STATIC MAGNETIC FIELDS QUICK REFERENCE SHEET

This document was developed by the AIHA NIR Committee. The intent is to provide general information to practicing Industrial Hygienists on NIR topics and to determine next steps for assessing and controlling NIR hazards. For additional, detailed information please refer to the reference section.

Characteristics – Lack frequency or wavelength; sometimes called dc (direct current) fields as their polarity is constant (current flow is unidirectional); freely penetrate many materials

Units of Measure

International System of Units (SI)	Centimeter-gram-second (cgs)
The tesla (T), magnetic flux density, usually designated as the "B" field	The gauss (G), magnetic flux density
The ampere per meter (A/m), magnetic field strength, usually designated as the "H" field.	
The henry (H), inductance	

$1\ G = 10^{-4}\ T$ 10 G = 1 milliTesla (mT) 1 G = 79.58 A/m* 1mG ≈ 80 mA/m
*in free space, biological materials, most any non-ferrous substances
$B = \mu H$, for non-ferrous materials, $\mu_0 = 4\pi \times 10^{-7}$ Henry's per meter
1 Tesla ≈ 800,000 amperes per meter

Significant Sources – Direct current intensive processes (e.g., aluminum extraction & chlor-alkali plants), magnetic resonance imaging (MRI)* in healthcare, and nuclear magnetic resonance (NMR) facilities with superconducting magnets in analytical labs, Electromagnets and large magnets enclosed in equipment such as lab etchers.
*Also a radiofrequency (RF) radiation exposure source for patients

Biological Effects – No specific target organ(s) identified. Possible displacement and /or functional impairment of ferro-magnetic medical implants, including cardiac pacemakers and implantable cardioverter-defibrillators (ICDs), potential for magneto-hydrodynamic effects (changes in hydrostatic pressure and electrical potentials across vessels in the human vasculature) on blood flow. Body movement in the stray fields near MRIs can produce adverse effects on neurocognitive performance and balance.

Exposure Guidelines

ACGIH 2012 TLVs	**Ceiling Value**
Whole Body (general workplace)	2 Tesla (T)
Whole Body (special worker training and controlled workplace environment)	8 T
Limbs	20 T
Medical device wearers	0.5 mT

0.5 mT = 5 Gauss

Specific exposure limits may apply to personnel that have embedded medical devices, the device manufacturer may provide specific guidance or limits.

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Exposure Assessment – For field surveys, Hall effect sensors (Gaussmeters) which indicate when placed perpendicular to magnetic field flux lines; when greater sensitivity is required, fluxgate magnetometers. Must orient flat transverse response probes to obtain peak response (field is perpendicular to flat side of probe tip), but orthogonal sensors which provide an isotropic response are available. Axial Hall effect probes give peak response when field is parallel to the probe's long axis. A zero chamber is required to zero meter prior to use.

Ancillary Hazards – Magnet weights require substantial structural support. Ferromagnetic (metal) objects (e.g., tools, gas cylinders, pocketknives, key rings, etc.) can be accelerated with great force and speed towards large magnets causing personal injury. Objects striking superconducting magnets can cause them to quench (become resistive); the rapid vaporization of the cryogenic liquid(s) in the magnets can displace air in the laboratory creating an asphyxiation hazard.

Control Measures – Isolation / controlled access to MRI and NMR units to keep embedded medical device wearers outside of 5 gauss (0.5 mT) magnetic field line and prevent ferro-magnetic objects from getting inside that line. Signage to warn potential entrants into areas occupied by the above units of the cited hazards and the potential for damage to magnetic media (credits cards, hard disk drives, ID cards, etc.). Superconducting magnets should have the asphyxiation hazard evaluated.

References and Additional Information

American Conference of Governmental Industrial Hygienists (ACGIH): Static Magnetic Fields TLV Documentation (2012).

AIHA Nonionizing Radiation Guide Series – General Concepts for Nonionizing Radiation Protection

Peter H. Wald and Greg M. Stave (eds.): Physical and Biological Agents of the Workplace, 2nd Edition. New York: John Wiley & Sons, 2002.

R.T. Hitchcock, C.E. Moss, W.E. Murray, R.M. Patterson, and R. James Rockwell: Chapter 22, Nonionizing Radiation in The Occupational Environment: Its Evaluation, Control, and Management, 2nd Edition. Fairfax, VA: AIHA, 2003.

R.T. Hitchcock and R.M. Patterson: *Radiation Control Program. In Radio-Frequency and ELF Electromagnetic Energies.* New York: Van Nostrand Reinhold, 1995.