

# **Amendments to REC Specifications and Construction Standards**

**Rural Electrification Corporation Limited  
New Delhi – September 2004**



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ATTACHMENT - A

**REC specification No. 1/1971 (R-1993)  
Hard-Drawn Stranded Aluminium and Steel-Cored Aluminium Conductors for  
Over-head Power Lines.**

- (a) **Following para shall be inserted in the beginning of Clause 4 (ALUMINIUM WIRES):**

“The aluminium strands shall be hard drawn from electrolytic aluminium rods of EC grade having purity not less than 99.5% and a copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC: 889-1987.”

- (b) **Following para shall be inserted in the beginning of Clause 5 (STEEL WIRES):**

“The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, or the electric furnace process, or the basic oxygen process and shall conform to the following requirements as to the chemical composition as prescribed in IS 398 (Pt. II) - 1996:

Element	% Composition
Carbon	0.50 to 0.85
Manganese	0.50 to 1.10
Phosphorous	Not more than 0.035
Sulphur	Not more than 0.045
Silicon	0.10 to 0.35

- (c) **Sub-clause 7.2 of Clause 7 (JOINTS IN WIRES & CONDUCTORS) shall be replaced by the following:**

“7.2 Aluminium Conductor Steel Reinforced:

**Aluminium Wires:** No joints shall be permitted in outer layer.

**Steel Wires:** No joints shall be permitted in any wire.”

- (d) **Sub-clause (b) of Clause 9 (TESTS) shall be replaced by the following:**

“(b)The following tests to be conducted for ACSR conductors shall conform to IS 398 (Pt. II) - 1996 and IEC : 888 & 889. The procedure for conducting these tests is given below:

**1 Type Tests**

The following tests shall be conducted once on a sample/samples of conductor (ACSR/AAAC) for every 1500 Kms. of production from each manufacturing facility:

- (a) UTS test on stranded conductor
- (b) DC resistance test on stranded conductor

**2 Acceptance Tests**

- (a) Visual and dimensional check on drum
- (b) Visual check for joints scratches etc. and length measurement of conductor by rewinding
- (c) Dimensional check on steel and aluminium/Al-alloy strands
- (d) Check for lay-ratio
- (e) Galvanising test on steel strands
- (f) Torsion and Elongation tests on steel strands
- (g) Breaking load test on steel and Aluminium strands
- (h) Wrap test on steel & Aluminium strands
- (i) DC resistance test on Aluminium strands
- (j) Procedure qualification test on welded joint of Aluminium strands

Note: All the above tests except (j) shall be carried out on aluminium and steel strands after stranding only.

**3 Routine Test**

- (a) Check to ensure that the joints are as per Specification.
- (b) Check that there are no cuts, fins etc. on the strands.
- (c) Check that drums are as per Specification.
- (d) All acceptance test as mentioned above to be carried out on each coil.

**4 Tests During Manufacture**

- (a) Chemical analysis of zinc used for galvanizing
- (b) Chemical analysis of Aluminium used for making Aluminium strands
- (c) Chemical analysis of steel used for making steel strands

**PROCEDURE FOR CONDUCTING TESTS ON ACSR CONDUCTORS**

**1 UTS Test on Stranded Conductor**

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length between fixing arrangement suitably fixed on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement

of strands. Thereafter the load shall be increased at steady rate to minimum UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

**2 D.C. Resistance Test on Stranded Conductor**

On a conductor sample of minimum 5m length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero metre and subsequently one metre apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C as per IS:398-(Part-V)-1982. The resistance corrected at 20°C shall conform to the requirements of this Specification.

**3 Chemical Analysis of Aluminium and Steel**

Samples taken from the Aluminium and steel ingots/coils/strands shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this Specification.

**4 Visual and Dimensional Check on Drums**

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification.

**5 Visual Check for Joints, Scratches etc.**

Conductor drums shall be rewound in the presence of the Owner or his representative. The Owner/his representative shall visually check for scratches, joints etc. and that the conductor generally conforms to the requirements of this Specification. Ten percent (10%) drums from each lot shall be rewound in the presence of the Owner's representative.

**6 Dimensional Check on Steel and Aluminium Strands**

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

**7 Check for Lay-ratios of Various Layers**

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this Specification.

**8 Procedure Qualification test on welded Aluminium strands.**

Two Aluminium wire shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the guaranteed breaking strength of individual strands.

**9 Chemical Analysis of Zinc**

Samples taken from the zinc ingots shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements stated in the Specification.

**10 Galvanising Test**

The test procedure shall be as specified in IEC : 888. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

### **11 Torsion and Elongation Tests on Steel Strands**

The test procedures shall be as per clause No. 10.3 of IEC : 888. In torsion test, the number of complete twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 250 mm.

### **12 Check on Barrel Batten strength of Drums**

The details regarding barrel batten strength test will be discussed and mutually agreed to by the Contractor & Owner in the Quality Assurance Programme.

### **13 Breaking load test on individual Aluminium and Galvanized steel wires**

The test shall be conducted on both Aluminium and Galvanized steel wires. The breaking load of one specimen cut from each of the samples taken shall be determined by means of suitable tensile testing machine. The load shall be applied gradually and the rate of separation of the jaws of the testing machine shall be not less than 25 mm/min. and not greater than 100 mm./min. The ultimate breaking load of the specimens shall be not less than the values specified in the Specification.

### **14 Resistance test on Aluminium wire**

The test shall be conducted on aluminium wires only, conforming to procedure as per IEC: 889. The electrical resistance of one specimen of aluminium wire cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value corresponding to 20 degree C. by means of following formula.

$$R_{20} = R_T \frac{1}{1 + \alpha \times (T - 20)}$$

Where

$R_{20}$  = Resistance corrected at 20 degrees C.

