International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

K.90
(05/2012)

SERIES K: PROTECTION AGAINST INTERFERENCE

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

Recommendation ITU-T K.90

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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.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T K.90	2012-05-29	5

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

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 Recommendation[1] 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 (2004), *Live working – Minimum approach distances for a.c. systems in the voltage range 7.5 kV to 800 kV – A method of calculation*.
<http://webstore.iec.ch/webstore/webstore.nsf/ArtNum_PK/32785?OpenDocument>

[ICNIRP 1] ICNIRP (2010), *ICNIRP Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (1Hz-100 kHz)*, Health Physics, Vol. 99, No. 6; pp. 818-836.
<http://www.icnirp.de/documents/LFgdl.pdf>

[ICNIRP 2] ICNIRP (2009), *ICNIRP guidelines on limits of exposure to static magnetic fields*. Health Physics, Vol. 96, No. 4; pp. 504-514.
<http://www.icnirp.de/documents/statgdl.pdf>

[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 $5.0\times10^{2}/f$ 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 $2.5\times10^{2}/f$ 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.

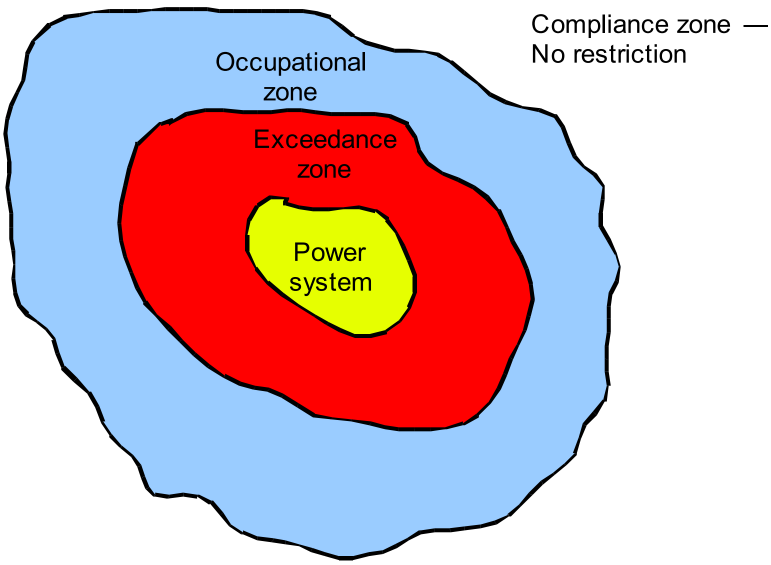


Figure 1 – Figurative illustration of exposure zones

5.3 Sparkover

A sparkover represents a failure of air as an insulating material. The sparkover voltage in air is influenced by the following:

– air density (temperature, pressure, altitude);
– humidity;
– airborne impurities;
– dimensions, separation, and shape of electrodes;
– time-dependent characteristics of the applied voltage.

Determination of minimum air insulation distance (MAID) is a complex matter requiring the knowledge of the environmental factors and the magnitude of the expected overvoltage likely to occur across the air gap. [IEC 61472] provides methods for determination of MAID under various conditions. In addition, local standards such as [b-IEEE 516] or power utility practices address determination of MAID under local conditions.

The minimum approach distance (MAD) is the sum of MAID and the ergonomic distance:

$$D_A = D_U + D_E$$

The ergonomic distance accounts for inadvertent movement of the worker. The value of the ergonomic distance is usually dependent on the system voltage. The network operator may select a value, or values may be given in relevant national or local standards. In view of the complexities of determining MAD, this Recommendation does not describe methods to determine MAD or give MAD values. The network operator should refer to appropriate local or national standards, or develop values in consultation with the power utility based on [IEC 61472]. Appendix I gives examples of values used in the United States of America.

6 Magnetic and electric field calculations

6.1 General procedure

The general procedure for a system of N conductors is to calculate the field by superposition. Suppose there are N conductors labelled by an index k running from 1 to N. Each conductor has a complex current $I_k = |I_k| e^{j\varphi_k}$ and complex voltage $U_k = |U_k| e^{j\varphi_k}$. Each conductor position is given by (x_k, y_k) where the origin is taken at any convenient point. The conductor system is assumed uniform in the z direction and has a length a that is much greater than the separation of the conductors and the separation between conductors and the worker's body. The goal of the calculation is to calculate the field at a point (x,y) or, in polar coordinates, point (r,θ). Each conductor is at a height h_k above the earth. Figure 2 shows an illustration of the geometry.

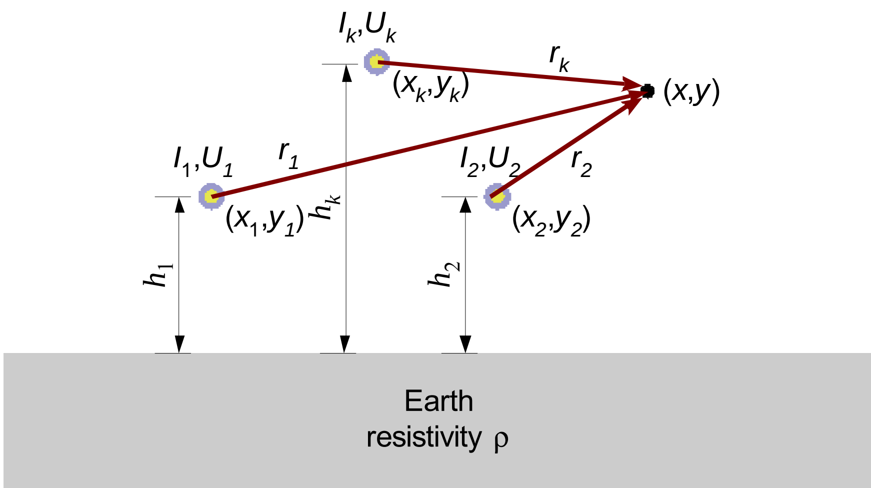


Figure 2 – Illustration of the geometry for calculating the magnetic and electric field

6.2 Magnetic field

The magnetic field magnitude for a single conductor of length a carrying a current I along is given by (Ampere's law):

$$B = \frac{I\mu_0}{2\pi r}\frac{1}{\sqrt{\left(\frac{r}{a}\right)^2+1}} \approx \frac{I\mu_0}{2\pi r} \text{ or}$$

$$H = \frac{I}{2\pi r}\frac{1}{\sqrt{\left(\frac{r}{a}\right)^2+1}} \approx \frac{I}{2\pi r}$$

where the last relation is valid for a long conductor expected in a power system. The distance r is given by:

$$r = \sqrt{(x-x_i)^2+(y-y_i)^2}$$

The effect of the earth can be taken into account by introducing an image conductor at the complex distance D_k below the earth surface given by:

$$D_k = h_k + 2p$$

where:

$$p = \frac{1-j}{\sqrt{2}}\frac{1}{\alpha}$$

and

$$\alpha = \sqrt{\mu_0\frac{\omega}{\rho}} = 2.8099\times10^{-3}\sqrt{\frac{f}{\rho}}$$

Given that the zone distances are usually on the order of one to a few metres near the conductor, the effect of the image conductor is negligible except in cases of extremely low earth resistivity.

