Instruction manual for packaging, transport, handling, installation, storage and maintenance of DRY type transformers

Content

1. Safety and risks

Please read this instruction manual carefully before servicing the product, disregarding the instructions may result in property damage, serious injury, or death.

The product covered in this manual must be operated only by qualified personnel.

This manual contains important information for the safety of personnel and the product.

If any problem not covered in this manual occurs, contact MAGNETRON S.A.S.

When working with transformers, operators are exposed to a series of risks and dangers, it is very important to know them in order to eliminate or minimize situations or conditions that may cause damage.

1.1 Personal security

- Stop any activity if working conditions are unsafe.
- All team members must know the instructions in this manual, the safety practices established in the workplace and the applicable legislation.
- Use clothing and personal protection elements according to the work to be carried out.

  - ✓ Long-sleeved cotton shirt.
  - ✓ Dielectric safety boots.
  - ✓ Bait or dielectric gloves.
  - ✓ Latex gloves (handling tools).
  - ✓ Safety glasses.
  - ✓ Dark glasses for sun protection (field activities).
  - ✓ Helmet.
  - ✓ Avoid wearing loose clothing.
  - ✓ Do not wear rings, watches, chains, earrings or any personal item that could cause harm.
  - ✓ Do not wear tennis shoes, shorts, short-sleeved shirts, and headphones.

1.2 Types of risks

➢ **Physical risks**

It refers to all environmental factors that depend on the physical properties of the bodies and that act on the tissues and organs of the worker's body, can produce harmful effects according to their intensity and exposure time.

They are related to the imminent probability of suffering bodily harm with or without direct contact, they

can be classified as labor or environmental.

They are the most common and can be caused by dangerous conditions at work:

- ✓ Noises,
- ✓ Lightning,
- ✓ Temperature,
- ✓ Humidity,
- ✓ Radiations,
- ✓ Vibrations,
- ✓ Electricity.

Listed below are some activities that must be carried out:

- Install localized lighting in those jobs that require it, when general lighting is moderate and may be insufficient.
- Avoid dead flow areas (where air does not circulate).
- Use work equipment that generates low noise levels.
- Locate noisy equipment or sources out of the way, if possible.
- Decrease the exposure time.
- Establish a job site rotation system.
- Use screens or shielding for radioactive sources.
- Apply the 5 golden rules when working with energy.

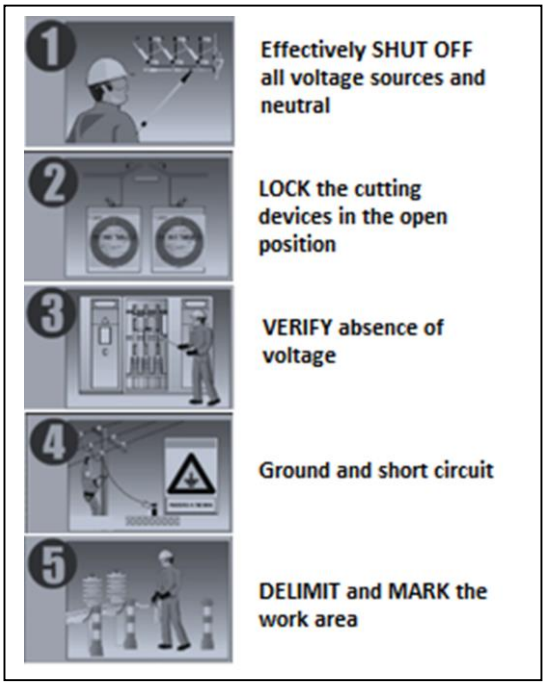


Figure 1: 5 golden rules

➢ Mechanical risks

They are associated with the set of physical factors that can give rise to an injury due to the mechanical action of machine elements, tools, work pieces or projected, solid or fluid materials.

The mechanical risk can occur in any operation that involves manipulation of hand tools, machinery, handling of vehicles, use of lifting devices.

- ✓ Collision with moving or stationary objects,
- ✓ Hits,
- ✓ Cuts,
- ✓ Entrapments due to overturning of machines or vehicles,
- ✓ Entrapments by or between objects,

- ✓ Projection of fragments or particles,
- ✓ Falling objects being handled.

Listed below are some activities that must be carried out:

- Train workers in preventive matters, theoretically and practically, on the work equipment necessary for their job.

- Guarantee the conditions and correct way of using machinery, based on the manufacturer's instructions.

- Promote the consultation and participation of workers in aspects related to mechanical risks.

- Guarantee periodic monitoring of the health status of workers.

- In the event of accidents or occupational diseases due to mechanical risks, the necessary corrective measures must be investigated and applied so that it does not happen again.

Figure 2: Signs of mechanical risk

2. Introduction

The IEEE C57.12.80 standard defines a transformer as a static electrical device consisting of one winding, or two or more coupled windings, with or without a magnetic core, to introduce mutual coupling between electrical circuits. Transformers are widely used in electric power systems to transfer energy by electromagnetic induction between circuits at the same frequency, usually with modified voltage and current values.

Likewise, it defines the dry-type transformer as a transformer in which the core and coils are in a gaseous or dry compound insulating medium.

Historically, insulating liquid-immersed transformers have been the most widely used option in electrical networks, but due to some problems associated with environmental management, the probability of fire, leakage control and general maintenance have motivated the evolution and use of dry type transformers

At present, the use of the transformer plays a very important role in the electrical supply. A failure in its operation can generate enormous inconveniences for companies, the industry or the population, since everyone uses the electrical service equally in their daily activities.

Dry transformers are normally made up of an active part made up of the core (magnetic circuit), the coil (electrical circuit) and the flange, which is defined depending on the type of transformer.

In the market there are several types of dry type transformers, the letter or name indicates the limits of temperature increase according to the insulation used.

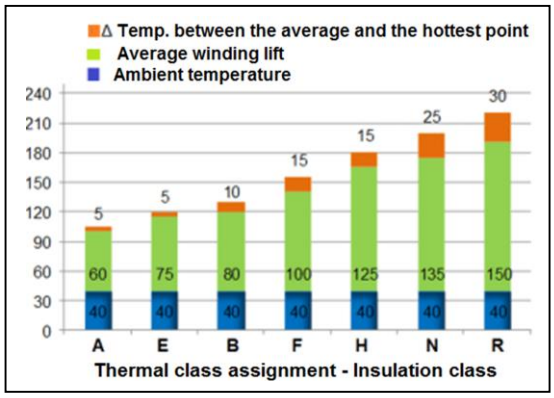


Figure 3: Limits of temperature increase (IEC 60076-11 – IEC 60085)

MAGNETRON S.A.S. offers its customers two types of dry transformers:

- Class F dry or epoxy resin encapsulated transformer.
- Transformer with open or dry winding class H.

2.1 Dry-type, epoxy-encapsulated or dry-type transformer F

They have reached a high degree of reliability, in such a way that they can be used in places with a high percentage of humidity and contamination, eliminating

problems such as fire risks and emissions of toxic and harmful substances.

They are made of insulating materials that retard flames and are self-extinguishing.

The transformer encapsulated in epoxy resin is designed to work in adverse conditions.

This type of transformers are classified according to weather conditions, the environment and behavior against fire.

2.1.1 Climate classes

- **Class C1:** The transformer is suitable for operation at ambient temperatures not lower than –5°C, but can be exposed during transport and storage to ambient temperatures below –25°C.

- **Class C2:** The transformer is suitable for operation, transport and storage at ambient temperatures down to –25°C.

- **Class C3:** The transformer is suitable for transport and storage down to -40 °C and for operation down to -25 °C.

- **Class C4:** The transformer is suitable for transport and storage down to -50 °C and for operation down to -40 °C.

- **Class C5:** The transformer is suitable for transport and storage down to -60 °C and for operation down to -50 °C.

2.1.2 Environmental classes

Ambient conditions are identified in terms of humidity, condensation, contamination, and ambient temperature.

Note: These are important not only during service but also during storage prior to installation.

With respect to humidity, condensation and contamination, three different environmental classes are defined:

Class E0: No condensation occurs in transformers and contamination is negligible.

This is commonly accomplished in a clean, dry indoor installation.

Class E1: Occasional condensation may occur on the transformer (when the transformer is de-energized), limited contamination is possible.

Class E2: Frequent condensation or heavy contamination or a combination of both.

Class E3: Frequent condensation or medium contamination or a combination of both.

Class E4: Frequent condensation or heavy pollution or a combination of both

2.1.3 Fire behavior classes

Class F0: There is no special fire hazard to consider.

Except for characteristics inherent in the transformer design, no special measures are taken to limit flammability.

However, the emission of toxic substances and opaque fumes will be minimized.

Class F1: Transformers subject to fire risk. Restricted flammability is required.

The emission of toxic substances and opaque fumes will be minimized

MAGNETRON S.A.S. offers its clients class F dry transformers with classifications C3, E4, F1.

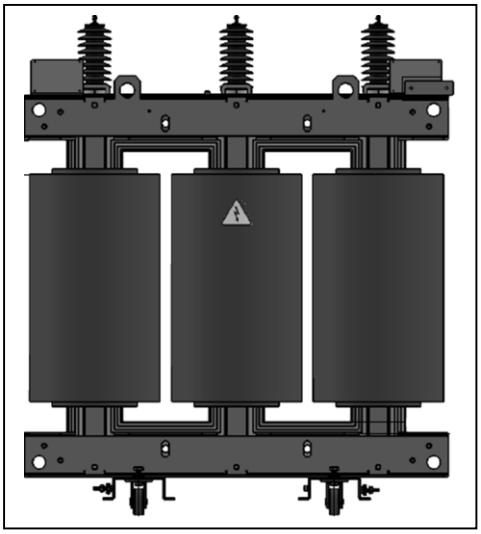


Figure 4: Dry encapsulation, class F

2.2 Dry transformer with open or dry winding H

It uses air as an insulating medium, for this reason the temperature of the windings is usually higher than in transformers immersed in insulating liquid.

MAGNETRON S.A.S. uses material in its manufacturing process that supports up to 180°C, is resistant to humidity and self-extinguishing.

In this type of transformers, MAGNETRON S.A.S. manufactures two types:

2.2.1 1.2 kV class

They usually do not carry voltage derivations and are confined in cabinets that protect them from atmospheric agents. Cells are supplied with the degree of protection (IP) that the client requests.

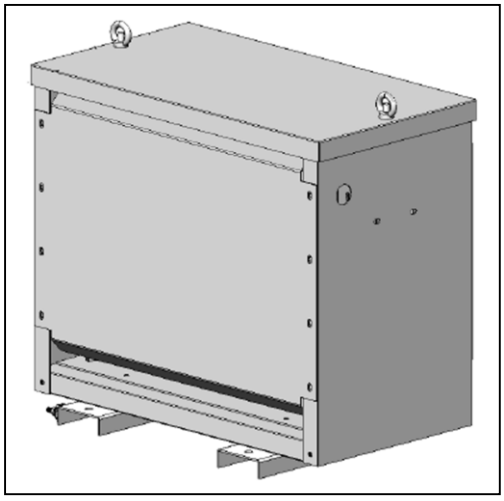


Figure 5: Dry class 1.2 kV

2.2.2 15 kV class

They are built with circular section windings and staggered section stacked cores. Its entire insulation scheme is designed with 180ºC class materials, so that it can withstand the heating and overload conditions established by standard.

They do not have a cabinet because they are designed to be included inside cells in medium voltage substations.

Note: The cabinet can be incorporated at the customer's request.

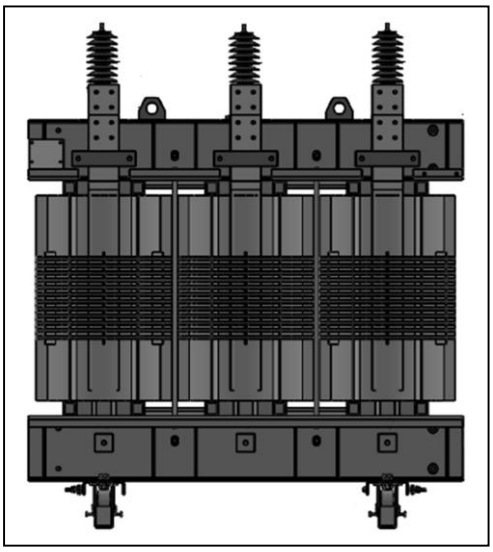


Figure 6: Dry class 15 kV

Dry type transformers manufactured by MAGNETRON S.A.S. are mainly used inshopping centers, hospitals, schools, tunnels, banks, airports, among others.

