// INSTALLATION & OPERATING MANUAL

Low-Voltage Dry Type Transformer

Receiving, handling, installation, grounding, energization, operation, and maintenance for ventilated and non-ventilated 600 V class dry type distribution transformers supplied by Bet Power.

DOCUMENT	APPLIES TO
BP-IOM-LVDT-001	15 – 2500 kVA · 208 – 600 V · UL 1561

Built for Speed. Priced for Reality.

// READ BEFORE INSTALLING

This equipment carries lethal voltages and its secondary is a separately derived system. Installation, connection, and maintenance must be performed only by qualified personnel following the NEC (NFPA 70), NFPA 70E, OSHA 29 CFR 1910 Subpart S, 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, connection diagram, tap table, 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, voltages, temperature rise, K-factor, and impedance 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 dry type transformer has exposed windings behind a bolted panel and a secondary that is a separately derived system. Nothing here replaces your site's lockout/tagout procedure, the arc-flash study, or NFPA 70E.

> // DANGER — HAZARDOUS VOLTAGE
> De-energize the primary feeder, lock out, and test for absence of voltage at both the primary and secondary terminals before removing any panel. The secondary can be back-fed from a downstream panel with a generator, PV, or UPS connection.

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) remove panels, change taps, or make connections.
2. Wear arc-rated PPE matched to the incident energy on the arc-flash label. A 480 V primary fed from a large switchboard can exceed 8 cal/cm^2 at the transformer terminals.
3. Keep all panels bolted whenever personnel are not actively working inside. The enclosure is the only barrier between the windings and people.
4. Never change taps with the transformer energized. Tap links are de-energized only.
5. Coil surfaces run at up to 150°C rise plus ambient. Do not touch windings, core, or the top of the enclosure without confirming temperature.
6. Do not store anything on top of or against the enclosure. Blocked ventilation openings overheat the windings.
7. Confirm the enclosure is bonded and the secondary system bonding jumper is installed (Section 08) before any secondary conductor is landed.

> **// WARNING — SEPARATELY DERIVED SYSTEM**
> The secondary is a separately derived system (NEC 250.30). It needs its own system bonding jumper and grounding electrode conductor, at the transformer or at the first disconnect, never both. Getting this wrong creates a shock hazard or a ground loop that defeats ground-fault protection.

// 02 Scope and product description

This manual covers Bet Power ventilated and non-ventilated low-voltage dry type distribution transformers, listed to UL 1561 and built to NEMA ST 20, single- and three-phase, 600 V class.

Typical ratings

PARAMETER	STANDARD RANGE
Rated power	15 – 2500 kVA three-phase; 15 – 167 kVA single-phase; 60 Hz
Primary voltage	208, 240, 415, 480, 600 V Delta or Wye; 120/240 or 480/240 single-phase
Secondary voltage	208Y/120, 240 Delta, 480Y/277, 480 Delta, 600Y/347 V; 120/240 or 480/240 single-phase

Taps	Two 2.5% above and four 2.5% below nominal (2A/4B) on 15 kVA and up; none on small units
Temperature rise	150°C standard; 115°C or 80°C optional (220°C insulation system)
Impedance	Per nameplate, typ. 2 – 6%
Efficiency	DOE 10 CFR 431 (2016 levels) unless otherwise specified
Sound level	NEMA ST 20 standard; typ. 45 dB (≤ 45 kVA) to 64 dB (≥ 1000 kVA)
Winding material	Aluminum standard; copper optional
Enclosure	NEMA 2 ventilated indoor standard; NEMA 3R ventilated outdoor optional; totally enclosed non-ventilated (TENV) optional; ANSI 61 gray
K-factor	K-1 standard; K-4, K-13, K-20 harmonic-mitigating optional
Options	Electrostatic shield, copper windings, seismic certification, wall/floor/trapeze mounting, weathershield

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

Standard construction

Core and coil

- Grain-oriented silicon steel core, mitered joints, clamped and bolted frame
- Windings vacuum-pressure impregnated (VPI) in polyester or epoxy varnish, 220°C insulation class
- Core and coil isolated from the enclosure on vibration-damping pads
- Primary tap links on a terminal board at the front of the coil

Enclosure and terminations

- Heavy-gauge steel enclosure with removable front and bottom panels; ventilation louvers top and bottom on ventilated units
- Lug pads or factory mechanical lugs on the primary and secondary terminal boards, AL9CU
- Ground pad inside the enclosure; X0 secondary neutral terminal
- Nameplate on the front panel: ratings, connection diagram, tap table, weight, and impedance
- Bottom conduit entry area with a removable plate; side entry on request

// 03 Receiving and inspection

Transformers ship upright on a skid, wrapped. 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 tilt / impact indicator if fitted. Check the skid and wrap for crush, puncture, or water.