$R_T$  = Resistance measured at T degrees C.

$\alpha$  = Constant mass temperature coefficient of resistance 0.004.

T = Ambient temperature during measurement

This resistance calculated to 20 degrees C. shall be not more than the maximum value specified in the specification.”

- (e) **The first para of Clause 10 (PACKING & MARKING) shall be replaced by the following:**

“The conductors shall be wound in reels or drums conforming to IS:1778-1980 ‘Specification for Reels and Drums for bare wire’ or the latest version thereof.”

As an alternative to wooden drum supplier may also supply the conductors in non-returnable painted steel drums. After preparation of steel surface according to IS:

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9954, synthetic enamel paint shall be applied on one coat of primer. Wooden/Steel drum will be treated at par for evaluation purpose.”

- (f) Sub-clause 10.1.4 of Clause 10 (PACKING & MARKING) shall be replaced by the following:**

“10.1.4 Short lengths, not less than 50% of the standard lengths, shall be acceptable to the maximum extent of 10% of the quantity ordered. A single drum may contain more than one length of conductor.”

ATTACHMENT - B

**REC specification No. 33/1984 (R-1993)**  
**Aluminium Alloy Conductors for Overhead Power Lines.**

- (a) Following para shall be inserted in the beginning of Clause 4 (PROPERTIES OF WIRES):

“The wire shall be of heat-treated aluminium, magnesium silicon alloy having a composition appropriate to the mechanical & electrical properties as specified in IS : 398(Part-4).

The Aluminum Alloy strands drawn from heat-treated aluminium alloy redraw rods conforming to Type B as per IEC: 104-1987. The chemical composition of redraw rods shall confirm to IS : 9997 – 1991 as given below:-

Elements	Percent
Si	0.50-0.90
Mg	0.60-0.90
Fe	0.50 max
Cu	0.10 max
Mn	0.03 max
Cr	0.03 max
Zn	0.10 max
B	0.06 max
Other Element (Each)	0.03 max
Other Element (Total)	0.10 max
Al	Remainder

- (b) Clause 9 (TESTS) shall be replaced by the following:

“9. TESTS

The following tests to be conducted for AAAC conductors shall conform to IS: 398 (Pt. IV) – 1979 and IEC : 888 & 889. The procedure for conducting these tests is given below:

**1 Type/Periodic Tests**

The following tests shall be conducted once on a sample/samples of conductor (AAAC) for every 1500 Kms. of production from each manufacturing facility:

- (a) UTS test on stranded conductor
- (b) DC resistance test on stranded conductor



**2 Acceptance Tests**

- (a) Visual check for joints scratches etc. and length measurement of conductor by rewinding
- (b) Dimensional check on Al-alloy strands
- (c) Check for lay-ratio
- (d) Elongation test
- (e) Breaking load/tensile test on Aluminum alloy strands
- (f) DC resistance test on Aluminum alloy strands
- (g) Wrap test on Aluminum alloy strands
- (h) Visual and dimensional check on drum

**3 Routine Test**

- (a) Check to ensure that there are no joints.
- (b) Check that there are no cuts, fins etc. on the strands.
- (c) Check that drums are as per Specification.
- (d) All acceptance test as mentioned above to be carried out on each coil.

**4 Tests During Manufacture**

- (a) Chemical analysis of Aluminum alloy used for making strands

**PROCEDURE FOR CONDUCTING TESTS ON AAAC CONDUCTORS**

**1 UTS Test on Stranded Conductor**

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length between fixing arrangement suitably fixed on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to minimum UTS and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

**2 D.C. Resistance Test on Stranded Conductor**

On a conductor sample of minimum 5m length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C as per IS:398-(Part-V)-1982. The resistance corrected at 20°C shall conform to the requirements of this Specification.

**3 Chemical Analysis of Aluminium alloy**

Samples taken from the Aluminium alloy ingots/coils/strands shall be chemically/spectrographically analyzed. The same shall be in conformity to the requirements stated in this Specification.

**4 Visual and Dimensional Check on Drums**

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification.

**5 Visual Check for Joints, Scratches etc.**

Conductor drums shall be rewound in the presence of the Owner or his representative. The Owner/his representative shall visually check for scratches, joints etc. and that the conductor generally conforms to the requirements of this Specification. Ten percent (10%) drums from each lot shall be rewound in the presence of the Owner's representative.

**6 Dimensional Check on Aluminum alloy Strands**

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

**7 Check for Lay-ratios of Various Layers**

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this Specification.

**8 Torsion and Elongation Tests on Aluminum alloy Strands**

The test procedures shall be as per clause No. 10.3 of IEC : 888. In torsion test, the number of complete twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 250 mm.

**9 Check on Barrel Batten strength of Drums**

The details regarding barrel batten strength test will be discussed and mutually agreed to by the Contractor & Owner in the Quality Assurance Programme.

**10 Breaking Load Test on Individual Aluminium Alloy Wires**

The test shall be conducted on Aluminum alloy wires. The breaking load of one specimen cut from each of the samples taken shall be determined by means of suitable tensile testing machine. The load shall be applied gradually. Si the jaws of the testing machine shall be not less than 25 mm/min. and not greater than 100 mm./ min. The ultimate breaking load of the specimens shall be not less than the values specified in the Specification.

**11 Resistance test on Aluminum alloy wire**

The test shall be conducted on aluminium alloy wires only, conforming to procedure as per IEC: 889. The electrical resistance of one specimen of aluminium wire cut from each of the samples taken shall be measured at ambient temperature. The measured resistance shall be corrected to the value corresponding to 20 degree C. by means of following formula.

$$R_{20} = R_T \frac{1}{1 + \alpha \times (T - 20)}$$

Where

R20 = Resistance corrected at 20 degrees C.

