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SPECIFICATION FOR ELECTRIC POWER CONNECTORS

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Indian Standard
SPECIFICATION FOR ELECTRIC POWER CONNECTORS

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Indian Standard
SPECIFICATION FOR ELECTRIC POWER CONNECTORS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 20 March 1970, after the draft finalized by the Switchgear and Controlgear Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 In the formulation of this standard, assistance has been derived from the following publications:

B.S. 159 : 1957 Busbar and busbar connections. British Standards Institution.

B.S. 3288 (Part I) : 1960 Insulator and conductor fittings for overhead power lines (performance and general requirements). British Standards Institution.

0.3 The connectors covered by this standard are primarily intended to establish electrical connection between conductors, between equipment and conductors, etc, in places like substations and generating stations. This standard does not cover fittings for insulators.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers power connectors having current rating of 200 amperes and above, which are components of high tension and extra high tension ac power systems and which are composed of such metals as aluminium and bronze.

*Rules for rounding off numerical values (*revised*).

1.1.1 This standard is mainly intended for power connectors used in substations and generating stations.

1.2 In addition to plugs and sockets which do not come under the scope of this standard, the following types of connectors are also not covered:

a) Connectors for use in equipment for telecommunications and in electronic devices employing similar techniques.

b) Connectors for use in frequencies other than the power freqency of 50 Hz.

c) Connectors for use in transmission lines such as midspan compression joints.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Bimetallic Connector — A connector designed for the purpose of connecting together two or more conductors of different materials (normally copper and aluminium conductors) for preventing electrolytic corrosion.

2.2 Conductor — A piece of material of any shape, rigid or flexible, meant for the purpose of carrying current.

2.3 Connector — A component for the purpose of providing connection(s) through a suitable mating part between.

2.4 Equipment Connector — A connector designed for the purpose of connecting the terminal of the equipment to the conductor(s).

2.5 Expansion Connector — A connector designed for the purpose of connecting together two or more conductors and incorporating means to allow for any relative movement with ample allowance for the relative movement between the conductors.

2.6 Junction Connector — A connector designed for the purpose of connecting together two or more conductors whose axes are either in line with or at an angle to each other.

2.7 Parallel Groove Connector — A connector designed for the purpose of connecting two or more conductors whose axes are parallel to each other.

2.8 Rigid Connector — A connector designed for the purpose of connecting together two or more conductors with no allowance for the relative movement between conductors.

2.9 Support Connector — A connector designed for the purpose of connecting the conductor(s) to the support insulator.

2.10 Tee Connector — A connector designed for the purpose of connecting two conductors whose axes are perpendicular to each other.

2.11 Type Tests — Tests carried out to prove conformity with the requirements of this specification. These are intended to prove the general quality and design of a given type of connector.

2.12 Routine Tests — Tests carried out on each connector to check requirements likely to vary during production.

2.13 Acceptance Tests — Tests carried out on samples selected from a lot for the purpose of varifying the acceptability of the lot.

2.13.1 *Lot* — All connectors of the same type, category and rating, manufactured by the same factory during the same period, using the same process and materials.

3. RATING

3.1 Rated Current — The rated current of power connectors shall be selected from one of the following values:

200, 400, 630, 800, 1 250, 1 600, 2 000, 2 500 and 3 000 amperes.

3.2 The rated frequency of the power connector shall be 50 Hz.

3.3 Rated Short-Time Current — The rated short-time current shall be one of the standard values laid down in Indian Standards for the associated circuit-breakers, switches, etc.

NOTE — When power connectors are directly associated with a circuit-breaker or a switch, the rated short-time current of the power connectors shall be not less than the corresponding rating for the circuit-breaker or switch.

4. MATERIALS

4.1 All matarials used shall conform to the relevant Indian Standards.

4.2 All aluminium and aluminium alloys used in the manufacture of the conductor shall conform to designation A6 of IS : 617-1959*.

4.3 Steel bolts and nuts shall conform to IS : 1363-1967† and IS : 1367-1961‡. Non-ferrous alloy bolts and nuts shall conform to the relevant Indian Standards.

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*Specification for aluminium and aluminium alloy ingots and castings for general engineering purposes (*revised*).

