# Physical MRI Safety

*By Joel Kellogg, ETS-Lindgren, and*
*Tobias Gilk, RADIOLOGY-Planning, a division of JUNK Architects*

Magnetic Resonance Imaging (MRI) safety can be analogized to a three-legged stool. Anything less than an equal development of three distinct domains – clinical safety, operational safety, and physical safety – makes for a very precarious position.

All the attention in the world spent checking the relative MRI safety of implants, or the thermodynamic stability of a contrast agent (examples of clinical safety) does nothing to enhance either of the other domains. Similarly, subject screening protocols, appointment of an MRI safety officer, or staff training regimens (examples of operational safety) are also necessary, but insufficient alone, to comprise an MRI safety program. In this article, we look at the third domain, physical MRI safety, and one of its most important constituent parts: ferromagnetic detection systems.

**Ferromagnetic Detection Systems**

Unlike "airport style" metal detectors, which alarm on all types of metals, true Ferromagnetic Detection (FMD) systems use an entirely different technology which only detects the magnetic properties of materials that could be drawn into an MRI scanner. In this way, FMD systems are specific to the greatest risk in MRI that can't be directly identified by the trained MRI staff: 'what is this material, and does it present a risk near the MRI scanner?'

**MRI Risks**

Magnetic projectiles remain one of the top sources of MRI injury and equipment damage, and are perhaps the greatest recent acute source of serious injuries and deaths in the MRI environment.

**FMD Requirements**

FMD systems have been required elements of the Facilities Guidelines Institute (FGI) building code, and elements of US Department of Veteran Affairs (VA) and US Department of Defense (DoD) design standards. Recommended by the American College of Radiology (ACR) Guidance Document for Safe MR Practices, FMD systems, even if not required for your project, are clearly industry best practice.

FMD systems, long popular as a useful tool to enhance the security and safety around MRI suites, are now frequently required elements. Many building codes, MRI design criteria, and licensure regulations now require the use of FMD. Design standards - governmental (VA and DoD) as well as civil (FGI Guidelines) – now call for FMD systems. One of the challenges of distilled codes and standards, however, is that the base recommendations may require a bit of modification to work best at any individual site, putting an even greater importance on the vendor.

While ferromagnetic detection systems provide an opportunity to enhance the security and safety around an MRI suite, both the type of technology chosen and the manner in which the ferromagnetic detection system is implemented drive the overall benefits achieved from an installation.

There are two different classes of ferromagnetic detectors, mass screeners intended to screen the subject all at once, and targeted or localized screeners, that detect in a focal area. We will begin by discussing the different applications of mass screeners - where and how they can be integrated into an MRI suite.

**Mass Screeners**

There are several ways that mass ferromagnetic detection systems may be implemented. The first is as a prescreen device (e.g. the ETS-Lindgren SAFESCAN FMDS Models 200 or 300) to help check the patient during the clinical screening process (prior to bringing the patient into the controlled access area). Essentially, a facility would take a patient through all the normal screening procedures and, as an additional step in the screening procedure, would have a patient pass by or through a highly sensitive ferromagnetic detection system intended to detect anything from larger ferrous objects (e.g. pocket knives or cell phones) to smaller objects (e.g. nail clippers, jewelry, or hairpins) and other small ferrous objects, depending on the device's siting and sensitivity setting.

The second application involves the use of a ferromagnetic detection system as a screener at the entryway to the MRI suite (e.g. ETS-Lindgren SAFESCAN FMDS Model 100 dual-pillar system). This application can help catch elements missed in the conventional patient screening, and materials being brought to the suite by persons who have circumvented the screening process, altogether, such as transport personnel, respiratory / anesthesia (or other clinical

personnel), or even housekeeping staff. Particularly in retrofit situations, there are often limitations with this type of application that are dependent upon where it is placed – at the entryway of the controlled access portion of the suite (Zone 3), or at the doorway to the MRI scanner room (Zone 4) – and the specific technology utilized in the ferromagnetic detection system which is employed.