RT = Resistance measured at T degrees C.

alpha = Constant mass temperature coefficient of resistance 0.004.

T = Ambient temperature during measurement

This resistance calculated to 20 degrees C. shall be not more than the maximum value specified in the specification.”

- (c) The first para of Clause 10 (PACKING AND MARKING) shall be replaced by the following:**

“The conductors shall be wound in reels or drums conforming to the latest version of IS: 1778-1961 “Specification for Reels and drums for bare wire.

As an alternative to wooden drum supplier may also supply the conductors in non-returnable painted steel drums. After preparation of steel surface according to IS: 9954, synthetic enamel paint shall be applied on one coat of primer. Wooden/Steel drum will be treated at par for evaluation purpose.”

- (d) Sub-clause 10.1.2.2 of Clause 10 (PACKING AND MARKING) shall be replaced by the following:**

“10.1.2.2. Short lengths, not less than 50% of the normal length shall be acceptable to the maximum extent of 10% of the quantity ordered. A single drum may contain more than one length of conductor.”

ATTACHMENT - C

**REC specification No. 3/1971(R-1993)  
Porcelain insulators and Insulator Fittings for 11 kV Overhead Power Lines.**

**(a) Sub-clause 8.1 (g) of Clause 8 (TESTS) shall be replaced by the following:**

“(g) Mechanical Failing load test (for Pin Insulators only) to be carried out as per procedure described at Sub-clause 8.4”

**(b) Sub-clause 8.1 (l) of Clause 8 (TESTS) shall be replaced by the following:**

“(l) Electro-mechanical failing load test (for Strain insulators only) to be carried out as per procedure described at Sub-clause 8.4”

**(c) A new Sub-clause 8.1 (m) (Thermal Mechanical Performance Test) shall be inserted to Clause 8 (TESTS) as follows:**

“(m) Thermal Mechanical Performance Test (for Strain insulators only) to be carried out as per procedure described at Sub-clause 8.4.”

**(d) A new Sub-clause 8.2 (d) (Hydraulic Internal Pressure Test) shall be inserted to Clause 8 (TESTS) as follows:**

“(d) Hydraulic Internal Pressure test on shells for strain insulators to be carried out as per procedure described at Sub-clause 8.4”

**(e) Sub-clause 8.3 (c) of Clause 8 (TESTS) shall be replaced by the following:**

“(c) Electro-mechanical failing load test (for strain insulators only) to be carried out as per procedure described at Sub-clause 8.4”

**(f) A new Sub-clause 8.4 shall be inserted to Clause 8 (TESTS) as follows:**

“8.4 Following procedure shall be used for conducting tests on insulators

**1.0 Hydraulic Internal Pressure Test on Shells (For Disc Insulators)**

The test shall be carried out on 100% shells before assembly. The detail and methodology for conducting this test has been illustrated at attached Annexure – 1.

**2.0 Thermal Mechanical Performance Test (if applicable)**

Thermal Mechanical Performance Test shall be performed in accordance with IEC-383-1-1993 Clause 20 with the following modifications:

(1) The applied mechanical load during this test shall be 70% of the rated electromechanical or mechanical value.

(2) The acceptance criteria shall be

(a)  $X$  greater than or equal to  $R + 3S$ .

Where

$X$  Mean value of the individual mechanical failing load.

$R$  Rated electro-mechanical / mechanical failing load.

$S$  Standard deviation.

(b) The minimum sample size shall be taken as 20 for disc insulator units.

(c) The individual electromechanical failing load shall be at least equal to the rated value. Also puncture shall not occur before the ultimate fracture.

**3.0 Electromechanical/Mechanical Failing Load Test.**

This test shall be performed in accordance with clause 18 and 19 of IEC 383 with the following acceptance

(i)  $X$  greater than or equal to  $R + 3S$

Where

$X$  Mean value of the electro-mechanical/mechanical/ failing load.

$R$  Rated electro-mechanical / mechanical failing load.

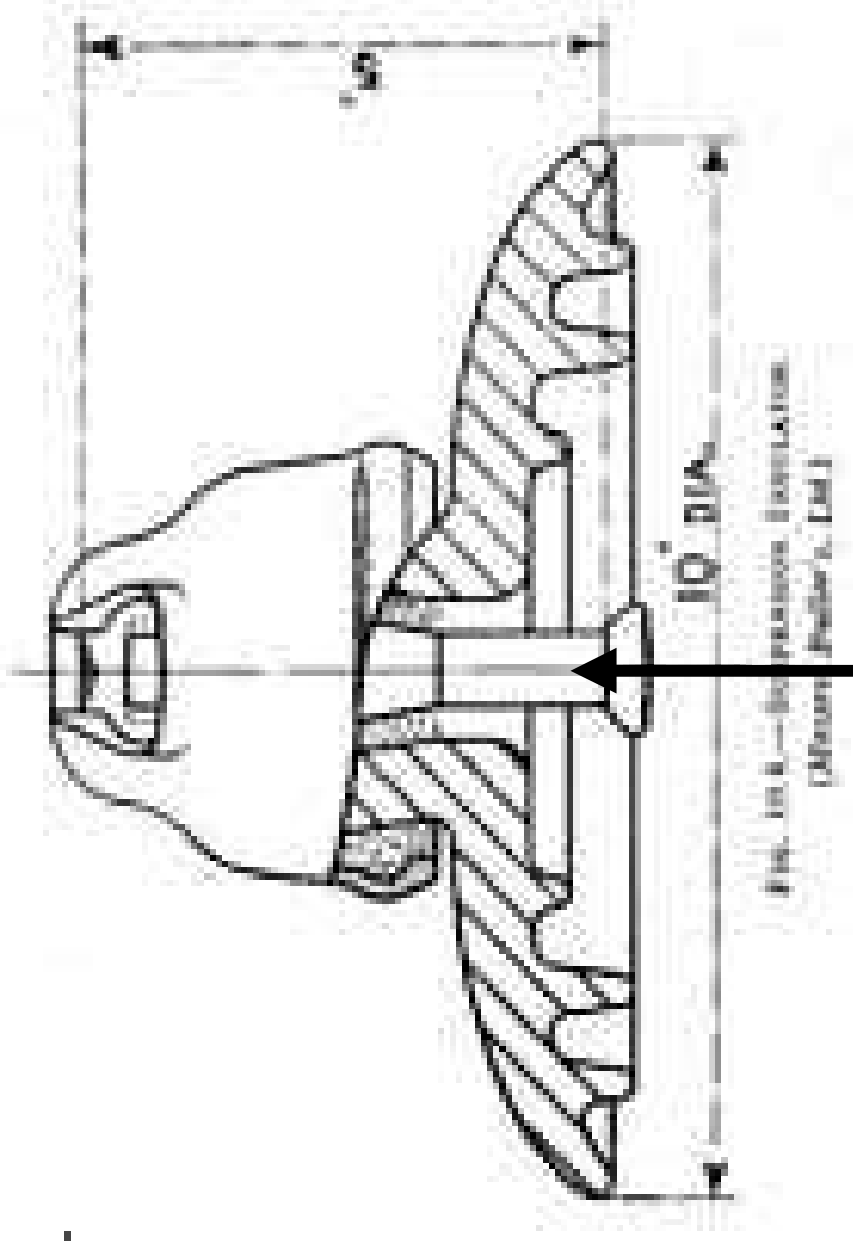
$S$  Standard deviation.

