

# **MRSO Exam Prep Course**

## **List of Definitions**

**AMBIENT TEMPERATURE:** The temperature of the surroundings as it circulates within the patient's environment.

**B<sub>0</sub> HAZARD AREA:** Region encompassing the MR apparatus in which the static magnetic field may induce damage.

**B<sub>1+</sub>:** The component of the RF magnetic field in the rotating frame that is effective for tilting the nuclear magnetization.

**Note 1:** B<sub>1+</sub> is derived from the flip angle estimated from the MR signal as detected from an adjustment volume, typically represented by an axial slab passing through MR ISOCENTER.

**Note 2:** The spatially localized amplitude of total B<sub>1</sub>, especially in the off-center position, can exceed the (spatially averaged and local) value of B<sub>1+</sub> by up to an order of magnitude.

**B<sub>1+</sub> PEAK:** Maximum value of B<sub>1+</sub>.

**B<sub>1+</sub> RMS:** Root mean square (RMS) of B<sub>1+</sub>, which represents the highest average value for any 10s period, evaluated throughout the sequence:

$$B_{1+}^{\text{RMS}} = \sqrt{\frac{\int_0^{t_x} (B_{1+}(t))^2 dt}{t_x}}$$

where  $t$  is time, and  $t_x$  is the integration time

Note 1 to entry: When a sequence is shorter than 10 s, the integration time equals the sequence duration, unless sliding window continuous integration across sequences is used.

**|dB/dt| PEAK:** Maximum time rate of change of the magnetic field's magnitude generated by the GRADIENT UNITS's combined outputs during the MR EXAMINATION, evaluated at the COMPLIANCE VOLUME.

**CIRCULARLY POLARIZED DRIVE:** Radiofrequency (RF) excitation where the two principal electromagnetic modes of a birdcage VOLUME RF TRANSMIT COIL are driven with equal amplitude and 90° phase difference.

**CIRCULARLY POLARIZED RF:** Time-varying B<sub>1</sub> field, where the field vector describes a circular trajectory in a plane orthogonal to the static magnetic field vector.

**Note 1:** The magnet's polarity determines the direction in the generated B<sub>1</sub> field, which rotates to create MR signals (the B<sub>1</sub> + component).

**Note 2:** When using CIRCULARLY POLARIZED DRIVE, a small B1 component (rotating in the opposite direction) is unavoidable in real-world VOLUME RF TRANSMIT COILS implementations. Consequently, the generated time varying B1 field vector deviates slightly from the ideal circular trajectory.

**COMPLIANCE VOLUME:** Space in which compliance of GRADIENT OUTPUT is inspected.

**Note 1:** In CYLINDRICAL MR EQUIPMENT with a WHOLE BODY MAGNET, the COMPLIANCE VOLUME is a cylinder with its axis coinciding with the PATIENT's axis and with a radius of 0.20 m and with a length equal to the height of the gradient coil.

**Note 2:** In MR EQUIPMENT with a TRANSVERSE FIELD MAGNET and a WHOLE BODY GRADIENT SYSTEM, the COMPLIANCE VOLUME is a cylinder aligned with the PATIENT's axis, of length equal to the gradient coil diameter and a radius of 0.20 m or equal to half the distance between the poles of the magnet, whichever is less.

**Note 3:** In all other MR SYSTEMS, the COMPLIANCE VOLUME is the volume where any part of a PATIENT body can be located appropriately according to the INTENDED USE of MR EQUIPMENT.

**CORE TEMPERATURE:** Temperature of the internal organs in the body and the aortic blood.

**CYLINDRICAL MR EQUIPMENT:** MR EQUIPMENT with a substantially cylindrical PATIENT aperture and a static magnetic field aligned with the long axis of the cylinder.

**Note 1:** This includes elliptical PATIENT aperture equipment.

**EFFECTIVE STIMULUS DURATION ( $t_s$ ,  $eff$ ):** Duration of any period of the monotonic increasing or decreasing gradient, used to describe its limits for cardiac or peripheral nerve stimulation. It is defined as the ratio of the peak-to-peak field variation and the maximum value of the time derivative of the gradient in that period (see figure below).

