INSTRUCTION MANUAL

DRY-TYPE TRANSFORMERS

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1. INTRODUCTION

This manual is intended to provide the user with all necessary information regarding transport, storage, installation and maintenance of WEG dry-type transformers. Compliance with these instructions will allow for a better performance of the transformer and will extend its useful life.

All WEG transformers are designed and built strictly according to the last editions of the ABNT standards. Therefore, the information contained herein remains subject to changes without previous notice.

For those who wish to obtain further information about the applicable standards, we recommend the reading of the following standards:

- IEC 60076-11: Dry-type transformers.
- IEC 60076-12: Loading guide for dry-type power transformers.

Also very important is to have in hands the publications about installation of transformers, issued by the network power suppliers of your region, since many of them have a normative character. For further clarifications, call our Technical Assistance Department.

Figure 1

2. BASIC INSTRUCTIONS

2.1. General instructions

All workers involved with electrical installation, whether in assembly, operation or maintenance work, should be permanently informed and updated about the standards and safety procedures that rule the work and we suggest that they adhere to them. It is the buyer responsibility to make sure, before the work begins, that all instructions have been read and understood and all involved workers are aware of the hazards involved in the proposed task. We recommend that only qualified personnel should carry out such work.

Fire-combat equipment and first-aid placards should be available at the work place, always placed in visible and accessible places.

2.2. Supplied condition

All transformers, after having been tested and released for shipment, are properly packed at the factory for a safe transport in order to assure their perfect operation. In addition, these transformers require a suitable protection against the elements during the transport. It is the responsibility of the freight carrier to assure that a shipped transformer will be properly sheltered, tied or fixed for transport. Upon receipt, we recommend a careful inspection in order to check the transformer for the integrity of its protection and for any damages occurred during the transport. In case damages have occurred, please notify immediately your local WEG representative and the freight carrier so that insurance indemnification can be claimed without problems.

Warning!
Compliance with the regulation NR 10 – SAFETY IN INSTALLATIONS AND IN WORK WITH ELECTRICITY is essential.

2.2.1. Receiving place

Whenever possible, the transformer should be unloaded directly onto its definitive mounting base. When it becomes necessary to unload it in a temporary place, the ground should be checked for proper conditions of safety and load distribution and also for proper level and cleanliness. It is convenient to keep the supplied plastic protection until the transformer is taken to its definitive place of installation.

2.2.2. Unloading and handling

All the work of unloading and moving the transformer should be carried out and supervised by specialized personnel and should be carried out in accordance with all cares that such a significant weight requires, following all applicable safety rules and using all indicated points of support.

The transformer should be lifted or hoisted by the points indicated in the drawings. Do not use any other points, otherwise severe damages can occur to the transformer. In case of horizontal movement, bi-directional wheels are supplied for this purpose. The use of a forklift to move the transformer is not recommended. However, if necessary, special cares should be adopted regarding to the transformer positioning.

When moving the transformer on the ground, strains should be applied only to its core pressing beams or the base beams.

Important: Transformers fitted with cubicles (protective boxes) should not be suspended by eventual eyebolts available on the cubicle. The transformer must be hoisted always by the leash eyes available on the top beams of the transformer (Located inside the cubicle).

Every care should be taken in not applying strains to improper places like the bus bars and the coils, which could cause irreversible damages and compromise the operation of the transformer.

Careful handling!
Do not submit the coils or their wedges to any strains, otherwise any displacement could affect the electric features of the equipment or cause damages when power is supplied to the equipment.

2.2.3. Inspection upon receipt

Before unloading, specially assigned personnel should carry out a preliminary inspection of the transformer in order to check for its external conditions, accessories and components for any deformity and condition of their painting. The packing list should be checked. In case of any evident damage, missing accessories and components or any indication of improper treatment during the transport, the manufacturer and the freight carrier should be notified.

2.3. Storage

When the transformer cannot be installed immediately, it should be stored, preferably with its original package, in a sheltered and dry place and free of dust and corrosive gases. In addition, the transformer should be stored in its normal position and be set apart from any area of intense traffic or subject to collisions. If necessary, we recommend the use of a plastic cover in order to avoid the settlement of dust on it. In case of transformers fitted with protective cubicle, sílica gel should be place inside the cubicle in order to absorb the humidity. This way, the transformer can be stored for a long time without any changes to its insulation features.

Components and accessories, when removed from the transformer either for transport or for storage, should be stored in suitable places, using the same cares as for transformers.

After a storage period, the dry transformer can be powered according to the corresponding instructions. A previous drying of the windings will not be necessary, since they do not absorb humidity.

3. INSTALLATION OF DRY-TYPE TRANSFORMERS

3.1. General considerations

All WEG dry transformers are designed to be operated at a maximum room temperature of 40°C and at a maximum altitude of 1000 meters, unless otherwise ordered. The place of installation should be a roofed building with suitable ventilation conditions for its proper cooling. Although they are quite resistant, dry transformers should not remain directly exposed to the elements.

