DAELIM SERVICE

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CONTENT:

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I, CONTINUOUS IMPROVEMENT SERVICE

As per the requirements of the Instructions to our clients, following is a description of the continuous improvement process DAELIM has in place to improve quality, delivery, service, technical and administrative processes that would enhance the proposed contract:: After getting the ISO9001 quality system certification， we fulfilled the GB/T19001-2000quality-management system——the quality secure mode of producing assembling and servicing to do the quality management． We enacted quality policy and target, and compiled a serial of products quality controlling process file. <Measurement contract of process>, <control of products process>,<after-sales service process>etc. We require the personnel to provide high-quality products to customers with high-quality work. Make sure customers buying with satisfaction and using with security. To enforce the management of products' quality, we strictly execute requiring of three according (according to standard of technique， according to pattern of designing, according to rules of technical file) to organize producing. And resolutely execute management of four wouldn't (wouldn't put unqualified material in to producing wouldn't pass unqualified component； wouldn't assemble unqualified equipment; wouldn't let unqualified products out factory) to do the process controlling, it efficiently ensured the equable of all products' quality.

To ensure the quality of after-sales service, we have established the after-sales service department, and compiled the process of after-sales service, rules of after-sales service. We require service-men should be passion, cordial, patient, careful, considerate and instant

to service for customers. Our general service: after receive telephone, the local service-men direct to the site to solve the problem, to security reasonable interest of the customer. When finishing all the work, service men must fill the bill of customers' feedback suggestion, and ask the customers' signature. Then deliver it to the after-sales service department as feedback.

II, MANUAL FOR VOLTAGE UP TO 35KV&AFTER SALES SERVICE

Contents

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1. Safety Information:

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians who are familiar with this equipment should install, operate, and service it. These instructions cannot cover all details or variations in the equipment, procedures, or process described, nor to provide directions for meeting every possible contingency during installation, operation, or maintenance.

The following conventions are used to indicate and classify precautions and on product safety labeling. Failure to observe precautions could result in injury to people or damage to property.

HAZARD Statement definition:

 This symbol/pictorial is used to identify an ELECTRICAL SHOCK or ELECTROCUTION hazard, all installation, maintenance, or repair should be performed by trained, experienced, and qualified personnel only.

 This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

Safety Instructions:

 WARNING: A potential risk exists if operating instructions are not followed which could result in severe personal injury or death, and equipment damage.

 WARNING: The contents of this manual should be carefully read and understood before attempting any test, repair, installation, removal, or operation of this equipment. Severe personal injury and equipment damage can occur from the result of improper handling, maintenance, or operation of this equipment.

 WARNING: Transformers should never be opened, serviced, or otherwise tampered with while they are energized, ungrounded or connected to the system. Removing or tampering with any covers, doors, bushings, or seals of an energized transformer may result in death, severe personal injury and equipment damage.

 WARNING: This equipment in not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply with these warnings may result in death, severe personal injury and equipment damage.

 WARNING: This equipment requires routine inspection and maintenance. Failure to properly inspect and maintain this equipment could result in unsafe conditions in and around this unit, which could lead to death, severe personal injury and equipment damage.

2. General Information:

2.1 Acceptance and Inspection upon Receipt:

All Daelim transformers are thoroughly tested and rigorously inspected before shipment from the factory to ensure the highest quality.

Upon receipt:

1. Thoroughly check all materials against the bill of lading.
2, Locate accessory parts that may have been shipped separately.
3.Carefully check the unit and associated components for any signs of damage caused during shipment. A damaged crate or pallet can be an indication of rough handling; if this condition is found, make a close inspection of the base and radiators (if equipped) and verify no damage has occurred.
4.In the event that significant damage to the unit or any associated equipment is noticed, rejection of the shipment should be made before it is unloaded. In the event of minor damages (nicks, scratches, etc.), carefully inspect the unit and note all damage on the carriers copy of the freight receipt. Daelim ships most units FOB Point of Manufacture, and it is the customer's responsibility to file a claim against the carrier.
Note: If acceptance of the transformer is made and damage to the unit is noticed at a later time, it is extremely difficult to file a claim against the carrier.

2.2 Proper Handling and Unloading

⚠ WARNING: Heavy Equipment. Improper handling can cause severe injury, death, or damage to transformer. Before moving the transformer, read the handling instructions provided in this manual.

⚠ CAUTION: The transformer weight is shown on the transformer nameplate. Most of the weight is in the tank that holds the core and coil assembly and the insulating liquid. Do not use hoists, cranes, jacks or forklifts with load capacity less than the transformer weight.

⚠ WARNING: Transformer accessories such as bushings, leads, arrestors, etc... Should never be used as a handle to move the transformer.

2.2.1 Moving transformers shipped on pallets

Transformers shipped on pallets may be lifted or moved by forklift trucks of proper capacity. When using a forklift, lift with the transformer tank closest to the mast of the forklift since most of the transformer weight is in the tank. Pallet mounted equipment may also be moved by crane or hoist.