The information, recommendations, descriptions and safety notes compiled in this document are based on guides, standards and the experience of MAGNETRON S.A.S.

This information does not include or cover all contingencies, therefore, if you require more information, contact MAGNETRON S.A.S.

3. Definitions

3.1 Transformer

Electrical device without moving parts that transforms electrical energy into its two main factors: Voltage and Current.

3.2 Dry type transformer

Device in which the core and windings are not immersed in liquid.

3.3 Dry type transformer with encapsulated windings

Device having one or more windings encapsulated with solid insulation.

3.4 Dry type transformer with unencapsulated windings

A device that does not have any of its windings encapsulated with solid insulation.

3.5 Totally Enclosed DRY Type Transformer

Air-immersed device with protective enclosure constructed in such a way that ambient air is not circulated to cool the core and windings but can be ventilated with the atmosphere.

3.6 Enclosed DRY Type Transformer

Device with protective enclosure built so that ambient air can circulate to directly cool the core and windings.

3.7 Sealed DRY Type Transformer

Device in air or submerged in air or gas, with sealed protective enclosure, built in such a way that there is no exchange between its content and the outside atmosphere, that is, it is not ventilated.

3.8 Primary winding

Winding that is connected to a power source.

3.9 Secondary winding

Winding to which a load is connected.

3.10 Medium voltage winding

Winding with the highest voltage.

3.11 Low voltage winding

Winding with the lowest voltage.

3.12 Self-extinguishing

Material that stops burning when separated from an external flame or source of heat.

3.13 Packaging

Fabricated deck usually in wood in which transformers are packed during storage and transport.

3.14 Packing basis

Flat and strong structure made of wood or metal that serves to protect and support the weight of the transformer.

3.15 Danger

Inherent situation with the capacity to cause injury or damage to people's health.

3.16 Risk

Combination of the probability that a dangerous event will occur with the seriousness of the injuries or damage to health that such an event can cause.

3.17 Epoxy resin

Epoxy resin, epoxy, porcelain or liquid glass is a thermosetting polymer that changes from a liquid to a solid state when a hardener or catalyst is applied to it.

3.18 Magnetostriction

It is a specific property of ferromagnetic materials and refers to their ability to change shape in the presence of magnetic fields.

3.19 Main radiation surface

Hypothetical surface that surrounds the object under test. It is assumed that from this surface sound is radiated.

3.20 Measuring surface

Hypothetical surface that surrounds the main radiation surface and on which the measurement points are located.

3.21 Prescribed contour

Horizontal line on which the measurement points are located.

4. Abbreviations

A	Amps
ANSI	American National Standards Institute
MT	Medium voltage
BT	Low voltage
DPS	Device for surges (lightning rod)
IEC	International Electrotechnical Commission
IEEE	Institute of electrical and electronic engineers
kg	Kilogram
kV	Kilovolt
kVA	kilo volt amps
lbf.ft	pound-force foot
m	Meter
max	Maximum
min	Minimum
mΩ	milliohms
MΩ	megohms
ntc	Colombian technical standard
Pn	neutral point
PTS	grounding system
Grd	Grounding
TTR	Transformer turns ratio

5. Handling

Caution: The transformer must be handled in a vertical position.

Caution: Under no circumstances should you lean on the MV insulators, LV terminals, connections, coils or stand on top of the transformer.

Keep the transformer on the base (wooden or metal) on which it is shipped to the place where it will be installed, as this provides greater protection.

Also, it can be kept on the casters or in the crate (if it has one).

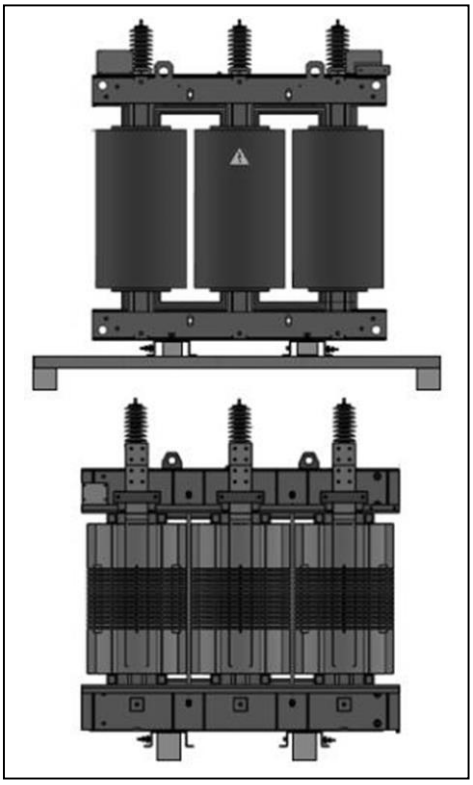


Figure 7: Transformers on wooden bases

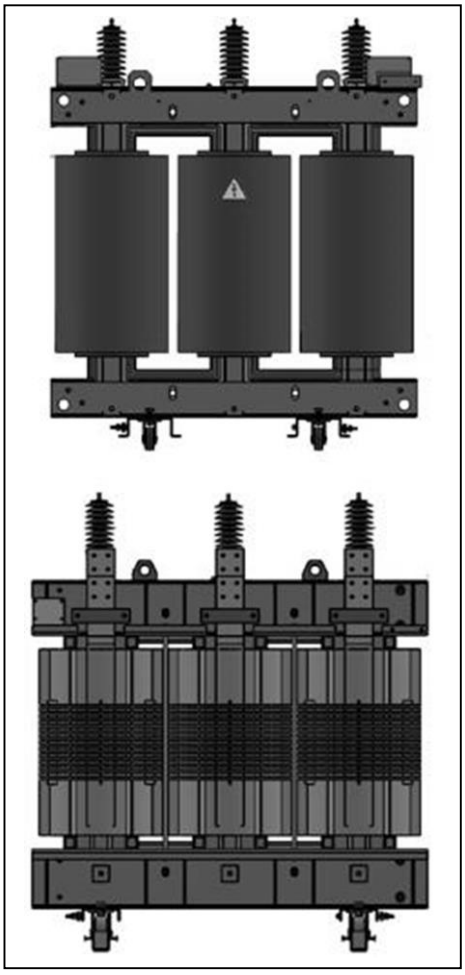


Figure 8: Transformer on the casters

For no reason allow the transformer to be dragged directly on the floor, the metallic structure may suffer deformations or the paint may deteriorate, giving rise to the oxidation of the sheet; Also, there may be mismatches in the structure, causing potential damage to the transformer.

It is not allowed to push the transformer leaning on the coils, the MV or LV terminals, the connections or on the accessories.

If required, you can lean on the flanges that hold the magnetic circuit to push it.

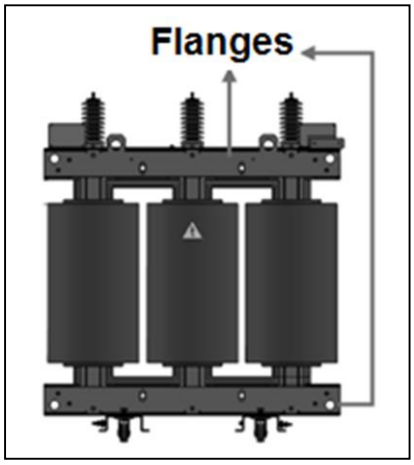


Figure 9: Support points to push the transformer

The transformer must only be lifted or hoisted using the four (4) lifting lugs, to transport it, use a forklift or crane.

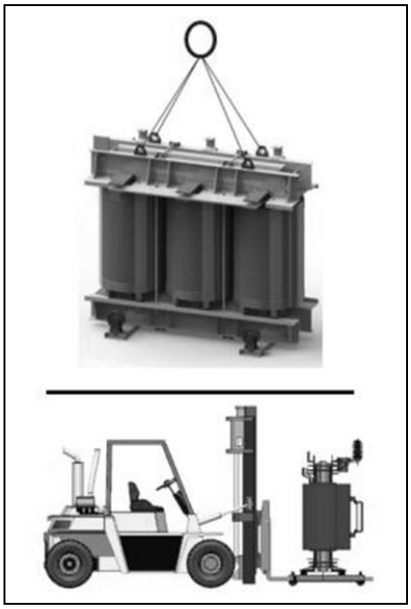


Figure 10: Handling transformers

Do not lift or move the transformer by using crowbars or jacks under accessories, connections or other devices, these elements are not designed to be subjected to this type of stress and ruptures, deformations or mismatches may occur.

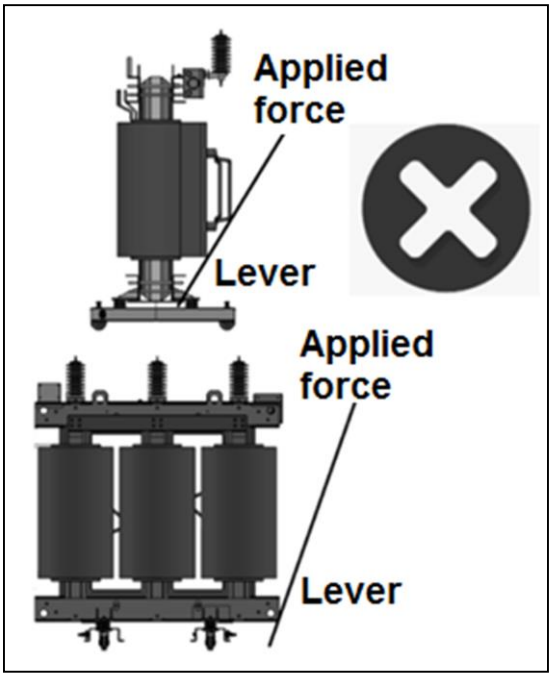


Figure 11: Improper handling

When a transformer cannot be handled by means of a crane, differential, load lift or stowage carrier, it can be moved by sliding it on its wheels, skids or rollers, taking care not to damage the base or not to drop it.

Use rollers or skates according to the weight of the product and in sufficient quantity to distribute the weight of the product.

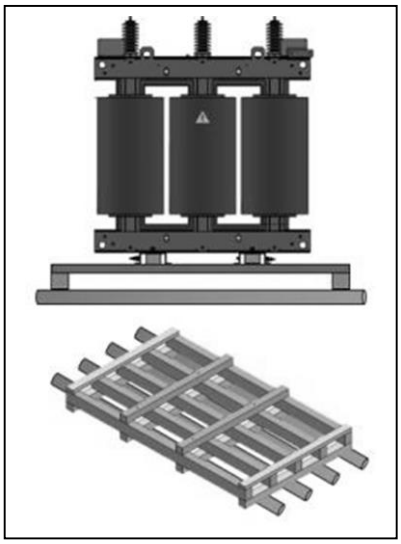


Figure 12: Use of rollers or skids for transportation

Transformers are provided with lifting devices or lifting lugs that are used to handle it with a crane, fiber slings must be used as they help protect the paint.

If you use stringsor metal slings, be sure to cover the parts in contact to avoid paint detachment.

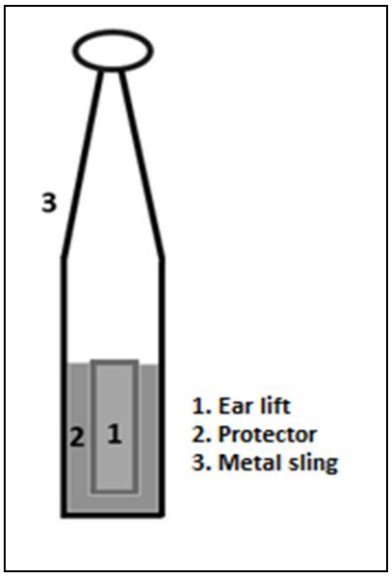


Figure 13 Paint protection on lifting lugs

Do not use the lifting lugs to transport the transformer, these devices are designed for lifting only.

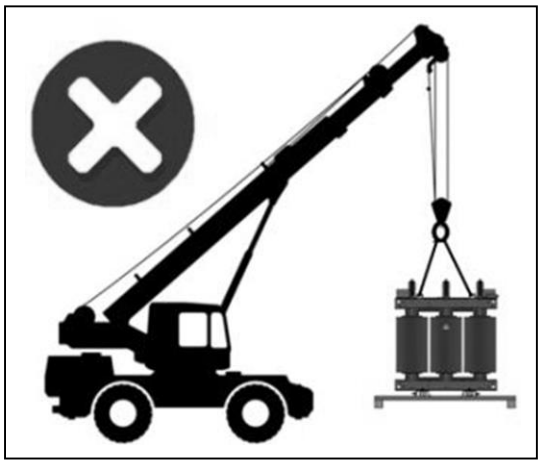


Figure 14: Prohibited to transport from lifting ears

6. Packaging

The transformer packaging must allow handling in such a way that, when any movement is required for its storage or transport, it can be easily lifted by the base of the packaging.

