Installation, Operation, and Maintenance Manual
Air Core Reactors

Issuer Reviser Approver

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CONTENTS

1 INTRODUCTION

This manual must be carefully consulted before opening the equipment packaging.

It contains essential information, including safety guidelines for handling, as well as instructions for installation and maintenance.

The supplied equipment has been manufactured in accordance with the contractual specifications, general guidelines, and applicable technical standards.

1.1 OBJECTIVES

This document aims to present information regarding the Installation, Operation and Maintenance of Air Core Reactors manufactured by GE Vernova, Itajubá, Brazil (AIB).

1.2 REFERENCES

[1] **ABNT NBR 5356-6:** Reatores para sistemas de potência;
[2] **IEC 60076-6:** Power transformers. Part 6: Reactors;
[3] **ANSI IEEE Std C57.16:** Standard requirements, terminology, and test code for dry type air core series-connect reactors;
[4] **ANSI IEEE Std C57.21:** Standard requirements, terminology, and test code for shunt reactors rated over 500 kVar;
[5] **ANSI IEEE Std C57.32:** Standard requirements, terminology, and test procedure for neutral grounding devices.

THE REACTOR MUST BE CONSIDERED AS LIVE PARTS AFTER ENERGIZATION.

ALL PEOPLE INVOLVED IN TRANSPORT, INSTALLATION, OPERATION AND MAINTENANCE OF AIR CORE REACTORS SHOULD READ THIS INSTRUCTION MANUAL BEFORE HANDLING THE EQUIPMENT.

2 CONSTRUCTION DETAILS

2.1 TECHNOLOGY

This manual applies exclusively to air core reactors.

FED – Fiberglass Encapsulated Design

MCD – Multi-Wire Cable Design

FTC – Flat Transposed Cable

In these designs, the reactor winding is composed of several conductors (wires or cables) connected in parallel forming cylinders. Each conductor is isolated by helically wrapped insulating film, and conductors of the same cylinder are mechanically immobilized and encapsulated in epoxy impregnated fiberglass filaments. According to the reactor specifications, one or more cylinders are connected in parallel through their crossarms where the winding input and output terminals are placed. The cylinders are separated by fiberglass spacers forming cooling ducts.

OSD – Open Style Design

In the OSD design, the reactor winding consists of aluminum profiles of rectangular cross section. These profiles are sized to withstand the current ratings of each application, and they are evenly separated by high mechanical strength shims (spacers). The two aluminum crossarms are held together at the ends of the windings by insulated fiberglass reinforced rods. All materials used are compatible with the insulation class of the equipment.

2.2 COMPONENTS

Crossarms: they are made of flat aluminum bars, held together to an aluminum core.

Windings: formed by conductors helically mounted forming cylinders connected in parallel.

Terminals: equipment electrical terminals, usually a crossarm extension with hole pattern and orientation to meet the customer needs.

Spacers: made of fiberglass and resin profiles. Their purpose of the spacers is to create cooling ducts between the cylinders.

Crossarm ties: fiberglass ties impregnated with resin that impart mechanical stiffness mainly in case of asymmetric short circuits.

Cylinder bracing (vertical): fiberglass ties impregnated with resin that ensure fastening of the winding cylinders to the upper and lower crossarms.

Mounting pads: (aluminum or stainless steel) profiles welded or screwed to the reactor crossarm to provide mechanical fitting of the reactor to its base and between stacked reactors.

Item	Description
A	Crossarms / Terminals
B	Winding
C	Fiberglass winding coating
D	Conductor(s)
E	Crossarms / Terminals
F	Supporting insulator
G	Base pedestals
H	Fiberglass spacer
I	Fiberglass shim (spacer)

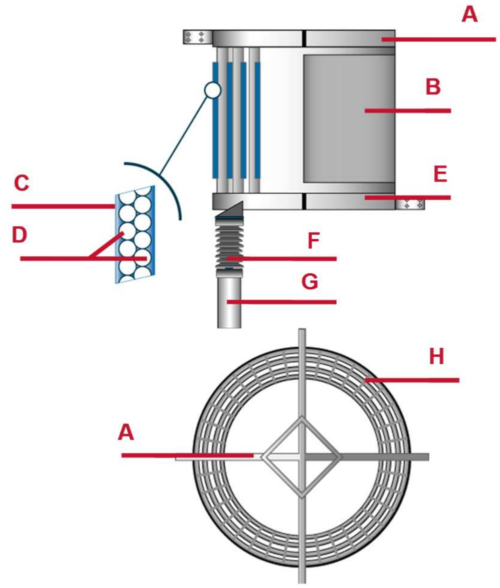


Figure 1 - FED Reactors

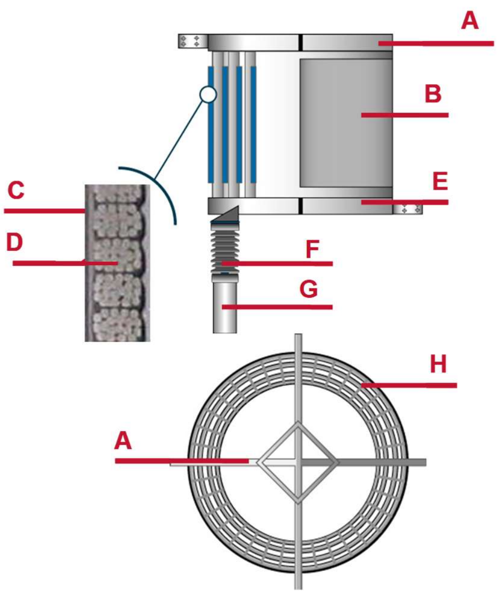


Figure 2 – MCD/FTC reactors

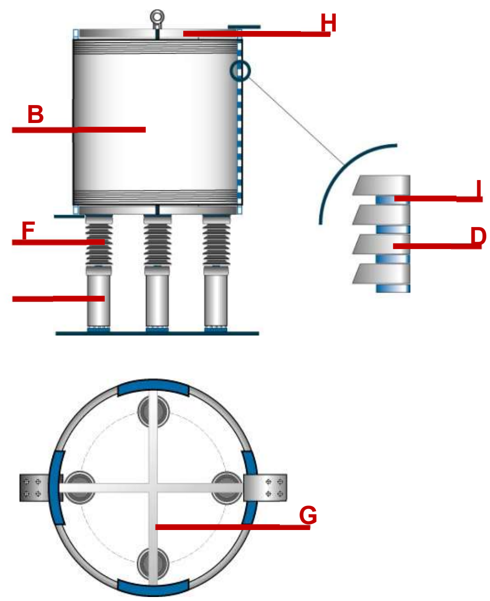


Figure 3 - OSD Reactors

Spacing pedestals: pedestals placed between the reactor base pads and insulators to keep clearance between the insulator cap and the reactor windings (reactors with high magnetic field levels) and/or for mechanical fitting of the equipment.

