Environmental, Technical, and Safety Codes, Laws and Practices Related to Power Line Construction in Russia

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1. INTRODUCTION

The design of power transmission line projects consists of two main elements: the determination of mechanical parameters of an overhead transmission line, and the computation of the required electrical parameters of the line.

In computing the mechanical parameters of a line, the following basic design elements are determined:

- the type of towers to be used in the transmission line;
- the design and parameters of the towers' bearing components; and
- the transmission line's span length, the number of suspension towers used, and related parameters.

Weight bearing requirements, ice-loading tolerances, and the expected wind load are the basic parameters used for the mechanical computations. These computations are based on specialized construction regulations in Russia for transmission lines and on Electrical Installations Construction Rules – 2002 (the 7th Edition).

The electrical calculations that must be done in designing a transmission line project includes the calculation of insulation intervals between grounded and current-carrying power transmission lines' elements computation, determination of insulators chain length, estimation of conductor – ground and conductor – transport insulation intervals, and choosing of schemes for grounding of transmission line towers. The main normative document on which electrical computations are based, is the Electrical Installations Construction Rules (7th Edition).

The principal standardized specifications relating to the computation of transmission lines' electrical parameters are described in greater detail in the following sections of this paper.

2. TRANSMISSION LINE INSULATION AND GROUNDING CHOOSING

When transmission line insulation is being chosen, it is first necessary to provide for safe conditions for people, animals and machinery moving under a line and near substation equipment. Overhead transmission lines project design experience in the past has shown that from an economic point of view it is appropriate to choose insulation so as to assure reliable and safe operation of a line at its normal voltage level. If, during insulation computations to determine insulation adequacy under switching or lightning surge conditions, a length of the insulator chain exceeds its capacity value under normal operation conditions, it is necessary, during the line design process, to make provision for special measures such as reactors, excess-voltage suppressors and other means to decrease over-voltage to a level where reliable insulation is provided under switching or lightning surge conditions.

There are two methods of choosing insulation levels and materials for transmission lines. The first method is applied for common transmission lines and substations, and is based on the Electrical Installations Construction Rules – 2002 (EICR-2002) and other normative documents used in Russia. These documents are based on the results of engineering experience in the transmission field and on the results of special scientific investigations. The second method is destined for special transmission lines and is based on statistical methods of computation.

During the computation of insulation parameters for a transmission line, first a towers design, the transmission line's span, and the conductor's cross sectional area are chosen based on technical and economic computations and on EICR-2002. The computation of overhead transmission line insulation parameters begins with the insulator chain length computation for normal voltage conditions. The most reliable criterion for choosing insulation levels is the previous engineering experience and the results of scientific investigations on the topic. On the basis of these considerations, an insulation level map is composed. If no such map can be composed, insulator chain length and insulator types are chosen based on EICR-2002. EICR provides the specific effective leakage distance. The values of the standardized specific effective leakage distances for sustaining insulator chains on 6 – 750 kV (kilo-Volt) overhead transmission lines are given in Table 1.

As the moisture discharge voltages of insulators operating in areas where air pollution is present decreases with decreasing atmosphere pressure, when choosing insulation for 110 – 750 kV transmission lines whose route traverses elevations from 1 to 2, 2 to 3, and 3 to 4 km, the corresponding specific effective leakage distances used in calculations have to be increased by 5, 10 and 15 %, respectively.

Table 1: Values of standardized specific effective leakage distance for sustaining insulator chains of 6 – 750 kV overhead transmission lines

Pollution Rate (PR)	**cm / kV (no less), at nominal voltage level, kV.**	
	Up to 35	*110-750*
1	1,90	1,60
2	2,35	2,00
3	3,00	2,50
4	3,50	3,10

In areas not included in zones affected by industrial pollution sources, including woods, tundra, forest-tundra and meadows, insulation with smaller specific effective leakage distances than those shown in Table 1 for the 1st PR are allowed.

The areas of the 1st PR are territories that are not in the affected zone of industrial and natural pollution sources (swamps, mountainous areas, rural area, and other relatively isolated areas).

In heavily industrial regions, when necessary, insulation with larger specific effective leakage distances than those shown in Table 1 for the 4th PR can be applied.

