



BSI Standards Publication

Overhead electrical lines exceeding AC 1 kV

Part 2-1: National Normative Aspects (NNAs) for
Austria (based on EN 50341-1:2012)

National foreword

This British Standard is the UK implementation of EN 50341-2-1:2022. It supersedes BS EN 50341-2-1:2020, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/11, Overhead Lines.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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English Version

**Overhead electrical lines exceeding AC 1 kV - Part 2-1: National
Normative Aspects (NNAs) for Austria (based on
EN 50341-1:2012)**

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European foreword

- 1 The Austrian National Committee is identified by the following address:

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Name of the relevant technical body: TK-L Starkstromfreileitungen und Verlegung von Energiekabeln (Overhead power lines)

- 2 The Austrian NC and its technical body TK-L “Overhead power lines” of Austrian Electrotechnical Association (OVE) prepared this Part 2-1 of EN 50341, listing the Austrian National Normative Aspects (NNA) under its sole responsibility, and duly passed it through the CENELEC and CLC/TC 11 procedures.

NOTE The Austrian NC also takes sole responsibility for the technically correct co-ordination of this EN 50341-2-1:2020 with EN 50341-1:2012. It performed the necessary checks in the frame of quality assurance/control. However, it is noted that this quality control was made in the framework of the general responsibility of a standards committee under the national laws/regulations.

- 3 This EN 50431-2-1, hereafter referred to as Part 2-1, is normative in Austria and informative in other countries.
- 4 This Part 2-1 shall be read in conjunction with EN 50341-1, hereafter referred to as Part 1. All clause numbers used in this NNA correspond to those of Part 1. Specific subclauses, which are prefixed “AT”, shall be read as amendments to the relevant text in Part 1. Any necessary clarification regarding the application of this NNA in conjunction with Part 1 shall be referred to the Austrian NC who will, in co-operation with CLC/TC 11, clarify the requirements.

When no reference is made in this NNA to a specific subclause, then Part 1 applies.

- 5 In case of “boxed values” defined in Part 1, amended values, (if any) which are defined in Part 2-1 shall be taken into account in Austria.

However, any “boxed value”, whether in Part 1 or in this Part 2-1, shall not be amended in the direction of greater risk in a Project Specification.

- 6 The National Austrian standards/regulations related to overhead electrical lines exceeding 1 kV AC are listed in 2.1 of this Part 2-1.

NOTE All national standards referred to in this Part 2-1 will be replaced by the relevant European Standards as soon as they become available and are declared by the austrian NC to be applicable and thus reported to the secretary of CLC/TC 11.

1 Scope

1.1 General

(A-dev) AT.1: A new overhead line is defined as the new construction of the totality of all conductors, their supports together with foundations, earthing grid, insulators, accessories and fittings used for the overground transport of electrical energy between two points A and B.

1.2 Field of application

(A-dev) AT.1: Stranded-conductors or cable structures with telecommunications components carried on the line that do not simultaneously function as earth wires or stranded conductors are subject to the provisions of Annex U.

2 Normative references, definitions and symbols

2.1 Normative references

(A-dev) AT.1: Normative references and other publications

Reference	Title
ÖNORM B 1990-1	<i>Eurocode - Basis of structural design - Part 1: Building construction - National specifications concerning ÖNORM EN 1990 and national supplements</i>
ÖNORM B 1991-1-4	<i>Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions - National specifications concerning ÖNORM EN 1991-1-4 and national supplements</i>
ÖNORM B 1992-1-1	<i>Eurocode 2 - Design of concrete structures - Part 1-1: General rules and rules for buildings - National specifications concerning ÖNORM EN 1992-1-1, national comments and national supplements</i>
ÖNORM B 1997-1-1	<i>Eurocode 7: Geotechnical design - Part 1: General rules - National specifications concerning ÖNORM EN 1997-1 and national supplements</i>
ÖNORM B 1997-1-3	<i>Eurocode 7 - Geotechnical design - Part 1-3: Pile foundations</i>
ÖNORM E 4007	<i>Electrical overhead lines; galvanized steel stranded conductors</i>
ÖNORM E 4101	<i>Electrical overhead lines; pin insulators type VHD and type VHD-G</i>
ÖNORM E 4102	<i>Electrical overhead lines; solid core line post insulators VKSt and VKS</i>
ÖNORM E 4104	<i>Electrical overhead lines; ball and socket; coupling dimensions</i>
ÖNORM E 4125	<i>Electrical overhead lines; ball and socket; IEC-coupling dimensions</i>
ÖNORM EN 1090-1	<i>Execution of steel structures and aluminium structures - Part 1: Assessment and verification of constancy of performance of steel components and aluminium components for structural use</i>
ÖNORM EN 1090-2	<i>Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures</i>
ÖNORM EN 12929-1	<i>Safety requirements for cableway installations designed to carry persons - General requirements - Part 1: Requirements for all installations</i>
ÖNORM EN 1991-1-4	<i>Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions</i>
ÖNORM EN 1992-1-1	<i>Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings</i>
ÖNORM EN 1993-1-1	<i>Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings</i>

