/____/____	_____
Nuclear Medicine	_____	____/____/____	_____
Other_____	_____	____/____/____	_____

3. Have you experienced any problem related to a previous MRI examination or MR procedure? ❒ No ❒ Yes
   If yes, please describe: _____
4. Have you had an injury to the eye involving a metallic object or fragment (e.g., metallic slivers, shavings, foreign body, etc.)? ❒ No ❒ Yes
   If yes, please describe: _____
5. Have you ever been injured by a metallic object or foreign body (e.g., BB, bullet, shrapnel, etc.)? ❒ No ❒ Yes
   If yes, please describe: _____
6. Are you currently taking or have you recently taken any medication or drug? ❒ No ❒ Yes
   If yes, please list: _____
7. Are you allergic to any medication? ❒ No ❒ Yes
   If yes, please list: _____
8. Do you have a history of asthma, allergic reaction, respiratory disease, or reaction to a contrast medium or dye used for an MRI, CT, or X-ray examination? ❒ No ❒ Yes
9. Do you have anemia or any disease(s) that affects your blood, a history of renal (kidney) disease, or seizures? ❒ No ❒ Yes
   If yes, please describe: _____

For female patients:

10. Date of last menstrual period:____/____/____ Post menopausal? ❒ No ❒ Yes
11. Are you pregnant or experiencing a late menstrual period? ❒ No ❒ Yes
12. Are you taking oral contraceptives or receiving hormonal treatment? ❒ No ❒ Yes
13. Are you taking any type of fertility medication or having fertility treatments? ❒ No ❒ Yes
    If yes, please describe: _____
14. Are you currently breastfeeding? ❒ No ❒ Yes

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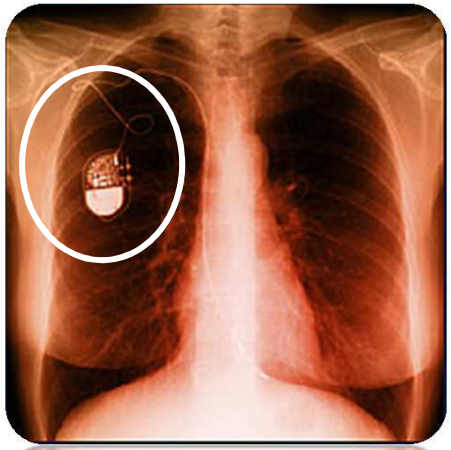
MRI Screening of Implants

A subject that has an aneurysm clip or cardiac pacemaker in question, can become fatal in MRI. If a subject has one of these implants do not scan them to prevent any potential fatalities causing death. Aneurysm clips can torque in the magnetic field, tearing the vessel causing an artery to bleed without immediate effects. Subjects with pacemakers must stay in Zone 1 and never cross the 5 gauss line. Pacemakers will lose the calibrated settings when placed in the MRI scanner changing the demand, causing heart rates to fluctuate significantly.

Aneurysm clip



Cardiac pacemaker

MRI Screening of Implants

Examples of two types of aneurysm clips. The right picture demonstrates an aneurysm clip that is highly attracted to the magnetic field compared to the left picture. Remember, any aneurysm clips are absolute contraindications and should never be allowed for a research MR scan.

MRI Screening of Implants

If you or your volunteer has any of these items, they can **NOT** be allowed into the scanning room

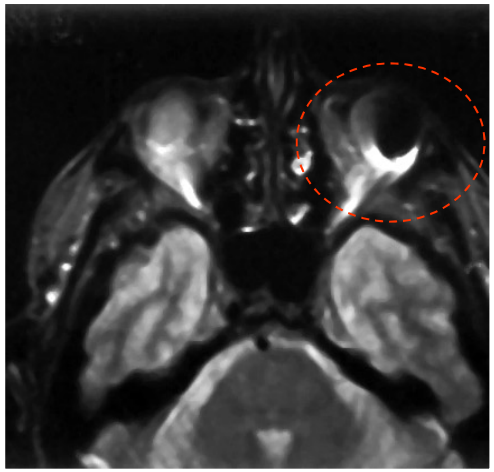
- Cardiac Pacemakers
- Cochlear (inner ear) implants
- Ferromagnetic or unidentifiable aneurysm clips of the brain
- Implanted neuro stimulators
- Metal or unidentifiable foreign bodies in the eyes
- Implanted pumps to deliver medicine that cannot be removed
- Full mouth braces or retainers that cannot be removed

