

# Technical requirements for the client's electrical installation

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# 1 Objective

- 1.1 This guide sets out the requirements of the TSO for the construction of the client's electrical installation. This guide is applied with the connection conditions.
- 1.2 The requirements in this guide are mandatory for the equipment from the connection point to the client's first circuit breaker (inclusive). The requirements for the equipment remaining on the client's side starting from the circuit breaker are recommended, except for those in chapters 9 and 10.

# 2 Requirements for the selection of the client's primary equipment

- 2.1 The client must ensure that:
  - 2.1.1 their electrical installations correspond to the prospective short-circuit currents, the value of which at the connection point shall be provided by the TSO in the tender for the connection contract;
  - 2.1.2 their electrical installations are equipped with relay protection and automatics as well as load reduction and/or isolation automatics in accordance with the requirements of the TSO, which are determined in the Grid Code, in the connection contract and during the coordination of the electrical part project;
  - 2.1.3 the earthing installation of electrical equipment or a set of equipment within the resistance area of the TSO's earthing installation is connected to the TSO's earthing installation via two beams and its earth conductor has the same thermal short-circuit resistance as the TSO's earth conductor of the earthing installation;
  - 2.1.4 at least one winding of their 110 kV or 330 kV power transformer must be in a delta circuit. Other types of power transformers must be approved in advance by the TSO, which shall issue the relevant conditions and requirements. The TSO has the right to refuse to connect other types of power transformers; the client shall be informed with the reasons for the refusal. It must be possible to earth the neutral of the power transformer by means of an earthing switch and it must be equipped with an overvoltage limiter and a short-circuit limiting reactor. The need and parameters of the reactor shall be determined by the TSO based on the level of short-circuit currents in the transmission network;
  - 2.1.5 the isolation level of its power transformer outlets and winding must be at least:

Object	Um	AC (50 Hz)	SI	LI
	kV	kV	kV	kV
		Internal Insulation	Line terminal	
A-B-C (HV)	362	510	950	1175
N	245	360	-	850
2a-2b-2c (MV)	123	230	-	550
2n	123	230	-	550
3a-3b-3c (LV)	40.5	75	-	185
	24	50	-	125
	17.5	38	-	95
	12	28	-	75
	7.2	20	-	60

- 2.1.6 electrical installations are protected against overvoltages.
- 2.2 The recommended rated voltages of the client's power transformers are 347/(117.5; 38.5; 22; 16.5; 11; 6.6) kV for the 330 kV power transformer and 115/(38.5; 22; 16.5; 11; 6.6) kV for the 110 kV power transformer.
- 2.3 The tap changer of the power transformers is preferably located on the side of the primary winding and must be adjustable under voltage.
- 2.4 The recommended steps of the tap changer are  $\pm 6 \times 1.33\%$  for 330 power transformers and  $\pm 9 \times 1.67\%$  for 110 kV power transformers.
- 2.5 It is recommended to install current transformers built into the bushings of the primary side of the power transformer for backup protection 5P20 and for control/measurement with cores with an accuracy class of 0.2S.

### 3 Principles of nominal voltage selection for client's equipment

Grid nominal voltage	330 kV	110 kV
Maximum allowed continuous operating voltage of	362	123
Maximum allowed short-term (20 min) voltage of equipment	379.5	126.5
Rated voltages of power transformers	347/(117.5)/...	115/(...)/

### 4 Short circuit resistance

- 4.1 When designing insulation, overvoltage and relay protection and automation, the client must take into account that automatic transformers must only operate with rigidly earthed neutral, 330 kV and 110 kV windings of conventional transformers can operate with rigidly earthed (also through neutral switch) neutral, neutral earthed via reactor or insulated neutral. However, the client must take into account that the earth fault current factor for the 330 kV transmission network is not over 1.2 and the earth fault current factor for the 110 kV transmission network is not over 1.4 (the earth fault current factor shows the relationship between the voltages generated in the whole phases during the earth fault and the phase voltages in the normal state). The client must also take into account that in the substations of the transmission network there are only surge arresters in the vicinity of the power transformers and the power cable couplings and in the distribution equipment with sulphur hexafluoride insulation for the protection of the TSO's equipment.
- 4.2 When designing electrical installations, it must be taken into account that all materials and equipment must be able to withstand the maximum mechanical stresses that may occur during the operation of the equipment.
- 4.3 All current conductors shall have a permissible short-circuit duration of at least one second, unless otherwise agreed.

