IEC 60913

Edition 3.0 2024-04
COMMENTED VERSION

INTERNATIONAL STANDARD

colour inside

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 45.060.01

ISBN 978-2-8322-8740-8

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

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 9
1 Scope 12
2 Normative references 12
3 Terms, definitions, symbols and abbreviated terms 16
3.1 Terms and definition 16
3.1.1 Systems 17
3.1.2 Conductors 21
3.1.3 Return circuit 22
3.1.4 Electrical 23
3.1.5 Geometrical 25
3.1.6 Structures 26
3.1.7 Foundations 27
3.1.8 Current collectors 28
3.1.9 Current collection 28
3.1.10 Testing 29
3.1.11 Miscellaneous 29
3.2 Symbols 29
3.3 Abbreviated terms 32
4 Fundamental design data 33
4.1 General 33
4.2 Line characteristics 33
4.3 Electrical power system design 33
4.4 Vehicle characteristics 34
4.5 Current collectors 34
4.6 Environmental conditions 35
4.7 Design life 35
5 System requirements 35
5.1 Design of electrical system 35
5.1.1 General 35
5.1.2 Temperature rise in conductors 35
5.1.3 Clearances between live parts of contact lines and earth 37
5.1.4 Clearances between adjacent live AC contact lines of differing voltage phases 40
5.2 Design of overhead contact line for current collection systems 40
5.2.1 General 40
5.2.2 Elasticity and its variation 41
5.2.3 Vertical movement of contact point 42
5.2.4 Calculated wave propagation velocity 42
5.2.5 Quality of current collection 43
5.2.6 Fatigue of contact wire 45
5.3 Mechanical design of contact wire loads 45
5.3.1 Permissible tensile stress σ_w 45
5.3.2 Maximum temperature K_{temp} 45
5.3.3 Allowable wear K_{wear} 46
5.3.4 Wind ~~and ice~~ loads ~~$K_{icewind}$~~ K_{wind} 46
5.3.5 Ice loads K_{ice} 46

5.3.6 Efficiency of tensioning devices K_{eff} 47
5.3.7 Termination fittings K_{clamp} 47
5.3.8 Joints K_{joint} 47
5.4 Mechanical design of catenary wire loads 47
5.4.1 Permissible tensile loading F_w 47
5.4.2 Maximum temperature K_{temp} 47
5.4.3 Wind loads K_{wind} 48
5.4.4 Ice loads K_{ice} 48
5.4.5 ~~Automatic tensioning accuracy and efficiency K_{eff}~~ Efficiency and accuracy of tensioning device K_{eff} 49
5.4.6 Termination fittings K_{clamp} 49
5.4.7 Additional vertical load K_{load} 49
5.5 Mechanical design of other stranded conductors 49
5.6 Mechanical design of solid wires 49
5.7 Mechanical design of ropes of non-conducting materials 49
5.7.1 General 49
5.7.2 Permissible tensile loading F_w 49
5.7.3 Wind loads K_{wind} 50
5.7.4 Ice loads K_{ice} 50
5.7.5 Termination clamps K_{clamp} 50
5.7.6 Vertical loads K_{load} 50
5.7.7 Minimum bending radius K_{radius} 50
5.8 Suspension systems 51
5.9 Tensioning ~~systems~~ device for flexible overhead contact lines 51
5.10 Geometry of overhead equipment 51
5.10.1 ~~Horizontal deflection~~ Lateral deviation of contact wire 51
5.10.2 Uplift 52
5.10.3 Variation in contact wire height 52
5.10.4 Contact wire height 53
5.10.5 Tolerances of lateral contact wire position 57
5.10.6 Span length 57
5.11 Contact line arrangement above turnouts and crossings 57
5.12 Overlap arrangements 58
5.13 Specific requirements for overhead contact lines for trolleybus systems 58
5.13.1 General 58
5.13.2 Line characteristics 59
5.13.3 Vehicle characteristics 60
5.13.4 Current collector system 60
5.13.5 Static contact forces 60
5.13.6 Trolleybus in the vicinity of tramways 60
5.14 Tolerances and limits 61
6 Structures and foundations 62
6.1 Basis of design 62
6.1.1 General 62
6.1.2 Basic requirements 62
6.1.3 Design with regard to structural limits 63

