RESEARCH MRI SAFETY TRAINING

BEHAVIORAL SCIENCES IMAGING CENTER.

THE MAGNETIC FIELD IS AT FULL POWER ALWAYS ....**IT IS ALWAYS "ON".**

Who is this training for?

MRI safety training is required for all faculty, staff and students who will work around and inside the MRI magnet rooms or will need access to the area.

Overview of Topics

1. Safety training schedule
2. Potential dangers of MRI
3. Safety Signage
4. Importance of proper safety
5. Regulating those around you
6. Emergency situations

Safety training schedule

Safety training should be completed annually and will consist of:

1. Filling out a personal MRI Screening Form
2. Reviewing safety PowerPoint
3. Watching the MRI safety video
4. Passing the MRI safety quiz

MRI Screening Form

- To ensure patient safety, completion of the MRI screening form is required prior to every MRI scan.
- The MRI Screening Form is used to help identify any potential dangers for you and your patients / subjects.
- The form consists of a series of questions intended to identify any metallic objects within your body that could be affected by the magnetic field.
- 2 screening forms are required:

  - During the consent process (RA)
  - Before the MRI (MRI Operator)

MRI Screening Sheet

All Patients will need this form filled out before an MRI can be done.

Ideally, the form should be filled out by:

a. **The Patient**

If the patient cannot fill it out:

b. **Family Members**

If there are no family members:

c. **Referring MD**

MPRC_MRI Screening Forms

UNIVERSITY of MARYLAND SCHOOL OF MEDICINE

MRI Screening Form

Maryland Center for Brain Imaging
Maryland Psychiatric Research Center
University of Maryland
55 wade Ave, Catonsville MD 21228

Date ____/____/____ Patient Number _____

Name _____ Age _____ Male___Female____
Last name First name Middle Initial

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 experienced any problem related to a previous MRI examination or MR procedure? _No _Yes
If yes, please describe: _____

3. 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: _____

4. Have you ever been injured by a metallic object or foreign body (e.g., BB, bullet, shrapnel, etc.)? _No _ Yes
If yes, please describe: _____

5. Are you allergic to any medication? _No _ Yes
If yes, please list: _____

6. 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

7. Do you have tattoos, permanent make-up done in the last 2 months? _No _Yes
If yes, location? _____

8. Do you have hair extensions? _No _Yes

9. Do you have any non-removable piercings? _No _Yes
If yes, location? _____

10. Do you have metal in your body (**pacemaker**, plates, aneurysm clips/coils, deep brain stimulator, pins, rods, joints, pellets, cochlear implants, etc.)? _No _Yes
If yes, please describe: _____

11. Have you ever been employed as a farm worker, metal grinder, or welder? _No _Yes

12. Do you wear dentures, partials, braces, or a non-removable orthodontic retainer? _No _Yes

13. Have you ever considered yourself to be claustrophobic? _No _Yes

For female patients:

14. Are you pregnant or could you possibly be pregnant? _No _ Yes

UNIVERSITY of MARYLAND SCHOOL OF MEDICINE

MRI Screening Form

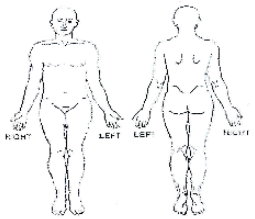
Maryland Center for Brain Imaging
Maryland Psychiatric Research Center
University of Maryland
55 wade Ave, Catonsville MD 21228

WARNING: Certain implants, devices, or objects may be hazardous to you and/or may interfere with the MR procedure (i.e., MRI, MR angiography, functional MRI, MR spectroscopy). **Do not enter** the MR system room or MR environment if you have any question or concern regarding an implant, device, or object. Consult the MRI Technologist or Radiologist BEFORE entering the MR system room. The MR system magnet is ALWAYS on.