(ii) The minimum sample size shall be taken as 20 for disc insulators units. However, for larger lot size, IEC 591 shall be applicable.

(iii) The individual electro-mechanical/mechanical failing load shall be at least equal to the rated value. Also electrical puncture shall not occur before the ultimate fracture.”

## Annexure - 1

# HYDRAULIC PRESSURE TEST ON DISC INSULATOR SHELL



120 KG/CM sq +/- 10 on the shell before cap and pin assembly to check the integrity of Porcelain

ATTACHMENT – D

**REC specification No. 13/1979**  
**Porcelain Insulators and Insulator Fittings for 33 kV Overhead Power Lines**

- (a) Sub-clause 3.6.1 (g) of Clause 3.6 (TESTS) shall be replaced by the following:**

“(g) Electro-mechanical failing load test to be carried out as per procedure described at Sub-clause 3.6.4.”

- (b) Sub-clause 3.6.1 (h) of Clause 3.6 (TESTS) shall be replaced by the following:**

“(h) Mechanical failing load test (for those of Type B string insulator units to which electro mechanical failing load test (g) is not applicable) to be carried out as per procedure described at Sub-clause 3.6.4.”

- (c) A new Sub-clause 3.6.1 (m) (Thermal Mechanical Performance Test) shall be inserted to Clause 3.6 (TESTS) as follows:**

“(m) Thermal Mechanical Performance Test (for Strain insulators only) to be carried out as per procedure described at Sub-clause 3.6.4.”

- (d) Sub-clause 3.6.2 (d) of Clause 3.6 (TESTS) shall be replaced by the following:**

“(d) Electro-mechanical failing load test to be carried out as per procedure described at Sub-clause 3.6.4.”

- (e) A new Sub-clause 3.6.3 (d) (Hydraulic Internal Pressure test) shall be inserted to Clause 3.6 (TESTS) as follows:**

“(d) Hydraulic Internal Pressure test on shells for strain insulators to be carried out as per procedure described at Sub-clause 3.6.4.”

- (f) A new Sub-clause 3.6.4 shall be inserted to Clause 3.6 (TESTS) as follows:**

“3.6.4 Following procedure shall be used for conducting tests on insulators:

1.0 Hydraulic Internal Pressure Test on Shells (For Disc Insulators)

The test shall be carried out on 100% shells before assembly. The detail and methodology for conducting this test has been illustrated at attached Annexure – 1.

**2.0 Thermal Mechanical Performance Test (if applicable)**

Thermal Mechanical Performance Test shall be performed in accordance with IEC-383-1-1993 Clause 20 with the following modifications:

(1) The applied mechanical load during this test shall be 70% of the rated electromechanical or mechanical value.

(2) The acceptance criteria shall be

(a)  $X$  greater than or equal to  $R + 3S$ .

Where

$X$  Mean value of the individual mechanical failing load.

$R$  Rated electro-mechanical / mechanical failing load.

$S$  Standard deviation.

(b) The minimum sample size shall be taken as 20 for disc insulator units.

(c) The individual electromechanical failing load shall be at least equal to the rated value. Also puncture shall not occur before the ultimate fracture.

**3.0 Electromechanical/Mechanical Failing Load Test.**

This test shall be performed in accordance with clause 18 and 19 of IEC 383 with the following acceptance

(i)  $X$  greater than or equal to  $R + 3S$

Where

$X$  Mean value of the electro-mechanical/mechanical/ failing load.

$R$  Rated electro-mechanical / mechanical failing load.

$S$  Standard deviation.

(ii) The minimum sample size shall be taken as 20 for disc insulators units. However, for larger lot size, IEC 591 shall be applicable.

(iii) The individual electro-mechanical/mechanical failing load shall be at least equal to the rated value. Also electrical puncture shall not occur before the ultimate fracture.”



**ATTACHMENT - E**

**REC specification No. 7/1974 (R-1993)  
Three-phase, 33/11 kV Step-Down Power Transformers.**

- (a) The heading of Clause 3 shall be read as GENERAL in place of STANDARD RATINGS:**
- (b) The first para of the Clause 3 (GENERAL) shall be deleted and a new Sub-clause 3.1 (STANDARD RATINGS) shall be inserted to Clause 3 (GENERAL) as follows:**

**“3.1 STANDARD RATINGS**

The standard ratings shall be 630 KVA, 1600 KVA, 3150 KVA and 5000 KVA for transformers with off-circuit taps.”