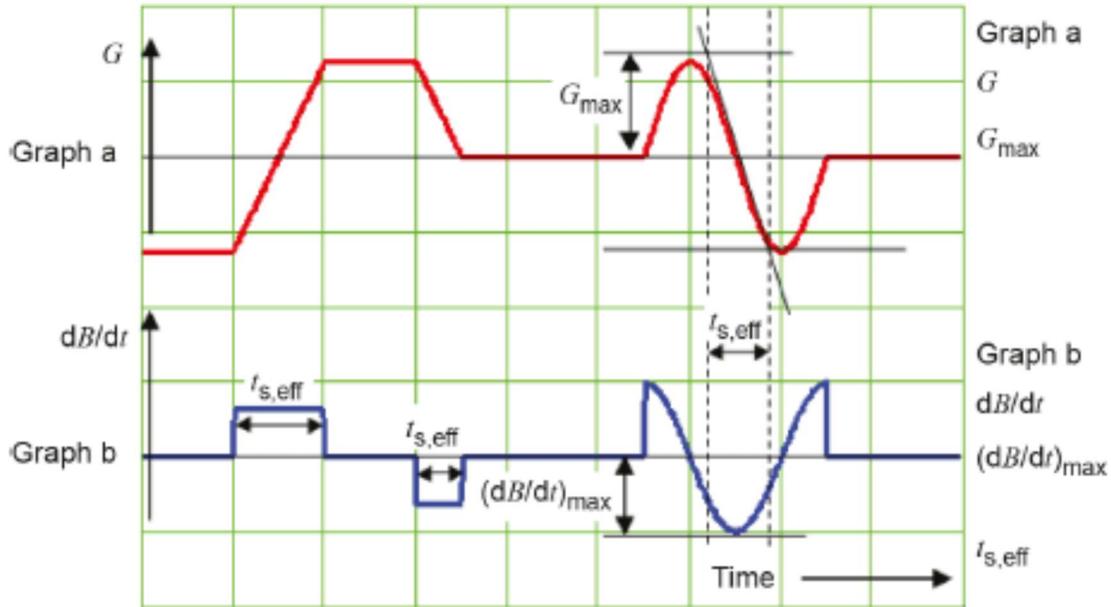


Image 0.1

- G:** Magnetic field gradient (T/m)  
**G<sub>max</sub>:** Maximum of gradient (T/m)  
**dB/dt:** Time rate of change of magnetic field (T/s)  
**(dB/dt)<sub>max</sub>:** Maximum time rate of change of magnetic field (T/s)  
**T<sub>s, eff</sub>:** Effective stimulus duration (s)

**EMERGENCY FIELD SHUT DOWN UNIT:** Subsystem enabling fast removal of the magnetic field of a superconducting or resistive magnet in case of an emergency.

**FIRST LEVEL CONTROLLED OPERATING MODE:** Mode of operation of MR EQUIPMENT where MEDICAL SUPERVISION mitigates RISKS associated with biophysical effects induced by exposure to electromagnetic fields.

**Note 1:** The electromagnetic fields essential to the operation of MR EQUIPMENT are the main magnetic field, the spatial encoding gradients, and RF. The operating mode for each field is independently assessed and reported.

**Note 2:** Indirect effects like displacement forces, acoustic noise, or interference with other MEDICAL DEVICES are not considered when identifying threshold exposure values.

**GRADIENT OUTPUT:** Parameter characterizing the gradient performance as the rate of change of the magnitude of the magnetic field or electric field induced by one or more GRADIENT UNITS under specified conditions and at a fixed position.

**GRADIENT UNIT:** All gradient coils and amplifiers that together generate a magnetic field gradient along one of the axes of the coordinate system of the MR EQUIPMENT.

**HEAD SAR:** Specific absorption rate (SAR) averaged over the mass of the head.

**Note 1:** The lower extent of the head is generally considered to be a line drawn from the foramen magnum anteriorly along the inferior border of the body of the mandible in a closed mouth position.

**INTERVENTIONAL MR EXAMINATION:** MR EXAMINATION applied to guide a medical (including invasive) procedure, e.g., biopsy or the treatment of a lesion.