Please indicate if you have any of the following:

_Yes _No Aneurysm clip(s) or coils
_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 (Deep Brain Stimulator)
_Yes _No Spinal cord stimulator
_Yes _No Internal electrodes or wires
_Yes _No Bone growth/bone fusion stimulator
_Yes _No Cochlear, otologic, or other ear implant
_Yes _No Insulin or other infusion pump
_Yes _No Implanted drug infusion device
_Yes _No Any type of prosthesis (eye, penile, etc.)
_Yes _No Heart valve prosthesis
_Yes _No Eyelid spring or wire
_Yes _No Artificial or prosthetic limb
_Yes _No Metallic stent, filter, or coil
_Yes _No Shunt (spinal or intraventricular)
_Yes _No Vascular access port and/or catheter
_Yes _No Radiation seeds or implants
_Yes _No Swan-Ganz or thermodilution catheter
_Yes _No Medication patch (Nicotine, Nitroglycerine)
_Yes _No Any metallic fragment or foreign body
_Yes _No Wire mesh implant
_Yes _No Tissue expander (e.g., breast)
_Yes _No Surgical staples, clips, or metallic sutures
_Yes _No Joint replacement (hip, knee, etc.)
_Yes _No Bone/joint pin, screw, nail, wire, plate, etc.
_Yes _No IUD, diaphragm, or pessary
_Yes _No Dentures or partial plates
_Yes _No Tattoo or permanent makeup
_Yes _No Body piercing jewelry
_Yes _No Hearing aid
(Remove before entering MR system room)
_Yes _No Other implant: _____
_Yes _No Breathing problem or motion disorder
_Yes _No Claustrophobia

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



IMPORTANT INSTRUCTIONS

Before entering the MR environment or MR system room, you must remove all metallic objects including hearing aids, dentures, partial plates, keys, beeper, cell phone, eyeglasses, hair pins, barrettes, jewelry, body piercing jewelry, watch, safety pins, paperclips, money clip, credit cards, bank cards, magnetic strip cards, coins, pens, pocket knife, nail clipper, tools, clothing with metal fasteners & clothing with metallic threads.

Please consult the MR Technologist or Radiologist if you have any questions or concerns BEFORE you enter the MR system room.

NOTE: You are required to wear earplugs or other hearing protection during the MRI procedure

I attest that the above information is correct to the best of my knowledge. I read and understand the contents of this form and had the opportunity to ask questions regarding the information on this form and regarding the MR procedure that I am about to undergo.

Signature of Person Completing Form: _____ Date ____/____/____
Signature Initials

Screened By: _____ Date____/____/____
Signature Title's

EMPLOYEE SAFETY

ALL EMPLOYEES MUST BE SCREENED TO WORK IN A MAGNETIC FIELD ENVIRONMENT JUST LIKE THE PATIENTS.

NO EXCEPTIONS.

Patient Screening and Contraindications

- NO ONE should enter the scan room without first being cleared by an MRI operator.
- Some implants/devices are contraindications for an MRI scan
- If a subject answers “yes” to any question on the MRI screening form, that issue must be addressed and resolved prior to entering the scan room
- NO cardiac pacemakers, defibrillators, aneurysm clips or electronic or magnetically activated devices

Patient Screening and Contraindications (Continued)

- Any injury from a foreign metallic body may be a contraindication for an MRI scan
- If someone has worked as a machinist, grinder, or welder and cannot absolutely confirm they always wore eye protection, they must first have orbital x-rays to confirm that there are no loose metallic bodies in the eye
- Any person who was injured by a metallic foreign body such as a bullet, BB, or shrapnel may not be able to proceed with an MRI scan unless there is proof that any remaining metal in the body is not in a location where it may move and cause injury/death.

MRI Safety Video

Watch the MRI safety video at:

mms://vidsrv1.mc.duke.edu/Radiology/MRISafety.wmv

Safety Signage

Signage

- FDA Guidance for the Submission Of Premarket Notifications for Magnetic Resonance Diagnostic Devices states:
- "The controlled access area should be labeled "Danger - High Magnetic Field" at all entries."
- The term "warning" does not convey the importance of a situation that may not only be potentially hazardous, but has been responsible for serious injuries and deaths.

Look for the warning signs!


