

Trihal

*Cast resin
transformer*





temps de front

$$T1 = 1,2 \text{ s} - 30\%$$

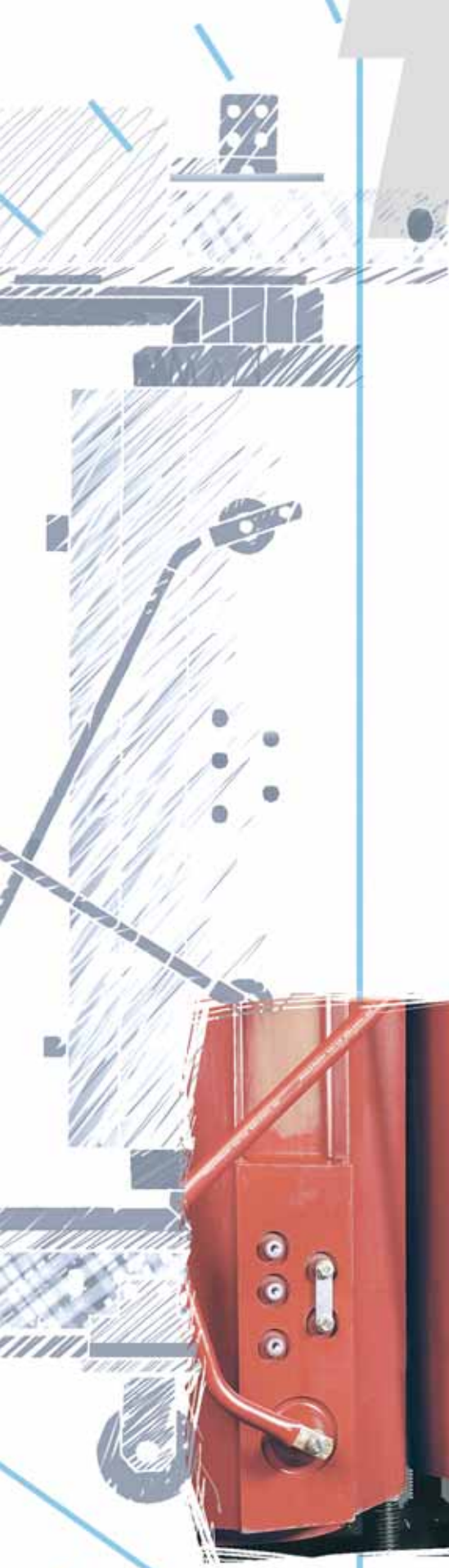
temps de queue

$$T2 = 50 \text{ s} - 20\%$$

relation entre T1 et T

$$T1 = 1,67 T$$

Trihal



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A technology developed and patented by France Transfo since 1985.



400 kVA, 20 kV/400 V, IP00 and IP31

type

Trihal is a three-phase dry type transformer **cast under vacuum in epoxy resin with an active filler.**

It is this active filler, essentially composed of **trihydrated alumina**, which is the origin of the **Trihal** trademark.

Trihal is an indoor type transformer (for outdoor installation, please consult us).

standard

Trihal complies with standards :

- IEC 60076-1 to 5 ;
- IEC 60076-11 (2004) ;
- IEC 60905 ;
- CENELEC (European Committee for Electrotechnical Standardization) harmonization document EN 60076-1, -2, -3, -5, HD 538-2 S1 : 1995, EN 60076-11 concerning dry type transformers.

range

- **HV/LV distribution transformers from 160 to 2500 kVA up to 36 kV.**

For higher rated power and voltages, please consult us.

Trihal transformers are supplied in many versions :

- without enclosure (IP00) ;**
- with IP31 metal enclosure : see the different types on pages «options»**

Please note! The resin provides insulation for the HV winding but does not provide protection from direct contact. Only the protective enclosure version provides this protection.

- **HV/HV power transformers up to 15 MVA and 36 kV.**

Please consult us.



Ennery assembly line



630 kVA - 20 kV/400 V

basic equipment

version without protective enclosure (IP00)

- 4 flat multi-direction rollers ;
- 4 lifting lugs ;
- haulage holes on chassis ;
- 2 earthing locations ;
- 1 rating plate (HV side) ;
- 2 “electrical hazard” warning labels (signal C10) ;
- off circuit tapping links, operational when transformer is de-energised, acting on the highest voltage to adapt the transformer to the true supply voltage ;
- HV connection bars with connections from above ;
- LV connections from above ;
- 1 test certificate and an installation, commissioning and maintenance manual.

version with IP31 protective metal enclosure.

- TRIHAL transformer without protective enclosure (IP00) as described above ;
- 1 metal IP31 (apart from the base: IP21) protective enclosure :
 - with standard anti-corrosion protection ;
 - lifting lugs for handling of transformer with its enclosure ;
 - 1 bolted panel on the HV side for access to HV connections and tapping points, fitted with 2 handles, an “electrical hazard” warning label (signal T10), a rating plate and a visible braid for earthing ;
 - drilled holes (with covers) on the left of the bolted HV side panel, intended for the mounting of a RONIS type ELP1 or a Profalux type P1 keylock ;
 - 2 panels to be drilled to pass the cables through cable glands on the enclosure roof: 1 HV side, 1 LV side (pilot holes and cable glands not supplied) ;
 - 1 gland plate situated on lower right hand HV side for possible incoming HV cable connection from below.

technology and construction

Trihal benefits from two key patented processes :

- a linear voltage gradient from the top to bottom of HV coil, generally used ;
- a fireproof casting system.

This technology, patented by France Transfo is implemented in the Ennery plant in France. The companies large production capacity ensures deliveries meet clients particular needs.

quality system

The certificate issued by AFAQ (French Association for Quality Assurance) states that Trihal transformers are manufactured in accordance with a quality system in compliance with the international standard ISO 9001.

environmental protection

The Trihal manufacturing plant is the first French facility to be certified to ISO 14001 in this sector, and has been so since 1998.

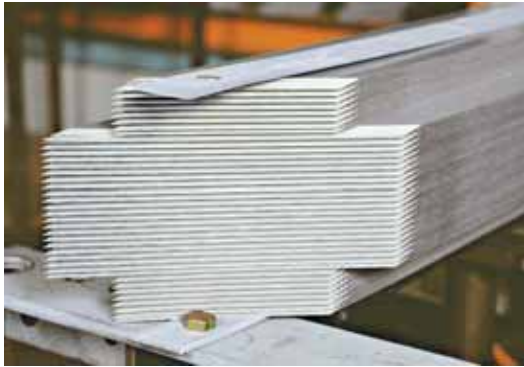
Trihal, is designed and produced to be environmentally friendly, providing an ecological response for HV/LV transformers.

Environmental protection is integrated in management systems in order to promote the protection of all natural resources and continuously improve conditions for a clean environment.

Product design focuses on minimising environmental impact.



Very low partial discharge level (≤ 10 pC) provides an excellent impulse strength.



magnetic core in assembling

magnetic core

The magnetic core is made from laminations of grain oriented silicone steel insulated with mineral oxide.

The choice and grade of steel and the cutting pattern and method of assembly minimises the loss level and the no-load current with the effect of a very low noise level.

Once assembled, it is corrosion protected using a class F, oven-dried alkyd resin.

low voltage winding

The low voltage winding is made of either aluminium or copper foil (according to manufacturer's preference) in order to achieve zero axial stresses under short circuit conditions; the foil is insulated by a class F inter-layer film, pre-impregnated with heat-activated, epoxy resin.

The ends of the winding are protected and insulated using a class F insulator.

The whole winding is polymerised by being placed in an autoclave for 2 hours at 130°C which guarantees :

- outstanding resistance to industrial atmosphere aggression,
- excellent dielectric withstand,
- very good resistance to radial stresses under bolted short circuit conditions.

Each LV winding terminates in a tin plated aluminium or copper connection point, enabling connections to be made without using a contact interface (grease, bi-metal strip).

Assembly is carried out according to current practices, including using spring pressure washers under nut and screw heads.

high voltage winding

The high voltage winding is usually wound from insulated aluminium or copper wire, using a method developed and patented by France Transfo : "a linear voltage gradient from the top to the bottom".

For higher currents, the medium voltage winding may be wound using so-called "strip" technology.

These methods are used to obtain very low stress levels between adjacent conductors.

This winding is cast and moulded under vacuum in a class F loading and fireproofed resin : the Trihal casting system.

These processes combine to give coils of very high **dielectric properties with very low partial discharge level (guaranteed ≤ 10 Pc)* which is a decisive factor in influencing the transformer's life span and its lightning impulse withstand⁽¹⁾.**

HV tapping points on the copper connection bars enable connections to be made without using a contact interface (grease, bi-metal strip). Assembly is carried out according to current practices, including using spring pressure washers under nut and screw heads.



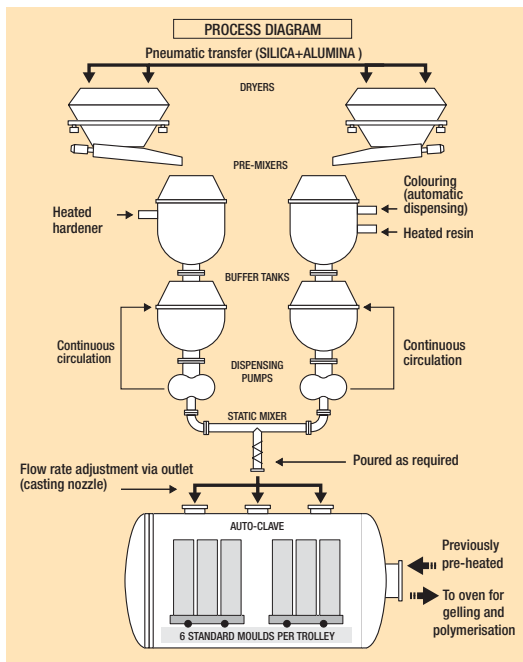
LV polymerization kiln



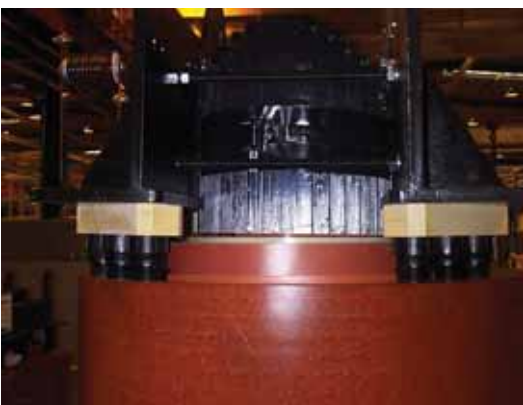
winding an HV coil in strip

* The actual level of partial discharge from the transformer alone is, in fact, lower than that measured, as "background noise" in the measuring environment inevitably leads to error.

