// INSTALLATION & OPERATING MANUAL

Medium-Voltage Substation Transformer

Receiving, handling, assembly, close-coupling, energization, operation, and maintenance for liquid-filled medium-voltage substation transformers supplied by Bet Power.

DOCUMENT	APPLIES TO
BP-IOM-MVST-001	500 – 10000 kVA · 2400 – 34500 V primary · 5 – 35 kV class

Built for Speed. Priced for Reality.

// READ BEFORE INSTALLING

This equipment carries lethal medium voltages on live-front bushings. Installation, connection, and maintenance must be performed only by qualified personnel trained in medium-voltage equipment, following the NEC (NFPA 70), NESC (IEEE C2), NFPA 70E, OSHA 29 CFR 1910.269, the serving utility's requirements, and the site arc-flash study. Keep this manual with the transformer for the life of the equipment.

// CONTENTS

What's in this manual

// HOW TO USE THIS MANUAL

Sections 03 through 10 are sequential. Complete each section's checklist before moving on. Section 11 onward is for the life of the equipment.

The unit-specific nameplate, outline drawing, wiring diagram, and factory test report govern over any general value in this manual. If they disagree, stop and call Bet Power Engineering.

> // NAMEPLATE FIRST
> Record the serial number, kVA (ONAN and ONAF), voltages, BIL, impedance, fluid type, and fluid volume from the nameplate into Appendix A before the unit leaves the receiving area.

// DIRECT LINES

Engineering	engineering@bet-power.com
Field support	support@bet-power.com
Logistics (24/7 desk)	logistics@bet-power.com
Orders	orders@bet-power.com

// 01 Safety

A substation transformer has live-front bushings on an open structure or in an air-terminal chamber, and it is often close-coupled to switchgear on both sides. Nothing here replaces your site's lockout/tagout procedure, the utility's switching orders, the arc-flash study, or NFPA 70E.

> // DANGER — HAZARDOUS VOLTAGE
> De-energize the primary and secondary, lock out, test for absence of voltage with a rated tester at every bushing, and apply grounds before opening any terminal chamber or touching any bushing. Assume every bushing is live until proven otherwise.

Signal words used in this manual

WORD	MEANING
DANGER	Will cause death or serious injury if not avoided.
WARNING	Can cause death, serious injury, or major equipment damage.
CAUTION	Can cause minor injury or equipment damage.
NOTE	Information that affects performance, warranty, or the next step.

Rules that apply to every section

1. Only qualified persons (NFPA 70E definition) trained in medium-voltage equipment open terminal chambers, change taps, sample fluid, or make connections.
2. Wear arc-rated PPE matched to the incident energy on the arc-flash label. Treat the LV throat and air-terminal chamber as above 40 cal/cm^2 until the study says otherwise.
3. Keep terminal chambers closed and bolted whenever personnel are not actively working inside. Where the transformer is close-coupled, the switchgear interlocks apply to the transformer chambers too.
4. Never operate the de-energized tap changer with the unit energized. Where a load tap changer (LTC) is fitted, only the LTC is operated energized.
5. Do not open the fill plug, sampling valve, or any gasketed opening with the unit energized. Do not draw fluid samples energized.
6. Do not energize a unit that has been dropped, tipped past 15 degrees, shows a fluid leak, has a bushing crack, or lost its positive pressure in transit without a documented reason.
7. Confirm the tank is grounded at two points before any primary or secondary conductor is landed.
8. Radiators, the tank top, and the conservator (if fitted) are not work platforms.

> // WARNING — MULTIPLE SOURCES
> Sites with on-site generation, solar, or battery storage can energize this transformer from the secondary side. Isolate every source, not just the utility feed, before working on either side.

Environmental

Mineral oil and FR3 natural ester are regulated for spills. Keep spill containment on site during filling, sampling, or any work that opens the tank. Units over 660 gallons require secondary containment under 40 CFR 112 (SPCC); confirm the site plan covers this unit.