## **5 Safety ranges**

- 5.1 When designing a substation, for safety reasons, the minimum permissible insulation distances specified in EVS-EN 61936-1 must not be reduced.
- 5.2 The safety margins must also take into account the impact of wind, environmental conditions and other circumstances, and larger ranges must be used accordingly.

## **6 Lengths of creepage distance**

- 6.1 The choice of equipment must be based on the environmental conditions prevailing in the substation from the point of view of insulation. As a general rule, the length of the creepage distance of the equipment shall be at least 20 mm/kV; if the TSO considers a longer creepage distance necessary, the TSO shall indicate this in the tender for the connection contract.

## **7 Radio interference and acoustic noise**

- 7.1 The choice and design of the equipment shall ensure that the radio interference caused by corona is lower than the values specified in the standards set by the TSO.
- 7.2 Technical solutions are accepted in which the radio interference, measured in accordance with IEC-CISPR 18 at a frequency of 0.5 MHz and at a distance of 20 m from the farthest device of the switchgear, is as follows:
  - 7.3 in rainy weather – less than 30 dB;
  - 7.4 in dry weather – less than 15 dB;
  - 7.5 Acoustic noise caused by the client's electrical installation shall not cause the noise level at the border of the substation of the TSO to exceed the limit value specified in legislation and/or the relevant plan.

## **8 Automatics and relay protection**

- 8.1 The basic protection of the relay protection of the client's electrical installation must be applied selectively in the event of a failure of the client's equipment and for at least 0.1 seconds after the failure has occurred.
- 8.2 Switching devices are controlled by the device owner.
- 8.3 The TSO shall install a separate limit switch cabinet in its substation, where the following measuring and control circuits (copper circuits) shall be provided for the client's basic protection and automatics:
  - 8.3.1 circuits from the protection winding of the current transformer of the connection bay (accuracy class 5P);
  - 8.3.2 voltage circuits from the voltage transformer of the connection bay and/or from the busbar voltage transformer(s) of the corresponding voltage class (accuracy class 0.5);
  - 8.3.3 control circuits for switching off the circuit breaker of the 110 or 330 kV connection bay belonging to the TSO (in the case of connection to the line and in the case of the client's automatic reconnection, the switching circuits of the circuit breaker will also be provided).

- 8.4 All circuits are limited by the terminal blocks of the limit terminal box.
- 8.5 The length of the test and control cables connected by the client to the limit switch cabinet to the client's basic protection and automatic equipment must not exceed 1000 m and must not pass through real estate owned by third parties. Thus, the client must realise and install basic protection for the TSO's substation on a neighbouring immovable or in a separate building on the TSO's substation property, to which a personal right of use must be established. If this is not possible, the client must also procure and install 110 or 330 kV voltage measuring transformers and a power switch in their electrical installation.
- 8.6 If the accuracy of the voltage and current measurements provided by the TSO does not meet the client's needs, the client must procure and install suitable measuring transformers in their electrical installation.
- 8.7 If it is not technically feasible to build copper circuits between the distributors, the technical solution shall be agreed between the TSO and the client on a case-by-case basis.
- 8.8 The client must take into account that the TSO does not provide auxiliary power or auxiliary energy (DC and AC voltage) for the client's installation and equipment, so the client must procure and install these themselves.
- 8.9 The exact number and volume of circuits between the TSO and the client's equipment will become clear during the coordination of the electrical part project.