(1) It is important to note that the level of partial discharge remains the same throughout the transformer's service life.



HV casting process



reinforced wedges for wind turbine

high voltage casting system

The system provides a **vacuum cast coating of fire resistant filled resin**, a technology developed and patented by France Transfo.

The class F casting system comprises :

- a bisphenol based **epoxy resin** with a suitable viscosity to ensure excellent impregnation of the windings ;

- an anhydride **hardener** modified by a flexiblising additive. This type of hardener assures very good thermal and mechanical properties. The flexiblising additive gives the casting system the necessary elasticity to prevent cracking during operation ;

- an **active powdered filler composed of silica and especially of trihydrated alumina** thoroughly mixed with the resin and the hardener.

Silica reinforces the casting's mechanical strength and improves heat dissipation.

The trihydrated alumina guarantees the Trihal transformer's intrinsic fire performance. The trihydrated alumina produces 3 anti-fire effects which occur in case of calcination of the casting system (when the transformer is exposed to flames).

- 1st anti-fire effect⁽¹⁾ : refracting shield of alumina.
- 2nd anti-fire effect⁽¹⁾ : barrier of water vapour.
- 3rd anti-fire effect⁽¹⁾ : temperature held below the fire point.

The result of the combination of the 3 anti-fire effects is immediate self extinguishing of the Trihal transformer⁽¹⁾.

In addition to its dielectric qualities, the casting system gives the Trihal transformer **excellent self extinguishing fire resistance and excellent environmental protection against aggressive industrial atmospheres.**

high voltage coil casting process

The process from proportioning the resin up to polymerization, is fully controlled by microprocessor, preventing any inopportune manual operation.

The trihydrated alumina and the silica are vacuum dried and degassed to eliminate all traces of humidity and air which could degrade the casting systems dielectric characteristics.

Half is mixed with the resin and half with the hardener under hard vacuum and controlled temperature, to give two homogenous premixes.

A new thin film degassing precedes the final mixing. Vacuum casting is then carried out in dried and pre-heated moulds at an optimal impregnation temperature.

The polymerization cycle begins with a gelification at 80°C and ends with a long polymerization at 140°C.

These temperatures are close to those of a transformer in service, enabling mechanical stresses to be eliminated which could lead to the coating cracking.

HV coil support wedges

The high voltage winding, which is encapsulated in hardened resin, looks like a thick-walled cylinder. This cylinder is centred on the magnetic core and is held in place vertically by an efficient wedging system, during transport, operation and even short-circuits and earthquakes. Thanks to the original design of these wedges, which we developed ourselves, they can be assembled in a variety of ways to suit different levels of HV insulation.

Where conditions of extreme stress exist and were clearly specified on the order form (very heavy HV coils, transport by sea or on very rough roads, installation in a wind turbine head, etc.) a **reinforced wedging system** (comprising two or even three sets of wedges) is used to palliate the situation and adapt the transformer to requirements.

(1) See page 14 : the anti-fire effects are represented on a section of Trihal coil.

option thermal protection

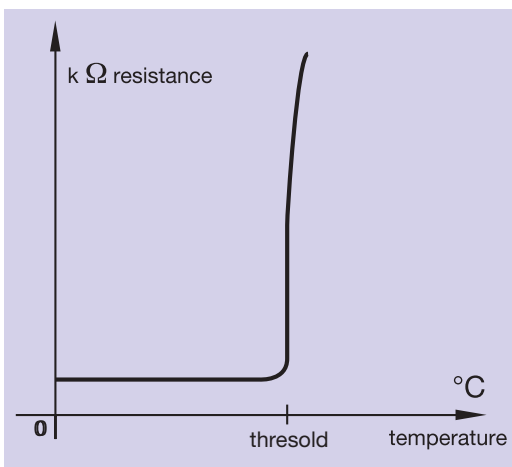
The first level of Trihal protection is by the temperature control device.

The Trihal cast resin transformer can be protected from any damaging temperature rises by monitoring winding temperature using various pieces of optional equipment.

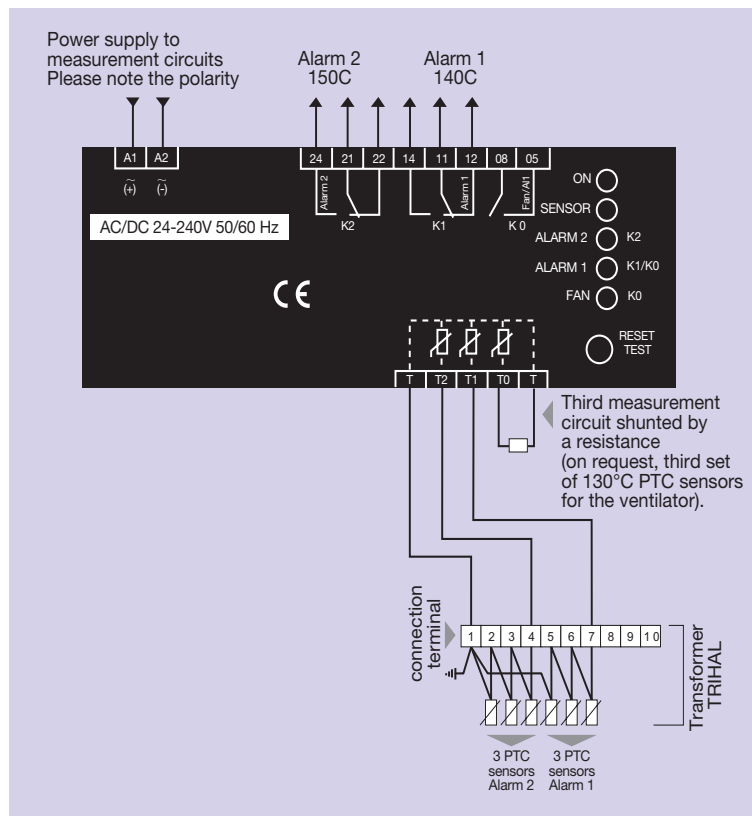
Z thermal protection

The standard version for naturally cooled (AN) transformers comprises :

■ 2 PTC sensor sets, positive temperature coefficient thermistances mounted in series : the first set for alarm 1, the second set for alarm 2. The main feature of a PTC sensor is the fact that the value of its resistance increases very steeply at a rated and factory-set threshold temperature which is not adjustable (see graph opposite). This abrupt increase is detected by a Z electronic converter. These sensors are installed in the live part of the Trihal transformer with one alarm 1 sensor and one alarm 2 sensor on each phase. They are placed in a tube, which enables them to be replaced as necessary.



characteristic graph of a PTC sensor



Z thermal protection connection diagram (normal use) equipment de-energised

option thermal protection



terminal block to connect sensors to the electronic converter

- 1 terminal block to connect the PTC sensors to the Z electronic converter. The terminal is equipped with a plug-in connector. The PTC sensors are supplied connected to the terminal, attached to the top part of the transformer.
- 1 Z electronic converter characterised by 3 independent measurement circuits. 2 of these circuits respectively control the variation in resistance in the 2 PTC sensor sets. When the temperature increases too much, alarm 1 (or alarm 2) information is processed respectively by the 2 independent output relays equipped with a changeover contact; the status of these 2 relays is indicated via 2 LED diodes. The third measurement circuit is shunted by a resistance R outside of the terminal block; it can control a third set of PTC sensors as long as this resistance is removed. In this case ("forced air" option available on request), the FAN information is processed by a third independent output relay, equipped with a closing contact and is intended to control fans; the position of this relay is shown by an LED diode marked FAN. In the case of one of these 3 sensor circuits failing (power failure or short circuit), an LED diode marked SENSOR lights up and indication of the incriminated circuit flashes. An LED diode marked ON signals the presence of voltage to the terminal block.

measurement circuits	supply voltage	AC/DC 24 to 240 V
	voltage tolerance	± 15 %
	frequency	0 ; 40 à 70 Hz
	input power	< 5 VA
	Cumulated resistance of a PTC sensor circuit for non-activation of the converter	≤ 1500 W
alarm output and switching contact	maximum switching voltage	AC 415 V
	maximum switching current	6 A
	switching capacity	AC 2000 VA (ohmic load), 120 W at 24 V DC
	rated operating current	2 A
	recommended upstream fuse	4 A time delay
	life expectancy	mechanical 3 x 10 ⁷ switching electrical (at maximum power) 10 ⁵ switching
	load reduction coefficient	0,50 with power factor φ = 0.30
Z electronic converter	permissible ambient temperature range	- 20° C to + 60°C
	overall dimensions (H x W x D)	90 x 70 x 58 mm
	weight	250 g
	protection index	terminal block IP 20 casing IP 30
	maximum connection capacity to one terminal	1 x 2.5 mm ² rigid
	fixing method	either on 35 mm rail according to EN 60715 or with M4 screw

The forced ventilation option for AF transformers is detailed page 11.

T thermal protection

This thermal protection device gives a digital display of winding temperatures and includes :

■ PT100 sensors.

The main feature of a PT100 sensor is that it gives the real time temperature on a scale of 0°C to 200°C, see graph opposite (accuracy $\pm 0.5\%$ of the measurement scale ± 1 deg.). Temperature control and display functions are performed via a digital thermometer. The 3 sensors, each comprising 1 white wire and 2 red wires, are installed in the live part of the Trihal transformer with 1 located on each phase.

They are placed in a tube, which allows them to be replaced if necessary.

■ 1 terminal block to connect the PT100 sensors to the T digital thermometer.

The terminal block is equipped with a plug-in connector. PT100 sensors are supplied connected to the terminal block fixed to the top part of the transformer.

■ 1 T digital thermometer characterised by 3 independent circuits.

2 of the circuits monitor the temperature captured by the PT100 sensors, one for alarm 1, the other for alarm 2. When the temperature reaches 140°C (or 150°C) the alarm 1 information (or alarm 2) is processed by 2 independent output relays equipped with changeover contacts.

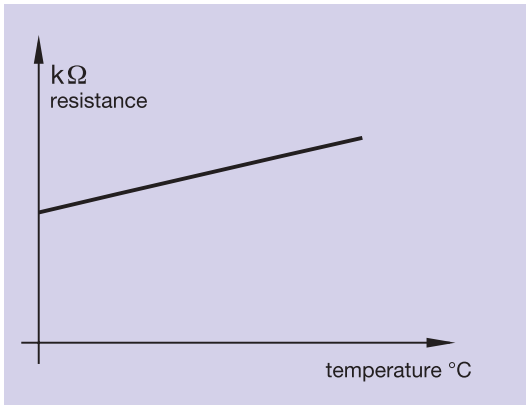
The position of these relays is indicated by 2 diodes (LED).