// 02 Scope and product description

This manual covers Bet Power liquid-filled medium-voltage substation transformers built to IEEE C57.12.00 and C57.12.36, tested per IEEE C57.12.90, with air-terminal chambers or throats for close-coupling to switchgear and switchboards.

Typical ratings

PARAMETER	STANDARD RANGE
Rated power	500 – 10000 kVA ONAN; ONAN/ONAF with fans adds 15 – 25%; 60 Hz, three-phase
Primary voltage	2400 – 34500 V (Delta or Grounded Wye); 5, 15, 25, 35 kV class
Secondary voltage	208Y/120, 480Y/277, 480 Delta, 600Y/347, 2400, 4160Y/2400, 12470Y/7200, 13800 V
Primary BIL	60 / 95 / 125 / 150 / 200 kV per voltage class
Taps	Two 2.5% above and two 2.5% below nominal, externally operated de-energized tap changer (DETC); LTC optional
Temperature rise	65°C standard; 55/65°C dual rating optional; 30°C average ambient
Insulating fluid	Mineral oil (Type II) or FR3 natural ester (less-flammable, K-class)
Impedance	Per nameplate, typ. 5.75% (≤ 2500 kVA), 6.5 – 7.5% (larger); IEEE tolerance ±7.5%
Cooling	ONAN (sealed tank, radiators); ONAN/ONAF with fans and controls; provisions for future fans
Terminations	HV: air-terminal chamber with cover-mounted bushings for cable, or throat flange to MV switchgear. LV: throat flange to switchgear or switchboard, or air-terminal chamber for cable or bus duct
Accessories	Liquid level gauge, dial thermometer with contacts, pressure/vacuum gauge, pressure relief device, drain valve with sampler, sudden pressure relay, winding temperature indicator, fan controls, surge arresters, ground pads
Efficiency	DOE 10 CFR 431 (2016 levels) unless otherwise specified

> // NOTE
> The values above are the standard range. The nameplate, outline drawing, and factory test report define the exact ratings, taps, accessories, and fluid for the serial number in hand.

Standard construction

Tank and core-coil

- Sealed-tank construction with welded cover (or bolted cover on larger units), designed for full vacuum filling; nitrogen or dry-air blanket above the fluid
- Core and coil braced for through-fault forces per IEEE C57.12.00; coils rectangular or circular, copper or aluminum
- Radiators welded or detachable with shut-off valves (shipped separately on large units)
- Jacking pads, base with fork pockets or rollers, two tank ground pads, lifting lugs

Terminations and accessories

- HV bushings in an air-terminal chamber (cover-mounted, with bus or cable landing pads) or a throat flange with transition bus to switchgear
- LV bushings and bus in the throat or LV air-terminal chamber; X0 neutral bushing with removable ground strap
- Externally operated DETC handle with padlock provision and position indicator
- Gauges and devices with alarm contacts wired to a terminal box on the tank side
- Nameplate (laser-etched stainless) on the tank side with the connection diagram, tap table, and fluid volume

// 03 Receiving and inspection

Substation transformers ship on a flatbed or lowboy, often with radiators, bushings, or terminal chambers shipped loose. Inspect before the carrier leaves.

01 Match the serial number and nameplate against the packing list and your PO. Photograph the nameplate.

02 Check the impact recorder or tilt indicator. If tripped, note it on the bill of lading and photograph it. Units over 5000 kVA typically ship with an electronic impact recorder; download or photograph the record.

03 Walk all four sides. Look for dents, scraped paint, bent radiator fins or shut-off valves, damaged bushings, bent lifting lugs, and damaged terminal chambers.

04 Check for fluid on the tank, the skid, or the truck deck. Any wetness is a leak until proven otherwise.

05 Read the pressure/vacuum gauge. A sealed tank should show positive or slight negative pressure, moving with temperature. Zero on a sealed tank after a temperature swing means a seal leak. Read the liquid level; it should be in the band for ambient temperature.

06 Check the nitrogen blanket (if the unit shipped with a nitrogen bottle and regulator) shows positive pressure.

07 Confirm loose-shipped items: radiators, bushings, terminal chambers, transition bus, fans, gauges, surge arresters, gaskets, hardware, fluid (if shipped separately), drawings, and the factory test report.