Base pedestals: pedestals placed below the insulators directly mounted on the equipment foundation.

3 TRANSPORT, RECEIVING, UNPACKING AND STORAGE

3.1 TRANSPORT

GE reactors are transported in packaging specifically designed for land, sea, or air transport, complying with major international regulations.

The entire journey - from dispatch at the factory to the storage location and subsequently to the installation site - must be carried out with the equipment still in its original packaging, using appropriate transport and lifting methods. Follow the instructions indicated on the packaging and instruction manuals.

During transport, it is essential that the units are properly positioned on the vehicles, in accordance with the recommended securing methods.

Speed limits indicated on the cargo labels and manuals must be strictly followed to ensure the integrity of the equipment.

Most reactors and accessories are packaged on pallets, allowing for handling by forklifts. Larger models, however, require the use of cranes for lifting, using the lifting points specified in the equipment's documentation and marked on the packaging.

Usually, each package contains only one single-phase unit, which may or may not include pedestals and insulators. Depending on size and weight, two or three units may be packed in the same package, either stacked or side by side.

Notes:

• In the event of accidents or damage to the reactor and/or packaging during transport, the procedures listed in the "Receiving" section must be fully followed.

• Stacking of boxes for transport or storage is not recommended unless previously authorized by GE.

3.2 RECEIVING

The receiving staff should inspect the reactors upon receiving according to the following procedures:

1. Check the condition of the packaging at the time of receipt, if possible, while still on the truck.
2. Verify the quantity and contents of the packages, comparing the received items — including equipment, materials, and accessories — with the supply documents (invoice, packing list, and/or purchase order), ensuring everything matches the specifications.
3. If any damage or defects are found in one or more packages, the following steps must be taken:

a. Inform the truck driver about the damages and ask if any incident occurred during transport.
b. Record on the Bill of Lading at least the following information: package number and/or equipment serial number, description of the damages found, and the driver's statement.
c. Take photos of all damages found, clearly identifying the package number(s) and/or serial number(s) of the reactor(s).

If the transport is the customer's responsibility:

- Contact the insurance company and follow their instructions.
- Report the incident to GE and wait for technical instructions on how to proceed with the damaged cargo. Only open the packages after GE's authorization.

If the transport is GE's responsibility:

- Notify GE immediately and keep the packages as received so they can be inspected and examined if necessary.
- Wait for technical instructions on how to proceed with the damaged cargo. Only open the packages after GE's authorization.

It is recommended to transport the equipment in their original packaging up to 2 months after receipt. Check that the packaging is in good condition before transport and handling.

3.3 UNPACKING

3.3.1 INSTRUCTIONS

Instructions according to manual MIRPC-002-A1.

3.3.2 UNPACKING INSPECTION

After unpacking, the reactor should be carefully inspected as follows:

1) Check if the package contents conform to the Invoice's description.

NOTE:

- **The customer should promptly notify GE if the received contents differ from the invoice description or if any components included in GE's supply are missing.**

2) Check all wire/cable terminations on the top and bottom crossarms for broken wires between the welded connection and the cylinder.

3) Check all fiberglass ties (between crossarms and vertical ties attached to the crossarms), if any.

4) Check the reactor painting/encapsulation surface (inner and outer) for damage.

5) Carefully inspect the area between the reactor cylinders to ensure there are no loose or lodged metal objects, such as screws, nuts, washers, or other elements that could compromise the integrity or operation of the equipment.

6) If any damage or defects are found:

   a) Take photos of all damages found, identifying the reactor by its serial number (nameplate);

   b) Notify GE immediately and await instructions on how to proceed with the damaged reactor.

> If there are safety devices for lifting (such as metal bars or steel rods between the lower and upper crossarms, for example), they should only be removed after the reactors have been installed in their final position.

3.4 STORAGE

Reactor storage must follow the guidelines below:

- **Indoor environment:**

Vertical packaging: Store in the original packaging, inspecting every 4 months. After 2 years, remove the plastic wrapping.

Horizontal packaging: Store in the original packaging for up to 2 months. After this period, remove from the packaging and position vertically with proper clearance from ground (Steel or wooden blocks must ensure a minimum clearance of 10 cm between the ground and the equipment)

- **Outdoor environment:**

Vertical packaging: For wooden packaging, store in the original packaging for up to 2 months; for metallic packaging, up to 8 months. After this period, remove the plastic wrapping and inspect the original packaging every 4 months. In case of deterioration, remove the packaging and place the equipment on suitable supports to keep them elevated and protected from direct contact with water, mud, or soil, inspecting every 4 months.

Horizontal packaging: Store in the original packaging for up to 2 months. After this period, remove from the packaging and position vertically on suitable supports to keep them elevated and protected from direct contact with water, mud, or soil, inspecting every 4 months.

- **General guidelines:**
  - Ensure that pallets or boxes with reactors are placed on suitable supports to keep them elevated and protected from direct contact with water, mud, or soil.
  - Never store the reactor with its mounting feet in direct contact with the ground. Steel or wooden blocks must ensure a minimum clearance of 10 cm between the ground and the equipment.
  - It is recommended to transport the equipment in the original packaging for up to 2 months after receipt. After this period, check the packaging condition before transport.
  - Stacking boxes for transport or storage is not recommended, except when authorized by GE.
  - Accessories (insulators, top hats, skirts, etc.) must be stored indoors, always in their original packaging.
  - For outdoor storage, in the event of snow accumulation or rain occurring at low temperatures, it is recommended to cover the package or reactor ducts to prevent ice formation between the cylinders of the equipment.

4 LIFTING PROCESS

Instructions according to manual MIRPC-002-A1.

5 ASSEMBLY

5.1 ASSEMBLY INSTRUCTIONS

Instructions according to manual MIRPC-002-A2.

5.1.1 Leveling the equipment

For equipment leveling, the reactor must be hoisted and positioned close to the support structure (insulators or pedestals), maintaining an approximate distance of 5 mm.

Figure 4: Clearance of 5 mm from the upper part of the supporting structure.