2.2.2 Lifting transformers by crane or hoist

Lifting lugs, welded to all transformer tanks, are designed and provided for lifting the complete unit as shipped. Daelim recommends lifting by these lugs as the primary means of movement. Care should be taken to ensure straps, chains, and cables used to lift the units are inspected prior to use. All straps, chains, cables, and lifting devices should be in good

working order with sufficient capacity to perform the job intended. Straps, chains, and cables should NEVER be looped from one lug to another to form a continuous loop around the unit or even on one side of the unit. Each chain, strap, or cable should be run only to one lifting lug at a time to prevent loss of control of the unit in the event of a failure with one of the lifting devices.
Cable pull angles should NEVER exceed 30° from vertical or damage to the lifting lugs may occur. Spreader beams/bars should be used to hold the cables apart and as close to vertical as possible to minimize the forces on the lifting lugs and lifting devices.

2.2.3 Skidding/Rolling Transformers

Daelim transformers are designed to be rolled or skidded into place where accessibility to a crane or other overhead lifting device is limited or not available. If the unit must be rolled, insure that the area is level, free from obstructions and debris, and is of sufficient strength and thickness to support the load. When rollers are used, use as many as necessary to distribute the weight uniformly.

2.2.4 Using Jacks to move transformers

Place jacks under the tank base on the open ends of the transformer tank. DO NOT place jacks under radiators, valves, cabinets or sheet metal components. ALWAYS use at least two jacks per side and raise evenly to prevent warping of the base.

3. Storage

3.1 Storage for 90 days or less

All Daelim units have been thoroughly dried at the factory and shipped with oil at the correct level. Transformers should always be stored with oil in place to prevent possible contamination and absorption of moisture.
Transformers should be stored in a dry location with no rapid or radical temperature changes. If possible, the transformer should be stored in its permanent location on the foundation which has been prepared for it. If the permanent foundation is not available, it should be stored in its correct upright position on a level foundation capable of withstanding the weight of the unit without deformation.

⚠ CAUTION: A Never store a transformer solely under the jacking steps, on jacks, or on temporary blocking. Never store the transformer on rollers. Never store the unit in or near standing water or in areas with high moisture, salt levels, or corrosive gases in the air.

3.2 Storage for more than 90 days

All Daelim transformers are shipped with a 2 psi dry nitrogen blanket. During long term storage, it is recommended that this nitrogen blanket be maintained by the addition of a bottle of dry nitrogen, through a regulator, to the transformer tank.

4.Installation

4.1 Pre-service inspection

ELECTRICAL SHOCK: Never attempt to change connections on an energized transformer. All installation, maintenance, or repair should be performed by trained, experienced, and qualified personnel only.

New transformers, or transformers which are being activated after a period of storage, should be thoroughly inspected before being connected to the power distribution system to identify damage which may have occurred during storage.

1.The transformer exterior should be inspected for nicks, dents, and scratches. Repair damage to weather-resistant finishes promptly.

2.The tank cover and manhole/hand hole cover seals and all gaskets or seals at bushings, gauges, fuses, operating devices, etc., should be inspected for evidence of insulating liquid seepage. Repair leaking or improperly tightened gaskets and seals before the transformer is placed in service.

3.The liquid level inside the tank must be checked (read directly form gauge on transformers equipped with liquid level gauge).

4.Basic electrical tests should be conducted before energizing a transformer which was stored for a period of 90 days or more. Tests include DC insulation Test and Transformer Turns Ratio (TTR). The results of these tests should be verified with the original factory test results to assure they are still within acceptable limits.

CAUTION: Check with local authorities in the intended installation area to verify compliance of any and all applicable laws.

4.2 Mounting the Transformer

The transformer must be placed on a concrete pad or steel deck of sufficient strength to support the full weight of the unit. The location must be flat and level and prepared to prevent the transformer form tilting beyond two degrees from horizontal

WARNING: Fire Hazard. Non-level installation of transformer can result in fire and cause severe personal injury or death. Prepare transformer installation site such that transformer does not tilt more than two (2.0) degrees from horizontal while the transformer is in service at the site.

4.3 External Connection

ELECTRICAL SHOCK: Hazardous voltage can cause severe injury, death, or damage to equipment. Ground transformer following industry-accepted safe grounding practices before making other electrical connections. De-energize power distribution wires that will be connected to transformer. Verify that wires are de-energized at the transformer before connecting to transformer.

ELECTRICAL SHOCK: Live front parts should such as cables, bushings and other components must be thoroughly tightened and periodically checked to prevent arcing and overheating.

Clean bushings and terminals before making Connections. Remove dirt, grease or foreign material. Contamination can cause failure of the bushings. Cables connected to the transformer terminals are to have sufficient flex to allow normal pad

movement due to ground freeze/thaw and settling. Insufficient cable flex may cause premature failure of the bushings

4.3.1 Ground Connection

The transformer tank must be connected to a permanent, low-resistance ground. If the tank is not solidly grounded and the transformer is connected to the power distribution system, then the tank should be regarded as energized. An energized tank is extremely dangerous. Contact with an energized tank can shock, burn, or cause death.

Daelim transformers are equipped with at least two ground pads unpainted, copper-faced-steel or stainless- steel pads (Fig. 1A) or two ground bosses (Fig. 1B) one on front and one on back of the transformer tank.