08 Record everything in Appendix A. Note any damage on the bill of lading **before signing**. Have the driver sign it.

> // WARNING
> If the impact recorder shows more than 3 g in any axis, or the unit was tilted past 15 degrees, internal leads or the core may have shifted. Do not energize. Contact logistics@bet-power.com within 24 hours with photos, the recorder data, and the bill of lading. An internal inspection or a core-ground and excitation test may be required.

// 04 Storage

Sealed substation transformers can be stored outdoors on a level, well-drained surface, with the positive pressure maintained. Loose-shipped radiators, bushings, and chambers must be stored indoors.

- Keep the unit upright on its base or on timbers, never directly on soil. Keep the base off standing water.
- Maintain positive pressure: check the gauge every 30 days. If pressure falls to zero, pressurize with dry nitrogen to 2 – 3 psig and find the leak. Log it.
- Keep terminal chamber covers bolted and bushing caps on. Cap every open flange (throat, radiator valves) with the shipping cover.
- Radiators stored flat, on timbers, flanges capped, indoors or under cover. Bushings in their crates, upright.
- Every 30 days: check liquid level, pressure, and for leaks. Log it.
- Storage over 12 months: perform insulation resistance, fluid dielectric, moisture, and DGA tests before energizing. Consult Bet Power Engineering on any results outside Section 09 limits.

CONDITION	LIMIT
Ambient temperature	**−40°C to +50°C**
Storage tilt	**Level ±5°**
Tank pressure	**Maintain +1 to +5 psig; never vacuum in storage**

// 05 Handling and moving

Shipping and total weights are on the nameplate and the outline drawing. A 5000 kVA unit can exceed 25000 lb filled. Size rigging for the shipping weight plus 25%, and confirm whether the unit shipped filled or dry.

Lifting

- Use all lifting lugs at once with a spreader bar so slings are vertical. Included sling angle 60° or steeper. Never lift by radiators, bushings, terminal chambers, or the conservator.
- Keep the unit upright. Maximum tilt: 15° during lift or transport.

- Lift only high enough to clear obstacles. Do not swing the load over people or switchgear.
- Units with detachable radiators: lift with radiators removed unless the drawing shows the lugs are rated for the filled, assembled weight.

Jacking, rolling, and skidding

- Jack only at the jacking pads at the tank base corners. Raise all four corners evenly, never more than 2 in at a time.
- Rollers or skates under the base rails or on the factory rollers only. Pull from the base pulling eyes with the force parallel to the base. Never push on the tank wall or radiators.
- Forklift: forks fully in the fork pockets from the side the drawing shows. Never pick from the radiator side.

> // CAUTION
> A partial lift or a jack under the tank wall dents the tank and can break the internal core-ground or lead supports. If a lift point is unclear, stop and check the drawing.

// 06 Site preparation and foundation

The outline drawing shows the footprint, anchor pattern, throat and terminal chamber locations, and the clearances. Build to that drawing. The values below are minimums where the drawing is silent.

ITEM	REQUIREMENT
Foundation	Reinforced concrete rated for the filled weight plus the coupled switchgear; level within 1/8 in over the full footprint and coupled lineup. Top 4 in above grade outdoors; housekeeping pad indoors.
Containment (indoor)	NEC 450.26 (mineral oil) requires a vault; NEC 450.23 (FR3, listed less-flammable) permits installation outside a vault indoors with a liquid confinement area and no combustibles within the listed clearances (typically 3 ft horizontal, 5 ft vertical for units ≤ 35 kV, up to 10 MVA) or with automatic sprinklers. Follow the AHJ.
Containment (outdoor)	Curbed pad or containment basin sized for 110% of the fluid volume plus rainfall, per the SPCC plan, for units over 660 gal. Oil-water separator or absorbent-filled sump where drainage is provided.
Clearance to buildings (450.27 / 450.23)	**Mineral oil outdoors: 10 ft to combustible walls or openings, or a fire barrier. FR3 outdoors: per listing, typically 3 ft to non-combustible walls, 5 ft to combustible. Confirm with the AHJ.**
Working space (110.34)	**Per voltage: 3 – 4 ft at 2.4 – 9 kV; 4 – 5 ft at 9 – 25 kV; 5 – 6 ft at 25 – 75 kV, in front of every terminal chamber and the tap changer handle**
Radiator clearance	**3 ft minimum on radiator sides for airflow; 5 ft where fans are fitted; no walls or equipment blocking the radiator face**