Check for any misalignment in the legs (i.e., clearance between the mounting pads and the supporting structure). Shims may be used to compensate for any gaps.

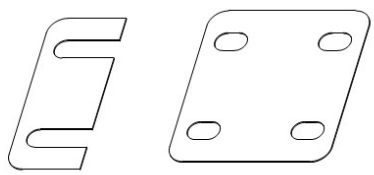


Figure 5: Compensation shims (supplied for large coils)

5.2 SCREW TIGHTENING TORQUE

The table below shows the recommended tightening torque for bolts in electrical connections and other connections.

Screw Metric	Screw UNC	Electrical Connection (Terminals)		Insulators and Pedestals		Other connections (*)	
		(daN.m)**	(lbf.ft)	(daN.m)**	(lbf.ft)	(daN.m)**	(lbf.ft)
M5 or M6	1/4”	-	-	-	-	1 – 1.5	7 – 11
M8	5/16”	-	-	-	-	1.5 – 2	11 – 15
M10	3/8”	3 – 4	22 – 30	-	-	2 – 3	15 – 20
M12	1/2"	4.5 – 5	30 – 40	4.5 – 5.5	30 – 40	3 – 4	20 – 30
M16	5/8”	7 – 8	50 – 60	12 – 14	80 – 100	-	-
M20	3/4”	10 – 12	73 – 88	16 – 18	118 – 132	-	-

Notes:

* Other connections: Fiberglass or plastic pieces, corona brackets, etc.

** 1 daN.m = 10 N.m ≈ 1 kgf.m

6 INSTALLATION ASPECTS

6.1 ELECTRICAL CONNECTIONS

The reactor's electrical connections must be made as specified below:

1) Using the appropriate connector, attach the input and output (cable, bar or tube) conductors to the reactor line terminals (usually a flat bar located on the equipment crossarms), applying the recommended tightening torque. We recommend the use of stainless steel bolts in both terminal and connector to avoid hot spots.
2) Typically, the reactor input/output terminals are interchangeable (except when defined in dimensional drawing). However, it is recommended that all reactors in the same system (project) be connected in the same way.
3) Check if the terminal material is compatible with the line conductor material to avoid aluminum galvanic corrosion (i.e., no contact between copper cables and the aluminum terminals).
4) Tinned copper plates or brass connectors may be used for establishing electrical contact with the reactor terminals, if necessary.
5) For mounting after long storage periods, the contact surfaces should be polished with a fine steel brush or sandpaper together with non-acid lubricating grease, which also helps to prevent aluminum corrosion. Corrosion may increase contact resistance and, consequently, causing overheating at contact points.

6.2 MAGNETIC CLEARANCES

The reactor magnetic field may cause induced currents in metallic parts located near the equipment (e.g. grounding system, foundation structures, metal lifting structures, metal fences, etc.). To prevent overheating due to current induction, the reactor assembly must meet the magnetic clearances recommended in the reactor drawing, except with prior approval by GE.

Particularly, two regions must be observed:

- Magnetic clearance **MC1** for the installation:
  - Within the MC1 region it is not recommended to install any metallic structure, even without forming closed loops, except for connection metallic parts (connectors, cables or tubes) and insulators.
  - Between the MC1 and MC2 region, the installation of small metallic parts or without forming closed loops is allowed.
  - "Small metallic parts": non-magnetic support structures (stainless steel or aluminum).
- Magnetic clearance **MC2** for the installation:
  - From the MC2 region onwards, the installation of large metallic parts is allowed, including the formation of closed loops.
  - "*Large metallic parts*": metallic fences, panels, auxiliary equipment (surge arresters, brakers, etc), steel columns and beams, steel plates oriented in horizontal position, concrete foundation with metallic rebars forming closed loops, ferromagnetic materials, steel structures.

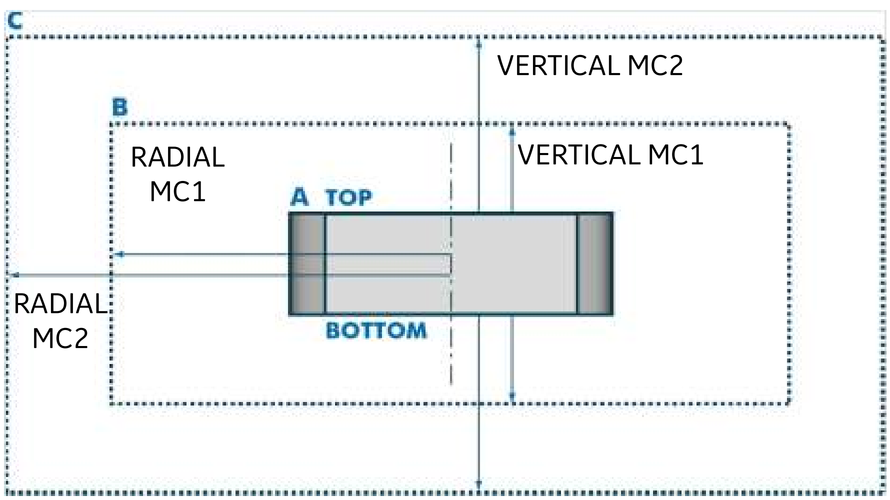
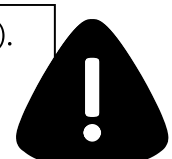


Figure 6: Magnetic distances MC1 and MC2.

- Keep metallic parts not forming closed loops outside zone B (MC1).
- Keep metallic parts forming closed loops outside zone C (MC2).
- The minimum magnetic clearances for reactor installation are recommended in the reactor dimensional drawings.



Note: References are IEEE Standard C57.16 Annex "E" and ICNIRP Guidelines – 2020.

If customer chooses to reinforce the foundation with non-metallic (e.g. fiberglass) rebars, as shown below and there are no metallic parts (grounding system or similar) near the reactor, it is possible to install it at a distance less than MC1 from its foundation. However, the minimum vertical electric clearance shall be followed according to the facility voltage level.