The resultant magnetic field due to a system of conductors (and their electric images) is calculated by the complex summation of contributing magnetic field vectors (their directions have to be established, apart from magnitudes given above). Finally, for the case of AC lines, the time-averaged magnitude (DC-equivalent value) is evaluated.

6.3 Electric field

The electric field generated by a system of conductors is due to the potential $U_k = |U_k| e^{j\varphi_k}$ applied to them. In that case, however, the electric coupling between conductors has to be taken into account. The respective computational techniques are sketched below.

For a single conductor of radius R at a height h above the ground the potential U at its boundary surface is given by the formula:

$$U = \frac{\lambda}{2\pi\varepsilon_0} \ln \frac{2h}{R}$$

where λ is the equivalent linear density of charge and $\varepsilon_0 = 8.854 \times 10^{-12} F/m$ – permittivity of the vacuum. In the formula the contribution of the conductor electrical image (the case of perfectly conducting ground) has been included as well.

From the above equation, for a given U, the equivalent linear density of charge can be evaluated (and its electrical image), which then serves to calculate the electric field vector at an arbitrary point (x,y). The single contribution to the electric field (either from the conductor or its electrical image) is given by:

$$\overline{E} = \frac{\lambda}{2\pi\varepsilon_0} \frac{1}{r} \hat{r}$$

where r is the distance from the conductor (or image) to the observation point, and $\hat{r}$ – the respective unit vector.

In the case of multiple conductors the procedure is very similar, except the equivalent densities of charge are calculated by solving the linear system of equations of the form (electric coupling):

$$[P][\lambda] = [U]$$

where $[P]$ is the coupling matrix:

$$P_{ii} = \frac{1}{2\pi\varepsilon_0} \ln \frac{2h_i}{R_i}$$

$$P_{ij} = \frac{1}{2\pi\varepsilon_0} \ln \frac{D_{ij}}{d_{ij}}$$

i,j $(1,\ldots,N)$ – the conductor indexes, D_{ij} – the distance between the conductor i and the image of the conductor j, d_{ij} – the distance between the conductor i and the conductor j, $[\lambda]$ – the equivalent densities vector, $[U]$ – the vector of potentials applied to conductors.

Once the above system of equations is solved the equivalent densities are used to evaluate the resultant electric field at an arbitrary point of observation, like in the case of a single conductor (described above).

Similarly to the magnetic field calculation, the resultant electric field due to a system of conductors (and their electric images) is calculated by the complex summation of contributing electric field vectors. Finally, for the case of AC lines, the time-averaged magnitude (DC-equivalent value) is evaluated.

7 Computer program

A computer program EMFACDC has been developed, together with a convenient user interface, which is based on the theoretical background presented above, and which serves as a tool for evaluation of the electromagnetic field distribution around power line systems and for finding the exposure zones. Several options of the observation points domain and the output data representations have been implemented as vertical and horizontal lines, planar cross-section, electric field distribution, magnetic field distribution and exposure zones borders. The detailed description of the program is given in Appendix II.

8 Examples of calculations

8.1 Simple geometries

This clause presents calculations of magnetic and electric fields and the corresponding exposure zones for certain simple geometries.

8.1.1 Single conductor

The case of a single current-carrying conductor provides a simple example for determining the zone boundaries for a given current value. The distance to the zone boundary X_0 is then:

$$X_0 = \frac{I}{2\pi H_0}$$

where H_0 is the exposure limit.

A similar relationship exists for the electric field. Assuming the potential gauge is such that the potential due to a single conductor, in SI units, is:

$$U(r) = -\frac{\lambda}{2\pi\varepsilon_0}\ln(r)$$

The distance to the zone boundary is (in SI units):

$$X_0 = -\frac{U_0}{\ln(R)}\frac{1}{E_0}$$

where U_0 is the potential at the surface of the cylindrical conductor and E_0 is the respective exposure limit. In this case, apart from U_0 and E_0, the distance depends also on the assumed effective radius (cylindrical conductor equivalent) R.

The graphs showing the dependence of the exposure zone border distance from the conductor on current (magnetic field) and voltage (electric field) are presented in Figures 3 and 4. They may serve for an estimation of exposure zones at a power line system under consideration. Moreover, in Figure 5, the exposure zones are plotted under the assumption of constant transmitted power (DC power line).

The general conclusion, which can be drawn from Figures 3 to 5, is that the placement of the zone boundaries is mainly determined by the electric field. For example, for the constant transmitted power of 500 MW, this is the case for all power lines of voltage above 110 kV.

