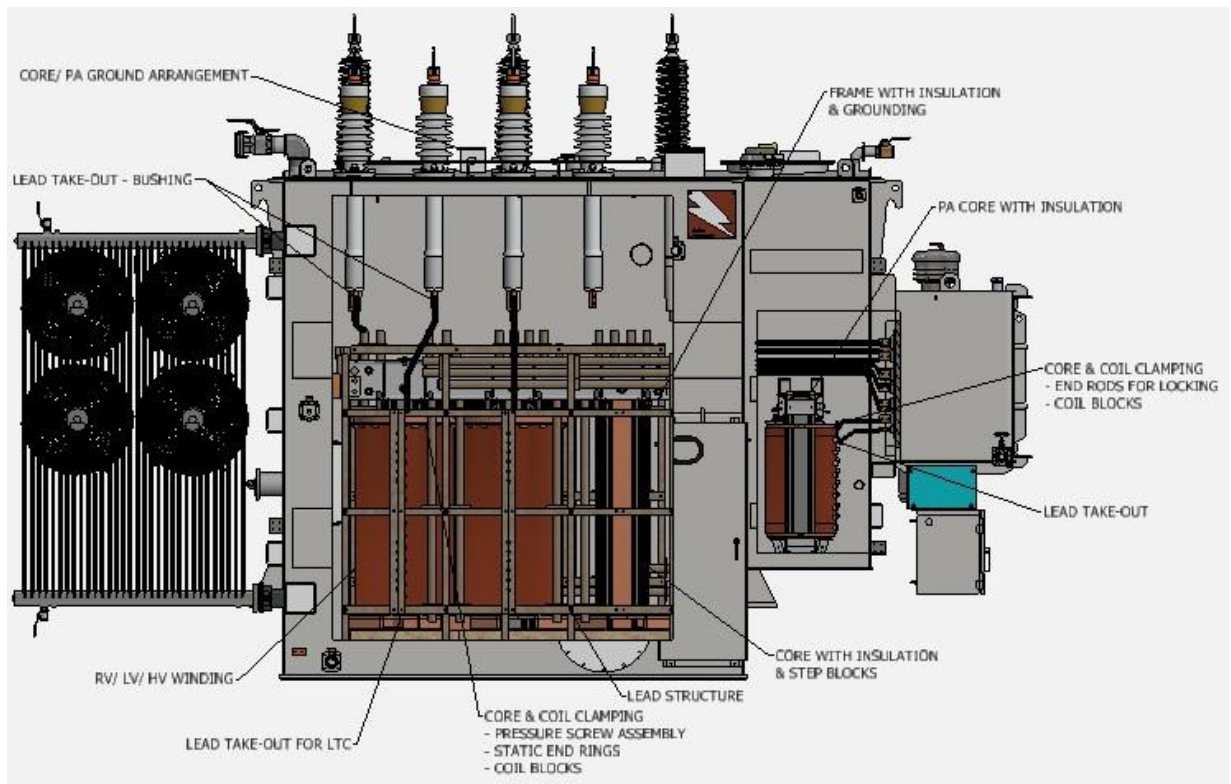


STANDARD SPECIFICATION

REMANUFACTURED TRANSFORMERS

Revision 2 June 2023



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1. INTRODUCTION

- 1.1. Jordan Transformer returns remanufactured transformers to the field with a renewed capability to fit their original application.
- 1.2. This specification describes design standards, workmanship, and deliverables for Jordan Transformer power transformer remanufacturing projects.
- 1.3. Modifications or additions to this specification for a project must be defined and mutually agreed upon during the quoting process and noted on the face of the purchase order.

2. ORIGINAL DOCUMENTATION

- 2.1. Customer shall provide nameplate, oil samples, photos (all sides), wiring and schematic diagrams to represent the transformer's current condition if available.
 - 2.1.1. Oil samples provided by the customer must ensure transformer oil is PCB non-contaminated.
- 2.2. Customer shall provide test reports to reflect the transformer design prior to remanufacturing.
- 2.3. Customer shall provide any failure reports as applicable.