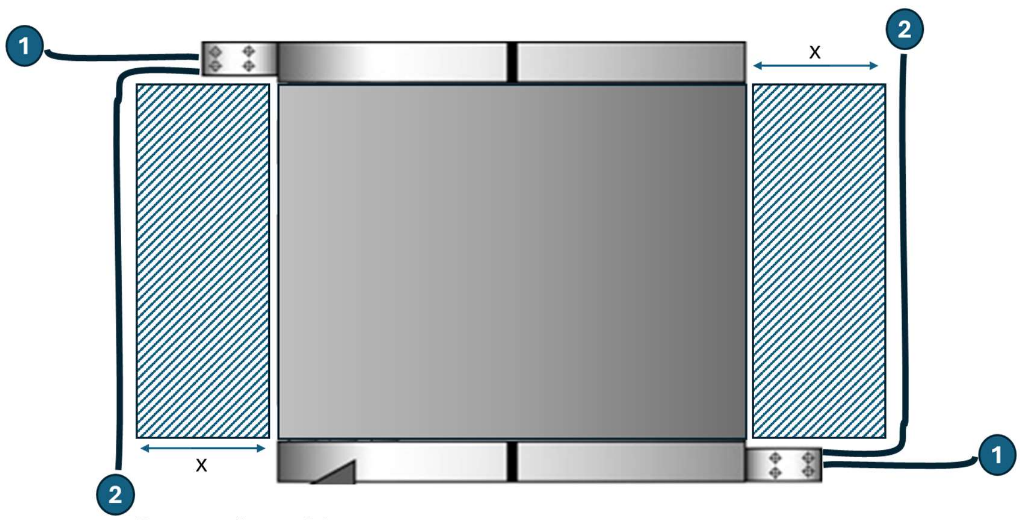
Figure 7: Foundation reinforcement using non-metallic (fiberglass) material.

If customer chooses to make the reinforcement using conventional steel rebars, it is possible that the reactor clearance is less than MC2 from its foundation. However, it is necessary to ensure at least the MC1 clearance, and non-formation of closed loops using small polymer ducts for insulation, as shown below.

Figure 8: Magnetic insulation for foundation rebars.

6.3 ELECTRICAL CLEARANCES

The arrangement of the connecting cables of the reactors shall comply with minimum clearance to prevent dielectric issues. The clearance to be ensured is based on the Basic Insulation Level of the equipment as shown below. Please contact GE in case of space constraints in the installation.



NBI kVp	X mm	X in
110	210	8
150	285	11
200	380	15
250	475	19
350	665	26
450	855	34
550	1045	41
650	1235	49
750	1425	56
900	1710	67
1050	2000	79
1175	2235	88
1300	2470	97
1425	2710	105
1550	2950	115
1800	3420	135

Connection cable arrangement:
Arrangement ❶ is the preferred and safest.
Arrangement ❷ requires a minimum electrical clearance “x” between the cable and the equipment surface.

Figure 9: Electrical clearances for connection of reactor cables

Examples of incorrect wiring and two correct wiring methods are presented below.

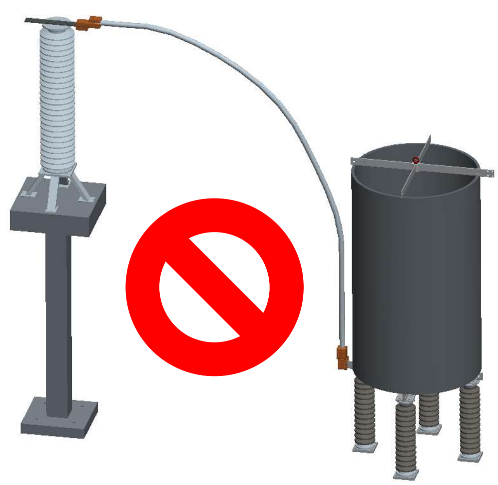


Figure 10: Example of incorrect wiring: Cable placed too close to the outer surface of the equipment.

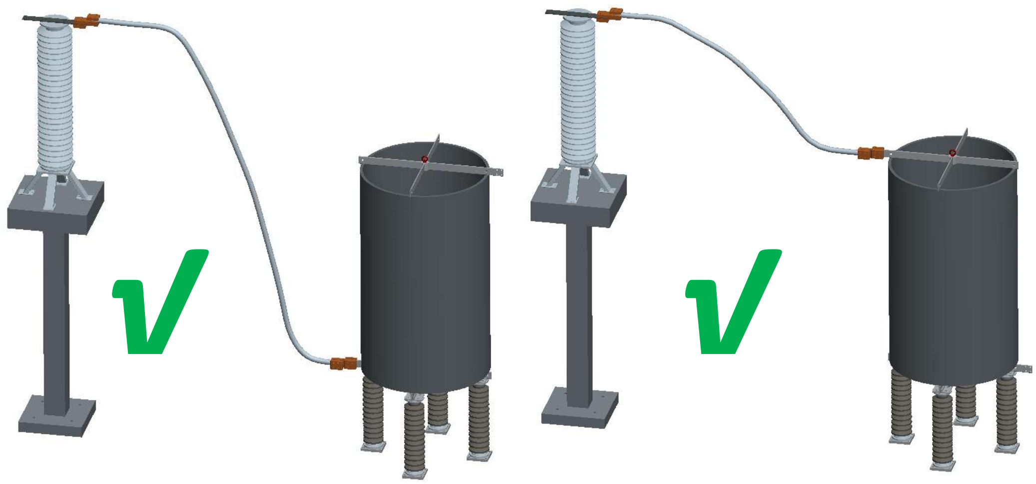


Figure 11: Example of correct wiring: Cable properly spaced from the equipment surface.

6.4 EARTHING OF PEDESTALS AND METALLIC STRUCTURES

The metallic parts of the support structures of the reactors, which are at null potential (floating), shall be earthed as follows:

1) Ground one of the pedestals by connecting it to the substation grounding system or through one or more copper rods if the grounding system is not accessible.
2) Connect the remaining pedestals to the grounded pedestal, leaving at least two pedestals disconnected from each other (to prevent a closed loop).
3) Alternatively, each pedestal can be individually grounded by connecting it to the substation grounding system or through one or more copper rods if the grounding system is not accessible.
4) Grounding connectors should be specified considering the materials of the pedestals and grounding conductors to prevent galvanic corrosion of aluminum in contact with copper..
5) GE may provide the appropriate grounding connectors upon request.