Procedure for MRI Screening of Implants

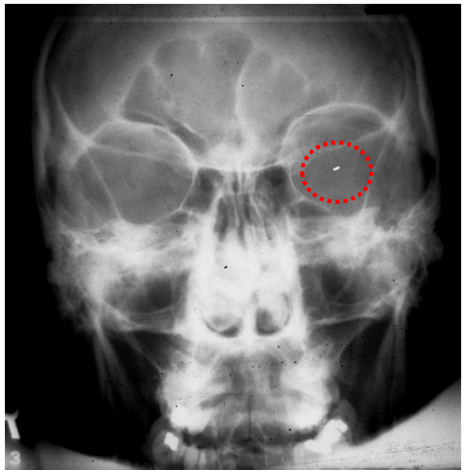
- If participants have any type of implants (i.e. orthopedic hardware, heart stents, surgery clips, electronic implants, etc.), you cannot proceed with the MRI scan until documents from the manufacturer, stating the conditions that must be followed to safely scan the participant has been approved by one or all of the following IRC personal: Jerry Sonico, Cameron Carter and/or Costin Tanase
- 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 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 may not be allowed to participate with the MRI scan.
- Violation of this policy are grounds for immediate suspension of the research lab and all scheduled MRI scans will be cancelled until violation has been resolved.

Intraocular Foreign Bodies

- X-rays of the eyes are needed to exclude metal foreign bodies in the eyes.
- If a subject is placed in the scanner with metal in the eye(s) this could result in damage to the retina and cause permanent blindness.



Artifact on MRI caused by metal in the eye



Metal in the eye seen on x-ray

Final Screening Tips

- Do not rely on the screening procedures from any other MRI facility to be adequate.
- Screen all visitors as if they were subjects.
- Screening should be done more than once – before entering the magnet room, ask one final time, “is there anything in your body that you were not born with!”
- Screening should be performed by MR safety trained individuals only.
- MR screening must be completed on each visit. Previous MR screening forms may not be current with respect to a participant or guest MR safety.
- Implants that are safe at 1.5T may NOT be safe at 3.0T, always verify!

Subject Monitoring

Q. Who should be monitored?

A. All subjects should be monitored verbally and visually.

Subject Monitoring

- **Question:**
  - **Who may require <u>additional</u> monitoring?**
- **Answer:**
  - Subjects who cannot communicate
  - Subjects with weak voices
  - Subjects who do not speak English
  - Subjects who are sedated
  - Subjects with diminished mental capacity

Hearing Protection

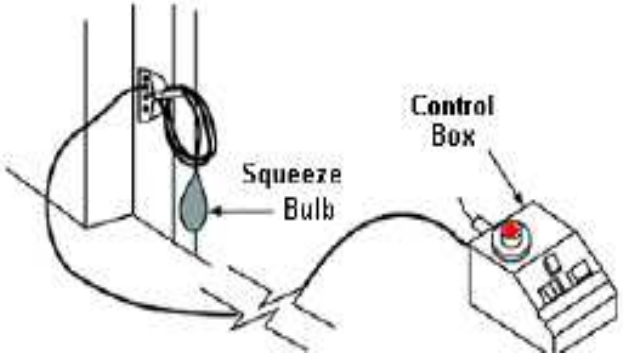
Use of earplugs and/or head phones is <u>always</u> required regardless of static field strength. All subjects including NHP (non-human primates) must use earplugs. Always check that your subject has correctly inserted the earplugs.

