



Insulator and conductor fittings for overhead power lines

Part 1: Performance, material, general requirements and dimensions



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- Australasian Railway Association
 - Australian Chamber of Commerce and Industry
 - Australian Electrical and Electronic Manufacturers Association
 - Australian Porcelain Insulators Association
 - Electricity Engineers Association, New Zealand
 - Energy Networks Association
-

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Australian Standard[®]

Insulator and conductor fittings for overhead power lines

Part 1: Performance, material, general requirements and dimensions

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-010, Overhead Lines, to supersede AS 1154.1—2004, *Insulator and conductor fittings for overhead power, Part 1: Performance, material, general requirements and dimensions*. After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian rather than an Australian/New Zealand Standard.

This Standard incorporates Amendment No. 1 (May 2020). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to provide users and manufacturers of fittings with definitions of terms, performance requirements, dimensions, test methods and acceptance criteria.

This Standard is one of a two-part series covering insulator and conductor fittings for overhead power lines, as follows:

Part 1: Performance, material, general requirements and dimensions (this Standard, which combines the former Part 1 and Part 2).

Part 3: Performance and general requirements for helical fittings.

In this revision reference is made to 120 kN rated fittings. These fittings employ M16 fasteners with 16 mm ball/socket couplings and, whilst maintaining the same dimensions, are essentially higher strength versions of the 70 kN fittings. These are NOT intended to be replacements for the previous rating of 125 kN that employed M18 fasteners with 20 mm couplings—these are mechanically similar but dimensionally quite different. If, for the purpose of maintenance, purchasers have need for 20 mm/125 kN fittings in their existing network, this is to be made clear to suppliers to avoid any confusion or incompatibility. Provision has been made by many to supply 106 kN fittings with high strength M18 bolts for these situations.

In the preparation of this Standard, consideration was given to IEC 61284:1997, *Overhead lines—Requirements and tests for fittings*, and IEC 61897:1998, *Overhead lines—Requirements and tests for Stockbridge type aeolian vibration dampers*, relevant parts of which have been incorporated in this Standard.

The following part of this Standard is technically identical to IEC 61284:1997:

Section 5, *Suspension and support fittings* is technically identical to Clauses 11.2—11.4 of IEC 61284:1997.

The following parts of this Standard are technically identical to IEC 61897:1998:

- (a) Clause 7.2.2.3, *Field test*, is technically identical to Clause 7.11.3.3 of IEC 61897:1998.
- (b) Clause 7.2.2.4, *Analytical method*, is technically identical to Clause 7.11.3.4 of IEC 61897:1998.

Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard.

The term ‘normative’ has been used in this Standard to define the application of the appendix to which it applies. A ‘normative’ appendix is an integral part of a Standard.

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STANDARDS AUSTRALIA

Australian Standard

Insulator and conductor fittings for overhead power lines

Part 1: Performance, material, general requirements and dimensions

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out performance and general requirements for insulator and conductor fittings (other than helical fittings, OPGW and ADSS fittings, which are covered in AS 1154.3) together with the critical dimensions for cast, forged or fabricated insulator fittings for use on overhead electric power lines using insulators with minimum failing loads of 70 kN, 120 kN and 160 kN.

Pulling eyes provided to assist installation and fittings for insulated service lines, aerial bundled cables and high-voltage covered conductors are not covered by this Standard.

Fittings for high-temperature conductors are not covered by this Standard.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1110	ISO metric hexagon bolts and screws—Product grades A and B
1110.1	Part 1: Bolts
1111	ISO metric hexagon bolts and screws—Product grade C
1111.1	Part 1: Bolts
1112	ISO metric hexagon nuts
1112.1	Part 1: Style 1—Product grades A and B
1112.2	Part 2: Style 2—Product grades A and B
1112.3	Part 3: Product grade C
1112.4	Part 4: Chamfered thin nuts—Product grades A and B
1154	Insulator and conductor fittings for overhead power lines
1214	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
1237	Plain washers for metric bolts, screws and nuts for general purposes
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1237.2	Part 2: Tolerances
1442	Carbon steels and carbon-manganese steels—Hot-rolled bars and semi-finished products
1444	Wrought alloy steels—Standard, hardenability (H) series and hardened and tempered to designated mechanical properties
1448	Carbon steel and carbon-manganese steels—Forgings (ruling section 300 mm maximum)