03 Walk all sides. Look for dents, racked enclosure corners, damaged louvers, and scraped paint.

04 Remove the front panel and inspect: coils and core clamp intact, no cracked varnish, no shifted coil, tap links in place and tight, terminal boards undamaged, no loose hardware in the bottom.

05 Check for water. A wet dry type transformer cannot be energized until dried and megger-tested.

06 Confirm loose-shipped items: lugs, mounting brackets, weathershield (3R), drawings, and the factory test report.

07 Record everything in Appendix A. Note any damage on the bill of lading **before signing**.

> **// WARNING**
> A unit that was dropped or tipped may have a shifted coil or broken core clamp. Do not energize. Contact logistics@bet-power.com within 24 hours with photos and the bill of lading.

// 04 Storage

Dry type transformers absorb moisture. Store indoors, dry, heated, in the shipping wrap. A NEMA 3R enclosure is weather-resistant in service only when installed with its weathershield and conduit sealed; it is not a storage container.

- Keep the unit upright on the skid, off the floor, in a space above dew point. Do not stack.
- Unheated or humid space: place a 100 – 250 W space heater or lamp inside the enclosure and keep the wrap loosely closed.
- Every 30 days: check for moisture, rodents, and dust. Log it.
- Storage over 6 months, or any sign of moisture: megger before energizing (Section 09). If below limits, dry per Section 09.

CONDITION	LIMIT
Storage temperature	**–30°C to +60°C**
Relative humidity	**≤ 80%, non-condensing**
Outdoor storage	**Not permitted, any enclosure type**

// 05 Handling and moving

Weight is on the nameplate. A 300 kVA unit is roughly 1500 lb; a 1000 kVA unit can exceed 4000 lb. Size rigging for the nameplate weight plus 25%.

- Lift by the base lifting holes or the core clamp lifting eyes only, as marked on the drawing. Use a spreader bar; sling angle 60° or steeper.
- Never lift by the enclosure panels, louvers, or the coil. Never lift by the core clamp if the drawing does not show lifting eyes there.
- Forklift: forks fully under the base channels from the front or the side per the drawing. Center the load.
- Keep the unit upright. Maximum tilt: 15°.
- Small units (≤ 75 kVA) can be handled by two people using the base. Do not carry by the panels.

> **// CAUTION**
> Dragging the unit on its base across concrete can crack the varnish on the coil supports. Roll on skates or lift.

// 06 Site preparation and mounting

ITEM	REQUIREMENT
Location	Indoor, dry, ventilated, readily accessible (NEC 450.13). Not in a location subject to washdown, corrosive fumes, or conductive dust unless a NEMA 4X or TENV unit was ordered. Outdoor only with a NEMA 3R enclosure and weathershield.
Ventilation clearance (450.9)	**Per nameplate; minimum 6 in from walls on the louvered sides, and 6 in from any non-louvered side to a combustible surface. Units ≥ 500 kVA: 12 in on louvered sides recommended.**
Working space (110.26)	**3 ft in front of the terminal panel (3.5 / 4 ft for Condition 2 / 3 at 480 V); 6.5 ft headroom**
Room ventilation	The room must reject the transformer losses: allow roughly 100 cfm per kW of losses (losses are on the test report; ~1.5 – 3% of kVA for 150°C rise). A 500 kVA unit in a closed closet will overheat.
Floor	Level, rated for the weight; 4 in housekeeping pad recommended. Floor-mount on the base with anchors through the base holes. Vibration isolation pads under the base where sound transmission matters.
Wall / trapeze mount	Units ≤ 75 kVA only, on the factory bracket kit, into structure. Never on drywall alone. Keep 6 in ventilation clearance behind the unit.
Ambient	**–20°C to +40°C, 24-h average ≤ 30°C; derate 1% per °C above 40°C; ≤ 3300 ft without derate**
Conduit entry	Through the removable bottom plate or the sides below the louvers; never through the top of a ventilated unit. Seal conduits with duct seal to stop warm air convecting condensation into the enclosure.

