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Transformer Technical Datasheet

Mod 03 07

TDS.TOS3277.V001

revision A/0

Rev.	Date	Prepared	Checked	Notes
0	19/01/18	N.Marcazzan	F.Scotuzzi	First issue

Revision index

Three phase transformer according to IEC 60076 for installation in safe zone with the following features:

uninhibited mineral oil (according to IEC 60296)

hermetic type (integral filling)

Type of load

The transformer is designed for continuous duty (4920 kVA @ 35°C; 4583 kVA @ 45°C with linear derating)

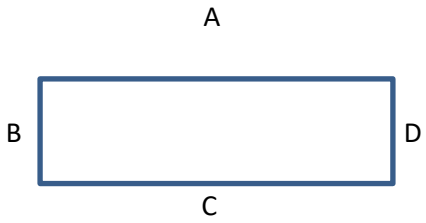
-inrush: 8xIn / half-life 0.42 s

-max phase-earth voltage on LV side 2.5 kV

-max dV/dt 0.5 kV/µs

Nominal ratings

Power 4.92 MVA ONAN



	Primary	Secondary
Power [MVA]	4.92	4.92
Rated voltage [V]	23000	630
Rated current [A]	123.5	4508.83
Material	AL	AL
Tap-changer	off-circuit	/
Taps	± 2 x 2.5%	/
Highest system voltage [kV]	24	3.6
Power frequency voltage [kV]	50	10
Impulse voltage [kV]	125	20
Bushing type	elastimold 36kV/630A	busbar 1kV/3150A
Bushing number	3	6
Bushing placement	cover side C	cover side A
Bushing protection	/	/

Electrical data

Frequency [Hz]	50		
Vector group	Dy11		
Impedance [%]	8	+10-0%	(at rated power, frequency and main ratio)
No load loss [W]	4920		
Load loss [W]	44300		
Total loss [W]	49220		
No load current [%]	0.4		

		Voltage drop				Efficiency			
Power factor		0.85	0.90	0.95	1.00	0.85	0.90	0.95	1.00
Load	1/4	1.25	1.08	0.85	0.24	99.27	99.31	99.35	99.38
	2/4	2.53	2.19	1.73	0.53	99.24	99.28	99.32	99.35
	3/4	3.83	3.34	2.65	0.85	99.06	99.11	99.16	99.20
	4/4	5.15	4.50	3.60	1.22	98.84	98.90	98.96	99.01

Environmental and working conditions

Minimum ambient temperature	-25	°C	
Maximum ambient temperature	45	°C	
Maximum installation altitude	1600	m	
Fluid temperature rise	55	K	
Winding temperature rise	60	K	
Corrosivity category	C4		durability: H
Lp(A) @ 1m	70	dB(A)	

Mechanical data

Weights

Fluid	2310	kg
Total	9630	kg

Base

Skid

suitable according to chilean ETG 1020

Overall dimensions

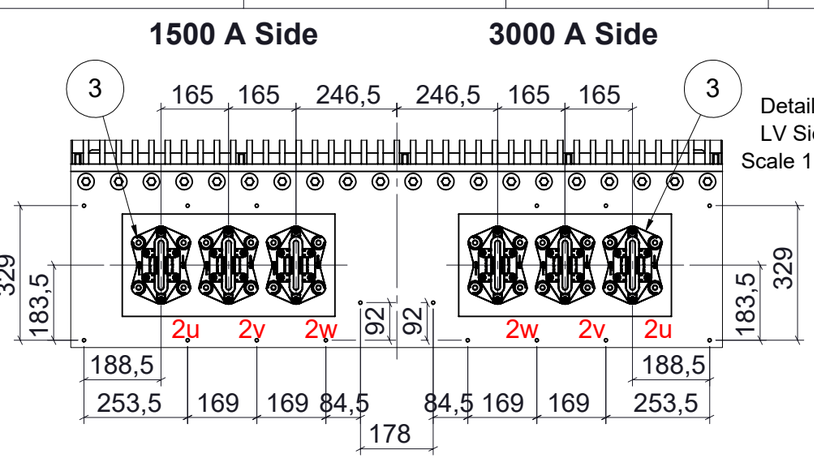
Service conditions			Shipment conditions		
Lenght	2685	mm	Lenght	2685	mm
Width	1605	mm	Width	1605	mm
Height	2195	mm	Height	2195	mm

Painting

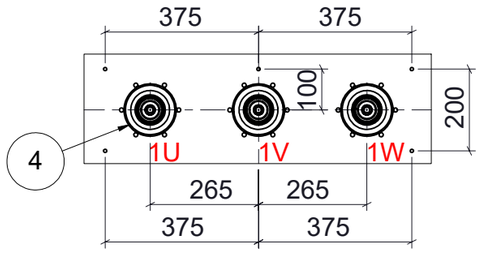
The external protection is suitable for ambient C4. All the metallic surfaces are sandblasted Sa 3. The paint thickness is 280µm. The color is RAL 7031.

Fittings

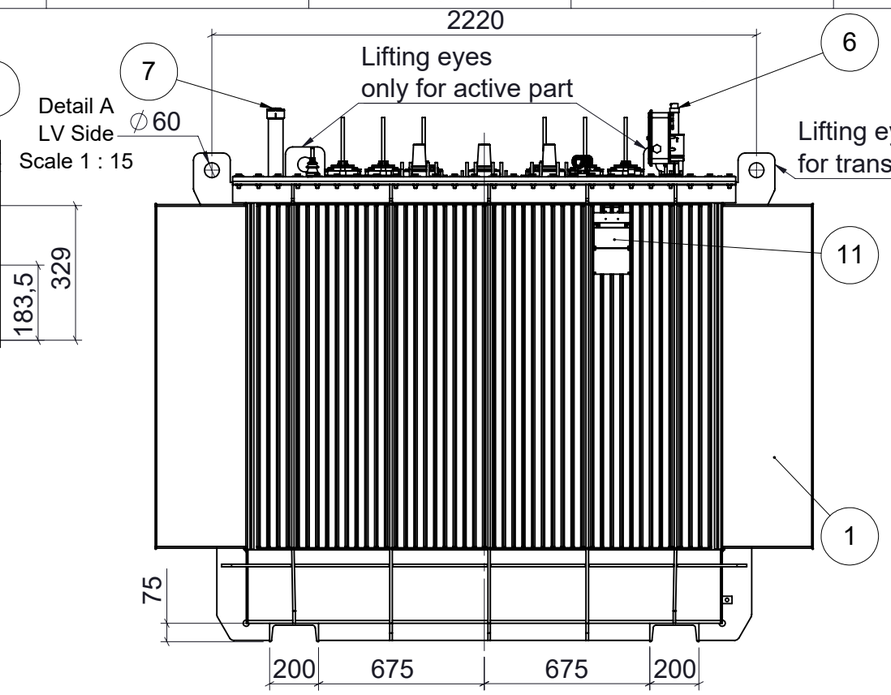
1 x Rating plate
2 x Earthing plate
1 x Filling plug
1 x Drain valve
1 x Sampling valve
1 x Spare thermometer pocket
1 x Electrostatic shield (with bushing)
1 x DGPT2 (safety device for hermetic transformers)
4 x Lifting lugs (for transformer plus skid)

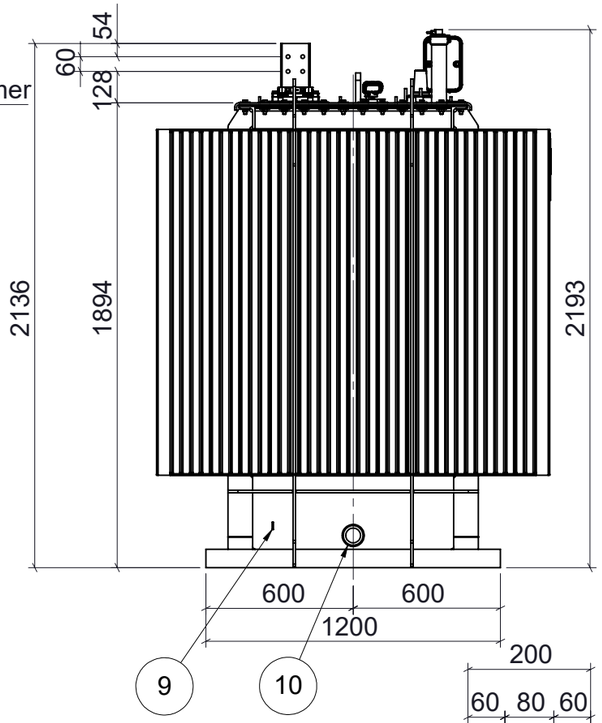


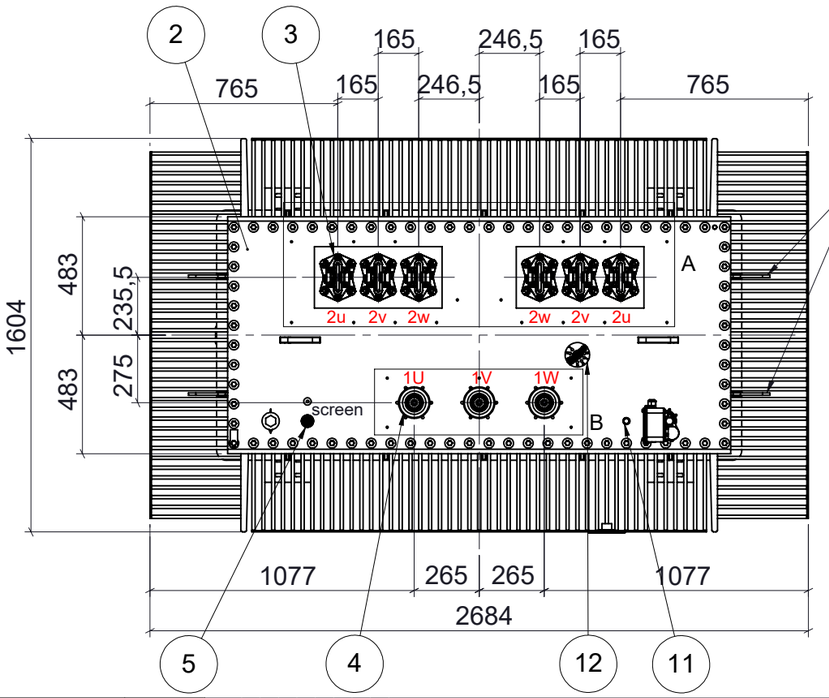
LV Bushings are suitable for indoor use
or they shall be protected by protection box

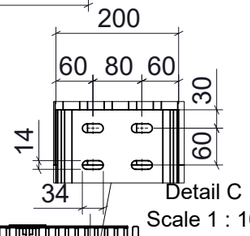


Detail B
HV Side
Scale 1 : 15



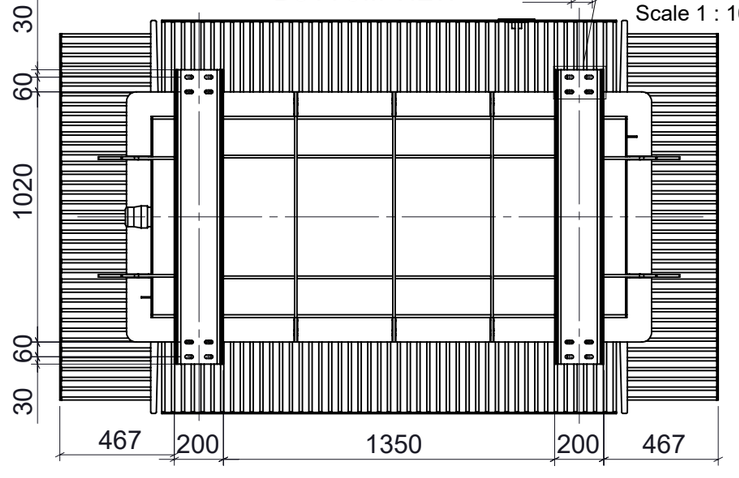






Detail C
Scale 1 : 10

BOTTOM VIEW



DGPT2 Settings:
Alarm = 100°C
Trip = 105°C

Transformer is designed for:
4920 kVA @ 35°C
4583 kVA @ 45°C

OIL WEIGHT	2310 [kg]
DRY WEIGHT	7320 [kg]
TOTAL WEIGHT	9630 [kg]

Other data on technical datasheet

Pos.	Description	Q.ty
12	Tap-changer type 095 20kV 150A 5 pos.	1
11	Rating Plate Standard Celme	1
10	Spare thermometer pocket	1
9	Drain valve	1
8	Earthing terminal	2
7	Oil filling plug G2	1
6	Integrated protection group DGPT2 option PT	1
5	Bushing type EN 50386 1kV - 250A tinned	1
4	Bushing type EN50180 36kV - 630A - interface type C	3
3	Bushing type CENELEC HD596S1 3kV - 3150A	6
2	Cover 2050x930	1
1	Tank 1920x800x1800	1

The dimensions are intended with the following tolerances unless otherwise stated

Up to 500 mm	± 5 mm
From 500 mm up to 1000 mm	± 10 mm
From 1000 mm up to 1500 mm	± 15 mm
From 1500 mm up to 2500 mm	± 20 mm
Over 2500 mm	± 30 mm
Perforation	± 1 mm
Fillets	± 0.5 mm
Angles	± 0.5 mm