A pollution rate near an industrial enterprise must be determined based on the type of industry and on the design volume of output goods from the industrial facility, as well as on the distance from the transmission line to the source of industrial pollution. The design volume of output goods is determined by summarizing the volume of all of the goods produced by an enterprise. PRs in the carryover zones of operating or under-construction factories must be determined according to the largest annual production level with respect to the expected plan of factory development (projecting no more than 10 years ahead). If there are several pollution sources (workshops) within a factory, expected production volumes must be determined by adding together the production volumes of all of the workshops on-site. If a pollution source of separate workshops is situated at a distance of greater than 1000 m from other pollution sources in a factory, the annual production volumes must be determined separately for such workshops and for the other parts of the factory.

In areas with a pure atmosphere, the length of an insulator chain and the number of insulators in a chain vary depending on insulator type and on the adhesion armature (which ties separate insulators together in a insulator chain) within the following bounds:

U_{nom} kV	110	220	330	500
Insulator chain length , m	1,3-1,7	2,3-2,5	2,9-3,5	4,3-4,5
Number of insulators in chain	6-8	10-14	15-21	21-29

The point of insulator chain suspension—the point where an insulator chain is suspended (attached to the tower)—is determined based on the computed insulator chain length and the chosen tower design, factoring in the normal operation voltage, requirements for switching and lightning surges, and the corresponding weather conditions. .

The shortest allowed insulation distances from a conductor to a grounded tower are shown in Table 2. Based on engineering experience, as well as on the discharge characteristics of the materials used, insulation distances are chosen including some reserve margin. These tolerances together are designed to ensure that there is only a small probability of an insulation fault at normal operation voltages, as well as during switching and lightning surges. The insulation distances calculated using these parameters also assure that transmission towers are safe to climb for the maintenance staff even while a transmission line is "live" (operating).

Table 2: The shortest insulation distances from current-carrying to grounded parts of overhead transmission lines

Computation condition	Shortest insulation distance, cm, at transmission line voltage level, kV							
	<= 10	20	35	110	150	220	330	500
lightning surges for insulator type:								
Pin-type	15	25	35	-	-	-	-	-
Suspended	20	35	40	100	130	180	260	320
Internal over-voltages	10	15	30	80	110	160	215	300
Operating voltage	-	7	10	25	35	55	80	115
Safe climbing of towers	-	-	150	150	200	250	350	450

In designing overhead transmission lines for a transmission project, the largest applicable design value of the distance from a conductor to a tower is chosen. For overhead lines of 6 – 750 kV, the distance from a conductor to a tower is thus usually, as shown in Table 2, defined by requirements for safety in climbing towers for maintenance purposes. For overhead transmission lines with routes lying below 1000 m above sea level, insulation distances from conductors and live armatures to the grounded parts of a tower must not be smaller than those shown in Table 2.

Decreasing the insulation distances from current-carrying parts and wooden towers that are not grounded by 10% is permitted, except that the insulation distances must still be chosen so as to meet requirements for safe climbing of towers.

When an overhead transmission line route lies in a mountain range, the insulation distances computed for the operating voltage and internal over-voltages must be increased by 1% for every 100 m when the total average elevation of a route is above 1000m.

The distance between conductors or between conductors and a rope are computed considering the possibility of the so-called “conductor galloping”, in which the self-oscillating process on one of the self-frequencies of a conductor in a long span has to be considered.

3. CHOOSING OVERHEAD TRANSMISSION LINE GROUNDING DESIGNS

The following parts of an overhead transmission line must be grounded:

1. the towers, which typically must have a lightning rope or other lightning protectors;
2. the reinforced concrete and metal towers of overhead transmission lines of 3 – 35 kV;
3. the towers carrying power or instrument transformers, disconnecting switches, protection devices, and other apparatus; and
4. the metal and reinforced concrete towers of 110 – 500 kV overhead lines without ropes or other lightning protectors, if grounding is necessary for the reliable operation of relay protection and automation devices.

The resistance of the towers' grounding devices must be no larger than the values shown in Table 3. In the following specific instances, the resistance of towers' grounding devices must be:

- for overhead transmission lines of 3 – 20 kV in populated areas, as well as for all the 35 kV overhead lines – no larger than the values given in Table 3;
- for overhead lines of 3 – 20 kV in non-populated areas with soil of specific resistance ρ below 100 Ohm·m — no larger than 30 Ohm, and with soil of specific resistance ρ above 100 Ohm·m — no larger 0.3 ρ.