†Specification for black hexagon bolts, nuts and lock nuts (diameter 6 to 39 mm) and black hexagon screws (diameter 6 to 24 mm) (*first revision*).

‡Technical supply conditions for threaded fasteners. **(Since revised).**

5. REQUIREMENTS

5.1 Freedom from Defects — The power connectors shall be smooth and free from cavities, blow-holes and such other defects which would be likely to cause them to be unsatisfactory in service.

5.2 Power connectors shall be so designed and proportioned that they are capable of safely withstanding stresses to which they may be subjected (including those due to short-circuit and climatic conditions) and that the effects of vibration both on the conductor and the connector itself are minimized. They shall be designed, manufactured and finished so as to avoid sharp radii of curvature, ridges and excrescences which might lead to localised pressure on or damage to the conductor in service.

5.3 Bimetallic connectors shall be used to connect conductors of two dissimilar metals.

Sufficient contact pressure should be maintained at the joint by the provision of the required number of bolts or other fixing arrangements. But the contact pressure should not be so great as to cause relaxation of the joint by cold flow. The joint should be such that the pressure is maintained within this range under all conditions of service. To avoid excessive local pressure, the contact pressure should be evenly distributed by the use of pressure plates, washers or suitable saddles of adequate area and thickness.

6. LIMITS OF TEMPERATURE-RISE

6.1 The limits of temperature-rise specified are based on the following reference ambient temperatures:

a) Maximum ambient air temperature	45°C
b) Maximum daily average ambient temperature	35°C
c) Maximum yearly average ambient temperature	30°C

6.2 The temperature-rise of power connectors above a reference ambient temperature of 40°C when carrying rated current shall not exceed 45°C.

6.3 If the ambient temperature exceeds that specified in **6.2**, the permissible temperature-rise shall be reduced by an amount equal to the excess ambient temperature.

7. PROTECTION AGAINST CORROSION

7.1 All parts of power connectors shall either be inherently resistant to atmospheric corrosion or be suitably protected against corrosion, both during storage and in service.

7.2 All ferrous metal parts intended for outdoor use, except those made of stainless steel, shall be protected by hot-dip galvanizing in accordance with IS : 2633-1964*.

7.3 The threads of nuts and tapped holes shall be cut after galvanizing and shall be well oiled or greased. All other threads shall be cut before galvanizing.

8. MARKING

8.1 The connectors shall be indelibly marked with rated current or any identifying mark to enable full particulars of the connector to be obtained.

8.1.1 The electric power connector may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

9. TESTS

9.1 Following shall be the tests to be carried out on the connector

9.1.1 *Type Tests* — The following type tests shall be carried out on three samples. The purchaser shall accept certified copies of type tests as evidence of compliance of connectors with the requirements of the relevant clauses of this specification, and the manufacturer shall hold available originals of such certificates, detailed drawings of the connectors and record of any alteration that may have been made in the connectors subsequent to type tests. The manufacturer shall, if required by the purchaser, certify that the connectors are identical in material and performance with those covered by a certificate of stated date:

a) Tensile tests (*see* **10**),

b) Resistance test (*see* **11**),

c) Temperature-rise test (*see* **12**),

d) Short time current test (*see* **13**),

*Methods of testing weight, thickness and uniformity of coating on hot dipped galvanized articles (Since revised).

e) Dimensional check (*see* **14**) and
f) Galvanizing test, where applicable (*see* **15**).

9.1.2 *Acceptance Tests*

a) Tensile test (*see* **10**),
b) Resistance test (*see* **11**),
c) Dimensional check (*see* **14**), and
d) Galvanizing test, where applicable (*see* **15**).

9.1.3 *Routine Tests*

a) Visual inspection, and
b) Dimensional check (*see* **14**).

9.2 For acceptance tests the number of samples to be tested shall be the nearest whole number to 0.5 percent of the batch offered for acceptance. If these samples meet the test requirements, the batch is deemed to comply with the standard. In the event of the sample not meeting the requirements, twice the original number of new samples shall be tested. If all these new samples meet the test requirements, the batch is deemed to comply with the standard, but if any fails to do so, the batch is deemed not to comply with the standard.

10. TENSILE TEST

10.1 The joint shall be assembled using the connector under test in accordance with the manufacturer's recommendations, on conductors of the sizes and types with which it is to be used.