1544	Methods for impact tests on metals
1544.2	Part 2: Charpy V-notch
1733	Methods for the determination of grain size in metals
1816	Metallic materials—Brinell hardness test
1816.1	Part 1: Test method
1816.2	Part 2: Verification and calibration of testing machines
1816.3	Part 3: Calibration of reference blocks
1831	Ductile cast iron
1832	Malleable cast iron
1931	High-voltage test techniques
1931.1	Part 1: General definitions and test requirements
2074	Cast steels
4291	Mechanical properties of fasteners made of carbon steel and alloy steel
4291.1	Part 1: Bolts, screws and studs
62271.301	High-voltage switchgear and controlgear—Dimensional standardization of terminals
AS/NZS	
1390	Cup head bolts with ISO metric coarse pitch threads
1559	Hot-dip galvanized steel bolts with associated nuts and washers for tower construction
1866	Aluminium and aluminium alloys—Extruded rod, bar, solid and hollow shapes
1867	Aluminium and aluminium alloys—Drawn tubes
2947	Insulators—Porcelain and glass for overhead power lines—Voltages greater than 1000 V a.c.
2947.1	Part 1: Test methods—Insulator units
2947.3	Part 3: Couplings
2947.4	Part 4: Test methods—Insulator strings and insulator sets
3678	Structural steel—Hot-rolled plates, floorplates and slabs
3679	Structural steel
3679.1	Part 1: Hot-rolled bars and sections
4435	Insulators—Composite for overhead power lines—Voltages greater than 1000 V a.c.
4435.2	Part 2: Standard strength classes and end fittings for string insulator units
4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
CISPR 16.1	Specification for radio disturbance and immunity measuring apparatus and methods—Radio disturbance and immunity measuring apparatus (all parts)
CISPR 18-2	Radio interference characteristics of overhead power lines and high-voltage equipment
	Part 2: Methods of measurement and procedure for determining limits

- IEEE
563 Guide on conductor self-damping measurements
664 Guide for laboratory measurement of the power dissipation characteristics of Aeolian Vibration
- CIGRE
SC22 WG22-04 Recommendations for the evaluation of the lifetime of transmission line conductors; *Electra* 63, March 1979
SC22 Guide to vibration measurements on overhead lines; *Electra* 163, WGTF22.11.02 Dec 1995

1.3 DEFINITIONS

For the purpose of this Standard, the definitions given in AS/NZS 2947.1, AS/NZS 2947.4 and those below apply.

1.3.1 Batch tests

Tests intended to verify the materials and workmanship of fittings that are performed on fittings taken at random from batches offered for inspection.

1.3.2 Calculated breaking load (CBL)

The calculated breaking load of a conductor as specified in the appropriate conductor Standard.

1.3.3 Class A joints

Joints that are subjected to electrical heat cycle tests but not to a short-time overcurrent pulse test.

1.3.4 Class B joints

Joints that are subjected to electrical heat cycle tests and to a short-time overcurrent pulse test.

1.3.5 Conductor fittings

Fittings attached directly to a conductor other than protective fittings.

1.3.6 Coupling position

The position of locking devices in socket couplings that permits the insertion or removal of balls.

1.3.7 Electrical control fittings

Fittings for controlling the electrical characteristics of an insulator set. The mechanical strength of such fittings is not necessarily related to that of a string insulator unit.

1.3.8 Failing load

The load at which a fitting fails during the prescribed test conditions.

1.3.9 Full tension fittings

Conductor fittings for anchoring or joining conductors under tension that are designed for a strength rating of at least 90% of their maximum conductor size CBL.

1.3.10 Insulator fittings

Fittings of an insulator set or fittings for attaching a bare conductor to a supporting structure other than string insulator units or conductor fittings.

1.3.11 Insulator pins

Rigid fittings for attaching pin insulators to a supporting structure.

1.3.12 Locking position

The position of a locking device in a socket coupling that prevents the insertion or removal of balls.

