



Instructions

Installation, Operation, and Maintenance of Substation
Transformers through 30,000 kVA





READ THIS IMPORTANT SAFETY INFORMATION

Read these instructions carefully and become familiar with the equipment before proceeding with installation, operation, or maintenance activities. This equipment contains extremely hazardous voltages. To prevent death, serious personal injury, or equipment damage, all information in these instructions should be read and observed. Safe use of this equipment is dependent on proper installation, operation, and maintenance procedures.

Certain information in this manual is marked with the words DANGER, WARNING, or CAUTION, which indicate hazards.

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious personal injury, and damage to the equipment.

WARNING indicates a potentially hazardous situation which, if not avoided, may result in death or serious personal injury, and/or damage to the equipment.

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate personal injury, and/or damage to the equipment.

No one should attempt to service or perform maintenance activities on the equipment until it has been effectively de-energized, and all high-voltage and low voltage bushing terminals have been properly grounded. Only qualified personnel should install, maintain, and operate this equipment. Qualified personnel are those who are trained in the installation, maintenance, and operation of high voltage equipment, trained in the proper use of personal protective equipment (such as rubber gloves, safety glasses, protective clothing, hard hats, etc.) and trained in appropriate first aid procedures.

The instructions contained herein are intended to be a general guide for the installation, operation and maintenance of this equipment, when operated in "Usual Service Conditions" as defined in IEEE Standard C57.12.00. Features presented herein may not be present in all equipment designs. Standard and optional features are subject to change without notice.

Although efforts have been made to ensure accuracy and completeness, these instructions do not address every conceivable application or circumstance that might be encountered. JCL Energy makes no representation or warranty with respect to, and assumes no responsibility for the completeness, accuracy, sufficiency, or usefulness of, these instructions.

Questions regarding installation, operation, and maintenance of the equipment, particularly when encountering unusual or special circumstances that may not be sufficiently covered by these instructions, should be directed to the JCL Energy.

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SECTION 1: RECEIVING INSPECTION

These instructions apply to substation transformers manufactured by JCL Energy. It is important to read the safety information on page 2 before attempting any installation, operation, or maintenance activities.

Although all transformers, components, and accessories are carefully inspected and tested prior to shipment, a thorough receiving inspection should be conducted to detect any damage or loss that might have occurred during shipment. The receiving inspection should be completed upon receipt and before unloading from the truck. Note any damage or discrepancies on the bill of lading, file a claim with the carrier, and notify the JCL Energy prior to unloading the transformer.

Drawings and Documents

Locate all shipping papers, packing lists, outline drawings, and other pertinent information. Use these documents and this manual during the inspection.

The transformer outline drawing indicates the locations of nameplates and warning labels, and provides physical dimensions and weights. The nameplate provides electrical characteristics, winding connections, and weights. The wiring diagram provides details of control, fan and alarm wiring.

DO NOT REMOVE OR OBSCURE ANY WARNING LABELS OR NAMEPLATES.

External Inspection

The following external inspections should be made at a minimum.

1. Verify that all equipment, accessories, and components listed on the bill of lading are present.
2. Ensure there are no signs of external damage.
3. Verify the paint finish has not been damaged.
4. Ensure that fittings, conduit, wiring, and other attachments are tight and undamaged.
5. Check for evidence of fluid leakage on the tank, valves, or cooling assemblies.
6. Check for damage to the bushings.
7. Check for damage to the shipping crates, packages, or other materials shipped separately from the transformer.

Tank Pressure

The tank vacuum/pressure gauge may indicate positive or negative when the transformer is received, depending on the relative fluid and ambient temperatures. This indicates that the transformer is sealed effectively. If the vacuum/pressure gauge reads zero, this may indicate the possibility of a tank leak; although, a zero reading can occur occasionally with changing internal and external temperatures. In the case of a zero reading, the tank should be pressure tested according to the instructions on page 9 (*Pre-energization Tests and Checklist*). Report any suspected tank leaks to the JCL Energy.

Internal Inspection

An internal inspection of the transformer tank is rarely necessary and is required only when there are indications that the transformer has received severe impact damage during transit. If an internal inspection is necessary, follow the instructions on page 7 for opening the transformer tank. Contact the JCL Energy before proceeding with any internal inspection.

SECTION 2: HANDLING

Lifting

Lifting hooks are provided near the top of the transformer tank for lifting. All four lifting hooks must be used simultaneously. The transformer must not be lifted from any points other than the provided lifting hooks. It is recommended that spreader bars be used to keep the lifting cables nearly vertical, reducing the likelihood of tank deformation or damage to painted surfaces. Transformers should be lifted in an upright position, allowing no more than 15 degrees of tilt from vertical. Lifting cables shall be no more than 20 degrees from vertical.

Jacking, Skidding, and Rolling

Jacking pads are provided at all four corners of the transformer base for use in jacking. Do not use cooling fins or pipes, valves, or sheet metal surfaces for jacking. Jacking must be done from two adjacent corners simultaneously to prevent warping of the tank bottom. When rolling, use an adequate number of rollers to distribute the transformer's weight evenly.