Close-coupling	Set the switchgear first, plumb and level. Match the throat flange centerline and height on the coordinated drawing. Provide the transition bus and flexible connectors from the switchgear supplier or the drawing.
Grounding	Ground grid or ring per IEEE 80 and the utility standard, with two ground conductors stubbed up at the tank ground pads; ground conductor at each terminal chamber.
Vehicle protection	Bollards where the unit is within 10 ft of a driving lane.
Ambient	**–30°C to +40°C, 24-h average ≤ 30°C; ≤ 3300 ft without derate**

// 07 Installation and assembly

Set the switchgear first. Bring the transformer to the switchgear, not the switchgear to the transformer.

01 Pull primary and secondary cables (where used) and protect the ends before setting the unit. Leave enough tail to reach the bushings with the minimum bending radius.

02 Remove shipping braces, skid, and any bolts or brackets marked "remove before installation." Keep flange covers on until the mating part is ready.

03 Set the unit on the foundation, aligned to the throat flange centerline of the switchgear (if close-coupled) and the anchor pattern. Level in both axes; shim under the base only.

04 Anchor to the foundation through the base anchor holes with the size and embedment on the drawing. Required in seismic areas and everywhere the unit is close-coupled.

05 Install detachable radiators: remove the flange covers, install new gaskets, bolt the radiator to the tank valve flanges, torque per the drawing, then open both shut-off valves (top and bottom) fully. Confirm each valve is open; a closed valve leaves a radiator cold and the transformer under-cooled.

06 Install cover-mounted bushings (if shipped loose) per the factory instructions and the internal lead diagram. This is a Bet Power field service or factory-trained operation on units over 5 MVA; call before starting.

07 Install the terminal chambers and transition bus. Bolt the transformer throat flange to the switchgear flange with the gasket and hardware supplied. Connect the flexible connectors between the transformer bushings and the switchgear bus per the coordinated drawing; torque per Section 08.

08 Install fans and fan controls (ONAF units) per the wiring diagram. Confirm fan rotation blows through the radiators.

09 Install surge arresters on the HV bushings (and LV where specified) with the shortest possible ground leads to the tank ground pad.

10 Bond both tank ground pads and every terminal chamber to the ground grid with the conductor on the drawing (#4/0 copper minimum on units ≥ 2500 kVA). Do this **before any cable is landed**.

11 Top off fluid to the 25°C fill line if the unit shipped dry or partially filled: see the fluid section below.

12 Set the DETC to the position required for site voltage. Confirm the handle is in a detent and padlocked. De-energized only.

13 Remove the X0 ground strap only if the design calls for an ungrounded, resistance-grounded, or impedance-grounded neutral. Standard is X0 bonded to tank; document in Appendix A.

14 Install the alarm and control wiring to the terminal box (Section 08). Seal the cable windows and chambers after all connections are inspected.

Fluid filling (units shipped dry or with radiators loose)

Fill only with the fluid type on the nameplate, from sealed drums or a filtered tanker, through the top filter press connection, under vacuum where the tank is rated for it (nameplate). Filling is a Bet Power field service operation or is performed by a qualified transformer service contractor under Bet Power's written procedure. Never mix mineral oil and FR3. Never fill with the unit energized.

> // WARNING
> Never operate the DETC with the transformer energized. Arcing inside the tank will destroy the tap changer and can rupture the tank.