The base of the packaging must have a minimum height of 10 cm to allow the entry of a forklift or a dunnage carrier.

Base (wood or metal) can be constructed so that the transformer sIt can be manipulated from the front, the back or from the sides.

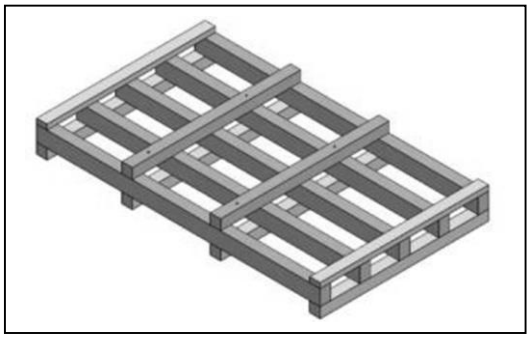


Figure 15: Wooden base for handling from either side

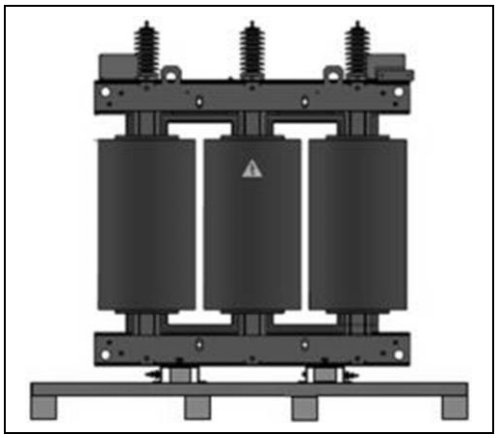


Figure 16: Transformer on a wooden base

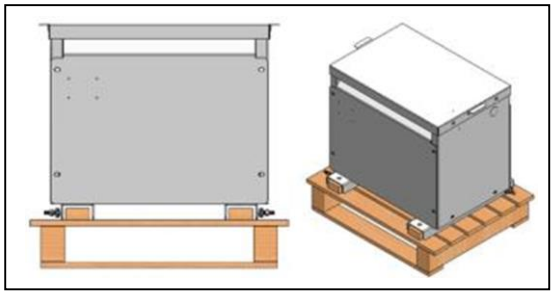


Figure 16-1: Transformer on wooden base

The transformer must be attached to the base of the packaging, to prevent it from suffering deterioration caused by sudden movements. In dry-type transformers, the coupling is done through screws.

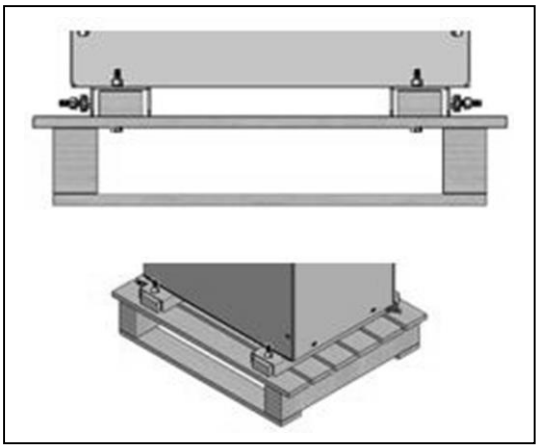


Figure 17: Anchoring the transformer to the base with screws

Dry transformers are protected externally with stretch film (plastic), which protects it from rain, dust or excessive humidity.

Keep the packaging and packing of the product, thus, the infiltration of liquids is avoided, metal particles, dust, etc.

When the dry transformer is completely covered with the crate, externally, on one side, the serial

number is painted, which helps to identify its characteristics.

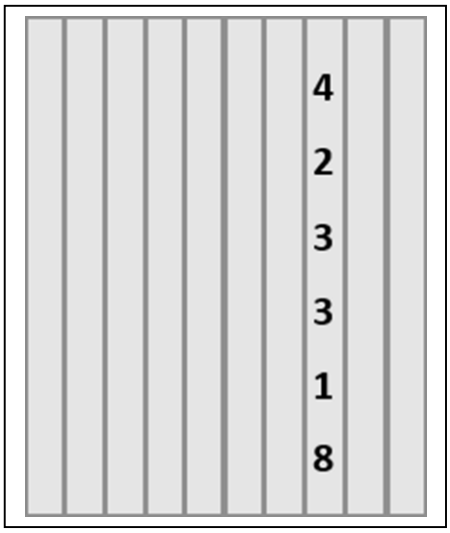


Figure 18: Serial number identified in the huacal

For transformers that must be lifted or transported by crane (by weight or size) and that are boxed, it must be ensured that the lifting lugs remain free and easily accessible for the location of the slings or slings; for this, the spaces in the upper part of the huacal are left free.

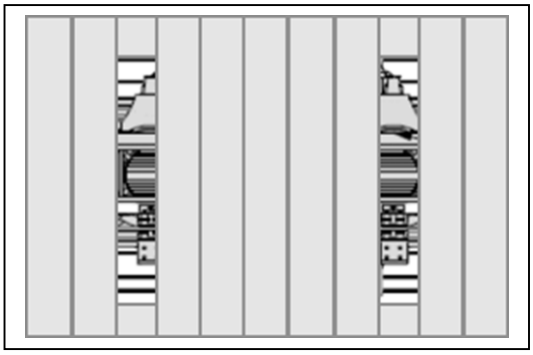


Figure 19: Lifting lugs available for lifting

Caution: Under no circumstances should you lean on the MV insulators, LV terminals, connections, coils or stand on top of the transformer.

7. Transport

Caution: The Dry transformers must be transported in fully covered vehicles.

Make sure that the tent or the walls and metal roof of the vehicle do not have holes or cracks that could cause water leaks inside.

Caution: In Colombia, the total height of the load, measured from the floor, cannot exceed 4.3 m.

The total weight of the load cannot exceed the capacity of the truck.

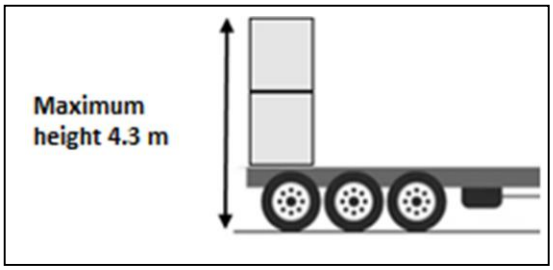


Figure 20: Maximum height of the load

Take into account the weight of the transformer to determine the appropriate lifting and/or transport elements, this information appears on the nameplate, in the test certificate or in the documents required for its transport.

Lift the transformer using the four (4) lifting lugs or the bottom of the packaging.

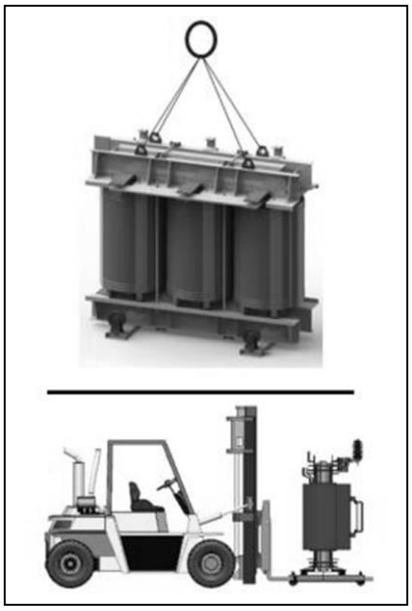


Figure 21: Parts for lifting or transporting the transformer

When lifting the transformer from the lifting lugs, make sure that the slings or slings do not come into contact with any component of the equipment such as insulators, terminals, connections, flanges, junction boxes, accessories, etc.

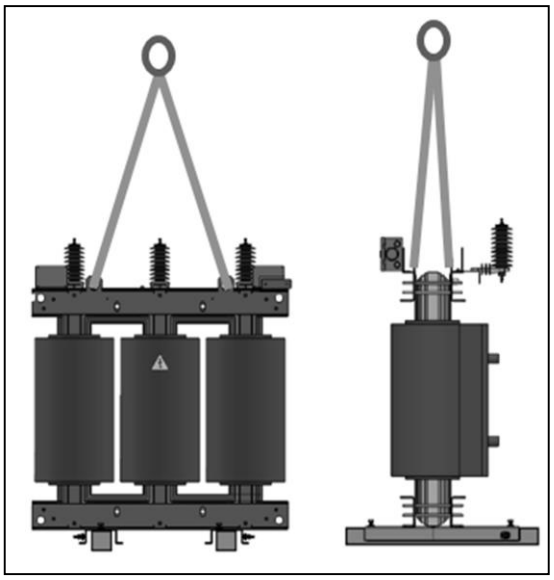


Figure 22: Elevation of the transformer from the lifting lugs

7.1 Transformers without crate

These transformers must be loaded at a single level and distributed within the truck or container to balance the load.

The base of the transformers acts as a separator, when there are spaces between them, wooden wedges must be fixed between them and the floor.

The function of the wooden wedges is to prevent displacement of the transformers when the transport is in motion.

Additionally, to improve cargo security, transformers must be slinged to the walls of the truck or container.

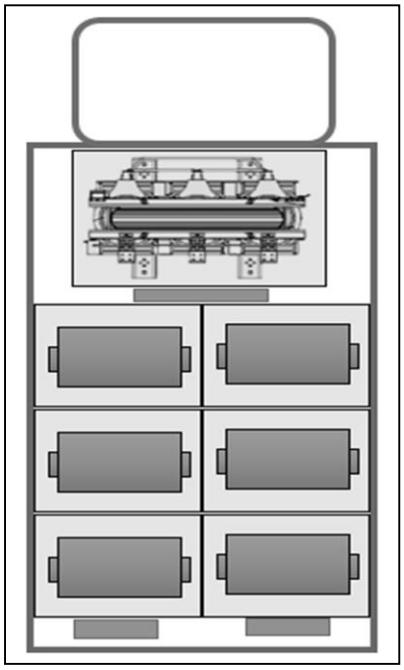


Figure 23: Loading, distribution, and chocking

When few units are loaded due to the size of the product, the load should be placed centered on the bed of the truck or container.

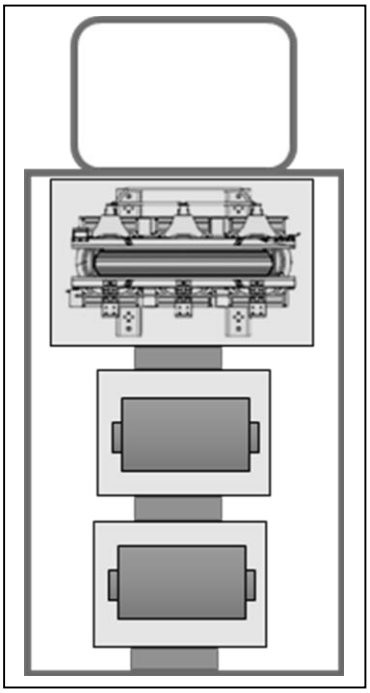


Figure 24: Balanced load

7.2 Transformers with crate

When a considerable number of transformers are transported, the load must be distributed within the truck or container in groups separated from each other.

The packaging of the transformers acts as a separator, when there are spaces between them, wooden wedges must be fixed between them and the floor.

The function of the wooden wedges is to prevent displacement of the transformers when the transport is in motion.

Additionally, each set must be tied together to form a solid unit and between them to the walls of the truck or container.

These transformers can be loaded on up to two levels, as long as the weight of the load located on the second level does not exceed 400 kg.

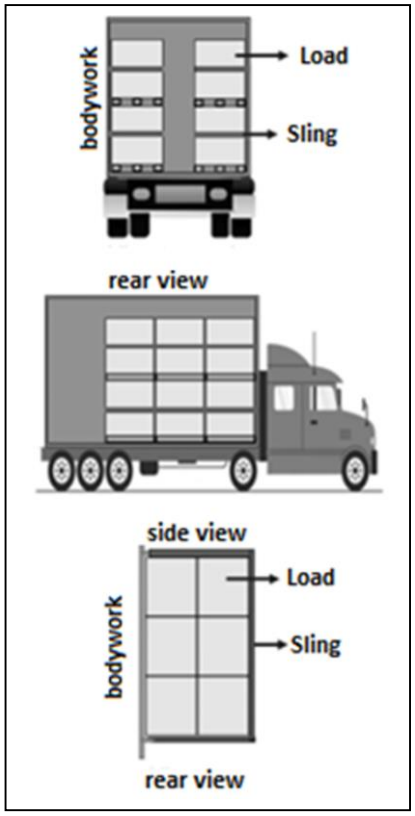


Figure 25: Correct way of loading and tying crated transformers

When few units are loaded due to the size of the product, the load should be placed centered on the bed of the truck or container.