3. DETERMINATION OF PROJECT FINAL SCOPE OF WORK (FSOW)

- 3.1. Incoming and un-tanking inspections shall be conducted within two (2) weeks of receiving the transformer to investigate potential root failure cause and assess full remanufacture scope of work.
- 3.2. An incoming inspection report will typically be provided no later than four (4) weeks after beginning the inspections.

The report will provide dispositions for all existing internal and external components such as: bushings, CTs, internal switches, LTC, core, core frames, lead structures, radiators, fans, gauges, pressure devices, controls equipment, etc.

The intent is to reuse steel components such as: tank, core, frames, and radiators.

- 3.3. Components are assigned one of four disposition categories from incoming inspection:

- 3.3.1. **Reuse:** Component will be cleaned and stored as appropriate but will otherwise be returned on the transformer in the same general condition as received.
- 3.3.2. **Modify:** Component will be modified to account for design changes or to conform with Jordan Transformer design standards or updated to industry standards. Commonly modified components include lead structure and core frames.
- 3.3.3. **Replace:** Component will be replaced due to a failed or obsolete condition.
- 3.3.4. **Add:** Component will be added to account for design changes or to conform with Jordan Transformer design standards or updated to current industry standards.

- 3.4. All modified, replaced, or added components shall be designed and constructed in conformance with the latest applicable standards of IEEE C57 specific power transformer design, construction, insulation, cooling, and rating requirements.
- 3.5. All main windings (high voltage, low voltage, tertiary voltage, and reactor voltage windings) will be replaced by default and lead cables as required.
- 3.6. The incoming inspection report and final scope of work (FSOW) proposal shall be reviewed and approved by the customer before start of design, procurement of parts, or remanufacturing efforts.

4. DATA COLLECTION

- 4.1. After an internal inspection and customer approval of inspection report, the core and coils will be disassembled.
- 4.2. One of each coil type (HV, LV, etc.) will be deconstructed to collect data on the original design.
- 4.3. A second coil of each type shall be retained as reference until the project is completed and shipped.
- 4.4. Core dimensions shall be measured and recorded after coils are un-landed during disassembly.

5. DESIGN

- 5.1. Using the existing core dimensions and original winding data, a new electrical design is developed in accordance with Jordan Transformer procedures and IEEE standards.
 - 5.1.1. Electrical redesign shall include all new conductor and insulation sized to fit within the existing core window and tank.
 - 5.1.2. Finite element short circuit design analysis shall be performed utilizing Andersen FLD12 analysis.
 - 5.1.3. Thermal and dielectric design analysis shall be performed to ensure the core and coil meet all applicable standards and requirements.
 - 5.1.4. As required, steel clamping structure, tie rods, lock irons, and jack bolts will be redesigned to withstand any increased clamping pressure and/or short-circuit forces.
- 5.2. An electrical design record shall be generated which compares key dimensional and performance data of the original and redesigned core and coils.
- 5.3. Test instructions shall be generated which prescribe quantitative parameters for transformer testing.
- 5.4. The design record and test instructions (collectively termed “Electrical Design”) shall be reviewed and approved by the customer before procurement of winding conductor or insulation package.
- 5.5. After approval of the Electrical Design, impacts on the design of lead structures, core clamps, control systems, external tank equipment, etc. shall be assessed and rectified.

6. WORKMANSHIP & MATERIAL

6.1. CORE & CLAMPING FRAMES

- 6.1.1. Core top yoke shall be disassembled sheet by sheet and wiped clean for reuse.
- 6.1.2. Cores shall be laid down on an upending table for all core insulation to be replaced.
- 6.1.3. Cores requiring internal cooling shall include expanded metal cooling duct spacers.
- 6.1.4. Adjacent core sections separated by a cooling duct shall be shorted together with a single jumper clip interleaved into the middle of the first book on either side of the cooling duct.
- 6.1.5. The core shall be grounded with a single jumper lead from an interleaved copper tab to the core ground bushing stud. The tab shall be interleaved near the middle of the main core element (or main element book beside the cooling duct) at the closest point to the core ground bushing stud.
- 6.1.6. New or modified clamping frames shall accommodate Jordan Transformer standard jack-bolts and jack-pads as well as steel channel end plates as required to provide additional strengthening.
- 6.1.7. A Megger test shall be performed after any movement, adjustment, or modification of the core assembly.