ÖNORM EN 1997-1	<i>Eurocode 7: Geotechnical design - Part 1: General rules</i>
ÖNORM EN 1997-2	<i>Eurocode 7 - Geotechnical design - Part 2: Ground investigation and testing</i>
ÖNORM EN 61232	<i>Aluminium-clad steel wires for electrical purposes</i>
ÖVE EN 60383-1	<i>Insulators for overhead lines with a nominal voltage above 1 kV - Part 1: Ceramic or glass insulator units for AC systems - Definitions, test methods and acceptance criteria</i>
ÖVE EN 60383-2	<i>Insulators for overhead lines with a nominal voltage above 1000 V - Part 2: Insulator strings and insulator sets for a.c. systems - Definitions, test methods and acceptance criteria</i>
ÖVE/ÖNORM EN 60071-1	<i>Isolation co-ordination, Part 1: Definitions, principles and rules</i>
ÖVE ÖNORM EN 61109	<i>Insulators for overhead lines - Composite suspension and tension insulators for a.c. systems with a nominal voltage greater than 1 000 V - Definitions, test methods and acceptance criteria</i>
ÖVE ÖNORM EN 61952	<i>Insulators for overhead lines - Composite line post insulators for A.C. systems with a nominal voltage greater than 1 000 V - Definitions, test methods and acceptance criteria</i>
ÖVE/ÖNORM E 8383	<i>Power installations exceeding 1 kV AC</i>
ÖVE/ÖNORM EN 50110-1	<i>Operation of electrical installations - Part 1: General requirements (Part 2-100: National annexes)</i>
ÖVE/ÖNORM EN 50182	<i>Conductors for overhead lines - Round wire concentric lay stranded conductors</i>
ÖVE/ÖNORM EN 50189	<i>Conductors for overhead lines - Zinc coated steel wires</i>
ÖVE/ÖNORM EN 50522	<i>Earthing of power installations exceeding 1 kV a.c.</i>
ÖVE/ÖNORM EN 60865-1	<i>Short-circuit currents - Calculation of effects - Part 1: Definitions and calculation methods</i>
ÖVE/ÖNORM EN 61936-1	<i>Power installations exceeding 1 kV a.c. - Part 1: Common rules</i>
ÖVE-L 1	<i>Construction of overhead lines up to 1000 V</i>
OVE Directive R23-1	<i>Electrical, magnetic and electromagnetic fields in the frequency range from 0 Hz to 300 GHz Part 1: Limiting exposure of members of the public</i>
VbF	<i>Federal Decree on flammable liquids</i>
VEMF	<i>Federal Decree on electromagnetic fields</i>
DIN 48207	<i>Stranded conductors; laying of stranded conductors for overhead lines</i>

2.2 Definitions

2.2.5

box values

(A-dev) AT.1: Unless otherwise specified in an NNA, boxed values are to be applied as minimum requirements.

2.2.109

(ncpt) AT.1:

conductor pull

is the product of the rated cross section of the conductor and the tensile stress acting in this cross section in the tangential direction of the sag curve.

(ncpt) AT.2:

tensile strength

is the value derived from the conductor pull divided by the rated cross section of the conductor.

(ncpt) AT.3:

Mean tensile strength

is the horizontal component of the tensile stress in the conductor that occurs at the mean annual temperature, generally +10 °C, excluding wind load.

(ncpt) AT.4:

upward or downward pull

is the product of horizontal conductor pull and the tangent of the angle of inclination of the straight line connecting the two suspension points against the horizontal.

(ncpt) AT.5:

rated cross section

of a conductor is the metallic cross section calculated from the data sheets. The rated cross section of an aerial cables is defined as the mechanical load-carrying section of the cable only.

(ncpt) AT.6:

span

is the sector of a line between two consecutive supports of that line.

(ncpt) AT.7:

span length

is the horizontal distance between two consecutive supports of that line.

(ncpt) AT.8:

section

is the sector of an overhead line having one or more spans between two consecutive tension towers.

(ncpt) AT.9:

A conductor crosses an object

when, as a result of being deflected by wind acting in the direction of that facility, the outline of the conductor intersects the outline of the object.

(ncpt) AT.10:

crossing span

The span to which the condition according to AT.9 applies.

(ncpt) AT.11:

sag

of a conductor is the vertically measured distance between a point of the conductor axis and the straight line connecting the conductor's two points of suspension.

(ncpt) AT.12:**fittings**

are constructional elements which are installed either individually or in combination on or between conductors, insulators as well as between conductors or insulators and supports.

2.3 Symbols(A-dev) AT.1: Symbols

a_{LTG}	Horizontal minimum clearance to a wind energy converter (WEC), depending on the line voltage	5.9.3/AT.5
a_{RaumLTG}	Horizontal clearance for adaptations, extensions and replacements of an overhead line near a wind energy converter, depending on the line voltage	5.9.3/AT.5
a_{RaumWEA}	Horizontal area for work, turning and manipulation during erection, operation and maintenance of a wind energy converter	5.9.3/AT.5
a_{WEA}	Horizontal minimum clearance between the outermost not deviated conductor of the overhead line and the vertical axis of the tower of the wind energy converter	5.9.3/AT.5
D_{WEA}	Diameter of the rotor of a wind energy converter	5.9.3/AT.5
E_d	Total design value of the effect of actions	4.12.2/AT.5
G_K	Characteristic value of a permanent action	4.12.2/AT.5
$I_v(h)$	Turbulence intensity at a reference height h above ground	4.3.4/AT.1
k_p	Earth resistance coefficient	S.7/AT.2
$k_{\text{I}25}$	Coefficient for a return period of 25 years for ice loads in an overhead line network with nominal voltages exceeding AC 1 kV up to and including AC 45 kV	4.5.2/AT.1
$k_{\text{w}25}$	Coefficient for a return period of 25 years for reference wind pressures in an overhead line network with nominal voltages exceeding AC 1 kV up to and including AC 45 kV	4.5.2/AT.1
M_{freq}	Moment caused by frequent loading	7.6.5/AT.2
M_{cont}	Moment caused by conductor type at -5 °C excluding wind and ice	7.6.5/AT.2
M_{char}	Moment caused by characteristic load cases	7.6.5/AT.2
$q_{\text{b},0}$	Basic velocity pressure	4.3/AT.1
$q_{\text{b},0,50}$	Basic velocity pressure with return period of 50 years	4.12.2/AT.5
$q_{\text{I}h}(h)$	Mean wind pressure associated with icing at reference height h above ground	4.6.3/AT.1
$q_{\text{Ip}}(h)$	Peak wind pressure associated with icing at reference height h above ground	4.6.3/AT.1
$q_p(h)$	Peak wind pressure at reference height h above ground	4.3.4/AT.1
$q_{\text{p},50}(h)$	Peak wind pressure with return period of 50 years at reference height h above ground	4.12.2/AT.5
$V_h(h)$	Mean wind velocity at reference height h above ground	4.3.2/AT.2
W_{50}	Wind action with return period of 50 years	4.12.2/AT.5
$W_{\text{C,IT},50}$	Wind action on ice-covered conductors with return period of 50 years, taking into account the enlarged diameter of the ice-covered conductor due to the ice load I_{50} .	4.12.2/AT.5
$W_{\text{M},50}$	Wind action on ice-free supporting structure with a return period of 50 years	4.12.2/AT.5

$W_{C,50}$	Wind action on ice-free conductor with a return period of 50 years	4.12.2/AT.5
$W_{C,\Psi,50}$	Wind action on ice-free conductor with a return period of 50 years	4.12.2/AT.5
z_0	Roughness length of ground	4.3.2/AT.1
f_{ctm}	Mean value of the central tensile stress of concrete	S.6
γ_c	Partial load factor of concrete	S.6
τ_d	Design value of the adhesive tensile stress	S.6

3 Basis of design

3.2 Requirements of overhead lines

3.2.2 Reliability requirements

- (snc) AT.1: Taking into account the local topographical and climatic conditions, load cases 2, 3, 4, 5 in 4.12.2 do not need to be taken into consideration for temporary lines with a duration of up to 6 months in seasons during which no ice loads are to be expected.
- (ncpt) AT.2: Reliability level 1 is to be applied with a return period of 50 years. A higher reliability level can be applied for specific projects.