1.3.13 Nominated conductor tension (NCT)

The maximum working load for limited tension fittings. (These values are stated by the manufacturer or specified by the purchaser.)

NOTE: The NCT value is based on the calculated maximum working tension under any combination of loads and temperature conditions to which the conductor may be subjected in specific applications. The loading, temperature conditions and maximum allowable conductor tension may be specified in statutory regulations or codes.

1.3.14 Nominated holding tension (NHT)

A test load that a support fitting is required to withstand without slip of the conductor. (These values are stated by the manufacturer or specified by the purchaser.)

1.3.15 Non-tension fittings

Fittings for electrical connections not subjected to line tension.

1.3.16 Protective fittings

Auxiliary fittings attached to a conductor.

1.3.17 Routine tests

Routine tests are intended to prove conformance of fittings to specific requirements and are performed on every fitting. The tests are conducted in a way that will not damage the fitting.

1.3.18 Specified minimum failing load (MFL)

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

1.3.19 Support fittings

Conductor fittings other than tension or non-tension fittings that grip a conductor and attach to a string insulator unit, an insulator fitting or another support.

1.3.20 Type tests

Tests intended to validate design characteristics. They are normally performed once only and repeated only when the design or the material of the fitting is changed.

1.4 GENERAL REQUIREMENTS

1.4.1 Defects

The fittings shall be free from defects that would be likely to cause them to be unsatisfactory in service.

1.4.2 Design

Fittings shall comply with the following:

- (a) Fittings shall be designed so that they comply with the relevant requirements of this Standard.
- (b) Holes carrying pins or bolts shall be either drilled or cored parallel-sided. For parts made of forged steel, holes may be punched. Holes that are not under mechanical stress may be made by cold or hot punching. Holes that are under mechanical stress may be made by hot punching at forging temperatures.

1.4.3 Materials

Unless otherwise specified in this Standard, fittings may be made from any material or combination of materials that enable the fitting to reach its specified performance.

The materials of compression fittings shall be capable of withstanding the cold-working due to compression. Steel compression fittings shall also be made of materials that will retain sufficient impact strength after the compression.

Examples of suitable materials are as follows:

- (a) Aluminium or aluminium alloy.
- (b) Galvanized steel.
- (c) Galvanized malleable or ductile iron or cast steel.
- (d) Stainless steel.
- (e) Copper and copper alloys.

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

Materials shall not induce corrosion in materials that are in contact with them.

Components shall be compatible with other components and the conductor with which they will be in contact.

1.4.4 Surface finish

Fittings shall be designed, manufactured and finished so as to avoid sharp radii of curvature, ridges and surface protrusions that may cause damage to a conductor. Fittings subjected to electrical stress shall be manufactured and finished so as to minimize surface tracking and radio interference.

1.4.5 Protection against corrosion

All parts of insulator and conductor fittings shall either be inherently resistant to atmospheric corrosion or be suitably protected against corrosion, both during storage and in service. All ferrous metal parts that will be exposed to the atmosphere in service, except those made of stainless steel, shall be protected by hot-dip galvanizing in accordance with AS/NZS 4680 for fabricated ferrous articles, except that no individual damaged or uncoated area shall exceed 10mm², and in accordance with AS 1214 for threaded fasteners.

1.4.6 Forming of carbon steel components (other than stainless steel or coated sheet steel and strip)

1.4.6.1 General

All forming shall be done prior to galvanizing.

1.4.6.2 Forged steel

Forgings shall be produced using steels and heat treatments complying with appropriate Standards.

Fully killed carbon and carbon-manganese steels having a fine austenitic grain size FG in accordance with AS 1733 and complying with one of the following grades of AS 1448 can be used:

- (i) Grade 1016 normalized with a hardness range 105 to 135 HB/10/3000.
- (ii) Grade 1022 normalized with a hardness range 130 to 160 HB/10/3000.
- (iii) X1320 normalized with a hardness range 160 to 190 HBW 10/3000.

- (iv) X1340 oil quenched and tempered with a hardness range 225 to 275 HB/10/3000.

NOTE: Materials with a hardness value outside this range can be validated by performing the Charpy Test as specified in Appendix A.

- (v) International grades and heat treatment equivalent to items (i), (ii) (iii) and (iv).