Notes:

- **The number of copper rods depends on the grounding system design of the installation site. The sizing and supply of the rods are not within the GE scope.**
- **For reactors provided with fiberglass structure (base fiberglass cylinder), only one foot must be earthed since all feet are connected to each other through the lower crossarm of the structure.**

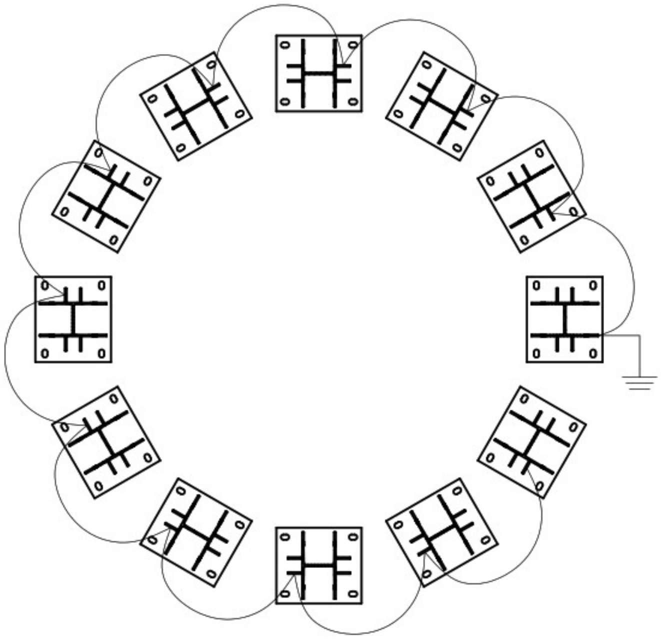


Figure 12: Earthing of base pedestals (Example with 12 points).

6.5 NOTES FOR CORONA RINGS (IF INCLUDED)

The corona rings must be mounted on insulating brackets**, with only one of the supports equipped with an aluminum contact to ensure that the ring is at the same potential as the crossarm.** It is essential **not to use more than one aluminum contact per ring**, as this may create a closed loop, leading to hot spots and potential damage.

For large reactors, the rings may be divided into sections. Each section must have only one aluminum contact to connect it to the crossarm potential. Again, multiple contacts per section must be avoided.

For special cases, a specific manual will be provided with detailed instructions for the proper installation of the corona rings.

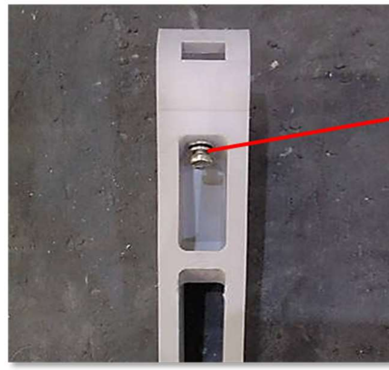
Attention: When installing the insulating brackets, observe the maximum torque of 2 daN·m (15 lbf·ft) on the bolts.

To inspect or remove the corona ring bracket:

1. Using a slot screwdriver, make slow and careful movements to remove the lock cap.
2. Remove the bolts, washers, and nuts. Retain all parts for reassembly after the inspection.
3. After the inspection, mount the corona ring onto the brackets with a gentle "click." Then, install the lock cap by inserting it into the inner side and making a circular motion from the inside outward. Use soft, slow movements. Once you hear a second "click," the ring is locked in place.
4. Tighten the bolts gently. A torque of approximately 2 daN·m (15 lbf·ft) should be sufficient.
5. Inspect the lock cap to verify that it was not damaged during the process.
6. After completing these steps, the corona ring inspection or assembly procedure is complete.
7. Please refer to the images on the following pages for better understanding.

For brackets with a contact plate:

1. Using a slot screwdriver, make slow and careful movements to remove the lock cap.
2. Remove the contact screw.
3. Remove the bolts, washers, and nuts, then remove the contact plate. Retain all parts for reassembly after the inspection.
4. Inspect the contact area to ensure it is unpainted and free of any debris that could prevent proper contact between the equipment's crossarm and the contact plate. If necessary, brush the area until bare aluminum is exposed. Clean this area thoroughly using a clean, dry cloth.
5. After cleaning and inspecting the crossarm contact area, reassemble the bracket, ensuring that the contact plate is in full contact with the freshly brushed aluminum surface.
6. Then, as shown in figure 17, ensure that the contact plate passes through the slot on the bracket, so that the ring will make proper contact with the plate during assembly.
7. Before mounting the corona ring to the brackets, loosen the contact screw until it no longer presses against the ring.
8. Mount the corona ring onto the brackets with a gentle "click." Then, install the lock cap by inserting it into the inner side and making a circular motion from the inside outward. Use soft, slow movements. Once you hear a second "click," the ring is locked in place.
9. Tighten the bolts gently. A torque of approximately 2 daN·m (15 lbf·ft) should be sufficient.
10. Tighten the contact screw just enough to press the ring and ensure consistent electrical contact.
11. Inspect the lock cap to verify that it was not damaged during the process.
12. After completing these steps, the corona ring inspection or assembly procedure is complete.
13. Please refer to the images on the following pages for better understanding.

	
Figure 13: Removing lock cap with a screwdriver.	Figure 14: Detail contact screw.

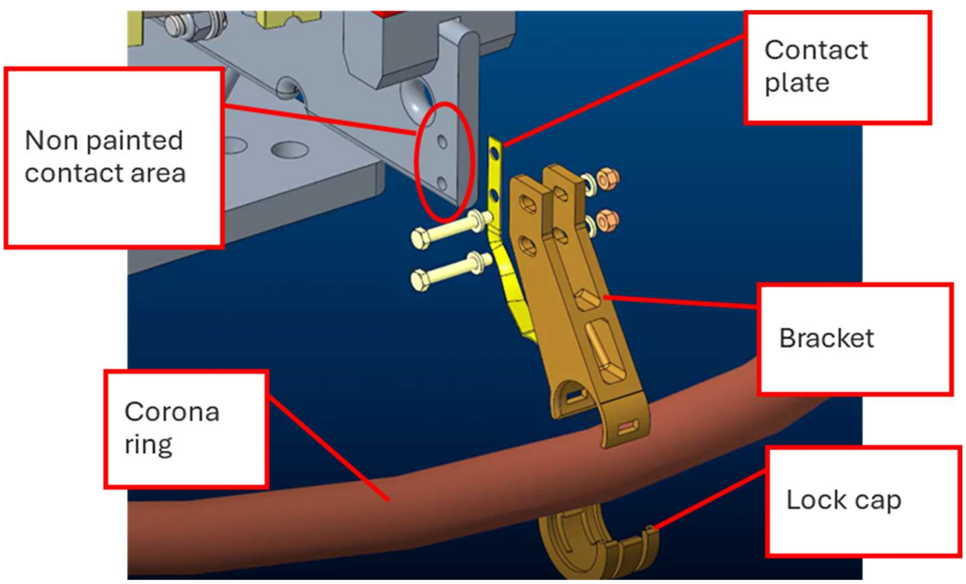


Figure 15: Removing or installing a bracket.