The resistance of towers' grounding devices for overhead lines 110 kV and higher must not be larger than the values given in Table 3. For overhead lines protected by the lightning ropes, the required resistance of grounding devices designed according to the relevant lightning protection conditions must be provided with outage ropes. For other conditions, this resistance must be provided using affiliated lightning ropes.

For overhead lines with towers taller than 40 m and protected by lightning ropes, grounding resistance must be at most half of the values given in Table 3.

Resistance values for the grounding devices of transmission towers must be provided and measured for commercial frequency currents during the periods of maximum resistance values in summertime. It is permitted to perform measurements in other periods, so long as the results of the measurements are corrected by applying a "season coefficient". When soil freezing exerts an influence on the grounding resistance value, however, such measurements cannot be performed.

Table 3: Maximum resistance values for grounding devices for overhead transmission lines

Specific equivalent soil resistance ρ, Ohm·m	Grounding device resistance maximum value, Ohm
below 100	10
from 100 to 500	15
from 500 to 1000	20
from 1000 to 5000	30
above 5000	$6 \cdot 10^{-3} \rho$

If the route of an overhead line of voltage level 110 kV or higher lies in areas with clay, loamy, or similar soils with specific resistance $\rho \leq 500$ Ohm·m, it is only necessary to use the bases of reinforced concrete towers as natural grounding. Sometimes the bases can be used without any additional requirements for artificial grounding, or they can be used in combination with of artificial grounding. In soils with higher values of specific resistance, the natural conductivity of the bases of reinforced concrete towers bases must not be taken into consideration, and the required grounding resistance value must be obtained only by applying artificial grounding.

4. CHOOSING CONDUCTOR – GROUND OR CONDUCTOR – TRANSPORT INTERVALS

Engineering experience with overhead transmission lines of 110 – 500 kV shows that all of the outages caused by transmission line routes being crossed by oversized machines (taller than 4,5 m) have occurred under normal operation conditions. This fact proves that the probability of a congruence between a line route crossing by an oversized machine and an over-voltage condition is very small. Consequently, the choice of transmission line dimensions can be made assuming conditions of reliable operation at the highest operating voltage. Engineering experience with 110 kV lines, which have the largest overall length, has shown that when the conductor's height over the ground is equal to 6 m there are practically no flashovers to oversized machines. It can therefore be assumed that the crossing of transmission line routes by oversized machines taller than 5.75 m is improbable. If we take as a base value a height value of 5.75 m, conductor dimensions over the ground for a transmission line of higher voltage classes can be calculated as the sum of the base height value and the smallest insulation distances from current-carrying to grounded parts of overhead transmission lines shown in Table 2.

For overhead transmission lines of 750kV and higher voltage levels, the conductor's height is chosen based on requirements for decreasing the deleterious effects of electrical fields on living organisms, particularly humans. For transmission lines of lower voltage, the conductor's height over the ground is chosen based on conditions that will allow safe passage under the transmission line.

5. EICR-2002 NORMS FOR PASSING, CROSSING AND APPROACHING OVERHEAD TRANSMISSION LINES

The distance from overhead transmission line conductors to the ground surface in non-populated and hard-to-reach areas must be not less than the values shown in Table 4.

Table 4: Smallest distance from overhead transmission line's conductors to the ground surface in non-populated and hard-to-reach areas

Area's characteristics	Smallest distance, m, at overhead transmission line voltage level, kV				
	≤110	150	220	330	500
Non-populated areas	6	6,5	7	7,5	8
Hard-to-reach areas	5	5,5	6	6,5	7
Inaccessible hill flanks, rocks, cliffs, etc.	3	3,5	4	4,5	5
Tundra regions, deserts, steppe with soils unsuitable for agriculture	6	6	6,5	6,5	7

5.1 Overhead transmission lines passing through woodlands, green plantations, ploughed fields, and other agricultural areas

Right-of-ways have to be cleared for overhead transmission lines passing through woodlands. The width of right-of-ways to be cut must be determined taking into consideration the conditions of the transmission line and of forest use in the area. These considerations include the potential for tree to fall on a transmission line and making sure, in designing the right-of-way, that line failures can be quickly repaired. These considerations in turn require taking into account, for example, the species of trees and soil types in the area, the accessibility of line routes, and other factors.