6.1.4 Classification of actions 63
6.1.5 Reliability levels 64
6.1.6 Models for structural analysis and resistance 64
6.1.7 Design values and verification methods 64
6.1.8 Wall anchors 66
6.2 Actions on overhead contact lines 66
6.2.1 General 66
6.2.2 Permanent loads 67
6.2.3 Variable loads 67
6.2.4 Wind loads 67
6.2.5 Ice loads 72
6.2.6 Combined wind and ice loads 73
6.2.7 Temperature effects 73
6.2.8 Construction and maintenance loads 73
6.2.9 Accidental loads 74
6.2.10 Special actions 74
6.3 Types of structures and related load cases 75
6.3.1 Load cases and load combinations 75
6.3.2 Type of structures and application of load cases 76
6.3.3 Partial factors for actions 79
6.4 Design of cross-span supports and structures 80
6.4.1 Analysis of internal forces and moments 80
6.4.2 Analysis of resistance 81
6.4.3 Material partial factors 81
6.4.4 Verification of resistance 82
6.4.5 Verification of serviceability 82
6.4.6 Material for structures 83
6.4.7 Corrosion protection and finishes 84
6.5 Foundations 84
6.5.1 General 84
6.5.2 Design of foundations 84
6.5.3 Calculation of actions 85
6.5.4 Geotechnical design 85
6.5.5 Partial factors for foundations 88
6.5.6 Verification of stability 89
6.5.7 Calculation of displacements 89
6.5.8 Materials for foundations 90
6.5.9 Structural details 90
6.5.10 Protection against corrosion and weathering 90
6.5.11 Electrical design 91
6.5.12 Installation of foundations 91
7 Assembly and Component requirements 92
7.1 General 92
7.1.1 Design life 92
7.1.2 Component identification 92
7.1.3 Corrosion and erosion 92
7.2 Supporting assemblies 93
7.3 Contact wire 93
7.4 Other conductors and ropes 93

7.5 Tensioning devices 94
7.6 Mechanical midpoints 94
7.6.1 General 94
7.6.2 Catenary wire fixed points 94
7.6.3 Contact wire fixed points 94
7.7 Droppers 95
7.7.1 Mechanical requirements 95
7.7.2 Electrical requirements 95
7.8 Clamps and line fittings 95
7.8.1 Mechanical requirements 95
7.8.2 Electrical requirements 96
7.9 Electrical connectors 96
7.10 Insulators 96
7.10.1 General requirements 96
7.10.2 Mechanical requirements 97
7.10.3 Insulator surface 97
7.11 Sectioning devices 97
7.11.1 Definition 97
7.11.2 Mechanical requirements 97
7.11.3 Electrical requirements 98
7.12 Disconnectors and drives 98
7.13 Protection devices 99
7.13.1 Covers and obstacles 99
7.13.2 Surge protection and voltage limiting devices 99
7.14 Specific components for trolleybus systems 99
7.14.1 General 99
7.14.2 Turnouts and crossings 99
7.15 Automatic earthing and short-circuiting equipment 100
7.16 Monitoring devices 100
8 Testing 100
8.1 Testing of components and assemblies – General 100
8.2 Support assemblies 101
8.2.1 Type test 101
8.2.2 ~~Random sample~~ Sampling test 110
8.2.3 Routine test 112
8.3 Contact wires 112
8.4 Other conductors 112
8.5 Tensioning devices 113
8.5.1 Tests required 113
8.5.2 Type tests for tensioning devices with balance weights 113
8.5.3 Type tests for tensioning device without balance weight 114
8.6 Mechanical midpoints 114
8.7 Droppers 114
8.7.1 Tests required 114
8.7.2 Mechanical fatigue test 115
8.7.3 Mechanical tests 118
8.8 Clamps, splices and other fittings 118
8.9 Electrical connectors 118
8.9.1 General 118