WARNING
NO PACEMAKERS
NO METALLIC IMPLANT
NO NEUROSTIMULATORS
Serious injury may result.


DANGER!
RESTRICTED ACCESS
STRONG MAGNETIC FIELD
The Magnet is Always On!
• NO CARDIAC PACEMAKERS OR IMPLANTABLE CARDIOVERTER DEFIBRILLATORS (ICDs)
Persons with certain metallic, electronic, magnetic, or mechanical implants, devices, or objects may not enter this area.
Serious injury may result.
Do not enter this area if you have any question regarding an implant, device, or object. Consult the MRI Technologist or Radiologist.
• NO LOOSE METAL OBJECTS
Objects made from ferrous materials must not be taken into this area. Serious injury or property damage may result.
Electronic objects such as hearing aids, cell phones, and beepers may also be damaged.

Remember, the magnet is ALWAYS on!

- Even when the MRI Scanner is not in use, the magnet is on. Ferromagnetic objects should **NEVER** be taken into the Scan Room.

MRI safety Zones

The MRI suite is divided into 4 safety zones.

ZONE 1: This region includes all areas that are freely accessible to the general public. It is typically outside of the MR environment itself and is the area through which patients and all personnel access the MR suite. This zone is not marked or labeled.

ZONE 2: This area is between the accessible zone 1 and the strictly controlled zones 3 and 4. Patients and other personnel are able to move throughout this area. However they must be mindful of where zone 3 begins. This area is marked with a safety sign.

MRI Safety Zones

ZONE 3: This area is the region that non MR safe equipment can result in serious injury or death if accidentally moved closer or into zone 4. Personnel are not to move freely through this zone. They must be accompanied by level 2 staff. MR safe practice guidelines must be adhered to for the safety of the patients and other non-MR staff.

ZONE 4 : This zone is the MR suite itself. Nobody that has not been screened will enter this zone under any circumstances. If the screening process has taken place, you may enter the suite but you MUST be accompanied by level 2 MR staff.

MRI Safety


MRI
MRI ZONE I
MRI Access Area
© Magmedix, Inc. 2009
www.Magmedix.com
866-646-3349


NOTICE
MRI ZONE II
MRI Patient Screening and Preparation
© Magmedix, Inc. 2009
www.Magmedix.com
866-646-3349


CAUTION
MRI ZONE III
Restricted Access
Screened MRI Patients and MRI Personnel Only
© Magmedix, Inc. 2009
www.Magmedix.com
866-646-3349


DANGER
MRI ZONE IV
Restricted Access
Screened MRI Patients Under Direct Supervision of Trained MRI Personnel Only
© Magmedix, Inc. 2009
www.Magmedix.com
866-646-3349

Safety Background

- The MRI scanner is a very large and powerful magnet
- Most clinical scanners are 1.5 - 3 Tesla scanners
- 3 Tesla = 30,000 gauss
- Earths magnetic field ~ 0.5 gauss

Image Courtesy of Siemens Healthcare

Forces in the MR Environment

- Magnetic field
  - missile effect: TRANSLATION
  - rotational effect: ROTATION/TORQUE

Translational Force

- this term describes the force which attracts ferrous objects to the center of the magnetic field
- may act to transform ferrous objects into missiles as they accelerate toward the magnet
- the force is greatest when the difference in field strength across the object is

Rotational Force

- this force relates to the North - South 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 and is greatest at the very center of the field (unlike the translational force which is greatest where the difference in magnetic field across the object is greatest)

Characteristics of the Magnetic Field

- the force of the field is measured in tesla (T); a typical scanner is approximately 1.5- 3.0 tesla
- **the force of the field is greatest at the periphery of the magnet. This FORCE INCREASES as you move closer to the magnet.**
- NOT ALL MAGNETS ARE THE SAME FIELD STRENGTH, THUS THEIR “ATTRACTIVE FORCES” WILL BE DIFFERENT.

What can you take into a magnetic field?

