



Academy Journal

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New Standard of Practice for the Design of MRI Facilities

Abstract | ***Article***

July 26, 2001, all was right in the world of architectural design for magnetic resonance imaging (MRI) facilities. On July 27, however, the whole world of MRI paid the ultimate price for failures in facility design, management, and operation.

On that day, a 6-year-old patient was receiving a postoperative scan when a ferrous oxygen cylinder was brought into the magnet room. The magnetic force drew the cylinder into the bore of the magnet, where it struck the young boy. He died two days later from injuries sustained in the accident.

In the four years since the fatal accident, MRI utilization has increased enormously. Outpatient imaging centers are appearing in strip malls with the same rapidity that dandelions appear in the spring. And today, 3.0 Tesla MRI systems, which are twice the magnetic field-strength of the most common magnet systems sold in the U.S. only a couple of years ago, are rapidly gaining market share. In short, more patients, more centers, and higher-strength magnet systems.

In that same time frame, with the exception of the American College of Radiology's 4-zone screening principle, not a single standard for the safe design of MRI facilities has been enacted.

There are hazards inherent to MRI equipment. The risks may be inevitable, but accidents in the MRI suite are not. Accidents, like that which killed the young patient, arise in part from failings of the design and operation of MRI suites. While the design of the facility where the accident occurred was not found to be at fault, architects and engineers do have a direct role to play in mitigating these accidents. The information is available. The standard has been established. Now it is our obligation to meet it.

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Small and Rural Hospitals: Critical



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On July 26, 2001, all was right in the world of architectural design for magnetic resonance imaging (MRI) facilities. Occasionally a steel-plated orthopedic shoe or floor polisher might get drawn into the MRI, but that was really an operational issue—and not a consideration for the architects and engineers who lay out these facilities. On July 27, however, the whole world of MRI paid the ultimate price for widespread failures in management, operation, and facility design.

Anyone who has worked around MRI is familiar, if only anecdotally, with the extreme power of the magnets at the heart of these imaging systems. They can attract ferrous objects and draw them to the center of the magnet at speeds of up to 40 miles per hour. This has led to a number of dramatic accidents. Often these accidents result only in interrupted patient care or damage to the MRI equipment. However, people have been injured in these accidents; most notable is the death of a young patient.

On July 27, 2001, a 6-year-old boy was receiving a postoperative scan at Westchester Medical Center in New York when a ferrous oxygen cylinder was brought into the magnet room. The magnetic force drew the cylinder into the bore of the magnet, where it struck the young boy. He died two days later from injuries sustained in the accident.¹

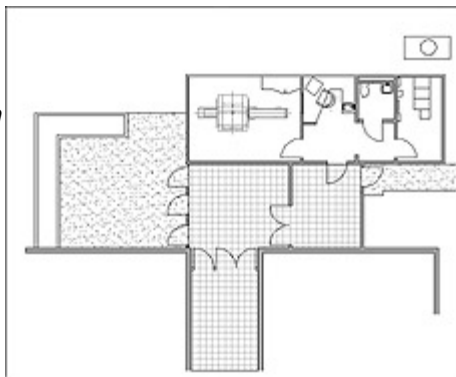


Figure 1. Re-created floor plan of Westchester Medical Center, MRI addition.

Immediately following the accident, the American College of Radiology (ACR) convened a panel to address issues of MRI safety—both those believed to have been contributing factors in the death and those that can affect the safety of every person receiving an MRI. Chaired by Dr. Emanuel Kanal, FACR, the panel issued the “White Paper on MR Safety” in 2002 as well as an update and revision in 2004.² ***While much of the content addresses issues of clinical care, the white paper does speak to how the layout, design, and program of an MRI facility should be developed***

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to support appropriate safety and screening protocols.