8.9.2 Mechanical fatigue tests 119
8.10 Insulators 119
8.11 Sectioning devices 120
8.11.1 Type test 120
8.11.2 Field test 121
8.11.3 Sampling tests 121
8.11.4 Routine tests 121
8.12 Disconnectors and drives 121
8.13 Surge protection and voltage limiting devices 122
8.14 Specific components for trolleybus systems 122
8.15 System test 122
8.15.1 Demonstration of conformity 122
8.15.2 Acceptance tests 123
8.15.3 Commissioning tests 123
9 Minimum documentation 124
9.1 General 124
9.2 System specification 124
9.3 Basic design 124
9.4 Installation design 124
9.5 Installation and maintenance 124
~~Annex A (informative) Current-carrying capacity of conductors ..... ~~
Annex A (informative) Structural details 126
Annex B (informative) Information on wind load calculation 128
B.1 Peak velocity pressure calculation 128
B.2 Drag factors C_{str} 129
Annex C (informative) Recommendations for ultimate limit state (ULS) design 130
C.1 General 130
C.2 Material partial factors for structural calculations 130
C.3 Design limits for pre-stresses concrete poles 130
C.4 Partial factors for foundations 131
Annex D (informative) Geotechnical soil investigation and soil characteristics 132
Annex E (informative) Overhead contact line for electric vehicles with pantographs on electrified roads 135
E.1 General OCL properties and road characteristics 135
E.2 Electrical properties of the OCL 135
E.3 Capacity and service life of the OCL system 136
E.4 OCL properties 136
E.4.1 OCL mechanical properties, horizontal and vertical dimensions 136
E.4.2 Design of begin and end of OCLS 138
E.4.3 Uplift and dynamic properties of the OCL 139
E.5 Contact forces 139
E.6 ERS clearance requirements 140
E.6.1 General 140
E.6.2 Contact wire clamps 142
E.6.3 Miscellaneous structure gauges and clearance requirements 142
E.6.4 Structure gauge width – Lateral clearance requirements 143
E.6.5 Clearance under bridges or height-limiting structures 143

Annex F (informative) Information on uniformity of elasticity of OCL within a span length 144
Annex G (informative) Seismic actions for OCS poles on viaducts 145
Annex H (normative) Special national conditions 146
Bibliography 149
List of comments 156

Figure 1 – Scope of contact line systems 12
Figure 2 – Static electrical clearance in air between live parts of an insulator and earthed equipment 39
Figure 3 – Relationship between contact wire heights and pantograph operating position 56
Figure 4 – Position of return wire in relation to right-of-way 59
Figure 5 – Wind action on lattice steel structures 71
Figure 6 – Definition of drag factors for double channel ~~structure~~ pole 72
Figure 7 – Description of dimensions and minimum conductor lengths 108
Figure 8 – Potential measuring points ~~at a connecting clamp and a butt joining clamp~~ 109
Figure 9 – Potential measuring points at a T-type infeed terminal 110
Figure 10 – Example of a tensioning device measurement test 114
Figure 11 – Examples of a dropper test cycle 116
Figure 12 – Example of a dropper tension test assembly 118
Figure 13 – Example of a test cycle for an electrical connection 119
Figure E.1 – Overlap span (plan view, exemplary design for anchoring, representation without electrical connections) 138
Figure E.2 – Defined points along the OCL (side view, idealized) 138
Figure E.3 – Clearance gauge overview 140
Figure E.4 – Clearance gauge detail 141
Figure G.1 – Simulation method for evaluation for the safety of poles against earthquakes 145

Table 1 – Temperature limits for material mechanical properties 36
Table 2 – Typical electrical clearances 38
Table 3 – ~~Clearance between differing phases~~ Typical clearances between adjacent live AC contact line systems of differing voltage phase 40
Table 4 – Contact force limits 43
Table 5 – Factor K_{temp} for contact wires 45
Table 6 – Factor K_{wind} for contact wires 46
Table 7 – Factor K_{ice} for contact wires 46
Table 8 – Factor K_{temp} for stranded conductors 48
Table 9 – Factor K_{wind} for stranded conductors 48
Table 10 – Factor K_{ice} for stranded conductors 48
Table 11 – Factor K_{radius} for ropes of non-conducting materials 50
Table 12 – Recommended maximum contact wire gradients for flexible contact lines 53
Table 13 – Important parameters to assist in the definition of tolerances and limits 61

~~Table 13 – Recommended values for factor C_{str} for different structure types .....~~

Table 14 – Parameters for wind load calculation 69

Table 15 – ~~Summary of~~ Load cases to be considered for each type of structures 79

Table 16 – ~~Summary of~~ Partial factors for actions to be considered 80

~~Table 16 – Recommended values for partial factors γ_M for steel material .....~~

~~Table 17 – Recommended values for partial factors γ_M for concrete structures.....~~

~~Table 18 – Recommended values for partial factors γ_M for foundations .....~~

Table 17 – Tightening torques M_t for regularly used bolts 102

Table 18 – Examples of bolt connections 103

Table 19 – Assignment of the strength of bolt and nut 103

Table 20 – Conversion factor for tightening torques.....104

Table 21 – Minimum conductor lengths 108

~~Table A.1 – Continuous current-carrying capacity of conductors and contact wires.....~~