Before taking any steps for assembling the transformer, make sure that qualified personnel and suitable equipment and tools will be available. The assembly should be carried out in compliance with all specific technical standards for dry transformers. The assembly of a transformer on a rainy day is not recommended.

Before starting the transformer assembly, the following checkups have to be carried out:

- Visual inspection, particularly for a proper leveling of its base;
- Suitable fixing of the transformer;
- Visual inspection for any damages occurred during the handling;
- Confirmation that the nameplate ratings are compatible with the technical specification of the equipment;
- Assessment of the transformer's grounding connections.

Warning!
To re-tight electrical and mechanical connections, please follow the steps described below: This will assure a proper pressing of the magnetic iron core and the contacto f the electric connections.

- Retightening of all connections as per the following procedure:
    1. Loosen the upper horizontal tie-bar internal nuts;
    2. Re-tighten the upper armor vertical tie-bar nuts;
    3. Re-tighten the upper horizontal tie-bar outer and inner nuts;

4. Loosen the lower horizontal tie-bar inner nuts;
5. Re-tighten the lower horizontal tie-bar outer and inner nuts;
6. Re-tighten all other mechanical connections (IP-box, wheels, grounding, etc);
7. Re-tighten all electrical connections.

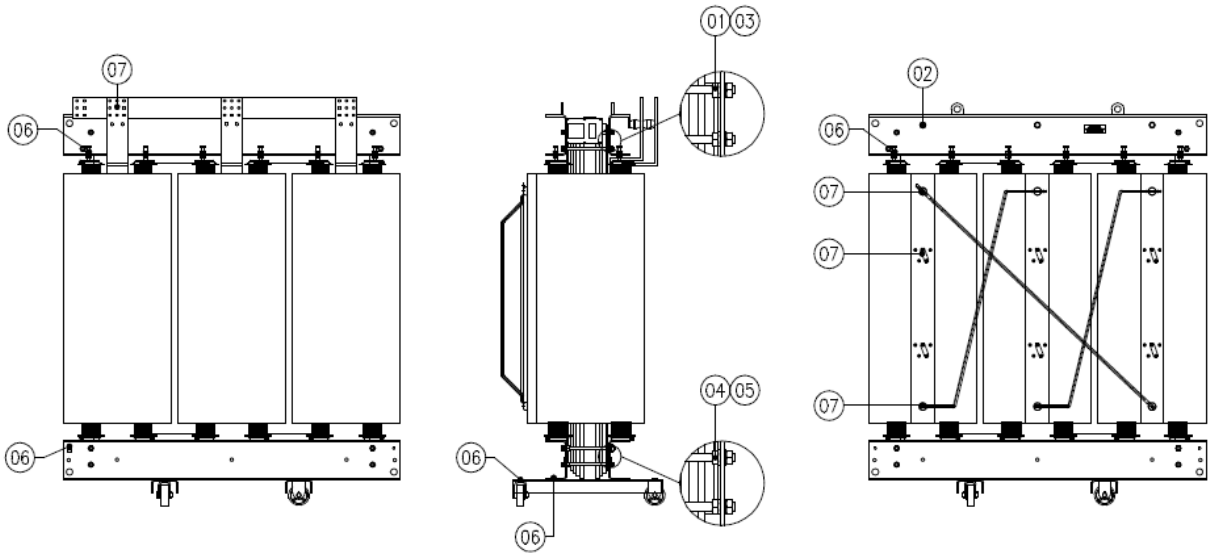


Figure 1

Table 1 – Tightening torque for connection bolts on bus bars

Low-voltage bus bars			High-voltage bus bars
GAUGE	**Class 5.6**	**Stainless steel**	**Brass**
M8	24.0	12	-
M10	48.0	25	10
M12	84.0	42	18
M16	200.0	102	40
M20	390.0	200	80

Table 2 – Tightening torque for connection bolts on the transformer's structure

Other bolts (Fixing of the active part)			
GAUGE	**Class 5.6**	**Class 8.8**	**Stainless steel**
M8	8	15	12
M10	16	30	25
M12	30	60	42
M16	70	140	102
M20	140	275	200

Danger!
Never apply power to the transformer without having first checked the tightening of electrical and mechanical connections.

3.2. Special conditions

Special operating, transport and installation conditions are those that might require a special construction and the review of some rated values, special cares during the transport and installation of the transformer.

Examples of such special conditions are:

- Installation at altitudes above 1.000 meters and at temperatures above 40°C;
- Exposure to excessive humidity, salty atmosphere, harmful gases and smokes to the equipment;
- Exposure to harmful dusts and powders;
- Exposure to explosive materials in the form of gases or powder;
- Requirement for an insulation other than that specified for the equipment;
- Limitation of the installation space;
- Transport, installation and storage in poor conditions and subject to abnormal vibrations and occasional collisions.