It is necessary to avoid construction of power lines in plantings (not only in tree plantations but in any green plantations) that stretch in ribbons in the direction in which the transmission line is oriented. In the case of such plantings, it is possible to avoid the cutting within of green plantations by moving a line route away from the green plantation zone.

In parks, national parks, green zones around settlements, valuable woodlands, and guard bands along railways and highways, the width cut for the transmission corridor should be calculated using the guidelines that the distance from conductors to a tree crown is not be less than 3 m for overhead lines below 20 kV; 4m for 35 – 110 kV lines; 5m for 150 – 220 kV lines; and 6 m for 350 – 550 kV lines. A tree crown radius is calculated taking into consideration its probable future growth. (typically, 25 years of growth).

5.2 Overhead transmission lines passing through populated areas

The distance from an overhead transmission line's conductor to the ground surface in populated areas, factoring in the conductor's maximum sag (but without taking into account conductor heating) must not be less, in Russia, than values given in Table 5. It is prohibited for an overhead transmission line to pass over buildings and other installations, except for buildings made of non-combustible materials and for industrial buildings.

Table 5: Minimum distance from overhead transmission line conductors to the ground surface, buildings, and installations in populated areas

Transmission line operating conditions	Building, installation	Minimum distance, m, at overhead line voltage level, kV					
		≤ 35	110	150	220	330	500
Normal operating conditions	To ground surface	7	7	7.5	8	8	8
	To buildings and installations	3	4	4	5	6	-
Broken wire in nearby span	To ground surface	4,5	4,5	5	5,5	6	-

5.3 Overhead transmission lines passing over railways

Where overhead transmission lines cross railways, aerial crossings are usually required. The distances from transmission line conductors to various elements of railway infrastructure must be no larger than the values given in Table 6.

Table 6: Minimum distance from conductors for overhead transmission lines crossing and approaching railways

Crossing or approaching	Minimum distance, m, at overhead transmission line voltage level, kV					
	≤ 20	35-110	150	220	330	500
	Crossing					
For railways of general and non-general purpose from conductor to rail head at overhead lines' normal operation conditions	7,5	7,5	8	8,5	9	9,5
	Approaching					
For non-electrified railways in sections of constrained line routes from deflected conductor to the boundaries of the railway zone	6	6	6,5	6,5	7	-

5.4 Overhead transmission lines approaching and crossing highways

Distances from conductors in cases where overhead transmission lines cross highways must be no larger than the values given in Table 7.

Table 7: Minimum distances in cases where overhead transmission line approach and cross highways

Crossing or approaching	Minimum distance, m, at overhead transmission line voltage level, kV					
	≤ 20	35-110	150	220	330	500
Vertical distances:						
a) from conductor to highway's surface:						
Transmission line normal operating conditions	7	7	7,5	8	8,5	9
In case of broken wire in nearby span	5	5	5,5	5,5	6	-
b) from conductor to vehicles in case of normal operating conditions	2,5	2,5	3,0	3,5	4,0	4,5
Across distances:						
a) from tower's foundation to highway's edge in case of crossing	Tower's height					
b) same, but in case of parallel courses	Tower's height plus 5m					

6. THE ECOLOGICAL IMPACT OF OVERHEAD TRANSMISSION LINE

The ecological and environmental impacts of overhead transmission lines are generally considered to include:

- electromagnetic noise that causes difficulties in the operation of a number of electronic devices (radio and television, communication lines, and others);
- induced currents and voltages from AC overhead transmissions line that pose hazards (risks) to human health; and
- Other impacts affecting the natural ecological balance (including deforestation, cutting trees to create right-of-ways in woodlands, and other land-use changes).

Since the 1950s in Russia, *radio-noise* has been considered in design parameters for AC overhead transmission lines for 400 – 550 kV projects. Radio-noise is caused by the "local" streamer corona on overhead transmission lines' conductors, and by the high-frequency (100 kilo-Hertz (kHz) – 10 MHz) currents generated by transmission lines. These currents create direct noise in high-frequency communication systems. In addition, high-frequency currents create radio-noise that can prevent the normal operation of various radio communication systems.