Other forging steels may be suitable provided they comply with the requirements of AS 1448 and have been heat-treated in accordance with the instructions of the steel manufacturer.

For cold weather applications (less than -5°C), suggested grades are X1320 and X1340 as above.

Other forging steels for cold weather and heat treatments may be suitable provided they comply with Appendix A.

If it can be shown that, after being normalized, steels having a carbon content of less than 0.33% will pass the specified mechanical tests set out in this Standard, they may be supplied in that condition.

Fully killed wrought alloy steels or stainless steels having a fine austenitic grain size and complying with grade 4140 of AS 1444 can be used. Stainless series steels shall be supplied in the annealed condition and the Standard series steel shall be supplied heat-treated.

1.4.6.3 *Malleable cast materials*

Malleable cast iron shall be grade B350-10, grade W400-5, grade P450-6 or grade P500-4 as specified in AS 1832. Other malleable cast materials may be used if they comply with appropriate international Standards and the requirements of this Standard.

1.4.6.4 *Spheroidal (ductile) or nodular graphite cast iron*

Spheroidal or nodular graphite cast iron shall be grade 500-7, grade 400-12 or grade 370-17 as specified in AS 1831. Other spheroidal or nodular graphite cast iron may be used if it complies with international Standards and the requirements of this Standard.

1.4.6.5 *Cast steels*

Cast steels produced by the lost wax process (investment castings) may be used, provided they also comply with both the mechanical and charpy requirements of AS 2074.

These cast steels shall be of the following grades:

- (a) Compositions in accordance with those specified for grades X1320 and X1340 in AS 1442. (These castings shall be supplied in the heat-treated condition.)
- (b) Grades C71A-1, C7A-2 and C7A-3 in accordance with AS 2074.
- (c) Other suitable grades according to recognized international Standards.

1.4.6.6 *Weldable and structural steel*

Weldable and structural grade steel shall be in accordance with AS/NZS 3678 or AS/NZS 3679.1.

1.4.7 Fasteners

1.4.7.1 *Hexagonal bolts*

Unless otherwise specified in this Standard, galvanized hexagonal bolts shall comply with AS 1110.1 or AS 1111.1 and be either—

- (a) grade 5.8 with a hardness range 152 to 238 HBW 10/3000; or
- (b) grade 8.8 with hardness range 238 to 318 HBW 10/3000.

Bolthead markings shall display both the manufacturer's mark and property class in accordance with AS 4291.1.

1.4.7.2 Hexagonal nuts

Unless otherwise specified in this Standard, galvanized hexagonal nuts shall comply with AS 1112 (all parts).

1.4.7.3 Flat washers

Unless otherwise specified in this Standard, flat washers shall comply with the AS 1237 normal series (all parts).

1.4.7.4 Cup head bolts

Unless otherwise specified in this Standard, cup head bolts shall comply with AS/NZS 1390.

1.4.7.5 Tower bolts

Unless otherwise specified in this Standard, tower bolts shall comply with AS/NZS 1559.

1.4.7.6 Spring washers

In the absence of an applicable Standard, spring washers shall serve their intended purpose without failure or being detrimental to the performance of the fitting.

1.5 GENERAL REQUIREMENTS FOR TESTS

1.5.1 Type tests

Test certificates giving the results of the appropriate type tests, performed on no fewer than three fittings identical in all essential details with those to be supplied, shall be regarded as evidence of compliance with this Standard. These tests shall be repeated only if specified by the purchaser. Type test certificates shall specify the overall dimensional details of the fittings.

Full details of the conductor used in the test shall be given, including whether it was ungreased, partly greased or wholly greased.

NOTE: Other evidence of compliance may be agreed upon by negotiation between the purchaser and the supplier.

1.5.2 Batch tests

1.5.2.1 Sampling

Samples for batch tests shall be selected in accordance with Table 1.1.

TABLE 1.1
SAMPLING FOR BATCH TESTS

Number in the lot (<i>N</i>)*	Number of samples
>1 ≤100	To be specified by the purchaser
>100 ≤300	5
> 300 ≤1200	10
>1200 ≤3000	14
> 3000 ≤10 000	20
>10 000	$0.002 \times N$ rounded up to the nearest whole number

* *N* is the number of fittings or devices offered for inspection.