Eye Protection

- Eyes must be protected from laser light
- Instruct Subjects to close eyes when utilizing the laser light for land-marking

Subject Alert System – Call Button

- This is the only communication while the MR scanner is operating
- When squeezed, the light on the control box illuminates
- Maintain verbal contact via system intercom
- Make available to all Subjects
- Cover bulb if latex allergies are present



Pregnancy

- Individuals at risk includes:
  - Subjects, Family, and Guests
  - Operators and Safety Monitors

Pregnancy

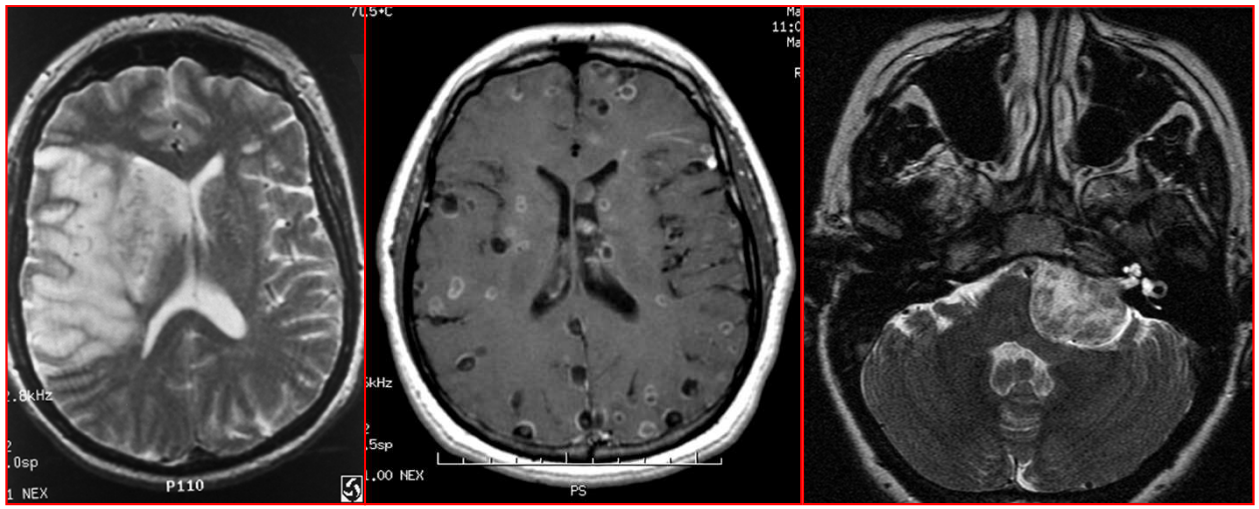
- Subjects
  - Pregnant subjects are not allowed to have an MRI research scan. If the subject might be pregnant, but is not sure, postpone the MRI research scan until confirmed that the subject is not pregnant.
- Family or guests
  - The same applies as above if the family member or guest will be staying in Zone 4. Do not allow family or guest into Zone 4 if pregnant.
- Operators and Safety Monitors
  - Are allowed in Zone 4 only when the MRI scanner is not operating (not making loud pulsing sound).

Tattoos

- There have been some documented cases of unusual sensation or tingling from a tattoo site during the procedure to receiving burns or raised skin at the site.
- The likely hood of this happening is very low but all subjects should be aware of the issue before agreeing to take part in a study.
- Subjects with tattoos will be informed of the risks of tattoos in the MRI environment prior to the MRI study. At this time they will have a chance to cancel the exam.
- If the subject complains of any unusual sensation during the exam the study will be immediately stopped.

Incidental Findings

In the event that you see something that appears abnormal on a subject's scan, notify one of the following persons Jerry Sonico, Costin Tanase, or Cameron Carter and we will follow-up on your subject's scan.



Stroke Parasites Acoustic neuroma

Infection Control and Cleanup

- The IRC's role and scope of participation in infection prevention and control includes those methods used in this department to reduce the risk of cross-contamination within the research subject population.

~ The MRI scan table and head coil must be wiped with sanitizing wipes after each use.
~ All items used for scans must be wiped with sanitizing wipes after each use (i.e. sponges and sandbags).
~ Replace linen (sheets and blankets) when running low.