Refer to the transformer outline drawing for the location of jacking pads on the transformer tank.

SECTION 3: STORAGE

Transformer Storage

Transformers can be stored if properly prepared. It is recommended that stored transformers be completely assembled. Prior to storage, transformers should be pressure tested according to the instructions on page 9

(*Pre-energization Tests and Checklist*). The gas space above the insulating fluid should be pressurized with dry nitrogen to a pressure between two and three PSIG.

This will prevent a negative internal pressure which might draw moisture into the tank.

If the transformer is not completely assembled, separate components and accessories should be stored in a clean dry area in their original shipping containers.

Extended Storage

If the transformer is to be stored for an extended period of time before being placed into service, it should be placed on a firm level surface.

All space heaters (if supplied) in terminal chambers, switch cabinets, control cabinets or other enclosures, must be connected and energized at all times to control moisture. If it is not practical to energize the control cabinet space heater, desiccant packets may be used to control moisture in control cabinets only. Desiccant packets must be replaced periodically to maintain effectiveness. It is recommended that the transformer be inspected periodically while it is in extended storage.

Results should be recorded and compared with previous results to ensure that no damage or change in condition has occurred.

SECTION 4: INSTALLATION

Location and Mounting

The transformer should be mounted on a level concrete foundation of sufficient strength to support the weight of the completely assembled transformer.

If the transformer is not level, insulating fluid may not circulate properly through the cooling assembly, possibly causing overheating and reduced transformer life. The mounting location should provide for adequate ventilation and easy access for inspection. The transformer should be located at least 24 inches from any obstruction. When installing transformers designed for indoor operation, adequate air inlets and outlets must be provided for proper cooling. Avoid locating transformers in corrosive areas.

Opening Transformer Tank

Transformers are usually shipped sealed and should not be opened unless necessary.



DANGER

SLOWLY RELEASE INTERNAL PRESSURE PRIOR TO REMOVING TANK ACCESSORIES. FAILURE TO DO SO COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE



DANGER

TO AVOID DEATH FROM SUFFOCATION NEVER ALLOW ANYONE TO ENTER THE TRANSFORMER TANK UNLESS AN ANALYSIS OF THE AIR IN THE TANK SHOWS AT LEAST 19.5% OXYGEN. THE GAS SPACE IN AN OPERATING TRANSFORMER USUALLY CONSISTS OF NITROGEN GAS. WHENEVER ANYONE IS IN THE TANK, A PERSON SHOULD BE STATIONED AT THE HAND HOLE OUTSIDE THE TANK TO ENSURE SAFETY OF THE PERSON INSIDE.

Transformer should not remain open for more than 12 hours at a time. If work is interrupted, the tank should be resealed, evacuated, and filled

with dry air or nitrogen.

To prevent contamination of the transformer tank, do not open the transformer in an unprotected area during inclement weather or where the air may contain dirt or other particles. Either of the above could cause a transformer failure. The tank opening should be protected against entry of foreign matter.

If it is necessary to remove some fluid from the tank to allow for inspection or other work, the transformer must be refilled with fluid after work is completed.

Personnel should not be permitted on top or inside the transformer while it is open unless they have emptied all pockets and checked for loose objects that might fall into the tank. All tools should be accounted for after work is completed. It is recommended that any tools used on top of the transformer or inside the tank be attached with safety cords to prevent them from being lost inside the transformer.

Personnel must not stand directly on any electrical insulation. Clean cloths should be used under working areas in the transformer to prevent objects from dropping into the core/coil assembly.

The following procedure should be used to remove the hand hole cover.

1. Thoroughly clean the hand hole cover. Remove all moisture, dirt, and grease to avoid contaminating the transformer's fluid compartment.
2. Relieve internal tank pressure by manually operating the pressure relief valve or gas filling valve.
3. Remove cover fasteners.
4. Gently pry the cover upward, making sure that the cover gasket does not fall into the tank. Lift the cover vertically to prevent damage to cover, bolts, and gasket.
5. Remove the gasket sections from the hand hole flange. Record the location and orientation of each gasket piece so they can be reinstalled correctly.

The following procedure should be used to reinstall the hand hole cover.

1. Place gasket sections in their original positions and orientations.

2. Reinstall hand hole cover. Reinstall fasteners and torque to 25 ft-lbs. After tightening all fasteners, re-torque each one to ensure proper torque.
3. Pressurize the headspace to 4 PSIG and check for fluid leaks. This pressure should be maintained for at least four hours.

When the internal inspection is complete, reseal the tank and refill with fluid (if any was removed prior to inspection). The gas space should be filled with dry air or dry nitrogen to 2 PSIG. Contact the JCL Energy if any internal damage is found during the internal inspection.

Installation of Detachable Radiators

When radiators are shipped detached, they should be installed according to the instructions below.