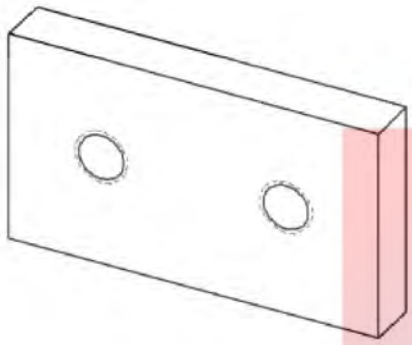

Fig. 1A

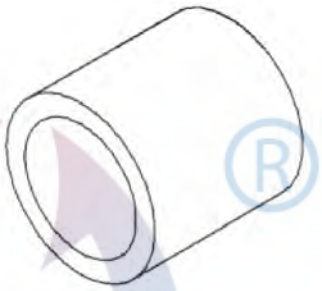

Fig. 1B

4.3.2 High Voltage Connection

Diagrams and information supplied on the nameplate must be followed for making connection.

Dead-front bushings are normally provided for high voltage connection to Submersible transformers, supplied with wells and inserts or single piece bushing.

4.3.3 Low Voltage Connection

Spade Terminals ranging from two holes to twenty holes are normally provided for low voltage connection to Submersible transformers.

5.Accessories

5.1 Pressure Relief Valve

Stainless Steel Automatic Pressure relief valve (Fig. 2) is standard on Submersible transformers and is intended to slowly release pressure to prevent rupture of the transformer tank. These valves are factory adjusted to vent at 5±2 PSI. Normal operation and atmospheric temperature fluctuations cause the oil and components in the tank to naturally expand and contract causing the gas filled head space inside the tank to fluctuate in pressure.

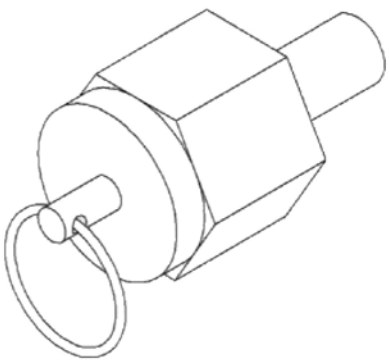

Fig. 2

⚠ CAUTION: Before performing any kind of service, which may include but is not limited to: opening the tank or inspection cover, removal of fuses, removal of bushings, opening drain or fill valves, or any other similar operation, the pressure inside the tank must be safely vented manually.

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⚠ CAUTION: Do not open the transformer in the presence of rain, fog, snow, or if there is condensation on the exterior components of the unit or when the outside air temperature is higher than the temperature of the unit. Even small amounts of moisture that are allowed to enter the transformer tank can decrease the dielectric strength of the insulating fluid and compromise the integrity of the unit.

To manually vent the tank, pull the ring supplied on the valve (as shown in the Fig.3} until all pressure or vacuum is relieved.

5.2 Fill Plug/Filler Valve with Schrader Valve

Fill Plug with Schrader Valve (Fig. 3 A) or Filler Valve with Schrader Valve (Fig. 3 B) is provided to facilitate addition of dielectric fluid and Nitrogen to the tank.

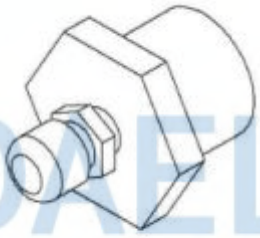


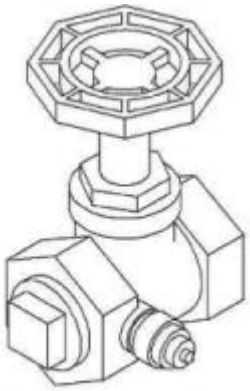
Fig. 3 A

Fig. 3 B

5.3 Drain Valve and Fluid Sampler

The Drain Valve and Fluid Sampler (Fig. 4) is provided to facilitate sampling of the dielectric fluid for testing and other purposes. The valve is also equipped with a plug ranging from 4" to 2” to provide means of draining the dielectric fluid. Three phase submersible transformers come equipped with a drain valve & fluid sampler while it is optional for single phase submersible transformers.

Sampling is usually performed on the side of the valve without the need to remove the end plug.



5.4 Liquid level gauge

A liquid level gauge (Fig. 5) is supplied to indicate the amount of dielectric fluid in the transformer tank. The gauge consists of a float arm inside the tank magnetically coupled to the indicator needle inside the gauge. The magnetic coupling maintains a liquid tight separation between the interior oil and the outside to minimize potential leaks. Three phase submersible transformers come equipped with a liquid level gauge while it is optional for single phase submersible transformers.

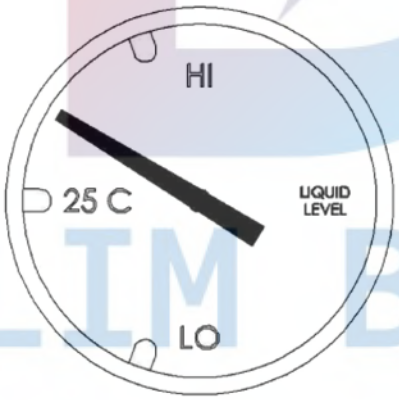


Fig. 5

Daelim utilizes several different brands and models of liquid level gauges depending on the application. Transformers can be supplied with a standard gauge or more sophisticated models with either one or two SPDT (Single Pole Double Throw) alarm contacts to facilitate external monitoring.

