SPECIFICATION GUIDE
ABB VACUUM CAST COIL DRY TRANSFORMERS

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ANNEX 1 : Technical schedule
1 General

1.1. Codes and standards

The equipment will be designed, manufactured and tested in compliance with the IEC, CENELEC and ISO codes and standards and specially the following codes and standards:

- IEC 60726  Dry type power transformers
- IEC 60905. Loading guide for dry type power transformers
- IEC 60076-1 to 5  Power transformers
- CENELEC HD 464 Dry type power transformers
- CENELEC HD 538 Three phase dry type distribution transformers
- ISO 9001

Preference of codes and standards:
In case of conflict between this specification and any of the referenced codes and standards, the following order of preference shall apply:

1. This specification
2. Referenced codes and standards
3. Acceptable alternative codes and standards

1.2. Service conditions

Service conditions are as follows:

- Altitude: Maximum 1000 meters above sea level
- Maximum ambient temperature:
  - Never exceeding 40°C and never below:
  - Minus 25 °C in the case of C2 transformers
  - Minus 5 °C in the case of C1 transformers

In addition, an ambient air temperature never exceeding:
  - 30°C average in any one day
  - 20°C average in any one year

(Note: Other environmental conditions may be accepted under request)
1.3. System characteristics

The characteristics of the purchaser's are as follows:
Rated service voltage: 
- HV: ______ kV
- LV: ______ kV
Number of phases: 3
Frequency: ______ Hz

1.4. Documentation

Prior to delivery of the equipment the supplier shall submit to the owner the following information:

- Definitive drawings
- Operation and maintenance manual for transformers
- Operation and maintenance manual for temperature control device
- Rating plate drawing
- Connection diagram
- Routine test reports
2 Design and construction

2.1. Rated power

The transformer shall be designed so that they can deliver continuously its rated current under steady loading conditions without exceeding the temperature rise, assuming that the applied voltage is equal to the rated voltage and that the supply is at rated frequency.

2.2. Overloads

Dry type AN cooled transformers, can be overloaded according to IEC 60905 Loading guide for dry type transformers. It must be admitted that loss of life in overload operation could be higher than in rated conditions.

2.3. Core assembly

The core shall be constructed of the best quality low loss cold rolled grain oriented steel laminations insulated on both sides.
Laminations shall be “step lap” overlapped to minimise core losses and noise.
The assembled core shall be braced in suitable steel frames that make up the base-frame and lifting facilities for complete transformer.
The core assembly shall enable the removal of the coils in the field, if this should become necessary.
The entire core assembly shall be covered with a resin based lacquer for corrosion protection before the coils are mounted.

2.4. HV and LV windings

The winding shall be fully insulated at continuous duty at the specified service voltage. The high and low voltage winding shall have insulation material, conforming to IEC726. The transformer shall have separate high voltage and low voltage windings. The insulation of the windings shall consist of approved materials, which do not deteriorate when the transformers are operated continuously at the maximum permissible temperatures. Dielectric strength of the insulation materials will conform to the lightning impulse values specified.
HV windings

HV windings will be vacuum cast with aluminium foil as conductor material and 155°C (F class) insulation system temperature (copper can be also accepted)
Winding design shall adequate to allow for full encapsulation with filled resin under vacuum. The resin system shall be two components epoxy filled with a mixture of inorganic fillers improving its thermal, mechanical and fire behaviour properties. The single resin components and filler will be carefully stirred and degassed under vacuum in order to eliminate all air bubbles and then mixed together throughout a static mixer just before to pour them, under vacuum, into the mould that contains the coil (winding)
The surface of the encapsulated winding shall be smooth and completely closed and impervious to moisture and common industrial contaminants.
The insulation material used shall be self – extinguishing if ignited by direct flame and no toxic gases will form during heating and/or burning.

HV connections
The HV cable terminals will be made in retined copper material, located above the top of the connection bars.
Each terminal will be drilled with a 13 mm hole ready for connection of cables.
The HV delta connection will be made through rigid copper bars protected by heat shrinkable tubing.

LV windings

The LV windings will be of non encapsulated design with aluminium foil wound (copper can also be accepted) together with an insulating preimpregnated B-stage epoxy resin and thermally cured in an oven to achieve thermal, mechanical and moisture penetration properties that are comparable, for LV coils, with those of casted windings.

LV connections

The LV connections will be made from above onto bars located at the top of the coils on the opposite side to the HV connections.
2.5. Short – circuits

The transformer shall be capable of withstanding, on any tapping, for two seconds (IEC value = 2 s), without damage, under service conditions, the thermal and mechanical effects of a short – circuit at the terminals of any winding.

2.6. Thermal insulation class

The insulation system temperature for HV and LV winding will be 155ºC (class F) .The average winding temperature rise for both HV (at rated tapping position) and LV windings at full load shall not exceed 100ºC.

2.7. Off circuit tappings

The transformer shall be provided with tapping links on the HV windings. Their position can be selected whilst the transformer is off circuit. Taping selection shall be by means of bolted links. The tapping range shall be:

- Plus 2.5% and 5%
- Minus 2.5% and 5%

Tappings with connection cables are not accepted.

2.8. LV and HV windings assembly

The low and high voltage coils of each phase shall be supported and clamped by lower and upper supporting blocks, each having rubber expansion blocks for thermal expansion. The position of the LV terminals shall be either at the opposite side of the HV terminals at the top or at the bottom of the transformer. The neutral bar terminal, if any, shall be at the same side as the LV phase terminal.

