



IEC 60913

Edition 3.0 2024-04

INTERNATIONAL STANDARD



**Railway applications – Fixed installations – Electric traction overhead contact
lines systems**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 45.060.01

ISBN 978-2-8322-8244-1

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

| | |
|---|----|
| FOREWORD..... | 9 |
| 1 Scope..... | 11 |
| 2 Normative references | 11 |
| 3 Terms, definitions, symbols and abbreviated terms..... | 14 |
| 3.1 Terms and definition | 14 |
| 3.1.1 Systems | 14 |
| 3.1.2 Conductors | 18 |
| 3.1.3 Return circuit..... | 19 |
| 3.1.4 Electrical | 20 |
| 3.1.5 Geometrical..... | 21 |
| 3.1.6 Structures..... | 23 |
| 3.1.7 Foundations..... | 24 |
| 3.1.8 Current collectors | 24 |
| 3.1.9 Current collection | 25 |
| 3.1.10 Testing | 25 |
| 3.1.11 Miscellaneous..... | 26 |
| 3.2 Symbols..... | 26 |
| 3.3 Abbreviated terms..... | 29 |
| 4 Fundamental design data | 29 |
| 4.1 General..... | 29 |
| 4.2 Line characteristics..... | 29 |
| 4.3 Electrical power system design | 30 |
| 4.4 Vehicle characteristics | 30 |
| 4.5 Current collectors | 30 |
| 4.6 Environmental conditions | 31 |
| 4.7 Design life..... | 31 |
| 5 System requirements..... | 31 |
| 5.1 Design of electrical system | 31 |
| 5.1.1 General | 31 |
| 5.1.2 Temperature rise in conductors | 31 |
| 5.1.3 Clearances between live parts of contact lines and earth..... | 33 |
| 5.1.4 Clearances between adjacent live AC contact lines of differing voltage phases..... | 35 |
| 5.2 Design of overhead contact line for current collection systems..... | 36 |
| 5.2.1 General | 36 |
| 5.2.2 Elasticity and its variation | 37 |
| 5.2.3 Vertical movement of contact point | 37 |
| 5.2.4 Calculated wave propagation velocity | 37 |
| 5.2.5 Quality of current collection | 38 |
| 5.2.6 Fatigue of contact wire | 40 |
| 5.3 Mechanical design of contact wire loads | 40 |
| 5.3.1 Permissible tensile stress σ_w | 40 |
| 5.3.2 Maximum temperature K_{temp} | 40 |
| 5.3.3 Allowable wear K_{wear} | 41 |
| 5.3.4 Wind loads K_{wind} | 41 |
| 5.3.5 Ice loads K_{ice} | 41 |