Liquid Levels may vary under normal operation according to temperature and pressure. The 25° C mark is only a reference fluid level at 25° C

For wiring and other information, please refer to the schematics included in the submittal drawings.

5.5 Temperature gauge

The temperature gauge (Fig. 6) is supplied to indicate the dielectric fluid temperature in degrees centigrade at the top of the oil column. Three phase submersible transformers come equipped with a Temperature gauge while it is optional for single phase submersible transformers.

The gauge consists of two needles (one white and one red). The white needle is the current oil temperature of the unit, while the red needle is a resettable maximum indicator. As the temperature of the oil rises, the white needle pushes the red needle higher with it. If the temperature of the oil declines the white needle follows and goes down with temperature, the red needle however remains at the highest temperature reached and acts as a recorder to indicate the highest temperature achieved by the unit. The red needle (maximum indicator) can be reset by turning the knob on the front of the gauge face.

The temperature gauge consists of a long thermocouple that extends into the tank inside a protective thermocouple well. The isolation between the thermocouple and the dielectric fluid facilities the removal and replacement of the gauge without draining down the dielectric fluid.

Fig. 6

The temperature gauge can be equipped with either one or two SPDT alarm contacts for remote monitoring or fan control. These alarm contacts are factory set but can be adjusted if desired.

To adjust the contacts, remove the face of the gauge. Look toward the center of the gauge for a small Allen head set screw. Loosen this set screw and manually move the contacts (red indicators toward the outer edge of the dial) to the desired temperature settings. Gently retighten the set screw and replace gauge face. For wiring and other information, please refer to the schematics included in the submittal drawings.

5.6 Pressure Vacuum Gauge

The pressure vacuum gauge (Fig. 7) indicates whether the head space pressure inside the tank is positive, negative or neutral. Three phase submersible transformers come equipped with a pressure vacuum gauge while it is optional

for single phase submersible transformers.

The pressure inside the tank will vary depending on the load of the unit, temperature of the oil and ambient temperature outside. As the oil temperature rises, the pressure inside the tank also rises. As the temperature falls, the pressure falls. It is common for a transformer to have either a positive pressure or a negative pressure.

Do not be alarmed by a consistent negative pressure (for example, if it's winter time In Wisconsin, it will probably be negative for the duration of the season). However, if the gauge consistently reads zero and does not appear to be changing with environmental or load conditions, this may be an indication of a leak and may need attention. Visually inspect the unit for any signs of a leak or damaged seal.

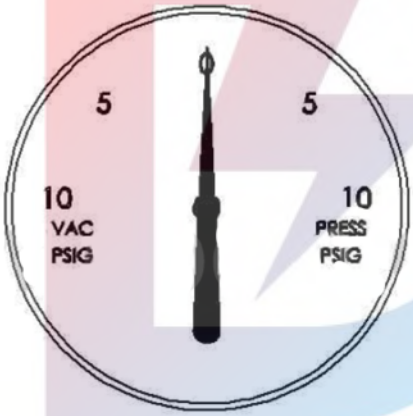


Fig. 7

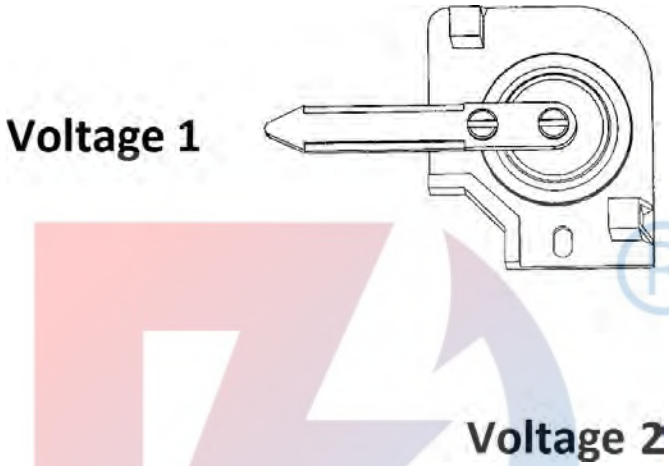
The pressure/vacuum gauge can also be equipped with SPDT alarm contacts (by adding a separate pressure alarm switch) for remote monitoring of positive and negative pressures. When requested, the pressure/vacuum gauge can also be equipped with a bleeder or regulator; when used in conjunction with an external nitrogen supply, positive pressure can be maintained inside the tank (2.5 to 3.0 PSI) The regulator is also equipped with a fitting and valve to take gas samples.

5.7 Dual voltage switch

WARNING: Excessive current can cause damage to transformer winding. Tap-changers and other switches must be in the position shown on the transformer nameplate.

WARNING: The transformer must be de-energized and grounded before dual voltage switch is operated. Attempting to change dual-voltage switch on an energized transformer may result in damage to the equipment and severe personal injury.

The Dual Voltage Switch (Fig. 17) is typically provided in dual primary padmount transformers to facilitate selecting one primary voltage from another.



For switch ratings and additional switch configurations refer to submittal drawings provided with the transformer.