1.5.2.2 *Acceptance*

If only one fitting fails to comply with any of the batch tests as prescribed, a new quantity equal to twice the first quantity shall be tested. The testing shall comprise the test in which failure occurred.

If two or more fittings fail to comply with the prescribed batch tests, the complete batch shall be deemed not to comply with this Standard.

1.6 VERIFICATION OF DIMENSIONS

It shall be verified that the test samples are in accordance with the relevant drawings and requirements agreed between the purchaser and the supplier.

SECTION 2 INSULATOR FITTINGS

2.1 ITEMS TO BE SPECIFIED BY THE PURCHASER

The following information should be specified by the purchaser or declared by the manufacturer at the time of order:

- (a) MFL of fitting and description.
- (b) Diameter and type of fastener to be used with fitting.
- (c) Materials from which the fitting is made.
- (d) Type of locking device clip for socket ended fittings, i.e. W type or split-pin.
- (e) Whether type tests are terminated at 125% MFL (see Clause 2.2.2).
- (f) Marking requirements (see Clause 8.2).
- (g) Clevis end fittings should be supplied with a pin or bolt of the appropriate strength rating.
- (h) Whether operation at low temperature is required.

2.2 MECHANICAL STRENGTH TYPE TEST

2.2.1 Test assembly

Each fitting shall be held in a tensile testing machine in a manner approximating as nearly as possible the arrangement to be used in service.

2.2.2 Procedure

A tensile force equal to 50% MFL shall be applied and maintained for 1 min. The force shall then be removed and the fitting measured for signs of permanent distortion.

The load shall then be reapplied and increased at a steady rate until failure occurs.

The test may be terminated at 125% MFL.

2.2.3 Requirement

There shall be no permanent distortion after the 50% load has been held for 1 min, and the eventual failure shall be of a ductile nature and shall occur at a load not less than the MFL.

In the event of the test being terminated or of failure occurring in the test rig at a load above MFL, elongation of the test fitting shall be such as will indicate that it is manufactured from a ductile material.

NOTE: The 'no permanent distortion' requirement of this test might result in fittings such as shackles, hooks and other fittings subjected to significant bending stresses having an actual failing load greatly in excess of the MFL.

2.2.4 Extended strength test

2.2.4.1 Procedure

If a fitting shows distortion at 50% MFL, the load may be re-applied and increased to 60% MFL and maintained for 1 min. The fitting shall then be measured again for permanent distortion. This test is not applicable to shackles.

2.2.4.2 Requirement

There shall be no increase in permanent distortion after the 60% load has been held for 1 min from that measured, after the 50% load has been held for 1 min.

NOTE: Some fittings, notably ball and socket couplings, have only a limited contact surface. This can create high bearing pressures, with resultant flow of the relatively soft galvanizing as bedding-in occurs. That this impression of elongation is false can be shown by carrying out the extended strength test.

2.3 HARDNESS TEST

As stipulated by this Standard or where specified by the purchaser, the Brinell hardness value of the fittings shall be measured 2 mm under the galvanized surface in an area that has not been unduly stressed and where the thickness before such stressing is not less than 10 mm.

2.4 ROUTINE TESTS

Ferrous insulator fittings that are castings or that have welded joints that are exposed to tensile stress in service are subjected to a tensile force of 50% NCT for limited tension fittings and 50% CBL for full tension fittings, then gradually increased and then held for a minimum of 10 s. Fittings are considered to have passed the test if there is no breakage, cracking or permanent distortion. Fittings that have passed the routine test shall be indelibly marked.

2.5 BATCH TESTS

2.5.1 Verification of dimensions

The dimensions of the fittings shall be verified as specified in Clause 1.6.

2.5.2 Mechanical test

A1

The mechanical test shall be the same as the type test specified in Clause 2.2.

2.5.3 Galvanizing tests

Galvanized coatings shall comply with the requirements of Clause 1.4.5.

2.5.4 Hardness test

The hardness test shall be the same as the type test specified in Clause 2.3.