| | | |
|--------|---|----|
| 5.3.6 | Efficiency of tensioning devices K_{eff} | 41 |
| 5.3.7 | Termination fittings K_{clamp} | 42 |
| 5.3.8 | Joints K_{joint} | 42 |
| 5.4 | Mechanical design of catenary wire loads | 42 |
| 5.4.1 | Permissible tensile loading F_{w} | 42 |
| 5.4.2 | Maximum temperature K_{temp} | 42 |
| 5.4.3 | Wind loads K_{wind} | 43 |
| 5.4.4 | Ice loads K_{ice} | 43 |
| 5.4.5 | Efficiency and accuracy of tensioning device K_{eff} | 44 |
| 5.4.6 | Termination fittings K_{clamp} | 44 |
| 5.4.7 | Additional vertical load K_{load} | 44 |
| 5.5 | Mechanical design of other stranded conductors | 44 |
| 5.6 | Mechanical design of solid wires | 44 |
| 5.7 | Mechanical design of ropes of non-conducting materials..... | 44 |
| 5.7.1 | General | 44 |
| 5.7.2 | Permissible tensile loading F_{w} | 44 |
| 5.7.3 | Wind loads K_{wind} | 45 |
| 5.7.4 | Ice loads K_{ice} | 45 |
| 5.7.5 | Termination clamps K_{clamp} | 45 |
| 5.7.6 | Vertical loads K_{load} | 45 |
| 5.7.7 | Minimum bending radius K_{radius} | 45 |
| 5.8 | Suspension systems | 45 |
| 5.9 | Tensioning device for flexible overhead contact lines | 46 |
| 5.10 | Geometry of overhead equipment | 46 |
| 5.10.1 | Lateral deviation of contact wire | 46 |
| 5.10.2 | Uplift..... | 47 |
| 5.10.3 | Variation in contact wire height..... | 47 |
| 5.10.4 | Contact wire height..... | 48 |
| 5.10.5 | Tolerances of lateral contact wire position | 50 |
| 5.10.6 | Span length | 50 |
| 5.11 | Contact line arrangement above turnouts and crossings | 50 |
| 5.12 | Overlap arrangements | 51 |
| 5.13 | Specific requirements for overhead contact lines for trolleybus systems | 51 |
| 5.13.1 | General | 51 |
| 5.13.2 | Line characteristics..... | 51 |
| 5.13.3 | Vehicle characteristics..... | 53 |
| 5.13.4 | Current collector system | 53 |
| 5.13.5 | Static contact forces | 53 |
| 5.13.6 | Trolleybus in the vicinity of tramways..... | 53 |
| 5.14 | Tolerances and limits | 54 |
| 6 | Structures and foundations | 55 |
| 6.1 | Basis of design | 55 |
| 6.1.1 | General | 55 |
| 6.1.2 | Basic requirements | 55 |
| 6.1.3 | Design with regard to structural limits | 56 |
| 6.1.4 | Classification of actions | 56 |

| | | |
|--------|---|----|
| 6.1.5 | Reliability levels..... | 57 |
| 6.1.6 | Models for structural analysis and resistance..... | 57 |
| 6.1.7 | Design values and verification methods..... | 57 |
| 6.1.8 | Wall anchors..... | 59 |
| 6.2 | Actions on overhead contact lines..... | 59 |
| 6.2.1 | General..... | 59 |
| 6.2.2 | Permanent loads..... | 60 |
| 6.2.3 | Variable loads..... | 60 |
| 6.2.4 | Wind loads..... | 60 |
| 6.2.5 | Ice loads..... | 64 |
| 6.2.6 | Combined wind and ice loads..... | 64 |
| 6.2.7 | Temperature effects..... | 65 |
| 6.2.8 | Construction and maintenance loads..... | 65 |
| 6.2.9 | Accidental loads..... | 65 |
| 6.2.10 | Special actions..... | 65 |
| 6.3 | Types of structures and related load cases..... | 66 |
| 6.3.1 | Load cases and load combinations..... | 66 |
| 6.3.2 | Type of structures and application of load cases..... | 67 |
| 6.3.3 | Partial factors for actions..... | 70 |
| 6.4 | Design of cross-span supports and structures..... | 71 |
| 6.4.1 | Analysis of internal forces and moments..... | 71 |
| 6.4.2 | Analysis of resistance..... | 71 |
| 6.4.3 | Material partial factors..... | 72 |
| 6.4.4 | Verification of resistance..... | 72 |
| 6.4.5 | Verification of serviceability..... | 72 |
| 6.4.6 | Material for structures..... | 72 |
| 6.4.7 | Corrosion protection and finishes..... | 73 |
| 6.5 | Foundations..... | 73 |
| 6.5.1 | General..... | 73 |
| 6.5.2 | Design of foundations..... | 73 |
| 6.5.3 | Calculation of actions..... | 74 |
| 6.5.4 | Geotechnical design..... | 74 |
| 6.5.5 | Partial factors for foundations..... | 77 |
| 6.5.6 | Verification of stability..... | 77 |
| 6.5.7 | Calculation of displacements..... | 78 |
| 6.5.8 | Materials for foundations..... | 78 |
| 6.5.9 | Structural details..... | 79 |
| 6.5.10 | Protection against corrosion and weathering..... | 79 |
| 6.5.11 | Electrical design..... | 80 |
| 6.5.12 | Installation of foundations..... | 80 |
| 7 | Assembly and Component requirements..... | 81 |
| 7.1 | General..... | 81 |
| 7.1.1 | Design life..... | 81 |
| 7.1.2 | Component identification..... | 81 |
| 7.1.3 | Corrosion and erosion..... | 81 |
| 7.2 | Supporting assemblies..... | 81 |
| 7.3 | Contact wire..... | 82 |
| 7.4 | Other conductors and ropes..... | 82 |
| 7.5 | Tensioning devices..... | 82 |