4 Actions on lines

4.3 Wind loads

4.3.1 Field of application and basic wind velocity

- (A-dev) AT.1: The basic wind velocity $V_{b,0}$ and the basic wind velocity pressure $q_{b,0}$ must be selected for a line or a line section in accordance with ÖNORM B 1991-1-4.

However, the basic wind velocity $V_{b,0}$ is at least 20.0 m/sec and the basic wind velocity pressure $q_{b,0}$ is at least 0.25 kN/m², terrain category II must be used. For overhead lines exceeding AC 1 kV up to and including AC 45 kV, terrain categories III and IV can be assumed in accordance with ÖNORM B 1991-1-4.

NOTE AT: If the altitude above sea level at the location is more than 250 metres above that of the nearest location specified in ÖNORM B 1991-1-4 Table A.1, the basic values of the basic speed pressure $q_{b,0}$ according to Table A.2 shall be assumed, in the absence of a site-specific wind analysis (e.g. from the Zentralanstalt für Metereologie und Geodynamik, Vienna).

- (A-dev) AT.2: If a return period different from 50 years has been chosen for the design of an overhead line, the windspeeds shall be derived based on formula 4.2 of ÖNORM EN 1991-1-4, applying a conversion factor C_T respectively C_{prob} .

4.3.2 Mean wind velocity

- (A-dev) AT.1: The following applies for terrain category II:

$$z_0 = \frac{h}{e^{\frac{1}{\psi(h)}}}$$

- (A-dev) AT.2: The mean wind velocity $V_h(h)$ must be determined according to ÖNORM B 1991-1-4 and is calculated for terrain category II as follows:

$$V_h(h) = V_{b,0} \left(\frac{h}{10} \right)^{0.15}$$

The factor for taking into account the terrain structure c_o is 1.0 according to ÖNORM B 1991-1-4.

4.3.3 Mean wind pressure

(A-dev) AT.1: The specified values in ÖNORM B 1991-1-4 Table A.1 and A.2 for the basic wind velocity pressures are based on an air density of 1.25 kg/m³. Depending on the altitude above sea level, the specified basic wind velocity pressures can only be reduced according to ÖNORM B 1991-1-4 Table 2.

4.3.4 Turbulence intensity and peak wind pressure

(A-dev) AT.1: The turbulence intensity $I_v(h)$ and peak wind pressure $q_p(h)$ must be determined according to ÖNORM B 1991-1-4 for terrain category II as follows:

$$I_v(h) = 0.18 \left(\frac{h}{10} \right)^{-0.15}$$

$$q_p(h) = q_{b,0} 2.1 \left(\frac{h}{10} \right)^{0.24}$$

4.4 Wind forces on overhead line components

4.4.1 Wind forces on conductors

4.4.1.1 General

(ncpt) AT.1: The designations of the coordinate axes u and v comply in Austria to x (for u) and y (for v). This affects the following formulae and the figures 4.1.a and 4.1.b.

(ncpt) AT.2: The increase in tensile forces in the conductors resulting from the wind loads can be ignored.

(ncpt) AT.3: These designations apply for $0 \leq \phi \leq 90^\circ$.
The upper sign applies for $(\phi + \theta_l/2) \leq 90^\circ$, the lower sign for $(\phi + \theta_l/2) > 90^\circ$.

(ncpt) AT.4: To determine the reference height of the conductors above ground, method 4 or 6 must be applied and applies both for the determination at the tower and for the determination within the span. Crossings of valleys and similar situations must be examined separately.

4.4.1.2 Structural factor

(A-dev) AT.1: The structural factor for conductors G_c must be determined according to ÖNORM B 1991-1-4 as follows:

$$G_c = \left(1 + 2k_p I_v(h) \sqrt{B^2 + R^2} \right) \cdot \frac{q_h(h)}{q_p(h)}$$

The peak factor k_p of 3.00 must be taken into account; the resonance response factor R^2 of 0.00 can be applied.

(ncpt) AT.2: The stipulation of the reference height of insulator strings above ground h may simplified be considered like the reference height of conductors above ground.

4.4.1.3 Drag factor

(ncpt) AT.1: Method 1, 2 or 3 can be considered.

4.4.2 Wind forces on insulator sets

(ncpt) AT.1: The wind loads on insulator sets must be taken into account in the design of the supports.
 $G_{ins} = 1.00$ and $C_{ins} = 1.20$.

4.4.3 Wind forces on lattice towers

4.4.3.1 General

(ncpt) AT.1: To determine the wind forces acting on the tower, method 1 must be used.

The drag factors C_{t1} , and C_{t2} depend on the solidity ratio panel face 1 or panel face 2, see Section 4.4.3.2, Figure 4.3. Drag factors on standard lattice tower designs can be set to the value 2.8 uniformly for the whole tower.

NOTE AT: The value 2.8 already takes into account the overall wind load on the front and rear tower panel face.

4.4.4 Wind forces on poles

(ncpt) AT.1: For poles with a height of ≤ 15 m (for concrete poles 20 m), the above-mentioned drag factors can be used irrespective of their slenderness ratio.

(A-dev) AT.2: For poles with a height of more than 15 m (for concrete poles more than 20 m) above the terrain, the wind loads on the structure must be determined according to ÖNORM EN 1991-1-4.

towers(ncpt) AT.3: For wooden poles with a circular cross section, the drag factor is 0.7.

4.5 Ice loads

4.5.1 General

(ncpt) AT.1: As a general rule, icing is not to be taken into account for towers. In exposed locations, special provisions may be required for specific projects.

Ice loads must be taken into account for the following components:

- Earth wires and conductors
- Insulator sets
- Warning spheres, radar markers, etc.

