SAR

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Specific Absorption Rate	
	(SAR) The **Specific Absorption Rate** is defined as the RF power absorbed per unit of mass of an object, and is measured in watts perkilogram (W/kg). The SAR describes the potential for heating of the patient's tissue due to the application of the RF energy necessary to produce the MR signal. Inhomogeneity of the RF field leads to a local exposure where most of the absorbed energy is applied to one body region rather than the entire person, leading to the concept of a local SAR. Hot spots may occur in the exposed tissue, to avoid or at least minimize effects of such theoretical complications, the frequency and the power of theradio frequency irradiation should be kept at the lowest possible level.Averaging over the whole body leads to the global SAR. It increases with field strength, radio frequency power and duty cycle, transmitter-coil type and body size. The doubling of the field strengthfrom 1.5 Tesla (1.5T) to 3 Tesla (3T) leads to a quadrupling of SAR. In high and ultrahigh fields, some of the multiple echo, multiple-slice pulse sequences may create a higher SAR than recommended by the agencies. SAR can be reduced by lower flip angle and longer repetition times, which could potentially affect image contrast. Normally no threatening increase in temperature could be shown. Even in high magnetic fields, the local temperature increases not more than 1°C. 2.1°C is the highest measured increase in skin temperature. Eddy currents may heat up implants and thus may cause local heating. FDA SAR limits: ■ Whole body: 4W/kg/15-minute exposure averaged; ■ Head: 3W/kg/10-minute exposure averaged; ■ Head or torso: 8W/kg/5 minute exposure per gram of tissue; ■ Extremities: 12W/kg/5 minute exposure per gram of tissue. IEC (International Electrotechnical Commission) SAR limits of some European countries: All limits are averaged over 6 minutes. ■ Level 0 (normal operating mode): Whole body 2W/kg; Head 3.2W/kg; Head or Torso (local) 10W/kg; Extremities (local) 20W/kg; ■ Level I (first level controlled operating mode): Whole body 4W/kg; Head 3.2W/kg; Head or Torso (local) 10W/kg; Extremities (local) 20W/kg; ■ Level II (second level controlled operating mode): All values are over Level I values. (For more details: IEC 60601-2-33 (2002)) In most countries standard MRI systems are limited to a maximum SAR of 4 W/kg, so most scanning in level II is impossible. For Level I, in addition to routine monitoring, particular caution must be exercised for patients who are sensitive to temperature increases or to RF energy. For Japan different SAR limits are valid.
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What is SAR, SAR Testing Requirements.

Specific Absorption Rate (SAR) is the unit of measurement for the amount of radio frequency (RF) absorbed by the body when using a wireless device. The **SAR value** is expressed in terms of watts per kilogram (W/kg) or milliwatts per gram (mW/g). The RF exposure limits used are expressed in the terms of SAR, which is a measure of the electric and magnetic field strength and power density for transmitters operating at frequencies from 300 kHz to 100 GHz. The FCC and other federal governmental agencies around the world require that any wireless device be evaluated to meet the **RF exposure limits** set forth in the governmental SAR regulations.

The most generally accepted method for measuring SAR values is the **direct method SAR test**. This method utilizes a model called a "SAM phantom" to simulate the human head and a "flat phantom" to simulate the human body. With this method, wireless devices are tested at the highest certified power level in laboratory conditions utilizing a SAR test system with a robot. An orthogonal probe is mounted on the robot arm to measure the RF fields transmitted into a calibrated tissue simulant.

Worldwide Standards

The **SAR testing requirement** is being added to many countries around the world. Numerous other countries are in the process of evaluating the need to add SAR testing to their requirement. The following is a list of the**standards for SAR**

testing at present.

FCC OET Bulletin 65 Supp. C
Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields – Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions.

IEEE 1528 Std.- 2003
Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques

Industry Canada – RSS – 102
Evaluation Procedure for Mobile and Portable Radio Transmitters with respect to Health Canada's Safety Code 6 for Exposure of Humans to Radio Frequency Fields

Industry Canada – Health Safety Code 6
Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz

Australian Communication Authority
Radiocommunications (Electromagnetic Radiation – Human Exposure) Standard 2003

Australian Communication Authority
Radiocommunications (Compliance Labelling - Electromagnetic Radiation) Notice 2003

Australian Communication Authority
Radiation Protection Series No. 3 – Maximum Exposure Levels to Radiofrequency Fields – 3kHz to 300 GHz

International Electrotechnical Commission (IEC) – IEC 62209
Procedure to determine the Specific Absorption Rate (SAR) for hand-held mobile telephones in the frequency range of 300 MHz to 3GHz

European Union – EN 50360
Product Standard to Demonstrate the Compliance of Mobile Phones with the Basic Restrictions Related to Human Exposure to Electromagnetic Fields (300 MHz – 3 GHz)

European Union – EN 50361
Basic Standard for the Measurement of Specific Absorption Rate Related to Exposure to Electromagnetic Fields from Mobile Phones (300 MHz – 3 GHz)

European Union – EN 50364
Limitation of Human Exposure to Electromagnetic Fields from devices operating in the Frequency Range of 0 Hz to 10 GHz, used in Electronic Article Surveillance (EAS), Radio Frequency Identification (RFID) and similar applications

European Union – EN 50371
Generic Standard to Demonstrate the Compliance of Low Power Electronic and Electrical Apparatus with the Basic Restrictions related to Human Exposure to Electromagnetic Fields (10 MHz – 300 GHz) – General Public

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Cell Phones

All cell phone models must be tested to meet the SAR requirements for most all countries around the world. All bands and technologies are tested or evaluated against the requirements. The phone is tested using a phantom head on both the right and left side of the head in a touch configuration. The phone is also tested with the phone touching the ear and tilted away from the cheek 15º. The phone is then moved to a flat phantom to simulate the phone next to the body. It is tested with a specified separation distance, which is included in the user's guide. The

US requirements are listed in OET bulletin 65 Supplement C, KDB 447498, KDB 648474 and KDB 941225. The testing procedure for a handset is described in IEEE1528-2005. The EU requirements are listed in IEC 62209 Parts 1 and 2.