These factors should be always checked in order to obtain the best performance of the transformer and also as prevention against any accidents or damages to the equipment. (Any eventual exposure to these factors can cause a reduced performance of the transformer according to temperature class of the material, dielectric stiffness of the insulating materials, and others.

3.3. Basic installation requirements

Dry-type transformers should be installed over foundations that are properly leveled and capable to withstand their weight. When a transformer is fitted with wheels, make sure the equipment will be equally supported on its base points in order to assure its stability and to prevent any deformation.

When installing the transformer, the following factors should be carefully taken in account:

- There should be a minimum spacing of 0,5 m between one transformer and another, and between the transformer and any adjacent wall in order to facilitate the access for inspection and ventilation, depending, however, on the project dimensions and the voltages;
- The room where the transformer will be installed should be well ventilated as to assure proper natural ventilation, since this is an essential parameter for a proper performance of a dry transformer. In this regard, it is important that the air inlets are located at the front part of the transformer near the bottom and the air outlets are located at the back part of the transformer, with near the top openings large enough to allow for a circulation of approx. 2,5 cubic meters of air per minute/kW of loss. (See the example calculation below).

Proper ventilation in the transformer room will Grant the expected useful life and stable operation either on continuous regime or under momentary overloads.

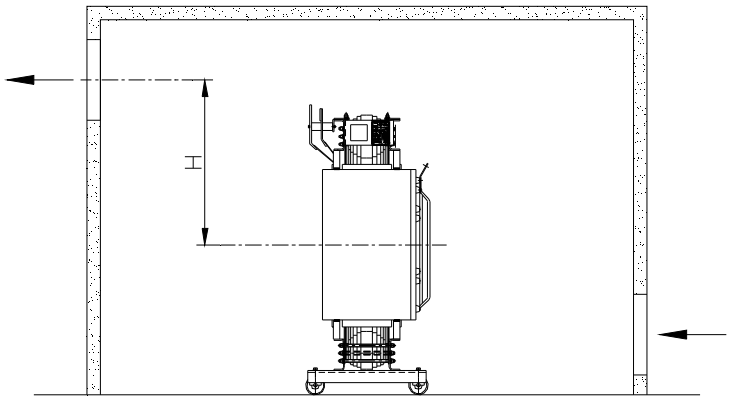


Figure 3

As normally the natural ventilation is not sufficient, fans can be installed to increase the air flow in the room according to figure 4 or, preferably, adopt the refrigeration of the room where the transformer will operate.

Danger!
If the transformer room is going to be air conditioned, make sure the conditioned air will not be directly blown on the transformer, otherwise water condensation can be built on it and can result in the transformer's burning.

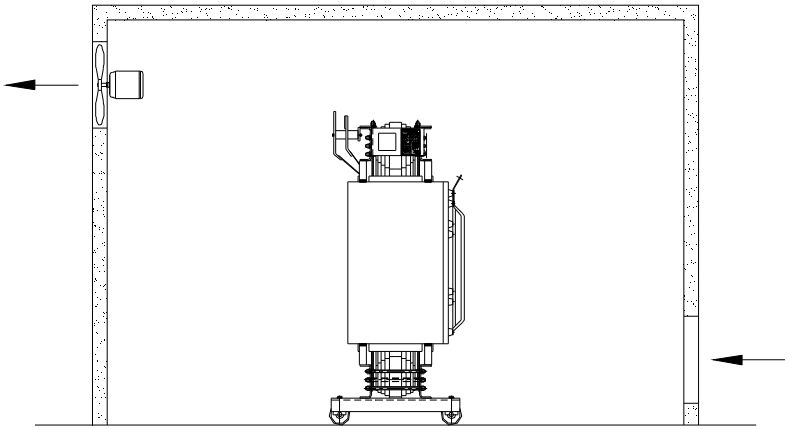


Figure 4

To calculate the approximate size of the openings or the airflow necessary in the room the following expressions cab be used, considering a difference of 15ºC between the inlet air and the outlet air.

$$S = 0{,}3 \times \frac{P_t}{\sqrt{H}}$$

$$S' = 1{,}1 \times S$$

$$V = 5 \times P_t$$

where:

P_t = total transformer losses sinked at 115°C [kW]

S = lower opening surface [m^2]

S'= upper opening surface [m^2]

H = distance measured between the middle of the height of the transformer and the middle of the upper opening for air outlet [m]

V = cooling air volume [m^3/min]

Example: Installation of two 2.000kVA dry-type transformers

Typical total losses PT for 2MVA dry-type transformer at 115°C = 27kW

Distance H between the middle of the transformer height and the middle of the air upper outlet opening: 1,5m

$$S = 0{,}3 \times \frac{27 \times 2}{\sqrt{1{,}5}} = 13{,}2 m^2$$

$$S' = 1{,}1 \times 13{,}2 = 14{,}5 m^2$$

From the calculated area we know that the installation of forced ventilation in the room will be necessary. The minimum flow of the fans will be:

$$V = 5 \times 27 \times 2 = 270 m^3 / \min$$

This example does not consider the presence of a protection cabinet, wich would be put in question in the case of a proper room for the transformer installation.