1. Verify that all valves on the tank are in the closed position.
2. Remove shipping plates from the valves on the tank and from the radiator flanges. Take care not to damage gaskets.
3. Inspect for moisture and contamination inside the radiator headers. Contact the JCL Energy if any contamination is found.
4. Clean all mating surfaces on the tank valves and radiator flanges and apply a small amount of petroleum jelly to the gaskets on the tank valve flanges to hold them in place during installation of the radiators.
5. Lift the radiators into position using the lifting eyes on top of the radiators and align holes in the radiator flanges with holes in the valve flanges. If fans are provided, attach the radiators having fans first, then attach the other radiators.
6. Insert bolts in the top and bottom flanges with bolt heads adjacent to the transformer tank.
7. Tighten bolts evenly alternating across corners until metal-to-metal tightness is achieved at all four corners of each flange

Filling Installed Radiators with Fluid

Follow the steps below to fill installed radiators with insulating fluid.

During the process do not allow the fluid level to drop below the top of the core and coil assembly. If the fluid level in the transformer becomes too low, stop the radiator filling procedure and add fluid to the tank before completing the filling process.



DANGER

TRANSFORMER OIL SHOULD ALWAYS BE HANDLED AS A FLAMMABLE FLUID. UNDER SOME CONDITIONS, SEALED TRANSFORMER TANKS MAY ACCUMULATE EXPLOSIVE GASES AND THE HANDLING OF TRANSFORMERS MAY GENERATE STATIC ELECTRICITY. SAFETY PRECAUTIONS BEFORE OIL FILLING OR FILTERING SHOULD INCLUDE PURGING ALL GAS SPACES WITH NITROGEN, GROUNDING THE TRANSFORMER, ALL BUSHINGS, AND ALL OIL HANDLING EQUIPMENT. FAILURE TO DO SO COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR EQUIPMENT DAMAGE.



WARNING

TRANSFORMERS SHOULD NOT BE LEFT UNDER VACUUM EXCEPT DURING THE VACUUM FILLING OPERATION. THE TANK SHOULD BE UNDER POSITIVE PRESSURE DURING PERIODS OF RAIN OR HIGH HUMIDITY IN ORDER TO PREVENT MOISTURE FROM BEING DRAWN INTO THE TANK. FAILURE TO FOLLOW THESE PRECAUTIONS COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR EQUIPMENT DAMAGE.

1. Loosen the top header plugs and slowly open the bottom radiator valves one at a time to start the flow of fluid.
2. Add fluid to the tank if necessary during the process to maintain the proper fluid level in the tank.
3. After the radiators are filled, open the top radiator valves.
4. Remove the top header plugs and reinstall them using Teflon pipe thread tape.
5. Ensure that top and bottom radiator valves on each radiator are in the full "OPEN" position.
6. Observe the fluid level gauge and ensure that the fluid level is correct. If the level is low, add fluid to the tank.

Installation of Surge Arresters

Surge arresters should be installed according to the following instructions and the outline drawing.



WARNING

FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR EQUIPMENT DAMAGE.

1. Carefully unpack and inspect surge arresters for damage.
2. When installing arresters, all mounting feet must be flush with the mounting surface before tightening bolts. Use shims if necessary.
3. Do not climb or stand on arrester. Do not place undue mechanical stress on arrester.
4. Use only the lifting devices provided on the arrester for lifting.
5. Arrester exhaust ports (if supplied) must be oriented so that exhaust will be directed away from other arresters and other equipment.

Installation of Air Terminal Chamber and 15 KV and 5 KV Switchgear Adapters

Air terminal chambers (if provided) are designed to protect personnel from high voltages and to provide a clean, dry environment for bushings. Air terminal chambers must be installed according to instructions on the drawing. Refer to transformer outline drawing, detail drawing, and station plan drawing.



WARNING

IMPROPER INSTALLATION OF CONNECTING CHAMBERS AND ADAPTERS MAY ALLOW WATER OR OTHER CONTAMINANTS TO CONTACT LIVE PARTS, POSSIBLY RESULTING IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.

Securely attach the flexible connectors supplied by the switchgear manufacturer to the switchgear bus bars. The number of flexible connectors supplied is determined by the transformer current and not by the current rating of the bus bar.

Check the length of flexible connectors and ensure that there is approximately 0.375 inch (10 mm) of slack. This will permit some movement of the bus bars to allow for expansion and contraction and possible settling of the transformer. Securely attach the ground bus connection between the transformer and switchgear.

Before reinstalling the adapter housing, check for adequate electrical clearances as indicated on the outline drawing and check tightness of connections and supports. Complete the installation by assembling the housing. Install the adjustable plate and ensure proper gasket sealing of the switchgear throat.

Pre-energization Tests and Checklist

The following tests and checks should be performed at a minimum to ensure that the transformer is ready to be energized. Do not energize the transformer without performing these tests and checks.