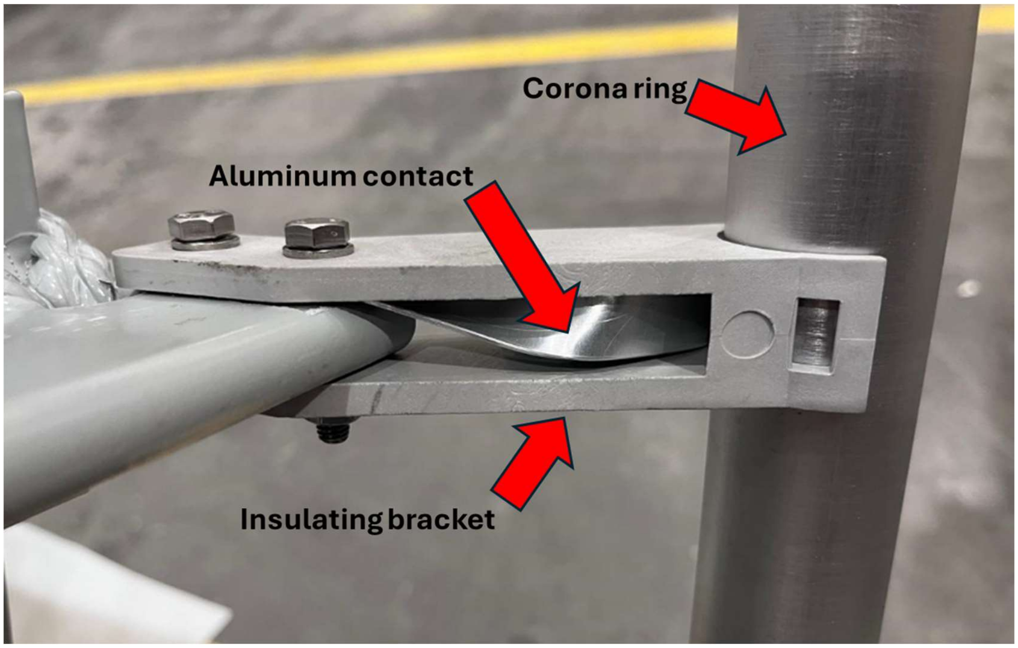


Figure 16: Contact point (Bracket with contact plate).

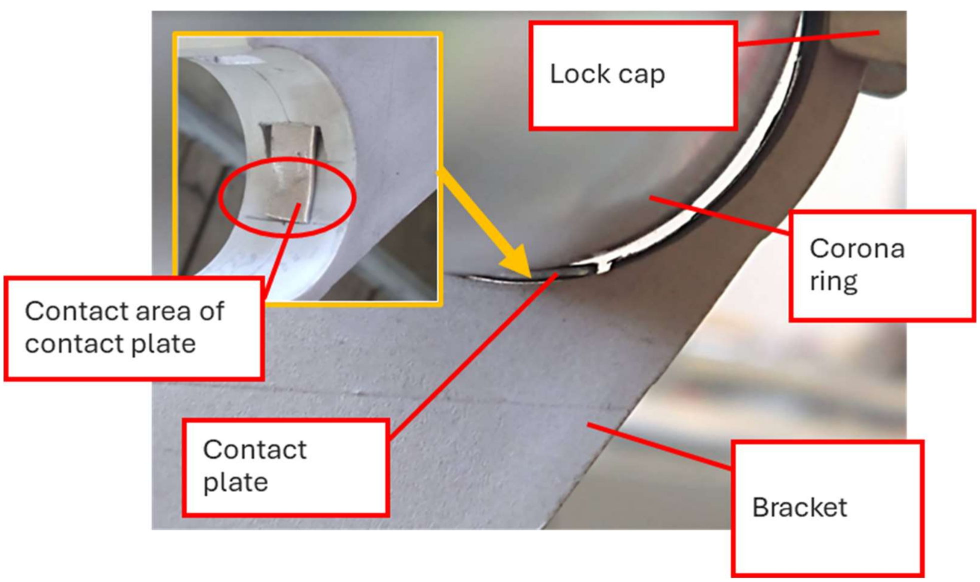


Figure 17: Contact details.

Figure 18: Lock cap detail.

7 COMMISSIONING

The commissioning team should check the following items before energizing the reactor:

1) Important details from the dimensional drawing: electrical and magnetic clearances, distance between reactors, and layout of components (insulators, pedestals, structures, etc.);
2) Torque of bolts for electrical connections (terminals and grounding points) according to the table in section 5.2;
3) Torque of bolts for components (insulators, structures, etc.) according to the table in section 5.2;
4) Verify that grounding and structural connections are made without forming closed loops (refer to sections 6.2 and 6.4);
5) Cooling ducts must be free of obstructions or debris. Carefully inspect the area between the reactor cylinders to ensure there are no loose or lodged metallic objects, such as bolts, nuts, washers, or other elements that could compromise the equipment's integrity or operation. For cleaning, use a **non-metallic** rod;
6) Check for any damage to the fiberglass ties of the reactor (between crossarms and between arms);
7) Check for any damage to the welded connections of the conductor wires to the reactor crossarm arms;
8) Check for any damage to the reactor's external surface and the overall condition of the paint. If necessary, perform paint touch-up according to the procedure indicated in this manual.

Notes:

- **Commissioning electrical tests: It is recommended measuring the DC resistance of the winding, inductance (impedance), and AC resistance. Test results can be compared with factory measurements provided in the routine test reports. Values may vary from those obtained under laboratory conditions.**
- **Attention: Insulation resistance tests (Megger) and dissipation factor (tan δ) measurements are not applicable for air-core reactors. The equipment may be damaged if subjected to these tests.**
- **Please use the commissioning form provided in Annex 1 of this document.**

8 MAINTENANCE

8.1 GENERAL INFORMATION AND MAINTENANCE PROGRAM

> Maintenance procedures recommended in this manual must be performed with the reactor de-energized and properly earthed by means of temporary earthing devices.
> If it is necessary to inspect the top part of the reactors, appropriate ladders or suitable lifting platforms must be used, in compliance with local occupational safety requirements.

Air-core reactors typically require minimal maintenance interventions.

The frequency of maintenance depends on storage conditions (prior to commissioning), installation conditions (outdoor or indoor use), and environmental factors (such as pollution, dust, etc.).