DESCRIPTION

Three-phase transformer 4665kVA
23000±2x2.5%/630V Dy11 50Hz

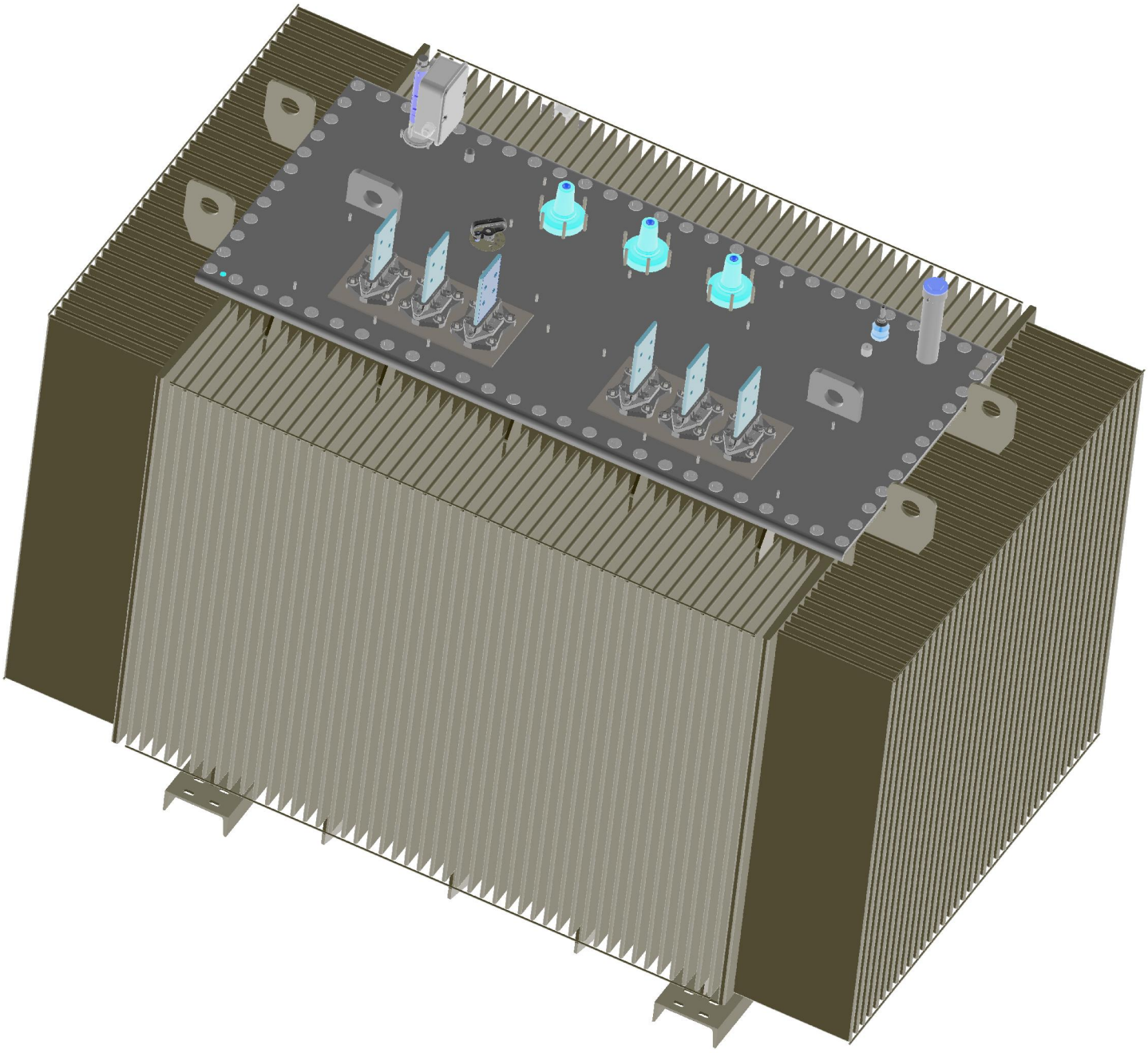
REV.	DATE	OBJECT	DRW.	APR.
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
A	19/01/2018	First issue	FS	NM

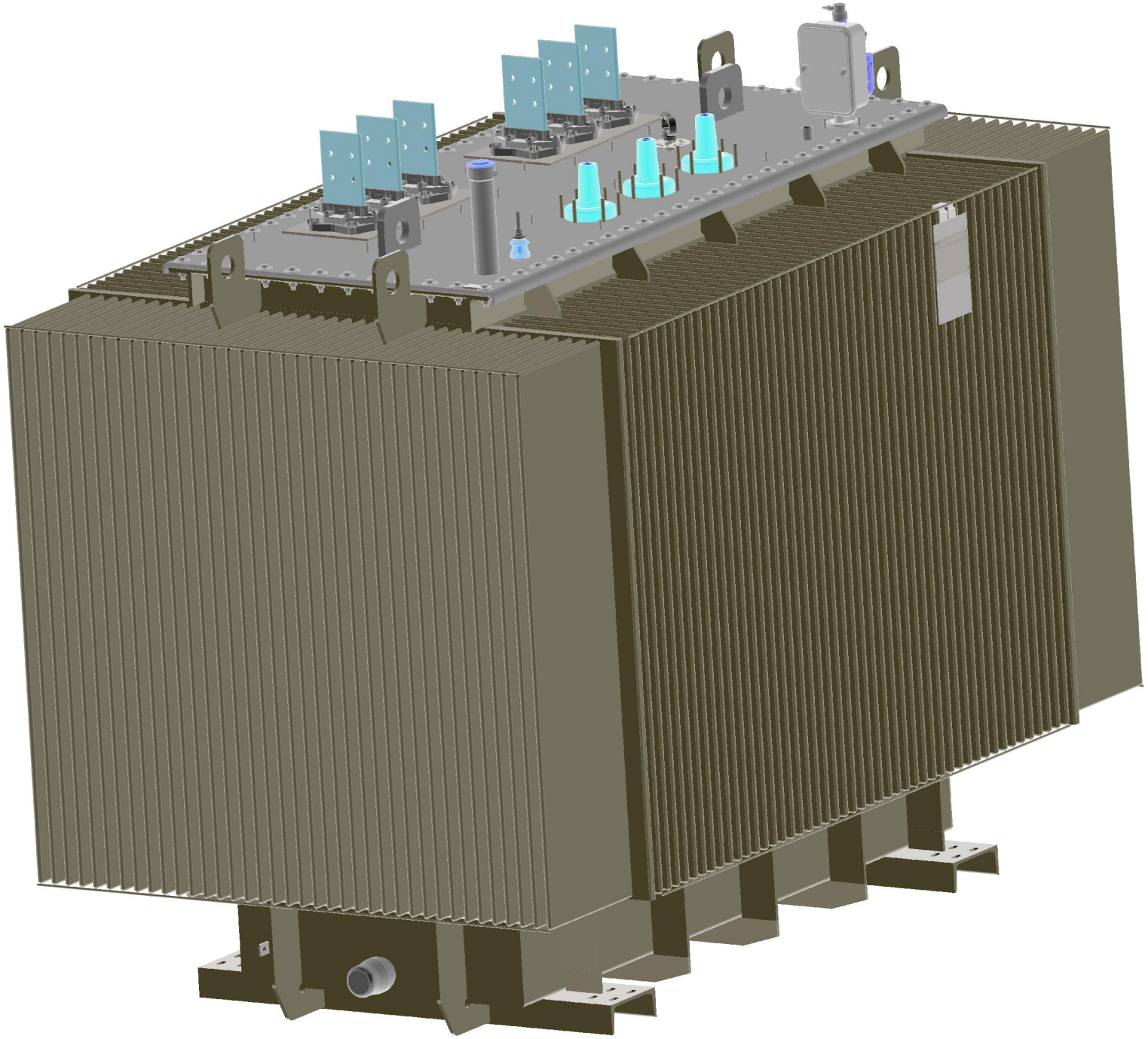
CELME s.r.l.

36054 - MONTEBELLO VICENTINO - VICENZA - ITALY

FORMAT	CODE	REV.
A3	TOS3277.V001	A

SCALE	TOT WEIGHT	SHEET
1:25	9630 [kg]	1 / 1





Operating handbook for the use and maintenance of transformers

2nd Edition

CELME

Operating handbook for the use and maintenance of transformers

Celme S.r.l.

2nd Edition

2nd Edition
Rev. 03
Release date: 05/07/2016

Check and emitted by the technical department
Approved by Quality Manager

Note:
Celme S.r.l. reserves the right to do technical modification and to change the contents of this document without prior notice. The last version of this handbook will be always available in our company and could be supplied on demand.
Norms indicated in this manual refer to the release year. It is responsibility of the user to verify if the norms are still valid.
Celme does not accept any responsibility for potential errors or possible lack of information in this document.

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Chapter 1

General considerations

Dear customer, congratulations for your choice of a Celme oil immersed transformer.

Since 1964 our company designs and manufactures oil immersed three phase electrical power transformers, with a power range from 50 kVA to 63 MVA and maximum voltage class of 170 kV. Our products find their application both in distribution sector and for special loads, can be sealed or breathing type and can be naturally cooled, with fans or heat exchangers. Celme underlines that all its transformers respect norms in force at the time of the order.

The variety of special products supplied by Celme calls for the transformer technical datasheet to identify type and accessories present.

Figure 1.0.1: sealed transformer

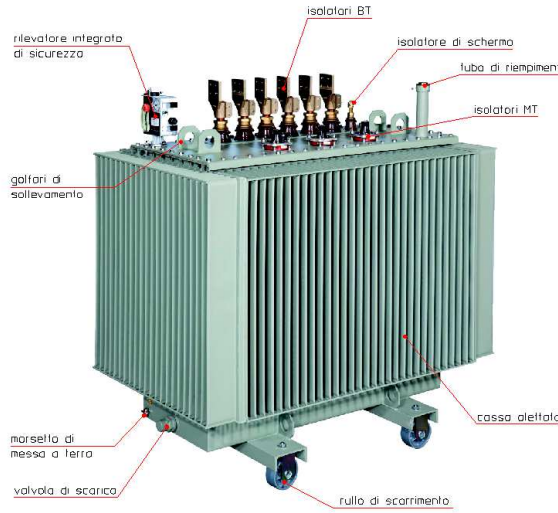


Figure 1.0.2: breathing type transformer with on load tap changer

1.1 Objective

This handbook has as its goal to provide guidelines to carry out, in safety conditions, all necessary phases as assembly, energizing and maintenance of a Celme transformer, according IEC 60076-1 norm.

The aim is to give the necessary assistance to the personnel involved, to make easier transformer supervising and maintenance activities. Celme handbook is directed to a skilled audience, provided of the necessary equipment.

Following these guidelines you can keep a high efficiency of your transformer and an extension of its lifetime.

1.2 Warranty terms and validity conditions

Celme transformers are covered for two years against manufacturing defects; other warranty terms for transformers can be agreed during the definition of the order and are indicated in the order confirmation. The warranty is valid for the substitution or reparation of failed transformer free at Celme.
Necessary condition to make use of the warranty is that:

- Transformer has been installed, started up and undergone to a standard periodic maintenance as indicated in this handbook;
- Celme seal, present on the transformer, has to be undamaged.

Warranty performances are not due in case of:

- Depending upon wars/revolutions, terrorism or vandalism, riots, strikes, earthquakes, fire, atmospherically phenomena, incorrect installation and connection, inappropriate or incorrect handling, radiations caused by artificial acceleration of atomic particles, damages subsequent to any other accidental or unforeseeable circumstances;
- If the customer tries to solve abnormal situations without Celme prior authorization;
- If the customer requires the intervention of third parties without Celme prior authorization;

- If the transformer is used for applications with different characteristics from those initially agreed.

For any clarification you can contact our sales department (see chapter8).

1.3 CE marking

CE marking of power transformers is applicable according the following directives:

- ATEX - 2014/39/EC
- EcoDesign - 2009/125/EC (applicable to transformers through EU regulation 548/2014)

Limits of applicability of the directives are listed within these. Celme, where applicable, release a declaration of conformity and carry the CE marking on the transformer's nameplate.

Other directives (e.g.: 2006/42/EC, 2004/108/EC, etc) are not applicable to power transformers. For more information refer to the "Position paper on EU directives WG4" issued by T&D Europe.

1.4 Archive

Product related documentation is provided to the customer at the delivery of the product and a copy is archived in Celme for at least 10 years from the construction of the transformer.

Chapter 2

Safety aspects/recommendations

Electrical systems under voltage can be cause of several risks. Electrical arcs can cause fires and explosions, an exposure to voltage field over 50V can cause heartbreak and a serious damage to the internal tissues.

Safety is defined as the absence of dangers for persons or objects when a transformer is in use or in storage. This means that type of stress, risks and possible source of failures have to be defined, prevented or controlled, in order to reduce risk level at an acceptable value. Transformers must not be used for purpose different from the transformation of electrical energy. The methods, parameters and requirements for the testing of transformer are defined in the IEC 60076-1 norm, in order to control that the design and the manufacturing is done according safety and quality aspects. This publication must be applied in the light of IEC specifications, such as, for example, specification referring to electrical systems and installations.

To maintain a high degree of safety Celme suggest applying these norms.

2.1 General rules

- The personnel responsible for transformers must have the necessary competencies to work on this type of electrical field. We suggest to attend a safety course and to plan, before to work on transformer, the operations to execute. People without authorization cannot have access to the area;
- The personnel responsible of operation in field must work with suitable safety clothing, such as fire-resistant clothing, gauntlet, helmets. . . ;
- In case of failure to the instrumentation installed, there must be defined an escape route. We suggest to be informed about safety rules in the plant and about the emergency numbers;
- It is very important that the plant has not to be under voltage during the activity of the personnel in charge of the operations. The plant could be energized again once the personnel will be in a safety area;
- All the metals part have to be connected to the earth by means of a suitable connection, dimensioned considering the short circuit current in case of failure;
- Labels, scheme and plan of the plant must be available to clarify the location of all electrical components;
- To be at least two persons present in order to have immediate support in case of any necessity;
- Special precautions have to be carried out in case of high ground elevation, with risk of falling.

2.2 Person and ambient safety

Usually the dielectric fluid normally used is inflammable and even in case of high flash point fluids is suggested the implementation of oil collection sump, in order to avoid leakages in the environment.

The current “Regulation for the prevention of work injuries” makes it compulsory to build sumps, tanks or other systems to prevent burning oil from spreading out of the cabin and fenced areas, for one – or more- oil transformers housed in non-insulated substations and containing a quantity of oil greater than 500Kg. The quantity of oil of each transformer is indicated in the technical datasheet and on the rating plate.

Here as follows you can find a description of some types of sumps or tanks usually employed.

A first type, generally used for lower power levels, is a prefabricated device, made by reinforced concrete, the construction details are shown in figure 2.2.1. This syphon- type oil recovery system collects the fluid and forces it to flow into a coil in which by taking out the oxygen, prevent burning oil from spreading out.

Another type of sump is illustrated in figure 2.2.2. This sump needs to be constructed together with other building works. Thanks to a slight slope of the floor the burning oil is piped into a siphon, extinguishing before reaching the oil collecting tank.

Another version of this system is indicated in figure 2.2.3 where the tank can be shared by more than one transformer, and the oil flows into this tank from the individual sumps via a siphon-type pipe system. The devices described above are suitable for indoor installation (in substation); otherwise the pit would be filled up with rainwater, if installed outdoors.

For outdoors installations the solution shown in figure 2.2.4 is more suitable. The tank is usually full with water up to the overflow. The oil flows down the pipes (point 3) and rises up again due to a lower specific weight, extinguishing due to lack of oxygen.

