

Overhead lines — Requirements and tests for fittings

The European Standard EN 61284:1997 has the status of a
British Standard

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National foreword

This British Standard is the English language version of EN 61284:1997, including Corrigendum September 1998. It is identical with IEC 61284:1997. It supersedes BS EN 61284:1996 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/11, Overhead lines, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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Summary of pages

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English version

Overhead lines — Requirements and tests for fittings

(IEC 61284:1997)

Lignes aériennes —
Exigences et essais pour le matériel d'équipement
(CEI 61284:1997)

Freileitungen —
Anforderungen und Prüfungen für Armaturen
(IEC 61284:1997)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

The text of document 11/119/FDIS, future edition 2 of IEC 61284, prepared by IEC TC 11, Overhead lines, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61284 on 1997-10-01.

This European Standard supersedes EN 61284:1995.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-07-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1998-07-01

Annexes designated “normative” are part of the body of the standard.

Annexes designated “informative” are given for information only.

In this standard, Annex A, Annex B, Annex C, Annex D, Annex E and Annex ZA are normative and Annex F, Annex G, Annex H, Annex I, and Annex J are informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61284:1997 was approved by CENELEC as a European Standard without any modification.

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1 Scope

This International Standard applies to fittings for overhead lines of nominal voltage above 45 kV. It may also be applied to fittings for overhead lines of lower nominal voltage and to similar fittings for substations.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication of this standard, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(466):1990, *International Electrotechnical Vocabulary (IEV) — Chapter 466: Overhead lines*.

IEC 60060-1:1989, *High-voltage test techniques — Part 1: General definitions and test requirements*.

IEC 60120:1984, *Dimensions of ball and socket couplings of string insulator units*.

IEC 60372:1984, *Locking devices for ball and socket couplings of string insulator units — Dimensions and tests*.

IEC 60471:1977, *Dimensions of clevis and tongue couplings of string insulator units*.

IEC 60826:1991, *Loading and strength of overhead transmission lines*.

IEC 61089:1991, *Round wire concentric lay overhead electrical stranded conductors*.

CISPR 16-1:1993, *Specification for radio disturbance and immunity measuring apparatus and methods — Part 1: Radio disturbance and immunity measuring apparatus*.

CISPR 18-2:1986, *Radio interference characteristics of overhead power lines and high-voltage equipment — Part 2: Methods of measurement and procedure for determining limits*.

ISO 1461, *Hot dip galvanized coatings on fabricated ferrous products — Specifications*.¹⁾

ISO 9000-1:1994, *Quality management and quality assurance standards — Part 1: Guidelines for selection and use*.

ISO 9001:1994, *Quality systems — Model for quality assurance in design, development, production, installation and servicing*.

ISO 9002:1994, *Quality systems — Model for quality assurance in production, installation and servicing*.

ISO 9003:1994, *Quality systems — Model for quality assurance in final inspection and test*.

ISO 9004-1:1994, *Quality management and quality system elements — Part 1: Guidelines*.

ISO 2859-1:1989, *Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection*.

ISO 2859-2:1985, *Sampling procedures for inspection by attributes — Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection*.

ISO 3951:1989, *Sampling procedures and charts for inspection by variables for percent non-conforming*.

3 Definitions

For the purpose of this International Standard the following definitions apply. These definitions are those which do not appear in the International Electrotechnical Vocabulary (IEV) or differ from those given in the IEV.

3.1

ball and socket coupling

coupling consisting of a ball, a socket and a locking device

3.2

bimetallic fitting

device which is suitable for jointing conductors of different materials

¹⁾ To be published.

3.3

characteristic dimension

dimension of a component of the test circuit or of a fitting which characterizes its effect on the electric field. In the case of a bundle, this dimension is approximately the diameter of an enclosing circle; in the case of a corona ring or sphere, it is its largest dimension, etc.