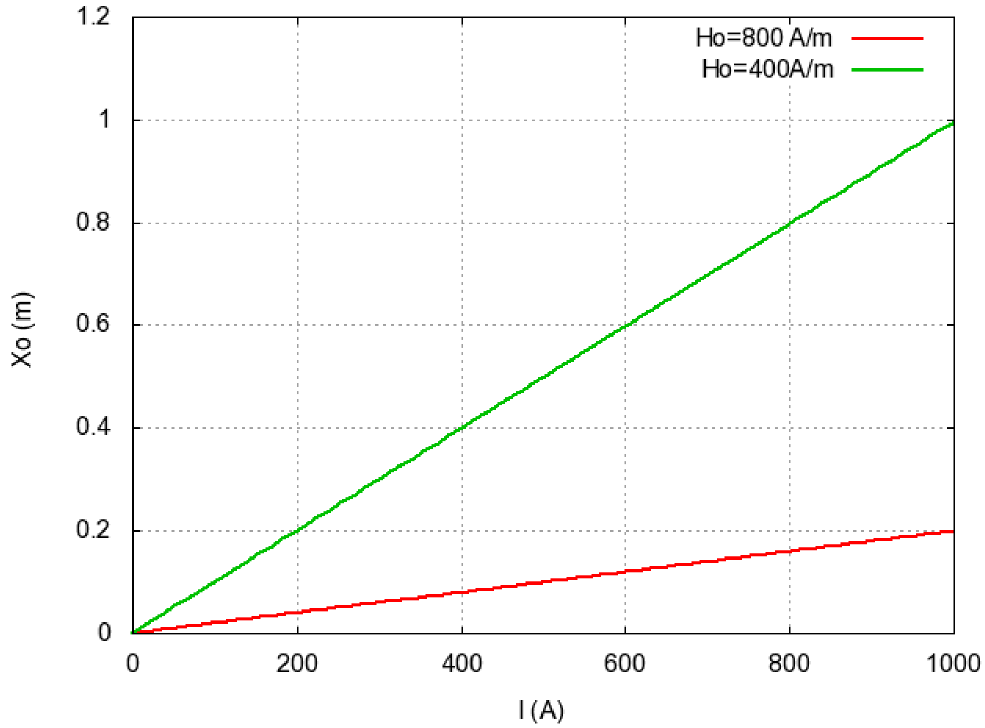


Figure 3 – Boundary of exposure zones X_0 as a function of current I for a single conductor

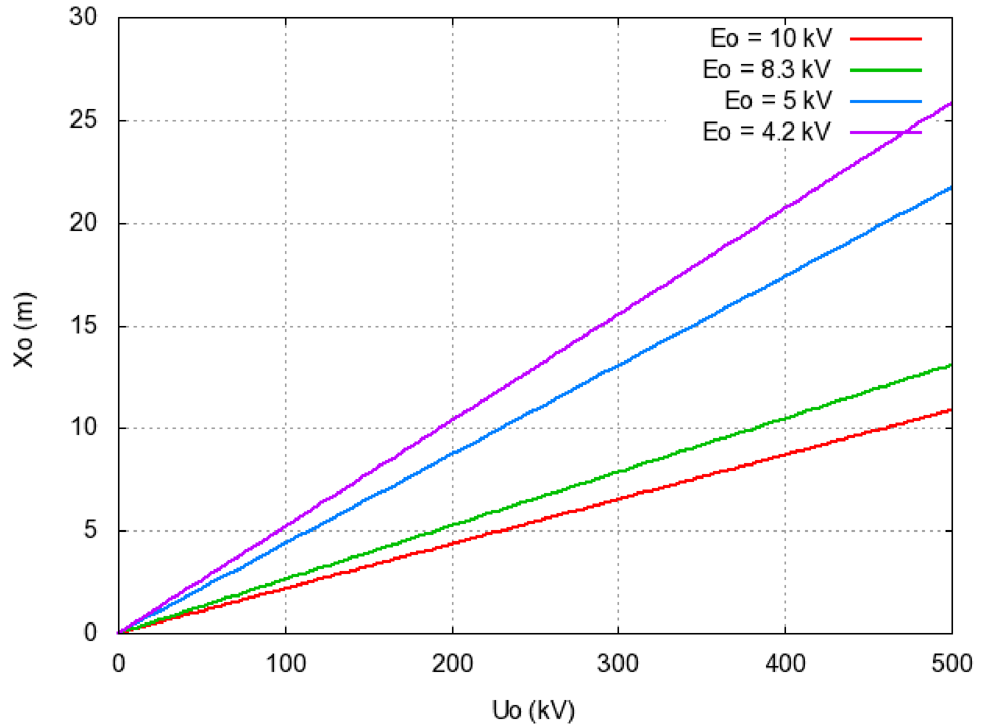


Figure 4 – Boundary of exposure zones X_0 as a function of potential U_0 for a single conductor of effective radius R = 0.01m

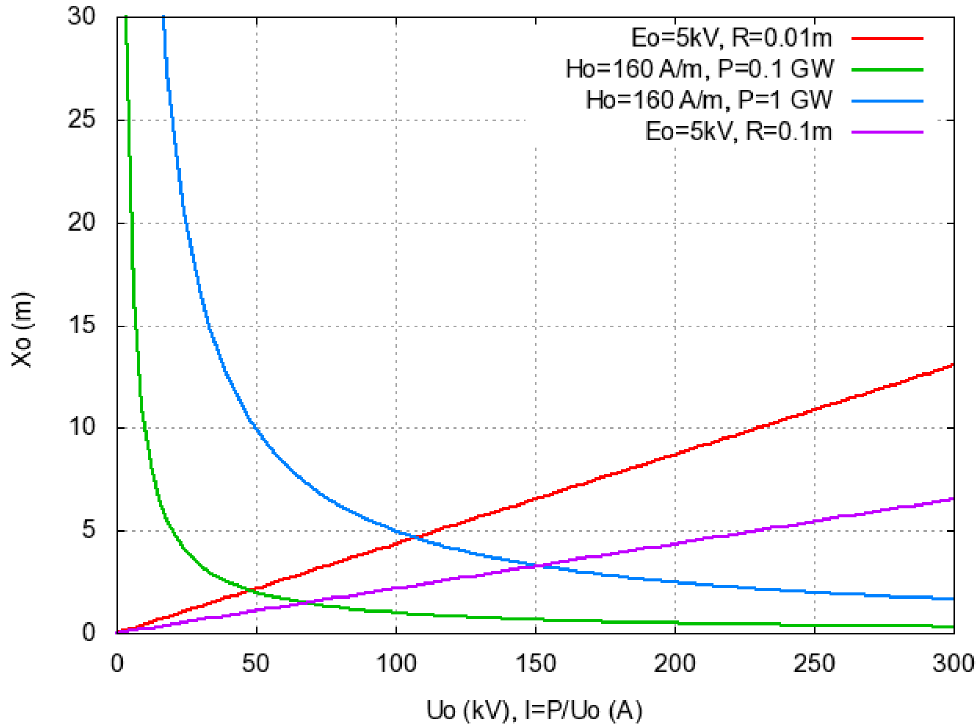


Figure 5 – Boundaries of exposure zones X_0 determined by limits for electric and magnetic fields, as a function of potential U_0 for a single conductor of effective radius (R) at constant transmitted power (P)

8.2 Typical examples of power lines

In this clause the examples of exposure zones for 3 typical power lines are presented. The exposure zones have been evaluated with the use of the EMFACDC program, according to limits given in Tables 1 and 2. The distances in XY axes are given in metres. The presence of perfectly conducting ground is assumed (at 0 m level) in all examples.