4.5.2 Ice forces on conductors

(snc) AT.1: The extreme value of the ice load I_{50} is determined as defined below.

(1) Earth wires and conductors:

$$I_{50} = 20 + 0.4 \times d$$

For overhead lines exceeding AC 1 kV up to and including AC 45 kV, the ice loads can be multiplied by the factor $k_{125} = 0.5$ if the heights above ground of the suspension points of the conductors do not exceed 20 m and no “additional measures for enhanced safety” according to 5.9.1/AT.5 are required.

The following applies in this case:

I_{50} extreme ice load in N/m

d conductor diameter in mm

k_{125} Coefficient for a return period of 25 years for ice loads in an overhead line network with nominal voltages exceeding AC 1 kV up to and including AC 45 kV

(2) Additional components:

Insulator sets: At least 30% of the dead weight

Higher percentage rates may be necessary for composite insulators.

Warning spheres, radar markers, etc.: At least 190 N/m² on the entire surface.

For overhead lines exceeding AC 1 kV up to and including AC 45 kV, the ice loads for additional components can be multiplied by the factor $k_{125} = 0.5$ if the heights above ground of the suspension points of the conductors do not exceed 20 m and no “additional measures for enhanced safety” according to 5.9.1/AT.5 are required.

For the conversion of ice loads for other return periods, by analogy, the formulas for the conductors apply.

- (3) The ice loads indicated above in general represent minimum loads. In particular exposed locations, it may also be necessary to take higher ice loads into account.

If less icing is to be anticipated due to the location of an overhead line and the local climatic conditions, then based on observations for many years and on an expert assessment, the extrem value if the ice load I_{50} can be reduced on this basis. A combination with k_{125} is not allowed.

4.6 Combined wind and ice loads

4.6.2 Drag factors and ice densities

(snc) AT.1: A drag factor of $C_{lc} = 1.00$ and an ice density of $\rho_i = 750 \text{ kg/m}^3$ must be used for the ice load calculation.

4.6.3 Mean wind pressure and peak wind pressure

(A-dev) AT.1: The peak wind pressure q_{lp} is calculated according to ÖNORM B 1991-1-4 for terrain category II as follows:

$$q_{lp}(h) = q_{1h} 2.1 \left(\frac{h}{10} \right)^{0.24}$$

4.6.6 Combination of wind velocities and ice loads

4.6.6.1 Extreme ice load I_T combined with a high probability wind velocity V_{IH}

(ncpt) AT.1: Recommended value for $\psi_W = 0.4$.

(ncpt) AT.2: Recommended value for $B_1 = 0.75$.

4.7 Temperature effects

(snc) AT.1: For the static design of the towers, a conductor temperature of -5 °C is to be applied for the wind load cases, the ice load cases and the combined wind/ice load cases. In addition, a load case must be investigated with a conductor temperature of -20 °C without ice loads and wind loads.

4.11 Other special forces

4.11.3 Forces as a result of enhanced use

(ncpt) AT.1: Outdoor antennas on towers

If the use of overhead line towers is enhanced by the attachment of additional equipment (e.g. outdoor antennas), these towers shall continue to be considered overhead line towers under the terms of this standard.

4.12 Load cases

4.12.2 Standard load cases

(ncpt) AT.1: Permanent actions are described in 3.4.2, Point 1), permanent loads are described in 4.2. The load cases listed in Table 4.6 must take the permanent actions according to 3.4.2 Point 1) into account.

(ncpt) AT.2: Direction of wind actions

Wind in y-direction: Wind perpendicular to the direction of the line, in the case of angle towers in the direction of the bisectors of the angles or in the direction of the main axis of the tower that deviates least from the direction of the bisectors of the angles.

Wind in x-direction: Wind in direction of the line, in the case of angle towers perpendicular to the bisectors of the angles or perpendicular to the main axis of the supporting structure that deviates least from the direction of the bisectors of the angles.

Wind acting diagonally: Wind perpendicular to the assumed diagonal of the tower body cross section.

(ncpt) **AT.3: Table 4.7/AT.3 - Overview of load cases for suspension and tension towers for overhead lines with a nominal voltage exceeding than AC 45 kV as well as for suspension and tension towers for overhead lines with a nominal voltage exceeding AC 1 kV up to and including AC 45 kV if “additional measures for enhanced safety” according to 5.9.1/AT.5 are required.**

Load case			Con- ductor tempe- rature	Wind			Ice				Dead weight
				Wind action	γ_W	ψ_W	Ice load	γ_I	ψ_I	α	
Wind load cases	1aa	Wind in y-direction	-5°	W_{50}	1.30						1.30
	1ab	Wind in x-direction	-5°	W_{50}	1.30						1.30
	1ac	Wind acting diagonally	-5°	W_{50}	1.30						1.30
Ice load cases	2a	Uniform ice load in all spans	-5°				I_{50}	1.30			1.30
	2b	Uniform ice load, transversal bending	-5°				I_{50}	1.30		α (0.50)	1.30
	2c	Unbalanced ice load, longitudinal bending	-5°				I_{50}	1.30		α_1 (T/0.75; WA/0.20) α_2 (1.00)	1.30
	2d	Unbalanced ice load, bending and torsion	-5°				I_{50}	1.30		α_3 (T/0.90; WA/0.80) α_4 (1.00)	1.30
Combined wind and ice actions	3aa	Extreme ice load (I_T) and wind load with a high probability (V_{IH}); wind in y-direction	-5°	W_{50}		0.40	I_{50}	1.30			1.30
	3ab	Extreme ice load (I_T) and wind load with a high probability (V_{IH}); wind in x-direction	-5°	W_{50}		0.40	I_{50}	1.30			1.30
	3ac	Extreme ice load (I_T) and a high probability wind load (V_{IH}); wind acting diagonally	-5°	W_{50}		0.40	I_{50}	1.30			1.30
	3ba	Wind load with low probability (V_{IL}) and nominal ice load; wind in y-direction	-5°	$W_{50} * B1^2$	1.30		I_{50}		0.35		1.30
	3bb	Wind load with low probability (V_{IL}) and nominal ice load; wind in x-direction	-5°	$W_{50} * B1^2$	1.30		I_{50}		0.35		1.30
	3bc	Wind load with low probability (V_{IL}) and nominal ice load; wind acting diagonally	-5°	$W_{50} * B1^2$	1.30		I_{50}		0.35		1.30
Lowest temperature	4	Temperature -20°	-20°								1.30
Operational load case	5a	Security loads, torsional loads	-5°				I_{50}	1.00		α_5 (T/0.00) WA/discontinuation of conductor α_6 (T/0.40; WA/0.70)	1.00
Safety loads	6a 6b	Construction and maintenance loads Loads due to the weight of linesmen	See 4.9								