6. Switching and Protection Devices

ELECTRICAL SHOCK: Can cause severe injury, death, or damage to equipment. De-energize transformer From a remote upstream source before operating no-load tap-changers, dual-voltage switches, or Delta-wye switches.

6.1 Tap Changers

Externally operated No-Load Tap changer (NLTC) (Fig. 8 A&B) is provided for all transformers, unless otherwise specified, to change from one operating voltage to another. Typical taps are configured at +2 X 2.5% of rated voltage; this means that the output voltage of the transformer can be adjusted in 2.5% increments Tap-changers will have a hot stick operable handle.

Please refer to Name Plate and other supplied information for more details.

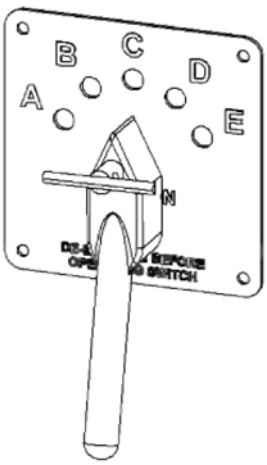


Fig. 8A

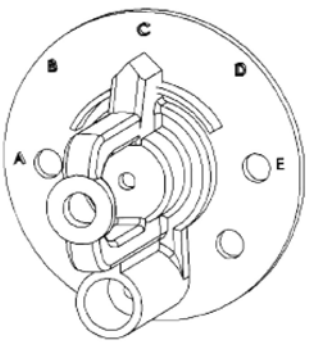


Fig. 8B

6.2 Load Break Oil-Ilmmersed Rotary Switches (LBOR)

WARNING: Do not operate load break equipment if a fault condition is suspected. Doing so can cause an explosion or fire.

WARNING: Use a hotstick to operate transformer load break equipment.

WARNING: After operating transformer load break equipment, check that voltages at transformer terminals are the expected values. Checking voltages verifies that load break equipment operated properly and that electrical circuit conditions are as expected.

WARNING: Before servicing transformer secondary connected equipment, verify that all transformer secondary terminals have zero voltage and ground the transformer secondary terminals following industry accepted safe grounding practices. Grounding secondary terminals protects against situations such as a standby generator energizing transformer from the secondary circuit.

6.2.1 Two-Position LBOR Switch

The Two-Position LBOR Switches (Fig. 9A) are provided optionally in submersible transformers to achieve load breaking or making and loop feed switching. LBOR's will have a hotstick operable handle

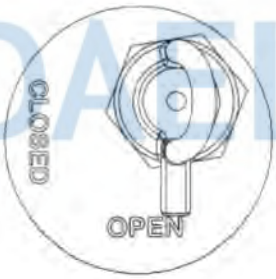


Fig. 9A

Multiple 2-Postion LBOR Switches may be utilized to achieve loop-Feed switching (Fig.9B)

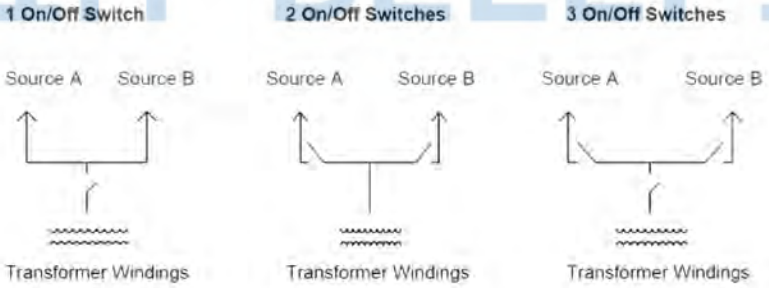


Fig. 9B

The spring-loaded activating mechanism of the switch ensures quick load break or load make operations in less than one cycle, and should be performed with a hotstick Please refer to Name Plate and other supplied information for more details.

6.2.2 Four-Position LBOR Switch

The Four-Position LBOR Sectionalizing Switch (Fig. 10 A & B) is provided optionally in loop-feed Submersible transformers to select the feed source, open or close the feed-thru loop and open or close the transformer.

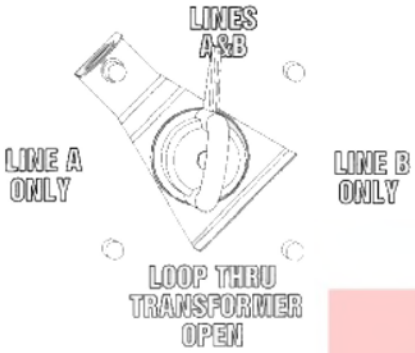


Fig. 10A – T-Blade 4-Position LBOR Switch

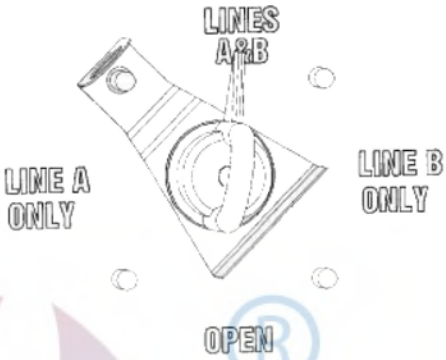


Fig. 10B –V-Blade 4-Position LBOR Switch

The spring-loaded activating mechanism ensures quick load break action and positive contact engagement through all positions. Switching can be accomplished in less than one cycle, and should be performed with a hotstick
For switch ratings and additional switch configurations refer to submittal drawings provided with the transformer.