The third circuit monitors sensor or electrical supply failure.

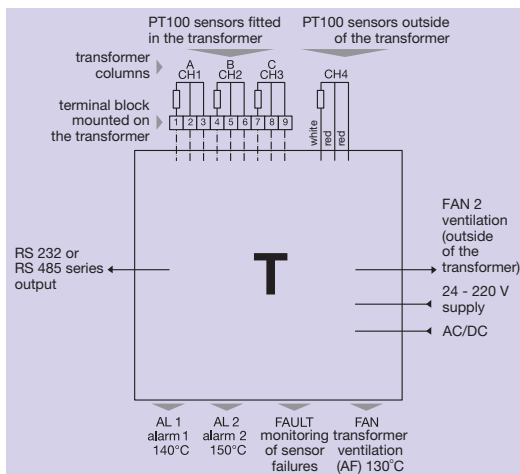
The corresponding relay (FAULT), which is independent and equipped with changeover contacts, is instantly switched as soon as the device is supplied power. Its position is also indicated by a diode (LED).

A FAN output is intended to control the start up of tangential fans in the case of forced ventilation of the transformer (AF) : this option is shown on page 11.

An additional input (CH4) can be connected to a sensor outside of the transformer (not supplied), intended to measure ambient temperature in the HV/LV substation.



characteristic graph of a PT100 sensor



operating principle diagram for the T digital thermometer

measurement circuits	supply voltage ⁽¹⁾	24 V to 220 V AC/DC	
	frequency	50-60 Hz AC/DC	
	input power	10 VA AC/DC	
alarm output and tripping contact	maximum switching voltage	250 V AC	
	maximum switching current	5 A (resistive circuit)	
	rated permanent/operating current	2 A sous 220 V AC/DC	
	recommended upstream fuse	3 A	
	life expectancy	mechanical	20 000 000 switching
		electrical	50 000 h/85°C
load reduction coefficient	0,50 max. power factor $\varphi = 0.30$		
operating conditions	permissible ambient temperature range admissibles	- 20° C to + 60° C	
	ambient humidity maxi maxi	90% RH (non condensable)	
T digital thermometer	overall dimensions (H x W x D)	96 x 96 x 130 mm	
	weight	520 g	
	terminal block protection index	IP 54 self extinguishing	
	maximum connection capacity on one terminal	25 mm ²	
	fixing method	92 x 92 mm, flush hole, attached with two rear pressure hooks	

(1) universal supply irrespective of polarity.

A digital output (RS 232 or 485) or a 4-20 mA analogue output is available for connection to a PLC or computer.

A FAN 2 output is available as an option to control the start up of an additional fan.

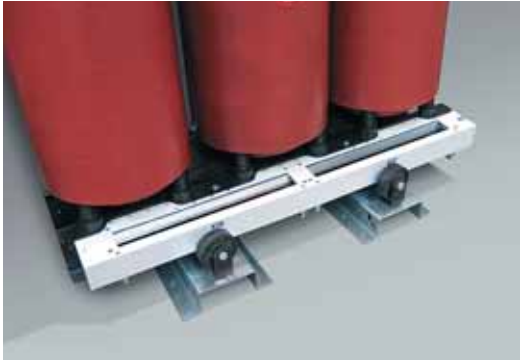
The T digital thermometer is delivered with an installation manual.

Please note : since the transformer is thermal class F, the user has responsibility for setting the T digital thermometer with a maximum temperature of 140°C for alarm 1 and 150°C for alarm 2.

Non compliance with these maximum temperatures release France Transfo from any liability for damage which may possibly be incurred by the transformer.

option forced ventilation

(Trihal adapts to its environment.



tangential fans on IP00

In the event of temporary overloading, to avoid overheating of the windings, it is possible to install forced ventilation.

For IP00 as for IP31, for powers equal or greater than 1000 kVA, it is possible to install forced ventilation to achieve a **temporary** increase in power of 40%, without any special modification.

In all cases, this temporary increase of 40% can be obtained if detailed on ordering.

However, if an increase in power is requested, account must be taken of the impact of this choice on the following points :

- sections of cables and of Prefabricated Busbar Trunking (PBT),
- the rating of the transformer's protective circuit breaker,
- the size of inlet and outlet openings for air in the transformer room,
- the life span of fans in service, which is considerably shortened compared with that of the transformer (3.5 compared to 30 years).

This option includes the supply of :

- 2 sets of tangential fans, pre-cabled and connected to 1 single power connector per set,
- 1 temperature measurement device, either Z or T type.

For Z type, a third set of PTC sensors is added to the standard thermal protection, in place of the R resistor which originally shunts the third Z converter measurement circuit (see diagram shown on the "Z thermal protection" option).

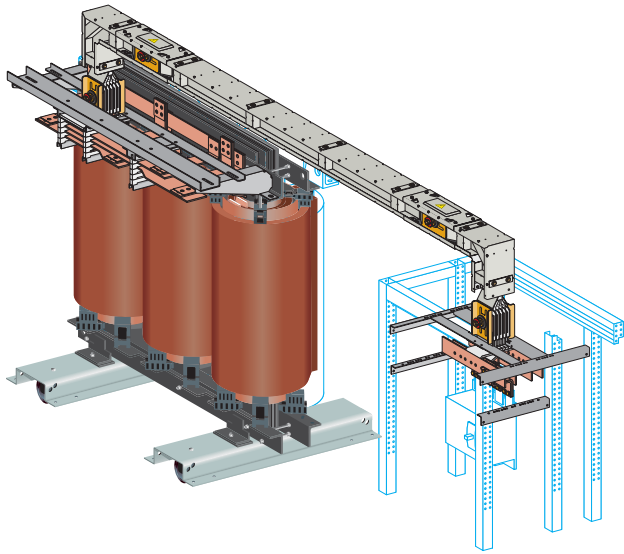
For T type, the digital converter comprises an output (FAN) intended to start the tangential fans (see diagram shown in the T thermal protection option).

This option includes either of the following, dependant on type of transformer :

- a wiring box, mounted outside of the protective enclosure, to which are connected, sensors and power supplies for the fan sets on a terminal block,
- a control cabinet, delivered separately (transformer IP00) or mounted on the protective enclosure, including :
 - motor protection fuses,
 - start up contactors,
 - thermal protection device.

This unit is connected to the temperature sensors and fan sets if the transformer is delivered with IP31 enclosure. Otherwise, it is the installer who makes the connections.

option connection



low voltage connection :

Cable ducting interface

Connection using Prefabricated Busbar Trunking (PBT) provides advantages in terms of safety and also saves time during connection, also enabling an installation to be produced in conformity with NF C 15100.

This solution ensures **maximum safety for people and property** due to its outstanding fire behaviour, in line with that of Trihal. It also ensures the **absence of halogenated products**, which is not the case for cabling.

Moreover, this harmony can also be found in terms of electromagnetic compatibility (EMC) : in line with IEC 60076-1, transformers are «considered as passive elements as regards to emissions and immunity to electromagnetic disturbances». For PBT, the concentrating of conductors limits electromagnetic radiation produced by high currents, as opposed to cables.

The option includes the connection interface, together with the junction block, with the whole assembly delivered already mounted on the LV cable connectors.

If the protective enclosure is provided for the transformer, a removable aluminium plate is screwed to the roof, vertically relative to the junction block.

It will be adapted on site in order to fit the sealing system connecting the PBT and thus enabling the ducting to comply with IP54.

If the transformer enclosure is supplied, the sealing system is supplied with the PBT.

Additional cable connectors

In the case of connection using a large number of cables, additional cable connectors can be supplied. It should be noted that the french UTE C15-105 guide dated June 1999 recommends not exceeding 4 cables per LV phase, and recommends the use of PBT beyond this limit.



250 A HV plug-in bushings and separable connectors on IP31

high voltage connection

Plug-in bushings

HV connections are always made using cables, terminated with cable lugs or square or angled, separable connectors (in this case, cable characteristics must be given).

These connectors, fitted to the end of the cable, are then connected to plug-in bushings which are delivered and fitted :

- on a horizontal panel, on the top part of the HV side for transformers without a protective enclosure (IP00),

- on the enclosure roof, HV side, for transformers with a IP31 protective enclosure.

A locking system for connectors can also be supplied and installed in plug-in bushings.

This system is delivered without any keylocks, but is prepared ready for a keylock either RONIS type ELP 11 AP – ELP 1 – ELP 2 or PROFALUX type P1 – P2 – V11 and V21.

high voltage surge arresters

If the installation is likely to be subjected to overvoltage of any kind (atmospheric or switching), the transformer **must** be protected by phase-to-earth surge arresters, installed directly on the transformer's HV connection terminals (either at the top or the bottom). These arresters consist of class 1, 10 kA insulators (20 kV for HV), which discharge overvoltage from the HV network to the earth, in accordance with standard IEC 994.

It is **essential** to install these surge arresters :

- where the lightning impact level N_k is greater than 25. The risk of direct or induced atmospheric overvoltage is directly proportional to N_k ;
- during the occasional switching (less than 10 operations a year) of a transformer with a weak load, or during a magnetisation phase.

It is also highly **recommended** to install them :

- where the substation is supplied by a network including overhead parts, then a cable that is longer than 20 m (case of an overhead-underground network). Surge arresters can be installed in an IP 31 enclosure, or even on existing equipment, provided that insulation distances are respected.



high voltage surge arresters on the lower part

options
protective enclosure
vibration damper
HV RC filter



protective enclosure IP31, IK7



bracket for HV cables entering the bottom of the enclosure

protective enclosure

This comes in various versions, according to the protective index required :

Indoor type with protective enclosure IP31 and IK7

This enclosure is particularly well suited to installation in work areas in order to provide protection of people and property.

Outdoor type, pole-mounted or pad-mounted with protective enclosure IP35 and IK10.

