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Evaluation techniques and working procedures for compliance with exposure limits of network operator personnel to power-frequency electromagnetic fields

PREPUBLISHED RECOMMENDATION

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Recommendation ITU-T K.90

Evaluation techniques and working procedures for compliance with exposure limits of network operator personnel to power-frequency electromagnetic fields

Summary

Recommendation ITU-T K.90 provides evaluation techniques and guidelines for compliance with safety limits for human exposure to electromagnetic fields (EMFs) of telecommunication network personnel (e.g., outside plant craft) at power frequencies (DC, 50 Hz and 60 Hz). This Recommendation does not set safety limits; it seeks to provide techniques and procedures for determining the need for any precautions at the work site.

This Recommendation includes an electronic attachment containing the EMFACDC program.

Keywords

Exposure to EMF, exposure zones, MV and HV power lines, workers.

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Electronic attachment: EMFACDC program

Recommendation ITU-T K.90

Evaluation techniques and working procedures for compliance with exposure limits of network operator personnel to power-frequency electromagnetic fields

1 Scope

This Recommendation¹ aims to help with compliance of telecommunication network personnel working in vicinity of medium-voltage (MV) and high-voltage (HV) power lines with safety limits for human exposure to electromagnetic fields (EMFs) at power frequencies (DC, 50 Hz and 60 Hz). Also, it aims to provide practical work rules as one of the means of safeguarding network personnel that may need to work in close proximity to the MV and HV power lines.

Where local or national laws, standards or guidelines on work safety or exposure limits to EMF exist and provide procedures that are at variance with this Recommendation, the pertinent local or national laws, standards or guidelines shall take precedence over the procedures provided in this Recommendation.

This Recommendation does not cover exposure to electromagnetic fields at frequencies other than DC, 50 Hz and 60 Hz. This Recommendation does not cover exposure to touch currents that arise as a result of coupling of electromagnetic fields generated by the power lines to other metallic objects, including telecommunication circuits.

[b-ITU-T K.52] aims to help with compliance of telecommunication installations and mobile handsets or other radiating devices used against the head with safety limits for human exposure to electromagnetic fields (EMFs).

[b-ITU-T Vol.VI] covers safety issues related to people coming in contact with telecommunication circuits exposed to the induction of AC electric power or AC electrified railway lines.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[IEC 61472] IEC 61472 (2013), *Live working - Minimum approach distances for a.c. systems in the voltage range 72,5 kV to 800 kV - A method of calculation*

<<https://webstore.iec.ch/publication/5486>>

¹ This Recommendation includes an electronic attachment containing the EMFACDC program

3 Terms and definitions

This Recommendation defines the terms defined in this clause. The definitions are harmonized with those used in [b-ITU-T K.52].

3.1 controlled/occupational exposure: Controlled/occupational exposure applies to situations where the persons are exposed as a consequence of their employment and in which those persons who are exposed have been made fully aware of the potential for exposure and can exercise control over their exposure. Occupational/controlled exposure also applies where the exposure is of transient nature as a result of incidental passage through a location where the exposure limits may be above the general population/uncontrolled limits, as long as the exposed person has been made fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

3.2 energized: Electrically connected to a source of potential difference or electrically charged so as to have a potential different from that of the earth.

3.3 exposed: Not isolated or guarded.

3.4 general public: All non-workers (see definition of workers in clause 3.9) are defined as the general public.

3.5 general population/uncontrolled exposure: General population/uncontrolled exposure applies to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure.

3.6 minimum air insulation distance (MAID) (D_U): The shortest distance between an energized electrical apparatus and/or worker's body at different potential. With a floating electrode in the gap, it is equal to or greater than the sum of the individual maximum air insulation distance. This is an electrical quantity and does not include an ergonomic factor for inadvertent movement.

3.7 minimum approach distance (MAD) (D_A): The minimum air insulation distance plus an ergonomic distance to account for inadvertent movement.

3.8 sparkover: A disruptive discharge between preset electrodes in either a gaseous or a liquid dielectric.

3.9 workers: Persons employed by an employer, including trainees and apprentices but excluding domestic servants.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC	Alternating Current
DC	Direct Current
EMF	Electromagnetic Field
MAD	Minimum Approach Distance
MAID	Minimum Air Insulation Distance
NESC	National Electrical Safety Code
RMS	Root Mean Square

5 General principles

There are three hazards to workers working near energized power lines. They are:

- 1 exposure to power-frequency magnetic fields;
- 2 exposure to power-frequency electric fields;
- 3 possibility of sparkover between the exposed energized conductor and the worker's body or tool held by the worker.

Typically, the risk from these hazards recedes rapidly as the separation between the worker and the power conductor increases. The following subclause describes these in more detail.