3.4

clevis and tongue coupling

coupling consisting of a clevis, a tongue and a clevis pin or bolt

3.5

connector

device for jointing one or more conductors or earth wires. It may be a tension or non-tension fitting

3.6

corona discharge

electric discharge that only partially breaks down the gas insulation around the fittings under test

3.7

corona extinction

voltage or conductor voltage gradient at which corona discharges cease during a decreasing test voltage sequence

3.8

corona inception

voltage or conductor voltage gradient at which corona discharges initiate during an increasing test voltage sequence

3.9

earth wire fitting

any component of an assembly for attaching an earth wire to a supporting structure other than a suspension clamp, a tension fitting or a mechanical protective fitting

3.10

factory-formed helical conductor fitting

fitting consisting of helically formed wires which provide the force necessary to grip the conductor or earth wire by self-tightening

3.11

insulator set fitting

any component of a suspension or tension insulator set other than a string insulator unit, a suspension clamp, a conductor tension fitting, an insulator protective fitting or a mechanical protective fitting

3.12

joint

connector and that part of the conductor or earth wire that has been brought into intimate contact with it by compression or other mechanical means

3.13

mechanical damage load

maximum load which can be applied to a fitting without an unacceptable permanent deformation when the fitting is tested under specified test conditions

NOTE The unacceptable permanent deformation should be agreed upon between purchaser and supplier.

3.14

mechanical failure load

maximum load which can be applied to a fitting under specified test conditions

3.15

mechanical protective fitting

any device attached to a conductor or to an earth wire for their mechanical protection

3.16**radio-interference voltage (RIV)**

voltage in the radio frequency range produced by an electromagnetic disturbance and which can be measured in accordance with CISPR 16 on the test circuit equipped with the fitting

3.17**spacer damper**

device which keeps apart the subconductors of a bundle in a given geometrical configuration and is able to reduce aeolian vibrations and subspan oscillations of the subconductors
[IEV 466-11-02, modified]

3.18**specified maximum radio-interference voltage**

maximum acceptable radio-interference voltage at a specified test voltage or conductor voltage gradient. This is specified by the purchaser or declared by the supplier

3.19**specified minimum corona extinction**

minimum acceptable voltage or conductor voltage gradient at which corona discharges cease. This is specified by the purchaser or declared by the supplier

3.20**specified minimum failure load**

minimum load specified by the purchaser or declared by the supplier at which mechanical failure will not take place

NOTE From the probabilistic point of view, the specified minimum failure load corresponds to the value having the probability of e % in the distribution function of the strength of the fitting. The exclusion limit e % is usually taken within 2 % to 5 % with 10 % being the upper limit (see IEC 60826).

3.21**specified minimum mechanical damage load**

minimum load specified by the purchaser or declared by the supplier at which unacceptable permanent deformation will not take place

3.22**specified minimum slip load**

minimum load specified by the purchaser or declared by the supplier at which slippage will not take place

3.23**vibration damper**

device attached to a conductor or an earth wire in order to reduce aeolian vibrations
[IEV 466-11-16, modified]

4 Requirements**4.1 General requirements****4.1.1 Design**

The fittings shall be designed so as to:

- avoid damaging the conductor under service conditions;
- withstand the mechanical loads relevant to installation, maintenance and service, the designed service current, including short-circuit current, the service temperatures and environmental circumstances;
- ensure that individual components are secured against becoming loose in service;
- have limited corona effects.

Fittings for live line maintenance shall be suitably designed for safe and easy handling.

Surfaces of compression fittings in contact with the conductor or earth wire shall be protected from becoming contaminated before installation.

Brittleness of finished parts shall be avoided by adopting suitable materials and manufacturing process.

4.1.2 Materials

Fittings shall be made of any material suitable for the purpose.

4.1.2.1 Metallic materials

The materials shall meet service life requirements and shall not be liable to intergranular or stress corrosion. They shall not cause corrosion of any other parts of the conductor or earth wire.