| | | |
|--------|---|-----|
| 7.6 | Mechanical midpoints..... | 83 |
| 7.6.1 | General | 83 |
| 7.6.2 | Catenary wire fixed points | 83 |
| 7.6.3 | Contact wire fixed points..... | 83 |
| 7.7 | Droppers..... | 83 |
| 7.7.1 | Mechanical requirements | 83 |
| 7.7.2 | Electrical requirements | 84 |
| 7.8 | Clamps and line fittings..... | 84 |
| 7.8.1 | Mechanical requirements | 84 |
| 7.8.2 | Electrical requirements | 84 |
| 7.9 | Electrical connectors..... | 85 |
| 7.10 | Insulators..... | 85 |
| 7.10.1 | General requirements | 85 |
| 7.10.2 | Mechanical requirements | 85 |
| 7.10.3 | Insulator surface..... | 86 |
| 7.11 | Sectioning devices | 86 |
| 7.11.1 | Definition | 86 |
| 7.11.2 | Mechanical requirements | 86 |
| 7.11.3 | Electrical requirements | 86 |
| 7.12 | Disconnectors and drives | 86 |
| 7.13 | Protection devices | 87 |
| 7.13.1 | Covers and obstacles | 87 |
| 7.13.2 | Surge protection and voltage limiting devices | 87 |
| 7.14 | Specific components for trolleybus systems | 87 |
| 7.14.1 | General | 87 |
| 7.14.2 | Turnouts and crossings | 88 |
| 7.15 | Automatic earthing and short-circuiting equipment | 88 |
| 7.16 | Monitoring devices | 88 |
| 8 | Testing | 89 |
| 8.1 | Testing of components and assemblies – General | 89 |
| 8.2 | Support assemblies | 89 |
| 8.2.1 | Type test | 89 |
| 8.2.2 | Sampling test..... | 98 |
| 8.2.3 | Routine test..... | 100 |
| 8.3 | Contact wires..... | 100 |
| 8.4 | Other conductors | 100 |
| 8.5 | Tensioning devices | 100 |
| 8.5.1 | Tests required | 100 |
| 8.5.2 | Type tests for tensioning devices with balance weights..... | 101 |
| 8.5.3 | Type tests for tensioning device without balance weight | 102 |
| 8.6 | Mechanical midpoints..... | 102 |
| 8.7 | Droppers..... | 102 |
| 8.7.1 | Tests required | 102 |
| 8.7.2 | Mechanical fatigue test..... | 102 |
| 8.7.3 | Mechanical tests..... | 105 |
| 8.8 | Clamps, splices and other fittings..... | 105 |
| 8.9 | Electrical connectors..... | 105 |
| 8.9.1 | General | 105 |
| 8.9.2 | Mechanical fatigue tests | 106 |