**LOCAL RF TRANSMIT COIL:** RF transmit coil other than a VOLUME RF TRANSMIT COIL.

**LOCAL SAR:** SAR averaged over any 10 g of tissue of the body.

**MAGNETIC RESONANCE:** Resonant absorption of electromagnetic energy by an ensemble of atomic nuclei situated in a magnetic field.

**MAGNETIC RESONANCE ENVIRONMENT:** Three-dimensional volume surrounding the MR magnet that contains both the SPECIAL ENVIRONMENT (Faraday shielded volume) and the *B0* HAZARD AREA.

**Note 1:** This volume is the region in which an item might pose a HAZARD from exposure to the electromagnetic fields produced by the MR EQUIPMENT and ACCESSORIES, and for which access control is part of the RISK mitigation.

**Note 2:** The entrance to the MR ENVIRONMENT is controlled by the RESPONSIBLE ORGANIZATION.

**Note 3:** The area where entry is controlled is sometimes called the MR-controlled access area.

**MAGNETIC RESONANCE EQUIPMENT:** MEDICAL ELECTRICAL EQUIPMENT for the MAGNETIC RESONANCE EXAMINATION of a PATIENT

**Note 1:** The MR EQUIPMENT is a PROGRAMMABLE ELECTRICAL MEDICAL SYSTEM (PEMS).

**MAGNETIC RESONANCE EXAMINATION:** PROCESS of acquiring data by MAGNETIC RESONANCE from a PATIENT.

**MAGNETIC RESONANCE EXAMINATION ROOM:** Room where PATIENT undergoes an MR EXAMINATION.

**MAGNETIC RESONANCE ISOCENTER:** Null point of the spatially encoding gradients.

**Note 1:** Typically, this also corresponds to the region of highest magnet homogeneity.

**Note 2:** Typically, this corresponds with the position in the system targeted for imaging.

**MAGNETIC RESONANCE SYSTEM:** Combination, as specified by the MR MANUFACTURER, of items of equipment, at least one of which is MR EQUIPMENT, to be inter-connected by FUNCTIONAL CONNECTION or by use of a MULTIPLE SOCKET-OUTLET.

**MAGNETIC RESONANCE WORKER:** Because of their profession, they are trained concerning RISKS, which can occur when entering the MR ENVIRONMENT.

**Note 1:** This definition does not cover MR volunteers and PATIENT's social companions.

**MAXIMUM GRADIENT SLEW RATE:** Rate of change of the gradient magnetic field by switching one GRADIENT UNIT between its maximum specified gradient strengths  $G_{+max}$  and  $G_{-max}$  in the shortest possible ramp time.

**MEDICAL SUPERVISION:** ROUTINE MONITORING supplemented with medical management of PATIENTS who can be at elevated RISK from exposure to the MR EQUIPMENT.

**MR EQUIPMENT OUTPUT CONDITIONING:** Functionality allowing the OPERATOR to specify conditions to particular outputs for the MR EXAMINATION.

**Note 1:** Such limits include those commonly specified in MR CONDITIONAL labeling.

**MULTI CHANNEL- $N$  DRIVE:** RF excitation where  $N$  independent waveforms are fed into a birdcage VOLUME RF TRANSMIT COIL with  $N \geq 2$ .

**Note 1:** " $N$ " to be replaced by the appropriate number, e.g., 2, 3, 4, etc.

**Note 2:** Transverse electromagnetic (TEM) coils can be characterized as MC- $N$  by using additional qualifications and controls.

**Note 3:** A VOLUME RF TRANSMIT COIL can have  $M$  additional feeds that derive their amplitudes and/or phases from the  $N$ -independent waveforms. ( $M + N$  total feeds).

**Note 4:** A coil operating in MC- $N$  can additionally provide CIRCULARLY POLARIZED RF and/or linearly polarized RF fields.

**Note 5:** Waveforms are classified as dependent if their amplitudes are identical and their phase difference is equal to the physical angular separation of the feed points. Independent waveforms can have an amplitude and phase relationship that varies with time during any RF pulse.

**NORMAL OPERATING MODE:** Mode of operation of MR EQUIPMENT where the biophysical effect induced by a specific electromagnetic field typically presents negligible RISK.