Warning!
If the transformer is fitted with protective cubicle, do not replace that Box with another because its ventilation might not be enough for a proper operation of the equipment.

3.4. Operation Altitudes

Our transformers are designed in compliance with ABNT standards, i.e., for installation in altitudes up to 1.000 m above the sea level. When installed in altitudes above 1.000 m, the transformer will have a reduced performance or will require a more effective cooling system. Therefore, a table of correction factors is provided bellow, considering the reduction of dielectric stiffness of the air as a function of the altitude:

Table3 - Corrections of dielectric stiffness of the air for altitudes of 1000 m above the sea level

Altitude (m)	Correction factor
1000	1,00
1200	0,98
1500	0,95
1800	0,92
2100	0,89
2400	0,86
2700	0,83
3000	0,80
3600	0,75
4200	0,70
4500	0,67

Source: NBR - Table 5

3.5. Space requirements for operation

The transformer should be installed and have its cables connected according to the required dielectric distances, for which proper standards are available for each voltage class. The transformer should be set apart from walls, grids, electrical conduits, cables and other devices according to the values specified in the following table. These distances are also important in order to meet the ventilation requirements:

Table 4 - Minimum external spacing for dry-type transformers

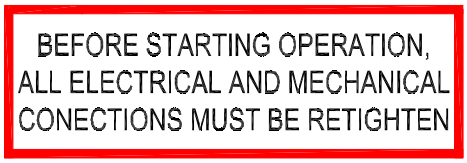
Voltage class of the equipment [kV](Effective)	Atmospheric impulse voltage [kV]	Minimum spacing PHASE-GROUND [mm]	Minimum spacing PHASE-PHASE [mm]
0,6	----	25	25
1,2	----	25	25
7,2	40	45	60
	60	65	90
15	95	130	160
	110	150	200
24,2	125	170	220
	150	200	280
36,2	150	200	280
	170	240	320
	200	300	380

3.6. Connections

All connections to the transformer should be made according to the diagram of connections stated on its nameplate. **It is important to check whether the nameplate ratings meet the specification of the system where the transformer is going to be installed.**

The cable ends should be flexible enough to prevent mechanical strains that could be caused by expansion and contraction, which could break the isolators, when

available. Such ends allow for significant weight of cables, but long distances without support should be avoided. Cables and bus bars should be suitably sized and the connections should be duly tightened up in order to avoid any overheating. All WEG dry-type transformers have their terminals marked according to applicable norms.



The thermal protective loop, when available, should be connected according to the instructions given in a separate manual.

The grounding mesh should be connected to these connectors by means of a bare copper cable having a suitable section.

The high-voltage terminals of the dry transformer are made of tin-plated copper.

The low-voltage terminals are made of a special alloy of aluminum in order to assure recommendable mechanical qualities for a good connection (Exceptionally, these terminals are made of copper).

The aluminum connection requires a few cares as described below:

- **Surface preparation:** Before making any connection, the aluminum surfaces have to be cleaned up in order to remove the thin oxide layer created naturally upon contact with the air, which causes poor conductance. The removal of such oxide layer can be made with the use of wire brush, fine sand paper, scratching, etc. It is important to carry out this operation as quickly as possible and right after it, the surface should be greased with a suitable oxidation inhibitor.
- **Aluminum-Aluminum connection:** The transformer terminals and the bus bars that are going to be connected to aluminum-aluminum connections should be treated as described above.

Warning!
Always check for the existence of copper-aluminum connections because they require special cares.

- **Aluminum-copper connection:**
  - Bare lead surface: Clean up;
  - Copper lead surface:
    - § Bare copper: Clean up;
    - § Copper coated with silver, tin or nickel: Clean up or clean up and add a plate made of bare copper or Cupal. After cleaning up, grease it with a suitable oxidation inhibitor.
- **Material employed for connections:** All parts, nuts, bolts and flat washers should be protected against corrosion.
- **Contact pressure:** The bolts should be tightened preferably with a spanner having a dynamometer or a torque-limiting spanner in order to obtain an even distribution of contact pressure. It is recommended to carry out a retightening of the bolts after a few weeks of use in order to equalize any accommodations (See table 1 in this manual).

3.7. Protective and maneuvering equipment

The transformer should be protected against overloads, short-circuit and voltage outbreaks by means of fuse switches, circuit breakers, isolating switches, lightning rods, etc., which should be suitably sized in order to be coordinated with the transformer and tested before any connections are made.

3.8. Temperature Monitor

In case the temperature monitor is fed with one of the transformer's phase, this must be made with the phase adjacent to the monitor, for instance, if the monitor is installed besides the phase 1, it's feeding must be made with such phase. In contrary, it will cause the monitor burning.