Sound	Do not mount on a wall shared with an occupied space. Vibration pads plus flexible conduit at the terminals cut structure-borne hum.

// 07 Installation

01 Set the unit on the pad or bracket (Section 06) and anchor through the base holes. Install vibration pads first if used.

02 Remove the front panel and the shipping blocks or bolts marked "remove before installation" on the drawing. Some units ship with the core and coil bolted solid to the enclosure for transit; those bolts must come out or the unit will hum loudly.

03 Remove the conduit entry plate, cut entries, deburr, bush, and reinstall. Vacuum any chips out of the enclosure bottom.

04 Bond the enclosure ground pad to the equipment grounding conductor of the primary feeder. Do this **before any phase conductor is landed**.

05 Set the primary taps per Section 08 for the measured site voltage. Confirm every tap link is on the same tap on all three coils and torqued.

06 Land primary, secondary, neutral, and grounding conductors (Section 08).

07 Install the system bonding jumper and grounding electrode conductor per Section 08 (separately derived system).

08 Check that nothing touches the coils: conductors must clear the coil surfaces by at least 2 in and must not rest on the core clamp.

09 Reinstall the front panel and all hardware. Install the arc-flash label.

Tap settings (standard 2A / 4B, 2.5%)

TAP	PRIMARY VOLTAGE (480 V UNIT)	USE WHEN
1	504 V (+5.0%)	Site primary runs high; secondary reads high
2	492 V (+2.5%)	Site primary slightly high
3	480 V (nominal, as shipped)	Site primary at nameplate
4	468 V (−2.5%)	Site primary slightly low
5	456 V (−5.0%)	Site primary low
6	444 V (−7.5%)	Site primary well below nominal
7	432 V (−10%)	Site primary well below nominal

> // NOTE — WHICH WAY
> Secondary too high with the primary at nominal: move to a higher-numbered voltage tap (fewer secondary volts per primary volt). Secondary too low: move toward tap 7. The nameplate tap table governs over this example.

// 08 Electrical connections

Primary

- Terminate on the primary terminal board lugs (AL9CU, 75°C). Aluminum conductors: wire-brush and apply oxide inhibitor.
- Phase sequence H1-H2-H3 matches the feeder A-B-C. On a Delta primary the phase order sets the secondary rotation; verify at energization.
- Primary overcurrent protection per NEC 450.3(B): 125% of primary full-load current (next standard size up) with secondary protection at 125%, or per the table. The primary breaker or fuse must also handle inrush; see Section 10.
- Land the primary equipment grounding conductor on the enclosure ground pad.

Secondary

- Terminate on the secondary terminal board lugs X1-X2-X3 and X0 neutral. Size secondary conductors per NEC 240.21(C) for the tap rule that applies (10 ft, 25 ft, or outside).
- Secondary neutral (X0) is full-rated on Wye units. For harmonic loads consider 200% neutral conductors on K-rated units.
- Do not land a secondary equipment ground on X0. It goes on the ground pad.

Separately derived system grounding (NEC 250.30)

- **System bonding jumper:** connects X0 to the enclosure ground pad. Install it at the transformer (standard) **or** at the first secondary disconnect, never both. Size per 250.102(C) based on the secondary conductors.
- **Grounding electrode conductor:** from X0 (or the ground pad, at the same point as the system bonding jumper) to the nearest effectively grounded building steel or metal water pipe within 5 ft of entry, or the building grounding electrode system. Size per 250.66.
- **Supply-side bonding jumper:** from the transformer ground pad to the first disconnect enclosure, sized per 250.102(C), run with the secondary conductors.
- Record in Appendix A where the system bonding jumper was installed.

Torque

TERMINAL	TYPICAL TORQUE	GOVERNS
Lug, #14 – #10	35 in·lb	Value on the lug or nameplate
Lug, #8 – #4	45 in·lb	Value on the lug or nameplate
Lug, #3 – 350 kcmil	250 – 275 in·lb	Value on the lug or nameplate
Lug, 400 – 750 kcmil	375 in·lb	Value on the lug or nameplate
Bus pad bolt, 3/8 in	20 ft·lb	Belleville under every nut
Bus pad bolt, 1/2 in	40 ft·lb	Belleville under every nut
Tap links	Per nameplate, typ. 60 – 120 in·lb	Nameplate

Flexible conduit or a short run of cable at the transformer terminals prevents vibration transmitting into rigid conduit and loosening lugs over time.