As a standard procedure, at least **one annual inspection** is recommended. However, depending on the combination of one or more of the conditions mentioned above, the interval may need to be reduced to **two inspections** per year (i.e., one every six months).

These inspections are particularly important after the reactor has been exposed to severe operational stresses (such as short-circuit currents or discharges) or to extreme environmental and weather events (such as tornadoes, earthquakes, among others).

Units installed in environments with high levels of pollution (e.g., coastal areas, near industrial sites, mining operations, or steel plants) should be assessed with a focus on identifying dark tracking marks and other signs of surface degradation. In such cases, it is recommended to **increase the inspection frequency** in order to monitor the progression of any detected deterioration. If such marks are found, please notify GE before re-energizing.

8.2 PREVENTIVE AND PREDICTIVE MAINTENANCE

8.2.1 PROCEDURES

The maintenance procedures are relatively simple and are described below:

1) Visual inspection of the reactor and its support structure:
    - Check if the cooling ducts are clear and free of foreign objects. If necessary, clean them using a **non-metallic** rod (e.g., fiberglass, wood or plastic);
    - Check the fiberglass ties of the reactor (between crossarms and between arms);
    - Check the welded connections of the conductors to the reactor crossarm arms;
    - Check the internal and external surfaces of the reactor for possible signs of paint deterioration;
    - Check the top and bottom of the winding for any abnormalities such as carbonization or arc marks (electrical surface discharges - *tracking*). If such marks are found, please notify GE before re-energizing;
    - Check whether the sealing materials around the cable and wire exits in the cylinders are intact, ensuring proper sealing
2) In polluted or aggressive environments with accumulation of dirt and contaminants, the reactors and insulators must be washed with water to clean the internal and external surfaces, the winding, and the support structures.
3) After washing, the reactors must be properly dried before re-energizing. The minimum drying time depends on the ambient temperature; typically, a 12-hour drying period is sufficient.
4) Check the electrical and mechanical connections of the reactor components and, if necessary, retighten the bolts (respecting the torque values recommended in this manual, section 5.2) of the following elements:
    - Line terminals;
    - Grounding terminals;
    - Insulators;
    - Pedestals and mounting pads.
5) If paint touch-ups are required, follow the procedures recommended in the “Painting” section of this manual.
6) If measuring equipment is available in the field, it is recommended to measure the DC resistance of the winding and compare it with the values obtained in the factory and/or during commissioning. Compare with the measurements taken at the factory (Acceptable variation: ±3% or ±2% for measurements taken in the field using the same equipment).

8.3 PAINTING

In case of repairing at site, it is essential that all paints used to finish the reactors are approved by GE.

Paints used for electrical equipment such as polyurethane or epoxy paints may be used.

In the case of repairing RTV silicone coat, use an insulating RTV coating suitable for electrical equipment.

As standard, the finish paint is a polyurethane paint base, high thickness, bicomponent.

At all stages of the painting process, the paint's technical data sheet must be reviewed to ensure compliance with the following manufacturer requirements:

1) Dry-to-handle time
2) Full curing time
3) Interval between coats
4) Pot life of the mixture
5) Application method: spray gun or brush
6) Mixing and thinning ratio

The durability of the PU paint or RTV coating is directly related to the environmental conditions at the installation site. Factors such as maximum and minimum temperatures, duration of exposure to peak operating temperature, UV intensity and exposure, extreme weather conditions, and the type and level of pollution play a key role.

8.3.1 PAINTING TOUCH UP

During paint inspections, assess for signs of degradation, such as significant discoloration, cracking, resin exposure to sunlight, and damage caused during handling or transportation. It is also essential to verify the integrity of the protective layer against environmental and chemical factors that may compromise the coating’s performance.

Based on the inspection results, touch-up or even complete repainting may be required, depending on the evaluation and discretion of the customer. In addition, it is important to document the conditions observed during the inspection and plan corrective or preventive actions to ensure equipment longevity and proper protection.

If paint touch-up is necessary, the following procedures must be followed:

1) Use masking tape to delimit the area of the reactor surface to be retouched;
2) Use fine sandpaper to remove the paint from the marked area;
3) Clean the area with solvent or alcohol;
4) Dry the area - do not apply paint to a wet surface;
5) Follow the paint manufacturer's technical data sheet for preparation;
6) Apply one coat of finishing paint, as specified by GE, using a brush or air spray gun;
7) If the equipment is outdoors, cover it with plastic to protect it from sunlight or rain for a minimum of 24 hours to ensure proper drying of the paint.
8) RTV silicone coat repair:
    a. To remove the RTV, use a plastic brush;
    b. Using a brush or paint roller, apply one coat of RTV coat, duly approved by GE.
    c. If the equipment is outdoors, cover it with plastic sheeting to protect it from sunlight or rain for a minimum of 72 hours to ensure proper drying of the coat.

Note:

- **The drying times mentioned above are based on an ambient temperature of 20°C and materials used by GE. For paints or RTV coats from other manufacturers, refer to the supplier's technical data sheet.**

8.3.2 REPAINTING

We recommend that a detailed inspection be carried out every 5 years and, if necessary, a partial or complete repainting of the equipment be performed.

This recommendation is not mandatory, but rather a preventive practice aimed at ensuring the optimal performance of the coating throughout its service life—especially in harsher environments with high UV exposure, contamination, pollution, salinity, or extreme temperatures.

The decision to repaint will be based on the condition of the coating observed during periodic inspections. If damage such as cracking, significant discoloration, or loss of thickness is identified, touch-up or full repainting may be considered to preserve the equipment's protection against environmental factors.

By adopting this practice, it is possible to maximize the longevity and performance of the coating, reducing the risk of premature degradation or failure.

9 REACTORS INSTALLED IN INDOOR AND/OR METALLIC CUBICLES

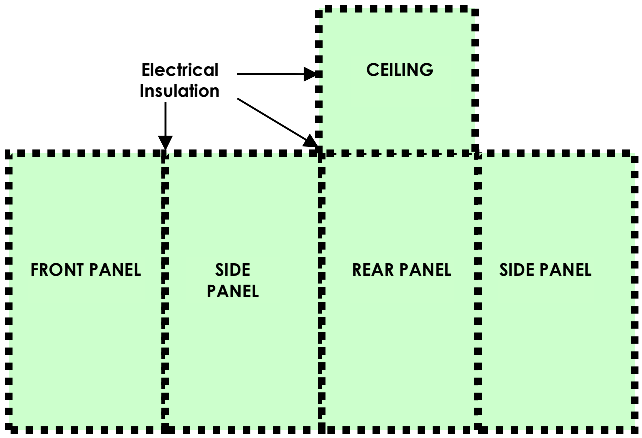


Figure 19: Magnetic insulation of metallic panels.