1. Insulating Fluid Test. Draw a fluid sample and test its dielectric strength. Dielectric strength of the new fluid should be 35 kV or greater.
2. Pressure Test. Check the transformer tank for leaks by pressurizing the tank with dry air or dry nitrogen through the pressure test fitting to a pressure of 3 to 4 PSIG. Let the tank stand under pressure for one to two hours, then examine the tank and fittings for leaks. Leaks above the fluid level can be detected by applying soap solution to all welds, joints, pipe fittings, and cable connections. Upon completion of this test, reduce the internal pressure to 1 or 2 PSIG.
3. Insulation Megger Test. Perform a 1000-Volt Megger test and a power factor test to ensure that none of the windings are grounded.
4. Ratio Test. Perform a ratio test at each tap position to ensure that transformer coil ratios and tap changer connections are correct.
5. Continuity Test and Resistance Test. Perform a continuity check on each winding.
6. Line Connections. In preparation for making line connections, check to make sure that all mating connector surfaces are clean and smooth. Connections must be tightened appropriately to prevent overheating and possible subsequent failure of the connection. Connections should be made with care to avoid placing undue stress on the bushings.
7. Tap Changer Setting. Check the tap changer setting to ensure it is set to the proper position for the required voltage.

8. Delta/Wye and Series/Multiple Switch Settings. Check delta/wye and series/multiple switch settings to make sure they are set correctly. If these connections are made using an internal terminal board, check to ensure that these connections are made properly according to the chart on the transformer nameplate. If the transformer is equipped with an internal terminal board, refer to page 7 for instructions and warnings prior to opening tank.
9. Grounding. Check to ensure that the transformer tank is permanently and effectively grounded. The transformer tank ground pad is located near the bottom of the tank.
10. Wiring. Check wiring of control and alarm circuits (if provided) to make sure there are no loose connections and no damage to insulation.
11. Fluid Level. Check to make sure the fluid level is correct as indicated by the fluid level gauge.
12. Tank Finish. Check all painted surfaces to make sure that there is no damage or corrosion.
13. Bolted Connections. Check all bolted connections for tightness.
14. Tools. Check to make sure that all tools and equipment are accounted for and have been removed from the transformer.
15. Fluid Temperature. Read the fluid temperature gauge and make sure the temperature is no lower than minus 20°C before the unit is energized.

SECTION 5: COMPONENTS AND ACCESSORIES

Refer to the outline drawing for a list of accessories furnished with the transformer.

Transformer Nameplate

A nameplate is supplied on each transformer according to ANSI standard C57.12.00. The nameplate provides certain physical and electrical information about the transformer.

Control Cabinet

Refer to the wiring diagram for a description of electrical circuits inside the control cabinet. Use caution when testing alarm switches to prevent damage to the switch.

DANGER

THE CONTROL CABINET CONTAINS DANGEROUS VOLTAGES. DEENERGIZE THE CONTROL CABINET VOLTAGE SUPPLY PRIOR TO PERFORMING WORK INSIDE THE CONTROL CABINET OR ON EXTERNAL ACCESSORIES CONNECTED TO EQUIPMENT WITHIN THE CONTROL CABINET. FAILURE TO DO SO COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.

Alarm Switch Ratings

When control wiring or alarm contacts are provided, refer to the control wiring diagram, or the outline drawing for contact type, contact ratings, and terminal locations.

Current Transformers

Current transformers (if provided) are mounted inside the transformer tank around the transformer line leads. For cover-mounted bushings, current transformers are located underneath the transformer cover. For tank-wall mounted bushings, current transformers are usually located on top of the core and coil assembly. Current transformer leads are always terminated inside a junction box. Refer to the transformer wiring diagram to identify the wire markings. Current transformer leads are always shorted and grounded to the tank at the factory before shipment.

WARNING

CURRENT TRANSFORMER SECONDARIES MUST BE CONNECTED TO A LOAD OR SHORT CIRCUITED TO AVOID DAMAGING VOLTAGES AT THE TERMINALS. FAILURE TO MAKE THESE CONNECTIONS COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.

Pressure/Vacuum Gauge

The pressure/vacuum gauge indicates the pressure in the tank gas space relative to atmospheric pressure.

The pressure will normally vary as a function of transformer temperature. If the transformer is lightly loaded or de-energized during times of low ambient temperature, the gauge may indicate a negative pressure.

Pressure/Vacuum gauges can be supplied with an optional alarm/signal switch. Refer to the schematic wiring diagram furnished with the transformer.

WARNING

IF THE PRESSURE/VACUUM GAUGE CONSTANTLY READS ZERO UNDER VARYING LOAD AND AMBIENT CONDITIONS, THE TRANSFORMER SHOULD BE CHECKED FOR A POSSIBLE TANK LEAK. A LEAK WILL ALLOW MOISTURE AND AIR TO ENTER THE TRANSFORMER, WHICH COULD DEGRADE THE INSULATION AND FLUID. LEFT UNREPAIRED, LEAKS COULD LIMIT TRANSFORMER LIFE OR CAUSE A VIOLENT FAILURE THAT COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR EQUIPMENT DAMAGE.