After Study Completion

Remember to do the following before leaving:

- Complete the MRI session form, front and back.
- Email the IRC tech support if you encountered or noticed any equipment problems.
- Place all sponges back in the plastic containers.
- Return any cables to the same position to avoid any accidents (specifically the response box cables).
- Clean up all trash and remember to gather up all your items.
- Confirm that all switches, buttons, software selections (i.e. audio and video) have been returned to the default position.
- Make sure the projector or monitor has been turned off.
- Put used laundry in the hamper.

After Regular Hours scanning

- Always have a minimum of 2 MR Safety Trained personnel or a ratio of one safety trained personnel to one non- safety trained personnel when you scan before 8am, after 5pm during the week, weekends and holidays.

Restriction in the MRI Scan Suites

- Within the MRI suites (Zone 3 and Zone 4), food, beverages and tobacco products are not allowed. There are no exceptions to this policy.

Responding to System Emergencies

Types of Emergencies

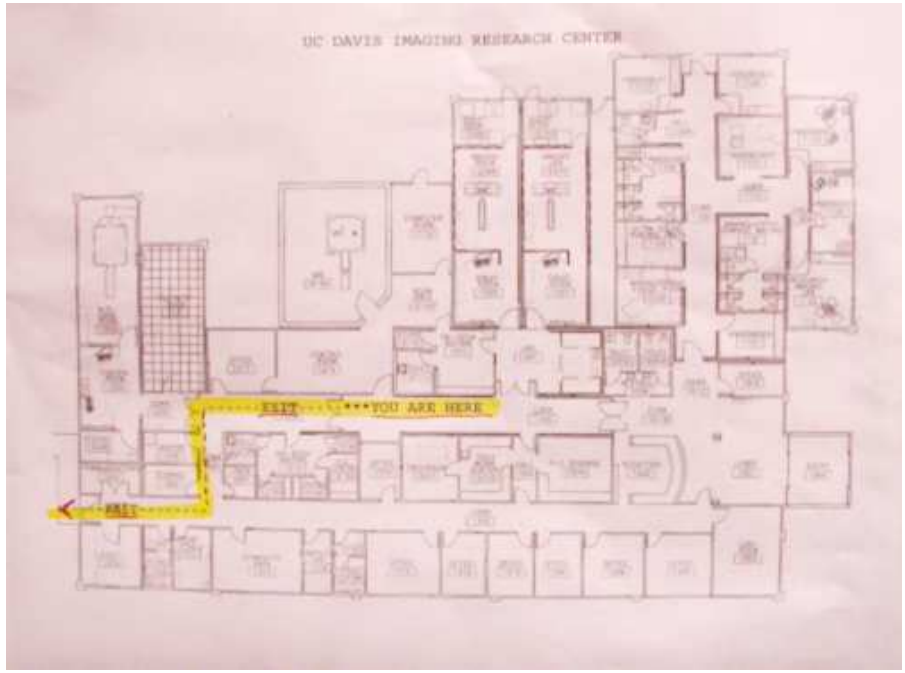
- Fire emergencies
- Medical emergencies
- Police emergencies
- Shutdown emergencies
- Quench emergencies

FOR ALL EMERGENCIES **Dial 911**

What you should know in Emergencies

Meet emergency personnel at the electronic doors. Make sure emergency personnel are aware that the magnetic field is on and must not enter Zone 4 (scanner room) with their equipment.

Emergency – Fire Evacuation



Locate the fire evacuation route map in case of fire. Fire alarms are at all exit doors. Pull fire alarm if fire occurs.

Emergency – Fire Extinguishers

Red tank not MRI Compatible. Do not bring into the scanner room

White tank is MRI Compatible. Can be brought into the scanner room

Medical Emergency Subject Evacuation

Typically Subjects can be evacuated from the scan room in less than 60 seconds.

If a subject has a cardiac arrest, stops breathing, a seizure, or any emergency requiring medical care, dial 911 and quickly remove the subject from the scanning room and transport them into the control room. When emergency personnel arrive let them know that they are not to enter the scan room with their equipment on or injury could occur.