(ncpt) **AT.4: Table 4.8/AT.4 - Overview of load cases for suspension and tension towers for overhead lines with a nominal voltage exceeding AC 1 kV up to and including AC 45 kV if no “additional measures for enhanced safety” according to 5.9.1/AT.5 are required.**

Load cases			Conductor temperature	Wind		Ice			Dead weight
				Wind action	γ_W	Ice load	γ_I	α	
Wind load cases	1aa	Wind in y-direction	-5°	$k_{w25} \times W'_{50}$	1.00				1.00
	1ab	Wind in x-direction	-5°	$k_{w25} \times W'_{50}$	1.00				1.00
	1ac	Wind acting diagonally	-5°	$k_{w25} \times W'_{50}$	1.00				1.00
Ice load cases	2a	Uniform ice load in all spans	-5°			$k_{i25} \times I_{50}$	1.00		1.00
	2b	Uniform ice load, transversal bending	-5°			$k_{i25} \times I_{50}$	1.00	α (0.50)	1.00
	2c	Unbalanced ice load, longitudinal bending	-5°			$k_{i25} \times I_{50}$	1.00	α_1 (T/0.95; WA/0.20) α_2 (T/1.00; WA/1.00)	1.00
Lowest temperature	4	Temperature -20°	-20°						1.00
Safety loads	6a 6b	Construction and maintenance loads Loads due to the weight of linesmen	See 4.9						

The reduction factors k_{w25} and k_{i25} may only be used in cases where the height of the suspension of the conductors does not exceed 20m.

(ncpt) **AT.5: Load cases for suspension and tension towers**

For overhead lines with a nominal voltage exceeding AC 45 kV as well as for overhead lines with a nominal voltage exceeding AC 1 kV up to and including AC 45 kV if “additional measures for enhanced safety” according to 5.9.1/AT.5 are required, Table 4.7/AT.3 applies.

In the following definitions of load cases for wind and ice, the corresponding self loads and the loads from wind and ice on insulator strings – and on additional components if required (e.g. warning spheres) – need to be considered on conductors

If multiple strings are used to install the conductors on the tower, the dimensioning of the towers and components of these towers must also take into account the failure of an insulator string in the most unfavourable position and most unfavourable load case.

Wind load cases (1)

$$E_d = \gamma_G * G_K + \gamma_W * (W_{M,50} + W_{C,50})$$

The following applies in this case:

E_d Total design value of the actions

G_K Characteristic value of a permanent action

$W_{M,50}$ Wind action on ice-free tower with a return period of 50 years

$W_{C,50}$ Wind action on ice-free conductors with a return period of 50 years

γ_G Partial factor for permanent action

γ_W Partial factor for wind action

The following must be taken into account:

- Dead weight of the tower with partial factor for permanent actions (γ_G).
- Horizontal and vertical conductor pulls at -5 °C, taking into account the dead weight of the conductors increased by the partial factor for permanent actions (γ_G).
- Wind pressure on tower, conductor and insulator strings ($W_{M,50}$ and $W_{C,50}$) taking into account the partial factor for the wind action (γ_W).

Basis for determining the wind pressure is the peak wind pressure

$$q_{p,50}(h) = q_{b,0.50} 2.1 \left(\frac{h}{10} \right)^{0.24}$$

The following applies in this case:

$q_{p,50}(h)$ Peak wind pressure with a return period of 50 years at height h

$q_{b,0.50}$ Basic wind velocity pressure with a return period of 50 years according to ÖNORM B 1991-1-4.

h Height above ground

To determine the wind pressure on the conductors, the structural factor (G_c) and the drag factor (C_c) must be taken into account. See 4.4.1.

$$W_{C,50}(h) = G_c * C_c * q_{p,50}(h)$$

Load case 1aa: Wind perpendicular to the line

The following loads must be taken into account:

- Dead weight
- Wind in y-direction (as shown in Figure 4.1.a)

Load case 1ab: Wind in direction of the line

The following loads must be taken into account:

- Dead weight
- Wind load in x-direction (as shown in Figure 4.1.a)

Load case 1ac: Wind acting diagonally

The following loads must be taken into account:

- Dead weight
- Wind load acting diagonally, perpendicular to the assumed diagonal of the tower body cross section.

Ice load cases (2)

$$E_d = \gamma_G * G_K + \gamma_I * I_{50}$$

The following applies in this case:

E_d Total design value of actions

G_K Characteristic value of a permanent action

I_{50}	Extreme ice load (I_{50}), ice load with a return period of 50 years
γ_G	Partial factor for permanent action
γ_I	Partial factor for ice actions

The following must be taken into account:

- Dead weight of the tower with partial factor for permanent actions (γ_G).
- Horizontal and vertical conductor pulls at -5 °C, taking into account the dead weight of the conductors increased by the partial factor for permanent actions (γ_G) and the extreme ice load (I_{50}) increased by the partial factor for ice actions (γ_I).
- The reduction of the ice load on individual conductors according to load case 2b, 2c and 2d.
- If suitable structural measures on suspension and angle suspension towers ensure that differential pulls do not occur to the full extent, these can be reduced to the extent of the effective relief.

Load case 2a: Uniform ice load in all spans

The following loads must be taken into account:

- Dead weight
- Extreme ice load $\gamma_I * I_{50}$

Horizontal and vertical conductor pulls must be determined at -5 °C, taking into account the dead weight and ice load, both increased by the partial factor (γ_G respective γ_I).

Load case 2b: Uniform ice load, transversal bending

The following loads must be taken into account:

- Dead weight
- Extreme ice load $\gamma_I * I_{50}$ on one side of the tower only, with ice loads on the opposite side reduced by α ($\gamma_I * \alpha * I_{50}$) (Figure 4.4)

Reduction of ice loads for individual conductors or conductor bundles according to Figure 4.4

The reduction value for ice load α is 0.50.