The materials of compression fittings shall be capable of withstanding the cold working due to compression. Furthermore, the steel compression components shall also have a sufficient impact strength after the compression.

Examples of suitable materials are the following:

- aluminium or aluminium alloy;
- galvanized steel;
- galvanized malleable or ductile iron;
- stainless steel;
- copper and copper alloys.

It is recommended that ISO standards for materials be used where they exist. Examples of ISO standards for fitting materials are listed in Annex F.

4.1.2.2 Non-metallic materials

Non-metallic materials employed shall have good resistance to ageing and be capable of withstanding service temperatures without detrimental change of properties. Materials shall have adequate resistance to the effects of ozone, ultra-violet radiation and air pollution over the whole range of the service temperature.

They shall not induce corrosion in materials which are in contact with them.

4.1.3 Dimensions and tolerances

The dimensions shall be shown on contract drawings.

Particular regard shall be paid to those dimensions which involve interchangeability, correct assembly, and those for which gauges are specified. Reference shall be made to relevant standards, for example IEC 60120, IEC 60372, etc.

Tolerances applied to dimensions shall ensure that the fittings meet their specified mechanical and electrical requirements.

4.1.4 Protection against corrosion

All parts of insulator, conductor and earth wire fittings shall be either inherently resistant to atmospheric corrosion or be suitably protected against corrosion, such as can occur in transport, storage and in service. All ferrous parts which will be exposed to the atmosphere in service, except those made of appropriate stainless steel, shall be protected by hot dip galvanizing in accordance, for example, with ISO 1461 or other means giving equivalent protection.

Moreover, unless special measures are taken, there shall never be contact between metals for which the difference in electrochemical potential can give rise to galvanic corrosion capable of impairing the efficiency of the whole equipment. This applies especially to those parts of the fittings that are in direct contact with the conductor.

All external threads shall be cut or rolled before hot dip galvanizing. Internal threads can be cut before or after hot dip galvanizing. If cut after galvanizing they shall be oiled or greased.

4.1.5 *Marking*

Marking shall ensure the system of traceability for each of the component parts of the fittings.

When practicable, and unless otherwise agreed between purchaser and manufacturer, fittings shall be clearly and indelibly marked as follows:

Fittings used as individual components

Castings

- a) identification of fittings
(reference number/specified minimum failure load);
- b) manufacturer's identification;
- c) date of manufacture (month and year);
- d) cast code.

Forgings

- a) identification of fittings
(reference number/specified minimum failure load);
- b) manufacturer's identification;
- c) date of manufacture (month and year).

Links and plates

- a) identification of fittings
(reference number/specified minimum failure load);
- b) manufacturer's identification;
- c) date of manufacture (month and year).

Assemblies of fittings

- a) identification
(reference number/specified minimum failure load);
- b) manufacturer's identification;
- c) date of manufacture of individual items (month and year);
- d) conductor diameter range or conductor code(s), as agreed between purchaser and supplier;
- e) fitting bolt installation torque (unless breakaway torque bolts are used).

Conductor compression fittings

- a) identification
(reference number/specified minimum failure load);
- b) manufacturer's identification;
- c) date of manufacture (month and year);
- d) conductor size or code name;
- e) compression die sizes;
- f) length to be compressed.

4.1.6 *Instructions for assembly*

The manufacturers shall provide the assembly instructions of the fittings as far as necessary.

4.2 Requirements for specific fittings

4.2.1 *Insulator set fittings and earth wire fittings*

For parts made of forged steel, holes which are under mechanical stress can be made by hot punching provided that the holes conform to tolerances on at least 70 % of punched thickness. For parts made of forged steel, holes which are not under mechanical stress can be made by cold or hot punching without the aforementioned limits.

4.2.2 Suspension clamps

The conductor or the earth wire installed in the suspension clamps can be used bare or equipped with armour rods.

The suspension clamps shall be so designed that the effects of vibration, both on the conductor or on the earth wire and on the clamps themselves, are minimized. The clamps shall be designed to avoid localized pressure or damage to the conductor or the earth wire.

