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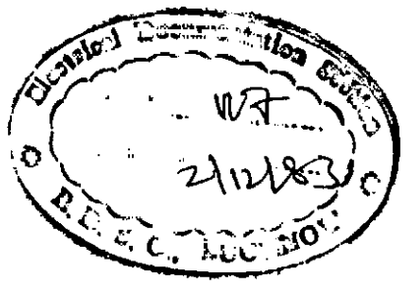

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RAILWAY BOARD

SPECIFICATION FOR SPECIAL DRY TYPE INSULATING TRANSFORMER FOR HEAD ON GENERATION

NOVEMBER 1983

ISSUED BY

RESEARCH DESIGNS AND STANDARDS ORGANISATION
MANAK NAGAR, LUCKNOW - 226011

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SPECIFICATION FOR SPECIAL DRY TYPE INSULATING TRANSFORMER FOR HEAD-ON GENERATION.

Tentative Electrical Design Specification for vertical type, indoor, 380 ± 22.5%V, 50±1.5 HZ, 1 Ph, Dry type, 120 KVA, 1:1 ratio, AN/AF ventilated, insulating, power transformer to be connected to secondary terminal of 389V (tertiary/Aux. winding) of 22.5 KV: 389V. Electric Loco main power transformer in WAM4 Loco and similar other locomotives.

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1.0 SCOPE

.1 This transformer is intended to be used under the programme "H-O-G" (head-on-generation) for supply of nominal power of 120 KVA, 1 phase, 380±22.5% volts to cater particular type of "Hotel load/train lighting service load" in the electric loco hauled important mail/express trains.

.2 This transformer will be fitted inside the loco and connected to 389V, a_0-a_1 terminals (Aux./Tertiary windings) of BOT 3460/HETT 3900/BOT-3900 transformer inside loco which derive electric power at 22.5 KV± 22.22%, 1 phase, AC, 50±1.5 HZ from catenary through pantograph and delivers 389±22.22% volts (at no-load condition). Impedendance voltage drop at this auxiliary winding is in between 4 and 5 per cent at full load of 270 KVA.

2.0 SERVICE CONDITIONS

.1 This is to be mounted in the space available at the site for electric braking resistance inside loco. This specification will generally be governed by conditions laid down in IEC-310 and IEC-77 except otherwise specified in the subsequent paragraphs.

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2.2 Vibration.

2.2.1 The vibration level at the specified site may be deemed for the purpose of design to be of value 3g in all the three directions (X, Y & Z axes). The construction of the unit should be robust, mechanically as well as electrically, to withstand constant vibration of such magnitude inside the loco.

2.3 Noise level.

2.3.1 The noise level at any variation of line frequency as well as at highest available voltage should be below 40 phon/1.1 SONES. This is to be measured with DAWE make, or similarly accurate, sound level meter, sound level indicators and sound level analysers.

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2.4 Environmental pollutions like Humidity, dampness, oil vapour, salinity, dust etc.

2.4.1 The electrical insulation and the materials used in the construction of the transformer should be comparable with the environment prevailing inside the loco. The humidity level will be varying between 0 to 100%.

2.4.2 The environment/weather proofing capability of the electrical insulation should be proved by actual tests as per international standards including IEC-113 and ASTM D570, D543 (for tracking tests on various polluting conditions).

2.5 Flammability of the materials.

2.5.1 Materials used for construction of the transformer should have self extinguishing/fire retarding capability and this must be proved by test as per international standard as in relevant IEC or ASTM D635 (amended upto date).

2.6 Ambient.

The air temperature is to be considered to be varying from 0 to 55°C inside the loco and the insulation should be compatiable to any temperature in this range. For calculating thermal capacity of the unit higher temperature limit of 55°C is to be deemed for the purpose of design.

3.0 Design and workmanship.

3.1.1 It is to be simple, compact, robust/rugged design.

3.1.2 Of excellent workmanship.

3.1.3 Easy for operation and maintenance.

3.1.4 All components are interchangeable; and of defined dimensions and tolerances.

3.1.5 Where machining can be done on jigs and fixtures for subsequent unit productions, the same are to be resolved.

3.1.6 Except otherwise specified materials used in the construction of this transformer must comply with relevant ISS or in its absence, IEC or internationally recognised/RDSO recognised specifications.