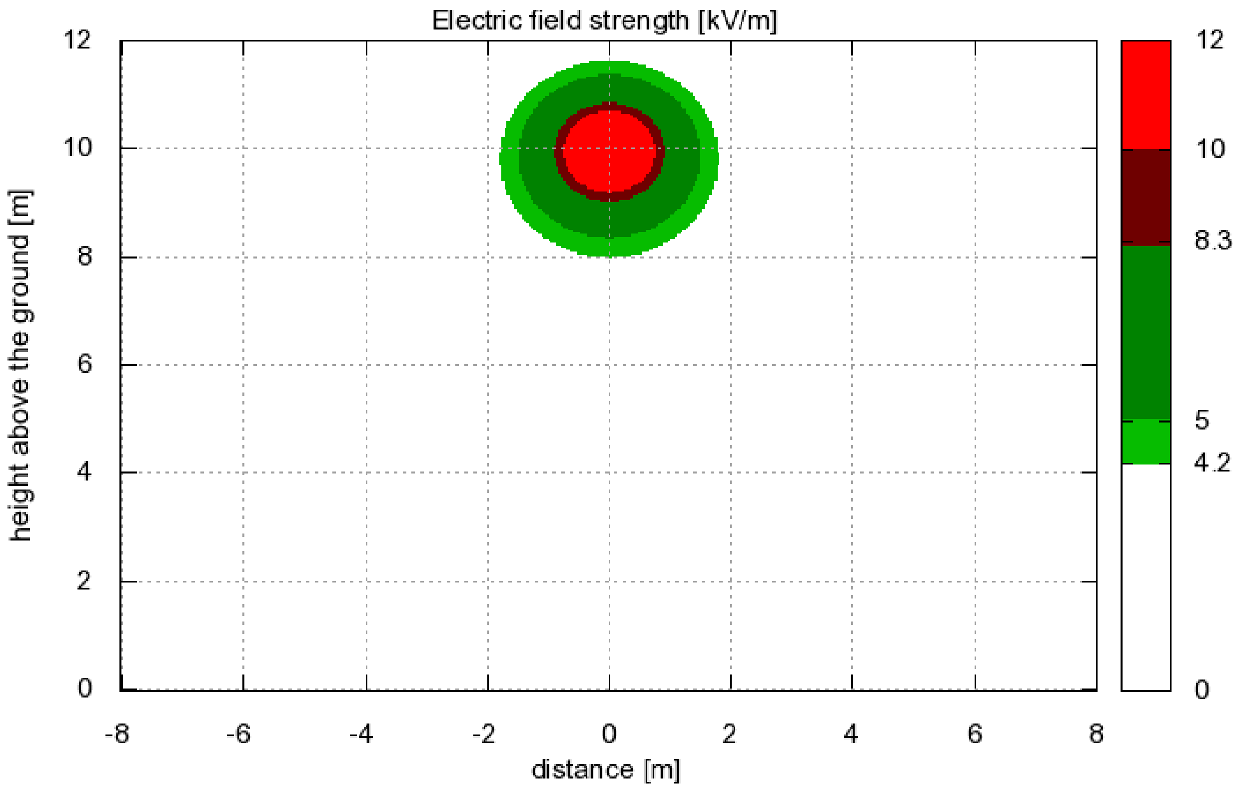
8.2.1 Single wire over the ground

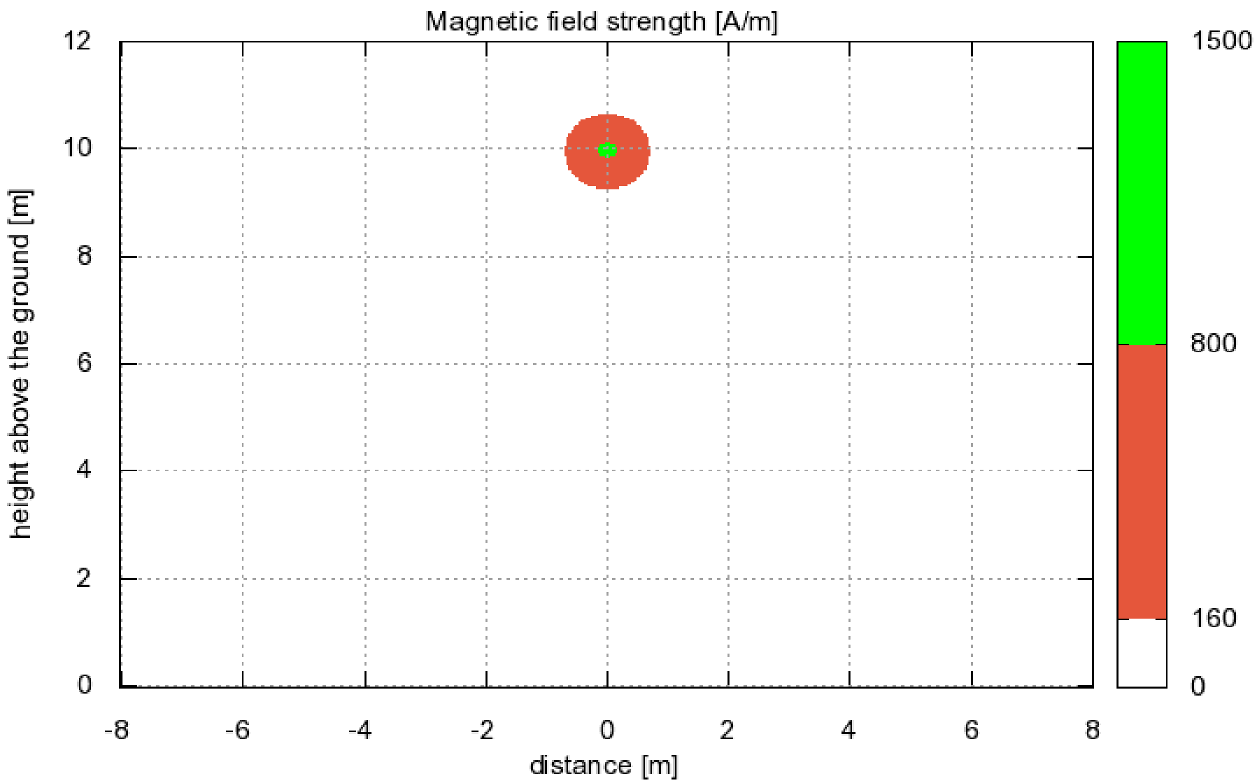
Conditions:

U: 110 kV, I: 1000 A

Line coordinates: (0, 10) (m)

Equivalent radius: 0.013 m.





