MEDIUM VOLTAGE DRY TYPE

CAST RESIN TRANSFORMERS

HANDBOOK OF INSTALLATION AND SETTING IN SERVICE

Trafomec - Gruppo Trafomec Via Pievaiola - 06068 Tavernelle - Perugia - ITALY
Tel. +39 075 83537.1 Fax. +39 075 8355835 www.gruppotrafomec.com

INDEX

1 - Preface
2 - Referring standards
3 - Admissible overloads
4 - Losses in function of the load

a - INSTALLATION

1.a - Handling of transformers
2.a - Types of installation
3.a - Environmental temperature
4.a - Operation temperature
5.a - Insulating distance
6.a - Safety distance
7.a - Heat dissipation
8.a - Tightening torque for electrical connections

b – SETTING IN SERVICE

1.b - Controls and electrical tests
2.b - Final controls on transformer
3.b - Setting in service and calibration of the protection devices

1 – PREFACE

The transformer is ready for installation at the dispatch. Only the electrical connections between cables and connections bars of the primary and secondary winding are to be performed.
The current document reports the useful recommendations for use, maintenance and check of the cast resin transformers.

2 – REFERRING STANDARDS

- Standard CEI 14-8 (Dry type power transformers)
- Standard CEI 14-4 (Power transformers)
- Standard CEI 11-18 (Designing of the plants according to the voltage)
- Standard CEI 28-3 (Coordination of the insulation parameter for voltages over 1kV)
- Draft project 547 of 27-4-55 and following amendments

3 – ADMISSIBLE OVERLOADS

- The transformers can stand the following overloads in nominal ambient temperature 30°C once in each 24 hours:

  +5% -continuously
  +10% for 2 hours
  +20% for 1 hour
  +30% for 30 minutes

- It is possible to use a transformer that is designed for nominal ambient temperature of 40°C in higher ambient temperatures, reducing the power according to the following chart:

Ambient temperature °C	40	45	50	55
Admissible load P	P	0.97 x P	0.94 x P	0.9 x P

4 – LOSSES IN FUNCTION OF THE LOAD

There are two types of losses in a transformer:

- No-load losses: these losses are due to iron core and do not vary by varying the load.
- Load losses: These losses are because of the current flow in the winding and depend to the supplied power furthermore they vary by varying the load as follows:

  - Full load = Rated losses
  - ¾ of the full load = **9/16** of the rated losses
  - ½ of the full load = **1/4** of the rated losses
  - ¼ of the full load = **1/16** of the rated losses

a – INSTALLATION

1.a – HANDLING OF TRANSFORMERS

Depending on the kind of packing of the transformer particular attention should be paid during the handling:

- Packing case or wooden crate: The handling could be performed by means of fork truck or hoist and crane endowing sling rope.
- Protection by Nylon foil: Handle using the lifting bolts that are positioned on the upper side of the transformer, by means of hoist or crane.
- When the transformer is fitted with a case, it would be necessary to remove the cover of the case and to hooke to the eye-bolts of the transformer, as indicated in the preceding point.
- When it is explicitly required from the customer, the eye-bolts of the transformer could be brought out of the cover of the box and in this case they could be used for handling.
- For short handling (or positioning) of the transformer it could be moved by means of wheels either in longitudinal sense or transversal, using the apposite hitches, positioned in the lower part of the frame.

2.a – TYPE OF INSTALLATION

- Indoor (without protection)
- Indoor (with case)
- Outdoor under a roof (with case)
- Outdoor (with case)

3.a – ENVIRONMENTAL TEMPERATURE

- For the transformers according to the moisture and pollution class, climatic class and flame behavior E0-C1-F0.
  The standards recommend that the cooling air temperature should not be more than 40°C and not less than 5°C; the daily average temperature should not exceed 30°C and furthermore the yearly average temperature value should be ca. 20°C.

- For the transformers according to the moisture and pollution class, climatic class and flame behavior E1-C1-F1.
  The environmental temperature during the working and putting in service should not be less than –5°C, however the stocking temperature can arrive till –25°C.

- For the transformers according to the moisture and pollution class, climatic class and flame behavior E2-C2-F1.
  The operation and stocking temperature should not be less than –25° C.

4-a – OPERATION TEMPERATURE

In the following chart have been reported the maximal temperature values for transformers operating at 40°C in relation of their thermal insulation class:

Insulation class	$T_{Max.}$ (°C)
B	130
F	155
H	180

Each transformer is endowed of N° 3 thermal sensors (PT100Ω), if not otherwise requested, position one for each low-voltage winding and connect it to the displaying and data management device that has two level of intervention (alarm and break down), the following values are recommended for their calibration:

Insulation class	T Alarm (°C)	T Break down (°C)
B	100	120
F	120	140
H	145	165

5.a – INSULATING DISTANCE

In the following chart have been indicated the minimal insulating distances to keep according to the standard CEI 11-18 among the live parts of the transformer and the surrounding metallic parts or other plant elements that are under voltage.

Max. voltage (Um) - kV -	Dielectric strength		Insulation distance (cm)
	Industrial frequency - kV -	Lightening pulse – kV-	
3.6	10	20 - 40	6
7.2	20	40 - 60	7 - 9
12	28	60 - 75	10 - 12
17.5	38	75 -95	13 - 16
24	50	95 - 125	17 - 22
36	70	145 - 170	27 - 32

When the transformer is fitted up with a hausing there is no need to keep the insulation distance while it is already kept between the transformer and the housing.