- (c) A new Sub-clause 3.2 (WINDING MATERIAL) shall be inserted to Clause 3 (GENERAL) as follows:**

**“3.2 WINDING MATERIAL**

Winding shall be made of Electrolytic Copper only.”

- (d) A new Sub-clause 3.3 (CORE) shall be inserted to Clause 3 (GENERAL) as follows:**

**“3.3 CORE**

The Core of the power transformer shall be as per details given below:

- i) The core shall be wound or cut or stack type.
- ii) Stage level inspection for core construction shall be carried out by the owner.
- iii) Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.
- iv) The core shall be constructed either from high grade, non-aging Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to grade M4 or better or of amorphous metal. The amorphous core shall be of high quality amorphous ribbons having very low loss formed into wound cores of rectangular shape and clamped together by frames firmly to prevent vibration or noise. The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that the flux density with + 12.5 % voltage variation from rated voltage and frequency variation of - 5% shall not exceed 1.9 Tesla. The bidder shall provide saturation curve of the core material proposed to be used.
- v) The bidder should offer the core for inspection and approval by the purchaser during the manufacturing stage. Bidder's call notice for the

purpose should be accompanied with the following documents as applicable as a proof towards use of prime core material:

- a) Invoice of the supplier
- b) Mills test certificate
- c) Packing list
- d) Bill of lading
- e) Bill of entry certificate to customs

Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute and not through any agent.

- vi) The laminations shall be free of all burrs and sharp projections. Each sheet shall have an insulating coating resistant to the action of hot oil.
- vii) The insulation structure for the core to clamp plates, shall be such as to withstand 2000 V DC voltage for one minute.
- viii) The completed core and coil shall be so assembled that the axis and the plane of the outer surface of the core assembly shall not deviate from the vertical plane by more than 25 mm.
- ix) All steel sections used for supporting the core shall be thoroughly shot or sand blasted, after cutting, drilling and welding.
- x) The finally assembled core with all the clamping structures shall be free from deformation and shall not vibrate during operation.
- xi) The core clamping structure shall be designed to minimize eddy current loss.
- xii) The framework and clamping arrangements shall be securely earthed.
- xiii) The core shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength.
- xiv) Oil ducts shall be provided, where necessary, to ensure adequate cooling inside the core. The welding structure and major insulation shall not obstruct the free flow of oil through such ducts.
- xv) The design of magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angle to the plane of the lamination, which may cause local heating. The supporting framework of the cores shall be so designed as to avoid the presence of pockets, which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.
- xvi) The construction is to be of 'core' type. The core shall be provided with lugs suitable for lifting the complete core and coil assembly. The core and coil assembly shall be so fixed in the tank that shifting will not occur during transport or short circuits."

- (e) A new Sub-clause 3.4 (TANK) shall be inserted to Clause 3 (GENERAL) as follows:**

**“3.4 TANK**

The Tank of the power transformer shall be as per details given below:

- i) The Transformer tank and cover shall be fabricated from high grade low carbon plate steel of tested quality. The tank and the cover shall be of welded construction.
- ii) Tank shall be designed to permit lifting by crane or jacks of the complete transformer assembly filled with oil. Suitable lugs and bosses shall be provided for this purpose.
- iii) All beams, flanges, lifting lugs, braces and permanent parts attached to the tank, shall be welded and where practicable, they shall be double welded.
- iv) The main tank body of the transformer, excluding tap changing compartments and radiators, shall be capable of withstanding pressure of 760 mm of Hg.
- v) Inspection hole(s) with welded flange(s) and bolted cover(s) shall be provided on the tank cover. The inspection hole(s) shall be of sufficient size to afford easy access to the lower ends of the bushings, terminals etc.
- vi) All bolted connections to the tank shall be fitted with suitable oil-tight gaskets which shall give satisfactory service under the operating conditions for complete life of the transformer. Special attention shall be given to the methods of making the hot oil-tight joints between the tank and the cover as also between the tank cover and the bushings and all outlets to ensure that the joint can be remade satisfactorily and with ease, with the help of semi-skilled labour. Where compressible gaskets are used, steps shall be provided to prevent over-compression.
- vii) Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space shall be provided between the cores and windings and the bottom of the tank for collection of any sediment.

The transformer top shall be provided with a detachable tank cover with bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. The surface of the cover shall be suitably sloped so that it does not retain rainwater.

- (f) A new Sub-clause 3.5 (PAINT) shall be inserted to Clause 3 (GENERAL) as follows:**

**“3.5 PAINT**

The paint material and procedure for the power transformer shall be as per details given below:

**i) Surface Preparation for tank, Pipes, etc. –**

All surfaces of transformer tank, pipes, etc shall be thoroughly blast cleaned with sand or shot or grit in accordance with ISO 8501 Part 1 to a minimum standard of Sa2½ to make the surface free from visible oil, grease & dirt, mill scale, rust, paint coatings and foreign matter. Machined areas and threaded components etc are to be covered during blasting to prevent damage.

The air that is used for blasting should be dry and free from oil. The flanges, angles, tank curbs and other such areas shall be preferably blast cleaned prior to fabrication and paint these with one coat of primer. After adequate blast cleaning of each large surface where blasting time is more than three hours, an overall blast cleaning is to be done on the entire surface once more so that entire surface areas is exposed as fresh for first coat of primer paint. The first coat of primer paint should be applied not later than 3-4 hours after preparation of surface to avoid oxidation.