8.2.2 Single circuit line, three-phases, delta configuration

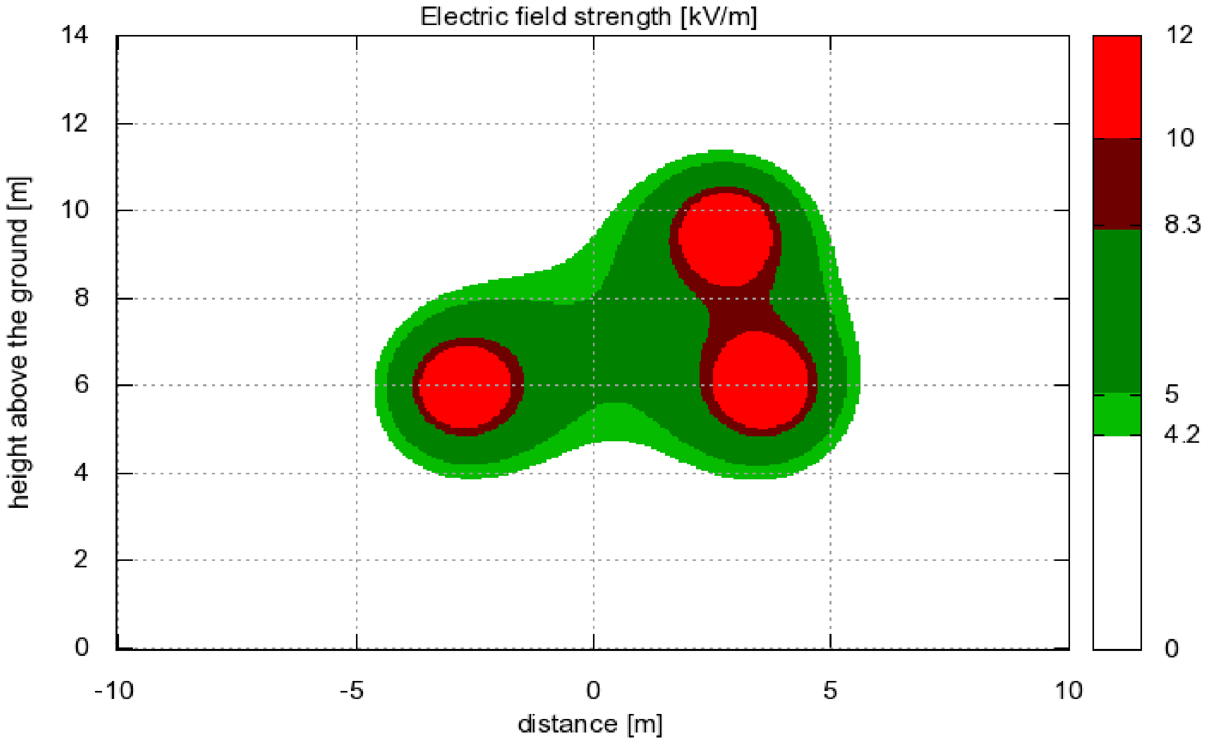
Conditions:

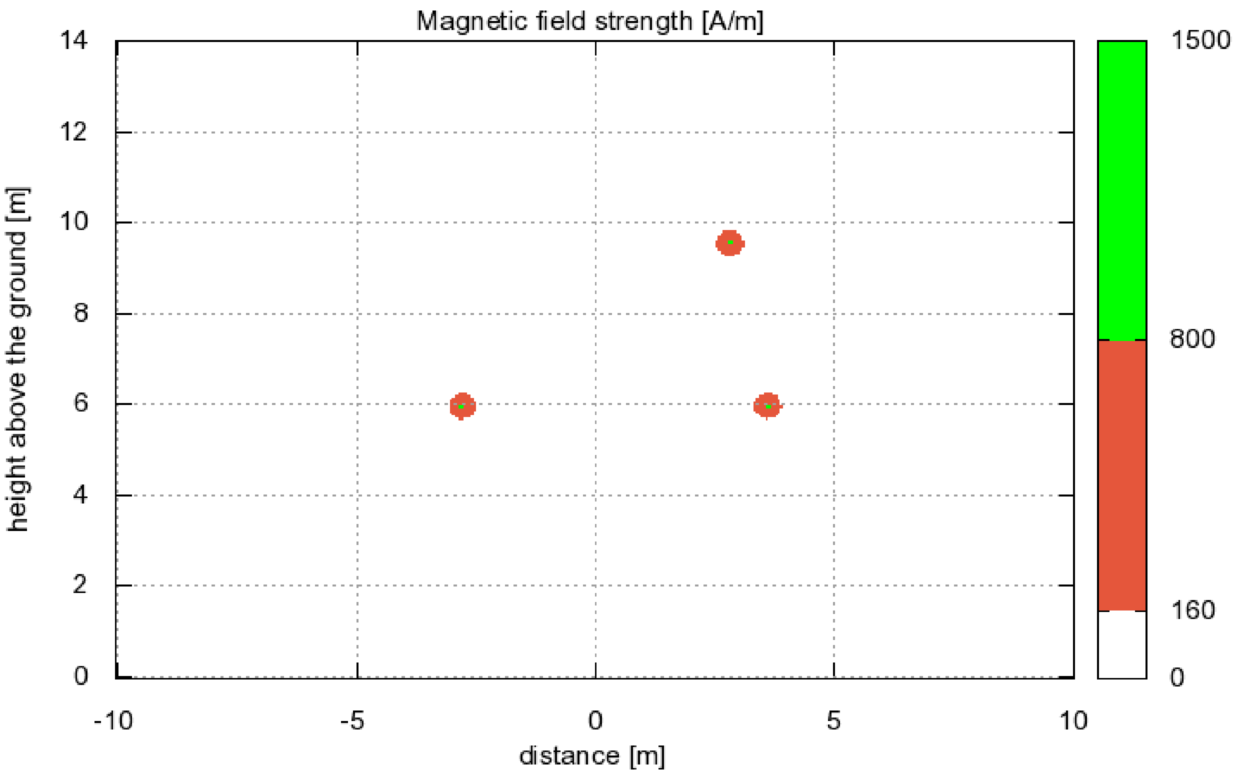
U: 110 kV, I: 400 A

Line coordinates: (–2.8, 6.0), (3.6, 6.0), (2.8, 9.6) (m), equivalent radius 0.015 m

Phases (AC) (0, 120, 240) (deg)

Conducting ground.