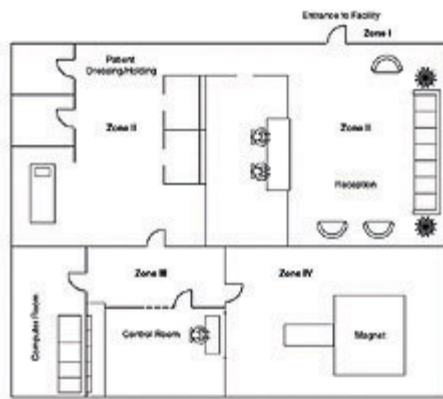


Figure 2. Reproduced from the ACR's "White Paper on MR Safety," combined papers of 2002 and 2004.

From a designer's standpoint, the clearest communication of this new responsibility came in the form of the diagrammatic floor plan, illustrating the 4-zone principle of sequential screening and access-controls, provided in the ACR's white paper.

Unfortunately for all MRI patients, the healthcare architecture community received the new guidelines with three years of deafening silence. Even the current proposed version of the AIA Guidelines for Design and Construction of Hospital and Health Care Facilities (under review at the time of this article) has only 10 sentences of guidance for the design of MRI facilities, five of which are merely placeholders for some presumed future wisdom.³

In the four years since the fatal accident, MRI utilization has increased significantly.⁴ Outpatient imaging centers are appearing in strip malls with the same rapidity that dandelions appear in the spring. And today, 3.0 Tesla MRI systems—twice the magnetic field-strength of the most common magnet systems sold in the U.S. only a couple of years ago—are rapidly gaining market share. In short, more patients, more centers, and higher-strength magnet systems are entering the marketplace.

In that same time frame, with the exception of the ACR's 4-zone screening principle, not a single standard for the safe design of MRI facilities has been enacted.

In the clinical world, it is called "standard of care," or the accessible, available, best-practice means of delivering care to a person. It dictates common protocols, such as sterilizing medical equipment, as well as the way in which care is delivered. Should an incident occur where a patient is hurt because a clinician failed to follow the standard of care, you can bet that the legal strategy quickly becomes one of damage control and not any assertion of innocence.

For design professionals, it is the similar "standard of practice" that provides the yardstick for the quality, care, and thoroughness of a design effort. For both clinicians and design professionals, the standard is considered to be discoverable. This means that you do not have to know about the standard to be held to it; it only needs to be

Access and Beyond

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HOSPITALity: Surgery Center Design for People, Not Procedures

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Inc.

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publicly available for you to learn about it. In essence, ignorance is no excuse if there is a means for you to educate yourself. Despite the fact that the information has been available for nearly three years, many current designs suggest that some architects and engineers have failed to avail themselves of this critical standard.

Unfortunately, a disturbing proportion of contemporary MRI facility design relies almost exclusively on vendor CAD templates. There is nothing inherently wrong with most vendor templates, but they are only provided to meet the technical operational requirements of the magnet system. The more global issues of MRI suite safety and operation are not, and have never been, addressed in vendor templates. Those who consider the vendor templates the end of design and not the beginning, those who cut and paste CAD drawings and ignore the larger safety issues, do so with callous disregard for the three-year-old standard of practice.

The truth is that there are no clip-art templates for safe MRI facility design. Each facility faces unique siting and construction constraints and provides different diagnostic and interventional services. Design elements can be standardized, but the overall composition must respond to the unique demands of the equipment, staff, patients, and site. Even the ACR's 4-zone diagram is only a diagram, meant to be descriptive and not a prescriptive solution to MRI safety concerns.

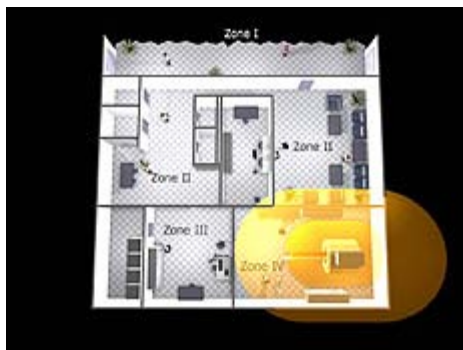


Figure 3. Normal and bloom extents of FDA exclusion zone of a typical 1.5 Tesla MRI superimposed on a CAD model of the ACR 4-zone diagram.