The thermal protection system will protect the transformer when it becomes overheated for some reason. Therefore, make sure it is properly supplied and working before applying Power to the transformer.

4. POWERING UP

The transformer should be powered up only after checking the following items:

- Make sure the name plate ratings are in accordance with the ratings foreseen for the place of installation;
- When transformers are to be operated in parallel, make sure they are connected with the right polarity;
- Make sure all connections to cables or bus bars are properly connected and well positioned;
- Make sure that all connections at the tap change panel are firmly tightened and at the same position in the three phases;
- Make sure the grounding mesh is correctly connected to the bolt provided for this purpose. In addition, make sure the grounding mesh has been correctly executed at the right place foreseen in the project and shown in the drawing;
- In case of transformers fitted with a thermal protective device, check the connections of the circuit, making sure that the voltage is in accordance and that the alarm and shut-off contacts are connected to their corresponding loops;
- Make sure there are no materials, equipment or any other impurities laid on the transformer, between the coils or obstructing the ventilation in the cooling channels. The cleaning should be carried out according to item 5.2;
- It is always recommendable to check the insulation resistance by making measurements between the LV and HV windings and from the windings to the ground.

After these checks are made, the transformer shall be connected to the system. Voltage shall be applied while the transformer is set to no load, and such voltage shall be measured at the secondary winding to check for the corresponding output ratings.

Operations under voltages other than the rated one can cause saturation significant loss increase, which could lead to over-heating and noise above the standard levels.

The load should be applied progressively until the rated power.

Warning!
If the transformer is set to an improper tap, noises above the standard levels are to be expected.

4.1. Re-starting the transformer for the rectifier after a failure in the system

When the system is shut down because of some problem, i.e., without the intervention of operators, the power supply to the transformer should be restored only after the following procedures:

1. The transformer's supply and load cables should be disconnected;
2. An ohmic-resistance essay should be carried out on all windings (LV and HV), between phases and between phase and neutral (The latter when applicable);
3. A transforming-ratio essay should be carried on all taps;
4. An insulation-resistance essay should be carried out on all windings between each other and against ground;
5. If all the above-mentioned essays show satisfactory results in comparison with the factory reports, then the core should be demagnetized as follows:
    - Using a suitable variable voltage source, apply one voltage ramp from the source's zero level until the transformer's rated voltage through the LV side while the HV is open and at the highest tap. Keep that voltage for two (2) minutes.

After these procedures are carried out with satisfactory results, the power to the transformer can be restored. All these procedures should be documented.

Following the above-mentioned procedures for re-starting the transformer after a system failure will assure that the transformer has not suffered damages due to any external short-circuits.

5. MAINTENANCE

Being one of the greatest advantages of this type of transformer, the dry transformers manufactured by WEG require very little maintenance. Nevertheless, it is necessary to establish a constant follow-up in order to prevent any troubles caused by the accumulation of dirt (Which could cause a loss of cooling performance and a consequent loss of power), inspect for any deformations of their structure, inspect all connections and other procedures.

Maintenance procedures:

1. Visual inspection of the place;
2. Cleansing as specified hereinafter in item 5.2, inspection of the air inlets and outlets;
3. Check all terminal connections for any occurred overheating;
4. Check the thermal protective assembly for proper operation;
5. The contacts of terminals and the changeover switch panel for a proper contact pressure.
6. Make sure the grounding is properly connected to the right terminals.

The transformer and its installation room should remain essentially clean all the time for a proper operation. Therefore, cleansing should be part of the check-list upon every periodic maintenance procedure.

5.1. Periodic inspections

5.1.1. Operational records

All operational records should be obtained from the reading of the available indicating instruments, from extraordinary occurrences related to the transformer and from every event related or not with the operation of the electric system that could affect the performance and/or intrinsic features of the equipment. It is recommendable

to carry out daily readings of the temperature indicators (make notes of the room temperature), load and voltage of the transformer.

5.1.2. Thermographic inspections

These inspections should be carried out periodically at the installations, particularly in order to detect any abnormal heating on the connectors.

5.1.3. Visual inspections

Periodic visual inspections should be carried out by following a previously established checklist, which should include all recommended points.

Some predictable defects can be listed along with a suggested solution.

TABLE 3 – TROUBLESHOOTING

ITEM	ABNORMALITY	PROBABLE CAUSE	CORRECTION
1	Overheating at the HV and LV terminals and connection points and the switching panel.	Poor contact.	Clean the areas of contact Tighten bolts and nuts.
2	Overheating of the transformer	Overload above the foreseen level.	Reduce the load. Increase the cooling.
		Insufficient circulation of cooling air.	Clean the cooling air channels of the transformer. Check the cooling air circulation ducts/openings for proper size and obstructions.
		Temperature of the cooling air above the foreseen level.	Reduce the load. Increase the circulation of cooling air.
3	Actuation of the protective relay (Alarm and/or shut off)	Overheating of the Transformer.	As per item 2.