3.1.7 Materials used in the construction of this transformer are to be so selected and proved by accelerated tests and calculations that they give a useful service life of 30 years at normal load, at the prevailing environmental conditions inside loco.

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3.1.8 If quality remains the same, the indigenous material is preferable to imported material, if former is not detrimental otherwise.

4.0 Deviations.

4.1 Deviation from the agreed design may be considered as a special case, if the manufacturer submits a specific proposal for the improved performance and/or cost reduction and the Rly. designers find on scrutiny that the proposal is not detrimental in any way and give consent in favour of the proposal.

4.2 No deviations at any stage, of the approved design is permissible without the prior written permission from the Railway designer.

4.3 When the developed transformer is complete in respect of construction with all modifications and incorporations of suggestions then the manufacturer is to declare in writing the final materials used, their property, characteristics, deviations and tolerances which will be binding on all subsequent productions of the same transformer by the manufacturer concerned.

5.0 Documents.

5.1 Drawing indicating overall dimensions, component dimensions, dimensions of different locations, their relative distances, schematic drawings are to be finalised and got approved by Railway designers before the developed unit is finally cleared technically and commercially.

5.2 The numbers of document sets will be finalised in mutual discussions between supplier and the Railway designer/user Railway. Generally it is sixty and sometimes more than that.

5.3 Similarly maintenance manuals, parts catalogue and price list of components bound in a long durable plastic covered detatchable books/files are to be supplied alongwith documents as in para 5.1.

5.4 Exploded isometric/pictorial view of the transformer indicating sequence of fitment of each part with catalogue list number of sufficient quantity are to be supplied as stated in para 5.1.

6.0 Material Inspection.

6.1 Before development and assembly of the transformer, concerned materials and components are to be jointly inspected by Railway designer/user Railway and manufacturer or any of their nominated representative. Fitment/assembly of the component/material should be done when approved by Railway designer/nominated Railway representative.

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6.2 During manufacture the unit will be liable for stage and routine inspections by Railway designer/Railway representative and manufacturer is bound to comply with their instructions, concerned with sound manufacture of the transformer.

6.3 Type test and routine test at the premises of the manufacturer or at a nominated place jointly selected by the manufacturer and Railway designer are to be done in present of Railway designer and in compliance with the guiding specification as already described and as under, and the IEC-310 and IEC-77 as and when applicable. For this purpose, manufacturer concerned must fix date well in advance, and communicate to Railway designer/Railway representative in writing to witness the test and for approval of the tests.

7. Type test and routine test certificate.

7.1 All these test certificates are to be printed in typical and regular manner in an approved format as stipulated by Railway designer, in A4 size form. Ten sets of each test must be handed over to Railway designer within seven days from the date of completion of the test.

8.0 Number of rating tests to be done by the manufacturer.

8.1 This transformer is to be tested at ;

8.1.1 Nominal continuous rating of 120 KVA at amb. of $55^{\circ}C$ and at temperature rise of winding (measured by resistance method) at or below $50^{\circ}C$; with natural convection cooling; at nominal voltage of 389V, at 475V & 328 volts, at 50±1.5 Hz.

8.1.2 At a rating to be determined on the basis of $120^{\circ}C$ temperature rise of winding (measured by resistance method) when ambient is taken as $55^{\circ}C$ - cooling by natural convection, for its continuous rating; at above three voltages and frequency.

8.1.3 Also to determine its continuous rating at ambient of $55^{\circ}C$ and winding temperature rise of $120^{\circ}C$ and forced air cooling, the blower size of which are also to be determined for its maximum available capacity and size within the volume of room available for the transformer (blower mounted at top).

8.2 Available volume of room for accommodating the transformer with all its accessories.

8.2.1 The available volume of the room is ;

a) Height - 1.10 metre.
b) Breadth x width - 1.0 x .8 metre.

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8.3 Determination of short time ratings.

8.3.1 Two extra overload ratings in each continuous rating group as in para 8.1.1, 8.1.2 & 8.1.3 are to be determined by tests and calculations, as per load conditions to be communicated by the Railway designer to manufacturer, in mutual discussions between the two.