The IP and IK protective indices refer to the following criteria :

IP protection indices

	First Figure	Second Figure
definition	protection against solid bodies	protection against liquids
scale	0 to 6	0 to 8
IP 31	protection against solid bodies > 2,5 mm	protects against vertical splashing by water
IP 21	protection against solid bodies > 12 mm	protects against vertical splashing by water
IP 35	protection against solid bodies > 2.5 mm	protects against water jets from all directions

IK protection indices

definition	protection against mechanical impact
scale**	0 to 10
IK7	protection against mechanical impact \leq 2 joules
IK10	protection against mechanical impact \leq 20 joules

** 0 = no protection

bracket for HV cables entering the bottom of the enclosure

Where required, a high-voltage cable bracket is available as an option to guide and support cables entering the enclosure from the bottom, via a removable, screw-on aluminium plate.

vibration damping

Roller anti vibration pads

This accessory placed under the rollers, avoids vibrations being transmitted from the transformer to its environment.

Damper unit

This device is installed in place of the roller and enables transmission of vibrations to the transformer environment to be attenuated by around 95 %.

high voltage RC filter

Repetitive HV circuit-breaker switching generates high-frequency voltage oscillations and can cause damaging overvoltage in the core of the transformer.

This is especially likely to occur where:

- the circuit-breaker is close to a significantly underloaded transformer (less than 10% of the rated output);
- the load is highly inductive or capacitive (very long cables, capacitors on the secondary side);
- the HV network is of the isolated neutral type or is high impedance earthed.

The solution is to install an RC damping filter between the HV and earth phases, as close as possible to the transformer's HV connection points.

Immediate self extinguishing. The IEC 60076-11 standard defines 3 tests on one and the same dry standard transformer.



fire behaviour tests

The fire behaviour test of the Trihal transformer's casting system is made up of tests on material and a test F1 according to the IEC 60076-11 standard.

■ tests on material

Tests on specimens of the Trihal casting resin were carried out by independent laboratories.

□ decomposition products:

The analysis and quantity of gases produced by the material's pyrolysis are carried out according to the clauses of standard NF X 70.100, identical to those of standard UTE C 20454.

Pyrolysis are carried out at 400, 600 and 800°C on specimens weighing approximately 1 gramme each. This test was carried out by le Laboratoire Central Préfecture de Paris (Central Laboratory Prefecture of Paris).

□ test results:

The table below indicates the average field (in mass of gas/mass of material) obtained from the values of the three tests carried out at 400, 600 and 800°C. The NS indication signifies the results are close to the limit of sensitivity thus lacking precision and therefore non-significant. The 0 indication signifies that the gases are absent or that their contents are below the equipments sensitivity.

Central Laboratory Prefecture of Paris
Test certificate number 1140/86 on December 2nd 1986

Decomposition products : gas content/temperatures

		400°C	600°C	800°C
Carbon monoxide	CO	2.5%	3.7%	3.4%
Carbon dioxide	CO ₂	5,2%	54,0%	49,1%
Hydrochloric acid	HCl in the form of	Cl ⁻	0	NS
Hydrobromic acid	HBr in the form of	Br ⁻	0	0
Hydrocyanic acid	HCN in the form of	CN ⁻	0	NS
Hydrofluoric acid	HF in the form of	F ⁻	0	0
Sulphurous anhydride	SO ₂	0.2%	0.17%	0.19%
Nitrogen monoxide	NO	0	NS	NS
Nitrogen dioxide	NO ₂	0	NS	NS

■ test F1

(as per the IEC 60076-11 standard § 28)

The STELF Laboratory of the National Prevention and Protection Center in France.
Test report n° PN94 4636 dated 19th avril 1994
630 kVA n° 601896.01

CESI Laboratory in Italy
Test report n° BC-97/024136

□ test method

A complete Trihal transformer column (HV+LV+core) was placed in the chamber described in IEC 60332-3-10 (relevant to electric cables).

The test was started when the alcohol in the tank (initial level 40 mm) was ignited and when the 24 kW radiant panel was switched on. Test time was 60 minutes in compliance with standard.

□ evaluation of results

The temperature rise was measured throughout the test. In compliance with the standard, it remained ≤ 420°C.

Δ t = 45 mn : temperature rise was 85°C (≤ 140°C, and in compliance with standard)
see figure 1

Δ t = 60 mn : temperature rise was 54°C (≤ 80°C, and in compliance with standard)
see figure 1.

No components such as hydrochloric acid (HCl), hydrocyanic acid (HCN), hydrobromic acid (HBr), hydrofluoric acid (HF), sulphur dioxide (SO₂), formic aldehyde (HCOH) were detected.



1st anti-fire effect : refracting shield



2nd anti-fire effect : barrier of water vapour



3rd anti-fire effect : temperature held below the fire point



in compliance
with the standard
HD 538.2-S1*

Trihal transformer coil after the test F1

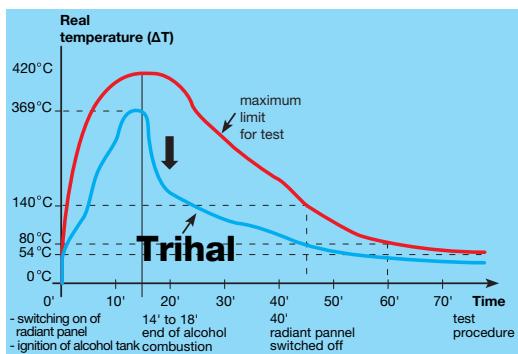


figure 1: temperature curve of F1 test

Trihal is resistant to load variations, overloads and atmospheric disturbances.



figure 1 : test C2

climatic tests

- test C2
(as per the IEC 60076-11 standard § 27.4)
Thermal shock

Kema laboratory in Holland
Test report n° 31813.00-HSL 94-1258
630 kVA n° 601896.01

CESI Laboratory in Italy
Test report n° AT-97/038547



- test method
The Trihal transformer was placed for 12 hours in a climatic room where the ambient temperature was initially lowered down to -25°C ($\pm 3^{\circ}\text{C}$) in 8 hours (figure 1).

- evaluation of results
The Trihal transformer was subjected to a visual inspection followed by dielectric tests (applied voltage and induced voltage tests at 75% of standard values) and partial discharges measurements.
Partial discharges level is critical for cast resin transformer reliability.

The standard imposes lower than or equal to 10 pC.
The result for Trihal transformer was < 2 pC.
No flashover or breakdown occurred during the dielectric tests.



figure 2 : test E2

environment tests

- test E2
(as per the IEC 60076-11 standard § 26.3.2)
Condensation and humidity

KEMA laboratory in Holland
Test report n° 31813.00-HSL 94-1258
630 kVA n° 601896.01

CESI Laboratory in Italy
Test report n° AT-97/038547



1 - condensation tests

- test method
The Trihal transformer remained for more than 6 hours in a climatic chamber with the temperature control to obtain condensation. Humidity was maintained by continuous water vaporization above 93% (figure 2).

- evaluation of results
Within 5 mn of the end of the vaporization, the Trihal transformer was subjected, in the climatic chamber, to an induced voltage test at 1.1 Um its rated voltage for 15 mn.
No flashover or breakdown occurred.

2 - humidity tests

- test method
The transformer remained in a climatic chamber for 144 hours with the temperature held at 50°C ($\pm 3^{\circ}\text{C}$) and relative humidity at 90% ($\pm 5\%$).

- evaluation of results
At the end of this period, the Trihal transformer was subjected to applied voltage and induced voltage tests at 75% of standard values.
No flashover or breakdown occurred.

Partial discharge level from day 1 ≤ 10 pC
 Insulation 24 kV : impulse tested at 125 kV
 Insulation 36 kV : impulse tested at 170 kV,
 200 kV indeed.

electrical tests

These tests verify contractual electrical characteristics.
 They include :

■ individual tests (or routine tests).
 These tests are systematically carried out on all Trihal transformers at the end of manufacturing and are subject to an official test report (see specimen on the next page).
 They consist of :

- measurement of characteristics :
 - resistance of windings ;
 - transformation ratio and vector group ;
 - impedance voltage ;
 - load losses ;
 - no load losses and no load current.

- dielectric tests :
 - applied voltage tests ;
 - induced voltage tests ;
 - measurement of partial discharge, acceptance criterion : 10 pC at 1.30 Ur, rated voltage. The acceptance criteria is set at 10 pC by standard IEC 60076-11 § 22.5.

■ type test.
 They are carried out on request and are at the clients expense.

□ lightning test⁽¹⁾
 The impulse test voltage is usually of negative polarity. The test sequence is composed of a calibration impulse between 50 % and 75 % of the full voltage followed by three impulses at full voltage.
 The applied is full standardized lightning impulse, see diagram.
 Trihal's basic offer proposes a choice of impulse withstand levels as standard, according to list 2 (see table below), i.e. for 36 kV an impulse test voltage of 170 kV, with the possibility of taking these values to 200 kV impulse for an insulation level of 38.5 kV.

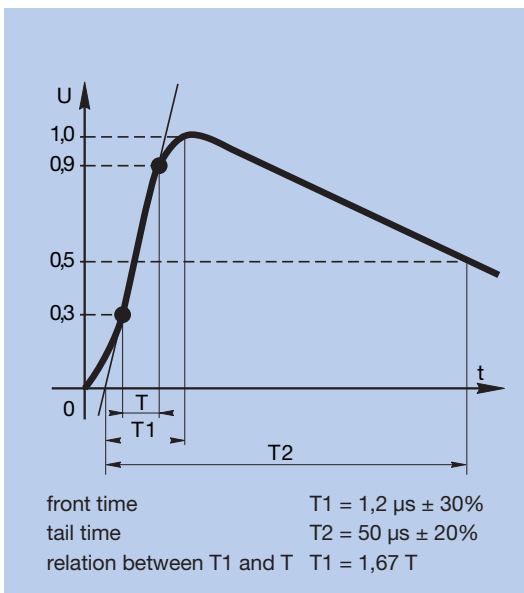
□ temperature rise test
 Carried out according to the simulated loading method. Heating measured by two tests :
 - one with only no load losses ;
 - the other with only load losses.
 The total temperature rise is calculated in accordance with IEC 60076-11.