// 09 Pre-energization checks

Every item below is a hold point. Record results in Appendix A.

- ☐ Nameplate voltages and connection match the feeder and the one-line. Primary overcurrent device sized per 450.3(B).
- ☐ All shipping bolts and blocks removed. Enclosure panels reinstalled, louvers unobstructed, nothing stored on or against the unit.
- ☐ Tap links on the same tap on all coils, torqued, position recorded.
- ☐ Enclosure bonded to the feeder equipment ground. System bonding jumper installed at one point only; grounding electrode conductor landed; location recorded.
- ☐ Every lug and tap link torqued with a calibrated tool and striped. Conductors clear of coils by 2 in.
- ☐ Insulation resistance (megger) with primary and secondary isolated: 1000 V DC primary-to-ground, primary-to-secondary, secondary-to-ground (500 V DC for 240 V windings). Acceptable: ≥ 100 MΩ each at 20°C; compare with the factory test report. Lift the system bonding jumper for the secondary-to-ground test and reinstall it after.
- ☐ If any reading is below 100 MΩ, dry the unit: 100 – 250 W heaters or lamps inside the enclosure with the panels off, or a fan circulating warm dry air, for 24 – 72 hours. Retest every 12 hours; energize only when the reading is stable and above limit.
- ☐ Enclosure interior vacuumed; no metal chips, tools, or hardware in the bottom.
- ☐ Downstream: secondary disconnect open, all loads off, no backfeed sources connected.
- ☐ Arc-flash label installed. Working space clear. Fire extinguisher (Class C) within reach.

// 10 Energization

01 All panels on. Secondary disconnect open. Nobody stands in front of the terminal panel; the person operating stands at the upstream device.

02 Energize the primary from the upstream breaker. Listen for 60 seconds. A steady hum is normal; rattling means a loose panel or a shipping bolt still in place, and a loud buzz means the core clamp is loose or a shipping bolt is missing.

03 Verify secondary voltage phase-to-phase and phase-to-neutral at the secondary disconnect line side with a rated meter. Voltage within ±2.5% of nominal at no load. Adjust taps only after de-energizing.

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

05 Run at no load for 30 minutes. Check for smell (fresh varnish smell is normal for the first days of operation; burning is not).

06 Close the secondary disconnect and apply load in steps.

07 After 4 hours at operating load, IR scan the terminal boards through the ventilation openings or with the panel off (then de-energize to reinstall). No lug more than 15°C above adjacent phases.

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

> **// WARNING — INRUSH**
> Magnetizing inrush on a dry type transformer can reach 10 – 15 × full-load current for the first cycles. A primary breaker that trips on energization is set too low on instantaneous, not a transformer fault. Do not repeatedly re-close; correct the setting or fuse type.

// 11 Operation

Loading

CONDITION	ALLOWABLE	LIMIT
Continuous, 30°C avg / 40°C max ambient	100%	Indefinite
Ambient above 40°C	Derate 1% per °C	Never above 50°C ambient
Short-time overload, from 50% preload	140%	1 hour, then ≤ 100%
Short-time overload, from 90% preload	115%	1 hour, then ≤ 100%
Lower-rise units (115°C / 80°C)	115% / 130% continuous	At 150°C rise equivalent; nameplate governs
Nonlinear load on a K-1 unit	Derate per IEEE C57.110	Or use a K-rated unit

Every 10°C of sustained winding temperature above design roughly halves insulation life. A transformer loaded to 100% in a 45°C mechanical room is being consumed, not used.

Temperature

Enclosure surface at the top can reach 65 – 90°C in normal operation on a 150°C rise unit; that is expected. Winding temperature is not visible without a winding temperature indicator; where one is fitted, alarm at 180°C and trip at 200°C for a 220°C insulation system.

Sound

Hum increases with primary voltage above nominal (over-excitation), with harmonic load current, and with a loose core clamp or enclosure panel. A change in sound level is the earliest sign of a problem; investigate it.

Changing taps in service

De-energize primary and secondary, lock out, test, and ground. Move every tap link to the same position on all three coils. Torque. Record the position. Re-energize and verify secondary voltage at no load.

