Occupational protection from electromagnetic fields

With effect from 1st July 2016, all companies are obligated to take a more intense look at the occupational risks to staff posed by electromagnetic radiation. From this date, all EU member states must have implemented the corresponding European Directive 2013/35/EU, which stipulates the "Minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields)".

The EU Directive has been implemented in Germany by means of an EMF Health and Safety Regulation issued by the Federal Labor and Social Services Ministry. Prior to its ratification, companies could use the minimum regulations and limit values outlined in Directive 2013/35/EU as a guide.

There are clear parallels between the EMF Directive and the European Directives on Noise and Vibration with regard to the requirements, obligations of employers, and measures to be taken. The Health and Safety Regulation for Noise and Vibration came into effect in March 2007. This is the German national implementation of the EU Directives 2003/10/EC "Physical agents (noise)" and 2002/44/EC "Physical agents (vibration)". In both cases, the main aim is to assess the possible risks to workers arising from noise or vibration for the various places of work within a company. If potential sources are detected and the permitted limit levels are exceeded, then appropriate measures must be taken where possible to protect employees from any effects that may be hazardous to health.

How electromagnetic fields occur

Every electrical device will generate an electromagnetic field because there will always be a magnetic field surrounding a conductor through which a current is flowing. In addition, an electric field will form between points having different voltage potentials. The higher the field strength and the shorter the distance from the field source, the stronger the effect on the human organism. There is an ever-increasing use of electrical equipment in the workplace, where the fields from individual sources may overlap be amplified as a result. This inevitably means an increase in field exposure in the occupational environment.

Manufacturers can reduce EMF by means of constructive measures such as screening and optimizing the wiring paths. Commercial products such as electrical tools or office communication equipment must meet the current product standards according to their conformance declaration, so they do not require any further measures as part of a safety assessment. However, all equipment and plant that generates high frequencies at high power levels or where large currents are flowing, such as in electric welding equipment, needs to be examined very carefully with regard to EMF.

Biophysical effects

Humans are unable to see or hear electromagnetic fields. As a rule, they only notice them when the health hazard exposure limit has been plainly exceeded. The effects mainly depend on the intensity, type and duration of action (Figure 1).

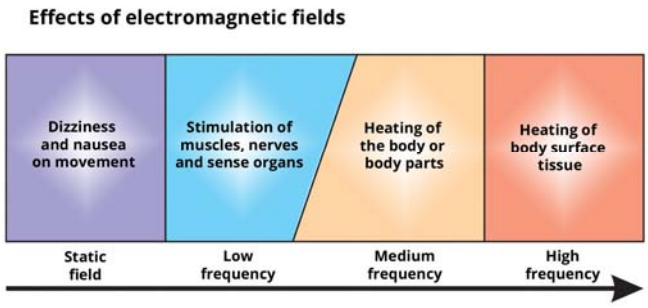

Figure 1: The negative effects of EMF on the human organism according to frequency.

The EMF Directive takes two types of direct biophysical effect that are caused by electromagnetic fields into account. On the one hand, these are thermal effects, which occur when tissue is heated by absorbing energy at frequencies between 100 kHz and 300 GHz. Such strong high frequency fields can cause internal burns, even blindness in extreme cases. On the other hand, the EMF Directive also considers the stimulation of muscles, nerves and sense organs. These effects are triggered by low frequencies of up to around 10 MHz, and can cause hallucinations, for example. The Directive emphasizes that the definitions of the limit values are based solely on scientifically proven direct short-term effects. Any long-term effects that may possibly occur are not taken into account, as there is currently no proof of any causal connection.

The Directive also looks at indirect effects, such as spark discharges or contact currents that can be induced by electromagnetic fields, as well as interference with heart pacemakers and metallic implants and the effects on ferromagnetic objects. For example, even the humble paperclip can become a projectile in an extremely strong magnetic field.

Exposure limit levels and action levels

The EMF Directive specifies exposure limit levels and action levels that are based on the internationally recognized recommendations of the ICNIRP (International Commission on Non-Ionizing Radiation Protection) (Figure 2).