Load case 2c: Unbalanced ice load, longitudinal bending

The following loads must be taken into account:

- Dead weight
- Reduced extreme ice load in a span ($\gamma_I * \alpha_1 * I_{50}$), and reduced extreme ice load in the adjacent span ($\gamma_I * \alpha_2 * I_{50}$) (Figure 4.5).

Reduction of ice loads for individual conductors or conductor bundles according to Figure 4.5

α_1 ... 0.75 for suspension towers and 0.20 for tension towers

α_2 ... 1.00 for suspension and tension towers

Load case 2d: Unbalanced ice load, bending and torsion

The following loads must be taken into account:

- Dead weight
- Extreme ice load reduced by α_3 in a span on a line half ($\gamma_I * \alpha_3 * I_{50}$), and an extreme ice load reduced by α_4 on all other spans ($\gamma_I * \alpha_4 * I_{50}$) (Figure 4.6).

Reduction of ice loads for individual conductors or conductor bundles according to Figure 4.6

α_3 ... 0.90 for suspension towers and 0.80 for tension towers

α_4 ... 1.00 for suspension and tension towers

Combined wind and ice actions (3)

Load cases 3a: Extreme ice load and a high probability wind load (v_{IH})

$$E_d = \gamma_G * G_K + \gamma_I * I_{50} + \psi_{WV} * (W_{M,50} + W_{C,IT,50})$$

The following applies in this case:

E_d	Total design value of actions
G_K	Characteristic value of a permanent action
I_{50}	Extreme ice load (I_{50}), ice load with a return period of 50 years
$W_{M,50}$	Wind action on ice-free tower with a return period of 50 years
$W_{C,IT,50}$	Wind action on ice-covered conductors with a return period of 50 years, taking into account the enlarged diameter of the ice-covered conductor due to the ice load I_{50} . When determining the wind load, the drag factor (C_{Ic}) must be taken into account according to Section 4.6.2.
γ_G	Partial factor for permanent action
γ_I	Partial factor for ice action
ψ_{WV}	0.40 Combination factor for wind action

The following must be taken into account:

- Dead weight of the tower with the partial factor for permanent actions (γ_G).
- Horizontal and vertical conductor pulls at -5 °C, taking into account the dead weight of the conductors increased by the partial factor for permanent actions (γ_G) and the extreme ice load (I_{50}) increased by the partial factor (γ_I) on the conductors.
- Wind pressure on tower and ice-covered conductors with ice-covered insulators ($W_{M,50}$ and $W_{C,IT,50}$), taking into account the combination value for the wind action (ψ_{WV}).

Load case 3aa: Extreme ice load (I_T) and a high probability wind load (v_{IH}), wind perpendicular to the line

The following loads must be taken into account:

- Dead weight
- Extreme ice load $\gamma_I * I_{50}$
- Wind load $\psi_{WV} * (W_{M,50} + W_{C,IT,50})$ Wind in y-direction

Load case 3ab: Extreme ice load and a high probability wind load (v_{IH}), wind in line direction

The following loads must be taken into account:

- Dead weight
- Extreme ice load $\gamma_I * I_{50}$
- Wind load $\psi_{WV} * (W_{M,50} + W_{C,IT,50})$ Wind in x-direction

Load case 3ac: Extreme ice load (I_T) and a high probability wind load (v_{IH}), wind acting diagonally

The following loads must be taken into account:

- Dead weight

- Extreme ice load $\gamma_I * I_{50}$
- Wind load $\gamma_W * (W_{M,50} + W_{C,IT,50})$ Wind direction diagonal

Load cases 3b: Low probability wind load (v_{IL}) and nominal ice load

$$E_d = \gamma_G * G_K + \gamma_W * B_I^2 * (W_{M,50} + W_{C,\psi,50}) + \gamma_I * I_{50}$$

The following applies in this case:

E_d	Total design value of the actions
G_K	Characteristic value of a permanent action
$\gamma_I * I_{50}$	Ice load reduced by combination factor I_{50}
$W_{M,50}$	Wind action on ice-free tower with a return period of 50 years
$W_{C,\psi,50}$	Wind action on ice-covered conductors with a return period of 50 years, taking into account the enlarged diameter of the ice-covered conductor due to the ice load $\gamma_I * I_{50}$. When determining the wind load, the drag factor (C_{cl}) must be taken into account according to Section 4.6.2.
B_I	0.75 Coefficient
γ_G	Partial factor for permanent action
γ_W	Partial factor for wind action
γ_I	0.35 Combination factor for ice action

The following must be taken into account:

- Dead weight of the tower with the partial factor for permanent actions (γ_G).
- Horizontal and vertical conductor pulls at -5 °C, taking into account the dead weight of the conductors increased by the partial factor for permanent actions (γ_G) and the extreme ice load (I_{50}) reduced by the combination factor for ice action (γ_I) on the conductors.
- Wind pressure on tower and ice-covered conductors with ice-covered insulators ($W_{M,50}$ and $W_{C,\psi,50}$) taking into account the coefficient (B_I) and the partial factor for the wind action (γ_W).

Load case 3ba: Low probability wind load (V_{IL}) and nominal ice load, Wind perpendicular to line direction

The following loads must be taken into account:

- Dead weight
- Low probability wind load (V_{IL}). When determining the wind load, the ice-covered conductors must be taken into account. Wind in y-direction..
- Nominal ice load $\gamma_I * I_{50}$

Load case 3bb: Low probability wind load (V_{IL}) and nominal ice load, wind parallel to line

The following loads must be taken into account:

- Dead weight
- Low probability wind load (V_{IL}). When determining the wind load, the ice-covered conductors must be taken into account. Wind in x-direction..
- Nominal ice load $\gamma_I * I_{50}$

Load case 3bc: Low probability wind load (V_{LL}) and nominal ice load, wind acting diagonally

The following loads must be taken into account:

- Dead weight
- Low probability wind load (V_{LL}). When determining the wind load, the ice-covered conductors must be taken into account. Wind direction acting diagonally.
- Nominal ice load $\psi_1 * I_{50}$

Lowest temperature (4)**Load case 4: Temperature -20°**

$$E_d = \gamma_G * G_K$$

The following applies in this case:

E_d	Total design value of actions
G_K	Characteristic value of a permanent action
γ_G	Partial factor for permanent action

The following loads must be taken into account:

- Dead weight

Horizontal and vertical conductor pulls must be determined at -20 °C, taking into account the dead weight increased by the partial factor.