The suspension clamps shall have sufficient contact surface to avoid damage by fault currents.

The wear resistance of the articulation assembly shall be sufficient to prevent deterioration in service.

Magnetic losses shall not exceed the laid down value, if specified.

The body of a suspension clamp shall permit oscillation around a horizontal axis perpendicular to the conductor.

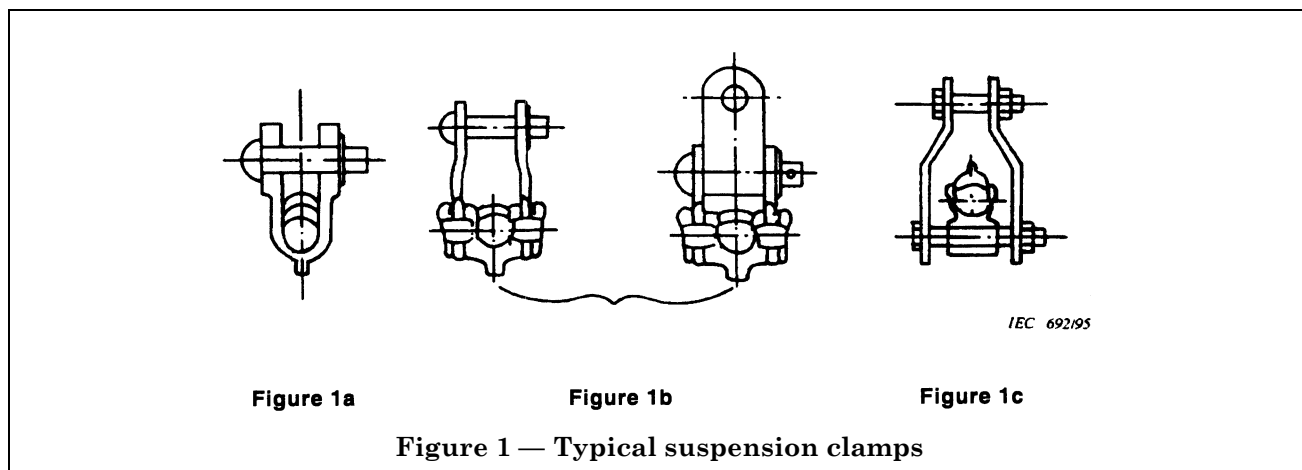
Typical suspension clamps are:

- clamps with articulation above the conductor; the pivot is above the horizontal plane passing through the conductor axis at the suspension point (see Figure 1a);
- clamps with articulation in the plane of the axis of the conductor (twin or triple articulation) (see Figure 1b); one of the three articulations is in the horizontal plane of the conductor axis;
- clamps with articulation under the axis of the conductor (see Figure 1c).

The manufacturer shall provide the purchaser with the usage limits of the suspension clamps.

NOTE For each type of clamp, the purchaser can choose between:

- standard clamps: the slip load of the conductor or earth wire is not lower than a specified minimum slip load;
- controlled slippage clamps: the slip load of the conductor remains between two values defined by mutual agreement between the purchaser and the supplier.



4.2.3 Fittings for jointing, terminating and repairing conductor and earth wire

Fittings for the purpose of jointing, terminating and repairing conductor and earth wire include, but are not limited to, the following:

- compression type connectors;
- cone or wedge type clamps;
- bolted type clamps;
- factory-formed helical fittings;
- fittings installed using an explosive charge.

The above fitting types may be used for tension and non-tension joints, and T connectors. When the fittings are designed so as not to provide electrical continuity of the conductor (e.g. a tension clamp) the fittings shall not reduce the electrical capability of the conductor or earth wire.

Fittings used for electrical continuity connections shall meet the requirements of clause 13.

Those fittings with auxiliary eyes intended for use during construction or maintenance shall be marked with a specified minimum failure load stated by the manufacturer.