Figure 2.2.1: Prefabricate siphon-type oil recovery system

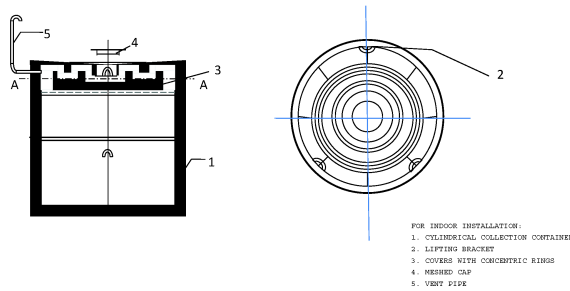


Figure 2.2.2: Standard oil collection system

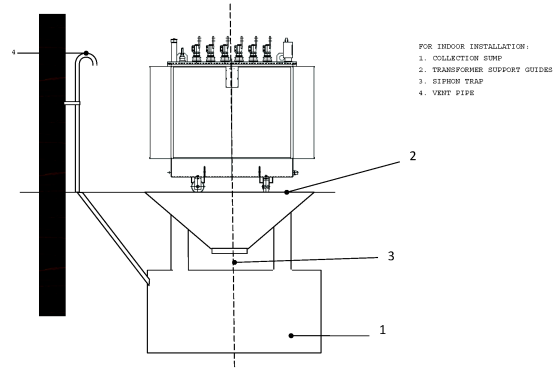


Figure 2.2.3: Standard oil collection tank set at a certain distance

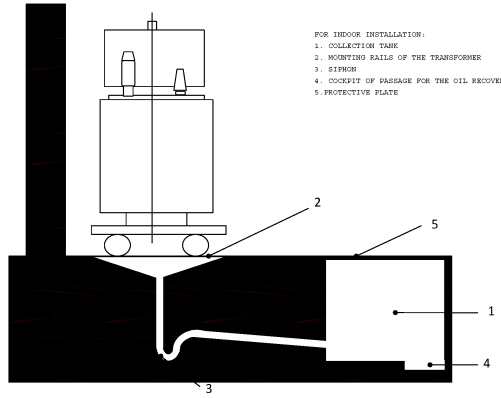
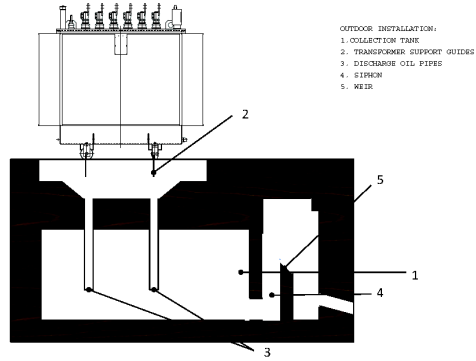


Figure 2.2.4: Oil collection tank for outdoors installation



Chapter 3

The oil transformer

The IEC 60076-1 defines transformer as “a static piece of apparatus with two or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of voltage and current usually of different values and at the same frequency for the purpose of transmitting electrical power”.

The main components of the so-called “active part” of the transformer are the magnetic circuit (core) and the windings. The core is the seat of the alternating magnetic flow and is made by high permeability and low losses magnetic steel sheets; windings are made of appropriately insulated conductors. The tank is the seat for the active part and is fulfilled with oil which, together with the cooling system, dissipates the losses produced by the transformer.

Why do you have to choose an oil transformer?

- because it allows higher efficiencies than other transformer types;
- because it can work in higher overload conditions than other technologies;
- because it leads to a saving of money for the final customer during the total lifetime;
- because there is a small percentage of breakdowns and average lifetime is over 30 years;
- because it produces less noises and does not transmit any vibration.

Here below a list of important information to understand what is the range of application of your transformer.

3.1 Name plate and documents enclosed

Celme transformer is always delivered together with some documents reporting the main characteristic. Celme suggests keeping these documents in order to maintain as much information as possible during the life of transformer and to make the incoming maintenance activities easier. A permanent name plate is attached to the tank of the transformer with the main data.

3.1.1 Technical datasheet

The technical datasheet indicates the “nominal data” of your transformer, necessary to characterized the transformer and define the guaranteed performance.

Data present in the technical datasheet are:

- Product code;
- Transformer type;
- Cooling type;
- Power, voltage ratio and currents;

- Connection type;
- Operating temperature;
- Guaranteed losses and short circuit impedance;
- Efficiency and voltage drop;
- Accessories;
- Total weight and oil weight;
- Dimensions.

The technical datasheet summarizes all the information necessary to feature your transformer. The product code is important as well as the transformer serial number because it permits an easier identification of transformer supplied.

3.1.2 Overall drawing

The overall drawing provide the customer with a rough picture of the type of transformer under progress, allowing him to check his needs with the designer proposal. Overall drawing gives following information: shape, dimensions, weights, phase disposition, etc.

3.1.3 Auxiliary connection diagram

Transformers can be supplied with some accessories and its contacts should be centralized in a panel or marshaling box. The auxiliary connection diagram gives the customer all the information necessary for the wiring.

3.1.4 Test report

The test report is the certification that the transformer respects the applicable norms and the other technical requirements defined by the customer (if any).

Routine tests done by Celme on each transformer are, as minimum:

- Measurement of voltage ratio and check of phase displacement;
- Separate source AC withstand voltage test;
- Short-duration induced AC withstand voltage test;
- Measurement of winding resistance;
- Measurement of no-load losses and current;
- Measurement of short-circuit impedance;
- Measurement of load losses;
- Test of auxiliaries.

Depending on the voltage insulation class of the transformer or on the basis of particular construction characteristics, other tests may be done in order to verify the correct status of the product. Furthermore, on demand of the customer while ordering, Celme can execute type and special tests, including, but not limited to:

- Lightning impulse test;
- Temperature rise test;
- Noise level measurement;
- Measurement of insulation resistance to earth of the windings.

3.1.5 Other documents

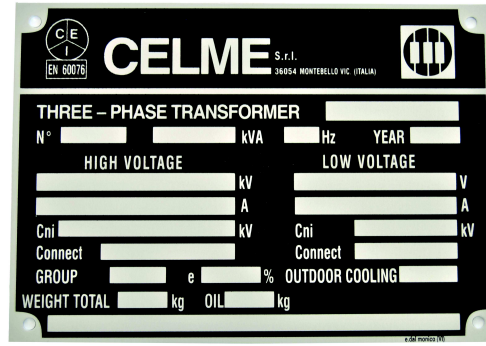
On demand Celme can provide other documentation as painting specifications, specific drawings, accessory catalogues etc.

3.1.6 Name plate

IEC 60076-normative requires a name plate on the transformer, made of atmospheric agents resistant material, fitted in a visible position and with following indelibly information:

- Type of transformer;
- Number of the norm IEC 60076-1;
- Manufacturer's name and address;
- Manufacturer's serial number;
- Year of manufacture;
- Number of phases;
- Rated power;
- Rated frequency;
- Rated voltages;
- Rated currents;
- Insulation levels;
- Connection group;
- Short circuit impedance, measured value in percentage;
- Type of cooling;
- Total weight;
- Oil weight;
- CE marking (if applicable, see 1.3).

Figure 3.1.1: Standard rating plate



3.2 Types of insulating fluids

Over the years the respect of environment situation and conditions and personnel safety influenced the research and development for safer and less polluting insulating fluids.

At the beginning of thirties transformers were filled with fluid containing polychlorinated biphenyls; these compounds, subject to electric arcs, produce high toxicity and polluting gases. During the seventies the environmental and human care process moves its steps and these compounds were partially banished by major world powers (Japan 1972, USA and Europa 1976). The use of fluid containing PCB is limited to close systems as transformers. The turning point happened on February 5th 1997 with D.L. no. 22 dated November 28th 1997 (GURI 278): this low allows a maximum contamination of the fluid of 25 ppm.

Since 1978 Celme uses only oil PCB-free and since 1992 gives its customer a declaration which guarantees the absence of this substance.

Insulating fluids used in Celme are mineral type, silicon type and ester-based type.

Uninhibited Mineral oil This type of oil is conform to IEC 60296 norm; it guarantees a low degradation and has a great resistance to oxidation process;

Inhibited Mineral oil This type of oil has a higher quality and is conform to IEC 60296 norm; it guarantees a low degradation and a good resistance to oxidation process, a longer lifetime of transformer and a less need of maintenance;

Silicon oil This type of oil is conform to IEC 836 and ASTM D 4652-92 norm; it guarantees a low degradation of the oil, a good resistance to oxidation process and a higher flash point;

Ester-based oil This type of oil is conform to IEC 61099 and has been specific studied to give a safe and superior alternative to traditional transformer oils. Its considerable efficiency gives a great safety against fires, a higher environmental protection and a higher tolerance to moisture.

Note: the directive no. 96/59/CE gives the guidelines for PCB disposal, therefore if your transformer contains these compounds and need some maintenance, Celme suggests to contact a specialized firm and arrange for its disposal.
Note 2: Celme keeps the declarations that our transformers are PCB-free since 1992; transformers supplied before 1992 can contain contaminated oil. This declaration can be demanded by our offices (see chapter 8).

3.3 Operating transformer

A transformer can work properly when energized according the information indicated in the rated plate and with an ambient temperature equal or inferior to the design temperature. Should these parameters not been respected the standard life of insulating materials, and consequently the standard lifetime of transformer, can be compromised. Celme suggests to refer to the *"Loading guide for oil-immersed power transformers"* IEC 60076-7, if the transformer has to be energized according its limit conditions.

3.3.1 Overload effects

When the transformer is energized beyond its nameplate rating, an overload can occur which can be distinguished in:

Long-time overload consequent to a continuous energization with higher load respect to the allowed load. This overload can be noticed only once the transformer reached a critical temperature phase;

Short-time overload consequent to a sudden increase of load (shorter than 30min). This can produce considerable problems in the normal functioning of transformer.

Main consequences of an overload are:

- Windings, core and oil temperature can reach dangerous levels;
- The electromagnetic flux can dissipate outside the core and can bring to additional currents and an overheating of metallic parts near that area;
- Moisture and gas parameters of insulating fluid can change with temperature variations;
- Bushings, tap changer, cables terminals and some accessories are exposed to high stresses if they work over their rated parameters.

The sensitivity of transformers to loading beyond nameplate rating usually depends on their size. As the size increases, the tendency is that:

- The leakage flux density increases;
- The mass of insulation, which is subjected to a high electric stress, is increased;
- The hot-spot temperatures are more difficult to be determined.

There are some allowed overload limits and IEC 60076-7 norm defines these limits:

Table 3.1: Current and temperature limits applicable to loading beyond nameplate rating

Types of loading	**Distribution transformers (<2.5MVA)**	**Medium power transformers (>2.5MVA <100MVA)**
Normal c yclic loading		
Current (p.u.)	1.5	1.5
Top-oil temperature (°C)	105	105
Long-time loading		
Current (p.u.)	1.8	1.5
Top-oil temperature (°C)	115	115
Short-time loading		
Current (p.u.)	2.0	1.8
Top-oil temperature (°C)	n.a. (see note 2)	115

Note: The temperature and current limits are not intended to be valid simultaneously.

Note 2: No limit is set for the top-oil and hot-spot temperature under short-time overload for distribution transformers because it is usually impracticable to control the duration of the overload in this case.
N.B. p.u. means "per unit".

In addition to that the norms give other specific limitations.

Limitations for distribution transformers (<2.5MVA)

The limits on load current and top-oil temperature stated in table 3.1 should not be exceeded, otherwise gas bubbles may develop driving to a jeopardizing of insulating fluid dielectric strength.

Apart from the insulating material which is subject to deterioration as a consequence of temperature increase, other parts of the transformer, such as bushings, cable-end connections and tap-changer may restrict the operation when loaded above the rated current. Oil expansion and oil pressure could also impose restrictions.

When the transformer is for indoor installation, take into account that oil temperature could quickly increase and reach high values.

On the other hand when the transformer is installed outdoor, wind, sunshine and rain may affect the loading capacity but their unpredictable nature makes it impracticable to take these factors into account.

Limitations for medium power transformers (>2.5MVA, <100MVA)

The limits on load current and top-oil temperature stated in table 3.1 should not be exceeded, otherwise gas bubbles may develop driving to a jeopardizing of insulating fluid dielectric strength.

Apart from the insulating material which is subject to deterioration as a consequence of temperature increase, other parts of the transformer, such as bushings, cable-end connections and tap-changer may restrict the operation when loaded above the rated current. Oil expansion and oil pressure could also impose restrictions.

During the operation at load beyond nameplate rating, the transformer may not conform to the thermal short-circuit requirements, as specified in IEC 60076-5. The transformer is designed to withstand to a short-circuit duration of 2 s, however the duration of short-circuit currents in service is shorter than 2 s in most cases.

Unless other limitations for voltage variations have been taken into account, Celme suggests not exceeding 1,05 times the rated voltage (for each tap) on any winding of the transformer.

3.3.2 Parallel of transformers

Transformers can be put in parallel for following needs:

Variability of the load In case of variable demand of power absorbed, many transformers connected together allow to keep a higher efficiency;

Safety If there is a damage on one transformer there is no black out and the net supply is not completely stopped;

Maintenance Transformers can be services switching them off one after the other, without interrupting the supply.

For a correct operation following circumstances must be verified:

- Same voltage ratio on each tap changer position (within the tolerance);
- Same phase connection group;
- Same short circuit impedance % (within the tolerance).

Since the ratio between voltage drop % due to short-circuit losses and inductive voltage drop % changes according the power of transformer, even in case of short-circuit % being equal, the parallel operation would run as much better as closer are the powers of transformers. Parallel operation for transformer with a power ratio higher than 1/2 are not advisable. This fact shall be taken into account buying the transformer.

Once the transformers have been placed in the correct position, this procedure must been followed before applying voltage:

- Connect respective phases of primary side;
- Connect respective phases of secondary side;
- Put to earth transformers, in preference with a unique grounding;
- Connect the neutral bushing (if present);
- Check the correspondence of tap changers' positions (in order to guarantee the same voltage ratio);
- Connect the primary side to the network, and let the secondary switch open;
- Apply voltage to the primary side and check that no voltage differences are found between the respective phases of secondary side (or solve the problem in case of differences);
- If there are no voltage differences close the secondary circuit.

If the above-listed conditions are not respected, a circulation current can occur, damaging the transformers. Celme is not responsible for any possible failures due to a wrong connection operation.