		Lack of supply voltage for the relay.	Check the relay for proper supply voltage. Check the relay and its wiring for proper operation.
4	Discharge between HV terminals Discharge between HV and mass	Reduction of the superficial resistivity of the insulating material due to the existence of foreign bodies.	General cleaning, removing all foreign bodies settled on its surface.
	Discharge between HV/LV Discharge between LV/mass	Destruction of the insulating material due to over-voltages, overheating or mechanical strains above the foreseen level.	Replace or repair the damaged part.
5	Excessive noise	Voltage higher than the foreseen one. Base of the transformer not evenly seated in. Resonance with other surfaces around the equipment.	Check for the most suitable voltage and adjust it to the most suitable tap. Check it for loose metallic surfaces (panels, closets, ducts, doors, etc.), which could cause vibrations.
		Resonances transmitted by the connections.	Install flexible elements between the transformer terminals and the installed cables.

5.2. Cleansing

An important factor for a better operation of this type of transformer is to keep it clean as constantly and effectively as possible in order to prevent any damage to its important features. For this reason, we have listed different cleaning procedures for each type of impurities, as follows:

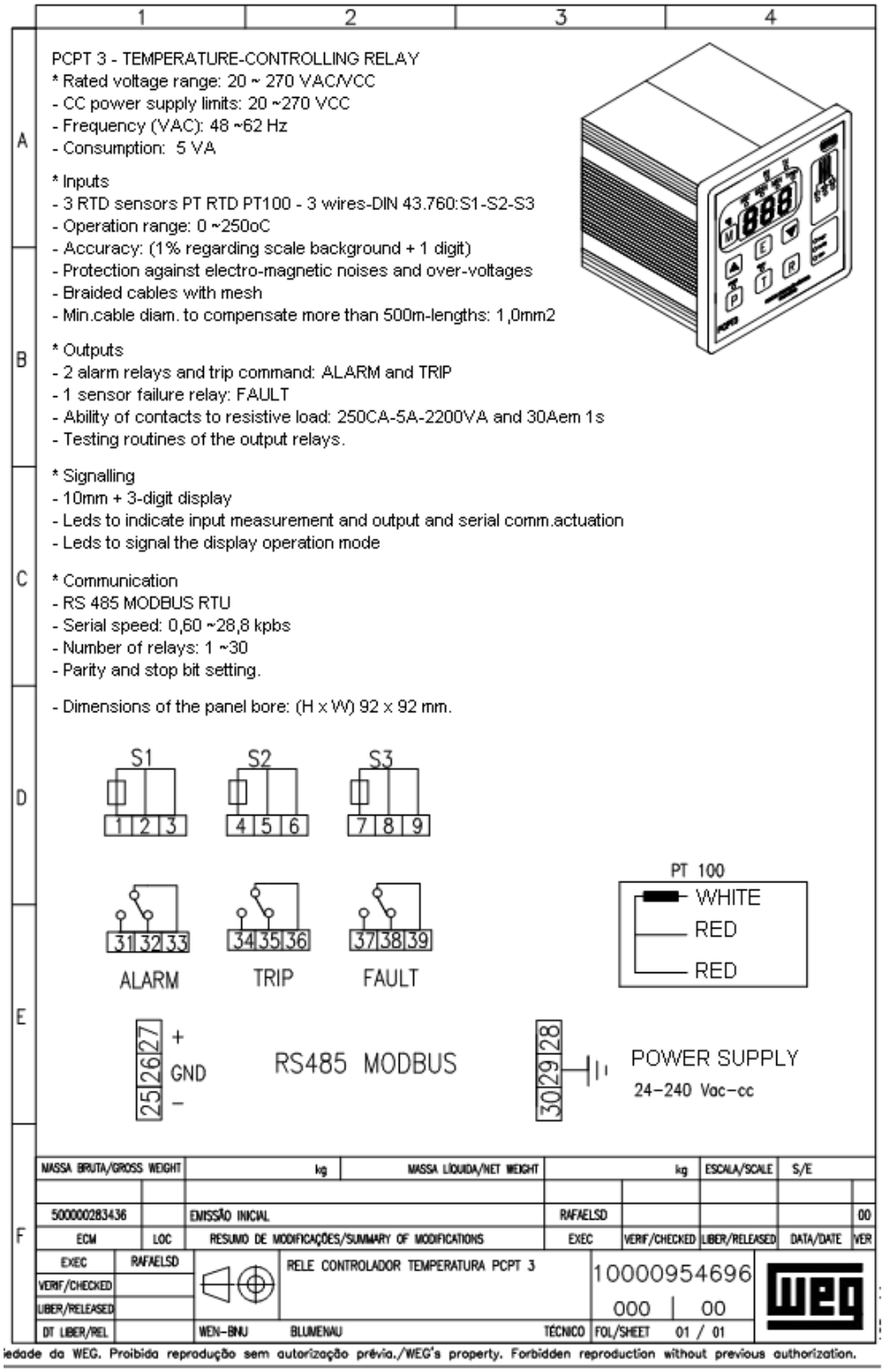
Table 6 - Cleansing procedures for dry-type transformers