6.2. WINDING

- 6.2.1. New coils shall be of circular disc or helical design.
- 6.2.2. Bare copper coil conductor, typically supplied by Essex or Rea, shall conform to ASTM B48 and shall be insulated with a paper wrapping consisting of no fewer than three helically wrapped papers per Jordan Transformer material specification MS- 50-01.26.22
- 6.2.3. A full insulation package is typically supplied by Weidmann.
- 6.2.4. Pre-compressed hard board insulation will be used for spacers, tubes, and blocking in coils where compression characteristics are critical for short-circuit calculations.
- 6.2.5. Thermally upgraded insulating material shall be considered for transformers with high winding temp rises. Typically, Nomex™ conductor tape for winding rises above 65°C and Nomex™ spacers and sticks at 95°C.
- 6.2.6. New phase-to-phase barriers will be supplied.
- 6.2.7. Individual coils shall be oven-dried under engineering-prescribed clamping pressures for no less than two (2) days at a temperature not to exceed 70°C during the sizing process.
- 6.2.8. Coils shall meet the designed height dimension to within one-eighth of an inch (0.125 inches) under engineering-prescribed clamping pressures before coil landing.

6.3. CORE & COIL ASSEMBLY

- 6.3.1. Transformer turns ratio tests shall be conducted on all three windings after landing coils and reinstalling core top yoke.
- 6.3.2. New lead structures typically consist of electrical grade maple, free of knots and voids. Structures may also incorporate laminated wood or high-density pressboard as assessed by Jordan Transformer engineering.
- 6.3.3. New fiber bolts shall be used, regardless of lead structure disposition.
- 6.3.4. All fiber bolt connections shall be double nutted on at least one end. Single nut fittings shall use Glyptal® 1276 or equivalent thread lock.
- 6.3.5. Lead cable crimp connections shall be made using AMPPOWER lugs and corresponding hydraulic crimp heads. For each different combination of cables and lug sizes, a test crimp shall be made and cut open to verify crimp quality and integrity.
- 6.3.6. Internal switches (LTC, DETC, S/P, etc.) shall be specified as repaired or supplied by trusted industry vendors such as Reinhausen and Quality Switch.
- 6.3.7. Core and coil assembly shall be oven-dried at 220°F (~105°C) for typically ten (10) calendar days and until measured dissipation factor levels off.
- 6.3.8. Ancillary insulation pieces to be installed inside the tank shall be oven dried at 220°F (~105°C) for typically seven (7) calendar days.
- 6.3.9. Core and coil assembly shall be tanked on the same day it leaves the dry-out oven to minimize moisture absorption back into the insulation.
- 6.3.10. Prior to final tanking, the windings shall have the full designed clamping pressure hydraulically applied and secured by the jacking system, all structure hardware shall receive its final tightening, and the core and coil shall receive a final QA inspection and cleaning.
- 6.3.11. If the customer desires to witness the tanking process, the requirement will be noted on the face of the purchase order.

6.4. VACUUM OIL FILLING & PROCESSING

- 6.4.1. Ergon HyVolt II non-PCB mineral oil shall be used.
- 6.4.2. After pulling vacuum for pressure testing, pressure shall be dropped to 1 Torr or less and held for a duration of one (1) hour for each hour of the tanking process plus the time specified in the Jordan Transformer procedure for the BIL of the transformer.
- 6.4.3. During oil filling, hot, processed oil shall be introduced through the bottom drain valve while maintaining a vacuum pressure below the required minimum by Jordan Transformer procedure for filling.
- 6.4.4. Oil will be circulated through Jordan Transformer's oil processing system until at least four (4) full passes

have been completed and oil samples meet ASTM D3487 dielectric mean requirements.