// 08 Electrical connections

Primary (HV)

- Close-coupled to MV switchgear: bolt the switchgear transition bus to the HV bushing pads through flexible connectors, plated hardware, Belleville washers, torqued per the table. Confirm phase-to-phase and phase-to-ground clearances in the throat per the drawing.
- Cable in an air-terminal chamber: terminate shielded MV cable with stress-cone terminations rated for the voltage class, on the bushing pads. Ground the cable shield to the chamber ground bus. Support cables on the chamber brackets so the bushing carries no weight.
- Phase sequence H1-H2-H3 matches the utility A-B-C. Confirm rotation at energization.
- Surge arresters on every HV bushing, MCOV selected for the system grounding (higher MCOV on Delta or ungrounded systems).

Secondary (LV)

- Close-coupled to switchgear or switchboard: bolt the switchgear bus to the LV bushings through flexible connectors, plated hardware, Belleville washers, torqued per the table. Install the throat gasket and bolt the throat flanges to seal the transition.
- Bus duct: bolt the bus duct flanged end to the LV bushings with the bus duct manufacturer's flexible connectors.

- Cable: terminate with compression lugs on the LV spade bushings; parallel conductors distributed evenly; NEMA hole pattern.
- X0 neutral bonded to the tank ground pad with the factory strap (standard), or wired to a neutral grounding resistor per the one-line. The secondary is a separately derived system (NEC 250.30); install the system bonding jumper at one point only and land the grounding electrode conductor.

Torque

BOLT SIZE	PLATED STEEL, GRADE 5	SILICON BRONZE	WHERE USED
3/8 in	20 ft·lb (27 N·m)	18 ft·lb	Small bushing studs, control
1/2 in	50 ft·lb (68 N·m)	40 ft·lb	HV bushing pads, LV spades ≤ 2500 kVA
5/8 in	85 ft·lb (115 N·m)	55 ft·lb	LV spades > 2500 kVA, throat bus
3/4 in	140 ft·lb (190 N·m)	—	LV bus ≥ 4000 A
Bushing stud nut	Per bushing label	—	Never over-torque a porcelain bushing

Accessory and alarm wiring

Gauge contacts (liquid level low, top-liquid temperature alarm and trip, winding temperature alarm and trip, pressure relief operated, sudden pressure relay trip, fan failure) are wired to the terminal box on the tank side per the wiring diagram. Contacts are dry, rated 5 A at 120 VAC. Wire the trip contacts (winding temperature trip, sudden pressure) to the primary breaker trip circuit per the one-line. Fan power (typ. 120 or 240 VAC single-phase) to the fan control cabinet. Route control wiring in conduit separate from power conductors.

> // NOTE — BI-DIRECTIONAL SERVICE
> Standard units tolerate reverse power flow (generation, BESS, PV) up to nameplate kVA. Confirm with Bet Power Engineering if reverse flow is expected to exceed 100% of rating or if the tap changer will be set for export voltage.

// 09 Pre-energization checks

Every item below is a hold point. Do not energize with an open item. Record results in Appendix A.

- ☐ Nameplate voltages, BIL, and connection match the drawings, the utility service, and the switchgear ratings on both sides.
- ☐ DETC set, in detent, padlocked; position recorded. LTC (if fitted) at neutral, control in manual.
- ☐ Tank grounded at both pads; terminal chambers grounded; ground resistance measured and recorded (5 Ω target, or per utility).
- ☐ All radiator valves open (top and bottom, every radiator). Radiators and tank show no leaks at flanges, gauges, valves, bushings, or welds.