Typically, in specific transmission line projects, the width of the passage (corridor) required on both sides of a transmission line (Δ) is designed so that outside the corridor radio reception remains normal. Taking into account Δ, it is necessary to limit the maximum electrostatic force on the surface of conductors in a transmission line, as the activity of the streaming corona depends on the electrostatic force. Consequently, the decrease in the radio-noise level (or a decrease in the required Δ for a given level of radio-noise) is connected with increasing the radius of the conductor or increasing the number of conductors in a bundled phase. This in its turn leads to an increase in transmission line costs. During periods of rain, sleet or rime (freezing rain), the streaming corona on conductors sharply intensifies, and affects radio reception near the line. The duration of such phenomenon is fairly standard, and usually does not exceed 10-15 % of the hours in a year.

A great deal of attention is paid in power line design to *acoustic noise* (specifically, hissing), which is produced by conductors' coronas. As with all of the other noises in the frequency range of 16 – 20 kHz, this noise is interpreted as annoying by the human ear. The noise level depends on the number of conductors in the bundled phase, and rises as the number of conductors increases. This makes the acoustic noise from the conductors' corona more of a problem for overhead transmission lines operating at a high voltage level (400 – 800 kV), and especially problematic for lines operating at ultra-high voltage levels (1000 kV and higher).

The volume of noise from transmission lines reaches its maximum during periods of rain and other atmospheric precipitation episodes. During rain storms, this noise is masked by the rain's noise, but in other cases (sleet, snow, rime, and mist, for example) when it is usually relatively quite, overhead transmission line can be perceived as the main acoustic noise source by nearby settled populations. According to the results of an investigation using experimental lines, the maximum permissible noise volume level outside a passage area with a width Δ /2 from the line's center pin during conditions of heavy rain must be lower than 45 decibels. As the listener moves away from the line, the noise volume level decreases. Measurements have also shown that the noise volume decreases, relatively to the volume during heavy rains:

- by 5 – 10 decibels in conditions of fog and with wet conductors ; and
- by 15 – 20 decibels in good weather.

The "*electrical discomfort*" under overhead transmission lines of 750 kV and near substations of 500 – 750 kV affects maintenance operations and other work that must be performed under transmission lines. The symptoms of "*electrical discomfort*" include, for example, the pricking of the skin on an exposed person's arms and feet because of electric sparks.

As the nominal voltage of a transmission line rises, the number of conductors in a bundled phase and in a bundle radius also increases. This leads to an increase in the charge Q, which is concentrated on a phase. Estimates have shown that charge Q on 750 kV transmission lines is 5-6 times as great as the same charge on 220 kV lines, and 10-15 times greater on 1150 kV lines than on 220 kV lines (Figure 1).

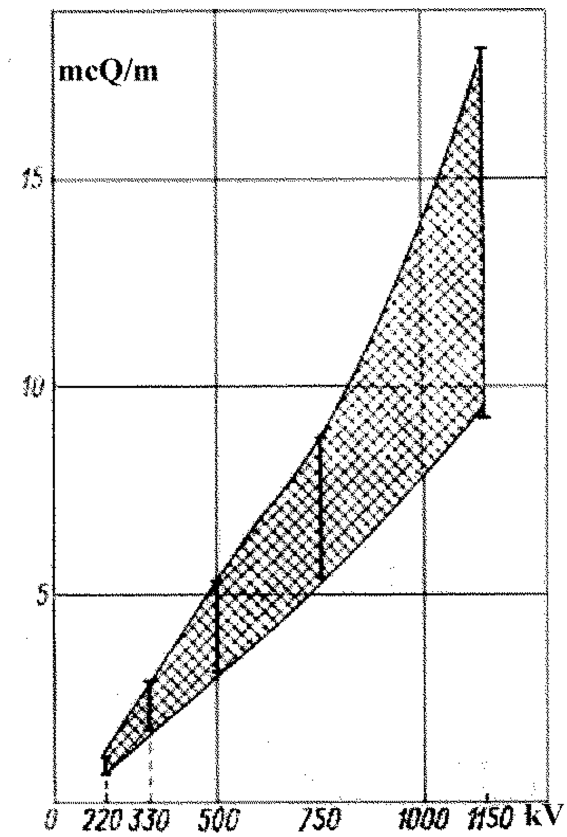

Figure 1: The dependence of the charge on conductors' surfaces on the nominal voltage of overhead transmission lines

The maximum electrical field strength (E) value near the ground surface under a line is limited in Russia by construction standards. This value must be E ≤ 10 kV/m. At this level of electric field strength "electrical discomfort" is felt by approximately 1% of humans, and the "discomfort" to the majority of humans is reduced to minimum. When transmission lines designed, the maximum electric field strength refers to conditions under which the conductors' sag is at a maximum. In the middle of Russia, this occurs only in the hottest seasons, and occurs only during about 1% of the hours during an average year.