10.2 The assembly shall be mounted in a tensile testing machine and anchord in such a way that the test load is applied in the direction of the conductor.

10.3 If the nominal breaking load of the conductor is less than 1 100 kg, a tensile load of about 5 percent of the breaking load of the conductor shall be applied and the conductor shall be marked in such a way that movement relative to the conductor can easily be detected. Without any subsequent adjustment of the connector, the load shall be steadily increased to 10 percent of the breaking load. This load shall be maintained for 1 minute. There shall be no movement of the conductor relative to the connector due to slip during this 1 minute period and no failure of the connector.

10.4 If the nominal breaking load of the conductor is 1 100 kg or more, a tensile load of 55 kg shall be applied and the conductor shall be marked in such a way that movement relative to the connector can easily be detected. Without any subsequent adjustment on the connector, the load shall be steadily increased to 110 kg. This load shall be maintained for 1 minute. There shall be no movement of the conductor relative to the connector due to slip during this 1 minute period and no failure of the connector.

11. RESISTANCE TEST

11.1 The largest conductor which the electric power connector will accommodate shall be used during the resistance test.

11.2 The resistance measurements shall be made by millivolt drop with the help of an accurate resistance bridge or other suitable means.

11.3 The resistance of 1·25 m of a conductor, including one connector, such as splices or elbows, shall not exceed the resistance of 1·25 m of the identical conductor without connectors, by more than 10 percent. For terminal connectors, the resistance measured shall be the sum of the resistance measurements taken from *A* to *B* and *C* to *D* as shown in Fig. 1. In cases where the conductor is a stranded cable, the strands shall be suitably bonded at the point of measurement.

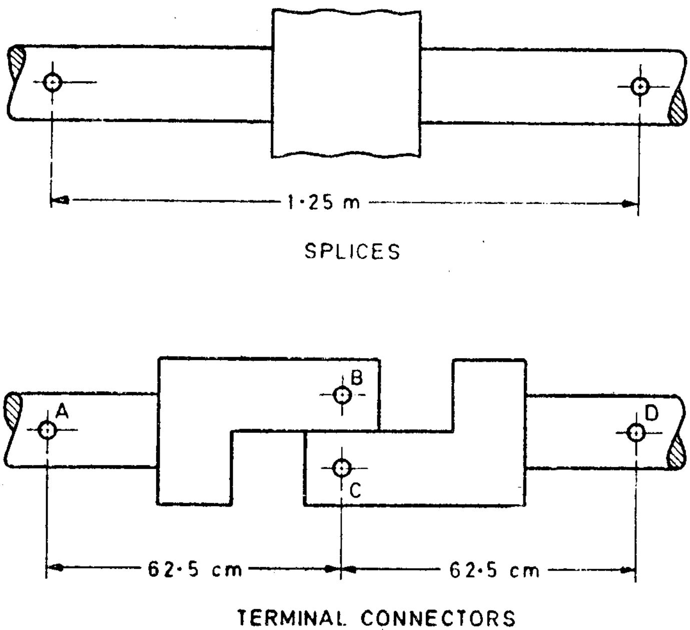

Fig. 1 Terminal Connectors And Splices

12. TEMPERATURE-RISE TEST

12.1 The values of the currents to be used in making temperature-rise tests for the various general types of connectors shall be determined in accordance with the following:

a) *Equipment Connectors* — The values of current shall be selected on the basis of the rating of the equipment to which the connector is connected or on the basis of the rating of the conductor for which the opening is designed, whichever is smaller.

b) *Junction Connectors* — The values of current shall be selected on the basis of the conductor which has the lower current carrying value where the openings are of two sizes and on the basis of the conductor which is common to both openings where the openings are of the same size.

c) *'T' Connectors* — The values of current shall be selected on the basis of the full rated current in the tap conductor only.

12.2 The test of temperature-rise for power connectors shall be made with alternating current at an average frequency not below 95 percent of the rated frequency.

12.3 The connector shall be assembled indoors in accordance with the manufacturer's recommendations on conductors of size and type with which it is to be used. Air shall be freely circulated around the assembly. No draughts shall be allowed.

12.4 Each test shall be made over a period of time sufficient for the temperature to reach a constant value (for practical purposes, this condition is attained when the variation does not exceed 1°C per hour). Temperature measurements shall be made using either thermometer or thermocouple.