An entryway application involves utilizing a ferromagnetic detection system to monitor and screen individuals and items attempting to enter an MRI suite, or MRI scanner room. Some vendors even integrate the ferromagnetic detection system in the door jamb of the entry point to the MRI scanner room (Zone 4). Door jamb detector systems, however, remove all potential flexibility in choosing the best location to meet a site's specific needs.

While the MRI scanner room door is sometimes represented as the 'default' location for FMD system placement, there may be much better options depending on the layout and workflow patterns. "Dockable" MRI tables from all manufacturers, for example, contain enough ferromagnetic material to set off a sufficiently sensitive FMD system. If an MRI provider has a significant proportion of non-ambulatory patients that need gurneys / tables to get into the MRI scanner, doorway systems at the entry to the MRI scanner room are likely not the best siting choice.

A third application would be a combination of prescreen and entryway systems. Utilizing both applications ensures that patients have been thoroughly screened prior to entering the MRI suite. It also ensures that the MRI magnet room itself has additional protection from all others that may enter the suite, including those previously identified as likely getting around the standard screening process.

**Focal Screeners**

While mass screeners are excellent tools for ambulatory patients, non-ambulatory patients represent a unique situation. Non-ambulatory patients, which are transported to the MRI via stretcher or wheelchair, cannot easily be screened by a mass screener, wall mount or entryway ferromagnetic detection systems. In these instances, a focal handheld FMD system (e.g. the ETS-Lindgren SAFESCAN Target Screener, FMDS model 400) offers a distinct advantage. A handheld system allows staff to screen the patient and to discern if there is ferromagnetic material on the individual (versus the transport equipment or ancillary equipment carried on the transport equipment). Particularly in a hospital setting where there are a significant proportion of non-ambulatory patients, the coordinated and combined use of both mass FMD and focal FMD systems typically represents the best option to provide safety screening to all persons entering the MRI area.

While the use of different screening systems may initially appear repetitive, it is important to recognize that MRI patients (and patient care workflows) are not homogenous, and that sites who wish to make sure that there is comparable safety for all in the MRI suite will need distinct processes for ambulatory patients, non-ambulatory patients, caregivers, and MRI-

irregulars (including anesthesia, transport, environmental services, engineering, security, etc…). Particularly in hospital settings, where these mixes are often the most diverse, a multi-product FMD system solution is frequently the best option to provide meaningful screening for all who might be at risk.

**Selecting / Siting Ferromagnetic Detection Systems**

When it comes to selecting products and developing site layouts, designers are presented with a myriad of options. The single best option is to plan the suite with the implementation of a ferromagnetic detection system as an integral part of the MRI suite. Designers and equipment planners will help MRI providers maximize the safety and investment by working with a FMD vendor who offers a variety of mass screener products as well as focal screeners, and – even more importantly – can bring expert siting assistance to match the products and locations to a user's specific workflow and operational needs.

As alluring as some may seem, many FMD product "features" exist only to combat poor siting and integration. Some MRI doorway FMD vendors, for example, offer 'exit alarm suppression' intended to prevent an alarm when a person is walking out of the MRI scanner room with a ferromagnetic object. A site that provides MR-guided breast biopsies, for example, will often have clinical staff entering and exiting the MR scanner room with needles and biopsy equipment that may trigger a FMD system. While exit alarm suppression may sound like a desired feature (so that incidental alarms on entering and exiting with biopsy equipment are cut in half), siting the FMD system at a location other than the MRI scanner room door is likely the superior solution.

While the performance of FMD products is vital, selecting the right product type(s) and placement is often the single most important element to FMD deployment. A doorway system might be the best product for a particular situation, but what about the wheelchair-bound patient, or the patient under anesthesia? How do we provide ferromagnetic screening to clinicians and hospital staff coming to the department? Are we providing FMD screening early enough, or at a location that works with the intended workflow?

For the facility manager, architect or equipment planner, project success is unlikely by only specifying a FMD product, even an expensive one with every 'bell and whistle.' Designers are already accustomed to coordinating with RF and magnetic shield system vendors for the planning of MRI scanner rooms, so the coordination for the selection and integration of FMD products should be seen as a natural outgrowth.