8.2.3 Single circuit line, three phases

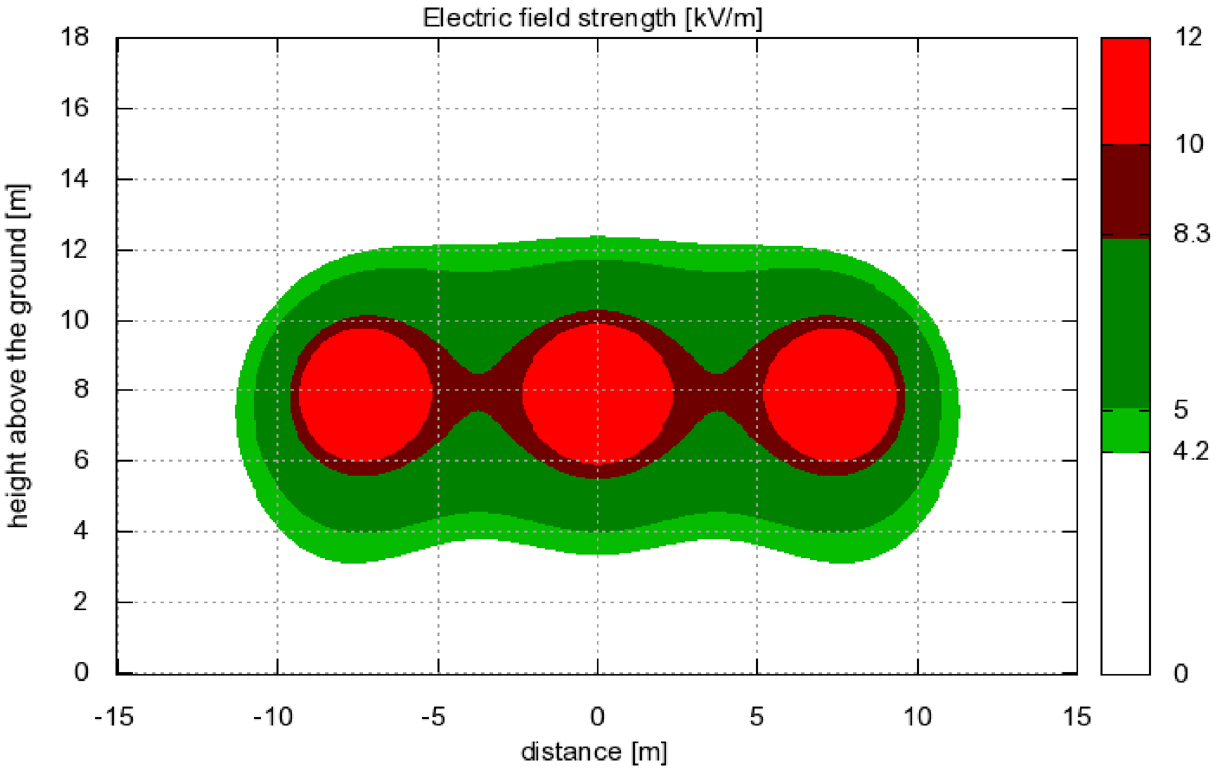
Conditions:

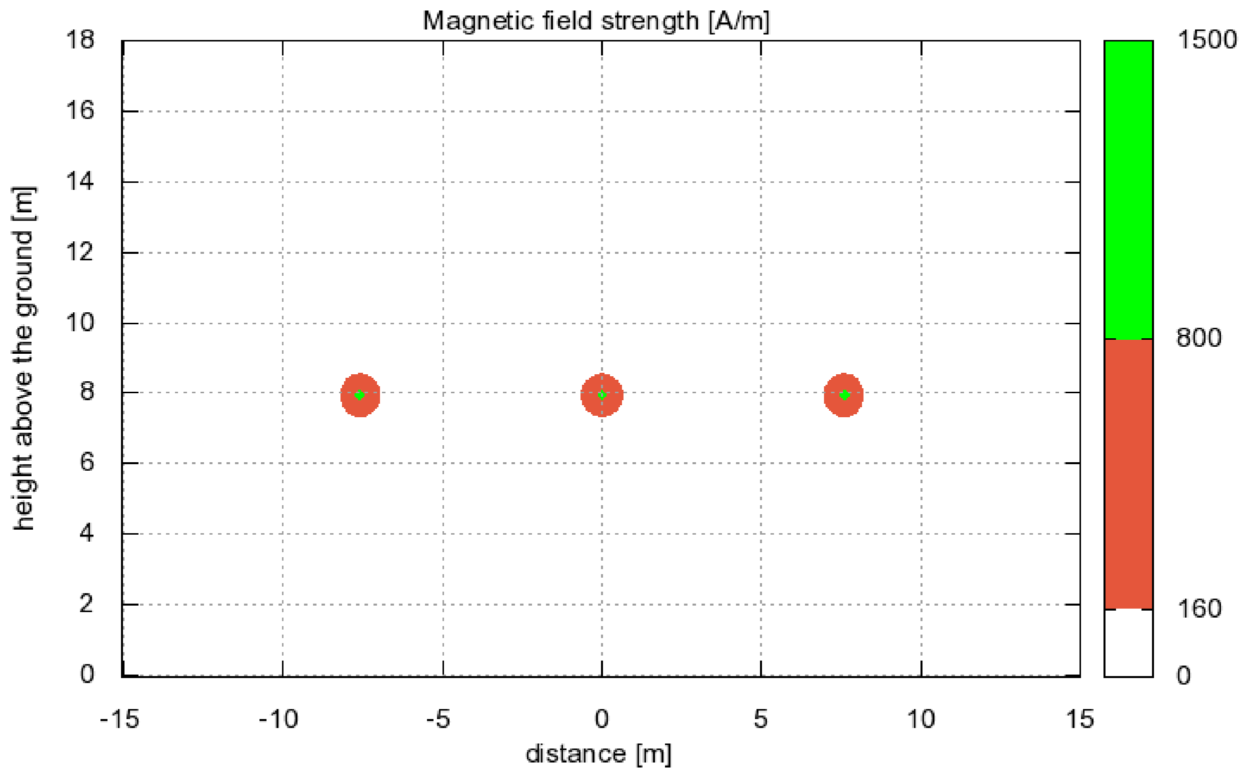
U: 220 kV, I: 900 A

Line coordinates: (–7.6, 8.0), (0.0, 8.0), (7.6, 8.0) (m), equivalent radius 0.025 m

Phases (AC) (0, 120, 240) (deg) or (120, 0, 240)

Conducting ground.