- ONLY ITEMS THAT ARE MRI COMPATIBLE. *Such as…*
  - Brass
  - Aluminum
  - Plastic

  - **IF YOU ARE NOT SURE IF AN OBJECT IS MRI SAFE…DON'T TAKE IT INTO THE ROOM. ASK A MRI Personnel!!!!!!!**

Magnetic Field

- What “objects” can you take into a magnetic field?

Anything that doesn’t contain iron.

To be safe…TAKE NOTHING INTO A MAGNETIC FIELD.

Work closely with the MRI Personnel who works in that type of environment each day. Question Everything.

Safety Background, potential projectiles, and safety reminders

Potential Dangers of MRI

Potential Projectiles

- Any ferromagnetic object may be attracted to the MRI scanner and become a projectile – this is known as the missile effect.
- The greater the amount of ferromagnetic material, the greater the force of attraction.
- The magnetic field extends beyond the bore of the magnet in all directions (fringe field)

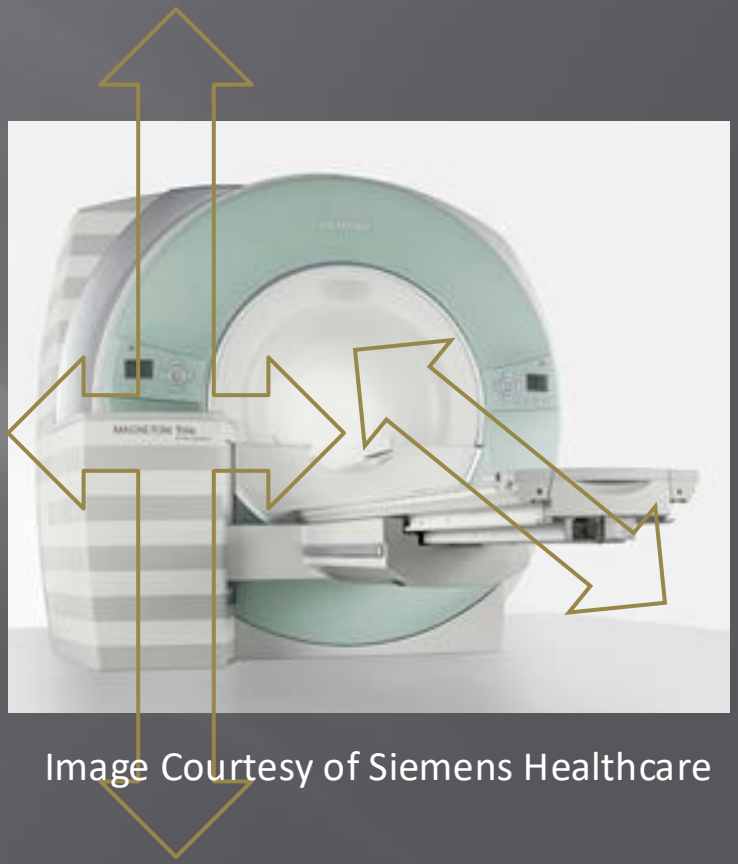
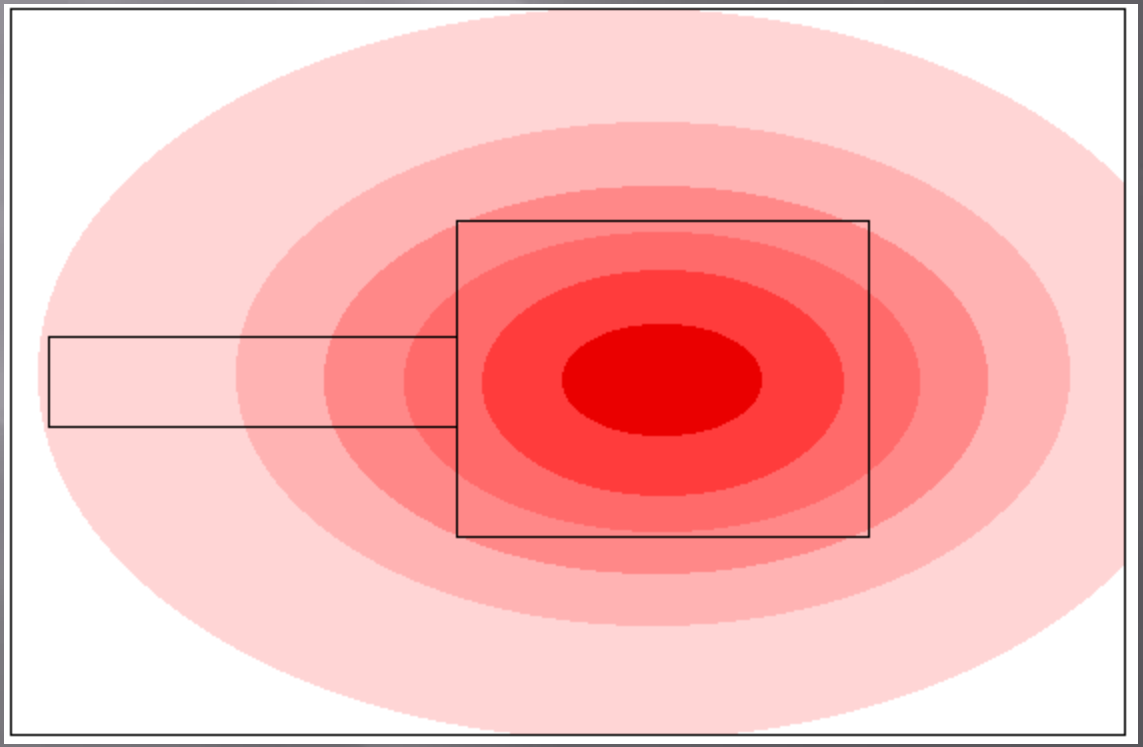