6.a – SAFETY DISTANCE

During the installation it should be taken in account to avoid the danger of accidental contact between the persons and the live parts of the transformer , including the cast resin parts, taking in consideration the good heat dissipation that is generated in the same transformer.
The minimal distances to keep for the protection of the persons from accidental contacts, according to the standard CEI 11-18 and the D.P.R. 547 are reported in the following chart:

Max. voltage (Um) - kV -	Dielectric strength		Safety distance (cm)
	Industrial frequency - kV -	Lightning pulse – kV-	
3.6	10	20 - 40	15
7.2	20	40 - 60	15
12	28	60 - 75	15
17.5	38	75 -95	18 - 20
24	50	95 - 125	22 - 28
36	70	145 - 170	34 - 40

7.a – HEAT DISSIPATION

In the general case of natural convection cooling (AN), in order to have a correct installation and a sufficient life duration of the transformer it is necessary to dissipate the generated heat in the iron core and the windings, taking care of not to exceed the fixed temperatures in relation of the insulation thermal class of the transformer.
In order to ensure the correct cooling of the transformer, the air should graze the cooling surfaces of the same transformer, consequently it is necessary to perform adequate openings on the hausing so that for every 1 kW losses, 3.5 m^3 of air can flow in a minute.
In the installation cabin it is necessary to perform openings for air inlet on the same level of the floor for receiving the fresh air and to perform openings on the apposite side on the upper side near the roof for outlet of the warm air.
The theoretical formula of the openings to perform in relation of the losses to dissipate is the following (Fig. 1):

$$\mathbf{S} = \frac{0.188\,\mathbf{P}}{\sqrt{\mathbf{H}}}$$

where

S = Section of the openings for air inlet / m^2
P = Sum of the iron losses and the winding losses at 120°C / kW
H = Difference of the levels of the two openings /m.

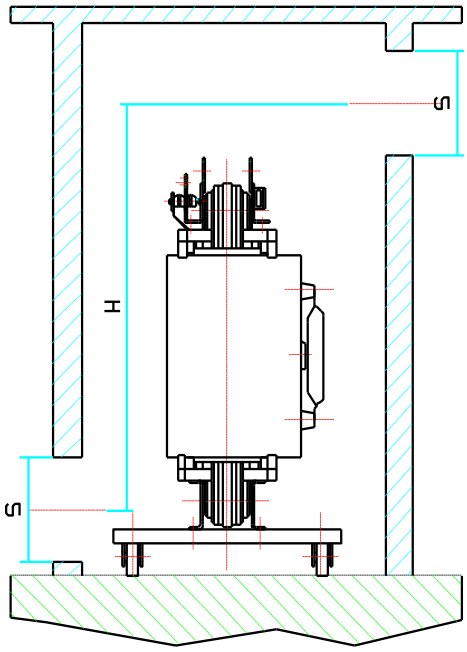

Fig. 1

8.a – TIGHTENING TORQUE FOR ELECTRICAL CONNECTIONS

It is appropriate to perform the fixing of the M.V. and L.V terminals and the connection bars of the tapings using the following values of the fixing torque:

Bolts	M8	M10	M12	M14	M16
M.V. (Nm)	9.81	19.7	39.3	58.9	
L.V. (Nm)	12.3	24.5	44.2	68.7	98.1

b – SETTING IN SERVICE

1.b – CONTROLS AND ELECTRICAL TESTS

Once the transformer is installed, connect the outputs of L.V and those of M.V., the grounding and the auxiliary circuits in the right sequence.
Before setting the transformer under voltage must be performed the following electric tests:

- Check by using the electrical connection scheme the right power supply of the transformer in the case that the transformer has n. two primary windings.

- Check that the voltage regulation tapings of the primary winding are positioned on the best position according to the voltage on the primary winding.
- Check the electrical and mechanical connections

- Check the dielectric strength among the windings and vs. grounding by means of a megger with the nominal voltage greater than 1000 V, the following values should be found by the measurements:

M.V. vs. L.V. connected to the grounding	20 MΩ
L.V. vs. M.V. connected to the grounding	10 MΩ

  In the case lower values are measured, clean accurately by means of compressed air the windings of the transformers and dry them by means of warm air in the oven or through other way and repeat the measurement again.

- In the case that the transformer is parallel connected to other transformers, check very accurately by means of Voltmeter the concordance among the phases (please pay attention to choose the right voltmeter, because in the case of the wrong parallel connection the measured voltage could be twice of the phase voltage).
  Furthermore verify that the ratings plates report the same values or compatibles while in other case the parallel connection between the transformers would not be possible.

2.b – FINAL CONTROLS ON THE TRANSFORMER

During the operations of connections and installation of the transformer it is possible that some tools, bolts and or washers have been inserted accidentally in the cooling ducts of the windings or left on the transformer. Since it is necessary to clean up the transformer accurately so that once the transformer is under voltage does not happen failures due to the presence of strange objects.

3.b – SETTING IN SERVICE AND CALIBRATION OF THE PROTECTION DEVICES

The setting in service of the transformer should occur by setting directly under the net voltage in no-load condition.
This switching causes an inrush current that can be more times higher than the rated current of the transformer (generally from 5 up to 12 times, in the bad switching conditions this can rise up to 18 times the rated current).
Therefore it needs to regulate optimally the max. current relay introducing a small delay about at least 20 ms.
Following are reported theoretically and indicative values that shows the increment factor of the inrush current to the nominal current **In**:

kVA	**100**	**160**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**	**2000**	**2500**
In	15	14	13	11	10	10	9	9	8	8	7	6	5