## **9 Quality requirements for electricity**

- 9.1 The values used by the TSO as planning values are presented here.
- 9.2 In the case of specific clients, the permissible limit values are lower and are defined separately for each specific client in the connection contract.
- 9.3 Voltage deviations caused by the client must not exceed 3% at the connection point.
- 9.4 Flicker;
- 9.4.1 Flicker 110 kV in the power grid:

$$E_{P_{st}i} = 1,0$$

$$E_{P_{hi}i} = 0,8$$

- 9.4.2 Flicker 330 kV in the power grid:

$$E_{P_{st}i} = 0,8$$

$$E_{P_{hi}i} = 0,6$$

- 9.5 Voltage asymmetry;

9.5.1 In normal operation, the 10-minute mean value of the negative sequence component shall not exceed 1.4% of the positive sequence component in weekly measurements in 95% of cases in the 110 kV network, and 1% of the positive sequence component in weekly measurements in 95% of cases in the 330 kV network.

9.6 Harmonics:

9.6.1 Voltage harmonics:

9.6.1.1 The planning values of the higher harmonic voltages (up to the 50th harmonic) of the 110 kV transmission network of the TSO are as follows:

Odd harmonics				Paired harmonics	
Cannot be divided by 3		Can be divided by 3			
Harmonic $h$	Relative voltage $u_h$ , %	Harmonic $h$	Relative voltage $u_h$ , %	Harmonic $h$	Relative voltage $u_h$ , %
5	3	3	2.7	2	1.5
7	2.7	9	1.1	4	0.8
11	2	15	0.3	6	0.4
13	1.8	21	0.2	8	0.4
17	1.4	27	0.2	10	0.3
19	1.2	33	0.2	12	0.3
23	1	39	0.2	14	0.3
25	0.9	45	0.2	16	0.3
29	0.8			18	0.3
31	0.7			20	0.3
35	0.6			22	0.3
37	0.6			24	0.25
41	0.5			>24	0.25
43	0.5				
47	0.45				
49	0.4				

9.6.1.2 The planning values of the higher harmonic voltages (up to the 50th harmonic) of the 330 kV transmission network of the TSO are as follows:

Odd harmonics				Paired harmonics	
Cannot be divided by 3		Can be divided by 3			
Harmonic $h$	Relative voltage $u_h$ , %	Harmonic $h$	Relative voltage $u_h$ , %	Harmonic $h$	Relative voltage $u_h$ , %
5	2	3	2	2	1.4
7	2	9	1	4	0.8
11	1.5	15	0.3	6	0.4
13	1.5	21	0.2	8	0.4
17	1.2	>21	0.2	10	0.35
19	1			12	0.3
23	0.9			14	0.3
25	0.8			16	0.25
29	0.7			18	0.25
31	0.65			20	0.25
35	0.6			22	0.25
37	0.55			24	0.2
41	0.5			>24	0.2
43	0.45				
47	0.4				
49	0.4				

9.6.2 Current harmonics:

9.6.2.1 Maximum permissible current emission values for the client at the connection point

% of maximum client current	
Current distortion limits	5%
Psychometric value of phase current	5:00 EL
Current sequence component	20%

### 9.6.2.2 Permissible limit emissions for odd current harmonics

Harmonic stage	Limit emissions of current harmonics with respect to the
$h < 11$	4.0
$11 \leq h < 17$	2.0
$17 \leq h < 23$	1.5
$23 \leq h < 35$	0.6
$35 \leq h < 50$	0.5
Total harmonic distortion factor (THD)	5.0

### 9.6.3 High frequency interference:

9.6.3.1 The client shall ensure that the electricity generated by the client's electrical installation shall not exceed 35 dB (0 dB = 0.775 V) in the frequency range (40-500) kHz measured at the connection point in the input of the standard remote switchgear, as the TSO uses high frequency communication in its network.