| | | |
|-----------------------|--|-----|
| 8.10 | Insulators..... | 106 |
| 8.11 | Sectioning devices..... | 107 |
| 8.11.1 | Type test..... | 107 |
| 8.11.2 | Field test..... | 108 |
| 8.11.3 | Sampling tests..... | 108 |
| 8.11.4 | Routine tests..... | 108 |
| 8.12 | Disconnectors and drives..... | 108 |
| 8.13 | Surge protection and voltage limiting devices..... | 108 |
| 8.14 | Specific components for trolleybus systems..... | 108 |
| 8.15 | System test..... | 109 |
| 8.15.1 | Demonstration of conformity..... | 109 |
| 8.15.2 | Acceptance tests..... | 109 |
| 8.15.3 | Commissioning tests..... | 110 |
| 9 | Minimum documentation..... | 110 |
| 9.1 | General..... | 110 |
| 9.2 | System specification..... | 110 |
| 9.3 | Basic design..... | 110 |
| 9.4 | Installation design..... | 110 |
| 9.5 | Installation and maintenance..... | 111 |
| Annex A (informative) | Structural details..... | 112 |
| Annex B (informative) | Information on wind load calculation..... | 113 |
| B.1 | Peak velocity pressure calculation..... | 113 |
| B.2 | Drag factors C_{str} | 114 |
| Annex C (informative) | Recommendations for ultimate limit state (ULS) design..... | 115 |
| C.1 | General..... | 115 |
| C.2 | Material partial factors for structural calculations..... | 115 |
| C.3 | Design limits for pre-stresses concrete poles..... | 115 |
| C.4 | Partial factors for foundations..... | 116 |
| Annex D (informative) | Geotechnical soil investigation and soil characteristics..... | 117 |
| Annex E (informative) | Overhead contact line for electric vehicles with pantographs on electrified roads..... | 119 |
| E.1 | General OCL properties and road characteristics..... | 119 |
| E.2 | Electrical properties of the OCL..... | 119 |
| E.3 | Capacity and service life of the OCL system..... | 120 |
| E.4 | OCL properties..... | 120 |
| E.4.1 | OCL mechanical properties, horizontal and vertical dimensions..... | 120 |
| E.4.2 | Design of begin and end of OCLS..... | 122 |
| E.4.3 | Uplift and dynamic properties of the OCL..... | 123 |
| E.5 | Contact forces..... | 123 |
| E.6 | ERS clearance requirements..... | 124 |
| E.6.1 | General..... | 124 |
| E.6.2 | Contact wire clamps..... | 126 |
| E.6.3 | Miscellaneous structure gauges and clearance requirements..... | 126 |
| E.6.4 | Structure gauge width – Lateral clearance requirements..... | 127 |
| E.6.5 | Clearance under bridges or height-limiting structures..... | 127 |
| Annex F (informative) | Information on uniformity of elasticity of OCL within a span length..... | 128 |
| Annex G (informative) | Seismic actions for OCS poles on viaducts..... | 129 |