13. SHORT-TIME CURRENT TEST

13.1 The test shall be arranged, as far as practicable, to produce conditions equivalent to those which would obtain in service when the connector under test carries fault current. The test may be made at any suitable voltage, and with the connector at any convenient temperature. The short-time current shall be applied for the specified time, and its rms value shall be determined from the oscillogram as indicated in Appendix A.

13.2 The rms value of the short-time current shall be not less than the rated short-time current, and the highest peak value of the major current loop during the first cycle of the test shall be not less than the rated making capacity of any directly associated circuit-breaker or switch.

13.3 Where, however, the characteristics of the test plant are such that the above requirements cannot be met, the following deviations are permitted provided that in (a) and (b) below the product of the square of the short-time current and the duration is not less than the product of the square of the rated short-time current and the rated time.

a) If the decrement associated with the test is such that the rated short-time current, measured in accordance with Appendix A, cannot be obtained for the rated short-time duration without applying initially an excessively high current, the current may be permitted to fall during the test below the specified value and the duration of the test increased appropriately, provided that the initial value of both peak and rms current are not less than those set out above.

b) If in order to obtain the required initial peak value, the rms value of the short-time current is increased above the value of the rated short-time current, the duration of the test may be reduced below the rated short-time duration.

13.4 The short-time current shall not produce any mechanical damage, such as permanent distortion or burning of parts, and shall not cause a temperature-rise that, added to the maximum temperature attained at rated current, would damage the current-carrying parts.

14. DIMENSIONAL CHECK

14.1 The dimensions of the connectors shall be checked against drawings and gauges.

15. GALVANIZING TEST

15.1 The quality of hot-dip galvanized ferrous components shall be determined by the tests given in IS:2633-1964* and shall satisfy the requirements of that standard.

APPENDIX A

[*Clauses* 13.1 *and* 13.3(a)]

DETERMINATION OF SHORT-TIME CURRENT

A-1. The method illustrated in Fig. 2 should be used to determine the short-time current.

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*Methods of testing weight thickness and uniformity of coating and hot dipped galvanized articles. (Since revised).

A-2. The total time BT of the test is divided into ten equal parts by verticals 0 to 10 and the rms value of the ac component of the current is measured at these verticals.

These values are designated I_0, I_1..............I_{10}.

where

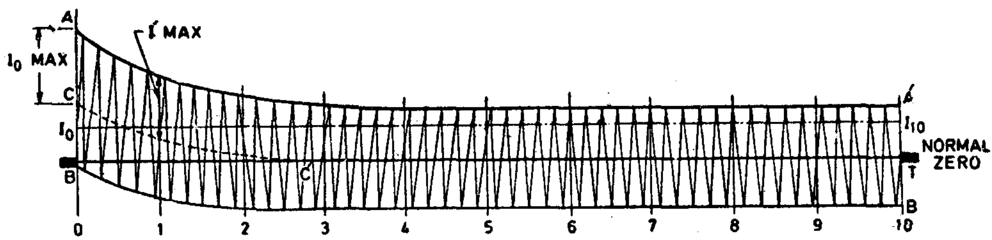
$$I = \frac{I_{Max}}{\sqrt{2}}$$

I_{Max} being the peak value of ac component of current.

A-3. For the purpose of this standard the dc component of current represented by CC' is neglected since in practice its inclusion in the determination is of negligible effect.

A-4. The equivalent rms current during the time BT is given by:

$$\sqrt{\tfrac{1}{30}\left[I_0^2 + 4(I_1^2 + I_3^2 + I_5^2 + I_7^2 + I_9^2) + 2(I_2^2 + I_4^2 + I_6^2 + I_8^2) + I_{10}^2\right]}$$



AA′, BB′	Envelope of current wave.
CC′	Displacement of current wave zero line from normal zero line at any instant.
$I_0 I_{10}$	R.M.S. value of ac component of current at any instant measured from normal zero. DC component is neglected.
I°Max	Peak value of ac component of current at instant of initiating short-circuit.
I′Max	Peak value of ac component of current at time division I.
BT	Duration of short-circuit.

FIG. 2 DETERMINATION OF SHORT-TIME CURRENT

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