Type of dirt found	Adopted procedure
Dry dust in general	1 and 4
Wet dust	3 and 4
Sea air (Salty air)	1 and 4
Metallic dust (industrial dust)	1 and 4
Oils in general	2 , 3 and 4
Graphite and similar	1 and 4

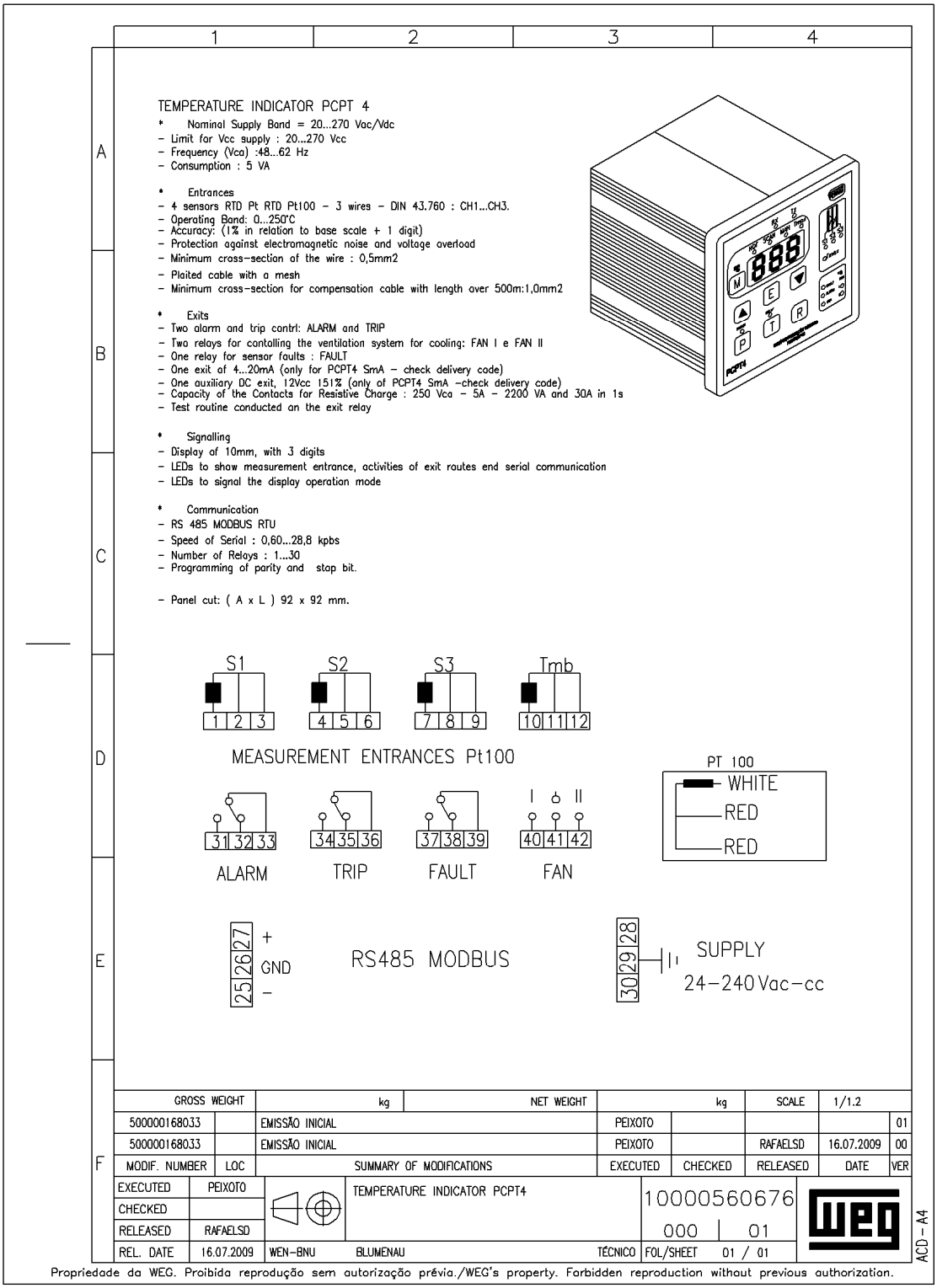
1) With the help of a vacuum cleaner or a duster and a dry cloth, remove all dust accumulated on the transformer. Thereafter, use compressed air to remove any remaining dust and clean the ventilation channels of the coils and between the coil and the core. The injection of compressed air into the ventilation channels should be carried out from the bottom to the top. The air pressure should be limited to approx. 5atm. To finalize, use a clean and dry cloth to remove any residues left on the coils, particularly around the terminals and the isolators.
2) With the help of a cloth moistened in benzene, remove all impurities from the core, ironwork and coils; repeat the operation with a clean and dry cloth. Make sure the channels have not been obstructed. If the impurities found in the channels are dry, adopt the procedure (1) for this cleaning. If not, identify the existing dirt and contact the factory in order to find out the best procedure. The use of benzene or other cleaning agent demands for special handling care.