Image Courtesy of Siemens Healthcare

Fringe field

- This line specifies the perimeter around a MR scanner within which the static magnetic fields are higher than five gauss. Five gauss and below are considered 'safe' levels of static magnetic field exposure for the general public.

As you approach the magnet, the fringe magnetic field gets STRONGER

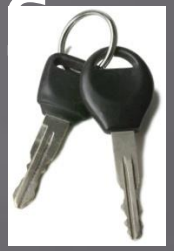


Projectile Accidents

- The MRI magnets are ALWAYS on (24 hours/day, 365 days/year)
- There is a STRONG fringe magnetic field around the magnets
- The fringe magnetic field is confined to the scan room

Potential Projectiles - examples

- Cell phone
- Keys
- Glasses
- Hair pins / barrettes
- Jewelry
- Safety pins
- Paper clips
- Coins
- Pens
- Pocket knife
- Nail clippers
- Steel-toed boots / shoes
- Tools
- Clipboards



No loose metallic objects should be taken into the Scan room!

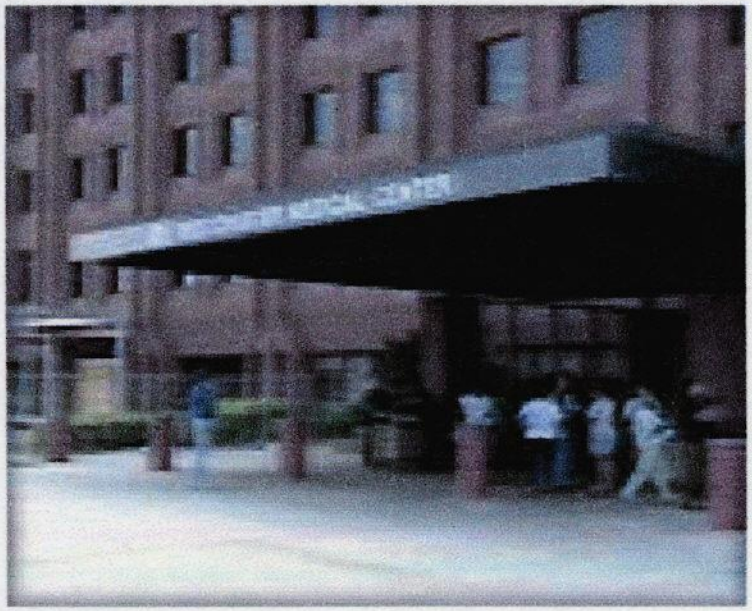
Potential Projectiles – Large Objects

- Due to the strength of the magnet, large objects such as chairs and IV poles can become projectiles and get stuck in the magnet!