6.4.5. Oil is circulated at 70°C maintaining no more than 5°C difference between inlet and outlet.

6.5. CONTROLS

6.5.1. Digital monitoring and controls devices (ETMs, SELs, etc.) shall be ordered with a default configuration package installed if available.

6.5.2. Testing of digital monitoring and controls devices shall consist of power-up and basic relaying, only if necessary, to verify the functionality of other sensors and devices.

6.6. BUSHINGS

6.6.1. New bushings shall conform to IEEE C57.19.01

6.6.2. New bushings shall be of the oil filled condenser design with mounting flanges and test or capacitance taps (type II).

6.7. TANK

6.7.1. The tank and radiators will be thoroughly flushed and cleaned prior to re-tanking the core and coil assembly.

6.7.2. New gaskets will be cut and installed for each bushing, gauge, and cover flange on the main transformer tank.

6.7.3. Viton DT-70C gasketing material shall be used for Nomex insulated transformers with 75°C rise or around bushings that are in buss ducts or carry more than 3000 Amps.

6.7.4. The tank shall be painted with ANSI 70 gray topcoat with a black tuff coat applied to the bottom of the transformer.

7. TRANSFORMER TESTING

7.1. Transformer shall be tested to IEEE requirements in accordance with the latest revision of IEEE Standards C57.12.00 and C57.12.90.

7.2. A typical Certified Test Report would include the following tests as applicable:

Turns Ratio	Applied Potential	DGAs
Winding Resistance	Induced Potential	Partial Discharge
Exciting Current	Load Losses	SFRA
Impedance	Doble Power Factor	
No Load Losses	Impulse	

7.3. If the customer desires to witness the testing, the requirement will be noted on the face of the purchase order.

8. DOCUMENTATION DELIVERABLES

- 8.1. Certified Test Report (CTR) to include all requirements per C57.12.00 and C57.12.90. See “TRANSFORMER TESTING” section for additional details.
- 8.2. Controls Functional Test Report (FTR) to verify auxiliary and control functions.
- 8.3. Nameplate(s) in accordance with IEEE C57.12.00 (section 5.12 of the 2021 revision).
- 8.4. A general user manual with drawings is provided with each project.
- 8.5. Drawing sets shall consist of:
 - 8.5.1. Outline (base plan and detail dimensions)
 - 8.5.2. Nameplate
 - 8.5.3. Outline of bushings
 - 8.5.4. Shipping drawing (if not shown on Outline)
 - 8.5.5. Controls schematic & Wiring diagrams are an option for purchase. No less than two (2) hard-copies and flash drive digital drawing sets shall be provided at the time of shipping.
 - 8.5.6. Current transformer excitation and ratio correction factor curves.
- 8.6. All digital drawing files shall be provided in Adobe “.pdf” format.

9. SHIPPING & LOGISTICS

- 9.1. Responsibility for dismantling, loading, and unloading the transformer for shipping to and from the Jordan Transformer factory shall be defined and mutually agreed upon during the quoting process and noted on the face of the purchase order.
- 9.2. Transformers and any accompanying equipment shall be shipped by truck and in compliance with all applicable federal, state, and local regulations including MN frost laws.
- 9.3. Remanufactured transformers shall be equipped with impact recorders. These recorders shall be returned to Jordan Transformer by the customer upon receipt of the transformer.
- 9.4. Remanufactured transformers shall be shipped oil-filled if allowable under shipping weight restrictions. If required to ship without oil, transformer shall be shipped under positive pressure dry air. The quote and final purchase order will specify which condition applies.
- 9.5. If auxiliary equipment is uninstalled to meet shipping restrictions, it shall be securely shipped separately.
 - 9.5.1. Removed bushings shall be crated such that they are supported by their flanges in accordance with ABB, PCORE, and other OEM specifications. Bushings are typically shipped upright if height allows.

9.5.2. Removed radiators shall be filled with dry nitrogen under positive pressure. Sections of lumber shall be used beneath the radiators, under strapping bands, and between any stacked radiators.

10. SPECIAL REQUIREMENTS

10.1. If the customer desires other special requirements, they will be defined and mutually agreed upon during the quoting process and noted on the face of the purchase order.