3) With the help of a cloth moistened with water and a small concentration of ammonia or alcohol, remove all impurities from the transformer. The cleaning operation can be supplemented by using one of the previously – described procedures according to type of dirt to be removed.
4) The last step should be carried out always using a clean and dry cloth in order to wipe the entire surface, particularly in the region of the connection terminals.

APPENDIX A – PCPT 3 TEMPERATURE-CONTROLLING RELAY



APPENDIX B – PCPT 4 TEMPERATURE-CONTROLLING RELAY



APPENDIX C – PCPT 8 TEMPERATURE-CONTROLLING RELAY

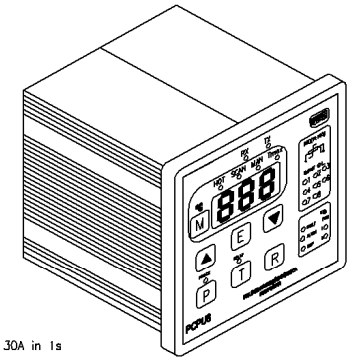
TEMPERATURE INDICATOR PCPU 8

* Nominal Supply Band = 20...270 Vac/Vdc
- Limit for Vcc supply : 20...270 Vcc
- frequency (Vca) :48...62 Hz
- Consumption : 5 VA

* Entrances
- 8 sensors RTD Pt RTD Pt100 – 3 wires – DIN 43.760 : CH1...CH8.
- Operating Band: 0...250°C
- Accuracy: (1% in relation to base scale + 1 digit)
- Protection against electromagnetic noise and voltage overload
- Minimum cross-section of the wire : 0,5mm2
- Plaited cable with a mesh
- Minimum cross-section for compensation cable with length over 500m:1,0mm2

* Exits
- Two alarm and trip contrl: ALARM and TRIP
- Two relays for contolling the ventilation system for cooling: FAN I e FAN II
- one relay for sensor faults : FAULT

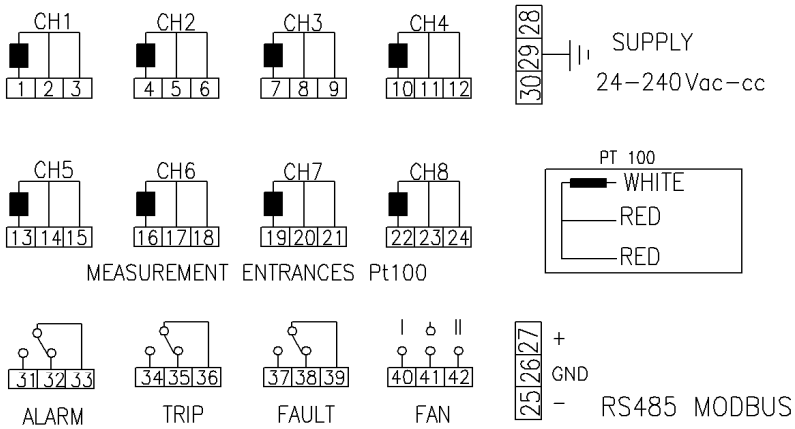
- Capacity of the Contacts for Resistive Charge : 250 Vca – 5A – 2200 VA and 30A in 1s
- Test routine conducted on the exit relay



* Signalling
- Display of 10mm, with 3 digits
- LEDs to show measurement entrance, activities of exit routes end serial communication
- LEDs to signal the display operation mode

* Communication
- RS 485 MODBUS RTU
- Speed of Serial : 0,60...28,8 kpbs
- Number of Relays : 1...30
- Programming of parity and stop bit.

- Panel cut: (A x L) 92 x 92 mm.



GROSS WEIGHT		kg	NET WEIGHT		kg	SCALE	1/1.2	
500000168033		EMISSÃO INICIAL		PEIXOTO				01
500000168033		EMISSÃO INICIAL		PEIXOTO		RAFAELSD	16.07.2009	00
MODIF. NUMBER	LOC	SUMMARY OF MODIFICATIONS		EXECUTED	CHECKED	RELEASED	DATE	VER

EXECUTED	PEIXOTO	TEMPERATURE INDICATOR PCPU8	10000560696	
CHECKED			000 | 01	
RELEASED	RAFAELSD			
REL. DATE	16.07.2009	WEN-BNU BLUMENAU TÉCNICO	FOL/SHEET 01 / 01	ACD – A4

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