All fittings shall be designed to minimize internal voids and to prevent the ingress or entrapment of moisture during service.

Fittings may be provided with an oxide-inhibiting compound intended to reduce metal oxidation at metal-to-metal electrical contact points. These compounds are commonly used in compression fittings to fill internal voids and to prevent ingress of water during service.

Fittings and connectors shall be designed in such away that after installation, the initial contact area between the fitting and the conductor does not raise stresses which can lead to failure under aeolian vibration or other conductor oscillation conditions.

Fittings and connectors intended to connect conductors of two dissimilar materials shall be designed to avoid bimetallic corrosion.

Fittings and connectors shall be designed to avoid localized pressures which may cause excessive cold flow of the conductor or earth wire material.

Fittings and connectors intended for the restoration of electrical and mechanical properties of a conductor shall have clearly defined manufacturer's instructions as to the extent of damage which they are intended to repair.

4.2.4 Insulator protective fittings

Should steel tubes be used for insulator protective fittings, both the internal and external surfaces of the tubes shall be hot dip galvanized.

When the tube is sealed after galvanizing, the quality of the internal surface shall be agreed between purchaser and supplier.

For insulator protective fittings designed to protect insulator sets against damage caused by power arcs (arcing horns, arcing rings, rings), the short-circuit current conditions shall be stated by the customer in the order.

The protective fittings shall be designed in such a way as not to be subject to breakage through fatigue due to vibration caused by the wind. The insulator protective fittings shall withstand a static mechanical load agreed upon between supplier and purchaser.

5 Quality assurance

A quality assurance programme taking into account the requirements of this standard can be used by agreement between the purchaser and the supplier to verify the quality of the fittings during the manufacturing process.

Detailed information on the use of quality assurance is given in the following ISO standards: ISO 9000-1, ISO 9001, ISO 9002, ISO 9003, ISO 9004-1.

6 Classification of tests — Type tests, sample tests, routine tests

6.1 Type tests

6.1.1 General

Type tests are intended to establish design characteristics. They are normally only made once and repeated only when the design or the material of the fitting is changed. The results of type tests are recorded as evidence of compliance with design requirements.

6.1.2 Application

Fittings shall be subject to type tests in accordance with Table 1. In addition other tests may be agreed between purchaser and supplier, for example corrosion tests, ageing tests, fatigue tests, short-circuit tests and power arc tests.

6.2 Sample tests

6.2.1 General

Sample tests are intended to verify the quality of materials and workmanship.

6.2.2 Application

Overhead line fittings shall be subjected to sample tests as listed in Table 1. The samples to be tested shall be selected at random from the lot offered for acceptance. The purchaser has the right to make the selection.

6.2.3 Sampling and acceptance criteria

Unless otherwise agreed between purchaser and supplier, the sampling plan procedures according to ISO 2859-1 and ISO 2859-2 (inspection by attributes) and to ISO 3951 (inspection by variables) shall be applied.

For each sample test, the type of inspection (by attributes or by variables) and the detailed procedures (inspection level, acceptable quality level, single, double or multiple sampling, etc.) shall be agreed between purchaser and supplier (see example in Annex I for inspection by attributes, and Annex J for inspection by variables).

NOTE Sampling inspection by variables is an acceptance sampling procedure to be used in place of inspection by attributes when it is more appropriate to measure on some continuous scale the characteristic(s) under consideration. In the case of failure load tests and similar expensive tests, better discrimination between acceptable quality and objective quality is available with acceptance sampling by variables than by attributes for the same sample size.

The purpose of the sampling process may also be important in the choice between a variables or attributes plan. For example, a purchaser may choose to use an attributes acceptance sampling plan to ensure that parts in a shipment lot are within a required dimensional tolerance; the manufacturer may make measurements under a variables sampling plan of the same dimensions because he is concerned with gradual trends or changes which may affect his ability to provide shipment lots which meet the AQL.