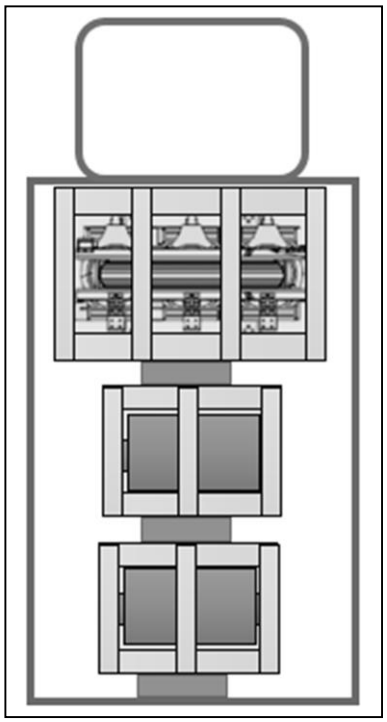


Figure 26: Balanced load

7.3 Special considerations

- When the base of the transformer and the vehicle floor are metallic, wooden boards must be located between them to prevent displacement.

  In addition, the base of the transformer must also be tied to the truck body.

Figure 27: Boards between the base and the floor of the vehicle

7.4 Download

Precautions: If you use strings or metal slings to lift the transformer, be sure to cover the parts in contact to avoid paint detachment.

The unloading of the transformers is the responsibility of the customer, unless otherwise specified in the contract. However, the following should be noted:

- If you have doubts about the gross weight of the product, the lifting elements to be used, the method to unload the product or any other activity, refrain from maneuvering and contact MAGNETRON S.A.S.
- Always use the appropriate mechanical means, forklift, crane, etc.
- The mechanical means used must have at least twice the capacity of the weight of the transformer.
- Lift the transformer only by the lifting lugs or the bottom of the packaging.
- When the transformer is elevated, the personnel who are part of the unloading must stay away from it.
- Transformers that are out of reach must be pulled to unload position, to do so:
  - Attach a sling to the hoist or mechanical means used and pass it around the base of the transformer packaging.
  - Pull the transformer until it is within reach of the mechanical means used.
  - Download the transformer.

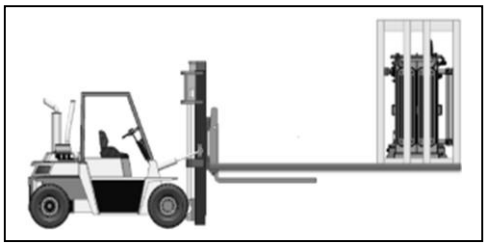


Figure 28: Proper way to pull a transformer in the discharge.

In the transformers that require a crane for unloading, the slings must be located through the holes provided in the upper part of the crate.

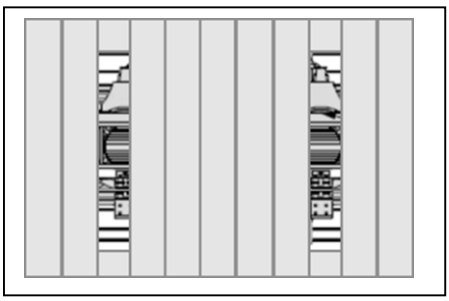


Figure 29: Holes to locate the straps

8. Reception

Caution: Before unloading the transformer, you must visually inspect its condition. Notify the transporter of any abnormality and record it.

Check that the removable parts of the transformer (orientable wheels, SPD, connections, etc.) arrive complete and in good condition.

The transformers covered in this manual are factory tested in accordance with the standards that govern them, are delivered fully assembled (unless limited by size and weight) and ready for installation, however, taking into account the difficulties that may occur during transportation, has to keep the following in mind:

- Check that the transformer arrives complete, to do so, compare it with the supplied transport list.
- Check that the security seals located in the places that have removable parts (connection boxes), have not been removed or show evidence of having been tampered with.

Figure 30: Security Seal

- Check the state of the MV insulators and the LV terminals, they should not be loose or present damage.
- Check the state of the connections, they should not be loose or burst.
- If the transformer is equipped with a temperature gauge or other accessories, check that they are in good condition.
- In the transformers that carry it, check the state of the tank, it should not show bumps, cracks or damage to its paint.
- Check that caster wheels (if fitted) arrive with the transformer.

Figure 31: Caster wheels

- Check that the hardware is completely and correctly adjusted.
- Check that the characteristics of the transformer correspond to what was requested (power, phases, voltages, serial number, etc.).
- Inspect the base of the packaging, it should not show damage.

- Make sure the transformer goesexternally covered with stretch film (plastic), which protects it from rain, dust or excessive humidity.

- In case of finding damage to the transformer, if possible, leave a photographic record of the findings.

- Inform the transporter of the abnormalities found.

- Contact MAGNETRON S.A.S. and notify what happened, supplying the complete information of the transformer.

- Keep in mind what is established in numeral 7 "Transportation" before unloading the transformer.

9. Storage

Caution: Keep the transformer in the packaging (base or crate), this protects it from damage or deterioration during storage.

Caution: The transformer must be stored indoors.

Once the transformer has been delivered to the customer, it is advisable to place it in its permanent location, even if it is not put into operation immediately.

Abide by the following instructions to ensure its good condition:

- Keep the transformer in its packaging and covered with thestretch film (plastic).
- The dry type transformer is designed to be installed and worked indoors, so please store it indoors.
- The storage place must be dry, clean and well ventilated.
- The surface of the storage place must be flat.
- If the storage place is prone to humidity, it is recommended to place bags with moisture absorbent products (silica gel) near the coils.
- Do not store it in places where there is presence of sludge, corrosive gases or explosive atmospheres.
- When storage is extended for more than six (6) months, has to periodically inspect the state of the wooden base or the crate and the plastic cover.
- If the transformer weighs less than 400 kg and is encased, they can be placed at two levels (one above the other) maximum.
- Do not store transformers on two levels (one on top of the other) when storage is longer than six (6) months.

10. Accessories

Caution: If any accessory is not covered in this manual or requires more information, contact MAGNETRON S.A.S.

The accessories installed in dry-type transformers can be classified into two types:

10.1 Normal accessories

Minimum required elements, supplied by the manufacturer with the transformers, useful for their identification, handling, installation, proper functioning and protection.

- MV insulators
- LV insulators and terminals
- Caster wheels
- Rating plate
- Non-voltage tap changer
- Devices for lifting or hoisting the transformer
- Grounding system
- Labeling of MV and BT terminals

10.2 Special accessories

Elements required by any particular standard or by customer request.

- Temperature monitor
- Fans

10.3 Accessories illustration

Some of the accessories used in the transformers that are the subject of this manual are detailed below.

10.3.1 MV insulator

Accessory, normally made of porcelain or epoxy resin, designed to mechanically hold the conductors that are part of the electrical line, keeping them isolated from earth and from other conductors.

Its main function is to make the bridge between the medium voltage terminals of the active part and the power supply.

Its characteristics vary according to the voltage level of the transformer, the basic level of insulation and the creepage and arc distances.

Figure 32: Epoxy resin insulators

10.3.2 Insulator and LV terminal

Accessories, normally made of porcelain or epoxy resin, designed to mechanically hold the conductors that are part of the power line, keeping them isolated from earth and from other conductors.

Its main function is to make the bridge between the low voltage terminals of the active part and the external load.

In 1.2 kV class dry-type transformers, it is normal to see porcelain insulators.

Its characteristics vary according to the voltage level of the transformer, the basic level of insulation and the creepage and arc distances.

In small and medium power transformers with a class greater than 1.2 kV, insulators and terminals are not normally used. The load coupling is made directly to the transformer's LV busbar.

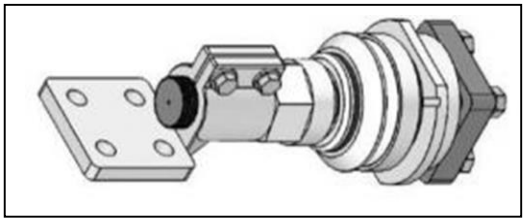


Figure 33: Insulator and LV

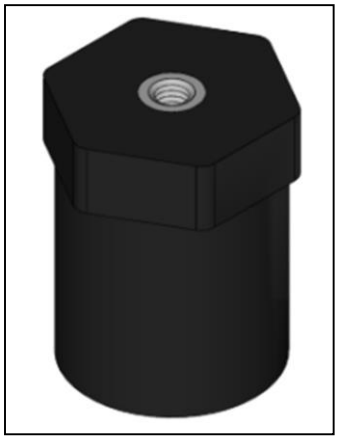


Figure 33-1: LV insulator in epoxy resin

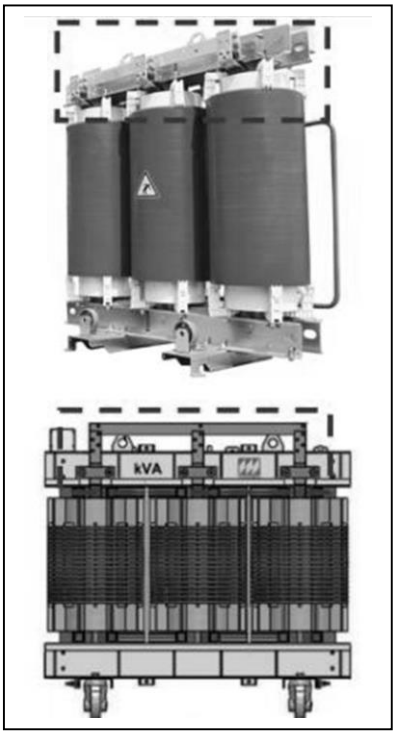


Figure 33-2: BT busbar

10.3.3 Caster wheels

Item used for:

- Fix the transformer on rails
- Move the transformer in short distances.

The wheels come in different sizes and can be fixed, swivel or with brakes.

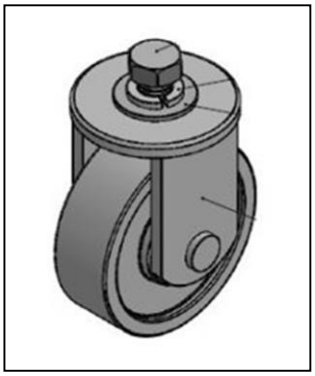


Figure 34: Caster wheel

10.3.4 Rating plate

It is an accessory made of a material resistant to corrosion (aluminum, stainless steel, etc.) where the most relevant information on the transformer is recorded.

The plate must be affixed in a visible place and its inscriptions must be legible and indelible.

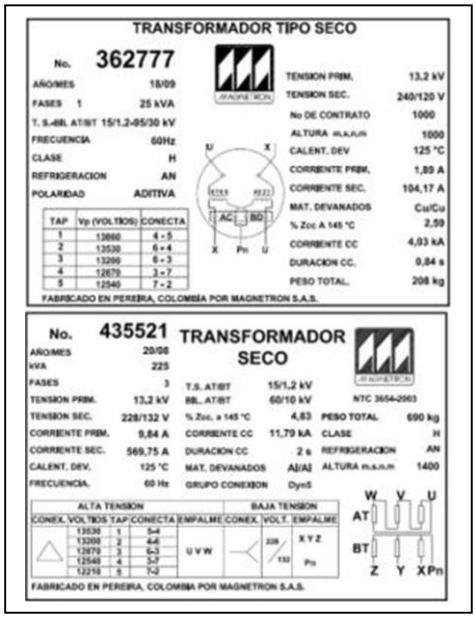


Figure 35: Example nameplate

10.3.5 Tap changer

Caution: The switch has an external handle, which must be operated only with the transformer de-energized.

The commutator varies the turns ratio in the primary winding until the required voltage is obtained in the secondary, compensating for the variations that are detected at the receiving points of a power transmission or distribution system.

The commutator used in dry-type transformers consists of:

- Class H: A bakelite board with bronze screws, which are joined with a copper plate in the required position.
- Class F: They have bronze bushings attached to their coils, which are joined through a copper plate screwed in the desired position.

