Clinical MRI systems continue to get more powerful.

In 2002 the FDA approved 3.0 T whole body scanners for clinical human use.

Currently 4.0 T, 7.0 T and 8.0 T scanners are routinely used for research. A 9.4 T research scanner at the University of Illinois at Chicago became operational in 2007 and is scanning human research subjects.

In 2003 the FDA set the maximum field strength allowable for clinical use in humans. The maximum static magnetic field was set at 8.0 T for adults and infants > 1 month, and 4.0 T for neonates.

Implants considered "MRI safe" at 1.5 T may be unsafe or conditional at field strengths of 3.0 T and greater.

The Reference Manual for MRI Safety is still an invaluable tool, but more and more often technologists must get additional information from the manufacturer to ensure that an implant is safe for MRI.

Many implants, both passive and active, are listed in the MRI Reference Manual as “Conditional”. These implants are considered safe to scan as long as certain conditions, which are set by the manufacturer, are followed.
There are four system-related factors that technologists should bear in mind when considering the safety and MRI compatibility of an implant:

- Static Magnetic Field
- Static Magnetic Spatial Gradient Field
- Gradient Magnetic Field
- Radio Frequency Field

The spatial gradient field is produced by the fringe field of the static magnetic field ($B_0$).

It is the spatial gradient field that is responsible for the "missile effect" where ferrous items are attracted to the scanner.
Color map of heat generated in an adult patient inside a coil

For this presentation we will use 3.0T and 1.5T magnets as examples

**System specifications - 3T**
- Static Magnetic Field: 3.0T
- Spatial Gradient Field: 15 Tesla per meter
- Gradient Magnetic Field: 45/40/40 mT/m
- Max RF Field (uT): 23.5

**System specifications - 1.5T**
- Static Magnetic Field: 1.5T
- Spatial Gradient Field: 5.6 Tesla per meter
- Gradient Magnetic Field: 45/40/40 mT/m
- Max RF Field (uT): 30

The following are the safety conditions stipulated by the manufacturer.
- Static magnetic field of 1.5T or less.
- Spatial Gradient field of 450 gauss/cm.
- Gradient Magnetic Field of 20T/Second or less.
- Maximum whole body SAR of 1.1 W/kg for 25 minutes of imaging.

**Multilink Mini-Vision Stent**

**Manufacturers Conditions**
- Static Magnetic Field of up to 3.0T
- Maximum Spatial Gradient Field of 3.3 Tesla per meter
- Maximum whole body SAR of 2.0 W/kg for 15 minutes of scanning
- This stent is safe immediately after implantation

It is important for technologists to know the specs on their systems.
The Importance of MRI Safety

According to the FDA, reported MRI accidents are up by more than 227% since 2004.

Although staff may have gone through all required training, accidents in the MRI environment can still occur.

According to the FDA, for MRI safety, items should be classified into three categories: MRI Compatible, MRI safe, and MRI Unsafe. Items should marked with stickers similar to those below.

- **MRI Safe**
- **MRI Conditional**
- **MRI Unsafe**

Studies have shown that up to 50% of patients do not disclose all metal items that may be on their person or implanted in their bodies.
Metal detectors are increasingly being used by hospitals to help screen MRI patients.

New technology is now available for much more sensitive screening of MRI patients.

Advanced screening of MRI patients is possible with the emergence of ferromagnetic metal detectors.

Ferromagnetic metal detectors pick up only metal objects that are ferrous and will be attracted to the magnet.

There are several different types of metal detectors available that are suitable for use in MRI.

- Hand held metal detectors are easy to use, require little or no set up and are relatively inexpensive.

Stand alone or walk through metal detectors are becoming very popular in MRI suites.

It is now possible to purchase non-ferrous patient carts and wheelchairs and IV pumps which are metal detector compatible.
Obtaining a complete medical history and carefully screening the patient at least two times prior to allowing them into the MRI environment is recommended by the ACR.

Outpatients are changed into scrubs or gowns. Family members going into the MR room with the patient may also be required to change if not metal detector compliant.

Access to the MRI Department should be limited. Personnel with access to Zone III and Zone IV should be strictly controlled by the MRI department.

A call system can be installed at the entrance to Zone III. Personnel seeking entrance must be buzzed in by trained MRI staff.

Walk through metal detectors can be placed at the entrances to the magnet rooms, and the entrances to Zone III and Zone IV.

The best way to improve MRI safety is to create a “culture of safety” in which all hospital personnel have a basic understanding of MRI and are willing to work together to create a safe environment for MRI patients and their families.
Thank You