Electrical field computations show that the electric field intensity decreases quickly in the direction orthogonal to the line route. The high electric field intensity zone (for example with E > 1 kV/m) along an overhead transmission line route, however, is quite wide. For 1200 kV transmission lines, for example, the width of this zone is about 200m (see Figure 2). Figure 2 also shows the high electric field intensity zone for 525 kV and 767 kV overhead transmission lines.

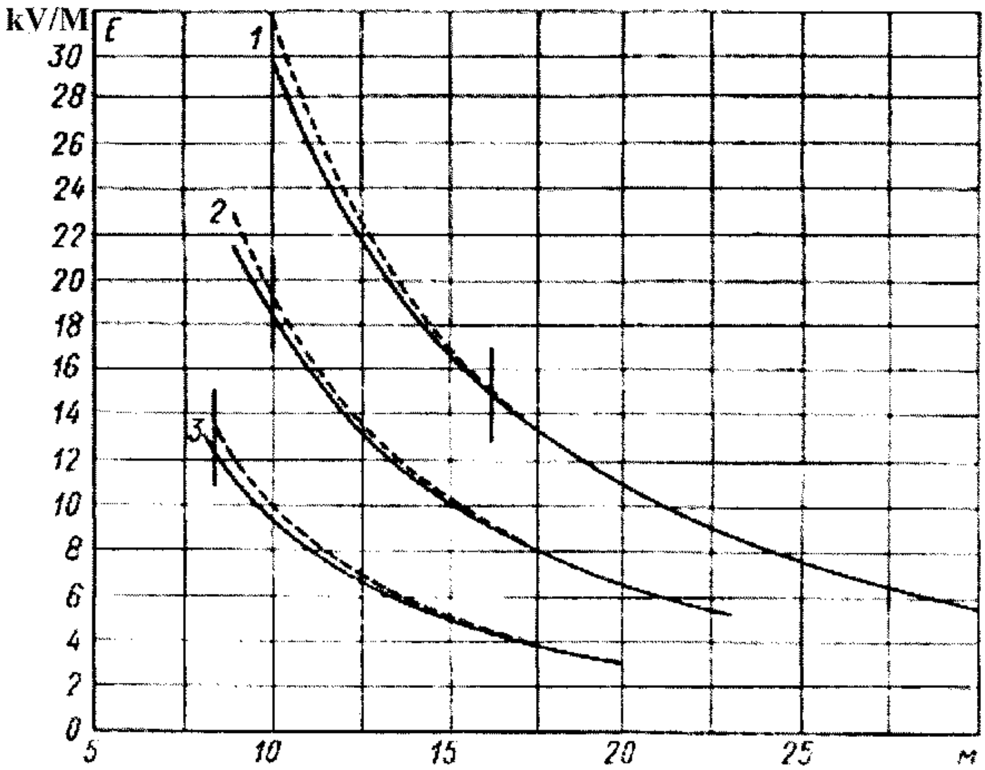

Figure 2: Maximum electrical field intensity under AC overhead transmission lines from minimum conductor suspension heights: 1 – 1150 kV, 2 – 750 kV, 3 – 500 kV. Solid lines – field intensity at the ground surface, dashed lines – intensity at the height of a human head.

Investigation performed at a high voltage power line installation with varied frequency (in Russia) with small and medium-sized animals, as well as with human volunteers showed that the capacitive current has the dominant influence on a human placed in a strong AC electric intensity field. According to the measurements made under overhead transmission lines operating at high and ultra-high voltage levels, the capacitive current of frequency 50 Hz flowing through a human is about 15 μA (Amperes)/kV/m. For systems of 60 Hz, the capacitive current will be 20% higher). At a permissible electrical field intensity $E \leq 10$ kV/m under overhead transmission lines of 525 – 1200 kV, the capacitive current flowing through a human is not larger than 150 – 180 μA, which corresponds to the current value that can be felt by 1% of human beings.