Automatic Pressure Relief Device

Small power transformers are sometimes furnished with a weatherproof, cover-mounted automatic pressure relief device (PRD) to relieve excessive tank pressures that might occur during operation of the transformer.

The device consists of a self-resetting, spring-loaded diaphragm and a visual indicating flag. When gas pressure in the tank exceeds the PRD's specified limit, the gas pressure will open the diaphragm, vent the excess pressure, and trip the visual indicating flag.

After the internal pressure decreases below the PRD reseal rating, the valve will automatically close and reseal the transformer. The visual indicating flag must be manually reset. The cause of PRD activation should always be investigated since pressure venting indicates a potential problem inside the transformer.

WARNING

DO NOT ATTEMPT TO DISASSEMBLE
A PRESSURE RELIEF DEVICE.
TO DO SO COULD RESULT IN EQUIPMENT
DAMAGE AND SEVERE PERSONAL INJURY.

PRDs can be supplied with an optional alarm/signal switch. Refer to the schematic wiring diagram furnished with the transformer.

Fluid Level Gauge

The fluid level gauge indicates the fluid level inside the tank. The transformer tank is filled with fluid at the factory to the normal level at a reference temperature of 25°C.

Fluid Temperature Gauge

The fluid temperature gauge indicates the fluid temperature at the top of the fluid column. The temperature gauge is mounted in a dry, leak proof well, permitting removal of the gauge without lowering the fluid level in the tank. The gauge is furnished with a resettable drag-hand pointer which indicates the maximum temperature reached since it was last reset.

The drag-hand can be reset by rotating the magnet at the center of the dial or, on some models, by pressing a reset button.

During normal operation the fluid temperature gauge should read less than the sum of the ambient temperature and the rated temperature rise. For example, a 50°C gauge reading at an ambient temperature of 25°C yields a top oil temperature of 75°C, which is below the transformer's 85°C rated temperature rise.

Winding Temperature Gauge

Transformers may be furnished with a gauge that displays estimated winding hot-spot temperature. The gauge uses a probe that measures the temperature of the transformer fluid plus auxiliary heat from a heating element that is energized by a current transformer mounted inside the transformer tank.

The gauge's temperature probe is mounted in a dry well, permitting removal of the gauge without lowering the fluid level. The gauge is furnished with a resettable drag-hand pointer that indicates the maximum temperature reached since it was last reset. The drag-hand can be reset by rotating the magnet at the center of the dial, or on some models, by means of a pushbutton.

Winding temperature gauges can be supplied with an alarm/signal switch. Refer to the schematic wiring diagram furnished with the transformer.

Thermal Overload Relay

Transformers may be supplied with a thermal overload relay which is similar in operation to the winding temperature gauge described above. The relay provides alarm/signal contacts that close at approximately 100% and 110% rated load.

Rapid Pressure Rise Relay

The optional rapid pressure rise relay (RPRR) monitors the rate of pressure rise in the transformer's oil space and signals when the rate exceeds a safe threshold.

This signal can trigger circuit breaker operation to de-energize the transformer and can send an alarm. The RPRR will not be actuated by normal pressure variations during operation of the transformer. A seal-in relay latches the output relay and illuminates an indicator lamp until the unit is manually reset. The seal-in relay and associated circuitry is mounted in a separate control cabinet.

If the RPRR has activated, internal arcing has likely occurred in the transformer tank, and the cause of such arcing must be investigated. The following steps are suggested to determine if there are any damages to the transformer and if so, to what extent.

1. Using a combustible gas detector, check for combustible gas products of decomposition in the gas space. Refer to the operating instructions that came with the gas detector.
2. Test the RPRR and seal-in relay panel to make sure they are operating properly. Refer to instructions furnished with RPRR and seal-in relay panel.
3. Test for insulation power factor, insulation resistance tests, and transformer turns ratio.
4. Remove the hand hole cover and inspect the tank interior for appearance and smell. A burning odor may be present.
5. Make any other tests which may be appropriate considering results of the tests listed above.

Transformer Cooling Fans

Optional cooling fans may be provided to increase the transformer load capability without overheating the transformer windings. Operation of the fans is controlled by a contact in the fluid temperature gauge or winding temperature gauge (when furnished) and by an “auto/manual” control switch. Controls for the fans are contained in a control cabinet mounted on the transformer.

DANGER

ALWAYS DE-ENERGIZE THE FAN CIRCUIT WHEN INSTALLING OR PERFORMING MAINTENANCE ON FANS. IN ADDITION, DE-ENERGIZE THE TRANSFORMER WHEN IT IS POSSIBLE TO COME CLOSE TO LIVE PARTS. FAILURE TO DO SO COULD RESULT IN SEVERE PERSONAL INJURY OR DEATH.

