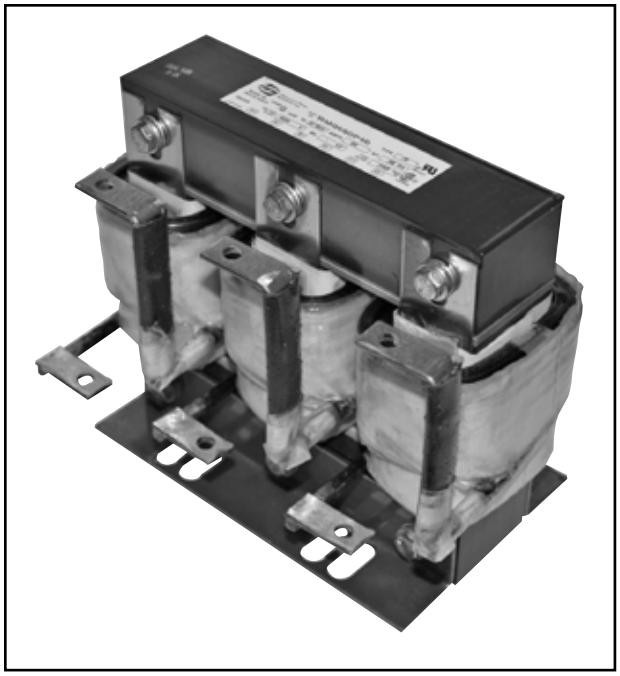
Hammond Power Solutions Inc.

INSTALLATION, OPERATION AND MAINTENANCE GUIDE

FOR DRY-TYPE IRON-CORE AND AIR-CORE REACTORS



Indoor/Outdoor Dry-Type Air & Iron Core Reactors

Literature No.: **IOMGIR**
Issue Date: October 2008

Safety Precautions

(1) Do not lift or move a reactor without proper equipment and experienced personnel.

(2) Do not off-load the reactor until a full inspection has been completed.

(3) Use terminals only for electrical connections.

(4) Connections should only be in accordance with the nameplate diagram or connection drawings.

(5) Make sure all power is disconnected before attempting any work on a reactor.

(6) Make certain all connections are complete and tightened before energizing the reactor.

(7) Do not attempt to change any taps while the reactor is energized.

(8) Do not change connections when a reactor is under excitation.

(9) Do not tamper with control panels, alarms, interlocks or control circuits.

(10) Do not adjust or remove any accessories or cover plates while the reactor is energized.

CONTENTS

SCOPE

This guide covers the recommendations for the application, installation, operation and maintenance of Dry-Type Iron-Core and Air-Core Reactors manufactured by Hammond Power Solutions Inc. (HPS). It must be emphasized that these abbreviated instructions should be used in conjunction with all standards covering such work and should be referenced accordingly.

These recommended practices are for general applications and any special requirements should be referenced back to HPS and/or their representative.

STANDARDS

Iron-core and air-core reactors covered include those manufactured in accordance with NEMA ICS 9. It is further recommended that installation work be governed generally by ANSI/IEEE C57.94. This is the IEEE Recommended Practice for Installation, Application, Operation and Maintenance of Dry-type General Purpose Distribution & Power Reactors.

RECEIVING & INSPECTION

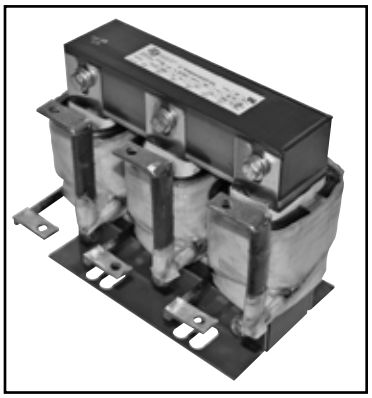
Before any equipment is off-loaded, reactors should first be inspected for correctness of shipping information. Confirm that the identifying part number on the nameplate of the reactor matches the packing list and Bill of Lading.

Inspect the reactors immediately upon receipt for evidence of damage or indication of rough handling that may have been caused during shipment.

Examination should be made before removing reactors from shipping vehicles. Inspection should also be made for any evidence of water or other contaminants that may have entered the reactor during transit. **A claim should be filed with the carrier at once** and the HPS should be notified.

Reactors are shipped either as a core and coil assembly, partially assembled inside an enclosure or completely assembled in a sheet metal enclosure or. All parts and components are wrapped in a clear plastic sheets and covered with a shipping tarpaulin. Drawings also accompany the shipment in a separate package that detail assembly if required.

Once the unit has been received, remove the covers or panels and proceed with an internal inspection for any evidence of damaged or displaced parts, loose or broken connections, damaged terminal, dirt or foreign materials and for the presence of any water or moisture. Corrective measures should be taken where necessary. If any damage is evident, contact HPS and/or your sales representative immediately. Remove shipping braces and bolts if present.



HANDLING - LIFTING & ROLLING

Smaller units and assemblies are shipped on wooden pallets surrounded by a plastic wrap.

The wood crate is suitable for moving with forklift truck. For larger reactors and assemblies, an overhead crane is essential.