6.3 Routine tests

6.3.1 General

Routine tests are intended to prove conformance of fittings to specific requirements and are made on every fitting. The tests shall not damage the fitting.

6.3.2 Application and acceptance criteria

Whole lots of fittings may be subjected to routine tests as listed in Table 1. Fittings which do not conform to the requirements shall be discarded.

7 Visual examination

Type tests shall include visual examination to ascertain conformity of the fittings, in all essential respects, with the contract drawings. Deviations from the drawings shall be subject to agreement between supplier and purchaser and shall be appropriately documented as an agreed concession.

Sample tests include visual examination in accordance with 6.2.3. Visual examination shall ensure conformity of manufacturing process, shape, coating and surface finish of the fitting with the contract drawings. Particular attention shall be given to markings required and to the finish of surfaces which come into contact with the conductor.

NOTE Verification of marking may include marking required by the purchaser in order to verify inspection or testing (e.g. hardness tests, indent marks, inspectors' stamps, etc.).

For fittings subject to corona type tests, the sample test shall include a comparison of shape and surface finish with one of the corona type test samples when agreed between purchaser and supplier.

Routine tests do not include visual examination unless otherwise agreed between supplier and purchaser or unless included in the quality assurance system of the supplier.

Table 1 — Tests on fittings

Clause	Test	Insulator set fittings and earth wire fittings			Suspension clamps			Tension joints and tension clamps			Partial tension fittings			Repair sleeve			Insulator protective fittings ¹⁾		
		Type tests	Sample tests	Routine tests	Type tests	Sample tests	Routine tests	Type tests	Sample tests	Routine tests	Type tests	Sample tests	Routine tests	Type tests	Sample tests	Routine tests	Type tests	Sample tests	Routine tests
7	Visual examination	X	X ²⁾	X ³⁾	X	X ²⁾	X ³⁾	X	X ²⁾	X ³⁾	X	X ²⁾	X ³⁾	X	X ²⁾	X ³⁾	X	X ²⁾	X ³⁾
8	Dimensional and material verification	X	X	X ³⁾	X	X	X ³⁾	X	X	X ³⁾	X	X	X ³⁾	X	X	X ³⁾	X	X	X ³⁾
9	Hot dip galvanizing	X ³⁾	X		X ³⁾	X		X ³⁾	X		X ³⁾	X		X ³⁾			X ³⁾	X	
10	Non-destructive testing	X ³⁾	X ³⁾	X ³⁾	X ³⁾	X ³⁾	X ³⁾	X ³⁾	X ³⁾	X ³⁾	X ³⁾	X ³⁾					X ³⁾	X ³⁾	X ³⁾
11	Mechanical tests — damage and failure load test	X	X	X ³⁾⁴⁾	X	X	X ³⁾⁴⁾	X	X ³⁾								X ³⁾	X ³⁾	X ³⁾
	— slip test				X	X													
	— clamp bolt tightening test				X	X ²⁾		X	X ²⁾										
	— tensile test							X	X		X			X	X				
	— damage and failure load test of the attachment point used during erection	X	X ³⁾					X	X ³⁾	X ³⁾⁴⁾									
12	Magnetic losses test				X ³⁾			X ³⁾											
13	Heat cycle tests							X ⁵⁾			X ⁵⁾								
14	Corona and RIV test	X ³⁾⁶⁾			X ³⁾⁶⁾			X ³⁾			X ³⁾			X ³⁾			X ³⁾⁶⁾		

¹⁾ Includes electrical gradient devices.

²⁾ Inspection by attributes only.

³⁾ By agreement between purchaser and supplier.

⁴⁾ Only as regards damage load test.

⁵⁾ Only for current-carrying joints.

⁶⁾ Only in connection with the complete insulator set.