**ii) Surface Preparation for radiator-**

All internal and external surfaces of radiator shall be thoroughly cleaned either by chemical cleaning or by blast with sand or shot or grit in accordance with ISO 8501 Part 1 to make the surface free from visible oil, grease & dirt, mill scale, rust, paint coatings and foreign matter. Suitable chemical should be used for chemical cleaning, if required. The air that is used for blasting should be dry and free from oil. After adequate surface cleaning, the first coat of primer paint/varnish should be applied not later than 3-4 hours after preparation of surface to avoid oxidation.

**iii) Painting- external & internal surfaces-**

Painting shall be carried out in closed and dust free area. The external surface shall be coated with suitable layers of paint and to form an impermeable layer so that air and water cannot reach the substrate. The paint selected shall be stable in outdoor condition such as rain, sunlight, pollution etc. Paint used for primer, under coat and top or finish coat should be from the same manufacturer and compatible to each other. In case in the rare event, paint used for primer, under coat and finish coat are not from the same manufacturer the compatibility test of the paint from different source shall be carried out. Painting shall be applied as per the recommendation of the paint manufacturer. The number of coats shall be such that the minimum dry film thickness (DFT) specified is achieved. The DFT of painted surface shall be checked with a measuring gauge to ensure specified DFT. Complete painting scheme for the transformer is tabulated below:

**iv) Painting-Transformer tank, pipes, radiator etc.-**

	SURFACE PREPARA TION	PRIMER COAT	INTERMEDI- ATE UNDERCOAT	FINISH COAT	TOTAL DFT	COLOUR SHADE
<b>Tank, pipes, etc. (External surfaces)</b>	Blast cleaning Sa2½	Epoxy base Zinc primer (30-40 µm)	Epoxy HB MIO (30-40 µm)	Aliphatic Polyurethane (min 50 µm)	Min 155 µm	697 shade as per IS 5
<b>Tank (Internal surfaces)</b>	Blast cleaning Sa2½	Hot oil resistant, non- corrosive varnish or paint or epoxy	--	--	Min 30 µm	Glossy white for paint
<b>Radiator (External surfaces)</b>	Chemical / blast cleaning (Sa2½)	Epoxy base zinc primer (30-40µm)	Epoxy base zinc primer (30- 40µm)	PU paint (min 50µm)	Min 110µm	Matching shade of tank/ different shade aesthetically matching to tank
<b>Radiator and pipes (Internal surfaces)</b>	Chemical cleaning if required	Hot oil proof, low viscosity varnish, flushing with transformer oil.	--	--	--	--

**v) Surface Preparation for Control cabinets/Marshalling Boxes-**

- a. Surface Preparation for all Transformer Control cabinets/Marshalling Boxes shall be carried out confirming to following Indian standard in dust free area:
  - 01) IS: 3618: Degreasing by solvent wiping: Phosphate Treatment of Iron & Steel for Protection against corrosion.
  - 02) IS: 6005: Code of Practice for phosphating of Iron & Steel.
- b. Chemicals: Suitable chemicals should be used and concentration of chemicals /weight of Phosphate coating should be checked regularly as per recommendation of the chemical manufacturer and applicable IS.
- c. Inspection: The surface for application of paint should be dry, free from oil, dirt, acid & loose adhering powder and reasonably smooth in finish without uncovered areas, rusty surfaces and roughness.

**vi) Painting- Control cabinets/Marshalling Boxes –**

Enamel paint shall be used with total paint thickness as minimum 80 microns.”

- (g) The first line of Sub-clause 9.1 of Clause 9 (LOSSES) shall be replaced by the following and the table showing losses shall remain unaltered:**

“9.1 The no-load and load-losses shall not exceed the values given in the following table:”

- (h) Sub-clause 9.2 of Clause 9 (LOSSES) shall be replaced by the following:**

“9.2 The above losses are maximum allowable and there will not be any plus tolerance. The capitalisation of losses will be allowed for lower losses offered. The following Capitalisation formula shall be used:

Capitalised cost of TRF = Initial cost of TRF + Rs. A x WI + Rs. B x Wc

Where :

WI = Iron loss in KW & A = 137408 Rupees for iron loss

WC = Copper loss in KW & B = 41222 Rupees for copper loss”

**ATTACHMENT - F**

**REC specification No. 2/1971 (R-1997)**

**Out-door type three phase, 11 kV/433-250 V Distribution Transformers upto and including 100 KVA.**

- (a) A new Clause 8A (PAINT) shall be inserted after Clause 8 (CONSERVATOR) as follows:**

**“8A. PAINT**

The paint material and procedure for the distribution transformer shall be as per details given below:

1 All paints shall be applied in accordance with the paint manufacturer's recommendations. Particular attention shall be paid to the following :

- a. Proper storage to avoid exposure as well as extremes of temperature.
- b. Surface preparation prior to painting.
- c. Mixing and thinning
- d. Application of paints and the recommended limit on time intervals between coats.
- e. Shelf life for storage.

1.1 All paints, when applied in normal full coat, shall be free from runs, sags, wrinkles, patchiness , brush marks or other defects.

1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident, and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to the manufacturer's recommendations. However, wherever airless spray is not possible, conventional spray be used with prior approval of purchaser.

1.3 The supplier shall, prior to painting protect nameplates, lettering gauges, sight glasses, light fittings and similar such items.

**2 Cleaning and Surface Preparation**

2.1 After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.

2.2 Steel surfaces shall be prepared by Sand / Shot blast cleaning or Chemical cleaning by Seven tank process including Phosphating to the appropriate quality.

2.3 The Pressure and Volume of the compressed air supply for the blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination prior to any painting.

2.4 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where blast cleaning is impractical.