FAN GUARDS ARE FURNISHED AND INSTALLED AT THE FACTORY TO PREVENT ACCIDENTAL CONTACT WITH ROTATING FAN BLADES. DO NOT REMOVE FAN GUARDS OR ALLOW PERSONNEL TO REACH INSIDE A GUARD. DOING SO CAN RESULT IN SERIOUS PERSONAL INJURY AND EQUIPMENT DAMAGE.

The auto/manual switch determines the mode of operation for the fan motors. When the switch is in the “manual” position, fans will operate continuously.

When the switch is in the “auto” position, fans will be automatically controlled by contacts in the fluid temperature gauge or winding temperature gauge.

Refer to the schematic wiring diagram provided with the transformer.

Fan motors are provided with thermal overload protection. The overload protection is usually contained within the motor. However, if the motors are located in a hazardous location, the overload protection device may be located in the control box. Refer to the wiring diagram provided with the transformer.

Fan motors have permanently sealed ball bearings and do not normally require maintenance, except as explained on page 15.

When fan assemblies are installed by the user, it is important to permanently remove the drain plug from the motor housing of each motor. This will allow condensation to drain from the motor housing.

De-energized Tap Changer

The de-energized tap changer may be used to adjust the voltage ratio of a transformer while it is de-energized. It is intended to allow adjustment of the output (secondary) voltage to the rated value. Do not use the tap changer to raise or lower the output voltage to any voltage other than that indicated on the transformer nameplate. If the tap changer is set to provide an output voltage different from rated voltage, a high noise level, high core loss, and core saturation may result.

DANGER

DO NOT OPERATE A DEENERGIZED TAP CHANGER UNLESS THE TRANSFORMER IS TOTALLY DE-ENERGIZED.

FAILURE TO DO SO WILL RESULT IN DAMAGE TO THE TRANSFORMER AND COULD RESULT IN SEVERE PERSONAL INJURY OR DEATH. DO NOT RE-ENERGIZE THE TRANSFORMER UNLESS THE TAP CHANGER IS FIRMLY LOCKED INTO POSITION.

The tap changer is operated by use of a rotating handle located on the outside of the transformer tank. Never operate a de-energized tap changer while the transformer is energized.

Tap changers normally have five or seven tap positions as indicated on the tap changer dial plate and the transformer nameplate. A locking mechanism is provided to lock the tap changer in position and prevent accidental operation. Do not re-energize the transformer until the tap changer is firmly locked into a tap position.

The transformer is shipped from the factory with the tap changer in the rated voltage position, unless otherwise specified by the customer.

Dual-Voltage or Delta/Wye Switch

Transformers designed with dual-voltage windings or re-connectable delta/wye windings as indicated on the nameplate are provided with a de-energized two-position dual-voltage or delta/wye switch. The transformer must be completely de-energized before operating the switch.

If the transformer is not de-energized before operating the switch, permanent damage will result.



DANGER

DO NOT OPERATE DUAL-VOLTAGE OR DELTA/WYE SWITCH UNLESS THE TRANSFORMER IS TOTALLY DE-ENERGIZED.

FAILURE TO DO SO WILL RESULT IN DAMAGE TO THE TRANSFORMER AND COULD RESULT IN SEVERE PERSONAL INJURY OR DEATH. DO NOT RE-ENERGIZE THE TRANSFORMER UNLESS THE DUAL-VOLTAGE OR DELTA/WYE SWITCH IS FIRMLY LOCKED INTO POSITION AND AT THE PROPER VOLTAGE.

High-Voltage Bushings

High-voltage bushings are typically shipped installed in the unit. If the bushings were removed for shipment, install the bushings per the manufacturer's guidelines.

Draw-lead bushings usually require no maintenance except as described on page 15. Maintenance instructions for condenser-type bushings are furnished with the bushings.



DANGER

DO NOT EXCEED THE CANTILEVER LOAD RATING OF THE BUSHING. GREATER LOADS MAY CAUSE BUSHING DAMAGE THAT COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.

Low-Voltage Bushings

Low-voltage bushings are typically shipped installed in the unit. If the bushings were removed for shipment, install the bushings per the manufacturer's guidelines.

Surge Arresters

Transformers may be furnished with optional distribution class, intermediate class, or station class surge arresters. Intermediate and station class arresters are shipped separately from the transformer to prevent damage. Upon delivery, unpack the arresters and carefully inspect them for damage, especially the porcelain components. Install surge arresters according to the instructions found on page 9.

Radiators

Transformers are furnished with radiator assemblies (usually panel type) to dissipate heat from the transformer. Cooling fans may also be furnished to provide additional loading capability without overheating the transformer. Radiator assemblies may be shipped separately from the transformer to reduce the shipping size of the transformer and to prevent damage. When radiators are shipped unattached, they should be installed in the field according to the instructions on page 8.

SECTION 6: MAINTENANCE



DANGER

THE TRANSFORMER MUST BE DE-ENERGIZED BEFORE BEGINNING ANY MAINTENANCE WORK. FAILURE TO DO SO COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.