When lifting, **never lift by the case only** unless there are clear instructions to the contrary. HPS reactors are most frequently supplied as a core & coil. However if supplied with a ‘knock down’ enclosures, enclosure roof panels, side access panels and cover should be removed. Lifting of the core and coil assembly should be done via the lifting provisions on the core of the

reactor. Care should be taken to avoid damage due to a height restriction. You will require at least 4-5 feet of clearance from the top of the enclosure or lifting eyes - including the spreader bars, to facilitate lifting.

The reactor core and coils, and assembled enclosures, are designed for lifting/fork lifting, unless other provisions have been requested. Insure forks extend completely under the enclosure.

Some care should be taken when handling the enclosure due to the lighter mechanical nature of the frames and panels.

STORAGE

Units must be stored in a warm, dry location, free of dust or air borne contaminants. The relative humidity to which the insulation materials are exposed should be kept as low as practical. The floor on which the reactor is stored should be impervious to the upward migration of water vapor. Take precaution to guard against water from any source such as roof leaks, broken water or steam lines, windows, etc. It is not recommended that dry-type units be stored outdoors. If that is unavoidable, units must be well protected from snow, rain and other elements. Protection should include an initial wrap of first quality canvas with a final outside covering of plastic tarpaulin. It would also be desirable to include a desiccant such as a silicon gel dry-out system to reduce the moisture content inside the assembly. If units are stored outdoors, dry-out is recommended as described below.

AIR-CORE REACTOR ASSEMBLY

To prevent shipping damages, some air-core reactors may be delivered without insulators fully assembled to the reactors. Refer to the outline drawings or special assembly instructions included with the unit.

Some air-core reactors may be fully assembled inside an enclosure with wood bracing to prevent shipping damages. After the reactors have been installed in it's final position, remove all mechanical bracings before any electrical test is performed and before the unit is energized.

Magnetic clearances around an air-core reactor when an enclosure is not provided can vary. As a rule of thumb, all small metallic parts not forming closed loops shall be a minimum of half of one coil diameter away from the reactor surface, horizontally and vertically. If other equipment is installed next to the reactor, more distance may be required especially if it is sensitive to a magnetic field.

The following considerations of closed loops on adjacent metallic structures are: When an air-core reactor without an enclosure is to be installed near a building's metallic structure or on a concrete floor with reinforced metallic bars, this information must be supplied to HPS at the initial quoting stage so that proper design action can be taken. If this information was not supplied in advance for the design process, corrective actions may be required to the unit in the field. Any costs to these corrective actions will be the sole responsibility of the purchaser.

DRY-OUT

If an indoor type reactor has been exposed to moisture such as condensation or rain, or stored in a high humidity environment, the unit must be dried out prior to energization. First, immediately remove the reactor from service. Then proceed with any of the following dry-out methods:

(1) Free moisture should be blown or wiped off any surface of the reactor to reduce the time of the dry-out period.

(2) Direct external forced air, hot or warmed, or radiant heat up through the windings with all the ventilation openings cleared. Recommended temperature should not exceed 110 ° C. Continue this for 24 hours or until all evidence of moisture or condensation is no longer visible.

(3) Dry-out with internal heating SHOULD NOT be permitted.

(4) Reactors that have been exposed to flood conditions, direct rain or sprinklers, may not be able to be dried out appropriately. Consult the factory for further instructions. **It is emphasized that only specifically authorized personnel undertake this work.**

LOCATION

Ventilated dry-type reactors normally are designed for installation indoors in dry locations. They will operate successfully where the humidity is high, but under this condition it may be necessary to take precautions to keep them dry if they are shut down for appreciable periods. Refer to dry-out instructions. Dry-type units covered by this guideline are designed for operation at altitudes not exceeding 1000 m (3300 ft.).

Environmental Considerations:

For ventilated indoor type dry-type reactors should not be located in environments containing contaminants including dust, fertilizer, excessive moisture, chemicals, corrosive gases, oils or chemical vapors.

Locations where dripping water is present are to be avoided. If this is not possible, suitable protection must be provided to prevent water from entering the reactor enclosure.

For outdoor type reactors suitable weather resistant and tamper-proof enclosures maybe required, and locations where there is driven water, snow , dust and sand particles should be avoided. Consult with HPS for further information.

Air-core dry-type reactors can be located outdoors without enclosure, but they must be designed especially for outdoor environmental protection.

Ventilation:

Adequate ventilation is essential for the proper cooling of reactors. Clean, dry air is desirable. Filtered air may reduce maintenance if the location has unusually high airborne contaminants.

If reactors are installed in vaults or other places with restricted air flow, sufficient ventilation shall be provided to maintain correct air temperatures. The limits are specified by CSA or ANSI standards.

It is common to install reactors in compartmentalized enclosures where openings are minimized. Though some reactors are short time rated, it is necessary to provide sufficient free circulation of air through and around each unit. This will also permit ready access for maintenance.

If the reactor is to be located near combustible materials, the minimum clearance distance established by The National Electrical Code should be maintained.