3 Protective Coating

3.1 As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anticorrosion protection.

4 Paint Material

Followings are the type of paints that may be suitably used for the items to be painted at shop and supply of matching paint to site:

- i) Heat resistant paint (Hot oil proof) for inside surface.
- ii) For external surfaces one coat of Thermo Setting Paint or 2 coats of Zinc chromate followed by 2 coats of Synthetic Enamel paint. The color of the finishing coats shall be dark admiral gray conforming to No. 632 of IS 5:1961

5 Painting Procedure

5.1 All painting shall be carried out in conformity with both specifications and with the paint manufacturer's recommendations. All paints in any one particular system, whether shop or site applied, shall originate from one paint manufacturer.

5.2 Particular attention shall be paid to the manufacturer's instructions on storage, mixing, thinning and pot life. The paint shall only be applied in the manner detailed by the manufacturer e.g. brush, roller, conventional or airless spray and shall be applied under the manufacturer's recommended conditions. Minimum and maximum time intervals between coats shall be closely followed.

5.3 All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is warm.

5.4 Where the quality of film is impaired by excess film thickness (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coatings and apply another. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25 %. In all instances, where two or more coats of the same paints are specified, such coatings may or may not be of contrasting colors.

5.5 Paint applied to items that are not to be painted, shall be removed at supplier's expense, leaving the surface clean, un-stained and undamaged.



**6 Damages Paint Work**

6.1 Any damage occurring to any part of the painting scheme shall be made good to the same standard of corrosion protection and appearance as that originally employed.

6.2 Any damaged paint work shall be made good as follows:

6.3 The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.

- a) A priming coat shall immediately applied, followed by a full paint finish equal to that originally applied and extending 50 mm around the perimeter of the originally damaged.
- b) The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before & after priming.

**7 Dry Film Thickness**

7.1 To the maximum extent practicable, the coats shall be applied as a continuous film of uniform thickness and free of pores. Over-spray, skips, runs, sags and drips should be avoided. The different coats may or may not be of same color.

7.2 Each coat of paint shall allowed to hardened before the next is applied as per manufacturer's recommendations.

7.3 Particular attention must be paid to full film thickness at edges.

7.4 The requirement for the dry film thickness (DFT) of paint and the material to be used shall be as given below:

S. No.	Paint Type	Area to be painted	No of Coats	Total Dry Film thickness (Min)
1	Powder Paint (a) Thermo setting powder	Inside outside	01 01	20 Micron 60 Micron
2	Liquid paint a) Zinc Chromate (Primer) b) Synthetic Enamel (Finish Coat) c) Hot Oil paint	Out side Outside Inside	02 02 01	45 micron 35 micron 35 micron

**(b) A new Clause 12 A (CORE) shall be inserted after Clause 12 (PERMISSIBLE FLUX DENSITY AND OVERFLUXING) as follows:**

“12A. CORE

The type of Core and Core material shall be as per given below:

**Amendments to REC specification No. 2/1971 (R-1997) : 10.8.2004**

- i) The core shall be wound or cut type. The stack type core is not permitted.
- ii) The design of magnetic circuit shall be such as to avoid static discharges development of short circuit paths within itself or in the earthed clamping structure.
- iii) Stage level inspection for core construction shall be carried out by the owner.
- iv) Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.
- v) The core shall be constructed either from high grade, non-aging Cold Rolled Grain Oriented (CRGO) silicon steel laminations conforming to grade M4 or better. The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that the flux density with + 12.5 % voltage variation from rated voltage and frequency variation of -5% shall not exceed 1.9 Tesla. The bidder shall provide saturation curve of the core material proposed to be used.
- vi) The bidder should offer the core for inspection and approval by the purchaser during the manufacturing stage. Bidder's call notice for the purpose should be accompanied with the following documents as applicable as a proof towards use of prime core material:
  - a) Invoice of the supplier
  - b) Mills test certificate
  - c) Packing list
  - d) Bill of lading
  - e) Bill of entry certificate to customs

Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute and not through any agent.

The complete design of core must ensure permanency of the core losses with CONTINUOUS WORKING of the transformers. The value of the flux density allowed in the design and grade of lamination used shall be clearly stated in the offer.

All parts of the core shall be of robust design, capable of withstanding any shocks to which they may be subjected during handling, lifting, transportation installation and service. Clamping of core and winding assembly with tank should be done by angle iron pieces, welded to tank walls and not to be done with flat iron pieces.

Adequate arrangement shall be provided to enable the core and winding to be lifted.

Use of seconds CRGO steel for core construction is strictly prohibited.

**ATTACHMENT - G**

**REC specification No. 70/1993(R-1997)  
Out-door type 3-phase 11 kV/433-250V Conventional and Sealed distribution  
transformers with Amorphous Metal Core upto and including 100 KVA.**

- (a) A new Clause 8A (PAINT) shall be inserted after Clause 8 (CONSERVATOR) as follows:**

**“8A. PAINT**

The paint material and procedure for the distribution transformer shall be as per details given below:

1 All paints shall be applied in accordance with the paint manufacturer's recommendations. Particular attention shall be paid to the following :

- a. Proper storage to avoid exposure as well as extremes of temperature.
- b. Surface preparation prior to painting.
- c. Mixing and thinning
- d. Application of paints and the recommended limit on time intervals between coats.
- e. Shelf life for storage.

1.1 All paints, when applied in normal full coat, shall be free from runs, sags, wrinkles, patchiness , brush marks or other defects.

1.2 All primers shall be well marked into the surface, particularly in areas where painting is evident, and the first priming coat shall be applied as soon as possible after cleaning. The paint shall be applied by airless spray according to the manufacturer's recommendations. However, wherever airless spray is not possible, conventional spray be used with prior approval of purchaser.

1.3 The supplier shall, prior to painting protect nameplates, lettering gauges, sight glasses, light fittings and similar such items.