Chapter 4

Accessories

The accessories reported below are usually installed on our transformers. These devices can have electrical contacts and being connected to marshaling boxes. A check on the datasheet in your hand should be made, to verify the correspondence with these accessories, which are only an example and can be different from the ones installed on your transformer.

4.1 Integrated safety device R.I.S. or DGPT2

The integrated safety device is a typical accessory installed exclusively on sealed type transformer. It integrates different functions - which are usually carried out by several transformer accessories – in a compact and reliable instrument. This device is made by a hardy plastic body, wet seal and resistant to extreme climate conditions; this body includes a series of instruments. These allow a constant surveillance of following operating conditions of the transformer:

Oil level detects gas formation or oil level variations. In case of considerable variation the float positions itself in the lower level, activating the electrical contact;

Temperature detects the oil temperature inside the transformer and is equipped with electrical contacts which can be set to give an alarm or disconnecting the transformer;

Pressure a manostat equipped with electrical contacts can detect an increase of internal pressure:

Gas formation through the oil level indicator and the minimum contact, a gas formation is clearly visible and this could be the sign of an internal fault of the transformer.

4.2 Buchholz relay

A gas formation inside the oil immersed transformer is always a sign of some abnormal functioning and can occur because of:

- Localized overheating or electrical arcs which bring to a decomposition of solid or liquid insulating material inside the transformer;
- The external ambient through circulating pumps;
- The inside of transformer, if the dielectric liquid is not treated properly before starting-up.

This device is usually installed on breathing type transformers, and is connected on one side to the tank and on the other to the conservator. In case of gas formation inside the transformer, the gas bubbles are carried to the conservator and the Buchholz relay in which the oil level decrease and the floats close the contacts.

Small gas formation can be seen in the inspection window on one side of the relay and a sample can be taken through the valve.

In case of rapid oil movement the flow valve disconnects the transformer.

The relay can be equipped with butterfly valves which allow rapid maintenance activities without draining the oil present inside the conservator.

4.3 Oil level indicator

The oil level indicator is usually placed on the side of conservator, and shows the oil present inside the transformer.

In oil level indicator with magnetic joint the movement of float bar and the indicator disk is done by a magnetic coupling. As a consequence of oil level variation there is a rotation of the magnet and a variation of the level indicated in the indicator dial. Contacts can be added to signal minimum and maximum oil levels.

4.4 Safety valve

Safety valves are used to measure the internal pressure of transformers. They are advisable when the pressure can have, for unforeseeable causes, instantaneous and uncontrolled increases, with consequent explosion risk. The main important feature of this valve is that it can release outside in very short period (thousandths of seconds) an eventual increase of pressure. A sudden and high short-circuit can lead to a huge gas formation which increases enormously the internal pressure value. If there is no escape for this pressure the consequence is the explosion of the transformer, with all the related effects. Through an expansion plate present on the valve, the oil can flow out, with the consequent decrease of the pressure.

This valve can be installed both on sealed type and on breathing type transformers and on demand trigging contacts can be added.

4.5 Silicagel air breather

This device is a case for salts of chemically pure silicon oxide, called Silicagel, which is color indicator. The air contained in the transformer passes through these salts as a consequence of thermal contraction of the oil. The Silicagel must absorb the moisture of the air and avoid in this way the contamination of the oil, while the color of the salts shows the saturation degree reached. Color variations of the salts are indicated in the label of the air breather. After complete saturation of the Silicagel, this has to be regenerated or substituted with a new one. Silicagel peculiar property is its high absorption power of atmospheric moisture. Air breathers are installed only on breathing time transformers, in order to avoid oil contamination.

4.6 Thermometer

This device is used to indicate the insulating liquid temperature inside the transformer. Usually they are provided with a feeler which contains a special liquid. This feeler is inserted in a pocket, positioned on the cover, in order to obtain top-oil temperature. On the dial there are two indicators which report the actual temperature and the maximum temperature reached respectively. Contacts can be added and set to the desired control temperature.

4.7 Tap changer

The transformer voltage ratio can be set by a device called tap changer. This is used to change the number of active turns, usually on primary side, to get the correct voltage on secondary side. There are two main tap changer types:

Off load A control can be installed on the cover to change the turns ratio. Each position of the tap changer is indicated by progressive numbering, in which number 1 indicates the maximum primary voltage and the highest number the minimum primary voltage. Regulation steps are indicated on the technical datasheet and

on the rating plate.
Some transformers present an additional control to change a connection inside the transformer and switch the voltage, as in the case of transformer with 10-20kV primary voltage.

⚠ *CAUTION: This type of tap changer can be managed only with the transformer de-energized, otherwise it may lead to serious problems for the transformer, severe personal injuries, or to death!*

On load This tap changer allows a variation of the turns ratio without de-energizing the transformer. Usually it is driven by a motor and can additionally have a regulator, which regulates itself automatically when the input voltage changes. For other clarification refer to the operating handbook of the supplier of on load tap changer given by Celme with the transformer.

4.8 Bushings

Bushings are terminal units which allow separating electrically one electric conductor to other conductive materials.

4.8.1 Standard bushings

Electrical connections of phases of transformer are brought out through these terminals. On demand of the customer can be used porcelain bushings, cast-resin type or busbar type.

4.8.2 Support bushings

They are usually installed to support components that are under voltage from other conductive materials, acting as an electric insulator between the two components.

4.9 Heat exchanger

The heat exchanger is a device in which there is an exchange of thermal energy. Through a pump, the oil contained in the tank is forced to circulate in a pipe in which the oil is cooled down by the air or by another cooling liquid. For other clarification refer to the operating handbook of the supplier of heat exchanger given by Celme with the transformer.

4.10 Capacitive screen

The capacitive screen between primary and secondary winding is designed to filter the harmonics in high frequency, avoiding in this way their spreading into the net. Celme transformers bring this screen out through a bushing, which must be connected to earth.

4.11 Other accessories

Above-listed accessories are the most common ones. Besides this list Celme can provide other accessories as current transformers, voltage transformers, pressure guard, winding thermal image, PT100 feeler in the oil, PT100 feeler in the core, space heater, marshaling boxes, cooling fans, shock log recorders, etc.

Any other information on relative accessory catalogues.

Chapter 5

Transformer start-up

In this section of the handbook Celme gives the necessary instructions to assembly and to start-up your transformer.

Start-up must be undertaken by skilled personnel, with appropriate equipment and accessories for this kind of operation.

Celme reminds that instructions below-listed are generic and are only an approach to the transformer. For some special transformer are given peculiar instructions, which can be considered prevailing on the general information written in this handbook.

For the installation of a transformer you have to refer to the current norms for industrial injury prevention. If the plant is characterized by an explosive or inflammable atmosphere refer to IEC 60079 Norm.

5.1 Transport and arrival on site

Usually transformers made by Celme are tested and shipped completely assembled, ready for the start-up with easy and quick preliminary operations. In case of needs (if the transformer is too big for road transportation or if there is some special plant requirement) the transformer can be shipped partially disassembled.

In case of big power transformer Celme suggests to check and plan the way to the plant, in order to avoid problems and obstacles (e.g. low bridges, bad or too steep roads) which can make the transport difficult and dangerous for the transformer.

Celme suggests to use flat-rack trucks and to position the transformer in order to balance the weight. Check the fixing ropes and position them without damaging the radiators or the cooling fins.

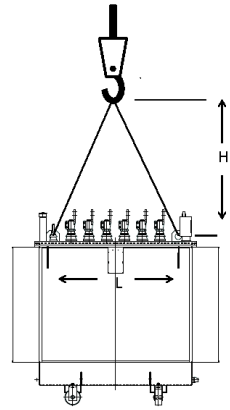
Celme personnel always support and check the positioning and fixing phase of the transformer on the truck.

5.1.1 Unloading of transformer

Before unloading the transformer you have to check that no components are missing or damaged. In this case please contact Celme and inform them about the situation before starting any operation.

If no irregularities have been discovered you can proceed with the unloading. First is necessary to hook the lifting hooks paying attention to maintain them parallel. In this way the weight of the transformer is balanced and there is no risk of structural damages. Take into account that ropes should be long enough so that H (fig. 5.1.1) is never lower than L. All lifting hooks should be used, and not only part of them. If the lifting of transformer and of active part is different, please use only the lifting hooks of transformers signed by the correct label. Small lifting operations can be also done by hydraulic jacks, if appropriate supporting plates are present.

Figure 5.1.1:



By moving the transformer is important not to force on the bushings, radiators or fins, and on all weak elements present on the transformer; there are proper hooks or wheel transom to move it. If the transformer has slides let it run on wooden or iron rails.

5.1.2 Storage

Celme suggests to install the transformer in the shortest time, and where is not possible, to store it in a dry ambient, with a high constant ambient temperature. Furthermore following instructions should be taken into account to keep the transformer in good health.

- Transformer for indoor installation should be stored in closed and covered room, in order to avoid deposits of dust and moisture;
- Transformer for outdoor installation should not be, in preference, exposed to the inclemency of the weather;
- Make sure that the storage area has a collection sump to avoid ambient contaminations in case of leakages;
- Install the air breather in order to avoid oil contamination, as described in the paragraph 5.2.2 and periodically check the status of the salts (see paragraph 6.2.1);
- If accessories of transformer component are shipped disassembled, take precautions against water condense;
- Prevent any damage of the tank which could lead to rust and deterioration of the painting;
- Periodically check the status and the integrity of auxiliaries;
- After long period of storage (about one year), breathing type transformers should be controlled, and in particular the dielectric rigidity of their oil (see paragraph 6.2.1). On the other hand for sealed type transformer this check is not necessary, because the oil is hermetically sealed inside the tank and cannot get in contact with the ambient. To operate on a sealed transformer please contact Celme in advance to get all necessary instructions (see paragraph 8);
- For transformers equipped with radiators the opening of the butterfly valves is very important, in order to let the oil flow and avoid anomalous pressures inside radiators;

- Check periodically the internal pressure of nitrogen filled transformer (must be kept at 0.2atm) and check if the level of the gas cylinder is enough. The oil, shipped separately, must be stored in hermetic case to avoid dust and moisture contamination and in ambient with a constant temperature.

5.1.3 Assembly of transformer

If the transformer is shipped partially disassembled, Celme supplies an instruction manual with detailed information for the assembly, the filling and for a proper preparation for the start-up.

Firstly the rigidity of the oil should be checked before filling the transformer. All the components should be properly tightened according the relative torque wrench setting values. At this point fill the transformer taking care not to contaminate the dielectric fluid. Finally check the setting of all accessories.

If required, proceed with tests on site.

5.1.4 Problems and solutions

During the receipt of a transformer you can meet some problems or failures. Here below a short list of most frequent situation that can occur on site, for other information please contact Celme.

Oil leakage possible oil leaking from the gaskets can be solved by checking and tightening the screws.

Missing or damaged components avoid any contamination of the oil by substitution, if possible, of the component.

Damages if present, can compromise the correct cooling of the transformer. Contact Celme for more information of the intervention to be done.

Painting deterioration in this case clean the surfaces with water or a degreaser. Wipe then the surfaces dry and paint them, taking care to use the same original painting (for more information of painting type please contact Celme).

5.2 Preliminary operations

Check the distance between the transformer and the walls or other transformers; this distance should be sufficient in order not to interfere with the cooling. Furthermore the room should allow an adequate circulation of the air.

Once the transformer has been placed, you can proceed with the start-up. Celme suggests to check on the technical datasheet the accessories installed or to be installed and follow relative instructions.

5.2.1 Cleaning

If the transformer has been stored for a long time proceed with a general cleaning, in particular of the bushings from dust and salt, which can cause a superficial discharge between the element under voltage and the tank of the transformer, bringing to the consequent damage of bushings and windings.

5.2.2 Air breather

Assembly the air breather on the connection present on the conservator.

Check the color of the salts (must be orange). If the color of the salts differs, please follow instruction as described on paragraph 6.2.1.

Celme suggests to use Teflon gaskets to avoid any air flow through this thread.

5.2.3 Buchholz relay

For safety reason Celme ships the transformer with floating position blocked by a small wooden plug. Remove that plug and check that no air bubbles are inside the relay, by venting through the tap.

If during the start-up or the first hours of operation the relay gives the signal proceed again with the release of the gas, before claiming.

5.2.4 Integrated safety device R.I.S. or DGPT2

The setting of this device is made by Celme. Usually contacts of thermometer are set to 100℃ for trigging and 95℃ for alarm. The pressure device disconnects at 400 mbar, while oil level indicator disconnects when the float reaches the lowest position. Check that this setting corresponds to the needs of the customer. You can find more information of the relative manual. Don't change the orientation of the device (the orientation should be clarified with Celme before shipping; if necessary please contact Celme).

5.2.5 Thermometer

The thermometer setting is done by Celme. Usually the contact for trigging is set to 100℃ and for the alarm to 95℃. Check that this setting corresponds to the needs of the customer.

5.2.6 Thermal image

The setting is done by Celme. Usually the contact for trigging is set to 105℃ and for the alarm to 100℃. Check that this setting corresponds to the needs of the customer.

5.2.7 Oil level

Check that the signal of oil level indicator corresponds approximately to the ambient temperature, for breathing type transformers, and on the other hand for sealed transformer must be at the maximum level. If the oil level is too low proceed as described on paragraph 6.2.1.

5.2.8 Protective box

Protective boxes have to be assembled according our outline drawings and taking care of bushings and all fragile components of the transformer.

Check finally that all the gaskets, and eventual other accessories as bars or current transformers, are correctly positioned.

5.2.9 Flanges and valves

Check that all valves, except for the one present on the conservator with rubber diaphragm (is necessary for the vacuum treatment of the transformer), are open and allow the oil flow.

5.2.10 Grounding and electrical continuity

Transformer shall be grounded through the small plates or stainless steel studs present on transformer (tank, radiators, protective boxes, etc.) with a conductor able to tolerate the fault current, in order to allow the discharge to earth if necessary.

Check the connection of the screen between the winding to earth, if present on the transformer, through the small stainless steel plate placed on the cover.

Near the small stainless steel plate on the cover (where is stamped the serial number of the transformer) Celme executes the earth continuity of main metal components, tank and cover. This is done through bolts and screws.

Check that the electrical continuity, if foreseen, is guaranteed also for other components as radiators, conservators etc.

5.2.11 Other accessories

For installation or connection of other type of accessories not described in this paragraph, please check the instruction manual of the supplier given by Celme.