Table A.1 – Recommended dimensions of connections and edge distances of jointing components 126

Table B.1 – Recommended values for gust response factor G_q.....128

Table B.2 – Recommended values for terrain factor G_t 128

Table B.3 – Recommended values for factor C_{str} for different pole types 129

Table C.1 – Recommended values for partial factors γ_M for steel structures.....130

Table C.2 – Recommended values for partial factors γ_M for concrete structures 130

Table C.3 – Recommended values for partial factors γ_M for foundations 131

Table D.1 – Geotechnical characteristic parameters of some standard soils according to EN 50341-1:~~2001~~2012, ~~Annex N for Europe~~ Table M.2 133

Table E.1 – Standard contact wire specifications.....136

Table E.2 – Contact wire vertical position parameters, all values measured perpendicular to the idealized top of the road surface.....137

Table E.3 – Contact wire horizontal position parameters.....137

Table E.4 – Defined points along the OCL (side view) 139

Table E.5 – Contact forces pantograph – OCL 139

Table E.6 – Clearance gauge overview description.....141

Table E.7 – Pantograph clearance definitions.....142

Table F.1 – Uniformity u of elasticity 144

Table H.1 – Typical tolerances of overhead contact line system.....146

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.

This commented version (CMV) of the official standard IEC 60913:2024 edition 3.0 allows the user to identify the changes made to the previous IEC 60913:2013 edition 2.0. Furthermore, comments from IEC TC 9 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

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 International Standard applies to electric traction overhead contact line systems in heavy railways, light railways, trolley busses and industrial railways of public and private operators.~~

~~It applies to new installations of overhead contact line systems and for the complete reconstruction of existing overhead contact line systems.~~

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 standard does not provide requirements for conductor rail systems where the conductor rails are located adjacent to the running rails.~~

This document is applicable to electric traction overhead contact line systems in heavy railways, light railways, for trolley bus lines, electric road systems **1** (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.

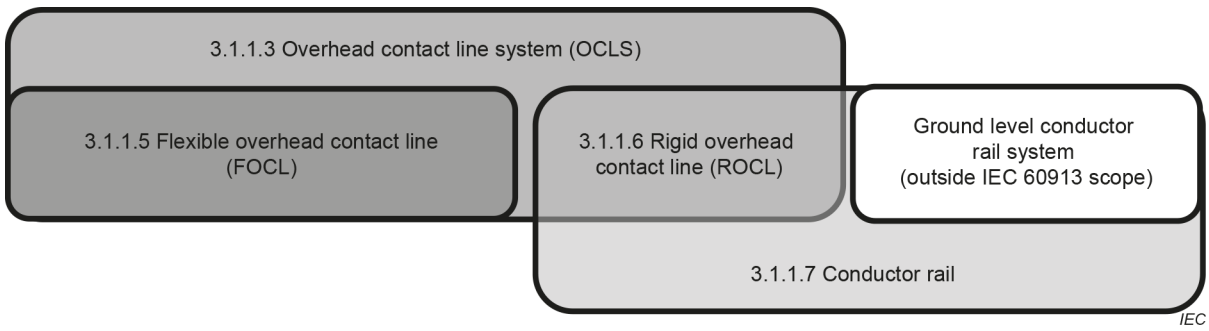


Figure 1 – Scope of contact line systems 2

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.

~~NOTE Normative references are made to ISO and IEC standards. For some necessary references, ISO and IEC standards do not exist. In these cases, references are made to European Standards which are normative for Europe according to EN 50119. For non-European countries these references are only informative and listed in the bibliography.~~

~~IEC 60050-811, *International Electrotechnical Vocabulary (IEV) – Chapter 811: Electric traction*~~

~~IEC 60071 (all parts), *Insulation co-ordination*~~

~~IEC 60099 (all parts), *Surge arresters*~~

~~IEC 60099-1, *Surge arresters – Part 1: Non-linear resistor type gapped surge arresters for a.c. systems*~~

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* (all parts), *Railway applications – Rolling stock – Pantographs – Characteristics and tests*~~

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 60889, *Hard-drawn aluminium wire for overhead line conductors*~~

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

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

~~IEC 61109, *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*~~

~~IEC 61232, *Aluminium-clad steel wires for electrical purposes*~~

IEC~~/TR~~ 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 61952, *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*~~