5.1 Field exposure limits

The relevant quantities for the power frequency exposure limit for human beings are the electric field and the magnetic field. Electric field is expressed in units of V/m. Magnetic field can be expressed as a magnetic flux density B or as magnetic field strength H . In vacuum and in air they are related by the expression:

$$B = \mu_0 H$$

where $\mu_0 = 4\pi \times 10^{-7}$ H/m is the permeability of free space.

One set of limits for electric and magnetic field exposure at power frequencies have been provided by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) ([ICNIRP 1], [ICNIRP 2]). In certain cases local or national regulatory agencies or standards bodies may promulgate magnetic field and electric field exposure limits at power frequencies. If such limits exist they should be used. If local or national limits at power frequencies do not exist, ICNIRP guidelines limits should be used.

The majority of documents providing guidelines to EMF exposure limits, including ICNIRP, use a two-tier limit structure where lower levels are specified for uncontrolled/general public exposure and upper levels for controlled/occupational exposure.

ICNIRP and other similar documents provide safety limits in terms of basic restrictions and reference (or derived) levels. The basic restrictions address the fundamental quantities that determine the physiological response of the human body to electromagnetic fields. Basic restrictions apply to a situation with the body present in the field. As the basic quantities are difficult to measure directly, most documents provide derived (reference) levels for electric field, magnetic field and power density. Reference levels may be exceeded if the exposure condition can be shown to be within the basic restrictions. The reference levels apply to a situation where the electric or magnetic field is not influenced by the presence of a body.

5.1.1 ICNIRP limits

5.1.1.1 DC limits

Whole-body continuous occupational exposure during the work-day should be limited to a time-weighted average magnetic flux density not exceeding 200 mT (approximately 160 kA/m in free space). Continuous exposure of the general public should not exceed a magnetic flux density of 40 mT (approximately 32 kA/m in free space). People with cardiac pacemakers and implantable defibrillators should avoid locations where magnetic flux density exceeds 0.5 mT (approximately 400 A/m in free space) [ICNIRP 2].

The magnetic fields are assumed to emanate from power system conductors. Since network operator personnel are not employees of the power system operator, the exposure limits for the general public should be applied to network operator personnel.

5.1.1.2 Limits at 50/60 Hz

The basic restrictions for occupational and for general public exposure at 50/60 Hz are defined in [ICNIRP 1] concerning the frequency range 1 Hz-100 kHz. They are based on the analysis of the risks coming from transient nervous system responses including peripheral (PNS) and central nerve stimulation (CNS), the induction of retinal phosphenes and possible effects on some aspects of brain function. In the document the basic restrictions are given in terms of internal electric field and constitute the basis for establishing the reference levels.

Reference levels for occupational exposure to time-varying magnetic fields in the frequency range 25-300 Hz are 1.0×10^{-3} T (8.0×10^2 Am⁻¹). The corresponding limit for the electric field is $5.0 \times 10^2/f$ kVm⁻¹, where f is the frequency in Hz. The relevant values for reference levels at power frequencies are given in Table 1.

Reference levels for general public exposure to time-varying magnetic and electric fields in the frequency range 50-400 Hz are, respectively, 2.0×10^{-4} T (1.6×10^2 Am⁻¹) and $2.5 \times 10^2/f$ kVm⁻¹, where f is the frequency in Hz. The relevant values for reference levels at power frequencies are given in Table 2.

Table 1 – Reference levels for occupational exposure

Frequency	B limit (H limit) mT (Am ⁻¹)	E limit kVm ⁻¹
50 Hz	1.0 (800)	10
60 Hz	1.0 (800)	8.3

Table 2 – Reference levels for general public exposure

Frequency	B limit (H limit) mT (Am ⁻¹)	E limit kVm ⁻¹
50 Hz	0.2 (160)	5
60 Hz	0.2 (160)	4.2

5.2 Exposure zones

The area surrounding the current-carrying power conductors can be classified into one of the three following zones.

- 1) Compliance zone: In the compliance zone, potential exposure to EMF is below the applicable limits for both controlled/occupational exposure and uncontrolled/general public exposure.
- 2) Occupational zone: In the occupational zone, potential exposure to EMF is below the applicable limits for controlled/occupational exposure but exceeds the applicable limits for uncontrolled/general public exposure.
- 3) Exceedance zone: In the exceedance zone, potential exposure to EMF exceeds the applicable limits for both controlled/occupational exposure and uncontrolled/general public exposure.

For many installations, the exceedance zone and the occupational zone are not accessible to people, or are only accessible under unusual circumstances, such as a person standing directly in front of the antenna. The risk assessment procedure presented in this Recommendation is concerned primarily with exposure of general public and workers in the course of their normal activities. See Figure 1.