GROUNDING

All noncurrent carrying metal parts in reactors must be grounded, including the core and enclosure.

For air-core reactor, care should be taken that grounding will not be forming closed loops.

FIELD TESTING

It is recommended that some field tests be made before placing a reactor in service to determine that it is in satisfactory operating condition and to obtain data for future comparison. Tests and procedures as recommended in ANSI/IEEE is recommended as a minimal.

Where low-frequency applied-voltage test for acceptance are conducted in the field, the test voltages shall not exceed 75% of factory test values. When field tests are made on a periodic basis, it is recommended that the test voltages be limited to 65% of factory test values. It is emphasized that any tests should be conducted by authorized personnel in accordance with recognized safety standards and codes.

1. If the reactor has been shut down for a period of time, it must first be visually inspected for evidence of condensation or moisture and dried out as described earlier.

2. If the nature of reactors is short time duty as outlined in NEMA ICS 9. Testing must be restricted to this duty.

3. Verify the selection of taps, as per the nameplate and ratio the connections - all taps should be in the identical position on each coil. Taps can only be changed when the unit is de-energized.

4. Some units may be provided with winding thermostats. These devices consist of bimetallic contacts. These “normally closed” contacts will provide a corresponding signal when coil temperatures exceed safe operating conditions.

5. Check for tightness and cleanliness of all electrical connections including taps, phase connections and grounds.

6. An insulation resistance test should be conducted on each unit. It determines the integrity of the insulation. An insulation resistance test is of value for future comparative purposes, and for determining the suitability of the reactor for a high potential test. This test should be completed before the high potential test.
   Variable factors affecting the construction and use of dry-type reactors makes it difficult to set limits for the insulation resistance. Experience to date indicates that 2 megohms, (one minute reading at approximately 25° C) per 1000 volts of nameplate voltage rating, but in no case less than 2 megohms total, may be a satisfactory value for insulation resistance. Insulation megger test (500V or 1000V DC). Tests to be done between:
   Coil to Ground

7. Resistance measurements of windings.

8. Impedance or inductance test for full winding and for all tap positions.

9. Ensure that minimum clearances are maintained per standards for all current carrying parts including connections and bus bars. The following table may be used as a guide for minimum clearance:

Reactor Voltage Class	Minimum Clearance (mm)	Minimum Clearance (in.)
1.2 KV	25	1
2.5 KV	50	2
5.0 KV	100	4
8.7 KV	130	5.3
15 KV	200	8
18 KV	250	10
25 KV	300	12
34.5 KV	400	16

Note: “Some specific component parts of a reactor may require clearances less than those indicated above. For those exceptions, you should comply with the instructions provided in the assembly drawings or installation procedure.”

MAINTENANCE

CAUTION

The reactor must be de-energized prior to any maintenance. It is also recommended that all terminals be grounded.

Periodic Inspection and Maintenance:

FAILURE TO DE-ENERGIZE THE REACTOR BEFORE OPENING THE ENCLOSURE COULD RESULT IN SERIOUS PERSONAL INJURY.

Generally, very little maintenance is required for dry-type reactors. However, periodic care and inspection is required to ensure long-term, successful operation. The frequency of inspection will depend on the conditions where the reactor is installed.

For clean, dry locations, an annual inspection is normally sufficient. For other locations where the air is contaminated with dust or chemical vapors, inspection at three or six month intervals may be required.

With the reactor de-energized, remove all access panels on the enclosure. Inspect for dirt particularly on insulating surfaces or any surface which tends to restrict air flow.

Insulators, terminals and terminal boards should be inspected for discharge (tracking), breaks, cracks or burns and tightness of hardware. It is necessary to clean these parts to prevent flashover due to the accumulation of the contaminant.

Evidence of rusting, corrosion, and deterioration of the paint should be checked, and corrective measures taken where necessary. Fans, motors, and other auxiliary devices should also be inspected and serviced.

CLEANING

If excessive accumulation of dirt is apparent on the reactor windings or insulators, the dirt must be removed to permit the circulation of air. Particular attention should be given to cleaning the top and bottom ends of the winding assemblies.

The windings may be cleaned with a vacuum cleaner, blower, or with compressed air. A vacuum cleaner is preferred as a first step followed by the use of compressed air. The compressed air should be clean and dry and applied at a relatively low pressure (not over 25 pounds per square inch).

Leads, lead supports, terminal boards, bushings, and other major insulating surfaces should be brushed or wiped with a dry cloth. The use of liquid cleaners is undesirable due to solvents which could have a detrimental effect on insulating materials.

Hammond Power Solutions Inc.

UNITED STATES

Hammond Power Solutions, Inc.
1100 Lake Street
Baraboo, Wisconsin
53913-2866

Tel: (608) 356-3921
Fax: (608) 355-7623

Toll free: 1-866-705-4684

CANADA

Hammond Power Solutions Inc.
595 Southgate Drive
Guelph, Ontario
N1G 3W6

Tel: (519) 822-2441
Fax: (519) 822-9701

Toll free: 1-888-798-8882

sales@hammondpowersolutions.com

www.hammondpowersolutions.com

Issue Date: October 2008