8.2.4 Double circuit line, three phases

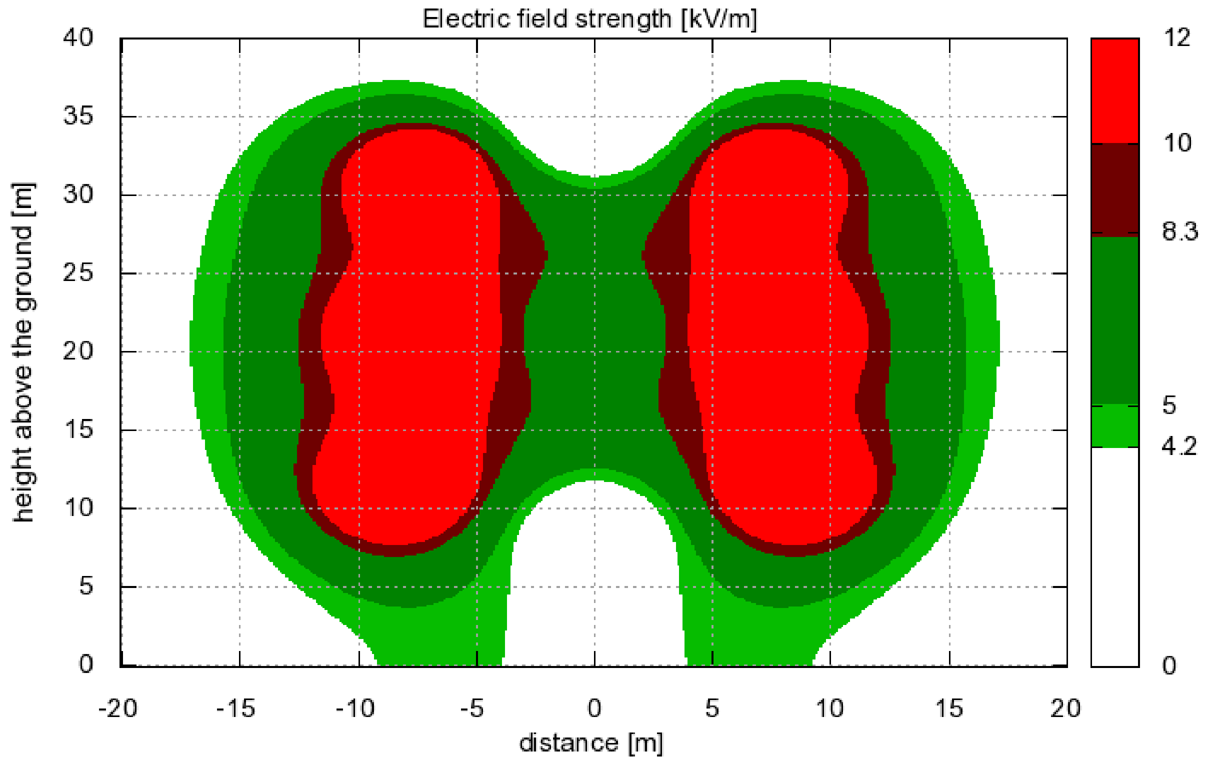
Conditions:

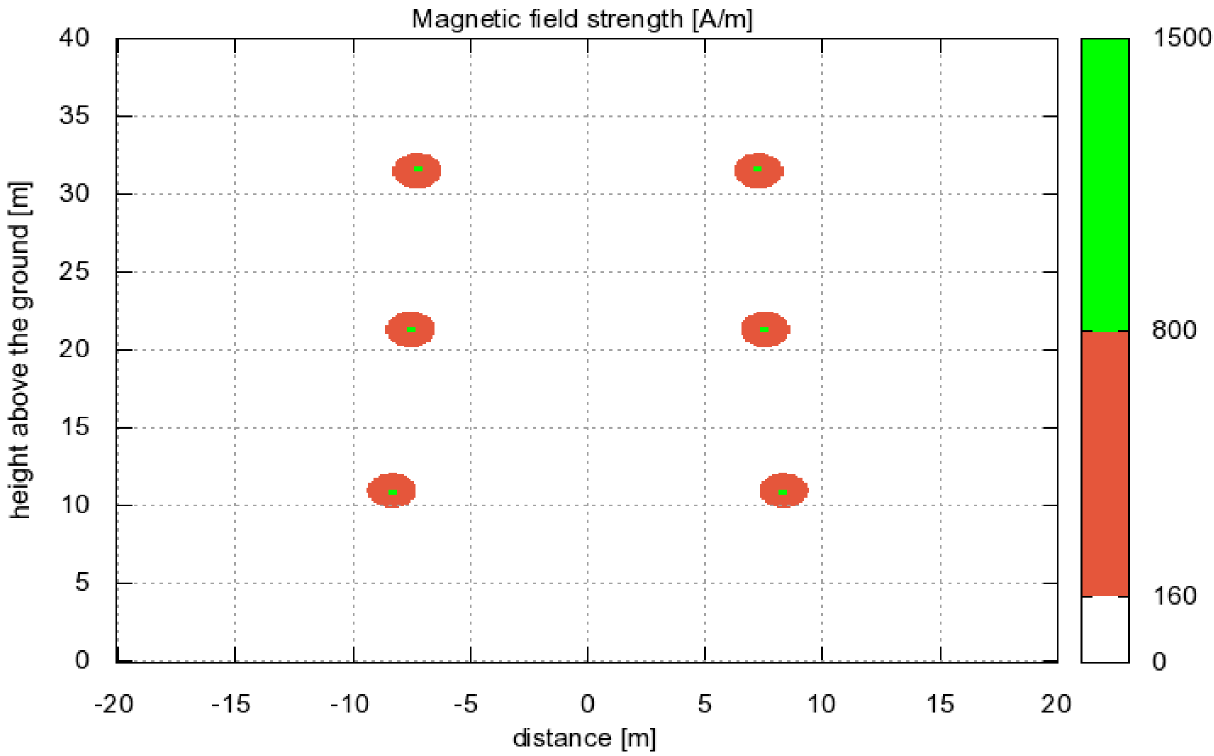
U: 400 kV, I: 1500 A

Line coordinates: (–8.3, 11.0), (–7.5, 21.4), (–7.2, 31.7) (m), equivalent radius 0.040 m
(8.3, 11.0), (7.5, 21.4), (7.2, 31.7) (m), equivalent radius 0.040 m

Phases (AC) (0, 120, 240), (0, 120, 240) (deg)

Conducting ground.





9 Work procedures

The network operator should establish a procedure for network personnel working near energized power lines. This should include a procedure to determine MAD based on a relevant local or regional standard, or a method based on [IEC 61472], including the altitude correction.

No network operator employee shall approach, or bring any conductive object, within the MAD to any exposed energized power system part. When repairing storm damage to communication lines that are used jointly with electric supply lines at that or another point, the network operator employee shall:

1. treat all such supply and communication lines as energized to the highest voltage to which they are exposed, or
2. assure that the supply lines involved are de-energized and earthed in accordance with the appropriate de-energizing procedure.