| | |
|--|-----|
| Annex H (normative) Special national conditions..... | 130 |
| Bibliography..... | 133 |
| Figure 1 – Scope of contact line systems | 11 |
| Figure 2 – Static electrical clearance in air between live parts of an insulator and earthed equipment..... | 35 |
| Figure 3 – Relationship between contact wire heights and pantograph operating position..... | 49 |
| Figure 4 – Position of return wire in relation to right-of-way..... | 52 |
| Figure 5 – Wind action on lattice steel structures | 63 |
| Figure 6 – Definition of drag factors for double channel pole..... | 64 |
| Figure 7 – Description of dimensions and minimum conductor lengths | 96 |
| Figure 8 – Potential measuring points | 97 |
| Figure 9 – Potential measuring points at a T-type infeed terminal | 98 |
| Figure 10 – Example of a tensioning device measurement test | 101 |
| Figure 11 – Examples of a dropper test cycle..... | 104 |
| Figure 12 – Example of a dropper tension test assembly | 105 |
| Figure 13 – Example of a test cycle for an electrical connection..... | 106 |
| Figure E.1 – Overlap span (plan view, exemplary design for anchoring, representation without electrical connections) | 122 |
| Figure E.2 – Defined points along the OCL (side view, idealized)..... | 122 |
| Figure E.3 – Clearance gauge overview..... | 124 |
| Figure E.4 – Clearance gauge detail | 125 |
| Figure G.1 – Simulation method for evaluation for the safety of poles against earthquakes..... | 129 |
| Table 1 – Temperature limits for material mechanical properties..... | 32 |
| Table 2 – Typical electrical clearances..... | 34 |
| Table 3 – Typical clearances between adjacent live AC contact line systems of differing voltage phase..... | 36 |
| Table 4 – Contact force limits | 39 |
| Table 5 – Factor K_{temp} for contact wires | 40 |
| Table 6 – Factor K_{wind} for contact wires..... | 41 |
| Table 7 – Factor K_{ice} for contact wires | 41 |
| Table 8 – Factor K_{temp} for stranded conductors | 43 |
| Table 9 – Factor K_{wind} for stranded conductors | 43 |
| Table 10 – Factor K_{ice} for stranded conductors | 43 |
| Table 11 – Factor K_{radius} for ropes of non-conducting materials | 45 |
| Table 12 – Recommended maximum contact wire gradients for flexible contact lines..... | 47 |
| Table 13 – Important parameters to assist in the definition of tolerances and limits..... | 54 |
| Table 14 – Parameters for wind load calculation | 61 |
| Table 15 – Load cases to be considered for each type of structures | 69 |
| Table 16 – Partial factors for actions to be considered | 71 |

| | |
|---|-----|
| Table 17 – Tightening torques M_t for regularly used bolts | 90 |
| Table 18 – Examples of bolt connections | 91 |
| Table 19 – Assignment of the strength of bolt and nut..... | 91 |
| Table 20 – Conversion factor for tightening torques | 92 |
| Table 21 – Minimum conductor lengths | 96 |
| Table A.1 – Recommended dimensions of connections and edge distances of jointing components | 112 |
| Table B.1 – Recommended values for gust response factor G_q | 113 |
| Table B.2 – Recommended values for terrain factor G_t | 113 |
| Table B.3 – Recommended values for factor C_{str} for different pole types..... | 114 |
| Table C.1 – Recommended values for partial factors γ_M for steel structures | 115 |
| Table C.2 – Recommended values for partial factors γ_M for concrete structures | 115 |
| Table C.3 – Recommended values for partial factors γ_M for foundations | 116 |
| Table D.1 – Geotechnical characteristic parameters of some standard soils according to EN 50341-1:2012, Table M.2 | 118 |
| Table E.1 – Standard contact wire specifications | 120 |
| Table E.2 – Contact wire vertical position parameters, all values measured perpendicular to the idealized top of the road surface | 121 |
| Table E.3 – Contact wire horizontal position parameters | 121 |
| Table E.4 – Defined points along the OCL (side view)..... | 123 |
| Table E.5 – Contact forces pantograph – OCL | 123 |
| Table E.6 – Clearance gauge overview description | 125 |
| Table E.7 – Pantograph clearance definitions | 126 |
| Table F.1 – Uniformity u of elasticity | 128 |
| Table H.1 – Typical tolerances of overhead contact line system..... | 130 |

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RAILWAY APPLICATIONS – FIXED INSTALLATIONS –
ELECTRIC TRACTION OVERHEAD CONTACT LINE SYSTEMS****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60913 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways. It is an International Standard.

This third edition cancels and replaces the second edition published in 2013. This edition constitutes a technical revision.

The European standard EN 50119 has served as a basis for the elaboration of this document.