5.3 Torque wrench setting

If there is only one gasket not perfectly tightened this could be the cause of an oil leakage. Other problems can be given also by an inadequate fixing of bushings which can bring to overheating in some points and the consequent overheating of the transformer. Celme suggests to check the torque wrench setting of the main points of the transformer, of the carpentry (tank, cover, protective boxes, conservator, etc.), of the bushing, of the accessories, etc.

Here in the table we indicate the torque wrench setting values of main components suggested by Celme.

Table 5.1: Suggested torque wrench setting

CHARPENTRY

Thread	Torque wrench setting [Nm] without gasket	Torque wrench setting [Nm] with gasket
M6	6	5
M8	15	12
M10	35	30
M12	50	40
M14	80	55
M16	120	85
M18	170	na
M20	260	na
M22	320	na
M24	410	na
M27	620	na
M30	840	na

BUSHING GASKETS

Thread	Torque wrench setting [Nm]
M12	12
M20	20
M30	30
M42	55
M48	60
M55	75
M64	90

INTEGRATED SAFETY DEVICE

Thread	Torque wrench setting [Nm]
M8	8

DRAIN VALVES

Thread	Torque wrench setting [Nm]
DIN22	120
DIN31	140

FILLING PLUG

Thread	Torque wrench setting [Nm]
2"GAS	50

THERMOMETER POCKET

Thread	Torque wrench setting [Nm]
3/4"GAS	20
1"GAS	20

Note 1: For cables, copper bars and other conductors connection to the bushing flags Celme suggests to use the same torque wrench setting indicated in the table carpentry.

Note 2: For flanged thermometer pocket the torque wrench setting is the same of the one for the integrated safety device.

Note 3: For bushing flags the torque wrench setting is the same of the one indicated in the table carpentry with gasket.

5.4 Last verifications

Check that all connections to primary and secondary side are correctly done, respecting the order of the phases indicated on each bushing and on each connection point. Take care that the bushings do not carry the weight of the connections and that the connections of screen, auxiliaries and earth are properly executed.

Check the correct working of the contacts of accessories installed on the transformer.

Check that the tap changer is in the correct position, the nearest to the net (see instruction paragraph 4.7).

After the general checking of the plant you can proceeding and energize the transformer, by closing the switch of the feeding line.

⚠ *CAUTION: This operation puts under voltage the transformer! Safety norms must be respected to avoid any equipment damage, severe personal injuries, or death!*

Celme suggests to let the transformer under voltage but without loading it (secondary side switch open) for 2 hours, and after this time check if any anomaly is present on the accessories. If no problems rose you can operate on the secondary side switch.

Celme suggests to draw up a preventive maintenance program (see paragraph 6.1) to check regularly the functioning of the transformer.

5.5 Start-up checklist

For your safety Celme suggests to check that all the operations for the start-up have been done before energizing the transformer.

Following checklist reports the main activities to be done. Celme reminds to refer always to the technical datasheet of the transformer to identify the type of machine.

Table 5.2: Check list

Verification	Flag
Transformer integrity	
Absence of oil leakages	
Cleaning	
Wheels assembly	
Correct tightening of connections	
Opening of radiators valves (except the valve of conservator with rubber diaphragm)	
Remove the mechanical block of Buchholz relays	
Oil level	
Air breather assembly	
Tap changer position	
Protective box assembly	
Correct settings of accessories contacts	

Chapter 6

Maintenance

The transformer needs periodic checks to maintain its efficiency and extend its lifetime.

The progress of degradation of a transformer is linked to the environment of the plant (temperature, moisture, type of atmosphere) and to the working conditions (load cycle).
When a transformer leaves Celme factory, the insulation system is dry and free of acids. This will change over the time as water and acids are produced through degradation of the cellulose material and accumulate in the transformer; as a result the speed of degradation of the paper and oil will increase. Removing these impurities from transformer can extend the lifetime of insulation system.

The aim is to give to the authorized personnel the correct instructions to operate in safety condition and execute all the necessary periodical inspections, in order to protect and assure the efficiency of the transformer.

NOTE: The manufacturer can't be responsible of the efficiency and safety of the transformer, if the assembly, connection and maintenance operations are not done by the manufacturer itself or under its supervision or done by non-authorized personnel.

⚠ *CAUTION: Take care of personnel and instrumentation safety during maintenance and inspection activities. These are dangerous operations, take care that the switches are open and, as a consequence, the transformer is out of voltage.*

6.1 Preventive maintenance program

During the first month of functioning is suggested to execute frequent verification and draw up a methodical inspection program; the inspection frequency is related to the particular functioning conditions.
Be careful if you notice any anomaly dealing with noise, color and smell.

6.1.1 Verification of the temperature

Check the level of temperature reached by the transformer because the lifetime of the insulating materials is directly connected with the temperature.
The maximum oil temperature (at 1000m a.s.l.) for transformer according IEC norm is 100°C and for the winding is 105°C.

6.1.2 Verification of the oil volume

The oil volume can be verified by a visual check on the oil level indicator installed on the transformer.
The expansion of the oil is directly proportional to the temperature reached.

If the oil level is too low, follow the procedure on 6.2.1.

6.1.3 Noise verification

Hearing a noise during the running of the transformer different from the usual one can be an evidence of anomalies. The possible causes are:

- Wrong fixing of plates or accessories;
- Untightening of the core fixing;
- Low efficiency of the plant / untightening of the grounding cables;
- Resonance of the tank and of radiators due to an anomalous power frequency.

6.1.4 Verification of component fixing

⚠ *CAUTION: Before performing any maintenance work, be certain that the transformer is de-energized and ground the transformer terminals. Failures to de-energize the transformer may lead to equipment damage, severe personal injuries, or death!*

Check the tightening of nuts and bolts and in particular the tightening of valves and wheels block, to avoid the displacement of the transformer (see table 5.1).

6.1.5 Verification of oil leakages

Check that no oil leakages are present, otherwise contact Celme. The leakage can be due to the deterioration of the gasket or to an incorrect positioning of the same.

6.2 Preventive maintenance program

It is important to prepare a periodical verification program and record the results. The primary purpose of periodical transformer maintenance is to ensure that the internal and external parts of the transformer are kept in good condition, preserving its efficiency in the long period. For personal safety reasons, only a limited amount of maintenance activities should be performed on the transformer when it is in operation.

Celme suggests to execute the verifications described in the table 6.1, respecting the indicated timing which can be reduced on the base of functioning and ambient conditions.

Table 6.1: Periodical maintenance program

Frequency of verification	Type of verification	Maintenance procedure	Note
every month	oil temperature	check and record the transformer liquid temperature and note the maximum value reached since the last reading	
every month	winding temperature	check and record the transformer winding temperature and note the maximum value reached since the last reading	
every month	oil level	check and record any variation since the last reading	
every three months	cooling system	check and clean eventual accumulation of dirt and foreign bodies that might impede airflow	⚠ *CAUTION: be sure that the transformer is de-energized.* You can clean them by directing a stream of low-pressure water over the surfaces.
every three months	substation	• check the cleaning • corrosion of metal parts • loosen connections • damaged or broken mechanical parts • excessive noise	⚠ *CAUTION: be sure that the transformer is de-energized.*
every three months	air breather	check color of the salts	
every year	bushings	examine the status of each bushing or terminal, the tightening of connections an presence of contamination and electrical arcs. Clean the area	⚠ *CAUTION: be sure that the transformer is de-energized.* The presence of hot point near the bushings can be a sign of untightening if the connection (see table 5.1).
every year	gaskets	check that no oil leakages are present	⚠ *CAUTION: be sure that the transformer is de-energized.*
every year	transformer check-up	general cleaning and verification of the operational status of accessories and their contacts	⚠ *CAUTION: be sure that the transformer is de-energized.* More details on paragraph 6.2.1
every two year	oil	take and oil sample and test it	⚠ *CAUTION: be sure that the transformer is de-energized.* More details on paragraph 6.2.1

Note: Verifications above-listed depends on the presence of the accessory on your transformer. Celme suggests to check the technical datasheet of the transformer and of the accessories installed.

6.2.1 Maintenance procedure

⚠ *CAUTION: Before performing any maintenance work, be certain that the transformer is de-energized and ground the transformer terminals. Failures to de-energize the transformer may lead to equipment damage, severe personal injuries, or death!*

Insulating oil

Regular verification and inspection can reduce the deterioration of the oil; the task of the oil in a transformer is to act as an electrical insulation and transfer heat from the transformer's active part into cooling system.

For this reason the oil must have following characteristics:

- low viscosity
- high flash point
- high dielectric rigidity
- dry and clean

The deterioration of the oil is due to moisture and dust which cause the oxidation process. These chemical reactions as decomposition and polymerization produce sediments which do not reduce the dielectric rigidity of the oil, but can affect the cooling of winding and core.
Some methods to reduce this process is the use of air breather, absorbing the moisture of the air and blocking dust before getting in contact with the oil, otherwise by the application of special diaphragm to separate oil and air.

In sealed type transformers the oil is not in contact with the air therefore the oxidation process can be neglected. Please always inform Celme before opening this type of transformer.

To check the oil condition some parameters should be measured such as oxidation degree, density, superficial tension and dielectric rigidity. Take an oil sample (about one liter) from the drain valve placed at the bottom of transformer tank and test it with the special machine according indication given by IEC norms. If you do not have this testing device send the sample to an authorized laboratory or to Celme.

In case the results are positive please consider that on breathing type transformer is advisable to do a complete treatment of the oil if the transformer is running since many years, in order to remove the sediments.

During the lifetime of a transformer a variation of the oil level can be seen, such as that a filling-up is necessary. The filling-up is possible for breathing type transformers from the filling plug installed on the top of conservator. For hermetic (integral filling) transformers, the customer shall contact Celme before the operation. The added oil must have the same characteristics of the one present in the transformer.
Granted that oil supplied after 1992 is PCB free, Celme suggests to be sure that the new oil is not contaminated, in order not to contaminate the one present in the transformer.

Bushings

Clean regularly bushings from dust and salt, which can cause a superficial discharge between the element under voltage and the tank of the transformer, and bring to the consequent damage of bushings and windings. The regularity of the cleaning depends on the environment and for cleaning is enough a soft wet cloth.

Check the tightening of the cables. Nuts and bolts can untighten due to transformer vibrations, with a consequent overheating of the terminals. The presence of heat point can be identified from the different color near the interested area, and is an evidence of an untighten of nuts and bolts (see table 5.1).

Check if there is any crack on the bushings or oil leakages. If a bushings is damaged, it should be substituted; if some leakages can be seen the first action to do is to check the tightening, and in case fix the bushings. If the leakage continues, contact Celme.

Cooling systems

The corrugated tank or radiators, together with cooling fans, whether present, are very important components of a transformer. Damages or any foreign body on these cooling systems can reduce the air flow, with a consequent increase of the temperature of transformer, which can cause serious problems.

A regular cleaning of the cooling system is very important, even with low pressure bolt of water; if there are detachable radiators check that the radiators' valves are open and allow the flow of the oil.

Thermometer

The thermometer is the window on the internal condition of the transformer, and for this reason is important to keep it efficient.

Clean regularly the dial, after many years of operation check the eventual presence of water or dust inside the pocket. Check the efficiency of the contacts.

Oil level indicator

Clean regularly the dial. Check if there is any leakage or vibration which can cause a wrong feedback from the device. Check the efficiency of the contacts.

Buchholz relays

Clean regularly the inspection window on one side of relays. Through this window you can check any presence of gas inside the transformer; if there are gas bubble inside, check the volume and the color. Take a sample and let it analyzed to check its causes.

After some years of activity a verification of the floats inside the relay should be done. If they don't move correctly or there are oil leakages the relays is not working properly. Check the efficiency of the contacts.

Safety valve

When there is a failure and the internal pressure of the transformer reaches the limit set by the manufacturer this valve pushes the expansion plate outwards, allowing the exit of the oil, and the consequent decrease of the pressure along with the closing of the disconnection contact.

Check regularly that no oil leakage is present on the valve and the efficiency of the contacts.

Air breather

Check the gasket resistance so that the air can enter only through the air breather.

The color of the Silicagel should be regularly checked, because they change color from orange to green when they absorb the moisture of the oil and in this way they don't accomplish anymore their dehydrating function; the salts should be at that point regenerated by treatment at a maximum temperature of 100°C until they come back to the original orange color.

Tap changer

Off load Check that the control on the cover is locked in the correct position, in order to avoid any unexpected movement.
Usually this type of tap changer does not need any special maintenance, however Celme advises to move it from the lowest up to the highest position after long immobility period of the control.

On load For the maintenance of this type of tap changer and its components please refer to the instruction manual of the component supplier given by Celme with the transformer.

Gaskets

Over time gaskets can deteriorate themselves and this process is speeded up by temperature variation and ambient typology. For this reason you should check the absence of micro porosity after some years of functioning, because this could lead to oil leakages. If necessary contact Celme.

Painting

The ambient conditions of the plant where the transformer is installed has a considerable influence on the painting. A saline and sulphurous ambient is the most aggressive one.

Check the panting especially near the cooling system, bolts, nuts and tubes. If a touch-up is necessary clean the surface from rust and dusts. The thickness and type of painting for the touch-up must be the same of the original applied on the transformer. If the surface to be painted is large please contact a specialized firm.

Substation

Celme suggest to keep the transformer installation room in good condition. In particular the efficiency of the switches should be periodically checked, as well as the absence of defects or damages or corrosion on the mechanical parts.

Other accessories

For maintenance of accessories which are not present on this list, but are installed on your transformer, refer to operating manual of the component supplier given by Celme with the transformer. Always check the efficiency of contacts if present.

Chapter 7

Possible faults and solutions

Table below shows the most common faults which can occur during the functioning of your transformer and their possible solution.