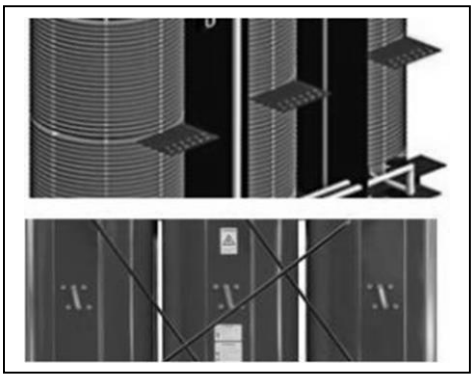


Figure 36: Branch switch

10.3.5.1 Steps to operate the CIRCULAR switch

- Disconnect the transformer from the power source.
- Verify the absence of voltage on the transformer by measuring the LV winding with a voltmeter.
- Ground the MV and BT terminals.
- Remove the nuts or bolts that secure the copper plate of the switch.
- Position the copper plate in the desired position.
- Re-secure the nuts or screws that fix the copper plate.
- Remove the ground connections from the MV and LV terminals.
- Measure continuity at the MV terminals to ensure that the switch is properly engaged.
- Re-energize the transformer.
- Measure the voltage on BT, confirm that it is the desired voltage.

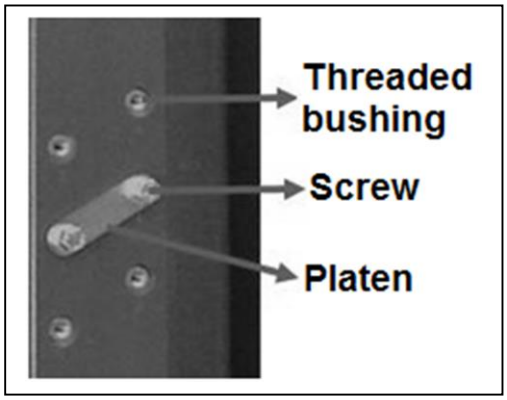


Figure 37: Parts of the commutator

10.3.6 Transformer hoisting device

Elements to lift or hoist the fully assembled transformer, are located in such a way that when hooking the straps or slings they do not lean against other accessories, nor against the bushings, nor do they damage the cover.

Normally, they are located on the upper flange of the transformer or on the cover if they have a tank, they can be:

- Perforations
- Bolted hooks
- Welded perforated plates

They are only used for hoisting or lifting, they are not for transporting.

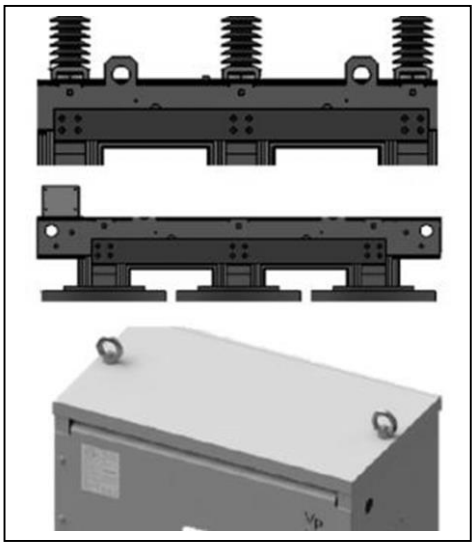


Figure 38: Lifting devices

10.3.7 Grounding system

The transformer is provided with screws (studs) or plates with their respective accessories to allow:

- The low voltage neutral point grounding is shipped connected from the factory.
- The grounding of the transformer to the grounding system where the transformer will be installed.

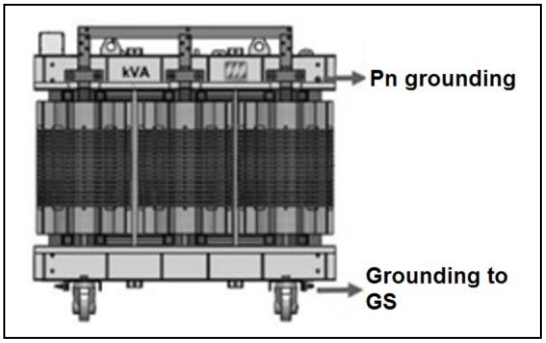


Figure 39: Landing points

10.3.8 Temperature monitor

It is a device designed to monitor and control temperature.

The temperature measurement is carried out through thermocouples located in each coil of the transformer.

The monitor has a digital indicator, which automatically displays the highest temperature value, although it is possible to individually select the temperature value in each phase.

Figure 40: Temperature monitor

11. Terminal marking

The marking of the MV and BT terminals in this type of transformers depends on the standard (NTC or ANSI).

11.1 NTC standard marking

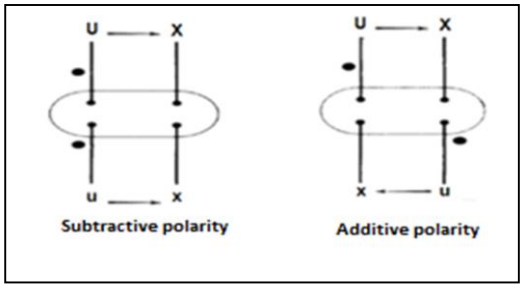


Figure 41: Single-phase dialing

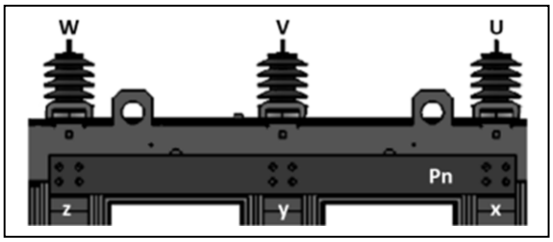


Figure 41-1: Triphasic dialing

11.2 ANSI standard marking

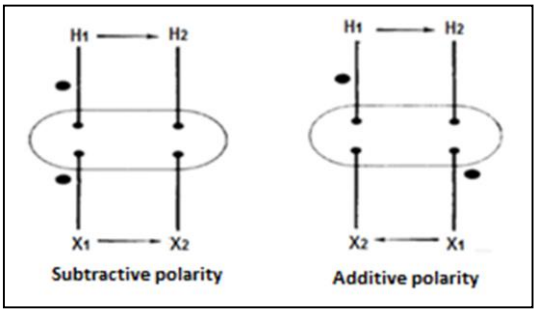


Figure 42: Single-phase dialing

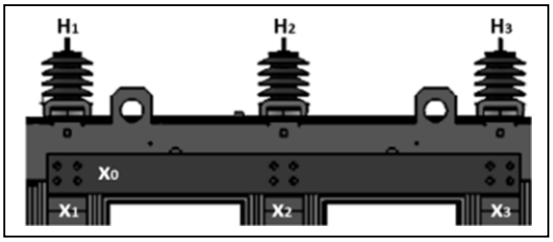


Figure 42-1: Triphasic dialing

- The markings in the medium voltage terminals are made with CAPITAL letters and for the low voltage terminals they are made with LOWER CASE letters.

Three-phase transformers have two other very important factors for their connection:

- Connection group
- Hourly index

11.3 Hourly index

It represents the phase angle between the vector diagram of the electromotive forces (voltages) of the primary winding and the secondary winding, when the transformer is in no-load condition.

In other words, it is the phase difference, in degrees, between the primary voltage and the secondary voltage.

The hourly index is so called because the offset is expressed according to the hours of a clock. Every hour, from 12 o'clock, represents a lag of 30º.

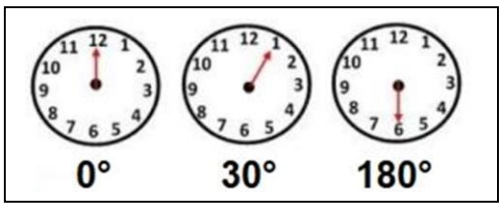


Figure 43: Hourly index examples

11.4 Connection group

It represents the type of connection for each of the windings, normally the primary winding and the secondary winding.

The connection group is represented by a series of letters and a number, as follows:

- The first letter, in CAPITAL LETTER, represents the connection of the highest voltage winding.
- The second letter, in LOWER CASE, represents the connection of the lower voltage winding.
- The number represents the phase difference, in degrees, between the primary voltage and the secondary voltage (1 = 30°).
- If a third letter (N on) is observed in the connection group, it indicates that the star connection (Y oy) has an accessible neutral point.

Example:

Dyn5

D	Indicates the connection of the HIGHEST VOLTAGE winding (Delta or triangle)
y	Indicates the connection of the LOWER VOLTAGE winding (Star)
n	Indicates that the star connection (Y or y) has an accessible point
5	It represents the phase difference in degrees, between the primary and secondary voltage, in this case 150° (5*30°)

12. Review and tests before installation

12.1 Revision

Before installing the transformer, check the following:

- Use a vacuum cleaner to remove all traces of dirt, dust, and foreign material that may be adhering to the transformer.
- If you have a tank, clean it.
- Check that the accessories attached to the transformer are in good condition and properly adjusted.
- Make sure that the transformer does not present blows or damage that could invalidate its proper functioning.
- Check that the MV connections are in place and that there are no bumps.
- Review the information on the nameplate and verify that it is in accordance with the requirements (power, voltages, etc.).
- Remove the transformer base and crate (if equipped).
- Verify that the bypass switch is well adjusted and in the required position.
- Make sure that the low voltage neutral point is correctly grounded.
- Make sure that all the parts and/or accessories to be installed, if any, are complete and in good condition.
- The surface where the transformer will be installed must be flat and capable of supporting its weight.
- If the transformer is located on rails, block the casters and verify that they are all supported.
- The transformer must be well secured to the installation base.
- It is recommended to mount the transformer on springs (shock absorbers), in such a way that they absorb vibrations.
- Check that, in the place of installation, the minimum safety distances are maintained.

  Note: The minimum distances reduce the noise level of the transformer and facilitate inspection, maintenance and cleaning activities.

- Make sure that the place of installation is adequately ventilated, this action limits the heating of the transformer.

12.2 Evidence

In order to ensure the proper functioning of the product and not affect the warranty of the equipment, the following tests must be carried out to validate the installation and energization of the same:

12.2.1 Transformation Ratio (TTR)

This test is performed to measure the ratio of voltages or turns between two or more windings.

Also, it is a test that allows to identify:

- The connection group.
- Short circuit between turns or layers.
- Failures due to burst or open terminals.
- Damage or misoperation of the commutator.
- Wrong or broken connections.

Depending on the equipment used, the test is performed as follows:

- **Analog or crank TTR**

With this equipment, the ratio of the transformer under test is compared with that of a reference transformer (internal to the equipment) whose ratio is adjustable in small steps.

The transformer under test and the TTR are connected in parallel applying voltage to the MV windings; the LV windings, in parallel, are connected to a sensitive detector which is forced to signal zero (0) by adjusting the transformation ratio of the reference transformer (TTR). The adjusted transformation ratio of the reference transformer (TTR) is then equal to the transformation ratio of the transformer under test.

This procedure must be carried out in all switch positions and in all phases if it is a three-phase transformer.

Figure 44: Analog or crank TTR

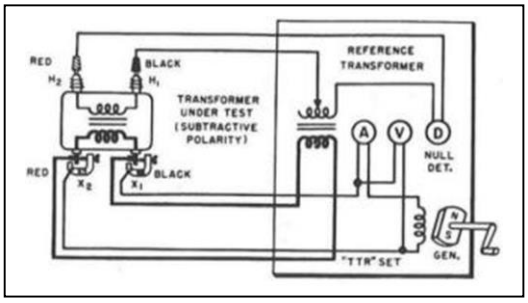


Figure 45: TTR connection to the transformer under test

- **Digital TTR**

With this equipment, an adjustable voltage is applied to the MV terminals and the output voltage of the winding corresponding to the BT is measured. The value of the transformation ratio results from the division of these voltages.

The MV and BT terminals of the metering equipment are connected to the MV and BT terminals of the transformer under test according to the marking of the corresponding phases. The equipment must be configured according to the connection group and the voltage to be applied, as standard 8V is used.

Figure 46: Digital TTR

- **Calculation of the transformation ratio**

They are carried out according to the connection group or the polarity of the transformer:

Phases	Connection type	Formula or calculations
1	Ii0 - Ii6	$RT = \frac{\text{Voltage HV}}{\text{Voltage LV}}$
3	Dd - Yy	$RT = \frac{\text{Voltage HV (Coil)}}{\text{Voltage LV (Coil)}}$
3	Dy	$RT = \frac{\text{Voltage HV (L-L)}}{\text{Voltage LV (L-L)} / \sqrt{3}}$
3	Yd	$RT = \frac{\text{Voltage HV (L-L)} / \sqrt{3}}{\text{Voltage LV (L-L)}}$

Figure 47: Formulas to calculate the transformation ratio

12.2.2 MV and LV winding resistance or continuity

This test is performed to ensure that the internal connections of the transformer are not loose or open.