- [ ] Liquid level in the normal band for ambient temperature. Pressure gauge reads +1 to +5 psig. Nitrogen blanket (if fitted) regulator set per nameplate.
- [ ] All bushing connections, throat bus, and flexible connectors torqued and striped. Clearances in the throat and chambers per the drawing. No tools, hardware, or debris in any chamber.
- [ ] X0 ground strap in place (or removed and NGR wired per design, documented). System bonding jumper at one point only; GEC landed.
- [ ] Surge arresters installed and grounded.
- [ ] Insulation resistance: 5 kV DC HV to ground and HV to LV; 1 kV DC LV to ground. Acceptable: ≥ 1000 MΩ HV, ≥ 500 MΩ LV at 20°C, corrected for temperature; PI ≥ 1.5. Compare with the factory test report.
- [ ] Transformer turns ratio (TTR) on each tap and phase: within 0.5% of nameplate. Winding resistance balanced within 2% between phases.
- [ ] Power factor / dissipation factor test (units ≥ 2500 kVA, recommended): overall ≤ 0.5% at 20°C for mineral oil, ≤ 1.0% for FR3.
- [ ] Fluid sample (all units; mandatory after storage over 12 months, any leak, or field filling): dielectric ≥ 30 kV (ASTM D877) or ≥ 40 kV (D1816, 2 mm) mineral oil, ≥ 35 kV (D1816) FR3; moisture ≤ 25 ppm mineral oil, ≤ 200 ppm FR3; baseline DGA taken and retained.
- [ ] Gauges and devices function-tested: thermometer contacts, level switch, pressure relief, sudden pressure relay (test button), winding temperature indicator, fan control and fan rotation.
- [ ] Downstream: secondary main open; all loads off; no backfeed sources connected. Upstream: primary protection settings verified against the coordination study, including inrush.
- [ ] Terminal chambers closed and bolted; throat flanges sealed. Arc-flash labels and MV warning signs installed. Site clear of unnecessary personnel. Fire extinguisher and spill kit within reach.

// 10 Energization

01 Close and bolt every chamber. Secondary main open. Nobody stands at the transformer during energization; the person operating stands at the upstream device or the remote control.

02 Energize from the utility or the upstream breaker per the switching order. Never energize by closing the secondary main from a live secondary bus unless the switching order specifically calls for backfeed energization.

03 Listen for 60 seconds. A steady hum is normal. Crackling, hissing, or a rising pitch means open the upstream device immediately.

04 Check secondary voltage phase-to-phase and phase-to-neutral at the switchgear PTs or the secondary main line side. Within ±2.5% of nominal at no load. Adjust the DETC only after de-energizing and grounding.

05 Confirm phase rotation at the secondary (A-B-C / clockwise) before any motor load is enabled.

06 Run at no load for 1 hour. Recheck for leaks, noise, gauge readings, and that the pressure gauge moves with temperature.

07 Close the secondary main and apply load in steps. Watch the top-liquid and winding temperature indicators.

08 After 4 hours at operating load: IR scan every bushing connection, flexible connector, and throat bus through IR windows or with chambers opened only if the unit is then de-energized to close them. No connection more than 15°C above adjacent phases. Radiators evenly warm top to bottom (a cold radiator has a closed valve).

09 Record energization date, voltages, tap position, rotation, and gauge readings in Appendix A. Send a copy of the completed record to support@bet-power.com for the unit file.

> // WARNING — INRUSH
> Magnetizing inrush can reach 8 – 12 × full-load current for several cycles. Upstream protection must be set to ride through it (differential relays need harmonic restraint enabled). A trip on energization is a protection setting problem first. Do not repeatedly re-close; each energization stresses the core and coil clamping.

// 11 Operation

Loading

CONDITION	ALLOWABLE	LIMIT
ONAN, continuous, 30°C avg ambient	100% of ONAN rating	Indefinite
ONAF, fans running	ONAF nameplate rating (typ. 115 – 125% of ONAN)	Indefinite with fans running
Continuous, 40°C avg ambient	≈ 92%	1% derate per °C over 30°C
Short-time overload, from 50% preload	150%	2 hours, then return to ≤ 100%; IEEE C57.91
Dual-rated 55/65°C units	112%	Continuous at 65°C rise
Top-liquid temperature	Alarm 95°C · Trip 105°C	Nameplate or settings sheet governs
Winding hot-spot	Alarm 110°C · Trip 120°C	Nameplate or settings sheet governs

Every 8°C of sustained hot-spot temperature above design roughly halves insulation life. Fans convert that margin into capacity; they do not make it free.