Table 7.1: Causes and solutions

SYNPTOMS	PROBABLE CAUSES	POSSIBLE SOLUTIONS
Low oil dielectric rigidity	Moisture presence	Check the status of the air breather and if necessary do the oil treatment
	Deteriorated oil	Contact Celme and do the oil treatment
Triggering of the medium voltage protection	Winding damage	Contact Celme
	Tap changer incorrectly positioned. The primary voltage does not correspond with the line	Set correctly tap changer position
	Inadequate fuses	Check and change fuses
Anomaly on secondary side	Absence of primary voltage	Check the installation and contact the local supplier of energy
	Tap changer incorrectly positioned. The primary voltage does not correspond with the line	Set correctly tap changer position
	Windings damaged	Contact Celme
Abnormal signal of an accessory	Triggering and alarm incorrectly set	Check settings
	Construction fault of the accessory	Check and substitute the accessory, against Celme authorization
Abnormal operating temperature	Insufficient air circulation High ambient temperature	Check ventilation and distance from walls
	Overload	Check possible increases of power absorbed
High acoustical sound level	Magnetic steel in saturation	Check input voltage
	Loosen components	Retighten

Chapter 8

Contacts

For any information or notification please contact:

CELME S.r.l.
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Fax: +39 0444 440191
Web: www.celmesrl.com
e-mail: celmesrl@celmesrl.com

SERVICE DEPARTMENT
e-mail: service@celmesrl.com

SALES DEPARTMENT
e-mail: sales@celmesrl.com

TECHNICAL DEPARTMENT
e-mail: tecnico@celmesrl.com

PRODUCTION DEPARTMENT
e-mail: produzione@celmesrl.com

ADMINISTRATIVE DEPARTMENT
e-mail: amministrazione@celmesrl.com

Note

Address : Via Cà Sordis 30/32 36054
Montebello Vicentino (VI)
Italy
Telephone: +39 0444 440254
Fax: +39 0444 440191
Web: www.celmesrl.com
e-mail: celmesrl@celmesrl.com

5. ACCESORIOS

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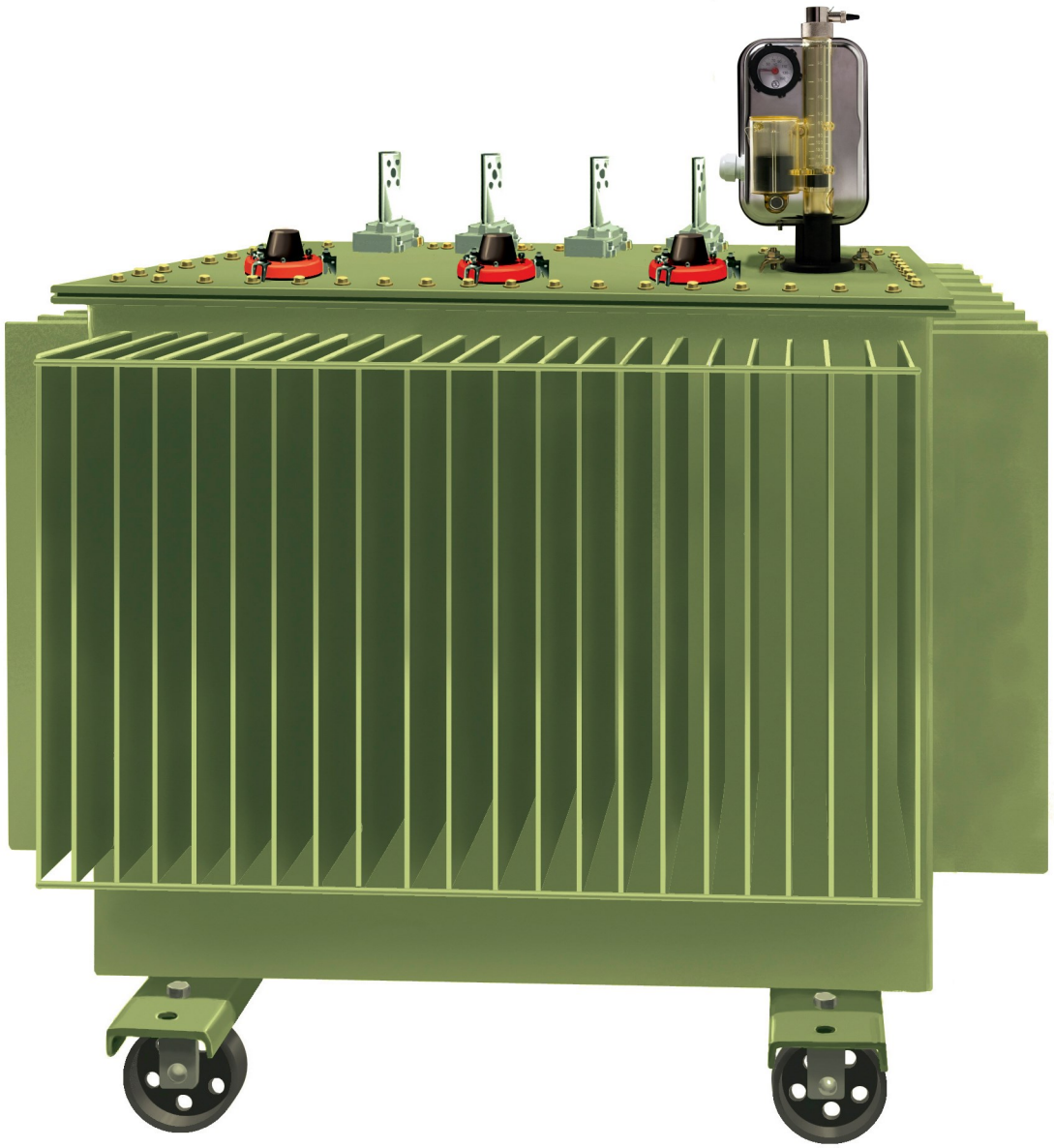
Tel: +33-1-3461-4232 – Fax: +33-1-3461-8919
info@automation2000.com – www.automation2000.com

INSTRUCCIONES TÉCNICAS
DGPT2®



1– INSTALACIÓN (TRANSFORMADORES HERMÉTICOS DE LLENADO INTEGRAL)

1.1 Preámbulo

El método de instalación que se describe a continuación se ofrece únicamente a título orientativo, siendo la instalación responsabilidad exclusiva del instalador.

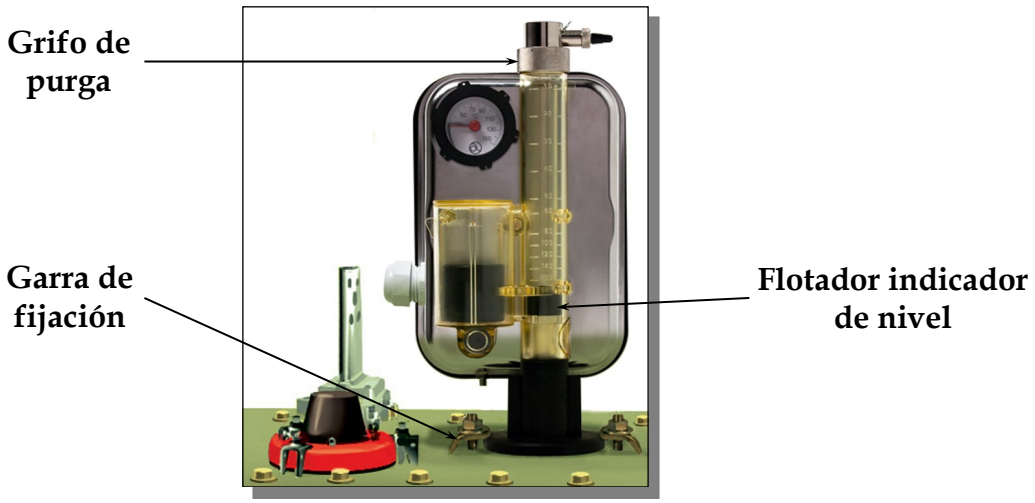
1.2 Precauciones de instalación

Antes de iniciar la instalación del DGPT2®, asegúrese de que:

- El transformador no esté bajo tensión.
- El dieléctrico del transformador esté a temperatura ambiente (aproximadamente 20°C).
- El nivel del dieléctrico del transformador esté situado ligeramente por debajo de la cubierta del transformador.
- El orificio sobre el que se vaya a montar el DGPT2® esté abierto.

1.3 Procedimiento de instalación

- Retire el grifo de purga y el flotador indicador de nivel del DGPT2®.
- Coloque la junta de Viton® (suministrada) en la hendidura de la brida del DGPT2®.
- Monte el DGPT2® sobre el orificio de la cubierta del transformador previsto a ese efecto.
- Coloque las garras de fijación (suministradas) sobre los pernos (3 a 120° o 4 a 90°) de acuerdo con las precauciones de sujeción (*ver página 4*). Los pernos de fijación deberán estar en un círculo con 97 mm de diámetro (±2 mm).
- Rellene el DGPT2® con el dieléctrico del transformador hasta alcanzar el nivel más alto del DGPT2®.
- Vuelva a colocar el flotador indicador de nivel antes de volver a atornillar el grifo de purga del DGPT2®.



2– INSTALACIÓN (TRANSFORMADORES QUE RESPIRAN CON CONSERVADOR)

2.1 Preámbulo

El método de instalación que se describe a continuación se ofrece únicamente a título orientativo, siendo la instalación responsabilidad exclusiva del instalador.

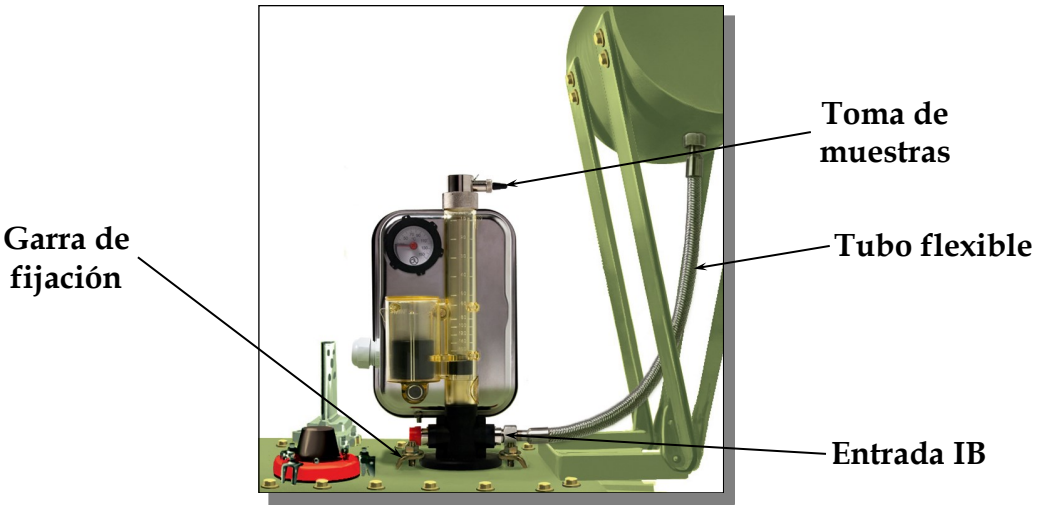
2.2 Precauciones de instalación

Antes de iniciar la instalación del DGPT2-IB, asegúrese de que:

- El transformador no esté bajo tensión.
- El dieléctrico del transformador esté a temperatura ambiente (aproximadamente 20°C).
- El conservador del transformador esté vacío.
- El nivel del dieléctrico del transformador esté situado ligeramente por debajo de la cubierta del transformador.
- El orificio sobre el que se vaya a montar el DGPT2-IB esté abierto.

2.3 Procedimiento de instalación

- Coloque la junta de Viton® (suministrada) en la hendidura de la brida del DGPT2-IB.
- Monte el DGPT2-IB sobre el orificio de la cubierta del transformador previsto para tal efecto.
- Coloque las garras de fijación (suministradas) sobre los pernos (3 a 120° o 4 a 90°) de acuerdo con las precauciones de sujeción (*ver página 4*). Los pernos de fijación deberán estar en un círculo con 97 mm de diámetro (±2 mm).
- Conecte un tubo flexible o un tubo con racor roscado 3/8″ hembra entre la entrada IB del DGPT2-IB y el conservador.
- Rellene el conservador hasta su nivel normal.
- Abra con suavidad la toma de muestras hasta que el nivel de dieléctrico alcance el nivel más alto del DGPT2-IB.



PRECAUCIONES DE SUJECIÓN

A la hora de apretar las tuercas HM8 sobre las garras de fijación del DGPT2®, asegúrese de que:

⇒ El par de sujeción no sobrepase nunca los 3 m.kg (30 N.m).
⇒ La brida NO TOQUE la cubierta del transformador (la junta plana de Viton® suministrada deberá quedar a la vista aproximadamente 1 a 2 mm).
⇒ Las garras de fijación del DGPT2® estén apretadas una tras otra en el sentido de las agujas del reloj, ligeramente la primera vez, después a un máximo de 3 m.kg (30 N.m) en la segunda vuelta.

PRECAUCIONES DE ESTANQUEIDAD

La estanqueidad del grifo de purga del DGPT2® está asegurada por una junta Viton® en la hendidura.

⇒ NO UTILICE NUNCA cinta de Teflon® (u otros materiales similares) para asegurar la estanqueidad del grifo de purga por medio del roscado.

3– FUNCIONAMIENTO ELÉCTRICO

3.1 Preámbulo

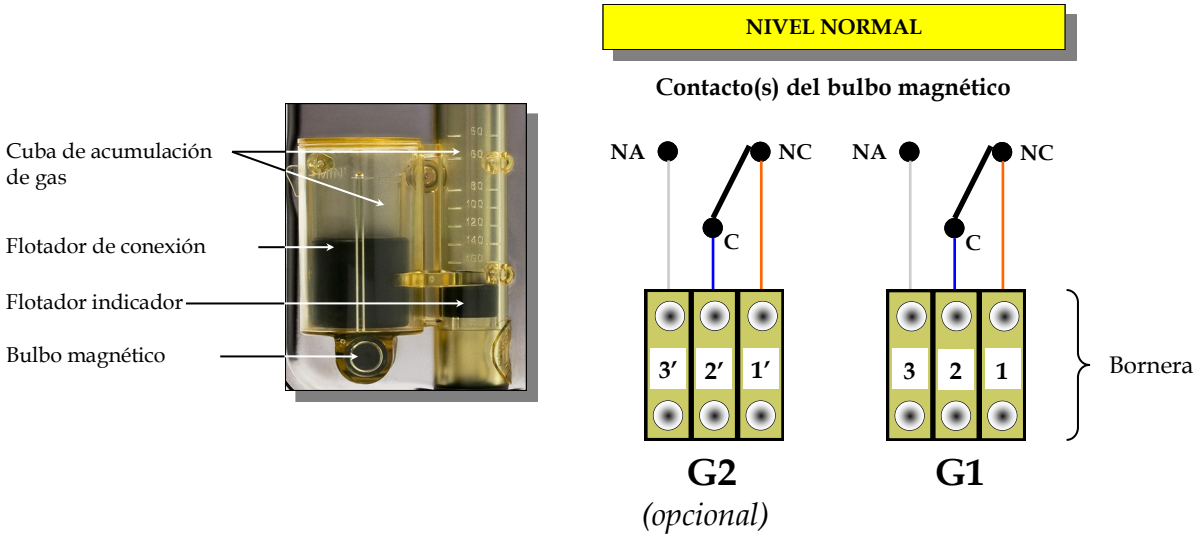
Los contactos del DGPT2® son de tipo «inversor». Por lo tanto, tienen un contacto «Común», un contacto «Normalmente Cerrado» y un contacto «Normalmente Abierto».