A real danger is posed by the *induced currents* produced by overhead transmission lines of 525 – 1200 kV in passing vehicles of large dimension using rubber tires (including trailers, harvesters, buses, and other vehicles). When a large metal insulated object (such as a harvester) is situated in the strong electric field produced by the bundled phase of a transmission line there is a capacitive susceptance between harvester and a bundled phase, and capacitive current begin to flow. Under such conditions of large capacitive susceptance between a vehicle and a bundled conductor, the capacitive current may rise 20 – 25 times (in comparison with the normal 0.15 – 0.18 mA). When such a current flows through a well-grounded human, it becomes similar in magnitude to the "release" current for a human being (6 mA for 0.5% of females and 9 mA for 0.5% of males), which can lead to a death if the current flows long enough through the heart cavity. The risks related to induced fields involving vehicles can in some cases be easily alleviated by applying "conductive" tires made of carbon rubber. In other cases it is necessary to increase transmission line dimensions in order to provide a safe electric field intensity E that is less than 10kV/m. On an overhead transmission line of 750 – 1150 kV at highway crossings it is recommended that electrical field intensity be decreased to 5 -7.5 kV/m.

There are additional, more radical methods that are sometimes applied to decrease electrical field intensity. These methods include increasing the height of transmission towers, which results in higher conductor suspension over the ground. For example, the minimal conductor suspension distance in Russia has been chosen to be 18m, although according to reliability and breakdown strength considerations it is possible to use a suspension distance of 12m. Increasing this distance leads to in increase in tower height, which increases tower costs by about 10%.

During the last several years, a great deal of attention has been paid to the *magnetic fields* produced by overhead transmission lines, cable lines, and substations and power plants installations. These fields are minimal for underground cables (about 1 μT, or micro-Tesla, at the ground's surface), but the induction B of the magnetic field can reach 10 μT directly under an overhead transmission line, and can reach about 1μT in houses on the border of a transmission line corridor. Near substations, B is about 20 – 30μT, and zones near in generators magnetic fields can reach levels of 2000 - 3000 μT.

Epidemiological and other medical investigations have been performed in several countries (Sweden, Canada, USA and others). Although these investigations paid special attention to researching the levels of magnetic fields with dangerous impacts on human health, results to date have not been conclusive regarding the health effects of magnetic fields.

7. CONCLUSION

When the transmission line insulation is chosen, the first concern is to provide safe conditions for people, animals and machinery moving under a line and near substation equipment.

The practice of designing overhead transmission line projects has shown that from an economic point of view it is appropriate to choose the type of insulation to use based on whether the operation of the lines will be reliable and safe at normal line voltage levels.

There are two methods of selecting insulation approaches. The first is used for common transmission lines and substations, and is based on the EICR-2002 and other normative documents that summarize engineering experience and the results of special scientific investigations. The second method of selection is used for special transmission lines and is based on statistical methods of computation.

For overhead transmission lines of 750kV and higher voltage levels, the height of the conductors is chosen according to the need to limit any deleterious effects of electric fields on living organism, especially humans. For transmission lines operating at a lower voltage level the conductor's height is chosen based on conditions that will allow workers and others to safely pass under the line.

In overhead transmission line projects using high voltage levels, the following environmental impacts must be considered:

- radio and television noise;
- acoustic noise generated by the conductors' local "corona".

A targeted choice of the bundling of conductors in overhead transmission lines can reduce these impacts.

Strong electric fields near overhead transmission lines of 500kV or higher voltage levels produce "electrical discomfort" for humans. The currents and voltages induced by these fields can be fatal for a human in cases where he or she comes in contact with a large vehicle with a rubber tires placed under a transmission line of 500kV or higher voltage. To eliminate this type of risk, vehicles must be grounded or must be provided with "conductive" tires, or the dimensions of the transmission line should be increased sufficiently to providing a safe electric field intensity (less than 10kV/m). With overhead transmission line of 750 – 1150 kV at highway crossings, decreasing electrical field intensity to 5 -7.5 kV/m is recommended.

8. REFERENCES

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