6.3 Deadfront Surge Arresters

ELECTRIC SHOCK: Can cause severe injury, death, or damage to equipment. De-energize transformer from a remote upstream source before servicing or operating surge arresters or disconnect switches. Check that all transformer terminals and bushings have zero voltage. Ground transformer following industry accepted safe grounding practices.

CAUTION: Excessive test voltage can damage surge arresters. Disconnect surge arresters before running impulse or potential tests on the transformer.

Surge Arresters (Fig. 11) are provided optionally in Submersible transformers to protect equipment and cables from overvoltage surges.

During steady state conditions, line-to-ground voltage is applied continuously across the arrester terminals. When surges occur, the arrester immediately limits the overvoltage to the required protective level by conducting the surge current to ground. Upon passage of the surge, the arrester returns to its initial state, conducting minimal leakage current.

Dead front Surge Arrester (Fig. 11) also called elbow arrestor is a pre-molded rubber elbow that houses zinc oxide Varistor technology to provide overvoltage system protection to dead front Submersible transformers.

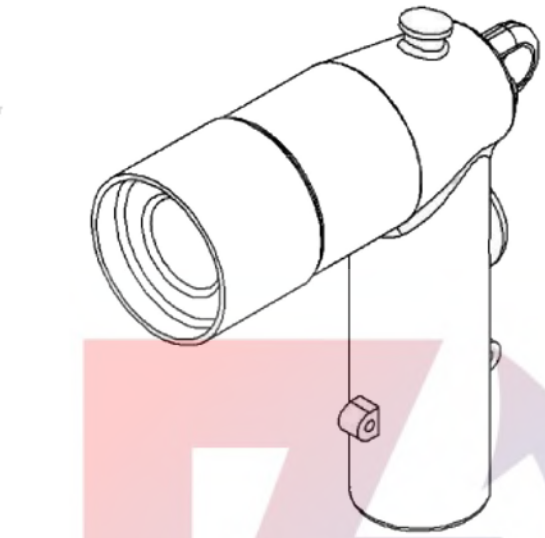


Fig. 11

6.4 Fusing

ELECTRIC SHOCK: Can cause severe injury, death, or damage to equipment. Use a hotstick to service a Bay-O-Net fuse. Do not install a fuse to complete an electrical circuit if a fault condition is suspected.
Do not re-energize suspected failed equipment. After installing fuses, energize transformer from a remote upstream source.

WARNING: Never attempt to remove fuses with pressure on the tank. Severe burns and personal injury may result from hot dielectric fluid.

6.4.1 Bay-O-Net Fuses

The Bay-O-Net fuse (Fig. 12 A) is used in series with an isolation link or current-limiting fuse "ELSP Back-up Fuse" to achieve over current protection and high current interrupting current rating. The bay-o-net fuses are field replaceable without needing to open the transformer tank.

Bayonet Fuses are only available for single phase submersible transformers

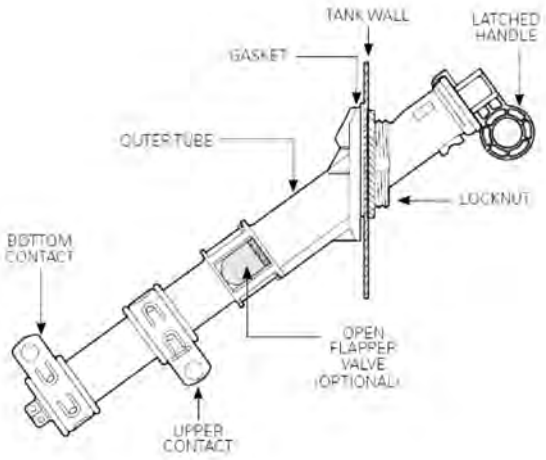


Fig. 12

u Province, China
'19
Zip code:225500

Bay-O-Net fuse replacement instruction (Fig. 13):

1.Relief pressure in the transformer tank by pulling out the pressure relief valve for 30 seconds or until the hissing sound of the valve stops.

2.Repeat step 1 to insure any residual pressure is released.

3.Attach a hot stick to the fuse holder eye and twist to unlock

4.Turn fuse holder 90° to break seal gasket and Bay-O-Net housing.

5.Draw fuse holder out quickly 8-10 inches to interrupt load

6.Wait several seconds for fluid to drain from the fuse holder and remove from housing

7.Remove fuse cartridge from fuse cartridge holder using a 34” wrench.