1) summary of standard test levels

system highest voltage (kV)	3.6	7.2	12	17.5	24	36	41,5
eff. kV 50 Hz - 1 mm	10	20	28	38	50	70	80
impulse kV 1,2/50 μs							
List 1	20	40	60	75	95	145	
List 2	40	60	75	95	125	170	200

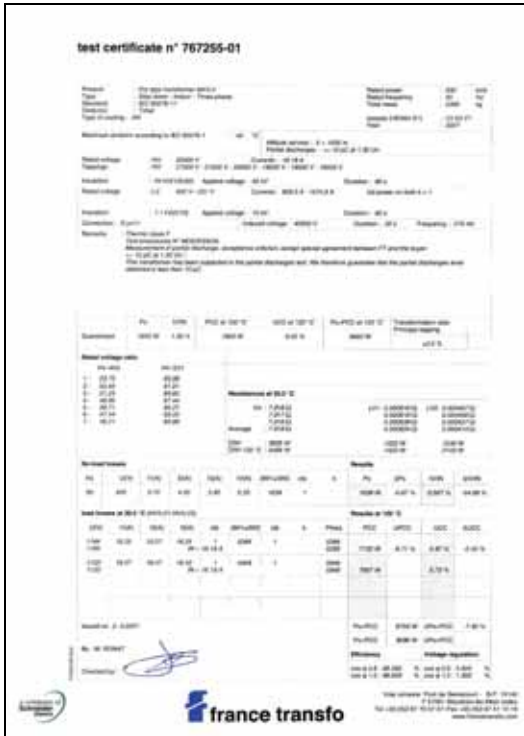


Ennery test line



full wave lightning impulse

(A clear and precise test report, joined to each transformer.



■ special tests.

These are carried out on request and at the expense of the customer.

□ short-circuit tests

These tests are carried out on a special test rig according to standard IEC 60076-5. Three tests are carried out on each column lasting 0.5 seconds. Satisfactory tests carried out on a Trihal transformer 800 kVA - 20 kV/410 V dated 29 February 1988 at the EDF Test Centre at Renardières (France)..

EDF Renardières Test Centre (France)
Test Report HM 51/20.812 dated 4 March 1988

□ short circuit withstand test of a Trihal transformer equipped with a PBT* feeder. Satisfactory test carried out on a Trihal transformer 2500 kVA – 20 kV/400V dated 18 November 1999 at the EDF Renardières Test Centre (France).

EDF Renardières Test Centre (France)
Test Report HM 21/20-998/1 dated 30 November 1999

□ noise level measurements :

- noise level measurements are part of the special test carried out on request and as an option.

- the transformer noise is mainly due to magnetostriction of the magnetic circuit.

- The noise level can be expressed in 2 ways :

- in terms of acoustic pressure level L_p (A) obtained by calculating the quadratic average of measurements carried out according to standard IEC 60076-10 at a distance of 1 metre on a transformer operating under no load ;

- in terms of acoustic power level L_w (A) calculated from the acoustic pressure level using the following formula :

$$L_w (A) = L_p (A) + 10 \log S$$

L_w (A) = weighted acoustic power level in dB(A) ;

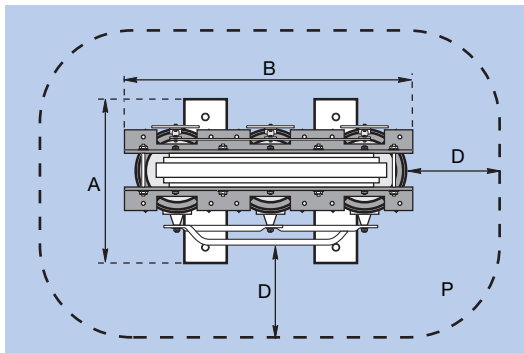
L_p (A) = average level of acoustic pressure measured in dB(A) ;

S = equivalent surface area used for the calculation in m^2 ;

$$= 1.25 \times H \times P ;$$

with H = height of transformer in metres ;

and P = measurement contour perimeter at a distance D .



$$P = 2 (A + B + D\pi)$$

$D = 1$ m for Trihal IP00

$D = 0.3$ m for Trihal with enclosure

* Prefabricated Busbard Trunking.

Trihal online...

www.francetransfo.com

All the information you will need to install and operate Trihal

- drawings with dimension tables to prepare the installation and environmental integration of the transformer,
- installation, commissioning and maintenance instructions to make sure that your equipment will last,

Along with:

- general, descriptive specifications for the Trihal cast-resin transformer,
- technical data sheets with electrical and mechanical performance levels per power rating,
- the factory testing procedures for each device we manufacture.

If you require evidence of Trihal's flexibility, you will find:

- E2-C2-F1 certifications defining Trihal's ability to adapt to the harshest operating conditions,
- lists of references per country, power rating, voltage, vector group, product range, insulation and geographic area.

The screenshot shows the France Transfo website interface. At the top right is a 'Home' link. The main header features the 'france transfo' logo. Below the header, there is a navigation menu with 'France Transfo' and 'Products > Trihal ca...'. The main content area is titled 'A comprehensive MV/LV distribution transformer catalogue'. On the left, there is a table of contents with expandable sections: 'Presentation', 'Offer overview', 'Trihal cast resin dry type MV/LV transformers' (which is expanded to show 'Technology', 'Options', 'Tests', and 'Installation'), 'Oil immersed MV/LV Minera transformers', 'Oil immersed HV/MV and MV/MV power transformers', and 'Special transformers'. To the right of the table is a large image of a modern building. Below the image is the Schneider Electric logo with the text 'a company of Schneider Electric'. At the bottom right, there is a copyright notice: '© 2006 France Transfo'.

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Services Products References **Pro area**


... resin dry type MV/LV transformers
... on quality with a 5-year guarantee*

... ind :
... charges ≤10 pC
... already installed
... into the MV/LV substation
... al features for all installations

... 1)
... requirements :
... environments (E2)
... shocks (C2)
... to short-circuits
... resistance


... a 5-year guarantee* is applied to all Trihal orders
... validation of the commissioning Check-list, and after
... approval

Trihal transformer



Documentations to download
 Trihal, 5-year guaranteed

International presence



References
 International network

Transfo

Go to "Pro area" and ask for your access code to this exclusive, specialists-only area.

"Pro area" contains:


- **technical documentation** on the specific features of the transformer and the impact of its environment.
- all our **in-factory testing procedures**, along with **reports on the special and standard tests** already performed.
- all you need to know to install, commission and maintain your transformer. Our downloadable **pre-commissioning checklist** (in Excel format) will help you. If you use it correctly, you can get an extended 5-year warranty – free of charge! (see how to use it on page 29).
- **standard drawings** of Trihal (IP00 or IP31).
- the **list of devices available in stock**, for those who can't wait. This list is updated **every day!**

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France Transfo Services Products References **Pro area**

france transfo

France Transfo, a Schneider Electric Company, puts its technical and industrial know-how at your disposal.



a company of Schneider Electric


Pro Area

Login :

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France Transfo in short



- company founded in 1920
- subsidiary of Schneider Electric
- more than 600 people
- turnover : 120 M€ in 2005
- 15000 transformers / year
- presence in 130 countries

International presence



References
 International network

© 2006 France Transfo

installation

(Easy and fast installation.



Trihal transformers (IP 00) installed on the universal exhibition from Seville, Expo 92

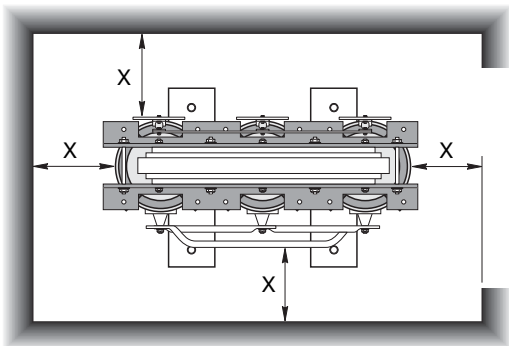


figure 1 - insulation distance without enclosure IP00



Trihal transformers with IP 31 metal enclosure installed in a steel works

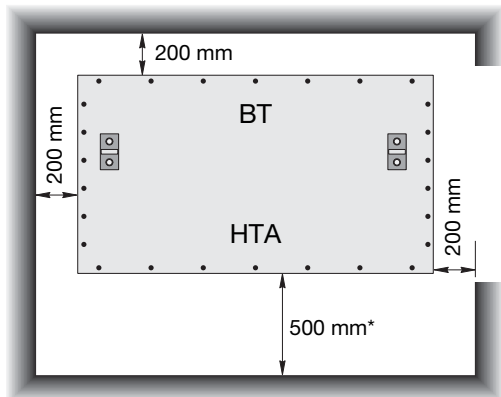


figure 2 insulation distance with enclosure
*access to the variation tapping links.

general information

Due to the absence of any liquid dielectric and the excellent fire behaviour of Trihal transformers, no anti-fire precautions are necessary providing the following guidelines are followed :

- the transformer should not be installed in a flood hazard area ;
- the altitude should not be above 1000 metres unless a higher altitude is specified at the time of enquiry ;
- the ambient temperature for the transformer to be within the following limits :
 - minimum : - 25°C ;
 - maximum : + 40°C (unless a higher temperature is designed for based on information provided at the time of enquiry).

Standard transformers are designed in accordance with IEC 60076 for an ambient temperature of :

- maximum : 40°C
- daily average : 30°C
- yearly average : 20°C.

- the local ventilation should allow the dissipation of the transformer total losses, including increased losses during AF operation.
- in highly polluted atmospheres (metal machining oil, conductive dust), the air coming into contact with the device should if possible be cleaned (filtering, inlet of outside air via a ducting).
- the transformer even with IP 31 metal enclosure is designed for an indoor installation (please consult us for an outdoor installation).
- provision should be made for access to connectors and tapping links.
- for mobile installations please consult us.

■ Trihal without enclosure (IP 00) (figure 1).

In this configuration, even with plug-in bushings, the transformer must be protected against direct contact.

In addition :

- care must also be taken to eliminate risks of water drops on the transformer (example : condensation from overhead pipings) ;
- maintain minimum clearance to the walls according to the following table :

Insulation (kV)	dimensions X in mm ⁽¹⁾	
	full wall	ventilation grill
7.2*	90	300
12*	120	300
17.5*	160	300
24*	220	300
36*	320	400

(1) do not take account of access to the variation tapping links.
*according to NF C 13-100 and HD 637 S1.

Please consult us if any of these distances can not be achieved.

■ Trihal with IP 31 metal enclosure (figure 2).

A minimum distance of 200 mm between the exterior of the enclosure and the walls of the building should be maintained to ensure adequate cooling.