**2 Cleaning and Surface Preparation**

2.1 After all machining, forming and welding has been completed, all steel work surfaces shall be thoroughly cleaned of rust, scale, welding slag or spatter and other contamination prior to any painting.

2.2 Steel surfaces shall be prepared by Sand / Shot blast cleaning or Chemical cleaning by Seven tank process including Phosphating to the appropriate quality.

2.3 The Pressure and Volume of the compressed air supply for the blast cleaning shall meet the work requirements and shall be sufficiently free from all water contamination prior to any painting.

2.4 Chipping, scraping and steel wire brushing using manual or power driven tools cannot remove firmly adherent mill-scale and shall only be used where blast cleaning is impractical.

**3 Protective Coating**

3.1 As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anticorrosion protection.

**4 Paint Material**

Followings are the type of paints that may be suitably used for the items to be painted at shop and supply of matching paint to site:

- i) Heat resistant paint (Hot oil proof) for inside surface.
- ii) For external surfaces one coat of Thermo Setting Paint or 2 coats of Zinc chromate followed by 2 coats of Synthetic Enamel paint. The color of the finishing coats shall be dark admiral gray conforming to No. 632 of IS 5:1961

**5 Painting Procedure**

5.1 All painting shall be carried out in conformity with both specifications and with the paint manufacturer's recommendations. All paints in any one particular system, whether shop or site applied, shall originate from one paint manufacturer.

5.2 Particular attention shall be paid to the manufacturer's instructions on storage, mixing, thinning and pot life. The paint shall only be applied in the manner detailed by the manufacturer e.g. brush, roller, conventional or airless spray and shall be applied under the manufacturer's recommended conditions. Minimum and maximum time intervals between coats shall be closely followed.

5.3 All prepared steel surfaces should be primed before visible re-rusting occurs or within 4 hours whichever is sooner. Chemical treated steel surfaces shall be primed as soon as the surface is dry and while the surface is warm.

5.4 Where the quality of film is impaired by excess film thickness (wrinkling, mud cracking or general softness) the supplier shall remove the unsatisfactory paint coatings and apply another. As a general rule, dry film thickness should not exceed the specified minimum dry film thickness by more than 25 %. In all instances, where two or more coats of the same paints are specified, such coatings may or may not be of contrasting colors.

5.5 Paint applied to items that are not to be painted, shall be removed at supplier's expense, leaving the surface clean, un-stained and undamaged.

**6 Damages Paint Work**

- 6.1 Any damage occurring to any part of the painting scheme shall be made good to the same standard of corrosion protection and appearance as that originally employed.
- 6.2 Any damaged paint work shall be made good as follows:
- 6.3 The damaged area, together with an area extending 25 mm around its boundary, shall be cleaned down to bare metal.
- a) A priming coat shall immediately applied, followed by a full paint finish equal to that originally applied and extending 50 mm around the perimeter of the originally damaged.
- b) The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before & after priming.

**7 Dry Film Thickness**

- 7.1 To the maximum extent practicable, the coats shall be applied as a continuous film of uniform thickness and free of pores. Over-spray, skips, runs, sags and drips should be avoided. The different coats may or may not be of same color.
- 7.2 Each coat of paint shall allowed to hardened before the next is applied as per manufacturer's recommendations.
- 7.3 Particular attention must be paid to full film thickness at edges.
- 7.4 The requirement for the dry film thickness (DFT) of paint and the material to be used shall be as given below:

S. No.	Paint Type	Area to be painted	No of Coats	Total Dry Film thickness (Min)
1	Powder Paint (a) Thermo setting powder	Inside outside	01 01	20 Micron 60 Micron
2	Liquid paint a) Zinc Chromate (Primer) b) Synthetic Enamel (Finish Coat) c) Hot Oil paint	Out side Outside Inside	02 02 01	45 micron 35 micron 35 micron

- (b) A new Clause 12 A (CORE) shall be inserted after Clause 12 (PERMISSIBLE FLUX DENSITY AND OVERFLUXING) as follows:**

“12A. CORE

The type of Core and Core material shall be as per given below:

- i) The core shall be wound or cut type. The stack type core is not permitted.
- ii) The design of magnetic circuit shall be such as to avoid static discharges development of short circuit paths within itself or in the earthed clamping structure.
- iii) Stage level inspection for core construction shall be carried out by the owner.
- iv) Each lamination shall be insulated such that it will not deteriorate due to mechanical pressure and the action of hot transformer oil.
- v) The core shall be constructed of amorphous metal. The amorphous core shall be of high quality amorphous ribbons having very low loss formed into wound cores of rectangular shape and clamped together by frames firmly to prevent vibration or noise. The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that the flux density with + 12.5 % voltage variation from rated voltage and frequency variation of -5% shall not exceed 1.9 Tesla. The bidder shall provide saturation curve of the core material proposed to be used.
- vi) The bidder should offer the core for inspection and approval by the purchaser during the manufacturing stage. Bidder's call notice for the purpose should be accompanied with the following documents as applicable as a proof towards use of prime core material:
  - a) Invoice of the supplier
  - b) Mills test certificate
  - c) Packing list
  - d) Bill of lading
  - e) Bill of entry certificate to customs

Core material shall be directly procured either from the manufacturer or through their accredited marketing organization of repute and not through any agent.

The complete design of core must ensure permanency of the core losses with CONTINUOUS WORKING of the transformers. The value of the flux density allowed in the design and grade of lamination used shall be clearly stated in the offer.

All parts of the core shall be of robust design, capable of withstanding any shocks to which they may be subjected during handling, lifting, transportation installation and service. Clamping of core and winding assembly with tank should be done by angle iron pieces, welded to tank walls and not to be done with flat iron pieces.

Adequate arrangement shall be provided to enable the core and winding to be lifted.

Use of seconds CRGO steel for core construction is strictly prohibited.