If interpreted literally, the diagram presents its own hazards, particularly when you overlay the FDA's 5-gauss exclusion zone from a typical MRI magnet over the ACR diagram. The 5-gauss exclusion zone penetrates the end wall of the MRI suite and has the potential of exposing persons to magnetic field strengths exceeding what OSHA and the FDA have determined to be the safe limits for unscreened persons.

That a single MRI suite prototype cannot be developed does not mean that a universal standard cannot be. It just happens to be a functional or programmatic standard. Instead of dictating quantifiable values, the ACR 4-zone principle describes sequential patient flow, access controls, screening, and visualization criteria. It is imbued with the flexibility to respond to a multitude of conditions, from cutting-edge intraoperative imaging suites to the ubiquitous strip-mall outpatient center.

The cost of this flexibility is that it demands of the designer a better understanding of the technical, clinical, and programmatic needs of the imaging provider. Designers who fail to understand and address the hazards present in

MRI suites, particularly in light of the death of the young patient, are failing their clients and, worse yet, all who seek healthcare from them.

Perhaps to better understand the issues architects are charged to address, we should turn to the ACR white paper on MR safety, the basis for our standard of practice, and hear from the clinical experts in MR safety as to what issues every MRI architect should address in their designs:

Finally, there is a whole host of other issues that should be considered during the site-planning stages and that is not dealt with in this manuscript. These include, among many others, cryogen emergency vent locations and pathways, 5-G line-siting considerations, patient access pathways, and considerations regarding fringe field blooming that may result in the event of failure of an actively shielded MRI system.

These issues, and many others, should be reviewed with those experienced in MR site planning and familiar with the patient-safety and patient-flow considerations before committing construction to a specific site design. In this regard, enlisting the assistance of an architecture firm experienced in this area, and doing so early in the design stages of the planning process, may prove most valuable.⁵

This is the charge to each of us. When the safety and well-being of patients is at stake, it is not sufficient to merely meet the building codes or the technical criteria of the magnet system vendors. Our professional obligation extends to protecting the health, safety, and welfare of those who inhabit the spaces we design. Nowhere is that obligation greater than for facilities specifically dedicated to the mission of protecting the public's health and safety.

There are hazards inherent to MRI equipment. The risks may be inevitable, but accidents in the MRI suite are not. Accidents, like that which killed the young boy, arise in part from failings of the design and operation of MRI suites. While the design of the facility where the accident occurred has not been found to be at fault, architects and engineers do have a direct role to play in mitigating these accidents. The information is available. The standard has been established. Now it is our obligation to meet it.

Endnotes

¹ The FDA synopsis of the accident is available on the FDA's Center for Devices and Radiological Health Web site (www.fda.gov/cdrh/safety/mrisafety.html).

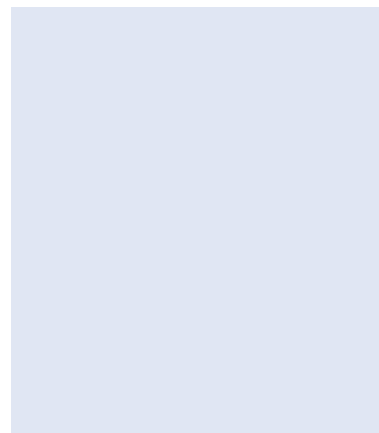
² The ACR "White Paper on MR Safety" is available for download from the American College of Radiology's Web site (www.acr.org).

³ A draft copy of the 2006 edition of the Guidelines manuscript, including proposed section 7.12.E on MRI

facilities, has been made available for review on the AIA Academy of Architecture for Health Web site (www.aia.org/aah_gd_hospcons).

⁴ *Market statistics on the increases in MRI utilization can be found on the AuntMinnie radiology Web site (www.auntminnie.com/index.asp?sec=sup&sub=bai&pag=dis&Itemid=66147).*

⁵ *Excerpted from ACR's "White Paper on MR Safety," Combined Papers of 2002 and 2004.*



The Academy Journal is published by the AIA Academy of Architecture for Health (AAH). The Journal is the official publication of the AAH and explores subjects of interest to AIA-AAH members and to others involved in the fields of healthcare architecture, planning, design and construction. www.aia.org/aah

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