- With an ohmmeter (multimeter) check the medium voltage connection, connect the meter between each pair of MV terminals as follows:

- In three-phase transformers between U-V U-W V-W or H1-H2 H1-H3 H2-H3.

- In single-phase transformers between U-X or H1-H2.

When the reading on the meter has stabilized, compare the results obtained with the values stated in the test certificate, there should not be a variation greater than +/- 5%.

- To verify the LV connection, connect the meter between each pair of terminals as follows:

- In three-phase transformers between x-y x-z y-z or x1-x2 x1-x3 x2-x3.

- In single-phase transformers between ux or x1-x2

  When the reading on the meter has stabilized, compare the results obtained with the values stated in the test certificate, there should not be a variation greater than +/- 5%.

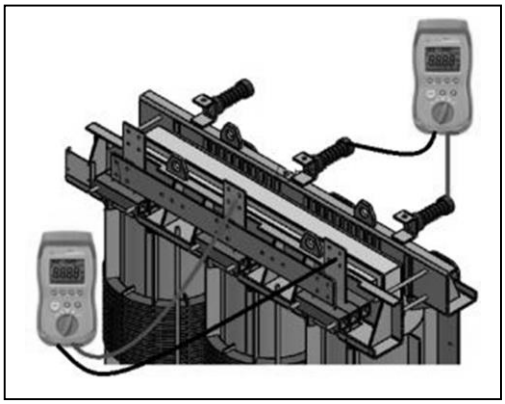


Figure 48: Winding resistance measurement in MT and BT

If, when carrying out the test, any of the following cases occurs, the transformer has suffered internal damage:

- When measuring the MV winding, some of the values returned are more or less double what is stated in the test certificate (figure 49).

- When measuring the MV winding, the meter does not record a measurement value.

- When measuring the LV winding, one of the values returned is more or less double that stated in the test certificate or does not register any value (figure 50).

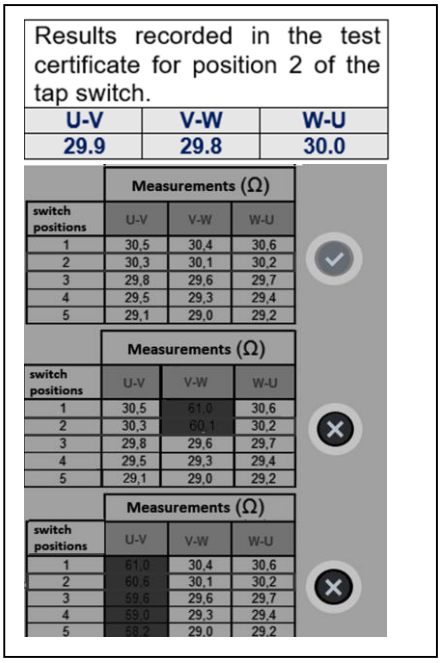


Figure 49: Examples of MV measurement

Results recorded in the test certificate for low voltage

U-V	V-W	W-U
2.31	2.30	2.31

Values measured in the field

U-V	V-W	W-U	
2.34	2.33	2.33	✓
4.70	2.33	2.33	✗
2.34	1.	2.33	✗

Figure 50: Examples of LV measurement

12.2.3 Insulation resistance

This test is carried out to have a vision of the state of the insulation in terms of contamination by the presence of moisture or metal particles.

- Use a 5 kV megger with a measurement range of 50 MΩ mínimum (use the same factory test voltage to minimize drift).
- Proceed as follows:

- In single-phase transformers, short-circuit the MV terminals (U-X or H1-H2) and the LV terminals (u-Pn-x or x1-x2-x3).
- In three-phase transformers, short-circuit the MV terminals (U-V-W or H1-H2-H3) and the LV terminals (Pn-x-y-z or x1-x2-x3).
- It is recommended to apply the test voltage, taking into account the class of the winding under test:

Class (kV)	Voltage DC (kV)
≤ 1.2	1
> 1.2	5

- Test for one (1) minute for each measurement (MT vs BT, MT vs T, and BT vs T).

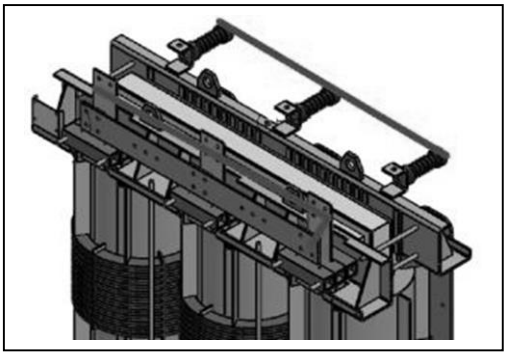


Figure 51: Short-circuit medium and low voltage terminals

- To carry out the different measurements (3) the cables are connected as follows:

  - MT-BT: Power cable (+) in MT and black cable (-) in BT, the cable saves anger in a ground terminal.
  - MT-T: Power cable (+) in MV and black cable (-) in T, the cable saves anger in BT.
  - BT-T: Power cable (+) in BT and black cable (-) in T, the cable saves anger in MT.

- **Results analysis**

  This test has no correspondence between the nominal power value, the transformer voltage and the insulation resistance, which is why the minimum values are left to the discretion of the manufacturer.
  To verify if the values measured at the installation site are in accordance, keep in mind the following criteria:

- Compare the results obtained against those reported by MAGNETRON SAS in the test certificate, these should be very close to or above what was measured at the factory.

- Take into account the minimum values established by MAGNETRON SAS according to the class of the transformer.

Class (kV)	Minimum resistance (MΩ)
1.2	1,000
15	10,000
34.5	50,000

- Apply James Biddle's empirical formula to calculate the minimum value of insulation resistance:

$$R = \frac{CE}{\sqrt{kVA}}$$

R = **Resistance at 20°C of the insulation measured in 1 min**
C = **Constant for measurements at 20°C**
C= **1.6 for transformers in oil**
C= **30 for dry transformers**
KVA= **rated power**
E= **Rated voltage in volts of the winding under test**

- The ANSI C.57.94 guide recommends the following values when the manufacturer's recommendations are unknown:

Winding kV Class	Insulation Resistance (MΩ)
1.2	600
2.5	1000
5.0	1500
8.7	2000
15.0	3000

Caution: If you have any questions or think that water has entered the transformer, contact MAGNETRON S.A.S.

12.2.4 Noise level measurement (sound pressure level)

Historically, the sound generated by the magnetic field inducing longitudinal vibrations in the core sheets has been dominant. The amplitude of these vibrations depends on the flux density in the laminations and on the magnetic properties of the core steel and is therefore independent of the load current.

The standards limit the level of noise produced by transformers, as manufacturers, some practices can be contemplated from the design to reduce it:

- Reduce the amount of flow magnetic.
- Supply a system of anti vibration support.
- Improve the fits of metal parts, etc.

To carry out the test, the following must be considered:

➢ **Environmental conditions**

- Reflective objects should be kept away from the transformer under test.

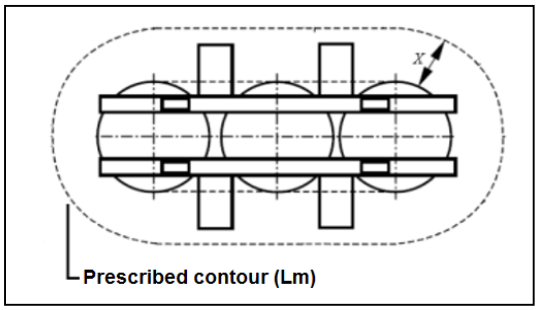
- The transformer must be located so that there are no acoustic reflection surfaces (walls or objects) less than 3 m away from the prescribed contour, with the exception of the floor or supporting surfaces.

➢ **Prescribed contour**

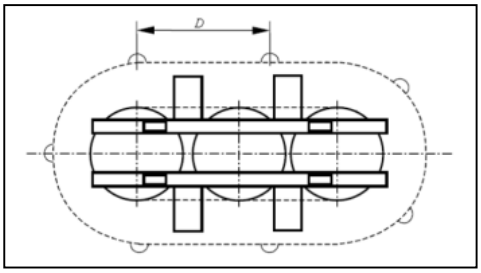
- Determine the distance (x) of the measurements, in dry-type transformers, for safety reasons, a minimum of 1 m is recommended.

- Determine the height of the transformer at which the measurements must be made.

  Note: At half the height if it measures ≤ 2.5m.



If it measures more than 2.5m, two contours are used to make the measurements, one at 1/3 and the other at 2/3 of the height.



- Determine the number of measurements to be made, based on the prescribed contour, the distances must be equal and not greater than 1m (D).

  Note: Once the measurement points have been defined, they must be marked on the floor to guarantee that the measurements are made in the same place.

➢ **Microphone position**

- The microphone of the measurement equipment must be positioned on the prescribed contour(s), moving around the

transformer at a constant speed.

- It is recommended to start the measurements from the front of the transformer (BT) and continue in a clockwise direction.

Note: The measuring equipment must be calibrated before and after each measurement.

➢ **Measurements to be made**

- Measurement of the initial background noise, with the transformer de-energized.
- Combined noise measurement, background noise plus energized transformer.
- Measurement of the final background noise, with the transformer de-energized.

➢ **Analysis of the results**

- The area of the measurement surface must be calculated.
- Calculate the environmental correction coefficient.
- Calculate the average sound pressure level.
- The average sound pressure level must be corrected
- Finally, the sound power level must be calculated.

➢ **Criteria for acceptance and rejection**

- Evaluate the validity of the measuring equipment.
- Assess the validity of the test site.
- Assess the validity of the measurement.

Caution: This test must be carried out by qualified personnel, for more information, contact MAGNETRON S.A.S.

12.2.5 Device testsof controlor protection

All the alarm and trip signals of the transformer protection devices must be tested for their proper operation.

13. Installation and commissioning

Caution: For Colombia, the installation of the transformer must be done according to the requirements of the technical standards NTC-2050, NTC-3582 and the technical regulation of electrical installations (RETIE).

For other countries, the rules or laws that apply to them must be followed.

The installation of the transformer is not the responsibility of MAGNETRON S.A.S. (unless otherwise specified in the contract), however, as an interested party that the product fulfills its function in the best conditions, the following instructions must be followed:

13.1 Mounting

The installation of the transformer must be carried out in an easily accessible place, where assembly and removal by crane or forklift is guaranteed, with the capacity to lift and transport the transformer.

The transformer must be installed in a place with a sufficient area that allows easy access to carry out inspection, cleaning, maintenance, etc.

The transformer must be installed in a vertical position.

The transformer must be well secured to the installation base.

If the installation of the transformer is done in closed places (interiors), good ventilation must be guaranteed to avoid abnormal heating.

When the transformer is installed in cubicles, make sure to comply with the minimum distances required for ventilation.

Capacity	Dimensions (mm)		
kVA	A	B	C
30	1600	1200	1900
45	1600	1200	1900
75	1600	1200	1900
112,5	1700	1300	1900
150	1700	1300	1900
225	1800	1300	2000
300	1800	1500	2000
400	1900	1500	2000
500	1900	1500	2200
630	2000	1500	2300
750	2000	1500	2300
800	2200	1500	2300
1000	2200	1600	2300

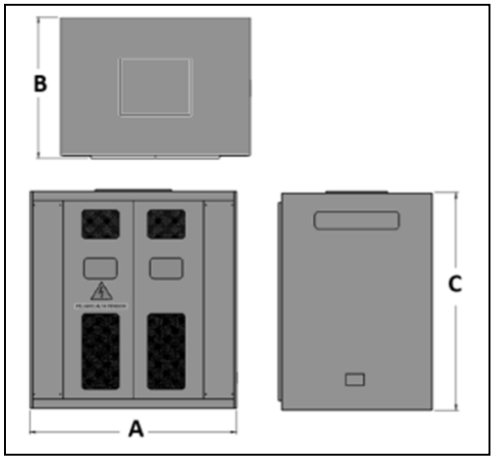


Figure 52: Minimum distances required for ventilation

Also, the minimum distances between any energized part of the transformer and the cell walls must be guaranteed.

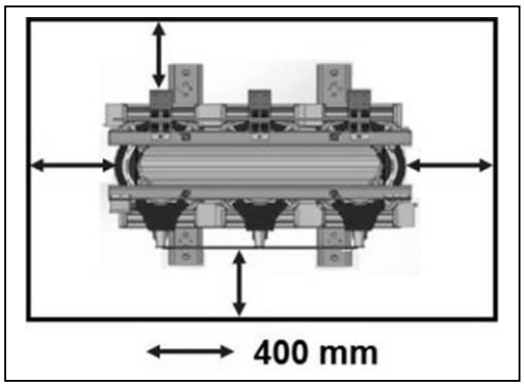


Figure 53: Minimum distances to the cell

13.1.1 General cell requirements

- It must rest on a support at angles that allows the entry of ventilation from below, with a lattice or mesh, that allows air to pass through and prevents the entry of animals or foreign bodies and only with the necessary space for the entry and exit of the conductors.