It is the responsibility of the owner to inspect, maintain, and keep the transformer in proper operating condition. Report all issues during the warranty period to the JCL Energy. All warranty repairs must be made or approved by the JCL Energy.



WARNING

TANK LEAKS MUST BE REPAIRED IMMEDIATELY UPON DISCOVERY. FAILURE TO DO SO COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.

Periodic Tests and Inspections

The following periodic tests and inspections are recommended for routine transformer maintenance.

1. Gauge readings (one month after initial energization and annually thereafter). Gauge readings, ambient temperature, and kVA load should be measured and recorded. Any abnormal reading suggests that further diagnostic testing or inspection should be done. If pressure/vacuum gauge and/or fluid level gauge readings suggest a possible tank leak, perform a pressure test according to instructions found on page 9 (*Pre-energization Tests and Checklist*). Tank leaks must be repaired immediately to prevent serious damage to the transformer and danger to life.
2. Cooling fans (annual). Check the cooling fans (if any) by setting the fan's "auto/manual" control switch to the "manual" position. The fans should rotate at full speed within approximately five seconds. The fans should rotate smoothly with minimal vibration.

3. Control wiring (annual). Control wiring should be checked to insure that wire insulation is in good condition. The control cabinet and associated conduit should be inspected to ensure that weather seals are intact. Control power supply voltage should be checked and compared to the voltage stated on the wiring diagram.
4. Paint finish (annual). Inspect the paint finish for damage or weathering that exposes the primer coat or bare metal. Repair any paint damage that might be found.
5. Fluid dielectric test (annual). Sample the insulating fluid as described below. The dielectric strength of the insulating fluid should measure at least 26 kV.
6. Bushing and surge arrester insulators (annual). Bushing and surge arrester insulators should be clean. If the surfaces are excessively dirty, they should be cleaned while the transformer is not energized.
7. Bushing terminals (one month after initial energization and annually thereafter). If the transformer is energized and under load, measure bushing terminal temperatures using an infrared scanner. Excessive bushing terminal temperature indicates a loose or dirty connection. If the transformer is not energized, use a torque measuring device to make sure terminal connections are tight.

Sampling of Insulating Fluid

Transformers are filled with insulating fluid which provides electrical insulation within the transformer tank and transfers heat generated in the coils to the tank wall and radiators. The fluid is either conventional transformer oil (mineral oil), Envirotemp® FR3 fluid, or silicone fluid.

Periodically check the transformer for proper fluid level by reading the fluid level gauge. Add fluid if necessary.

When adding fluid, add only the same type fluid that is in the transformer.

It is also recommended that a fluid sample be drawn annually and tested for dielectric strength. Samples should be drawn from the bottom of the tank. Use proper sampling procedures to prevent erroneous test results. Dielectric strength should measure 26 kV minimum.



Gaskets

Visually check all gaskets for cracking or other signs of deterioration. Replace as necessary.

When replacing a gasket carefully clean mating surfaces to remove any rust, dirt, transformer fluid, old gasket material, or other contamination that might prevent a good seal.

Use an appropriate gasket cement when installing new gaskets. Do not reuse old gaskets. Six months after replacing a gasket, check and retighten if necessary.

Additional Maintenance Instructions

Contact the JCL Energy for additional maintenance instructions.

Repair Parts

Repair parts can be ordered from the JCL Energy. A description of the part and the transformer serial number will be required to ensure that the correct part has been ordered.

Warranty Claims

The JCL Energy should be notified immediately when problems are discovered during the warranty period. All warranty repairs must be made or approved by the JCL Energy.

TORQUE OF BOLT

INSIDE(BUS:BAR,BUSHING TERMINAL)						
SIZE	BRASS OR COPPER BOLT			A2-70 OR S45C BOLT		
	kgf-cm	N-m	lb-ft	kgf-cm	N-m	lb-ft
M8	102	10	7.5	163	16	11.8
M10	160	16	12.0	336	33	24.3
M12	204	20	15.0	581	57	42
M16	280	28	21.0	1479	145	106.8

BUSHING MOUNTING (Material: Stainless steel)						
SIZE	WITHOUT FLANGE			WITH FLANGE		
	kgf-cm	N-m	lb-ft	kgf-cm	N-m	lb-ft
M10	163	16	12	-	-	-
M12	286	28	21	286	28	21
M16	367	36	27	408	40	29.48
M20	-	-	-	510	50	36.86
M24	-	-	-	710	70.4	50
M30	-	-	-	1010	100	71
M36	-	-	-	1420	140	99.4

OUTSIDE (HEX BOLT + HEX NUT)						
SIZE	STAINLESS STEEL(A2-70)			STEEL(S45C 8.8)		
	kgf-cm	N-m	lb-ft	kgf-cm	N-m	lb-ft
M8	163	16	11.8	183	18	13.2
M10	336	33	24.3	367	36	26.5
M12	581	57	42	642	63	46.4
M16	1479	145	106.8	1581	155	114.2
M20	2856	280	206.3	3111	305	224.7
M24	4947	485	357.4	5406	530	390.6
M30	9894	970	714.8	10761	1055	777.5
M36	17238	1690	1245.5	18768	1840	1356