8.Remove end plug using a 34" and a 4" wrench

9.Replace the fuse

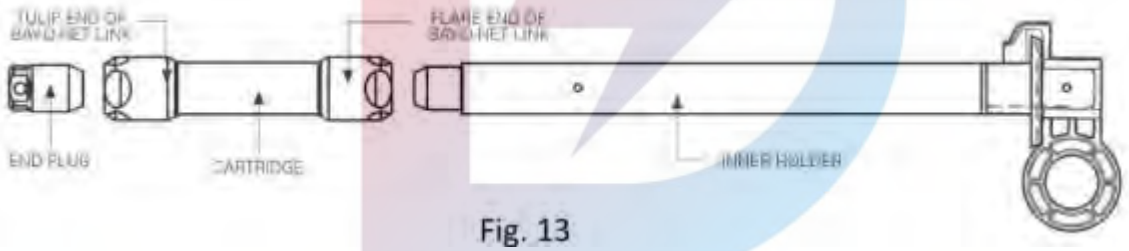


Fig. 13

6.4.2 Dry-Well Canister Fuses

The dry-well housing (Fig. 14 A&B) consists of filament-wound glass tubing with a resin-rich outer surface, this outer surface serves as the barrier against oil permeation through the tubing wall.

The current limiting fuse that these fuse-holders are designed to accept will not function properly if exposed to transformer oil; the interior of the fuse holder must remain oil tight.

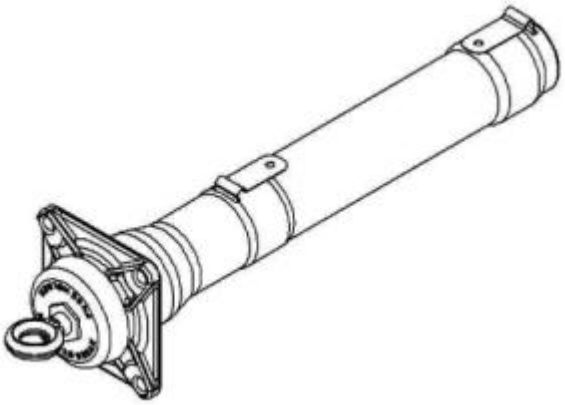


Fig. 14A

Non-Loadbreak Dry-Well Canister Fuse replacement instruction (Fig. 14B):

1. De-energize transformer from a remote upstream source

2. Disassemble by loosening 4 set screws
3. Attach a hot stick to the fuse holder eye and pull out
4. Draw fuse holder out
5. Replace the fuse and reinsert the fuse with the fuse holder
6. Assemble by tightening 4 set screws

Loadbreak Dry-Well Canister Fuse replacement instruction (Fig. 14B):

1. Disassemble by loosening 4 set screws
2. Attach a hot stick to the fuse holder eye
3. Draw fuse holder out rapidly to interrupt load “Load Break”
4. Replace the fuse and insert it rapidly “ Load Make”
5. Assemble by tightening 4 set screws.

7. Dielectric Fluid

7.1 Type II Mineral Oil

Submersible transformers filled with mineral oil that complies with ASTM D-3487, TYPE II.

TYPICAL PHYSICAL AND CHEMICAL PROPERTIES

pH: N/A PCB:No

Auto ignition temperature: > 315C° Relative density (H20 = 1): 0.89

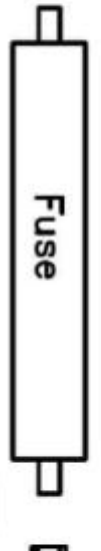
Pour point: -54° C

Evaporation rate (butyl acetate = 1): N/A Volatile organic compounds: < 0.001 g/L

Miscibility: mixes with other dielectric fluids except silicone Appearance and odor: Clear bright liquid with Mine

closed cup flash point: >145° C

Boiling point: >238° C



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Vapor pressure (mm Hg): < 0.01 @ 20° C Vapor density (air = 1): N/A
Solubility in water: negligible; < 0.1% Viscosity: 9.3 TO 9.5 CsT at 40° C

7.2 High Fire Point Dielectric fluid

Submersible transformers filled with High Fire Point Dielectric fluid typically use Envirotemp FR3 fluid which complies with ASTM D-6871
FR-3 is a natural ester derived from renewable vegetable oils — providing improved fire safety and environmental benefits that are superior to mineral oil.

TYPICAL PHYSICAL AND CHEMICAL PROPERTIES
pH: neutral PCB:No
Auto ignition temperature: 401 - 404° C Relative density (H20 = 1): 0.92

Pour point: -18 to -24° C
Evaporation rate (butyl acetate = 1): nil Volatile organic compounds: < 0.001 g/L
Miscibility: mixes with other dielectric fluids except silicone
Closed cup flash point: 320 -— 330° C Boiling point: >360° C
Vapor pressure (mm Hg): < 0.01 @ 20° C Vapor density (air = 1): N/A
Solubility in water: negligible; < 0.1% Viscosity: 32 -— 34 CsT at 40° C
Appearance and odor: clear light-green liquid with slight vegetable oil odor

8.Factory Testing

CAUTION: The information below is not intended to be as a guideline for testing transformers, please refer to IEE/ANSI C57,.12.90-2006 and ANSI/NETA ATS-2009 for more details.

8.1 Routine Tests

8.1.1 Ratio
The turn ratio of a transformer is the ratio of the number of turns in the high-voltage winding to that in the Low voltage winding. When the transformer has taps, the turn ratio shall be determined for all taps and for the full winding.
Note: The ratio test can also be used to test polarity, phase relation, and phase sequence.

8.1.2 Winding Resistance
Resistance measurements are of fundamental importance for the calculation of the /2R component of conductor losses and calculation of winding temperatures at the end of a temperature rise test.