**Note 1:** The electromagnetic fields essential to the operation of MR EQUIPMENT are the main magnetic field, the spatial encoding gradients, and RF. The operating mode for each field is independently assessed and reported.

**Note 2:** Indirect effects like displacement forces, acoustic noise, or interference with other MEDICAL DEVICES are not considered when identifying threshold exposure values.

**PARTIAL BODY SAR:** SAR averaged over the region of the body that receives 95 % of the deposited RF power.

**PERIPHERAL NERVE STIMULATION THRESHOLD LEVEL:** Value of the GRADIENT OUTPUT related to the onset of PNS sensation for the PATIENT.

**QUENCH:** Decay of the magnetic field resulting from the loss of super-conductivity, the associated rapid conversion of fluid cryogen to cryogenic gas, and possible gas escape into the environment.

**ROUTINE MONITORING:** Monitoring the PATIENT using visual and audio techniques during the MR EXAMINATION by qualified staff.

**SEARCH COIL:** Small diameter coil used in a compliance test to measure  $B_1+$  or GRADIENT OUTPUT.

**SECOND LEVEL CONTROLLED OPERATING MODE:** Mode of operation of the MR EQUIPMENT for which the RESPONSIBLE ORGANIZATION defines RISK acceptability as part of a human studies protocol and where MEDICAL SUPERVISION is implemented to mitigate such RISK.

**Note 1:** The operating mode controls the thresholds for RISks associated with electromagnetic fields essential to the operation of MR EQUIPMENT, viz., the main magnetic field, the spatial encoding gradients, and RF. The operating mode for each field is independently assessed and reported.

**Note 2:** Significant RISK in this mode can also relate to indirect effects like displacement forces, acoustic noise, heating of RF coil surfaces and cables, or interference with other MEDICAL DEVICES.

**SPATIAL FIELD GRADIENT:** Spatial rate of change of the main magnetic field:  $|\nabla|\vec{B}_0||$

**SPECIFIC ABSORPTION (SA):** RADIO-FREQUENCY energy absorbed per unit of mass, calculated from WHOLE BODY SAR.

**Note 1:** SA is also known as SED (specific energy dose) or SAE (specific absorbed energy). Transition to the exclusive use of SA is recommended.

**Note 2:** Use of SA associated with other SAR types, is not recommended.

**Note 3:** Using the units [W·min/kg] and [kJ/kg] is acceptable. Providing the conversion factor and/or the quantities in both units can be appropriate.

**SPECIFIC ABSORPTION RATE:** RADIO-FREQUENCY power absorbed per unit of mass.

**TIME RATE OF CHANGE OF THE MAGNETIC FIELD (dB/dt):** Time rate of change of the magnitude of the magnetic field.

**Note 1:** The dB/dt generated by the GRADIENT UNITS is assumed to be evaluated in a suitably low-frequency range (e.g., < 5 kHz) to disregard the effects of switching amplifier ripple.

**Note 2:** Motion in the static magnetic field also causes dB/dt.

**TRANSVERSE FIELD MAGNET:** Magnet for which the static magnetic field is at right angles to the long axis of the PATIENT's anatomy being imaged.

**VOLUME RF TRANSMIT COIL:** RF transmit coil suitable for use in MR EQUIPMENT that produces a homogeneous RF field over an extended volume encompassed by the coil.

**Note 1:** A VOLUME RF TRANSMIT COIL is typically a WHOLE BODY RF TRANSMIT COIL or an RF TRANSMIT COIL designed for homogeneous exposure of a specific part of the body.

**WHOLE BODY GRADIENT SYSTEM:** Gradient system of sufficient size to perform an MR EXAMINATION on the torso of adult PATIENTS.

**WHOLE BODY MAGNET:** Magnet of sufficient size to perform an MR EXAMINATION on the torso of adult PATIENTS.

**WHOLE BODY RF TRANSMIT COIL:** VOLUME RF TRANSMIT COIL of sufficient size to perform an MR EXAMINATION on the torso of adult PATIENTS.

**WHOLE BODY SAR:** SAR averaged over the total mass of the body.