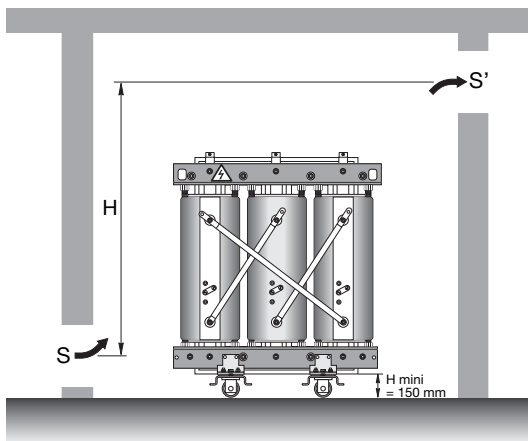


figure 1 - substation natural ventilation

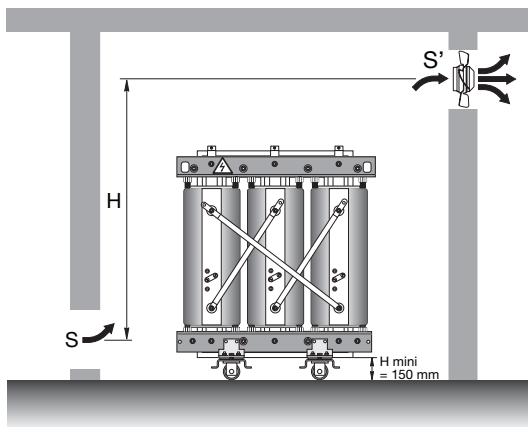


figure 2 - substation forced ventilation

substation ventilation

- determination of the height and area of ventilation grills.

In the general case of natural cooling (AN), the ventilation of the substation or of the enclosure must ensure by natural convection the dissipation of the heat produced by the transformer's total losses.

In the case of a sufficiently ventilated substation, appropriate ventilation will consist of a fresh air intake opening of S section at the bottom of the substation and an outgoing air opening S' located above on the opposite wall at height H metres above the intake opening (figures 1 and 2).

To ensure efficient cooling of the transformer and sufficient air circulation, it is essential to maintain a minimum height of 150 mm under the live section, by installing rollers or an equivalent booster.

It must be noted that restricted air circulation reduces the transformer's continuous and short term overload capacity.

- formula for ventilation (figure 1) :

$$S' = \frac{0.18 P}{\sqrt{H}} \text{ and } S' = 1.10 \times S$$

P = sum of the transformer's no-load and load losses expressed in kW at 120°C.

S = area of the lower air intake opening (allow for mesh factor) expressed in m².

S' = area of the air outlet opening (allow for mesh factor) expressed in m².

H = height difference between the two openings expressed in metres.

This formula is valid for an average ambient temperature of 20°C and an altitude of 1000 m.

Example :

- one single Trihal transformer 1000 kVA,
- Po = 2300 W, Pcc at 120°C = 11000 W,
- i.e. P = 13.3 kW.

If the distance between the grills = 2 m, then S = 1.7 m² of net surface area necessary.

If we imagine a grill obstructing the air inlet by 30% ; the air inlet grill surface area should then be 1.5 m × 1.5 m, and that of the air outlet should be 1.5 m × 1.6 m.

- substation forced ventilation (figure 2) :

Forced ventilation of the substation is necessary for ambient temperatures above 20°C, or small or badly ventilated rooms for applications with frequent overloads.

The fan can be thermostat controlled and operate as an extractor in the top part of the room.

Advised flow (m³/second) at 20°C = 0,1 × P.

P = sum of the transformer's no-load and load losses expressed in kW at 120°C.

The incoming HV and LV connections can be made from the top or the bottom.

connections

HV side connections are made by cables.

LV side connections are made conventionally by cables, but can also be made using the «very safe» alternative using Prefabricated Busbar Trunking (PBT).

In all cases shown the cables or busbars must be supported to avoid mechanical stress on the HV or LV terminals or HV plug in connectors.

The HV connections should be made to the top part of the delta connection bars. The LV connections are made at the top of the transformer.

Warning :

- The distance between HV cables or busbars and the surface of the winding should be at least 120 mm except on the flat face of the HV side where the minimum clearance will be set by the HV terminal.

The clearance to the outer HV delta bar should also be a minimum of 120 mm.

- The resin coating, or the use of plug in connectors does not give protection against direct contact and the transformer must not be touched when it is energised.

- The overvoltage limiter (type CARDEW.C) can not be installed on the transformer LV busbars : the working temperature can not exceed 40°C (unless specifically designed for higher temperatures).

- Trihal without metal enclosure (IP 00).

- standard HV and LV connections.

- The outgoing (or incoming) LV conductors can be made from above or below (figures 1 and 2).

- The outgoing (or incoming) HV conductors can be made from above or below (figures 1 and 2).

In the case of an outgoing (or incoming) conductor from below it is necessary to put a spacer (spacer will not be supplied by France Transfo).

- HV connections with plug in connectors (figure 3).

- LV connections using prefabricated electrical trunking (PBT)(figure 4).

On site installation is simplified as far as possible, with very easy fitting, assembly and dismantling :

- the transformer is delivered pre-equipped with the PBT connection interface,

- the possibility of adjusting on site by ± 15 mm in all 3 directions,

- connection and disconnection is achieved within an hour at most providing optimum continuity of service.

As an example, the French guide C 15-005 recommends not exceeding 4 cables per LV phase, a limit which does not exist for PBT, which should therefore be used beyond this. PBT/Trihal interface connection, tested in the factory, guarantees conformity of the installation to NF C 15-100.

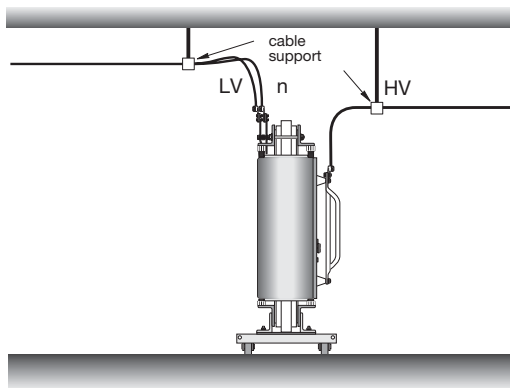


figure 1 - standard HV and LV connections from above

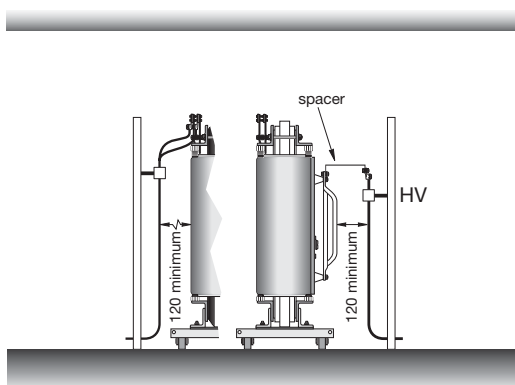


figure 2 -standard HV and LV connections from below

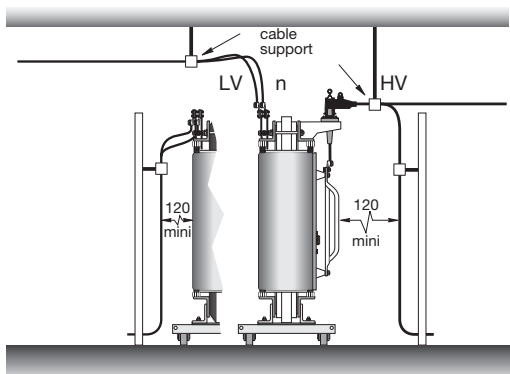


figure 3 - HV connections with plug in connectors

LV connections using prefabricated electrical trunking (PBT)



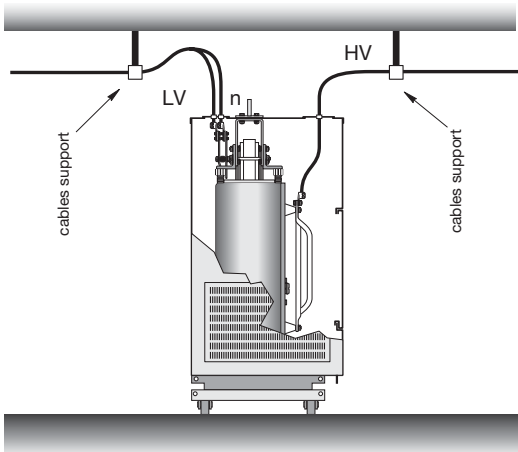


figure 1 - standard HV and LV connections from above

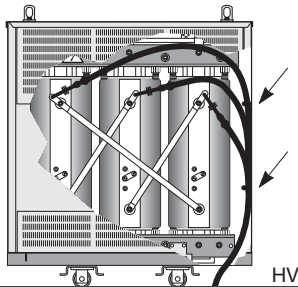


figure 2 - standard HV connection from below

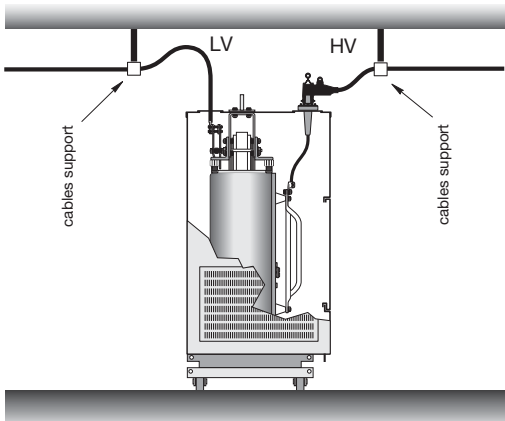


figure 3 - HV connections with plug in connectors (option)

■ Trihal with IP 31 metal enclosure.

□ standard HV and LV connections (figures 1 and 2).

- The outgoing (or incoming) LV conductors must go upwards from the terminals under the enclosure cover. The LV conductors should never pass between the HV coils and the enclosure.
- The outgoing (or incoming) HV conductors can pass above (figure 1) or below (figure 2).

□ HV connection from below.

- The outgoing (or incoming) HV conductors can come from below directly to the connection terminal (figure 2). In this case incoming conductors are passed through the removable flap door located at the bottom right of the HV side.

- The HV cables must be fastened inside the enclosure on the HV side panel. A cable bracket can be ordered as an option, for this purpose.

It is advisable to verify the feasibility of this type of connection in relation to the section and the bending radius of cables and the space available in the enclosure.

□ HV connection by plug in connector (figure 3).

□ LV connections using prefabricated electrical trunking (PBT) (figure 4).

Warning :

It is necessary to verify conformity with the IP31 protection index after having drilled the insulation gland plate for HV, LV and other.