Gauges and what they should read

GAUGE	NORMAL	INVESTIGATE
Liquid level	In the band for the marked temperature (25°C fill line at 25°C)	Below LOW at any temperature; above HIGH when cold
Top-liquid temperature	Ambient + load rise, typically 45 – 85°C loaded	> 95°C, or drag-hand pointer above 95°C
Winding temperature	Top-liquid + 10 – 20°C under load	> 110°C
Pressure / vacuum	–5 to +7 psi, moving with temperature	Stuck at 0 through a temperature swing (seal leak); > +8 psi (gassing)
Pressure relief device	Pin flush, flag not raised	Flag raised: device operated; find the cause before resetting

Switching

- Primary switching is done at the upstream switchgear per the site switching order, never at the transformer.
- Vacuum breakers upstream can produce switching surges (current chop). Surge arresters at the bushings are the defense; do not remove them.
- LTC (where fitted): operate in AUTO under the voltage regulator relay, or in MANUAL from the control cabinet. Log operations; the LTC contacts have a maintenance interval by operation count on the LTC nameplate.
- DETC: de-energized only. See Section 07.

Protection coordination

Upstream relaying or fusing must coordinate with the transformer damage curve (IEEE C57.109), the inrush point, and the secondary main. Differential protection (87T) is recommended on units ≥ 5 MVA. Sudden pressure relay and winding temperature trip should trip the primary breaker directly. Provide the factory test report and impedance to the utility's protection engineer on request.

// 12 Maintenance

A liquid-filled transformer tells you what is wrong through its fluid. Sample it on schedule, trend it, and act on the trend, and the unit will outlive the building. Keep a log; the warranty and the insurance carrier will both ask for it.

INTERVAL	TASK	UNIT STATE
Monthly	Walk-around: leaks at gauges, valves, radiator flanges, bushings, welds; corrosion; chambers bolted; pressure relief flag; fans cycling (ONAF); radiator airflow clear; containment sump dry; vegetation cleared 3 ft.	Energized

Quarterly	Read and log liquid level, top-liquid temperature (reset drag hand), winding temperature, pressure, load current per phase, fan run hours, LTC counter. Trend against previous quarters.	Energized
Annually	IR scan of all bushing connections, flexible connectors, throat bus, and radiators under load. Test all alarm and trip contacts. Test fans and fan controls. Inspect arresters and ground leads. Touch up paint on any scratch to bare metal. Torque-check bushing connections (de-energized).	IR energized; rest de-energized
Annually (fluid)	Fluid sample from the sampling valve: dielectric strength, moisture, acidity, interfacial tension (mineral oil), color, and dissolved gas analysis (DGA). Trend per IEEE C57.104 (mineral oil) or C57.155 (natural ester).	De-energized for sampling
Every 3 years	Insulation resistance with PI, TTR on all taps, winding resistance, power factor (≥ 2500 kVA), bushing power factor (condenser bushings). Exercise the DETC through all positions (de-energized) and return to the service tap. Inspect the LTC per the LTC manual by operation count.	De-energized, grounded
After any fault or relay operation	DGA, insulation resistance, TTR, winding resistance, visual on bushings and chambers, before re-energizing. Sudden pressure relay operation: internal inspection by Bet Power field service before re-energizing.	De-energized, grounded

Fluid sampling

1. De-energize, lock out, and ground. Clean the sampling valve and flush 500 mL into a waste container.
2. Draw the sample slowly into a clean amber glass bottle (dielectric, moisture, acidity) or a gas-tight syringe (DGA). No headspace for DGA.
3. Label with serial number, date, fluid type, and top-liquid temperature. Ship to a lab reporting per ASTM D3487 (mineral oil) or D6871 (natural ester).
4. Top off only with the same fluid type, degassed and filtered. Never mix mineral oil and FR3. Contact Bet Power for the correct fluid and procedure.

Fluid limits in service

TEST	MINERAL OIL	FR3 NATURAL ESTER
Dielectric, ASTM D1816 (2 mm)	≥ 35 kV	≥ 30 kV
Moisture, ASTM D1533	≤ 30 ppm (≤ 25 ppm at 35 kV class)	≤ 300 ppm
Acidity, ASTM D974	≤ 0.20 mg KOH/g	≤ 0.30 mg KOH/g
Interfacial tension, D971	≥ 25 dyne/cm	Not applicable
Power factor, D924 at 25°C	≤ 0.5%	≤ 1.0%
DGA	Trend per IEEE C57.104 / C57.155. Acetylene above 5 ppm, ethylene rising, or total combustible gas doubling between samples is an investigate condition. Call Bet Power Engineering with the lab report.	