> En los esquemas propuestos en este apartado, los contactos siempre están representados sin tensión y en reposo, es decir, por defecto en la función representada.

3.2 Esquemas de funcionamiento

3.2.1 Desprendimiento de gases

El desprendimiento de gases se debe generalmente a un defecto eléctrico en la parte activa del transformador, en el que el arco eléctrico formado no es suficiente para provocar un aumento de presión instantánea.



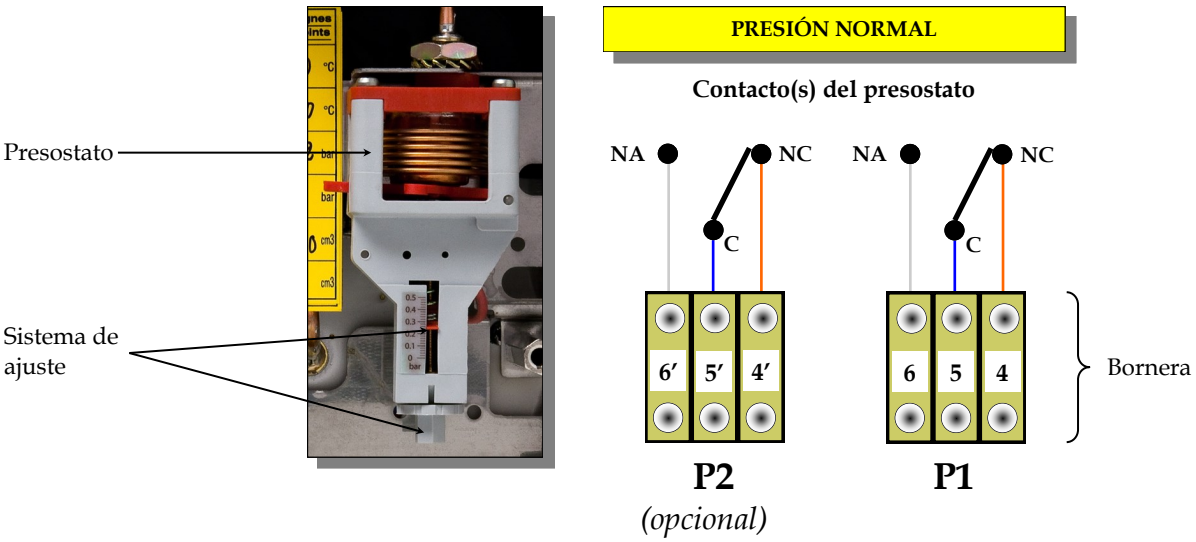
Cuando el desprendimiento de gases en el interior de la cuba de acumulación de gas alcanza ciertos valores (función de la densidad del dieléctrico), el contacto del bulbo magnético oscila.

Densidad del dieléctrico < 1 ➔ Volumen < 140 cm^3
Densidad del dieléctrico = 1 ➔ Volumen = 140 cm^3 (±5 cm^3)
Densidad del dieléctrico > 1 ➔ Volumen > 140 cm^3

3.2.2 Exceso de presión

El exceso de presión se debe generalmente a un cortocircuito franco, en el que el arco eléctrico formado provoca indirectamente un aumento de presión instantánea.

El punto de referencia del exceso de presión es siempre definido por el fabricante del transformador.

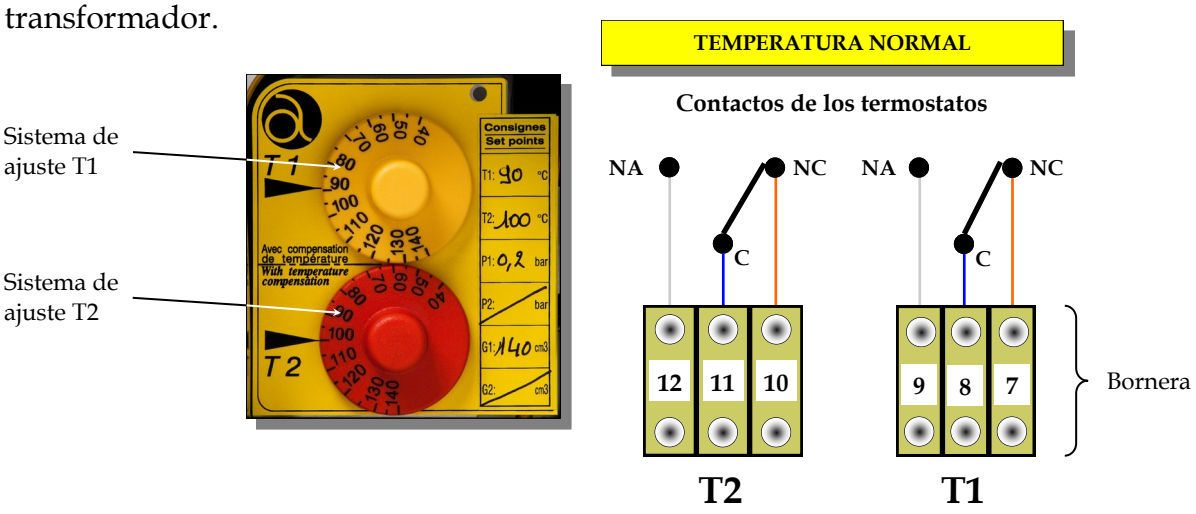


Cuando la presión en el interior de la cuba del transformador alcanza los valores de referencia (±0,01 bar), el contacto del presostato oscila.

3.2.3 Temperatura

El aumento de la temperatura se debe generalmente a un defecto eléctrico que provoca un calentamiento localizado, o una sobrecarga del transformador (por encima de las condiciones de servicio recomendadas por el fabricante).

Los puntos de referencia de temperatura son siempre definidos por el fabricante del transformador.



Cuando la temperatura del dieléctrico alcanza los valores de referencia (±2,5°C), el contacto del termostato oscila.

4– PRUEBAS

4.1 Precauciones

Antes de iniciar las pruebas:

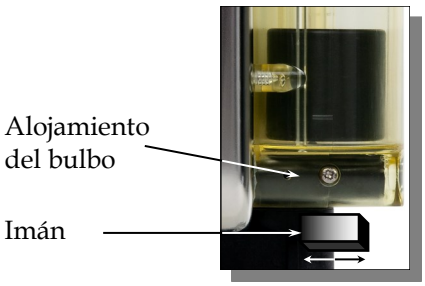
- Asegúrese de que el transformador no está bajo tensión.
- Compruebe cuidadosamente el cableado.
- Compruebe que la alimentación de los servomecanismos está presente, con el fin de poder testar los circuitos hasta el elemento final (indicador luminoso, etc. para la alarma; accionadores diversos para la función de conexión).

4.2 Desprendimiento de gases

Elemento correspondiente: bulbo magnético

El desplazamiento de un imán (Ø 22 mm mínimo, espesor 10 mm) bajo el alojamiento del bulbo magnético (o al lado) hace oscilar el contacto inversor.

Compruebe que el circuito funciona correctamente.



4.3 Exceso de presión

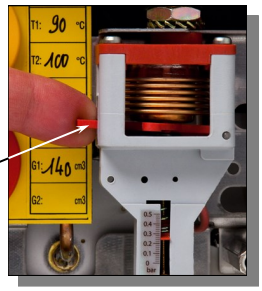
Elemento correspondiente: ***presostato tipo 1***

Presione el pulsador de test situado en el lado izquierdo del presostato.

El contacto inversor oscila.

Tras comprobar que el circuito funciona correctamente, deje de presionar el pulsador de test.

TIPO 1



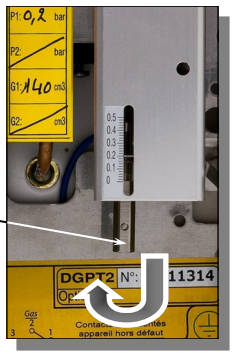
Elemento correspondiente: ***presostato tipo 2***

Gire la rueda reguladora en el sentido de las agujas del reloj, para poner el punto de referencia a cero.

El contacto inversor oscila.

Tras comprobar que el circuito funciona correctamente, vuelva a ajustar el punto de referencia en el valor indicado en la placa de identificación.

TIPO 2



4.4 Temperatura

Elementos correspondientes: termostatos T1 y T2

Gire el botón regulador hacia menos de 40°C.

El contacto inversor oscila.

Tras comprobar que el circuito funciona correctamente, vuelva a ajustar el punto de referencia en el valor indicado en la placa de identificación.

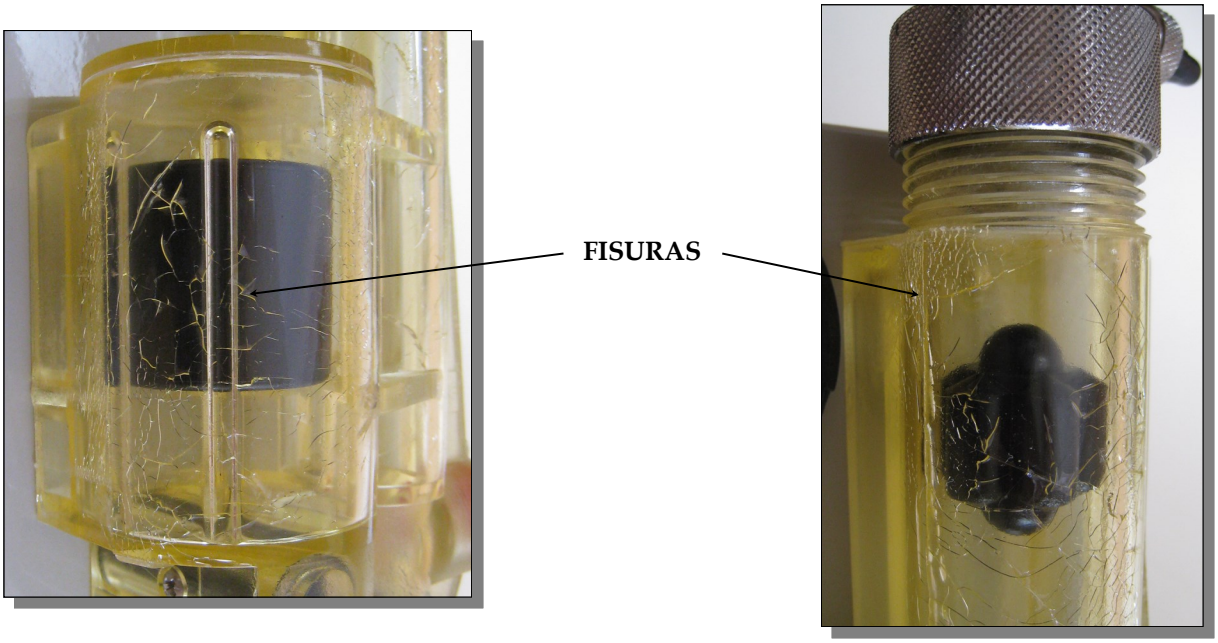
5– PRECAUCIONES DE LIMPIEZA

5.1 Precauciones básicas

El cuerpo del DGPT2® está realizado en poliamida transparente específicamente tratado contra rayos ultravioletas y para uso en exteriores.

Cuando tenga que limpiar el cuerpo del DGPT2®, asegúrese siempre de que el producto de limpieza (o el producto de detección de fugas) que utiliza no contiene ninguno de los productos químicos que figuran en la lista de la página 9. El diesel y el queroseno son excelentes productos de limpieza.

Si alguna vez utiliza un producto de limpieza que contenga uno de esos productos químicos, aparecerán fisuras en el cuerpo del DGPT2®. Éstas son provocadas por el relajamiento de las tensiones de interior de la poliamida. Estas fisuras provocarán fugas que harán que el DGPT2® quede inutilizable hasta que su cuerpo no se remplace.



5.2 Pérdida de transparencia

En zonas de ambiente contaminado, capas sucesivas de sedimento pueden alterar la transparencia del cuerpo del DGPT2®, e incluso ocultar completamente la visibilidad del nivel del dieléctrico y de los flotadores.

En ese caso, la mejor solución para restituir una visibilidad parcial consiste en:

- Utilizar un producto de limpieza que no contenga ninguno de los productos químicos que figuran en la lista de la página 9.
- Utilizar una pasta fina de pulir para carrocería automóvil.

5.3 Productos químicos que nunca deberá utilizar con el cuerpo del DGPT2®

#
1,2-dicloroetano
1,2-dicloroetileno
1,4-dioxano
3-metilbutan-1-ol

A
Acetona
Ácido acético glacial
Ácido benzoico*
Ácido clorhídrico concentrado
Ácido clorosulfúrico
Ácido metanoico concentrado
Ácido nítrico, 2%
Ácido nítrico, 10%
Ácido nítrico, 30%
Ácido sulfúrico concentrado
Ácido tártrico o tartárico*
Alcohol alílico
Alcohol amílico
Alcohol butílico normal
Alcohol butílico terciario
Alcohol etílico
Alcohol furfurílico
Alcohol isoamílico
Anilina

B
Benzaldehído
Bromo líquido
Butano-1,3-diol
Butano-1,4-diol
Butano-2,3-diol
Butileno glicol

C
Ciclohexano
Clorato de potasio*
Clorodifluorometano
Cloroformo
Cloruro de metileno
Crotonaldehído

D
Diclorofluorometano
Diclorometano
Dimetilformamida

E
Etanol
Etilamina, 33%
Etilendiamina
Etilenglicol
Etil metil cetona

G
Gasolina (5% metanol)

H
Hidrato de hidrazina, 80%

I
Isopropanol

N
Nitrilo acrílico

P
Propan-1-ol
Propilenglicol

**: solución saturada en agua a 23°C*

6– CARACTERÍSTICAS

6.1 Carcasa

- Carcasa y cubierta de acero inoxidable AISI 304 con 2 tornillos precintables
Índice de protección: IP56, IK07
- Salida de cable por prensaestopa M25 de anclaje (dos posiciones posibles)
Capacidad de sujeción: 13-18 mm
- Conexión eléctrica por bornera de 6 elementos
Capacidad de sujeción: 4 mm² (12 o 18 bornes)
- Tornillo de diámetro 5 mm de toma de tierra en el interior de la carcasa
- Tornillo de diámetro 6 mm de toma de tierra en la base exterior de la carcasa
- Aislamiento: 500 VCC, 20 MΩ entre bornes y tierra
- Rigidez dieléctrica: 2 000 VAC, 1 minuto entre bornes y tierra
- Incendio: las prensaestopas, los bornes, los hilos, etc. son de material autoextinguible y sin halógeno. La carcasa metálica protege del fuego.