Photo credit: www.simplyphysics.com

http://simplyphysics.com/flying_objects.html#

http://simplyphysics.com/flying_objects.html#



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.com

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.

The routine imaging procedure was performed after Colombini underwent surgery for a

A Horror Story

Here's one I heard from an Oxford Magnets engineer which was later independently verified by a technologist who had been hired to work at this site.

A brand new magnet had just finished being installed into a brand new building.

All of the acceptance testing had been completed and the magnet was to be turned over to the customer the very next day.

There was only one minor problem to be dealt with first.

One of the sprinklers in the scan room had a tiny leak. A welder was brought in to fix the leak, but somebody forgot to tell him that the magnet was at field.

So..... in walks this welder with his acetylene torch system. His tank flies into the magnet, the valve breaks off, sparks and catches fire.

Since he was in there to fix a leak in the sprinkler system, it had been turned off first.

The brand new building burned to the ground!

http://simplyphysics.com/flying_objects.html#

Remember this mnemonic:

MRI =

Metal **R**esults (in)

Injury

Peripheral nerve stimulation (PNS)

The rapid switching on and off of the magnetic field gradients is capable of causing nerve stimulation. Volunteers report a twitching sensation when exposed to rapidly switched fields, particularly in their extremities

BURNS

- It is "possible" for patients to get 1st, 2nd, or even 3rd degree burns in an MRI if items such as ECG cables are looped and are touching the patients skin (even if these devices are MRI compatible).
  - All "cables" should not touch the patients skin directly, and should NOT be in a LOOPED configuration.

Safety (continued)

- Auditory safety
  - Activation of gradient magnetic fields produces significant vibrations in the gradient coils.
  - MRI acoustical noise has been shown to produce reversible hearing impairment and could potentially produce permanent damage.
  - Hearing protection is recommended for all patients undergoing an MRI procedure on a high-field MRI system (1.5T and 3.0T).
  - Noise attenuating ear-plugs or head phones are routinely used in MRI

Safety (continued)

-FDA Safety Guidelines for MR Devices

-Acoustic noise level

International standard: 140 dB relative to 20 mPa

Emergency Shut Down

- Press this button in the case of a Fire, sparks, smoke
- Disable electrical power to equipment in the scan room.

Another danger in MRI: QUENCH!

- MR scanners are supercooled with inert gases such as helium.
- If these cryogens BOIL OFF either intentionally or unintentionally, a quench has occurred. THIS IS EXTREMELY BAD.
- When to Quench?

Quench is done in an emergency, to run the magnetic field to ZERO in order to remove a projectile/patient from the scanner in extreme emergencies.

- If a quench occurs, remove all staff from the room immediately

QUENCH!

- THE WORRY WITH A QUENCH IS THE POTENTIAL FOR ASPHIXIATION AND FROST-BITE TO THE HEALTH CARE WORKER AND PATIENT.

Importance of Proper Safety

Why is proper MRI safety so important?

- To protect your patient / subject
- To protect your co-workers / colleagues
- To protect yourself

Regulating those around you

Keep the MR control area safe

- Keep doors to the MR control area shut
- Do not let people into the MR control area or scanner rooms
- Do not share access codes
- Monitor your subjects while they are in the MRI area

Emergency Situations

- In the event of an emergency, you should first remove the subject from the MRI scan room
- Stand near the doors to the scan room to insure no unauthorized emergency personnel can enter

- NO CODE OR CODE LIKE PROCEDURES WILL BE RUN IN THE MRI ROOM.

Safety Training summary

- Annually review your safety training
- Always be aware of the potential dangers of MRI
- Never take anything metal into the scan room
- Always make safety a top priority while in the MRI environment

THE MAGNETIC FIELD IS AT FULL POWER ALWAYS ....**IT IS ALWAYS "ON".**

The End