Subject Evacuation 1.5T

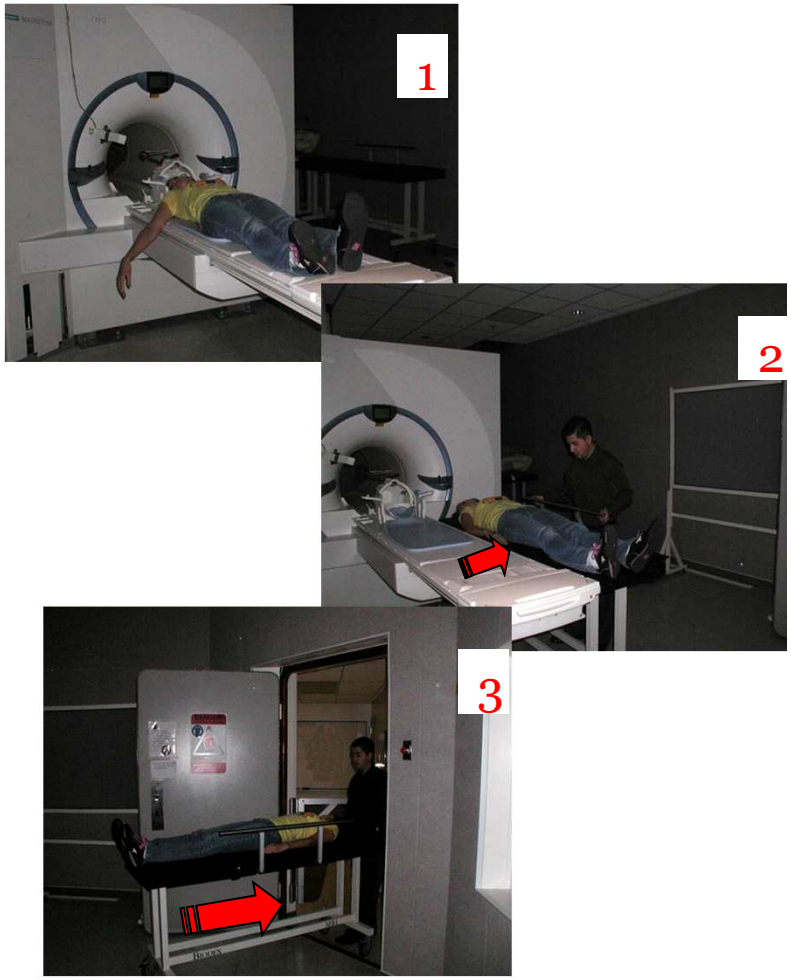
<u>1.5T Subject Evacuation</u>

1. Pull subject out of the scanner.
2. Undock table by pressing foot pedal at end of the table.
3. Wheel subject into the control room and secure door to magnet room.

Subject Evacuation 3.0T

<u>3.0T Subject Evacuation</u>

1. Pull subject out of the scanner.
2. Put gurney along side of scan table and pull subject on to gurney.
3. Wheel subject into the control room and secure door to magnet room.



Emergency - Police

If law enforcement is needed dial 911. The same precaution applies, no metal must enter the scan room to avoid the danger of injury.

Emergency – Scan Room

Each magnet is equipped with two emergency buttons:

- Emergency Stop / Shut Off
  - Turns off all incoming electrical power. The scanner electronics will turn off, as well as, the operating computer.
  - **The magnetic field however will still be on.**
- Quench or Emergency Run Down
  - Causes immediate collapse of the superconductive magnetic field within a minute. The magnetic field will dissipate.

FAMILIARIZE YOURSELF WITH THESE BUTTONS AND **KNOW** THE DIFFERENCE!