6.2 Cuerpo plástico

- Cuerpo plástico en poliamida con estabilizador antiultravioleta
Índice de protección: IP56, IK07
- Graduación del volumen de gas en cm³ (10-160 cm³)

6.3 Bulbo magnético

- Bulbo magnético con 1 contacto (2 bulbos opcionales)
- Contactos inversores
- Precisión de medida: ±5 cm³

6.4 Presostato

- Presostato de fuelle metálico y resorte de ajuste equipado con un microcontacto (2 microcontactos independientes opcionales)
- Contactos inversores
- Punto de referencia regulable y precintable
- Escala: 0–500 mbar (0-700 mbar por encargo)
- Precisión de pantalla: ±10 mbar
- Precisión de medida: ±5 mbar
- Tiempo de reacción: < 5 milisegundos

6.5 Termostatos

- 2 termostatos independientes de dilatación de líquido regulables
- Compensación de temperatura ambiente
- Contactos inversores
- Escala: 40–140°C
- Precisión de pantalla: ±2,5°C
- Precisión de medida: ±3°C a 60°C, ±1,5°C a 90°C

6.6 Termómetro

- 1 termómetro de dilatación de líquido con acceso de aguja marcadora precintable
Diámetro del cuadrante: 50 mm
- Compensación de temperatura ambiente
- Aguja marcadora para indicar la temperatura máxima alcanzada
- Escala: 40-150°C
- Precisión de lectura: ±1°C
- Precisión de medida: ±4°C a 60°C, ±1,5°C a 90°C

6.7 Racor

- Racor a la base de la carcasa por una brida de composite con dedo frío previsto para montaje por perforación de diámetro 60 mm (junta y garras de fijación suministradas).
Diámetro de la brida: 85 mm
Dedo frío: 104 mm (largura), 27-24 mm (diámetro desde debajo de la brida hasta la extremidad inferior)
- La brida y el dedo frío no son conductores de electricidad.

6.8 Condiciones de servicio

- Temperatura ambiente: –40°C a 65°C
- Temperatura del dieléctrico: ≤ 140°C

6.9 Poder de corte

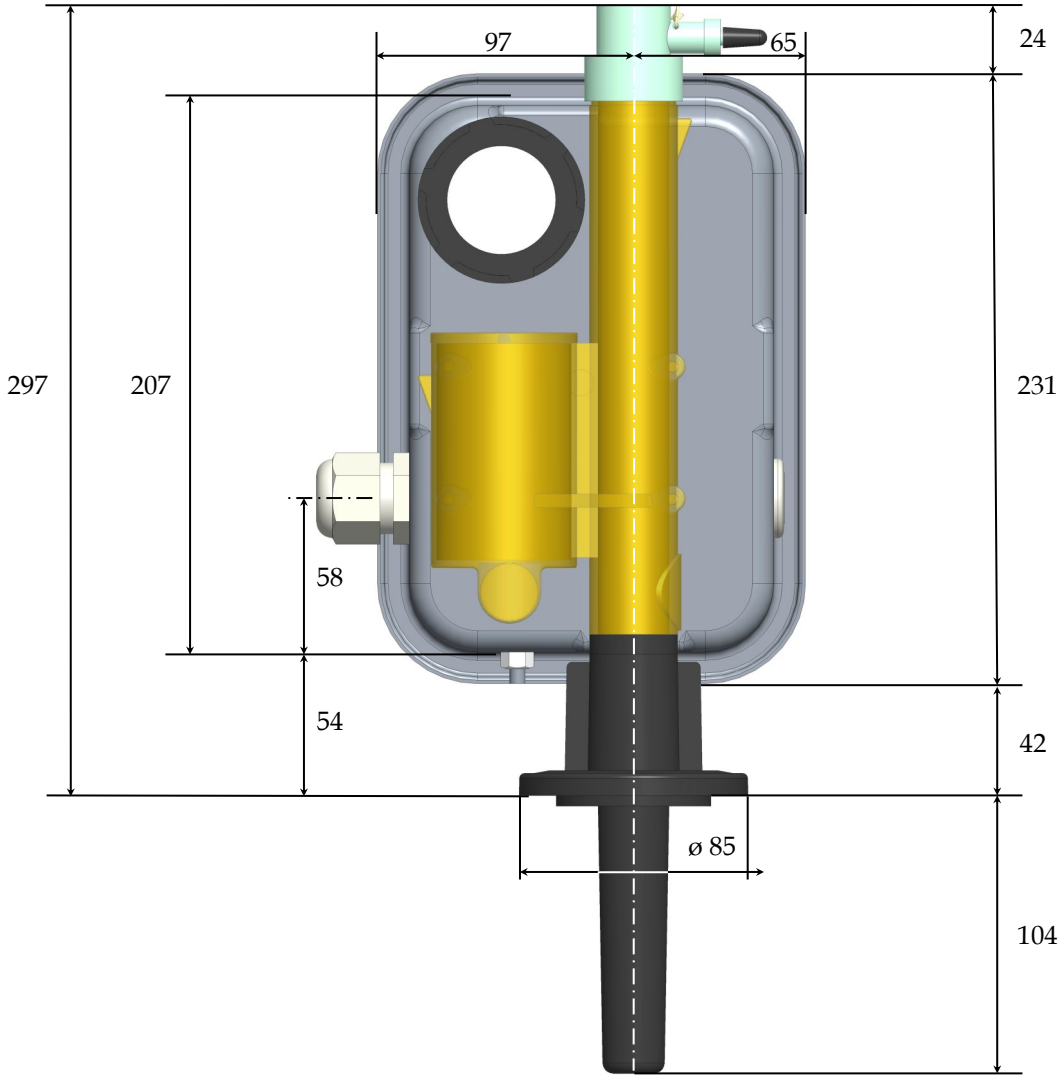
Función	CARGA RESISTIVA - *L/R < 40 ms*				
	24 VCC	**48 VCC**	**110 VCC**	**220 VCC**	**250 VAC** *50/60 Hz cos φ 0,5*
Desprendimiento de gases	1 A	1 A	0,5 A	0,25 A	1 A
Exceso de presión	2 A	3 A	0,5 A	0,25 A	5 A
Temperatura	4 A	4 A	1 A	0,5 A	8 A

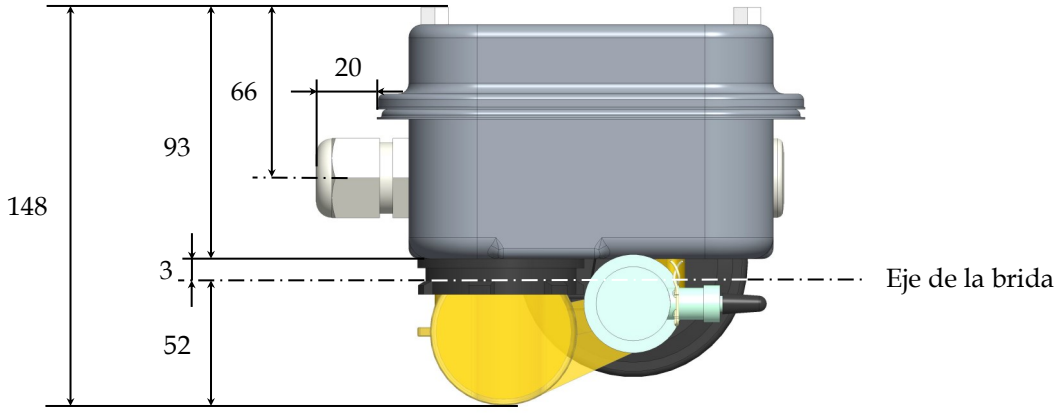
6.10 Conformidad con las normas

El DGPT2® cumple las siguientes normas:

- IEC EN 50216-1
- IEC EN 50216-3
- IEC EN 60529
- NF EN 60439-1
- NF EN 60950
- NF C17-300
- NF C52-107

7– PLANOS DE DIMENSIONES





8– OPCIONES

2G: 2 contactos de gas sincrónicos

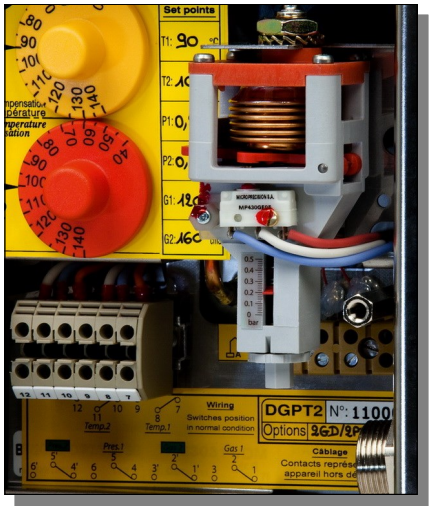
El DGPT2® está equipado con dos bulbos magnéticos cuyos umbrales de conmutación son idénticos.
Las características de los bulbos son idénticas a la de los DGPT2® estándar.
De acuerdo con la norma CEI EN 50216:3, los contactos oscilan para un volumen de gas en el interior del cuerpo transparente comprendido entre 100 y 200 cm³.

2GD: 2 contactos de gas con umbrales desplazados

El DGPT2® está equipado con dos bulbos magnéticos cuyos umbrales de conmutación están desplazados aproximadamente 40 cm³.
De acuerdo con la norma CEI EN 50216:3, los contactos oscilan para un volumen de gas en el interior del cuerpo transparente comprendido entre 100 y 200 cm³.

2P: 2 contactos de presión sincrónicos

El DGPT2® está equipado con un presostato con dos microcontactos cuyos umbrales de conmutación son idénticos.
El umbral de conmutación está definido por el cliente.



2PD: 2 contactos de presión con umbrales desplazados

El DGPT2® está equipado con un presostato con dos microcontactos cuyos umbrales de conmutación son desplazados.
El decalaje de los umbrales de conmutación (10 a 100 mbar), definido en el pedido, no puede ser modificado por el cliente.
El punto de referencia indicado en el presostato es el umbral de conmutación P1.

CE: conector externo

El DGPT2® está equipado con un conector externo tipo Harting sobre la cubierta, que permite la conexión y la desconexión de relé sin necesidad de abrir la carcasa metálica.

FA: termómetro visible en el lado de la cubierta

El cuadrante del termómetro es visible en el lado de la cubierta de la carcasa metálica del DGPT2®.

HT: cuerpo con brida alta temperatura

El DGPT2® está equipado con un cuerpo con brida y dedo frío resistente a una temperatura de dieléctrico inferior o igual a 170°C.

IB: conexión a un conservador

El DGPT2® está equipado con una brida con dos racores machos 3/8″ para conexión a un conservador (o a otro accesorio).

PA: prensaestopa marino

El DGPT2® está equipado con un prensaestopa de tipo marino en lugar y en la posición del prensaestopa estándar.
Asegura un anclaje y la continuidad de armadura, así como la estanqueidad a la vaina interna y externa del cable de conexión.

PT: sonda Pt100

El DGPT2® está equipado con una sonda de resistencia de platina (100 Ω a 0°C y 138,5 Ω a 100° C) instalada en el dedo frío. Está conectada a una bornera independiente por 3 o 4 conductores en función de las necesidades del cliente.

SO: grifo de purga con válvula de expansión térmica

El DGPT2® está equipado con un grifo de purga provisto de una válvula de expansión térmica en lugar y en la posición del grifo de purga estándar.
Su calibración la define el cliente y es ajustada por Automation 2000.

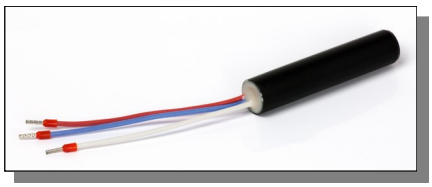
X: ambiente corrosivo y marino

El DGPT2® está equipado con una carcasa metálica con cubierta de acero inoxidable AISI 316L, así como con un grifo de purga en latón con niquelado químico, y con garras de fijación de acero inoxidable AISI 316L (*Índice de protección:* IP67, IK07).

9– ACCESORIOS Y PIEZAS SUELTAS

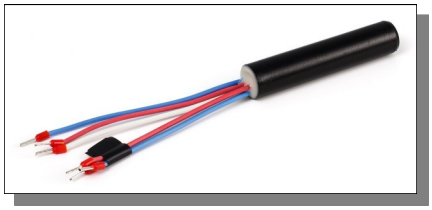
Bulbo magnético simple

Pieza suelta para DGPT2® estándar.



Bulbo magnético doble sincrónico

Pieza suelta para DGPT2® con opción 2G.



Bulbo magnético doble con umbrales desplazados

Pieza suelta para DGPT2® con opción 2GD.

Garras de fijación

Pieza suelta de acero o de acero inoxidable AISI 316L.

Grifo de purga

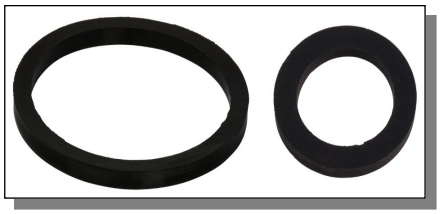
Pieza suelta en latón niquelado.

Grifo de purga con válvula de expansión térmica

Pieza suelta en latón niquelado.
El tarado de la válvula lo define el cliente y será ajustado por Automation 2000.

Junta plana para brida

Pieza suelta de Viton®.



Junta plana para grifo de purga

Pieza suelta de Viton® para grifo de purga con o sin válvula de expansión térmica.

Protección antimagnética

Este accesorio permite prevenir los encendidos intempestivos del bulbo magnético del DGPT2® en ambientes altamente magnéticos.
Está realizado en acero inoxidable ferromagnético AISI 430, suministrado con su tornillo de fijación.

Tubo flexible 3/8″ para conexión a un conservador

Este accesorio está constituido por un tubo de ondas de acero inoxidable AISI 316L cubierto de una trenza de acero inoxidable AISI 304L. Está equipado en estándar con un racor 3/8″ hembra en acero inoxidable AISI 316L con dos extremos. La largura del tubo flexible se define en el pedido.