- It must be bolted to the ground and with means to dampen vibrations and noise.

- The side covers, the back and the front, will have the necessary lattice or mesh dimensions for adequate ventilation.

- In some cases, the cells may have domes for the hot air to escape or their own forced ventilation system may be installed.

- The cell will have enough space in such a way that:

  - Allow to house the transformer.
  - Have adequate ventilation.
  - Guarantee electrical distances to energized parts.
  - Guarantee the radius of curvature of conductors.

- Provide openings with a grill at ground level for the inlet of fresh air and openings at the top, on the opposite side of the transformer, for the outlet of hot air.

13.2 Grounding system

- The low voltage neutral point, the SPDs and the transformer must be solidly grounded.

  Note: Cabinets and control and protection accessories that require it must also be grounded.

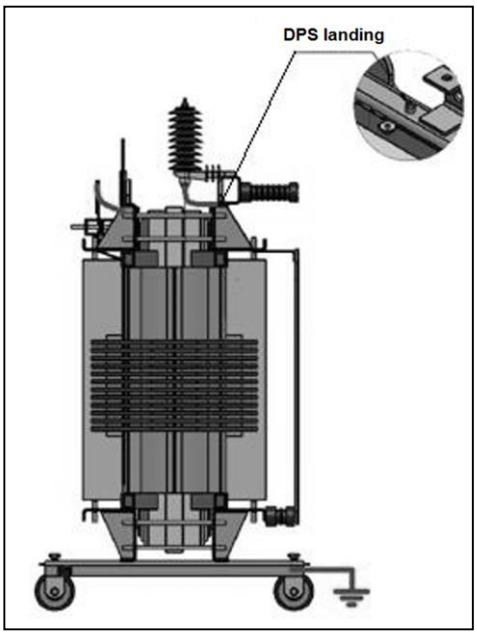


Figure 54: Grounding parts of the transformer

- The objectives of a grounding system are:
  - Guarantee the safety of living beings.
  - Protection of facilities.
  - Electromagnetic compatibility.
  - Allow protection teams to quickly clear faults.
  - Serve as a common reference to the electrical system.
- Grounding system resistance reference values.

Application	Maximum values of grounding resistance (Ω)
Structures and metallic turrets of lines or networks with guard cable	20
High and extra high voltage substations	1
medium voltage substations	10
lightning protection	10
Low voltage connection neutral point	25
Networks for electronic or sensitive equipment	10

13.3 Connection sequence

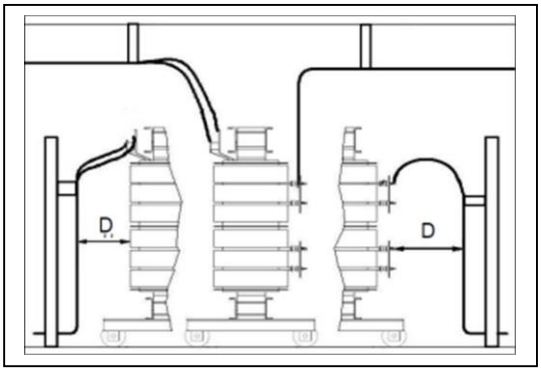
- Make all connections to the grounding system.
- Make the BT connections.
- Make the MV connections.

IMPORTANT

Wired or barrier connections must:

- Be fixed to a solid structure to avoid mechanical stress on the transformer connections.

- In accordance with the distances recommended by IEC 60076-3.



kV	D (mm)
≤ 1,1	≥ 0
≤ 3,6	≥ 60
≤ 7,2	≥ 90
≤ 12	≥ 120
≤ 17,5	≥ 160
≤ 24	≥ 220

Figure 55: Minimum distances LINE-EARTH or PHASE-PHASE

Caution: The connections cannot be stressed. The medium voltage ones must have a shape and mechanical rigidity that does not allow them to move with the wind or vibrations, in such a way that they come into contact with parts that should not be energized or approaches that produce electric arcs.

13.4 Commissioning

Caution: To energize the product, it must be guaranteed that the reviews and tests listed in number 12 of this manual gave compliant results; otherwise, the energization cannot be carried out and you must contact MAGNETRON S.A.S. personnel to receive instructions.

Also, remember to use the appropriate tools and protections, such as: Pole, dielectric gloves, rubber boots, etc.

- Check that all connections are tight, secure and tight.
- The transformer and the place of installation must be clean and free of obstacles.
- The load must be disconnected
- Energize the transformer in no-load, keep it like this for about four (4) hours minimum.
- Make sure that the transformer does not produce abnormal noises (humming, crackling, flickering, etc.).
- Check the output voltage and check that it is balanced and within the required.
- Gradually install the load and keep checking the output voltage.

- Once all the load is installed, check the operation of the transformer for several hours.
- Keep a written record of the final installation conditions.
- Clean and order the work area.

14. Transformers with two or more months in storage

If the transformer has been stored for a period equal to or greater than two months, without being energized or since its last energization, the following procedure must be followed:

- Carry out the checks and tests described in this manual, from numeral 12.1 to numeral 12.2.3.
- If and only if the results are satisfactory, proceed as follows:
  - ✓ Energize the transformer without load, for a minimum of 4 hours.
  - ✓ Once the minimum energizing time without load has expired, gradually connect the load, according to the following table:

Connection of the load once the energization time has elapsed (Hours)	% Burden
3	25
6	50
9	75
12	100

- Once all the load is installed, periodically check the operation of the transformer.
- Keep a written record of the final installation conditions.
- Clean and order the work area.

If during the execution of the tests described in this guide, from numeral 12.1 to numeral 12.2.3, you encounter any inconvenience, take into account the recommendations in the table:

Note: If the inconvenience persist, do not intervene on the transformer and contact MAGNETRON S.A.S.

Inconvenience presented What to review?	Does not give transformation ratio	It does not give resistance of the windings in MV	Very low insulation resistance	short in insulation resistance
Check condition of measuring equipment and cables	X	X		
Check correct interlocking and adjustment of the switch	X	X		
Check connection of the TTR to the transformer, according to the connection group,	X			
Check measuring equipment, that it is in the correct range		X		
Cleaning of MV and BT terminals			X	
Test temperature			X	
Correction results by temperature			X	
Check that the neutral point is disconnected from earth				X
If it has an electrostatic screen, it must not be grounded.				X

15. Maintenance

Caution: If it is not carried out and evidence of the execution of preventive maintenance, it will cause the loss of the guarantee.

Caution: During the warranty period, report all failures or eventualities to MAGNETRON S.A.S. for no reason does the transformer intervene.

To intervene on the transformer, disconnect the MV and LV voltage sources in order to put it out of service.

Disconnect the MV terminals, short them and connect them to the grounding system.

Disconnect the LV terminals, short them and connect them to the grounding system.

Delimit and mark the work area.

The owner of the transformer is responsible for inspecting, maintaining and keeping it in good condition.

The transformer is an electrical machine designed and manufactured to function 20 years or more under normal conditions of environment and use.

Dry transformers do not require maintenance, in any case, it is good practice to carry out periodic inspections, especially if the machine is exposed to particular environmental conditions.

15.1 Preventive Maintenance

The permanent inspection will contribute to the safe and reliable operation of the transformer.

Once a year the transformer must be inspected, verifying the following:

- External inspection
- General inspection
- Routine electrical tests
- Tests to protection devices

15.1.1 External inspection

Review and record the external conditions of the transformer.

The inspection must include the following points:

- Condition and cleanliness of the transformer.
- State and cleanliness of the insulators or busbars of MV and LV.
- Condition and cleanliness of the lightning rods (DPS).
- Conditions of the grounding system.
- Verification of electrical connections.
- Verification of tap changer operation.
- State of the paint, verifying possible oxidation points.
- Internal inspection of the control board (if equipped).

- Status of control or protection accessories (if any).
- Conditions of the installation site.

Eventualities that may arise must be corrected.

15.1.2 General inspection

The inspection includes verification of the temperature of the windings, adequate ventilation and compliance with the minimum required distances.

It is important to record the measurements, they serve as a reference for future inspections and help identify potential failures or abnormalities.

15.1.3 Routine electrical tests

Electrical tests must be performed with the transformer de-energized.

The tests to be carried out are:

- Transformation relation,
- Winding resistance,
- Insulation resistance.

15.1.4 Tests to control or protection devices

It is recommended to review the proper functioning of these devices every year.

15.2 Corrective maintenance

- During the warranty period, report all failures or eventualities to MAGNETRON S.A.S. for no reason does the transformer intervene.

- For interventions outside the warranty period, contact MAGNETRON S.A.S. or use a specialized transformer workshop.

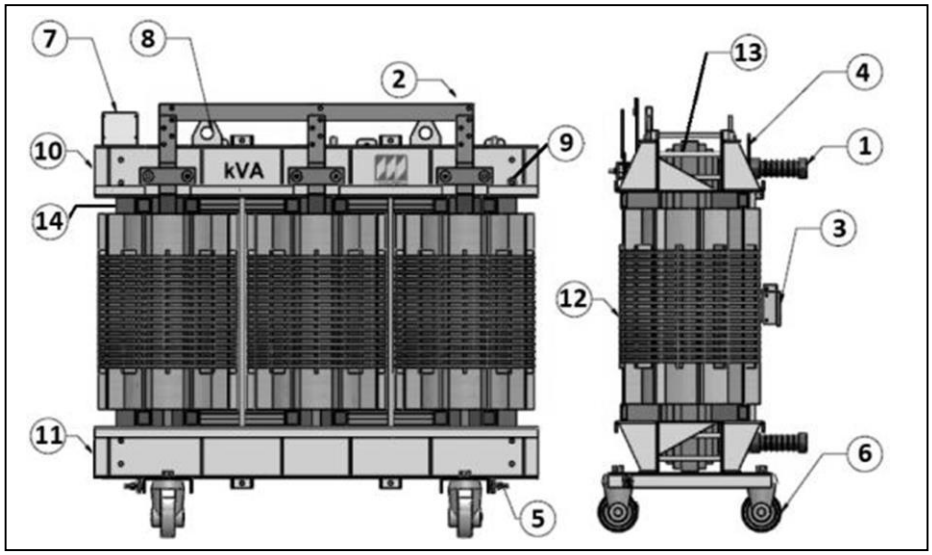


Figure 56: Class H dry transformer parts

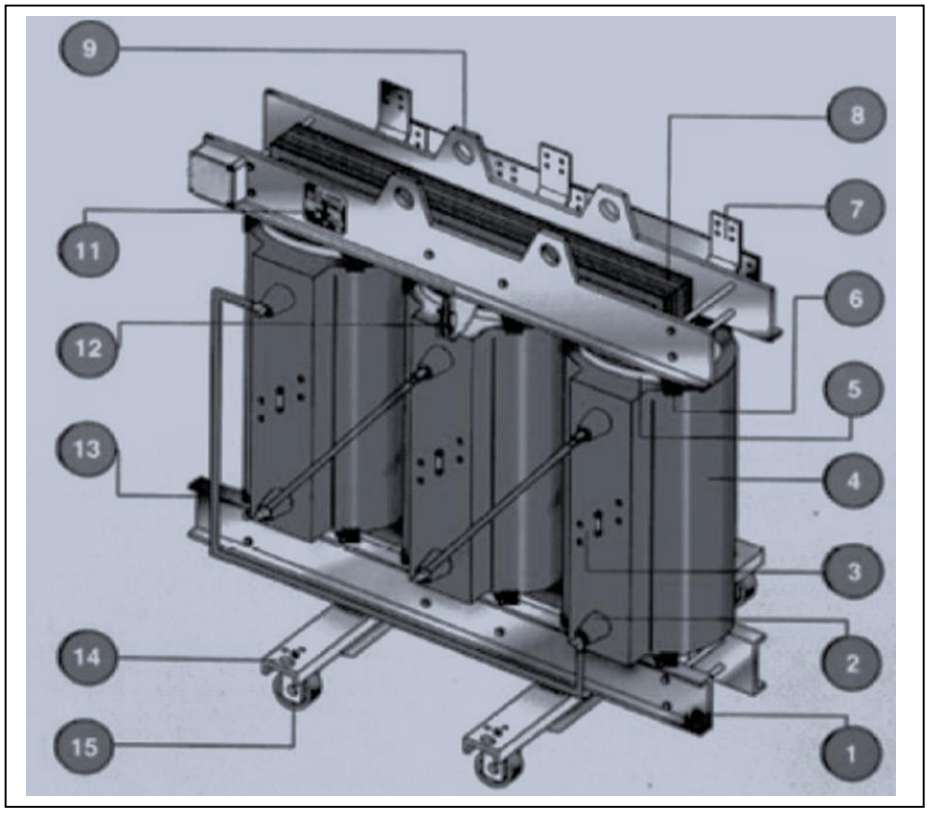


Figure 57: Class F dry transformer parts

Item	Description class H dry accessories
1	MV insulators
2	LV terminals or busbar
3	Branch switch
4	DPS Supports
5	Transformative landing
6	Caster wheels
7	Rating plate
8	Ears to lift or hoist
9	Pn Landing
10	Top flange
11	Bottom flange
12	Windings
13	Core
14	Lockdowns

Item	Description dry class F accessories
1	Transformative landing
2	MV insulators
3	Branch switch
4	MV winding
5	LV winding
6	Lockdowns
7	BT busbarage
8	Core
9	Ears to lift or hoist
11	Rating plate
12	Temperature thermoprobe
13	Flange
14	Transfer ring
15	Caster wheels

16. Repair

- The owner of the transformer is responsible for inspecting, maintaining and keeping it in good condition.