Operational load cases (5)

$$E_d = \gamma_G * G_K + \gamma_1 * I_{50}$$

The following applies in this case:

E_d	Total design value of actions
G_K	Characteristic value of a permanent action
I_{50}	Extreme ice load (I_{50})
γ_G	Partial factor for permanent action
γ_1	Partial factor for ice actions

Load case 5a: Security loads, torsional loads**Suspension towers**

The following loads on suspension towers must be taken into account:

- Dead weight
- Extreme ice load I_{50}
- The extreme ice load I_{50} reduced by α_5 , in a single span for one conductor or conductor bundle and the extreme ice load I_{50} reduced by α_6 in the adjacent span. Ice load I_{50} on all other conductors.

Horizontal and vertical conductor pulls must be determined at -5 °C, taking into account the dead weight and the ice load.

α_5 ... 0.00

α_6 ... 0.40

If suitable structural measures on suspension and angle suspension towers ensure that differential pulls do not occur to the full extent, these can be reduced to the extent of the effective relief.

Tension towers

The following loads on tension towers must be taken into account:

- Dead weight
- Extreme ice load I_{50}
- Discontinuation of a conductor or conductor bundle in a in span and the extreme ice load I_{50} reduced by α_6 in the adjacent span. Ice load I_{50} on all other conductors.

Horizontal and vertical conductor pulls must be determined at -5 °C, taking into account the dead weight and the ice load.

α_6 ... 0.70

Load case 5b: omitted

Safety (6)

Load case 6a: Safety loads, construction and maintenance loads

If the expected construction and maintenance loads are not covered by the load cases 1 to 5 listed above, they must be specifically defined for each project.

Load case 6b: Safety loads, loads due to the weight of linesmen

Loads due to the weight of linesmen, have to be considered according to 4.9.2. A partial factor of 1.5 applies.

This standard does not cover safety systems, they are subject to separate provisions.

For wooden poles, there is no need to assume construction loads for the tower body.

(ncpt) AT.6: For overhead lines with a nominal voltage exceeding AC 1 kV up to and including AC 45 kV, applies in areas where no “additional measures for enhanced safety” according to Table 5.9.1/AT.5 are required, Table 4.8/AT.4. The following simplifications apply.

- All partial factors on the load side must be applied with 1.0.
- Towers must be designed for load cases 1, 2a, 2b, 2c, 4 and 6, where α_1 of 0.95 applies to suspension towers.
- If the heights of the conductors suspension points above ground do not exceed 20 m, the reference wind pressures can be multiplied by the factor $k_{w25} = 0.9$, and the extreme ice loads can be multiplied by the factor $k_{i25} = 0.5$

NOTE AT: The factors k_{w25} and k_{i25} take into account a return period of 25 years, which is adapted to an overhead line network exceeding AC 1 kV up to and including AC 45 kV.

(ncpt) AT.7: Tapping towers

For tapping towers, the load cases according to the Tables 4.7/AT.3 and 4.8/AT.4 must be applied by analogy in the most unfavourable combination respectively.

4.13 Partial factors for actions

(ncpt) AT.1: The partial factors and combination factors must be applied according to 4.12/AT.3 and AT.4.

5 Electrical requirements

5.2 Currents

5.2.1 Normal current

(A-dev) AT.1: These conditions for the rating are as follows: For the nominal current, the type and dimensions of a conductor must be selected such that the maximum design temperature of the conductors at an ambient temperature of 35 °C, a global radiation of 895 W/m² and a wind velocity of 0.6 m/s acting perpendicular on the conductor is not exceeded.

5.4 Classification of voltages and overvoltages

5.4.2 Representative power frequency voltages

(A-dev) AT.1: Table 1/AT.1 - in addition to Table 5.1, the following nominal voltages apply:

Nominal mains voltages U_n [kV]	Highest system voltage U_s [kV]	Highest voltage for equipment (minimum value) U_m [kV]
60	72.5	72.5
380	420	420

5.5 Minimum air clearance distances to avoid flashover

5.5.1 General

(ncpt) AT.1: The procedure according to the empirical method is to be applied.

5.5.3 Empirical method based on European experience

(ncpt) AT.1: In order to evaluate the minimum discharge gap (a_{som}) of the insulator sets, the towers in the vicinity of the crossing span must be considered. Generally speaking, the next 3 towers in all directions should be included for this purpose.

(ncpt) AT.2: For the values of $D_{50\text{ Hz}_p_p}$ and $D_{50\text{ Hz}_p_e}$ refer to Table 5.5. For the highest system voltages < 52 kV, the values if the highest system voltage is 52 kV are to be used.

5.6 Load cases for the calculation of clearances

5.6.1 Load conditions

(ncpt) AT.1: Load cases for the determination of electrical clearances

- (1) Highest conductor temperature according to 5.6.2 incl. AT.1 and AT.2
- (2) Extreme wind load according to 5.6.3.1/AT.1 to AT.4
- (3) Extreme ice load according to 5.6.4/AT.1
- (4) Nominal ice load (I_3) according to 5.6.4/AT.2
- (5) Combined wind and ice loads do not need to be taken into account.

The characteristic actions (without partial factors) must be used to calculate the clearances.

The lowest design temperature for the conductor is to be assumed as -20 °C. A different lowest conductor temperature can be defined in the project specification.

5.6.2 Maximum conductor temperature

(ncpt) AT.1: A minimum value of +40 °C must be applied as the highest conductor temperature.

(ncpt) AT.2: The cooling effect of the wind can be included in the calculation of the deflection of the conductor.