The design of the complete assembly should be in that way if necessary, an exchange of separate high and low voltage coils can be done.
2.9. Noise level

Noise level shall not exceed the values stated in CENELEC standards.

2.10. Earthing terminal

Provision shall be made to connect external earthing at position close to the bottom the enclosure at two points. Earthing terminal shall be adequately dimensioned to receive the external earthing conductor/strip.

2.11. Internal earthing arrangement

All metal parts of the transformer with the exception of the individual core laminations core bolts and associated individual clamping plates shall be maintained at some fixed potential. The top main core clamping structure shall be connected to the enclosure by copper strap. The bottom clamping structures shall be earthed by suitable method. Details shall be submitted.

2.12. Finishing

Surfaces preparation treatment and painting procedure:

Material: Steelsheet, completely rust-free.

Cleaning and degreasing
Phosphating (amorphous)
Pressure washing
Passivity process without chrome containt
Drying process
Painting through powder coating (epoxy polyester powder)
Polymerization

Average thickness: 70 µm, no any point lower than 50 µm
Standard Colour: RAL 7032 enclosure / RAL 3002 metallic parts of transformer
Adherence degree: 0-1, according to EN ISO2409
Saline mist resistance: Minimum 250 hours without the oxidation progressing for more than 2 mm after X-shaped scratch made in the centre of the test piece. Tests according to ASTM B117.

2.13. Accessories
The transformers shall be equipped with all the accessories deemed necessary for proper operation by the manufacturer plus the ones specified in the specification. Additional available accessories shall be quoted as options.
- Lifting eyes or lifting lugs.
- Bi-directional wheels
- HV and LV terminals
- Earthing terminals
- Pulling holes on the underbase
- Winding temperature control system:
  The transformer will be equipped with a thermal protection device. It will consist of sensors and temperature control unit. The sensors will be supplied assembled and wired to the terminal block fixed on the upper part of the transformer. The temperature device provided shall have two numbers of potential free contacts for trip/alarm. In order to avoid any malfunction due to magnetic interferences, the temperature device will not be assembled in the transformer, but it will be packed for its transport with the transformer.

- Transformer shall have a rating plate of weatherproof stainless steel material placed in a clear position. Nameplate information as called for by IEC726 shall be provided. This includes:
  - Type of transformer
  - IEC codes must be stated
  - Manufacturer’s name
  - Serial number
  - Year of Manufacture
  - Number of phases
  - Rated power
  - Rated frequency
  - Rated voltage
  - Rated currents
2.14 Enclosures

Standard transformers are supplied without enclosures, protection class IP00. Additional protection may be offered by use of an enclosure to protection IP20 to IP33, which provide safety barrier against accidental live contact.

Standard enclosure:

The enclosure is made of bolt-on type sheets of steel of the bolt-on type with removable panels and supported from the transformer framework. Its removable base can be installed without having to lift the transformer.

Central front and rear handle panels will be provided for access to the tap changer.

Inlet-outlet of cables are situated at the bottom of the enclosure through aluminium gland plates to be machined by the customer.

For indoors applications the sheet steel will be galvanized without paint, for outdoors applications will be painted in a grey colour, RAL-7032, if not otherwise is specified (Painting procedure can be submitted).

Design for IP21 and IP31
Design for IP23 and IP33

Rain protection

2.15 Package system

The package system will follow different rules depending on the way the transformer will be transported.

Transport by land
A protecting plastic bag will cover the transformer and will be based on a pallet.
Transport by sea
Thermo – isolating bag: The transformer will be fitted in a bag made of a thermo – isolating material (C – 315), according to the MIL B 131 code. This bag will be made of:
- 1 film of PVC
- 1 film of aluminium
- 1 film of polyester or unweaved cloth

Before closing the bag in vacuum, some dehydrating bags will be placed inside absorbing the humidity and a bubble plastic will cover all the cutting edges.

Dehydrating material: It will be an activated clay (Bentonite) distributed in bags (weight: 250 g) according to the MIL D 3464 D code.

Package: Made of pinewood
- Bottom: It will be a platform made by a 25 mm thickness board joint to a frame created by 2 boards of 100x100 mm and 2 of 50x100 mm, all together nailed to a screed ground
- Cover: Boards (thickness: 25 mm) will be joined by bars of 100x25 mm
- Sides: Boards (thickness: 25 mm) will be joined by bars of 100x25 mm

Fixing: Wood pieces (100x50 mm) will be placed to fix the transformer to the package.

Iron fittings:
- Bottom: 4 squares with a length of 250 mm and wings of 100x100 mm.
- Cover: 4 steel angle of a length of 1000 mm and wings of 100x100 mm.
- Sides: Galvanised sheet (length: 100 mm) and wings of 100x100 mm
3. Inspection and testing

3.1. Routine tests

The transformers are subject to inspection during their manufacture. Routine test of each transformer shall be according to IEC726:

- Measurement of windings resistance
- Measurement of the transformation ratio and vector group
- Measurement of impedance voltage and load loss
- Measurement of no load loss and no load current
- Applied voltage dielectric test
- Induced voltage dielectric test
Measurement of partial discharges will be included

3.2. Type and special tests

Type or special tests may be available under request, subject to prior agreement of the supplier:

- Temperature rise test
- Lightning impulse test
- Noise level test

3.3. Inspection

The equipment shall be subject to inspection and testing during manufacture and after completion by one representative from the Buyer. All the expenses for travel, accommodation, visa, etc. of the representatives in connection with the inspection, shall be borne by the Buyer. Acceptance by Buyer’s representative of any transformer shall not relieve the manufacturer from any of this performance guarantee, or from any of the other obligations resulting from this contract.