- During the warranty period, report all failures or eventualities to MAGNETRON S.A.S. for no reason does the transformer intervene.

- All repairs under warranty must be done by MAGNETRON S.A.S. or an authorized service workshop.

- For repairs outside the warranty period, contact MAGNETRON S.A.S. or use a specialized transformer workshop

17. Problems and possible solutions

Remember to fully comply with the revision and testing numerals before installation and installation (numerals 12 and 13).

The adjustments of the accessories must be made with a torque wrench and applying the recommended torque in numeral 17 "Adjustment torque".

Accessory adjustments are made only externally, for internal adjustments, contact MAGNETRON S.A.S. or an authorized workshop.

Inconvenience presented **What to review?**	expels the canuelas	Blow the fuses	Voltage difference between LV phases	It does not give voltage output in BT
Connection of the transformer to the MV line	X			X
Lightning rod state	X			
Lightning rod characteristics	X			
Energize no load	X	X		
Check condition of fuses		X		
Check that the fuses are correct (amperage)		X		
Correct landing of the transformer (tank)		X	X	
Correct landing of the Pn			X	
Check wiring connection settings			X	X
Clean and monitor if persists				
Check tightening torque (externally)				
Check input voltage				X
Check input voltage		X		
Correct anchoring of the commutator				X
Test the transformer	X			X

Inconvenience presented What to review?	Does not give transformation ratio	It does not give resistance of the windings in MV	Very low insulation resistance	short in insulation resistance	Vibrations or noise
Check condition of measuring equipment and cables	X	X			
Check correct interlocking and adjustment of the switch	X	X			
Check connection of the TTR to the transformer, according to the connection group,	X				
Check measuring equipment, that it is in the correct range		X			
Cleaning of MV and BT terminals			X		
Test temperature			X		
Correction results by temperature			X		
Check that the neutral point is disconnected from earth				X	
If it has an electrostatic screen, it must not be grounded.				X	
Input voltage					X
Core and Flange Fittings					X
Ground Transformer Attachment					X
Minimum distances to reflective objects					X
Connections, which are not rigid, especially those of BT					X

Symptoms	Causes	Checks and Actions
Overtemperatures in the windings	Continuous overloads, incorrect external connections, lack of ventilation, high ambient temperature, damaged or misdirected fans, high harmonic content.	Nominal characteristics Ventilation Connections
Reduced voltage	Loss of connection to the primary.	Connections
Excessive secondary voltage	High supply voltage; incorrect primary connection.	Nominal characteristics
Unbalanced secondary voltages	Overload, connections in different dams per coil.	Nominal characteristics
Insulation breakdown	Continuous overloads, dirt on the coils, mechanical damage due to displacement, line voltage impulses.	Nominal characteristics Cleaning Displacement Surges
Opening of fuses or switches	Fuses or switches with non-delayed opening, short circuits, overloads.	Nominal characteristics Protection devices
Cable overheating	Connections not fixed correctly, incorrect section of the cables.	Connections Ventilation

Magnetic core		
Vibrations and noise	Low frequency and/or high voltage supply, loose fixings due to transport or movement, incorrect connections in the dams, installation on suspended floors or near walls, rigid conductors.	Nominal characteristics Mechanical connections
Overheating	High input voltage, inadequate load, harmonics, core dirt.	Nominal characteristics Maintenance
High current in no-load	Low frequency, high input voltage	Nominal characteristics
Dielectric materials		
Smoke	Excess varnish can overheat the first time the transformer is energized and cause smoke. This is not a problem but if the smoke remains it could have burned the insulation.	N/A
Burnt insulation	Line voltage impulses, excessive dirt and dust on the coils.	Surges Maintenance
Overheating	Closure of channels or inadequate ventilation.	Ventilation

18. Tightening torques

Caution: The torques correspond to the hardware described in each accessory. It is recommended to consult MAGNETRON S.A.S. each time an adjustment is required.

Not all the accessories that are part of the transformers are listed.

The different adjustments that are made in the external accessories of the transformer are made following the recommendations of the suppliers in terms of adjustment torques. The most relevant are listed below:

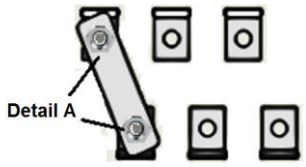
18.1 Screws in general

Torque (lbf * ft)						
Iron				Stainless steel		
Diámetro	Grado 2	Grado 5	Grado 8	Diámetro	A304	A316
1/4	5,5	8	12	1/4	6	7
5/16	11	17	25	5/16	11	12
3/8	20	31	44	3/8	20	21
7/16	32	49	70	7/16	31	33
1/2	49	75	107	1/2	43	45
9/16	70	109	154	9/16	56	59
5/8	97	150	212	5/8	92	96
3/4	173	266	376	3/4	127	131
7/8	166	429	606	7/8	194	202
1	250	644	909	1	286	299
1-1/8	354	794	1287	1-1/8	413	432
1-1/4	500	1120	1875	1-1/4	523	546
1-3/8	655	1469	2382	1-1/2	888	930
1-1/2	870	1950	3161			

Torque (lbf * ft)				
Brass / Bronze			Aluminum	
Diámetro	Latón	Bronce	Diámetro	2024 -T4
1/4	5	6	1/4	4
5/16	9	10	5/16	7
3/8	16	18	3/8	12
7/16	26	29	7/16	19
1/2	35	40	1/2	26
9/16	47	53	9/16	34
5/8	76	86	5/8	60
3/4	104	118	3/4	82
7/8	159	178	7/8	124
1	235	265	1	184
1-1/8	337	383	1-1/8	265
1-1/4	428	485	1-1/4	336
1-1/2	727	822	1-1/2	570

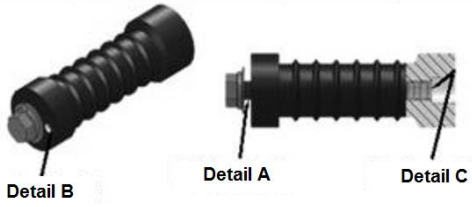
18.2 Branch switch

Detail	Description	Torque (lb-ft)	
		Stainless	Bronze
A	Adjustment screw 3/8"	20	18



18.3 Epoxy resin insulator

Detail	Description	Torque (lb-ft)	
		Stainless	Bronze
A	Adjustment screw 3/8"	20	18
B	Adjustment screw 1/4"	6	6
C	Adjustment screw 5/8"	92	86



19. Environment

MAGNETRON S.A.S. is a company committed to the environment, for this reason, our transformers meet all the requirements related to the subject.

MAGNETRON S.A.S. has identified potential risks that may cause harmful environmental effects on the environment.

In addition, MAGNETRON S.A.S. provides its clients with a series of environmental advice, in order to prevent and minimize contamination throughout the life cycle of the transformer.

The environmental councils are consigned in the environmental management plan, made up of 5 environmental management programs.

If you want to know more about environmental programs, contact MAGNETRON S.A.S.

The final receiver of the transformer must comply with current legislation and that applies to it.

When the transformer has completed its useful life, the following measures can be taken:

- LV busbar and winding conductors can be recovered and sold for scrap or recycled (copper or aluminium).
- In the encapsulated ones, the resin is managed as inert urban waste.
- The metallic parts can also be recycled or sold as scrap (flanges, core, wheels, screws, etc.).

This type of transformer does not generate waste in its normal operation.

The packaging (base and crate) with which the transformer is supplied are made of wood and can be reused or recycled depending on their condition.

Caution: The dry type transformer is self-extinguishing and burns with difficulty, however, if fire occurs, do not use water to fight it, use carbon dioxide, foam or dry powder.

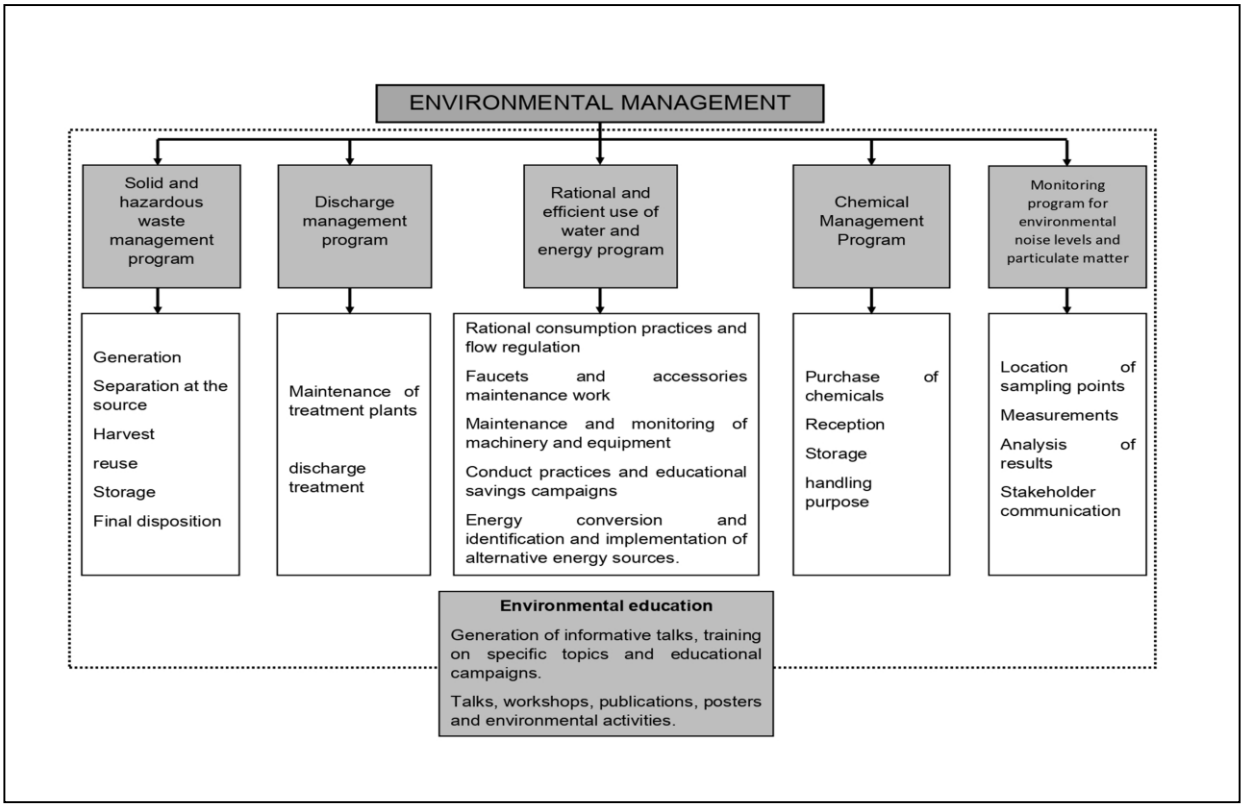


Figure 58: MAGNETRON S.A.S. Environmental Management Plan

20. Warranty Terms and Conditions

Refer to the guarantee certificate that is delivered with each product; behind it, there are the instructions that must be followed to make the guarantee effective and the conditions that invalidate it.

21. Contact Us

For more information or to provide technical support, contact us through the following means:

	servicioexterno.magnetron.com.co
	customerservice.magnetron.com.co
	(57) 3187117456 (57) 3157100 extension 101