8 Dimensional and material verification

Type and sample tests shall include verification of dimensions, in accordance with clause 6, to ensure that fittings are within the dimensional tolerances stated on contract drawings. The purchaser may choose to witness the measurement of selected dimensions or may inspect the supplier's documentation when this is available. Measuring devices/gauges shall be selected with regard to the required precision and accuracy. Documentary evidence of calibration of such devices shall be provided on request.

Routine tests shall include a specified level of dimensional checking when required by the contract quality plan.

NOTE Particular attention should be given to those dimensions potentially affecting fitting interchangeability (for example ball and socket couplings (IEC 60120); clevis and tongue couplings (IEC 60471) or mechanical and/or electrical performance.

Type and sample tests shall also include verification of materials to ensure that they are in accordance with contract documents. This verification shall normally be carried out by the purchaser inspecting the supplier's documentation relative to material purchasing specifications, certificates of conformity or other quality documentation. When agreed between purchaser and supplier, material verification shall include tests appropriate to the material specification.

Routine tests shall include a specified level of material verification (including tests) when required by the contract quality plan.

9 Hot dip galvanizing

Type and sample tests shall include, galvanizing tests in accordance with clause 6 to ensure that galvanized coatings comply with the requirements as specified in future ISO 1461.

The coating thickness shall conform to Table 2 and Table 3 of the above-mentioned standard unless otherwise specified or agreed by the purchaser. However, for the purpose of this standard, Tables 2 and 3 of future ISO 1461 shall apply to the following categories of items (and not to the categories specified in future ISO 1461):

Table 2: Coating thickness on samples except:

- washers;
- threaded components;
- small parts which are centrifuged (significant surface area $\leq 1\,000\text{ mm}^2$).

Table 3: Coating thickness on:

- washers;
- threaded components;
- small parts which are centrifuged (significant surface area $\leq 1\,000\text{ mm}^2$).

10 Non-destructive testing

The purchaser shall specify or agree to relevant test methods, classification (type, sample, routine tests) and acceptance criteria.

Examples of non-destructive tests are as follows:

- magnetic test;
- eddy current test;
- radiograph test;
- ultrasonic test;
- proof load test;
- dye penetrant test;
- hardness test.

11 Mechanical tests

11.1 Number of fittings to be tested

Type tests

Mechanical type tests shall be carried out on three fittings. All fittings shall pass the test.

Sample tests

Mechanical sample tests shall be carried out according to sampling procedures reported in 6.2.3.

11.2 Test piece and attachments for mechanical damage and failure load tests, conductors used in the mechanical tests

A fitting under test shall be complete with all components and shall be tested in a manner as near as possible to the arrangement used in service. In order to avoid their unacceptable deformation, it is permissible to strengthen the attachments required to transmit the mechanical loads to the test fitting.

A number of mechanical tests involve the use of conductors loaded to failure. The intent of these tests is to evaluate fitting performance on the conductor(s) for which it is intended. Requirements and tests for conductors are covered by IEC 61089.

Throughout this standard, the word “conductor” is used when the test applies to fittings for conductors or earth-wires.

11.3 Insulator set fittings and earth wire fittings

The fitting under test shall be loaded in a direction which is as close as possible to the direction of load in service (see Figure 2).

In cases where it is difficult, in a single test arrangement, to reproduce the load distribution which occurs in service, this may be represented by part loads applied in successive tests on the same fitting, or on others taken from the same sample. However, it shall first have been ascertained that this splitting of loads is valid for the purpose of verifying the performance required of the fitting.

11.3.1 Mechanical damage and failure load test (see Figure 3)

The fitting shall be held in a tensile testing machine and the load shall be gradually increased until it reaches the specified minimum damage load. This load shall be kept constant for 60 s. It shall then be removed and the measurement of the permanent deformation of the fitting carried out. Then the load shall be gradually increased until it reaches the specified minimum failure load at which it shall be kept constant for 60 s. Then the load shall be increased until the failure of the fitting occurs.

NOTE For very high mechanical failure loads, when the safety of equipment and operators is at risk, the test may be stopped at 1,2 times the specified minimum failure load. In this case inspection by attributes shall be used.