Additional procedures are under study.

Appendix I

Minimum approach distance values for communication workers in North America

(This appendix does not form an integral part of this Recommendation.)

This appendix provides examples of MAD values for communication workers used in the United States of America. The values are taken from the National Electrical Safety Code (NESC) [b-ANSI C2/NESC]. The values are valid at elevations below 900 m. Altitude correction factors are required at other elevations.

Table I.1 – Overhead supply lines and equipment minimum approach distances to exposed energized parts

Voltage range (phase-to-phase, RMS)	MAD (m)
0 V to 50 V	Not specified
51 V to 300 V	Avoid contact
301 V to 750 V	0.31
751 V to 15 kV	0.65
15.1 kV to 36.0 kV	0.91
36.1 kV to 46.0 kV	1.06
46.1 kV to 121.0 kV	1.21
121 kV to 140.0 kV	1.38

Appendix II

Description of the program EMFACDC

(This appendix does not form an integral part of this Recommendation.)

Input data

- **Coordinates of the plotted area** (x1, x2, y1, y2) define the area at which to visualize the EM field. The area is shown in the schematic view in the main window (see Figure II.1). The "step" parameter defines the distance between the adjoining sampling points in the grid at which the calculations will be done; it also determines the time of calculation (the density of the grid determines the length of calculation).
- **Parameters for the line chart**

  Parameters at "Horizontal line" and "Vertical line" define the positions of the lines along which the EM field will be calculated and then plotted.
- **Wire parameters**

  In this part the user defines the parameters of the line: number of wires, the effective radius (the same for all the wires), wires coordinates in Cartesian coordinate system shown in the window, voltages, currents and corresponding phases at the wires.

  The button "Clear" clears the form to introduce easily the user's own parameters.
- **Conducting ground**

  In this part the user decides whether the perfectly conducting ground should be taken into account.

Examples

Some predefined examples of typical power lines may be loaded using option Project->Open in the main menu. These examples are present in the file "examples.em". The calculation for a chosen example can be done by making choice in the "Examples" window and then clicking on the "Start" button. New examples may be added or deleted and new projects may be saved.

Clicking on the "Start" button runs the calculations. When the message "Calculation finished" appears, the results are saved on the disk in the form of graphical files whose list is presented in the right-down corner of the main window. To open a chosen graph, a double click on its name in the list is required.

The graphical files are saved on the disk in the sub-folder "temp" inside the folder where the program is run from.

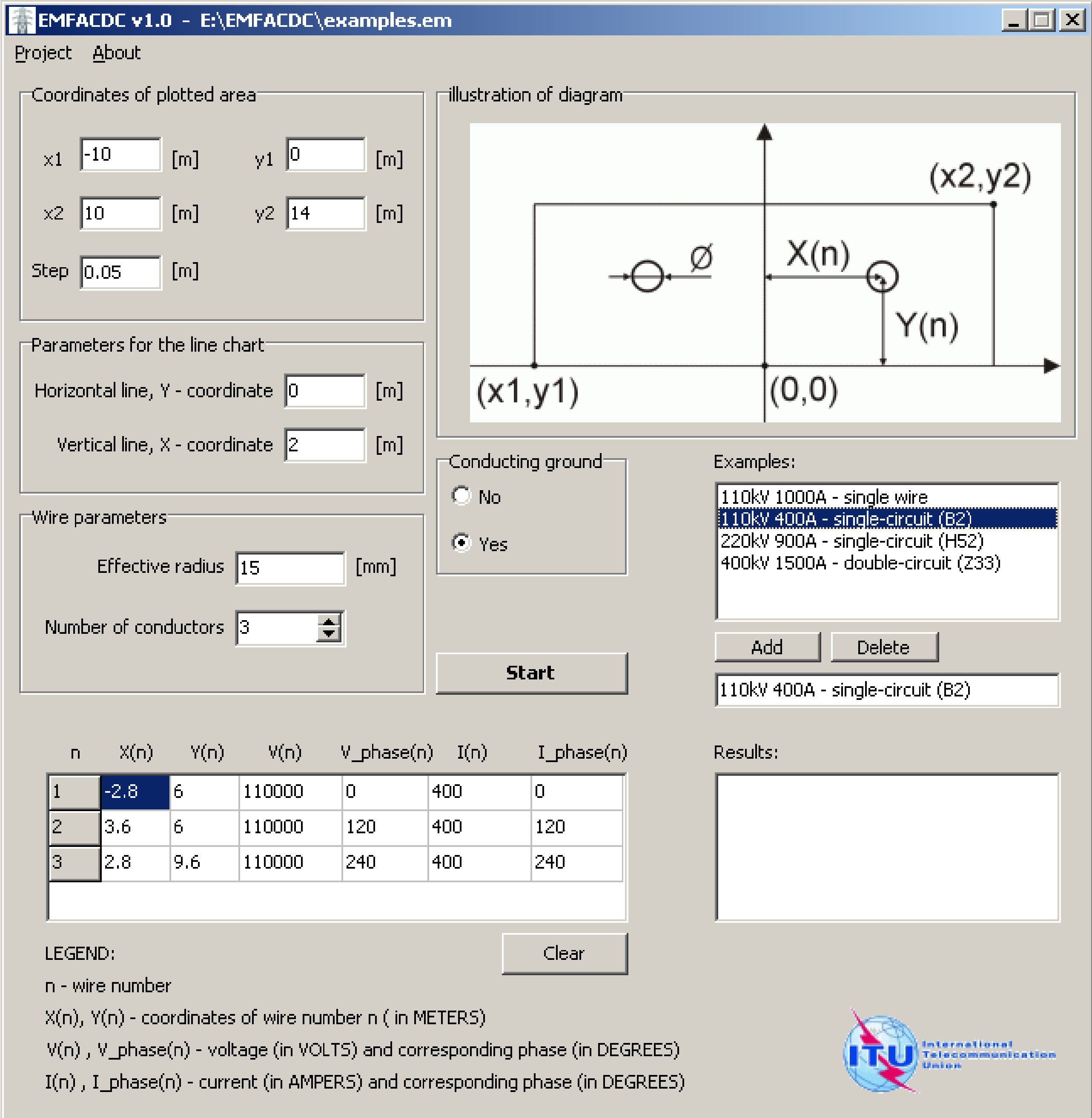


Figure II.1 – Screenshot of the EMFACDC program

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Printed in Switzerland
Geneva, 2012