This edition includes the following significant technical changes with respect to the previous edition:

- a) title modified;
- b) requirements for urban rail systems are included;
- c) requirements for rigid overhead contact line (ROCL) are included;
- d) additional definitions for new terms are included (Clause 3);

- e) clearances and geometry of overhead contact line are improved (Clause 5);
- f) urban aspects are added, for example wall anchors (Clause 6);
- g) requirements for monitoring devices, automatic earthing and short-circuiting equipment are included (Clause 7);
- h) requirements for overhead contact line for electric vehicles with pantograph on electrified roads are added (Annex E)
- i) improvements on the basis of EN 50119:2020 and the questionnaire 9/2619A/Q

The text of this International Standard is based on the following documents:

| Draft | Report on voting |
|-------------|------------------|
| 9/3031/FDIS | 9/3052/RVD |

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The reader's attention is drawn to the fact that Annex H lists all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this document.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

RAILWAY APPLICATIONS – FIXED INSTALLATIONS – ELECTRIC TRACTION OVERHEAD CONTACT LINE SYSTEMS

1 Scope

This document specifies the requirements and tests for the design of overhead contact line systems, requirements for structures and their structural calculations and verifications as well as the requirements and tests for the design of assemblies and individual parts.

This document is applicable to electric traction overhead contact line systems in heavy railways, light railways, for trolley bus lines, electric road systems (Annex E) and industrial railways of public and private operators. This document is applicable to new installations of overhead contact line systems and for the complete renewal of existing overhead contact line systems.

This document does not apply to ground level conductor rail systems (see Figure 1).

NOTE Ground level conductor rail means conductor rails located adjacent to the running rail, e.g. the third rail or a conductor rail in the ground.

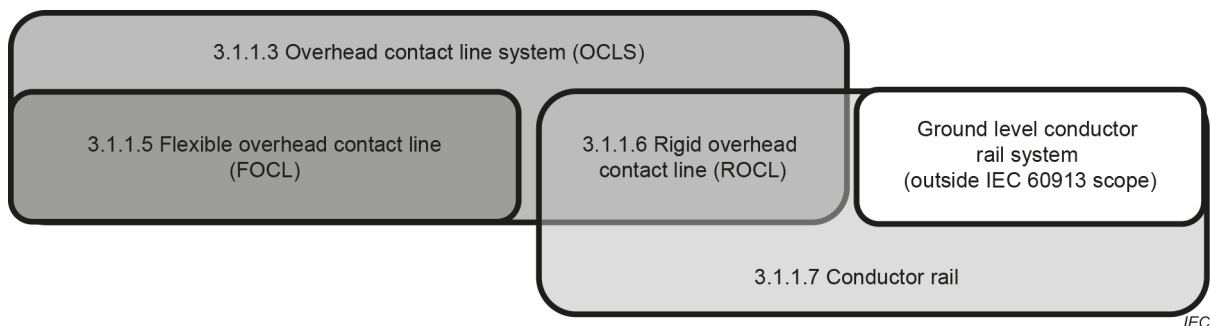


Figure 1 – Scope of contact line systems

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60099-4, *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems*

IEC 60168, *Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1 000 V*

IEC 60273, *Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1 000 V*

IEC 60305, *Insulators for overhead lines with a nominal voltage above 1 000 V – Ceramic or glass insulator units for AC systems – Characteristics of insulator units of the cap and pin type*

IEC 60383 (all parts), *Insulators for overhead lines with nominal voltage above 1 000 V*

IEC 60433, *Insulators for overhead lines with a nominal voltage above 1 000 V – Ceramic insulators for AC systems – Characteristics of insulator units of the long rod type*

IEC 60494-1, *Railway applications – Rolling stock – Pantographs – Characteristics and tests – Part 1: Pantographs for main line vehicles*

IEC 60494-2, *Railway applications – Rolling stock – Pantographs – Characteristics and tests – Part 2: Pantographs for metros and light rail vehicles*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60660, *Insulators – Tests on indoor post insulators of organic material for systems with nominal voltages greater than 1 000 V up to but not including 300 kV*

IEC 60672-1, *Ceramic and glass insulating materials – Part 1: Definitions and classification*

IEC 60672-2, *Ceramic and glass insulating materials – Part 2: Methods of test*

IEC 60672-3, *Ceramic and glass-insulating materials – Part 3: Specifications for individual materials*