OUTSIDE (HEX BOLT OR STUD BOLT + TAPPED)						
SIZE	STAINLESS STEEL(A2-70)			STEEL(S45C 8.8)		
	kgf-cm	N-m	lb-ft	kgf-cm	N-m	lb-ft
M8	71.4	7	5.1	81.6	8	5.8
M10	153	15	11.0	173.4	17	12.5
M12	255	25	18.4	306	30	22.1
M16	663	65	47.9	765	75	55.2
M20	1326	130	95.8	1530	150	110.5
M24	2295	225	165.8	2601	255	187.9
M30	4590	450	331.6	5253	515	379.5
M36	8007	785	578.5	9180	900	663.3

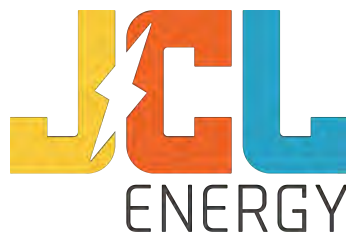
□Tolerance : ±10%

DAILY INSPECTION & MAINTENANCE

No.	ITEM	CONTENTS AND NOTES
1	Transformer temperature	1) Check and record the oil and winding temperature. 2) Record ambient temperature, load and voltage. <u>EXPLANATORY NOTES :</u> 1) The transformer temperature directly affects the life of the insulating material. 2) The maximum temperature rise limits are specified for both oil and winding temperature. During the daily inspection, check not only that temperatures are within the maximum limit, but also that these temperatures lie within a satisfactory range by comparing their values with the test results in the test report, load conditions and ambient temperature.
2	Oil level	1) Check and record the level of oil shown by the oil level indicator. 2) Check that the glass of oil level indicator is not dirty.
3	Noise	1) Check for any abnormal sound and vibration etc. <u>EXPLANATORY NOTES :</u> Learn by hearing an average & regular sound ; If an irregular noise is heard, compare with remembered normal sound and further investigation should be done immediately.
4	Oil leakage	1) Check for oil leaks at any connections such as valves, meters and particularly welding points.
5	Pressure relief	1) Check for cracks, damages and traces of oil spouting in the pressure relief device.
6	Cooling equipment	1) Check for oil leaks. 2) As regards forced oil cooled or fan cooled type : - Check for abnormal rotating sounds and vibration.
7	Off-circuit tap changer	1) Check whether the tap position is correct or not. ⚠ CAUTION Do not operate tap changer when the transformer is energized.
8	Bushing	1) If the bushing is provided with oil level gauge, check oil level and oil leaks. 2) Check visually the extent of any contamination on the bushing. 3) Check the over heat of terminals.
9	Loose connections and valves	1) Check for any loose connections such as connectors main circuits, grounding circuits, auxiliary circuits, foundation bolts and the like. 2) Valves are vulnerable to vibration. These should be checked particularly carefully.
10	Gas leakage	1) In the case of N ₂ gas sealed transformer, measure the nitrogen gas pressure and check for gas leaks.
11	Instrument	1) Check indicators and relays.
12	The others	1) Abnormal exciting noise and vibration.

PERIODICAL INSPECTION

No	INSPECTION ITEMS		PERIOD
1	Insulation oil	1) Measurement of dielectric strength. (2 mm gap)	Annually
		2) Dissipation factor 100 °C Dissipation factor 25 °C	Annually
		3) Interfacial tension(mN/m) ASTM D971	Annually
		4) Neutralization numbering KOH/g	Annually
		5) water content(mg/kg °C AT 50 °C)	Annually
2	Insulation of winding	1) Measurement of the insulation resistance between windings and between winding and ground with a 2000V megger.	2 or 3 years
3	Fan motor/ Oil pump motor	1) Insulation resistance 2) Abnormal sound and vibration	6 months
4	Off-circuit tap changer	1) Check for operation 2) Check for any oil leaks	Annually
5	Bushing	1) Inspection of local heating 2) Check for any oil leaks 3) Check for oil level if provided 4) Check for any pollution or damage to the bushing	2 or 3 years
6	Protective relays	1) Check for external construction 2) Check for operating and insulation resistance for thermometer, level gauge, flow indicator, gas detector, pressure relay, vacuum gauge etc.	2 or 3 years
7	Control panel and terminal box	1) Check the water-tightness	2 or 3 years
		2) Check the tightness of all connections.	
		3) Operation of all switches annunciates and lamps to observe proper functions according to schematic diagrams.	Annually
		4) Insulating resistance	2 or 3 years
8	External of transformer	1) Check transformer tank and its accessories for any oil leak, rust, coating damage	Annually
		2) Check to see whether all connections are in good conditions or not.	



**Instructions for Installation, Operation and Maintenance Of
Substation Transformers Through 30,000 kVA**