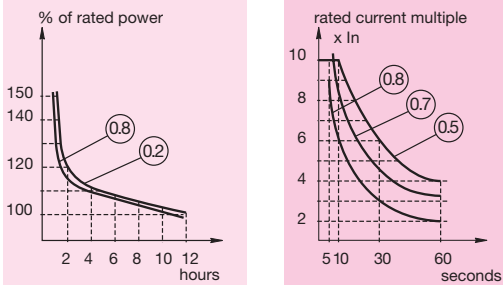
figure 4 - LV connections with PBT on enclosure

overloads

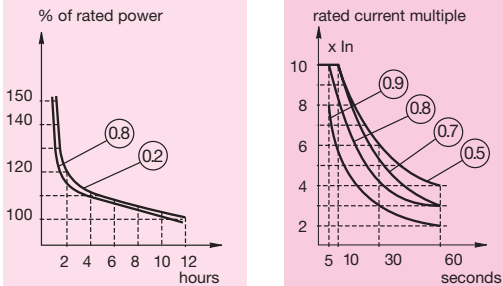
admissible temporary overloads for daily load cycle

acceptable short time overloads

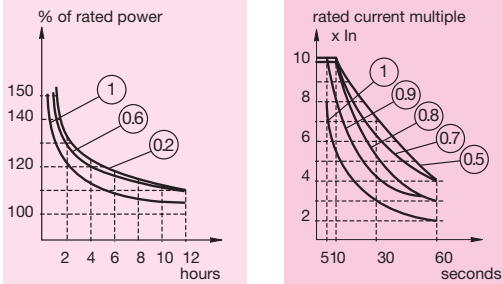
annual ambient temperature + 10C



annual ambient temperature



annual ambient temperature - 10C



overloads graphs according to the ambient temperature

general information

The transformers are designed to operate at rated power at ambient temperature defined by IEC 60076 :

- maximum : 40°C ;
- daily average : 30°C ;
- yearly average : 20°C.

Without particular specification, the reference temperature is the annual average of 20°C.

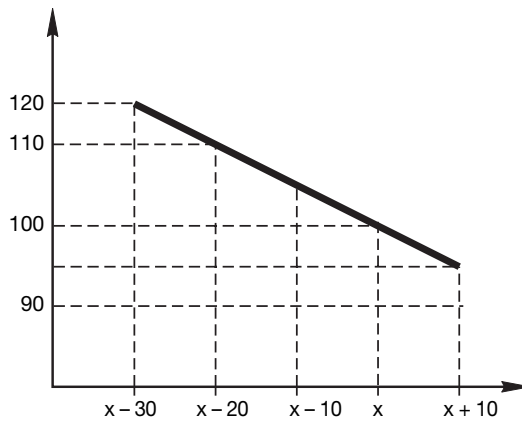
■ overloads are allowed without reducing the transformer's service life if they are compensated by a normal load below the rated power (description in IEC 60905 standard).

$$K = \frac{\text{load}}{\text{rated power}}$$

The admissible overloads are also subject to the average mean ambient temperature. The 1st column gives the cyclical daily overloads.

The 2nd column indicates the acceptable short time overloads.

■ the figure below shows the acceptable constant load as a function of the average temperature compatible with normal life duration.



ambient temperature in °C
(x = annual average temperature)

■ one can operate a transformer designed for operation in yearly average ambient temperature of 20°C at higher temperatures by reducing the rating as shown in the table :

yearly average ambient temperature	admissible load
20°C	P
25°C	0.97 x P
30°C	0.94 x P
35°C	0.90 x P

handling, storage



loading in our factories

handling

The transformers are equipped with provisions for safe handling.

■ lifting with slings (figure 1).

Lifting is carried out using the 4 lifting holes for a transformer without an enclosure and by 2 lifting lugs in the case of a transformer with an enclosure. The slings should not form an inside angle greater than 60°.

■ lifting with a fork lift truck (figure 2).

The lifting capacity of the fork lift truck should first be checked. If suitable, the forks should be inserted inside the base channels after removing the rollers.

■ towing.

Towing the transformer with or without enclosure should be done from the underbase. For this purpose hole of 27 mm. diameter are provided on every side of the underbase. owing can be done in two directions : in the axis of the underbase and perpendicular to that axis.

■ fitting the rollers.

either by lifting with slings (figure 1) ;

or by lifting with a fork lift truck (figures 1 and 2).

In this case position the lifting forks in the underbase channels.

Place timbers of greater height than the rollers under the channels and lower the transformer on to them.

Position jacks and remove the planks.

Attach the rollers in the desired position (bi-directional rollers).

Lower and remove allowing the Trihal to rest on its rollers.

Note: it is strictly forbidden to exert even the slightest stress on the cast-resin HV coils during transformer handling operations!

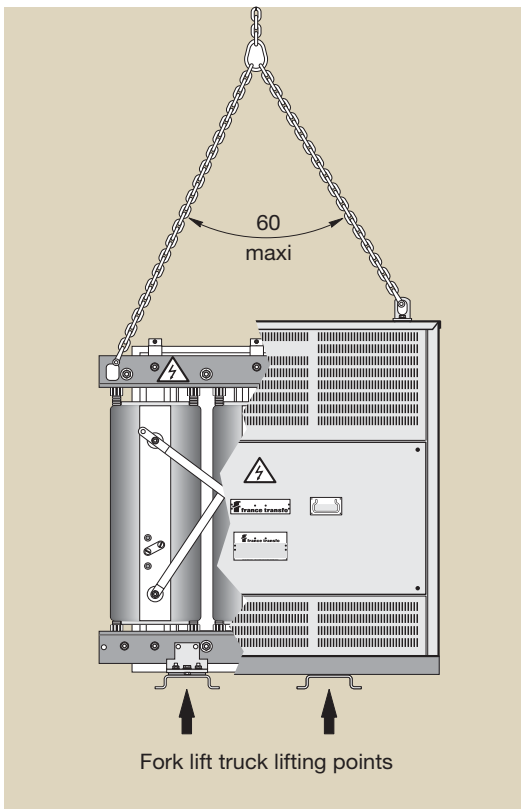


figure 1 - lifting with slings or fork lift truck

storage

The Trihal transformer should be protected in storage from water drops and dust generating work (masonry, sanding, etc.). If the Trihal transformer is delivered with a plastic cover which should be kept over the equipment whilst it is in storage.

The Trihal transformer can be stored at a temperature down to - 25°C.

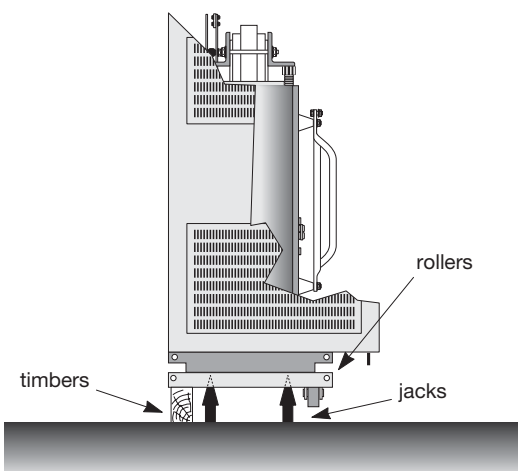


figure 2 - fitting the rollers

commissioning maintenance

An instruction manual for installation and commissioning is attached to each transformer.



commissioning

■ installation local (see page 20 and 21).

The location should be dry, clean, finished and free from risk of water entry. The Trihal transformer should not be installed in an area liable to be flooded. The location should have sufficient ventilation to ensure the transformers total heat losses can be dissipated.

■ checking the condition after storage.

If the Trihal transformer is found accidentally to be very dusty, clean it by vacuum cleaner or by blowing with compressed air or nitrogen and thoroughly clean the insulators using paper towels.

■ Trihal transformers supplied with a plastic cover.

To avoid contamination by foreign bodies (screws, nuts, washers, etc.), the cover should remain in place during the whole connecting operation : to gain access to HV and LV connections tear the cover.

■ Trihal transformer supplied with metal enclosure.

The enclosure should in no place support loads other than the supply cables for the transformer. The installation inside the enclosure of unauthorised equipment or accessory not supplied by France Transfo except the connection cables correctly installed as shown in the relevant section, is not permitted and invalidates the guarantee. For any modifications, attachments and mounting of accessories, please consult us.

■ HV and LV connections cables (see page 12).

In no case should fixing points be made on the transformer core and windings. The distance between the HV cables, the LV cables, or the LV bars and the surface of the HV winding should be at the least 120 mm. except on the high voltage side where the minimum distance is to be considered from the most protruding delta connection.

Particular care should be taken concerning the earthing of HV cable shields.

The distance of 120 mm should be complied with between earthing cables and the surface of the HV winding.

■ connection of HV connectors.

Connection tightening torque on the HV terminal and tapping links with flat + contact washers (brass screws):

tightening torque for bus bars bolts	M8	M10	M12	M14
tightening torque N.m	10	20	30	50

■ connection of LV connectors.

Connection tightening torque for the LV bars :

tightening torque for bus bars bolts	M8	M10	M12	M14	M16
tightening torque N.m	12.5	25	45	70	100

■ case of reactive energy compensation: i.e. an installation combining transformers, capacitor banks and LV switchboards.

Power factor correction equipment, which is to be connected close to the transformer busbars, should have inrush current limitation to prevent the generation of transient over-voltages. This can be achieved by switching individual capacitors using a contactor incorporating a pre-insertion device (e.g. LC1-D.K. Schneider contactor with preinsertion resistance).

The pre-commissioning checklist that comes with every Trihal transformer (see page 30 of this brochure) will help you make sure that you have completed the commissioning procedure correctly!



commissioning after checking

insulation voltage(kV)	minimum clearance (mm)
7.2	270
12	450
17.5	450
24	450



checking before commissioning

■ auxiliary wiring.

Auxiliary wiring from the transformer (connection to the plug-in connectors) should be attached on rigid supports (without any ties) and have sufficient clearance from live parts. The minimum clearance to respect is determined by the insulation voltage indicated on the rating plate. See the opposite table.

Do not fix accessories etc... to the core and windings of the transformer.

■ parallel operation.

Verify the identity of the HV and LV voltages and the compatibility of characteristics and especially the vector groups and the impedance voltage.

Make sure that the same tapping is selected for transformers to be coupled in parallel according to the IEC 60076-1 standard.

■ checks before commissioning :

- remove the protective cover and check all the connections (arrangements, distances, tightening torques) ;
- check cable and bus bars entries after connection to ensure IP rating has been maintained ;
- verify the position identity of tapping links on the three phases are in accordance with the diagram on the rating plate ;
- verify the transformers general state of cleanliness and carry out an insulation test verifying HV and LV earth and HV and LV insulations using a 2500 V insulation tester (meeger).

The approximate values of resistances are :

HV/earth = 250 M Ω

LV/earth = 50 M Ω

HV/LV = 250 M Ω

If the values measured are significantly below, verify the transformer is not moist. If it is, dry it with a rag and repeat the verification.