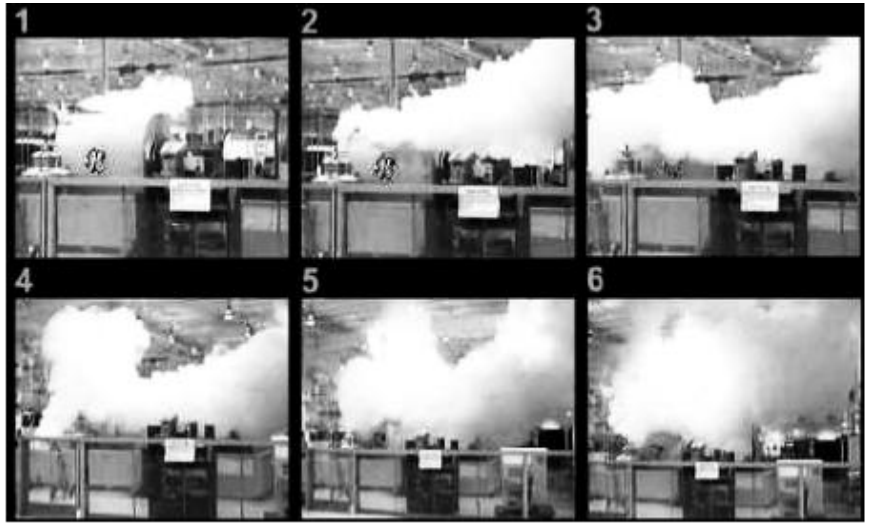
Emergency Stop / Shut Off Button

- Shutting power may be required for situations such as:
  - Fire in the computer room
  - Fire, sparks, loud noises emanating from the scan room
  - Flooding or sprinkling system goes off
  - Catastrophic equipment failure

- Keep in mind that when this button is pushed, it does <u>not</u> initiate a quench, the magnetic field remains on. Exercise caution to make sure that all ferromagnetic materials remain outside of the scan room, they can still become projectiles.

Emergency - Quench

Once a superconducting magnet is ramped up and fully magnetized, it literally takes no additional current or power to keep the magnet going. There's zero resistance -- that's the "superconducting" part -- so the current flowing in the magnet coils will run forever. That is, forever if the liquid helium cooling the magnet is kept cold enough, which is quite close to Absolute Zero. If the cooling system becomes faulty, the magnet starts to develop resistance, which cause heat, which causes more resistance, and more heat, and so on until all the liquid helium gets hot enough to become a gas, which then erupts in a jet-engine-sounding event known as a quench. That's thousands of dollars worth of helium you see in the photo sequence going up in smoke.



MRI Scanner Superconducting Magnet Quench

Emergency Run Down Button - Quench

- MR scanners are super cooled with helium.
- If these cryogens boil off either intentionally or unintentionally, a quench has occurred.
- This is extremely bad.
- An intentional quench is done in an emergency to run the magnetic field to zero. This is done in extreme situations only e.g. life threating situation where someone is trapped in or on the scanner.
- If a quench occurs, everyone must be removed from the room immediately. The vapors and gases are very cold and can cause frostbite. They also often condense the moisture in air, creating a highly visible fog that can replace oxygen in the room and potentially cause asphyxiation.

Quench – What should you do?

- In the unlikely event of a quench and the vent fails, the procedure is to **evacuate the Subject and all personnel** from the magnet room. Failure to follow these precautions can result in serious injury.
- Do not press the button except in a life threatening situation.
- The quench button will have a clear protective covering or yellow cover with a red "X" over the button so it cannot be pressed inadvertently.
- ***Do <u>not</u> attempt to test this button!***

Quench Buttons

3T Scanner room Quench button

3T Control room Quench button

1.5T Scanner room Quench button

MRI Magnet Room Environment

If you are conducting a study that requires that you bring special equipment into the scan room other than equipment already there, it must be approved by the IRC MRI Safety committee.

- Never assume that equipment is safe to bring into the scan room until it has been tested
- Equipment not approved can cause damage and injury
- Equipment not approved can also cause image artifacts and signal loss

MRI Magnet Room Environment

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.

MRI Accidents or Incidents

- If you, visitors or subjects are involved in an accident involving injury and/or an incident that may result in equipment damage, always document the event and report it to the MRI Safety officer within 24 hours.
- This will be reviewed by the IRC MRI Safety Committee for further corrective action.

You Have Completed the MRI Safety Training Module

Proceed to the MRI Safety Training Quiz. You must pass with at least 80%.