For reactors installed in indoor substations or metal cubicles, follow the procedures below:

1) Louvers (windows) for inlet air flow should be provided in the upper and lower thirds of the side and front panels of the cubicle.
2) The minimum internal dimensions of the cubicle should comply with the dimensions informed in the reactor dimensional drawings and/or specific technical documentation.
3) To prevent closed loops on the cubicle panels, it is recommended to insulate them electrically using, insulation material between the panels and insulating bushings on the assembly screws.

NOTE: The stated losses values of the reactor do not include additional induced losses in the cubicle.

10 ENVIRONMENTAL EFFECTS

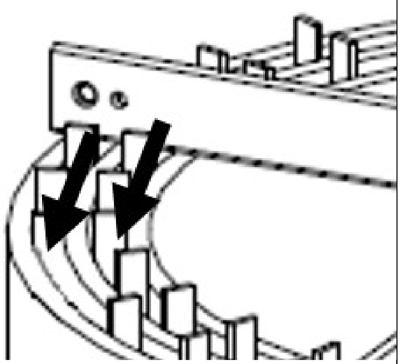
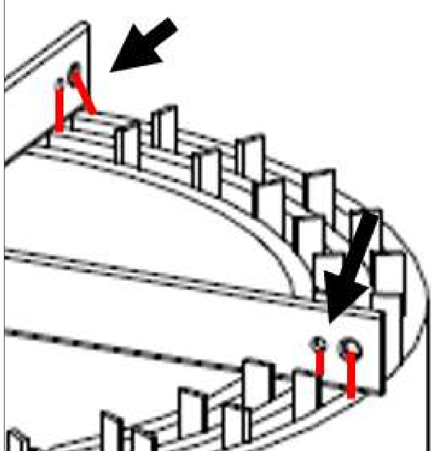
Reactors are built with materials considered environmentally friendly. For product disposal, follow the processing below to minimize environmental effects:

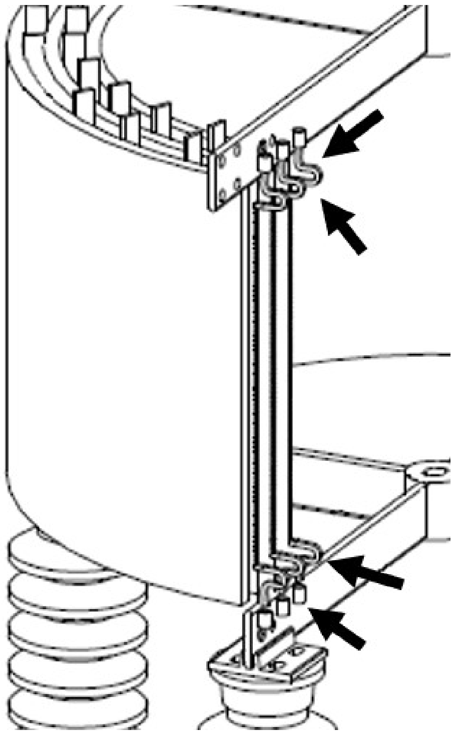
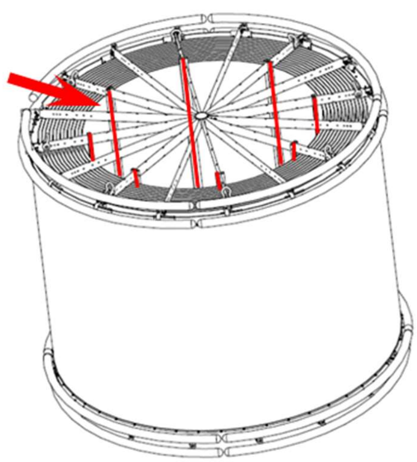
Item	Material	Destinação Recomendada
Crossarms	Aluminum or copper	Recycling
Winding encapsulation	Epoxy impregnated fiberglass	Co-processing, or licensed industrial landfill
Conductors	Aluminum or copper	Recycling
Insulators	Porcelain or polymer	Co-processing, or licensed industrial landfill
Pedestals	Aluminum, stainless steel or galvanized steel	Recycling
Spacers	Fiberglass and epoxy resin	Co-processing, or licensed industrial landfill

11 ANNEX 1 – COMMISSIONING FORM

The commissioning team should check the following items before energizing the reactor:

Equipment Serial Number		***Date***		
Operator				
Supervisor				
Inspector				
General Observations				
Items to check	***Reference document***	***Measured values / Observations***	***Operator checked***	***Supervisor checked***
Overal arrangement of components (insulators, pedestals, structures, etc.).	Dimensional Drawing.		☐	☐
Minimum distance between reactor centerlines.	Dimensional Drawing (De).		☐	☐
Tightening torque of electrical connection screws (terminals and earthing points).	Check the values in the table of section 5.2.		☐	☐
Tightening torque of mechanical connection screws (insulators, structures and accessories).	Check the values in the table of section 5.2.		☐	☐
Check earthing connections or structures to avoid forming loops.	Check sections 6.2 and 6.4, and dimensional drawing for clearances MC1 and MC2.		☐	☐

DC resistance measurement.	Please refer to the equipment's test report for comparison purposes. (Acceptable variation: ±3%).		☐	☐
Inductance (Impedance) measurement.	Please refer to the equipment's test report for comparison purposes. (Acceptable variation: ±2%)		☐	☐
AC resistance measurement.	Please refer to the equipment's test report for comparison purposes.		☐	☐
Attention!!! Tests of measurement of insulation resistance (Megger) and measurement of dissipation factor (tan δ) *<u>are NOT applicable</u>* for air core reactors. The equipment can be damaged upon these tests.				
Cooling ducts without obstructions or debris. For cleaning, use a **<u>non-metallic</u>** rod (wood, fiberglass or plastic).			☐	☐
No damages in the reactor fiberglass ties.			☐	☐

No damages in the connections (welding) of the wires/cables to the reactor crossarms.			☐	☐
After the lifting operation, check for the presence of steel bars inside the coil (between the top and bottom crossarms). Supplied for large coils. They must be removed before energization.			☐	☐

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