**FMD Vendors**

There are no shortage of catalogue vendors, and third-party sales agents that sell FMD products, or single-solution vendors who – once you've bought their product – have no vested interest in your ongoing satisfaction. An integrated manufacturer, like ETS-Lindgren, will provide you with not only the product expertise, but also an ongoing relationship that involves the other products and services that are integral parts of an MRI suite.

In general, focus on vendors who spend more time asking about the site for the FMD installation – what is the patient mix… what are the success metrics for the deployment… what are the unusual patients / situations they encounter – and less time talking up their product (or bad-mouthing a competitor's product).

FMD products can significantly improve the safety of an MRI operation, but a poorly selected, sited, or integrated FMD may wind up causing more headache than a solution that is tailored to the MRI provider's specific needs.

**FMD Product Selection Do's & Don'ts**

Don't assume doorway systems are your only option. There may be much better choices for your project.

Do work with vendors who offer a variety of FMD products and formats. You don't have one workflow / patient type, why buy from a vendor who has only one or two product formats?

Don't assume 'more features are better' as bell-and-whistle laden systems often temporarily hide deeper problems.

Do get expert sales consultation to help get the right product(s) sited in the right locations. Vendors who talk product more than client process should be avoided.

Don't depend on device event logging for The Joint Commission (TJC) requirements, or risk creating a sea of false event reports.

Do work directly with companies that sell their own products, not resellers / catalogue shops.

**Biographies**

**Tobias Gilk** is former member of the ACR's MRI Safety Committee, and contributing author for the 2007 ACR Guidance Document on MR Safe Practices. He presently serves as Principal of his own consulting firm, Gilk Radiology Consultants , and Senior Vice President of RAD-Planning, a radiology architectural and design consulting firm,. He has written or contributed to major MRI / radiology standards and guidance, including the VHA Imaging Series Design Guides, the DoD Radiology Space Planning Criteria, the American Society of Healthcare Engineering's *Designing and Engineering MRI Safety* monograph, and both the 2010 and 2014 editions of the Facilities Guidelines Institute's Guidelines for Design and Construction of Health Care Facilities. Mr. Gilk can be reached at tgilk@MRIpatientsafety.com.

**Joel Kellogg** is the Manager of Technical Engineering and Consulting with ETS-Lindgren in Wood Dale, IL. Since joining ETS-Lindgren in 1998, he has been involved in the company's magnetic resonance imaging (MRI) products and services, including surveys and engineered solutions for vibration, acoustic, EMI (electro-magnetic interference), and RF (radio frequency). His research interests include active or electronic solutions for EMI and ferromagnetic detection systems for MR safety applications. In addition to managing the product line, Mr. Kellogg provides consulting services to aid in the siting of equipment that is sensitive to or creates RF, EMI, vibration, and/or acoustic environmental issues, including

magnetic resonance equipment. He received his Master's in Business Administration (MBA) from the Keller Graduate School of Management in 2007 and his Bachelor of Science, Electrical Engineering (BSEE) from the University of Wisconsin – Madison in 1998. He may be reached at 630-307-7200 or joel.kellogg@ets-lindgren.com.

**MRI Safety Web Resources**

2013 ACR Guidance Document on MR Safe Practices - http://onlinelibrary.wiley.com/doi/10.1002/jmri.24011/pdf

Interrelating Sentinel Event Alert #38 with the ACR Guidance Document - http://www.acr.org/~/media/ACR/Documents/PDF/QualitySafety/MR%20Safety/InterrelatingSentinelEventAlert38.pdf

MRI Safety 10 Years Later - http://www.psqh.com/component/content/article/137-november-december-2011/992-mri-safety-10-years-later.html

Facilities Guidelines Institute - http://www.fgiguidelines.org/

Designing and Engineering MRI Safety - http://www.ashe.org/resources/management_monographs/mg2008gilk.html

Is Ferromagnetic Detection Cost Effective? - http://mrimetaldetector.com/blog/2009/05/is-ferromagnetic-ferrous-detection-cost-effective/

New Tools For MRI Safety - http://www.psqh.com/julaug08/mri-safety.html