Do not

- Pressure-wash gauges, bushings, or the terminal box.
- Paint over the nameplate, gauges, pressure relief device, or bushing porcelain.
- Open the tank cover, hand-hole, or bushing mounting in the field. Internal work is a Bet Power field service operation.
- Close a radiator valve on an energized transformer to fix a leak; de-energize first.
- Reset a sudden pressure relay and re-energize without an internal inspection.

// 13 Troubleshooting

SYMPTOM	LIKELY CAUSE	ACTION
Secondary voltage high or low at no load	DETC setting; primary voltage off-nominal; LTC at wrong position	Measure primary; de-energize, ground, move DETC; check LTC control.
Secondary voltage unbalanced	Open primary phase; blown primary fuse; loose bushing connection	Isolate. Check fuses, bushing connections, upstream.
Loud or changing hum	Over-excitation; loose external hardware or radiator; DC offset from nonlinear load; core clamp loose (after transport shock)	Check primary voltage and tap; tighten hardware; check harmonics; if noise started after transport, call Bet Power.
Upstream trips on energization	Inrush not coordinated; differential without harmonic restraint	Review settings vs. 8 – 12 × inrush. Do not repeatedly re-close.

High top-liquid temperature	Overload; radiator valve closed; fans failed; blocked airflow; high ambient; low liquid level	Reduce load; open every valve; check fans; clear radiators; check level.
One radiator cold	Shut-off valve closed; radiator sludged	Open valve; if still cold, isolate and flush (de-energized).
Pressure stuck at 0 psi	Seal leak (gasket, gauge fitting, weld, bushing)	Locate with soap test at +3 psi (de-energized); contact Bet Power.
Pressure > +8 psi, rising	Internal gassing / incipient fault	De-energize. Draw DGA. Do not re-energize until reviewed.
Pressure relief operated	Internal fault or severe overload; over-pressurized nitrogen	De-energize. DGA and internal inspection before re-energizing.
Sudden pressure relay trip	Internal arcing fault (or relay mis-wired / vibration)	Do not re-energize. DGA, then internal inspection by Bet Power.
Fluid at containment or on tank	Gasket, radiator, bushing, valve, or weld leak	Contain. Check level. De-energize if below LOW. Contact Bet Power.
Hot spot on IR at a bushing	Loose connection; undersized connector; bushing internal failure	De-energize, retorque. If the bushing body itself is hot, replace the bushing.
DGA shows acetylene	Arcing inside the tank (DETC, lead, core ground)	Call Bet Power Engineering with the report before re-energizing.

// 14 Warranty and support

Bet Power is the manufacturer of record for this transformer and holds the warranty. The full warranty statement is published at bet-power.com/resources/documentation and governs over this summary.

- Warranty requires installation and operation in accordance with this manual, the nameplate, and applicable codes, and a maintenance and fluid-test log per Section 12.
- Warranty does not cover damage from mis-handling or transport shock after delivery, over-tilt, loss of positive pressure in storage, improper filling or fluid contamination, overload beyond IEEE C57.91 limits, operation with radiator valves closed or fans failed above the ONAN rating, lightning or switching surge without arrester protection, or field modification of the tank or internals.
- Bushings, gauges, relays, fans, LTCs, and arresters carry their manufacturer's warranty, administered by Bet Power.

Getting help

You talk to the person who built the quote and the engineer who reviewed the order. No ticket queue. Have the serial number, nameplate photo, current gauge readings, and the latest DGA report ready.

Field support and warranty	support@bet-power.com
Engineering (protection, fluid results, loading, coordination)	engineering@bet-power.com
Logistics desk, 24/7 (shipping damage, delivery)	logistics@bet-power.com
Web	bet-power.com/contact