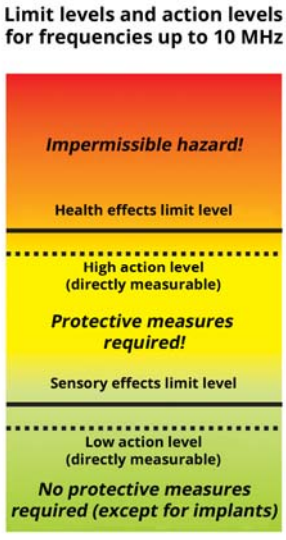

Figure 2: Diagram of limit levels and action levels for EMF frequencies up to 10 MHz.

The exposure limit levels are the maximum levels permissible within the body of the employee. On the whole, these levels cannot be measured directly. For this reason, the EMF Directive defines physical parameters in the form of so-called action levels, which are directly measurable. The safety of personnel is demonstrated sufficiently if the action levels are not exceeded. In this situation, the exposure limit levels are deemed not to have been exceeded automatically.

The EMF Directive distinguishes between thermal and non-thermal effects. The former are not only dependent on the field strength; they also depend on the frequency. The Directive therefore defines frequency dependent action levels in the range between 100 kHz and 300 GHz. If these levels are exceeded, protective measures are needed. The

measuring equipment used must therefore be able to assess the field strength accurately according to frequency and to add the individual influences together correctly. This is because there are usually many different frequencies present in the high frequency range, for example in the vicinity of transmitting equipment. In such cases, portable field monitors worn on the person can provide timely warning of excessive field strengths.

The non-thermal effects are also frequency dependent. Accordingly, the EMF Directive defines frequency dependent action levels for the range between 1 Hz and 10 MHz. These are classified as low action levels, above which sensory effects or transient alteration of sensory perception can occur, and high action levels, above which effects hazardous to health are likely. Protective measures are necessary as soon as the low action levels are exceeded. Preventive measures must be used to ensure that the high action levels are never exceeded.

Typical low frequency fields occur overwhelmingly in the industrial environment and are often impulse type fields. The EMF Directive therefore specifies the use of the “weighted peak method’ as the reference measurement method for non sinusoidal fields. This method assesses the peak values in the time domain. Measuring devices that are specifically designed for safety measurements will have this measurement method, also called the shaped time domain (STD) method, already implemented. Alternative methods as well as calculation of the electromagnetic field are also permitted by the Directive as long as they produce approximately equivalent and comparable results.

Special care with regard to protection is needed for persons who have implants that can be affected by EMF, such as pacemakers, and persons who may be at higher risk, such as pregnant women. This group of people is at higher risk even below the action levels, which means that the risk assessment must be even more critical.

Employers’ obligations

A new requirement of the EMF Directive is that employers must assess the risk separately for each workplace. This risk assessment must be made by professionals and must be repeated at appropriate intervals and must also be documented in traceable form (figure 3).

Figure 3: The new EMF Directive requires that, from now on, a professional must make a separate risk assessment for each workplace.

However, it is not necessary to make measurements everywhere or every time. In many cases where only low current devices are used, such as in offices or laboratories, the conformance declaration (CE mark) provided by the equipment manufacturer is entirely sufficient. Nevertheless, even in such cases it is the total exposure that is crucial, so this will need to be calculated separately if necessary. In all other cases, though, measurements must be made (figure 4). Wherever the action levels are exceeded, the employer will have to take appropriate action. This could be in the form of a technical change, such as by using an alternative process, screening, or personal protective equipment. Or it could be organizational, by controlling access, restricting access times, or through operational instructions.

Figure 4: Narda offers a comprehensive range of measuring devices including software for verifying workplace compliance with Directive 2013/35/EU.

The EMF Directive does not stipulate any specific protective measures or implementation details. A guideline entitled “Non-binding guide to good practice for implementing Directive 2013/35/EU Electromagnetic Fields” has been issued on behalf of the EU Commission to make it easier to put the Directive into action. The guideline includes descriptions of calculation methods, measurement methods, simplified procedures for small and medium enterprises (SMEs) and the formal requirements that must be met by employers. A corresponding technical rule book for Germany is currently being produced by the Industrial Safety Board (ABS).

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