// 12 Maintenance

Dry type transformers fail from dirt blocking cooling, moisture on the coils, and loose connections. Maintain per NFPA 70B and keep a log.

INTERVAL	TASK	UNIT STATE
Monthly	Walk-around: louvers unobstructed, nothing stored against the unit, no change in sound, no discoloration on the enclosure, room ventilation running.	Energized

Quarterly	Read and log load current per phase and secondary voltage at the disconnect. Check per-phase balance. Check enclosure surface temperature with an IR gun; log it against the previous quarter.	Energized
Annually	IR scan the terminal boards through the louvers under ≥ 40% load. De-energize: remove panels, vacuum the coils, core, and enclosure bottom; wipe louvers; check tap links and lugs for discoloration; torque-check lugs; check core clamp bolts; inspect varnish for cracks or tracking; megger primary and secondary.	IR energized; rest de-energized
Every 3 years	All of the annual tasks plus: clean the coils with a vacuum and soft brush (never compressed air toward the coils); inspect vibration pads; verify system bonding jumper and grounding electrode conductor intact; check secondary neutral current under load against phase current.	De-energized, locked out
After any fault	Megger, inspect coils for discoloration or movement, check the core clamp, verify tap links, before re-energizing.	De-energized

Test limits in service

TEST	ACCEPTABLE	INVESTIGATE
Insulation resistance, 1000 V DC, 1 min	≥ 100 MΩ at 20°C	< 100 MΩ, or a 50% drop from the last test
Polarization index (10 min / 1 min)	≥ 1.5	< 1.5: moisture or contamination; dry and clean
IR, any lug	≤ 15°C over adjacent phase	15 – 40°C repair at next outage; > 40°C repair now
Enclosure top surface	≤ 90°C on a 150°C rise unit	> 90°C: overload, blocked ventilation, or high ambient
Secondary voltage balance	≤ 2%	> 2%: loose connection or primary unbalance

Do not

- Blow compressed air into the coils. It drives dust into the winding ducts where it cannot be removed. Vacuum only.
- Use solvent on the coils. Varnish is the insulation.
- Paint the coils, core, or louvers. Paint on the louvers cuts airflow.
- Re-varnish in the field. That is a shop operation.
- Run the transformer with a panel off for cooling. It changes the airflow path and exposes the windings.

// 13 Troubleshooting

SYMPTOM	LIKELY CAUSE	ACTION

Primary breaker trips on energization	Inrush not coordinated; instantaneous set too low; wrong fuse type	Correct the setting or use time-delay fuses. Do not repeatedly re-close.
Secondary voltage high or low at no load	Tap setting; primary voltage off-nominal	Measure primary; de-energize and move taps per Section 07.
Secondary voltage unbalanced	Open primary phase; tap links on different taps; loose lug; unbalanced single-phase load	Check primary at H1-H2-H3; verify tap links; torque; rebalance load.
Loud hum or rattle	Shipping bolt left in; loose panel or core clamp; primary over-voltage; harmonic load	Remove shipping bolts; tighten; check tap; check THD.
Runs hot / smells hot	Overload; blocked louvers; room ventilation failed; high ambient; nonlinear load on K-1 unit	Measure load; clear louvers; fix ventilation; check THD.
Hot spot on IR at a lug	Loose lug; undersized conductor; aluminum without inhibitor	De-energize, clean, re-terminate, torque, stripe.
Low megger reading	Moisture; dirt on the coils; condensation from conduit	Dry per Section 09; clean; seal conduits with duct seal.
Ground-fault trips downstream	System bonding jumper installed in two places; neutral-ground bond downstream	Verify one bond only per Section 08.
Neutral current high	Harmonic (triplen) loads; unbalance	Measure THD; rebalance; consider K-rated replacement.
Varnish smell	Normal curing for the first 1 – 2 weeks of loaded operation	Monitor. Burning smell or smoke is not normal: de-energize.

// 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 log per Section 12.
- Warranty does not cover damage from mis-handling, moisture ingress, blocked ventilation, overload beyond Section 11 limits, nonlinear loading beyond the K-rating, primary over-voltage, or field modification.

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, tap position, and the latest megger and load readings ready.

Field support and warranty	support@bet-power.com
Engineering (taps, K-factor, protection sizing)	engineering@bet-power.com
Logistics desk, 24/7 (shipping damage, delivery)	logistics@bet-power.com
Web	bet-power.com/contact