IEC 60850, *Railway applications – Supply voltages of traction systems*

IEC 60947-1, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 61089, *Round wire concentric lay overhead electrical stranded conductors*

IEC TS 61245, *Artificial pollution tests on high-voltage ceramic and glass insulators to be used on d.c. systems*

IEC 61325, *Insulators for overhead lines with a nominal voltage above 1 000 V – Ceramic or glass insulator units for d.c. systems – Definitions, test methods and acceptance criteria*

IEC 61284:1997, *Overhead lines – Requirements and tests for fittings*

IEC 61773, *Overhead lines – Testing of foundations for structures*

IEC 61992-1, *Railway applications – Fixed installations – DC switchgear – Part 1: General*

IEC 61992-4, *Railway applications – Fixed installations – DC switchgear – Part 4: Outdoor d.c. disconnectors, switch-disconnectors and earthing switches*

IEC 62128 (all parts), *Railway applications – Fixed installations – Electrical safety, earthing and the return circuit*

IEC 62236-2, *Railway applications – Electromagnetic compatibility – Part 2: Emission of the whole railway system to the outside world*

IEC 62313, *Railway applications – Power supply and rolling stock – Technical criteria for the coordination between power supply (substation) and rolling stock*

IEC 62486:2017, *Railway applications – Current collection systems – Technical criteria for the interaction between pantograph and overhead contact line (to achieve free access)*

IEC 62497-1:2010, *Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment*
IEC 62497-1:2010/AMD1:2013

IEC 62497-2, *Railway applications – Insulation coordination – Part 2: Overvoltages and related protection*

IEC 62498-2:2010, *Railway applications – Environmental conditions for equipment – Part 2: Fixed electrical installations*

IEC 62505-2, *Railway applications – Fixed installations – Particular requirements for AC switchgear – Part 2: Disconnectors, earthing switches and switches with nominal voltage above 1 kV*

IEC 62621, *Railway applications – Fixed installations – Electric traction – Special requirements for composite insulators used for overhead contact line systems*

IEC 62641: 2022, *Conductors for overhead lines – Aluminium and aluminium alloy wires for concentric lay stranded conductors*

IEC 62724, *Railway applications – Fixed installations – Electric traction – Insulating synthetic rope assemblies for support of overhead contact lines*

IEC 62846:2016, *Railway applications – Current collection systems – Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line*

IEC 62848 (all parts), *Railway applications – DC surge arresters and voltage limiting devices*

IEC 62917, *Railway applications – Fixed installations – Electric traction – Copper and copper alloy grooved contact wires*

IEC 63190, *Railway applications – Fixed installations – Electric traction – Copper and copper alloy catenary wires for overhead contact line systems*

IEC 63248: 2022, *Conductors for overhead lines – Coated or clad metallic wire for concentric lay stranded conductors*

IEC 63438, *Railway applications – Fixed installations – Protection principles for AC and DC electric traction power supply systems¹*

IEC 63453, *Railway applications – Current collection systems – Validation of simulation of the dynamic interaction between pantograph and overhead contact line²*

ISO 630 (all parts), *Structural steels*

ISO 898-1:2013, *Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs with specified property classes – Coarse thread and fine pitch thread*

¹ Under preparation. Stage at the time of publication: IEC/AFDIS 63438:2023.

² Under preparation. Stage at the time of publication: IEC/CCDV 63453:2023.

ISO 898-2:2012, *Mechanical properties of fasteners made of carbon steel and alloy steel – Part 2: Nuts with specified property classes – Coarse thread and fine pitch thread*

ISO 1461:2022, *Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*

ISO 2394, *General principles on reliability for structures*

ISO 2859 (all parts), *Sampling procedures for inspection by attributes*

ISO 4354, *Wind actions on structures*

ISO 10721 (all parts), *Steel structures*

ISO 14713 (all parts), *Zinc coatings – Guidelines and recommendations for the protection against corrosion of iron and steel in structures*