In the contrary please contact your usual correspondent.

maintenance

In normal use and environment at conditions inspect the transformer each year and vacuum clean or blow with dry compressed air to remove excessive dust.

The frequency of cleaning will be a function of service conditions.

During such maintenance the connection bolts should be checked for tightness using a torque wrench.

In the case of greasy dust deposits, only use a cold degreasing product to clean the resin surfaces.

after sales services

For any information or replacement parts it is essential to quote the main characteristics on the rating plate and especially the transformers serial number.

the experience of a major manufacturer
international competency
swift assistance
a quality service

getting your transformer energised

Commissioning assistance

Our after sales technicians make sure your France Transfo equipment is correctly commissioned.

+33 (0)3.87.70.57.72

fr-frt-sav@fr.schneider-electric.com

<http://www.francetransfo.com>

Telephone or online assistance

If you have a question or a problem, just pick up the phone.

We are at your disposal from Monday to Friday, 8.30 am to 5.30 pm (French time).

France Transfo on call service

In the event of an emergency outside of these times, you can reach France Transfo's on-call service at the same number, 24/7.

on-site

Repair

France Transfo's TRIHAL transformer technology means that full on site repairs are possible, even under difficult access conditions.

Training

Training suited to each type of equipment is given throughout the world.

Expertise

Replacement part emergency supply

The after sales service has a large stock of replacement parts, as befits a major transformer manufacturer, thus enabling us to supply standard parts with very quick delivery times.

Moreover France Transfo's engineering office and ten year archives mean that you benefit from a solution that is perfectly suited to your application.

Assembly or supervised assembly

warranty extension ... to 5 years

How to benefit from this warranty

All Trihal* transformers ordered after 1st July 2006 may be guaranteed for 5 years, provided that:

1. The installation, commissioning and maintenance instructions delivered with the transformer are **followed to the letter**; the main part of these instructions can be found in the "10 commissioning precautions" on the back of the electrical test report.

2. The pre-commissioning checklist provided with the transformer is **completed correctly**, giving:

- * the transformer's serial number, which can be found on the rating plate,
- * an answer to each point (either "yes" or "NA" if not applicable),
- * the insulation resistance measurement results, which must be equal to or greater than the limits specified in the installation, commissioning and maintenance instructions,
- * the date on which the 27-point inspection was carried out,
- * the signatures of the inspector and his manager,
- * the effective commissioning date, which must be no more than 7 days after the inspection date,
- * the final transformer installation site,
- * your full details.

3. **Please return** the checklist to the address below, **within 15 days** of the effective commissioning date



france transfo
Support ADV
Voir Romaine - Pont de Semécourt
BP 10140
F - 57281 Maizières-lès-Metz

France Transfo will examine and approve your checklist as soon as it arrives, and will send you a letter **confirming your 5-year guarantee**.

Important : Each point on the checklist will be reviewed during maintenance operations, prior to recommissioning and throughout the transformer's service life.

* new equipment, never having been repaired.

**LIST OF ITEMS TO BE CHECKED
PRIOR TO TRANSFORMER COMMISSIONING**



Circle
Yes or NA for
each line

Carefully read the installation instructions provided, and install the transformer accordingly, before fully completing this checklist !

1	The information on the rating plate has been checked and meets requirements	Yes	
2	The tapping links have been adjusted to the voltage network, and are identical on the 3 windings	Yes	
3	Note the 3 insulation resistance measurements in these 3 boxes - see instructions, page 6. MV and LV cables will be disconnected during this measurement.	HV / Ground MΩ	LV / Ground MΩ
			HV / LV MΩ
4	The MV connection bars and the off circuit tapping links must remain tightened to 20 N.m	Yes	
5	The distances required for transformer cooling have been respected on all sides: see instructions, page 3	Yes	
6	The transformer room is clean and not liable to flooding	Yes	
7	The room is properly ventilated, with a clean air inlet at the bottom of the wall and an outlet at the top, in accordance with classic engineering practice : see instructions, page 2	Yes	
8	The plastic cover remained in place up to commissioning day	Yes	
9	There is no condensation or foreign bodies on the transformer (dust, greasy substances, conducting particles...)	Yes	
10	Energised parts are at the minimum required distance from surrounding exposed conductive parts : see instructions, page 3	Yes	
11	The MV and LV cables are supported, and are at the correct distance from the MV windings : see instructions, page 3	Yes	
12	The transformer is grounded via the points marked: 	Yes	
13	The connection to the transformer's LV bars includes flexible leads, which are not subjected to mechanical stress, in case of junction on busbars: see instructions, page 3	Yes	NA
14	The ground continuity of the MV surge arresters has been checked	Yes	NA
15	There are no breaks or short circuits in the heat sensor circuit	Yes	NA
16	The temperature sensors are correctly connected to the thermal relays	Yes	NA
17	The thermal relay is correctly connected to the control panels, tripping sequences are set and checked	Yes	NA
18	The fans and their related relay circuitry are working properly	Yes	NA
19	The overload protection devices on the HV or LV side have been set	Yes	NA
20	The I max protection device has been adjusted to the transformer's inrush current and time constant : see your Schneider representative for adjustment values	Yes	NA
21	The H2 (harmonic) check of the electronic protection relay (e.g. Schneider's SEPAM) is active (Max I _o divided by sum of 3 CT)	Yes	NA
22	The transformer's upstream and downstream protections have been checked, and confirmed by test	Yes	NA
23	The protection index (IP..) is respected, particularly when cables go through the housing	Yes	NA
24	If the transformer is enclosed, the bonding braids have not been moved	Yes	NA
25	The LV capacitor bank contactors are fitted with pre-insertion resistors	Yes	NA
26	In the case of parallel operation, the points listed on page 6 of the instructions have been checked	Yes	NA
27	Locking mechanisms (mobile enclosure panel + plug-in bushings) have been checked	Yes	NA

NA : not applicable

Date: Technician name: Signature:	Date: Manager name: Signature:	Effective commissioning date:
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GEa 215200 c

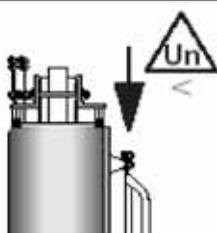
Trihal

10 PRECAUTIONS AVANT MISE EN SERVICE COMMISSIONING PRECAUTIONS



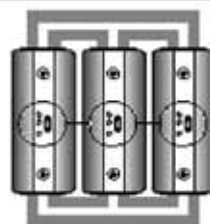
S'assurer que la tension d'alimentation n'est pas supérieure à celle indiquée sur la plaque signalétique.
Éviter les coupures et ré-enclenchements répétitifs.

Check that the voltage indicated on the rating plate is correct for the system voltage
Avoid repetitive tripping and reclosing.



Vérifier la position correcte et identique des barrettes de réglage, sur les 3 phases (voir plaque signalétique) et respecter le couple de serrage des connexions et barrettes HT (2 daN.m).

Check the tapping links are correctly and identically positioned on the 3 phases (see rating plate), and check the tightening torque (2 daN.m) for HV tapping links and connections.



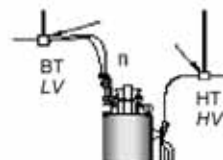
Garantir une distance minimale, entre parties sous tension et masse ou tout corps voisin, en fonction de la tension d'isolement du transformateur, sauf validation particulière du constructeur.

Make sure there is a minimum distance between the live parts and the ground or any neighbouring object in relation to the transformer's insulation voltage, unless otherwise stipulated by the manufacturer.

Isolément Insulation kV	Distance mini Min distance mm
7.2	90
12	120
17.5	160
24	220
36	320

Éviter les contraintes mécaniques sur les points de raccordement au transformateur.
Assurer le maintien des câbles HT et BT (effet de fouettement sur courant de défaut ou d'enclenchement).

Avoid mechanical stress on the connection points of the transformer
Make sure the HV and LV cables are held in place (whip effect on the fault or inrush current)



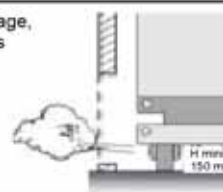
Assurer une ventilation correcte du local, une entrée d'air propre en partie basse, et une sortie en partie haute.

Make sure the premises are correctly ventilated and have a clean air inlet in the lower half and an outlet in the upper half.



Assurer, pour le transformateur avec habillage, une garde au sol sous l'habillage d'au moins 150mm pour permettre le refroidissement.
Raccorder l'habillage à la terre.

Keep a minimum clearance of 150 mm between the transformer with its enclosure and the ground in order to ensure cooling.
Connect the enclosure to the earth.



Vérifier l'absence sur le transformateur de tout corps étranger.
Faire sécher le matériel s'il est humide.

Check the transformer does not have any foreign matter on it.
Dry the equipment if it is wet.



Assurer le nettoyage du transformateur avant la mise sous tension (en particulier corps gras ou particules conductrices).

Clean the transformer before commissioning it (check especially for greasy matter or conductive parts).



Régler les protections en fonction du courant d'enclenchement et de la constante de temps du transformateur.
Raccorder correctement les circuits de protection thermique aux organes de commande
Contrôler la continuité des masses.

Set the protections according to the transformer's inrush current and time constant.
Connect the operating device thermal protection circuits correctly.
Check earthing continuity.



Limiter obligatoirement le courant d'enclenchement des batteries de condensateurs côté BT en utilisant des résistances de pré-insertion.

It is compulsory to limit the inrush current of the LV side capacitor banks using the pre-insertion resistors.



Pour tout complément d'information, contacter le : +33 (0)3 87 70 57 72
For further information please contact: +33 (0)3 87 70 57 72



**applies environmental management principles
developed by Schneider Electric**

the advantages

for the development of customer
and partner relations with :

- Better involvement of personnel;
- Increased responsibility for management teams;
- A contribution to reducing the consumption of power, water and raw materials;
- A privileged qualification of Schneider Electric as supplier;
- Specific sales assistance for our customers and partners : sales argument, export sales dynamic.

the guarantees

for a lasting development with :

An environmentally-friendly product development
using news techniques to better conserve natural resources.

Thanks to current methods, the choice of the configuration and components of products makes allowance for their environmental impact.

A continuously improvement of the environment protection at all the sites by generalising the implementation of a common environmental management system.

The organisation will be based on an international standard :
the ISO 14001.



Schneider Electric Industries SA

Postal address:
france transfo
BP 10140
F-57281 Maizières-lès-Metz cedex
France
tél : 33 (0)3 87 70 57 57
fax: 33 (0)3 87 51 10 16
<http://www.francetransfo.com>

Due to the evolution of standards and materials, the present document will bind us only after confirmation from our technical department.