8.3.2 Extra tests also to be done by manufacturer at extra charges in future in mutual agreement between Railway designer and manufacturer.

9.0 Design specification and the guiding parameters.

9.1 The base rating of the transformer is 120 KVA.

9.2 It will be a vertical type, dry, 1:1 ratio, 1 phase, 50±1.5 Hz, multi rating, AN/AF cooled power transformer working nominally at 389V but often its input voltage will vary ±22.22% at no load.

9.3 Overall insulation, also the insulating materials used for structural purposes are to be of weather proof, moisture resistance, (preferably hydrophobic), having protective varnishes against moisture, dust, dirt, oil vapour saline air; and of class 'B' insulation, except :

a) Conductor insulation which should be of modern 'C' class insulation material with class 'H' hydrophobic silicon varnish;

b) Spacers between core and winding; which should be moder class 'C' insulation material, insulation varnished with hydrophobic class 'H' silicon varnish;

c) Wedges between coils, which should be of modern class 'C' insulation material with, hydrophobic, class 'H' silicon varnish.

d) And all the main terminal/tap supports; which must be class 'C' hydrophobic insulating material suitably varnished by class 'H' insulating varnishes.

9.4 The coil conductors are to be of high conductivity, electrolytic copper.

9.5 The conductors are preferably class 'C' inter conductor insulated, edge blunted, split, rectangular strips, suitably transposed so as to reduce copper eddy loss to the minimum practicable.

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The 'C' class conductor insulation may preferably be of super refined glass braid suitably varnished by 'H' class silicon varnish. Otherwise hydrophobicity treated polyimidefilm covered CU. Conductors may also be used for winding.

Spacers and wedges may be of composite 'C' class insulation comprising few or most of the materials like highly refined glass, quartz, mica, treated glass fibre textle in built in form and suitably varnished with Class 'H' anti hygroscopic, hydrophobic varnishes may be used.

Materials are, as explained earlier, are to be tested for their desired propery specially diel. strength, ageing strength, arc resistance/flame resistance, moisture absorption tests as per ASTM (amended various upto date) or relevant IEC specifications.

Laminations.

Preferably CRGO 3% - 3.25% Si, 0.28mm thick or 28 M4 B.S.I. class or its equivalent Alleghene - Ludlum class or similar class with 0.375 watt/KG loss at 1T at 50 HZ may be used.

Oven baked lamination varnish may be tested for its durable service.

Flux density at 475V (no load) input voltage should not exceed 1.6T. If noise level is higher than specified, then this value must be reduced further besides improving the sound fitment of core members and coils.

Metred joint is preferred if not detrimental otherwise.

Stepped circular core (nearly 10 steps) is preferred.

Bolt less construction is preferred. But if it is difficult, then non-magnetic bolt of high resistivity material (covered by high temperature class 'C' insulation) of high impact strength and high tensile strength with provision for adequate cooling may be provided.

The sleeves, bushes around the bolt and also the insulations of laminations must withstand diel. strength of 500V AC, 50 Hz for one minute.

Overall efficiency at full load and U.P.F $\geq$ 97.5%.

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9.9.7.2 Prototype tests and routine tests: Except otherwise specified, as per IEC 310 and IEC-77, including ageing test, (as per IEEE or IEC or similar specification, taking into consideration of diel. strength, 100% moisture, salinity, vibration, etc.), short circuit test and special tests as in previous paragraphs. Inpulse test is to be done in consultation with Rly. designers only.

9.9.8 The inpedence drop at full load and of U.P.F. of this transformer itself should not exceed 4.5% and drop due to total resistance at secondary terminal at full load and at U.P.F. in this transformer only should not exceed 1.2%.

9.9.9 Taps at input side and output side, 4 taps of +10% around 380V main terminal are to be provided in ISS manner.

10.0 Further details.

10.1 Further details will be supplied on specific and written request from the manufacturer, and if the Railway designers consider necessary for the same.

10.2 As it is a job of development nature, as such constant and mutual discussions between Railway designers and manufacturers leading to agreements further are expected.

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