5.6.3 Wind loads for determination of electric clearances

5.6.3.1 Wind load cases

- (ncpt) **AT.1:** To determine the internal and external clearances in case of wind deflection, the extreme wind load at the wind velocity averaged over 10 min with a return period of 50 years is to be applied. The wind load is determined according to 4.3. From this, the mean wind pressure on the conductor according to 4.3.3 based on the mean wind velocity at reference height h above ground $q_h(h)$ as well as the wind load must be determined as follows. The air density ρ of 1.25 kg/m³ without reduction is to be applied.
- The structural factor for conductors $G_c = 0.80$
 - The drag factor for conductors $C = 1.0$
 - For overhead lines exceeding AC 1 kV up to and including AC 45 kV, the wind load can be multiplied by the factor $k_{W25} = 0.9$ if the heights above ground of the suspension points of the conductors do not exceed 20 m and no “additional measures for enhanced safety” according to 5.9.1/AT.5 are required.
 - The reference height of the conductors above ground is determined according to 4.4.1.1/AT.4.
- (ncpt) **AT.2:** The conductor temperature for the deflected conductor under extreme wind load is assumed to be +40°C. A different conductor temperature can be defined in the project specification.
- (ncpt) **AT.3:** For bundle conductors with horizontally arranged individual conductors, the reduced wind load on the lee side of the sub-conductor amounts to 80% of the wind load on the front conductor.
- (ncpt) **AT.4:** The strain on the conductor caused by wind during deflection does not need to be taken into account.
- (ncpt) **AT.5:** The deviation of insulator strings can simply be considered like the deviation of the conductor.

5.6.4 Ice loads for determination of electric clearances

- (snc) **AT.1:** The extreme value of the ice load is defined with a return period of 50 years according to 4.5.2/AT.1 at a conductor temperature of -5 °C.
- For overhead lines exceeding AC 1 kV up to and including AC 45 kV, the ice load can be multiplied by the factor $k_{I25} = 0.5$ if the heights above ground of the suspension points of the conductors do not exceed 20 m and no “additional measures for enhanced safety” according to 5.9.1/AT.5 are required.
- (snc) **AT.2:** The nominal ice load I_3 is defined with a return period of 3 years at a conductor temperature of -5 °C.
- $$I_3 = C_T I_{s0}$$
- $$C_T = 0.37 \text{ (Annex B.3, Table B.2)}$$

NOTE AT: The application of the extreme and nominal ice loads is described in the individual sections.

5.6.5 Combined wind and ice loads

- (ncpt) **AT.1:** To calculate the external clearances, it is not necessary to assume combined wind and ice loads.

5.8 Internal clearances within the span and at the top of support

(A-dev) **AT.1:** Overhead lines must be designed in such a way that live conductors are arranged with sufficient clearance from one another and from earthed components of their towers to avoid electrical flashovers.

(ncpt) **AT.2:** The internal conductor clearances within the span must be determined according to the load cases in 5.6 under the position of the conductors according to 5.7. The method according to (1) or (2) must be selected for this purpose:

- (1) The minimum clearance within the span must correspond at least to the value c determined according to Annex F.
- (2) Clearances between conductors within a span are to be determined on the basis of a deflection drawing.

(2.1) In this case, the proximity of adjacent conductors under the various load cases under equal deflection due to wind must be verified. The minimum clearance is $k_1 D_{el}$ respective $k_1 D_{pp}$ (for the definition of k_1 , see AT.3 below).

(2.2) The mutual convergence of the conductors when the lower conductor bounces up after dropping off the ice load must also be verified both in the non-deflected as well as in the deflected state (e.g. according to Krautt). The final value of the increasing ice load is I_{50} . The minimum clearance is $D_{50 \text{ Hz}_p_e}$ respective $D_{50 \text{ Hz}_p_p}$.

NOTE AT: If circuits of separate utilities are carried on joint structures, the possibility of mutual convergence of the conductors must be minimised; i.e. consideration should be given to the use of movable cross arms, the consequences of broken insulators, induction and maintenance.

(ncpt) **AT.3:** The factor k_1 is defined as 0.75 in line with Annex F.

(ncpt) **AT.4:** Conductors arranged one above the other and not deflected that have a nominal voltage exceeding AC 45 kV are:

- (1) either mutually offset so that the minimum horizontal distance between the conductors is equivalent to the value $k_1 D_{el}$ respective $k_1 D_{pp}$ or
- (2) arranged so far apart from one another that the clearance between the conductors is not less than $D_{50 \text{ Hz}_p_e}$ respective $D_{50 \text{ Hz}_p_p}$ plus 1.7 times the difference between the sag of a conductor without an additional load and the sag of a conductor with an extreme ice load (I_{50}) at -5°C .

(ncpt) **AT.5:** Where neighbouring live conductors are kept apart in a span by means of interphase spacers resulting in subspans, the clearances according to 5.8/AT.2 may be reduced. The application of Annex F is permissible if the sag which would occur assuming 1.6 times the value of the respective subspan is used as a basis.

(ncpt) **AT.6:** If differently routed lines of equal or different voltages are brought together to share a joint tower, the respective clearances of the individual line system in each of the last spans of the converging lines prior to reaching the joint tower are to be determined according to 5.8 and are not to be arranged according to 5.9 (external clearances).

(ncpt) **AT.7:** Clearances on the tower : Bare conductors and other bare components (e.g. jumpers, connections to equipment, etc.), carrying voltage towards each other are to be arranged so that their minimum distances apart are as follows:

- D_{pp} at highest temperatur of the conductor
- $k_1 D_{pp}$ at extreme ice load

- $k_1 D_{pp}$ at extreme wind load

For covered conductors and insulated cables for overhead lines with voltages > 1 kV and ≤ 45 kV the clearances from table 5.9 apply.

(ncpt) AT.8: Clearances on the tower : Deflected bare conductors and bare components must be separated from components of the tower not carrying voltage are to be arranged so that their minimum distances apart are as follows:

- D_{el} at highest temperatur of the conductor
- $k_1 D_{el}$ at extreme ice load
- $k_1 D_{el}$ at extreme wind load

For covered conductors and insulated cables for overhead lines > 1 kV and ≤ 45 kV the clearances from table 5.9 apply.

(ncpt) AT.9: Clearances on the tower : For the supporting of lines on power stations, transformer stations, outdoor substations, tapping towers, etc., the provisions according to 5.8/AT.7 and 5.8/AT.8 apply to the clearances between attachment points and the conductor arrangement (jumpers, connections, etc.).

(ncpt) AT.10: The electrical clearances to earthed components are to be understood as clearances to earthed components of the tower . These clearances are not to be applied for the electrical dimensioning of insulator sets. There are other standards that govern the coordination of insulation for insulator sets.

5.9 External clearances

5.9.1 General

(ncpt) AT.1: The shortest clearance is referred to below as the spatial distance.

(ncpt) AT.2: If the lateral clearance of live conductors from an object falls below the value specified in the relevant sections, the live conductors must be arranged in such a way that the spatial distance required in the relevant sections is not fallen below.