2.6 DOCUMENTATION

Type Test certificates and performance data of the fittings shall be made available to the purchaser if requested.

SECTION 3 TENSION FITTINGS

3.1 ITEMS TO BE SPECIFIED BY THE PURCHASER

The following information should be specified by the purchaser or declared by the manufacturer at the time of order:

- (a) Conductor size, type, breaking load and appropriate Standard.
- (b) Whether the conductor is ungreased, or partially or wholly greased.
- (c) Material or materials from which the tension fitting is made.
- (d) Dimensions of dies to be used if a compression-type tension fitting is specified.
- (e) Any installation instructions to be provided by the manufacturer.
- (f) Recommended bolt tightening torque, if a bolted-type anchor or tension fitting is specified.
- (g) Whether the heating cycle test is required (see Clause 3.4).
- (h) Marking requirements (see Clause 8.2).

3.2 GENERAL

Tension fittings shall satisfy the appropriate test requirements set out in Table 3.1. All tension fittings are regarded as Class A joints (see Clause 1.3.3).

TABLE 3.1
TYPE TEST REQUIREMENTS FOR TENSION FITTINGS

Test	Test conditions	Criteria	Reference for test method
(1) Holding strength test for full tension fittings (mandatory)	(1) Preload to 50% CBL (2) Test load 90% CBL for 1 min	(a) No slip between fitting and conductor at test load (see Note 1) (b) No failure at test load (c) Load and nature of failure recorded	Clause 3.3.1
(2) Hardness test		As stipulated by this Standard or where specified by purchaser	Clause 3.3.2
(3) Electrical heat cycle test (optional)	Tension 2.5 % CBL 250 cycles at 80°C temperature rise	(a) Temperature of fitting not to exceed temperature of conductor (b) No local heating, burning or fusing of any part of the fitting or conductor	Clause 4.4

NOTES:

- 1 Where steel compression fittings are being tested, it is not necessary to cut open the fittings.
- 2 For all types of conductors, the temperature (temperature rise plus ambient temperature) shall be less than 170°C.

3.3 MECHANICAL STRENGTH TYPE TESTS

3.3.1 Holding strength test for full tension fittings

3.3.1.1 General

For fittings of the current-carrying type, the heat cycle test specified in Clause 3.4 may be performed before the holding strength test on the same conductor and fittings.

3.3.1.2 *Test assembly*

The fitting shall be assembled in accordance with the manufacturer's instructions on conductors of the size and type with which it is to be used. The free length of the conductor between the fitting under test and any other clamp or fitting in the test assembly shall be not less than 100 times the overall diameter of the conductor.

3.3.1.3 *Procedure*

A tensile force of approximately 50% CBL shall be applied and the conductor shall be marked in such a way that movement relative to the fitting can be detected. Without any subsequent adjustments to the fitting, the force shall be increased to 90% CBL and maintained for 1 min.

The force shall then be increased steadily until failure occurs. The load and nature of the failure shall be recorded.

3.3.1.4 *Requirement*

During the 1 min period in which the tensile force is held at the fixed value, there shall be no movement of the conductor relative to the fitting due to slip nor any failure of the fitting.

If doubt exists after the required 1 min holding period, the fittings shall be re-marked at this holding load and held for a further 1 min period. Any movement after this further 1 min holding period shall be classed as slip.

3.3.2 **Hardness test**

As stipulated by this Standard or where specified by the purchaser, the Brinell hardness value of the fittings shall be measured 2 mm under the galvanized surface in an area that has not been unduly stressed and where the thickness before such stressing is not less than 10 mm.

3.4 **ELECTRICAL HEATING CYCLE TYPE TEST**

3.4.1 **General**

The heating cycle test shall be carried out on an assembly of conductor(s) and fittings(s), assembled in accordance with the manufacturer's recommendations and heated by passing a current through the assembly. The fitting is assessed by reference to the resistance measurement taken both before and after the heating cycle test and by visual examination of the opened fitting(s) after the test.

3.4.2 **Test assembly**

Measurement fitting shall be assembled in accordance with the manufacturer's recommendations on conductor(s) of the size and type with which it is to be used. Current connections shall be made to the conductor at a distance from the fitting of not less than 50 times the diameter of the conductor.

