

Occupational exposure to static and time-varying EMF of MRI devices

JOLANTA KARPOWICZ, KRZYSZTOF GRYZ

*Central Institute for Labour Protection – National Research Institute,
00-701 Warszawa, Czerniakowska 16, POLAND, e-mail: jokar@ciop.pl, krgry@ciop.pl*

Key words: MRI, occupational exposure, electromagnetic fields, measurements methods, assessment methods

Combined EMF produced by MRI devices consists of the following components: static magnetic field of high dB/dx spatial inhomogeneity - existing permanently during the shift, pulses of RF and low frequency magnetic field of high rate of rise/fall dB/dt - existing only during patients examination. The level of the workers' exposure depends both on the type of the magnet and ergonomical design of the particular MRI device, as well as on technical accessories available while attending to examined patients.

The paper will present methods used for measurements and assessment of such exposure and obtained results: Hall probe static magnetic fields measurements, oscilloscopic measurements of pulsed fields, and RMS RF electric and magnetic fields measurements. The results collected during inspection measurements done next to more than 15 various MRI devices with magnets of static flux density from app. 0.2 T to 2 T will be presented.

Exposure of workers to static fields of strong MRI magnets (permanent, resistive or superconducting) can be significant. Fortunately during patient's examination, health care personnel is seldom exposed to a gradient and RF fields close to magnet. RF and gradient fields exposure can occur if patient needs special attention during examination (e.g. claustrophobic individual, children, serious health condition, ...) or during the contrast injecting for the so-called dynamic contrast examination. Exposure assessment of various groups of workers making activities in the vicinity of MRI was done according to the occupational safety and health regulations and standards established in Poland, which was applied to exposure level and exposure duration. The comparison with EC directive- and IEEE standards- based exposure assessment was also done.

The majority of MRI devices can be a source of so-called dangerous exposure ($B > 100$ mT for whole body or $B > 500$ mT for hands), and all devices can be a source of so-called excessive exposure of workers during working day ($W > 1$) in the case of improper work organisation (i.e. when the attendant is not keeping sufficient distance from the source of the field or remains too long in the exposed area). It has been noticed that proper ergonomic conditions allowed to considerably reduction of the exposure level and duration.

Working practice for avoiding exposure during work should be recommended workers for as long as there are questions about health effects of chronic exposure to strong static and time-varying EMF. Sufficient reduction of the workers exposure level is possible when requirement of the possibility of it's operation in the distance from the magnet no less than 0.5 m is introduced to MRI device design process. Workers training should also present them methods for exposure reduction. Medical staff should have got at disposal the proper equipment for reducing the exposure, e.g. long dielectric manipulators for adjusting RF coils, an imaging table automatically pushed away from the magnet or undocked for patient's preparing before the examination, an optical positioning system for a fast and easy set up of the RF coil.