~~IEC 61992 (all parts), *Railway applications – Fixed installations – DC switchgear*~~

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 61992-5, *Railway applications – Fixed installations – DC switchgear – Part 5: Surge arresters and low-voltage limiters for specific use in d.c. systems*~~

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

~~IEC 62128-1:2003, *Railway applications – Fixed installations – Part 1: Protective provisions relating to electrical safety and earthing*~~

~~IEC 62128-2:2003, *Railway applications – Fixed installations – Part 2: Protective provisions against the effects of stray currents caused by d.c. traction systems*~~

IEC 62236-2~~:2008~~, *Railway applications – Electromagnetic compatibility – Part 2: Emission of the whole railway system to the outside world*

~~IEC 62271-102, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*~~

~~IEC 62271-103:2011, *High-voltage switchgear and controlgear – Part 103: Switches for rated voltages above 1 kV up to and including 52 kV*~~

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 (all parts), *Railway applications – Insulation coordination*~~

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 (all parts), *Railway applications – Fixed installations – Particular requirements for a.c. switchgear*~~

IEC 62505-2, *Railway applications – Fixed installations – Particular requirements for AC switchgear – Part 2: ~~Single-phase~~ Disconnectors, earthing switches and switches with ~~U_n~~ 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 cladded metallic wire for concentric lay stranded conductors*

IEC 63438, *Railway applications – Fixed installations – Protection principles for AC and DC electric traction power supply systems*[1]

IEC 63453, *Railway applications – Current collection systems – Validation of simulation of the dynamic interaction between pantograph and overhead contact line*[2]

ISO 630 (all parts), *Structural steels*

---

[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 898-1:2013, *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*

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 3010:2001, *Basis for design of structures – Seismic actions on structures*~~

ISO 4354, *Wind actions on structures*

ISO 10721 (all parts), *Steel structures*

~~ISO/TR 11069:1995, *Aluminium structures – Material and design – Ultimate limit state under static loading*~~

~~ISO 14688-1, *Geotechnical investigation and testing – Identification and classification of soil – Part 1: Identification and description*~~

~~ISO 14688-2, *Geotechnical investigation and testing – Identification and classification of soil – Part 2: Principles for a classification*~~

~~ISO 14689-1, *Geotechnical investigation and testing – Identification and classification of rock – Part 1: Identification and description*~~

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

~~ISO/TS 17892 (all parts), *Geotechnical investigation and testing – Laboratory testing of soil*~~

~~ISO 22475-1, *Geotechnical investigation and testing – Sampling methods and groundwater measurements – Part 1: Technical principles for execution*~~

~~ISO 22476-2, *Geotechnical investigation and testing – Field testing – Part 2: Dynamic probing*~~

~~ISO 22476-3, *Geotechnical investigation and testing – Field testing – Part 3: Standard penetration test*~~

~~ISO 23469:2005, *Bases for design of structures – Seismic actions for designing geotechnical works*~~

IEC 60913

Edition 3.0 2024-04

INTERNATIONAL STANDARD

colour inside

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



IEC 60913:2024-04(en)

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.

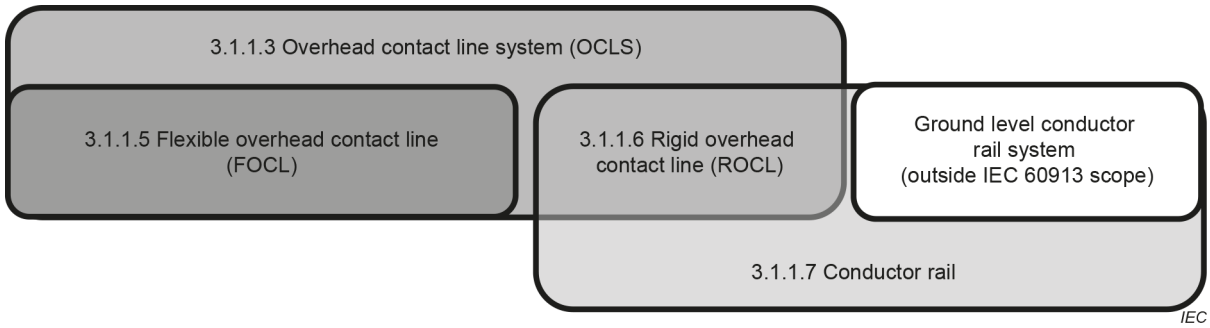


Figure 1 – Scope of contact line systems

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 cladded 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*