Acceptance criteria

- | | |
|--------------|---|
| Type tests | Regarding damage load, the test is passed if no permanent deformation of the fitting greater than that agreed occurs at or below the specified minimum damage load.
Regarding failure load, the test is passed if failure of the fitting does not occur at a load less than or equal to the specified minimum failure load. |
| Sample tests | As stated in 6.2.3, the test data shall be evaluated following the sampling procedure and relevant acceptance criteria agreed between purchaser and supplier. With inspection by attributes, each fitting which complies with the requirements specified in the acceptance criteria for type tests shall be considered a conforming unit. |

11.3.2 Mechanical damage and failure load test of the attachment point used during erection

The test shall be carried out following the scheme agreed between purchaser and supplier. The method for increasing the load during the test and the method for evaluating the test results shall be that shown in Figure 3.

11.4 Suspension clamps

11.4.1 Vertical damage load and failure load test

The test shall be performed in accordance with the following method A or method B.

Method A

The test shall be carried out as in Figure 4a or Figure 4b or according to an equivalent scheme. Armour rods shall be applied to the conductor if they are used in service. The number of fittings tested, the method for increasing the load during the test and the method for evaluating the test result shall be those stated for the damage and failure load test of insulator set fittings. The angle α , at the specified minimum damage load, shall be the maximum design angle specified by the supplier.

Method B

First step The clamp shall be mounted in the testing machine, as shown in Figure 4a or Figure 4b, and loaded to achieve the angle α . Then the load shall be gradually increased to the specified minimum damage load which shall be kept constant for 60 s. Afterwards, the clamp shall be unloaded and measurements of the permanent deformations, if any, carried out and recorded.

Second step Instead of the conductor, the clamp shall be installed on a rigid bar of suitable size and mounted, complete with the suspension straps, in the testing machine. With α approximately zero, the clamp shall be loaded similarly to Figure 4b and the load gradually increased to the specified minimum failure load. This load shall be kept constant for 60 s and afterwards increased until failure of the fitting.

NOTE For very high mechanical failure loads, when the safety of equipment and operators is at risk, the test may be stopped at 1,2 times the specified minimum failure load. In this case inspection by attributes shall be used.

The acceptance criteria are as in 11.3.1

11.4.2 Slip test on standard clamps with a specified minimum and maximum slip load

The conductor used in the test shall be the one for which the clamp is intended. The test shall be carried out as follows (see Figure 5a):

- a) assembly of the conductor section between the extremities of a tension machine, the conductor being subjected to a load equal to 20 % of its Rated Tensile Strength (RTS);
- b) assembly of the clamp on the conductor thus set up, the nuts or bolts being tightened with the torque specified by the supplier;
- c) reduction to zero of the load applied to the conductor and detachment of the conductor from one end of the tension machine;
- d) attachment of the clamp to the free extremity of the tension machine;
- e) application to the whole unit of a load equal to 20 % of the specified minimum slip load and application of a displacement transducer in such a way that movement of the conductor relative to the fitting can be detected. In the absence of a transducer, a mark shall be made on the conductor to detect the above-mentioned movement;
- f) gradual increase of the load until it reaches the specified minimum slip load. This load shall be kept constant for 60 s;
- g) gradual increase of the load until the slippage of the conductor inside the clamp occurs.

As an alternative to the above procedure the slip test may be conducted in accordance with the method shown in Figure 5b which is as follows:

- 1) assembly of the conductor section between the extremities of a tension machine, the conductor being subjected to a load equal to 20 % of its RTS;
- 2) assembly of the clamp on the conductor thus tensioned, the nuts or bolts being tightened with the torque laid down by the supplier;
- 3) connection of the clamp at extremity W of an appropriate tensioning device, and application of a displacement transducer or a reference mark on the conductor at the end of the clamp, in order to measure slippage between the conductor and the clamp;