“Published initially in 2002, the ACR MR Safe Practice Guidelines established de facto industry standards for safe and responsible practices in clinical and research MR environments.”
Level 2 Personnel

Level 2 MR personnel: Those who have been more extensively trained and educated in the broader aspects of MR safety issues, including, for example, issues related to the potential for thermal loading, burns, proper hearing protection and a solid understanding of how to handle implants and devices...

- MR Technologists
- MR Radiologists / Medical Director

Patient Screening

“Non-emergent patients should be MR safety screened on site by a minimum of 2 separate individuals. At least one of these individuals should be level 2 MR personnel. At least one of these 2 screens should be performed verbally or interactively.”

Patient Screening

Emergent patients should be MR safety screened by a level 2 MR Personnel on a case by case situation, keeping in mind the following should be assessed:
- Patient Medical Record
- Any previous radiographs
- Physical/Visual inspection of the patient for any markings indicating a previous procedure
- Consult with the Radiologist

** Final determination is decided by the radiologist to image the patient in MRI**
Gradient Magnetic Fields

Two types of gradient fields

1. Time-varying Magnetic Field Gradients \( \frac{dB}{dt} \)
   - produced by the gradient coils: Inside
   - vary in amplitude over time

2. Static Magnetic Field Gradient \( \frac{dB}{dx} \)
   - produced by the magnet itself: Outside
PNS

- FDA Limit: No Painful Stimulation
- Greatest further from isocenter
- Varies with patients
- Normal Operating Mode: 80% of the peripheral nerve stimulation mean
- 1st Level Controlled: 100% of the peripheral nerve stimulation mean

More likely to be seen when using sequences with very high slew rates

- Echo Planar Imaging
- DWI
- Ultra-short TR Gradient Echoes
- Localizer
- Body imaging / MRA

Extra Caution

- Patients with implanted or retained wires in anatomically or functionally sensitive areas (e.g. myocardium, epicardium or brain) should be considered at higher risk
- Decision to limit the $dB/dt$ and maximum strength of the gradient subsystems during imaging should be reviewed by the level 2 MR personnel-designated attending radiologist supervising the case or patient
Hearing protection must be provided for everyone in the scan room during an exam.

FDA

...instructions from manufacturers of MR equipment should state that hearing protection is required for all patients studied on MR imaging systems capable of producing sound pressures that exceed 99 dB.

IEC 60601-2-33

...for all equipment capable of producing more than an A-weighted rms sound pressure level of 99 dB, hearing protection shall be used for the safety of the patient and that this hearing protection shall be sufficient to reduce the A-weighted rms sound pressure level to below 99 dB.
Spatial Field Gradient at a given distance from the wall

x = Spatial gradient, G/cm
y = Distance, cm

GE Optima MR450w 70 cm bore

<table>
<thead>
<tr>
<th>Spatial gradient (G/cm)</th>
<th>Distance (y) (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>6.0</td>
</tr>
<tr>
<td>0.2</td>
<td>5.0</td>
</tr>
<tr>
<td>0.3</td>
<td>4.0</td>
</tr>
<tr>
<td>0.5</td>
<td>3.0</td>
</tr>
<tr>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>2.0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*Note: This is the initial of the slope, there is no straight isotropic band that does not break through or affect the spatial gradient.

Radio Frequency (RF) Field

Electric field
Magnetic field
Direction
Wavelength

Electromagnetic Energy
- Magnetic (B-field)
- Electric (E-field)
Various underlying health conditions may affect an individual's ability to tolerate a thermal challenge including cardiovascular disease, hypertension, diabetes, fever, old age, and obesity. In addition, medications including diuretics, beta-blockers, calcium blockers, amphetamines, and sedatives can alter thermoregulatory responses to a heat load. Importantly, certain medications have a synergistic effect with RF radiation with respect to tissue heating. The environmental conditions (i.e., ambient temperature, relative humidity, and airflow) that exist in the MR system will also affect tissue temperature changes associated with RF energy-induced heating.

SED: Specific Energy Dose

Specific to the body part and tissue

Energy of the RF

Dose into the body

Units of Joules/kg

*Also referred to as SAE (Specific Absorbed Energy)

240 W-min/kg (14440 J/kg)*

Research shows that this level will produce a temperature rise to 43° C (109° F) above which patient with normal thermal regulation may suffer tissue damage


Avoid contact with the bore wall at all times.

Padding should be between 0.5 cm and 1.0 cm.

Avoid skin-to-skin contact.

Do not create loops with coil wires.
The magnetic field generated by the RF transmit coil

The positively rotating component of the $B_1$ field useful for imaging

$B_{1+\text{rms}}$

Root-mean-square
time average over all RF pulses

Sample shown from a GE system

Courtesy Mark Conroy, PhD