Current connections made to the conductor(s) shall make effective contact with all those strands of the conductors that would be taken into account in calculating their equivalent resistances.

The assembly shall be erected indoors so that air may circulate freely around it. It shall not be exposed to draughts. The conductor shall be approximately horizontal and tensioned by a force of approximately 2.5% of the breaking load.

NOTE: If the conductor temperature is 75°C to 80°C above ambient temperature at the end of each heating period, it can be considered that draughts have not adversely affected the performance of the test.

3.4.3 Test current

The test current shall be adjusted during the first 25 heat cycles so that a steady-state temperature rise of the conductor of 80°C above an ambient temperature of 5°C to 40°C is achieved. This heating current shall then be used for the heating periods of the test, regardless of subsequent changes in the steady-state conductor temperature rise.

3.4.4 Procedure

The procedure shall be as follows:

(a) Electrical resistance

- (i) *Method* The resistance of the assembly shall be measured between points on the conductor(s) at either side of the fitting in accordance with Clause 3.4.5 and this measurement shall be recorded.

The resistance may be measured with may be made with direct current or with alternating current at any convenient frequency or by any other suitable means.

- (ii) *Requirement* The resistance measured shall not exceed 75% of the *measured* resistance of the equivalent length of conductor.

- (b) *Heating cycle* The test current shall be passed continuously through the assembly for a period of 30 min.

The test current shall then be interrupted and the assembly allowed to cool to within 5°C above the ambient temperature.

This sequence of operations shall be repeated for 250 cycles of heating and cooling.

The fitting shall not be tightened or adjusted during the test.

- (c) *Fitting temperature* During the last five temperature cycles, the temperature of the fitting shall be measured while the test current is flowing.

3.4.5 Potential points

Potential points for resistance measurements shall be installed on the conductor at a distance of up to 25 mm from the ends of all test joints.

For stranded conductors, an example of a practical potential point is three turns of tinned copper wire.

Care should be taken to ensure that the potential point is twisted tightly in position before measurements are taken.

Figure 3.1 shows one acceptable method of providing a practical potential point. Other types of frequently used potential points could be used.

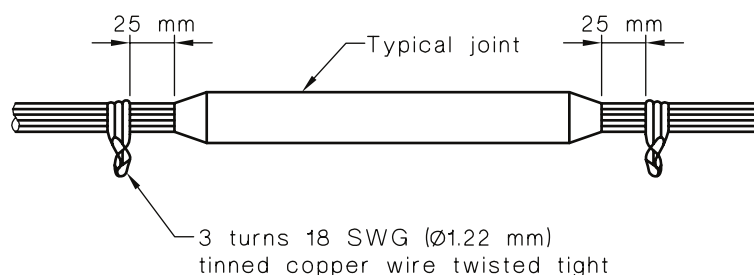


FIGURE 3.1 TYPICAL POTENTIAL POINTS

3.4.6 Requirement

During the last five cycles, the maximum temperature at any point on the surface of the fitting shall not exceed that of the conductor.

The fittings shall be opened and there shall be no sign of local heating, burning or fusing of any part of the fitting or conductor.

3.5 ROUTINE TESTS

Tension fittings that are castings or that have welded joints that are stressed in service are subjected to a tensile force of 50% MFL for 1 min. Fittings are considered to have passed the test if there is no breakage, cracking or distortion that can be seen by normal or corrected vision without the aid of magnification or measurement. Fittings that have passed the routine test shall be indelibly marked

3.6 BATCH TESTS

3.6.1 Verification of dimensions

The dimensions of the fittings shall be verified as specified in Clause 1.6.

3.6.2 Mechanical test

The holding strength test specified in Clause 3.3.1 shall be used except that the test need not be continued until failure occurs.

3.6.3 Hardness test

The hardness test shall be carried out on all samples to verify that the batch has hardness consistent with the type test. If the hardness is within the acceptable range, the mechanical test can be reduced to four samples.

3.6.4 Galvanizing tests

Galvanized coatings shall comply with the requirements of Clause 1.4.5.

3.7 DOCUMENTATION

Type Test certificates and performance data of the fittings shall be made available to the purchaser if requested.