8.1.3 No Load and Excitation Current

No-load (excitation) losses are losses that are incident to the excitation of the transformer. No-load losses include core loss, dielectric loss, conductor loss in the winding due to excitation current, and conductor loss due to circulating current in parallel windings. These losses change with the excitation voltage.
Excitation current (no-load current) is the current that flows in any winding used to excite the transformer when all other windings are open-circuited. It is generally expressed in percent of the rated current of the winding in which it is measured. The no-load losses consist primarily of the core loss in the transformer core, which is a function of the magnitude, frequency, and waveform of the impressed voltage. No-load losses also vary with temperature and are particularly sensitive to differences in waveform; therefore, no-load loss measurements will vary markedly with the waveform of the test voltage.

8.1.4 Load Losses and Impedance Voltage

The load losses of a transformer are losses incident to a specified load carried by the transformer. Load losses include /¢R loss in the windings due to load current and stray losses due to eddy currents induced by leakage flux in the windings, core clamps, magnetic shields, tank walls, and other conducting parts
The impedance voltage of a transformer is the voltage required to circulate rated current through one of two specified

windings when the other winding is short-circuited, with the windings connected as for rated voltage operation. Impedance voltage is usually expressed in per unit or in percent of the rated voltage of the winding across which the voltage is applied and measured

8.1.5 Dielectric Strength

The dielectric test of the transformer is intended to check the ability of main insulation to earth, inter turn and line end insulation to earth. It is generally performed in two different steps, likewise, Separate applied voltage withstand test (Hi-Pot) and induced voltage withstand test

8.2 Special/Design Tests

8.2.1 Insulation Power Factor

The insulation power factor is the ratio of the power dissipated in the insulation in watts to the product of The effective voltage and current in volt-amperes when tested under a sinusoidal voltage and prescribed Conditions.

8.2.2 Insulation Resistance

Insulation resistance tests are made to determine the insulation resistance from individual windings to ground or between individual windings. Insulation resistance tests are commonly measured in mega ohms or may be calculated from measurements of applied voltage and leakage current.

8.2.3 Temperature Rise

A temperature-rise test is defined as a test to determine the temperature rise above ambient of one or more of the transformer’s windings, as measured at the terminals. The result for a given terminal pair or winding is the average value of the temperature of the entire circuit; it is not the temperature at any given point ina specific winding. The term average

temperature rise refers to the value determined by measurements on a given terminal pair of the winding. It does not refer to the arithmetic average of results determined from different terminal pairs of the transformer

8.2.4 Lightning Impulse

Lightning impulse tests shall consist of and be applied in the following order: one reduced full wave, two chopped waves, and one full wave. The time interval between applications of the last chopped wave and the final full wave should be minimized without intentional delays, to avoid recovery of dielectric strength if a failure were to occur prior to the final full wave. Impulse tests shall be made without excitation.
Please refer to IEEE Standard C57.98-2011.

8.2.5 Audible Sound Level

Audible sound from transformers originates principally in the transformer core and transmits through the dielectric fluid and/or structural supports, to the outer shell and/or other solid surface, where it radiates as airborne sound. In some situations, the windings may be a noise source under rated load conditions, but this noise is not included in this standard. The frequency spectra of the audible sound consists primarily of the even harmonics of the power frequency; thus, for a 60

Hz power system, the audible sound spectra consists of tones at 120 Hz, 240 Hz, 360 Hz, 480 Hz, and so on. The audible sound also contains the noise emitted by any dielectric fluid mechanical cooling system. Mechanical cooler sound consists of broadband fan noise, plus discrete tones at the fan blade passage frequency and its harmonics.

9.Maintenance

9.1 Spare Parts

Daelim specializes in manufacturing custom transformers and makes only limited quantities of any one design. Replacement parts are best handled on a case-by-case basis. Should additional or replacement parts be necessary for any Daelim unit, please contact the factory and provide all available nameplate data.

9.2 Routine Inspection

Routine inspection of the exterior of the unit should be performed periodically. The inspection interval should take the environmental conditions of the site into consideration. Salty, damp or otherwise corrosive environments will require shorter inspection intervals than dry and mild conditions.

Periodically check between the radiators (if equipped) for debris and obstructions. Ensure that the unit is getting adequate airflow and that brush, overgrowth or surrounding equipment is not impeding proper airflow. If the unit is equipped with forced air cooling, manually cycle the fans using the switch in the control panel to ensure proper operation. Clean any dirt or buildup away from the base and cabinet areas to prevent premature rust and deterioration.

During an external inspection, check the paint for signs of deterioration, including cracked or chipping paint and rust spots. If paint damage or deterioration has occurred, touch-up or repaint the exterior of the unit as soon as possible to prevent further degradation. Daelim uses several different painting processes depending on the application. An inquiry to the

factory, with the serial number of the unit, will determine the type and compatibility of the touch-up paint required.

Gauges should be checked regularly for proper operation. The temperature gauge should fluctuate with load conditions and ambient temperature but should never read over the design value on the nameplate plus the average daily ambient temperature (for example, if it is a 25° C day and it has a 65° C rating on the nameplate it should not read over 90° C on the gauge). The liquid level gauge will also fluctuate slightly with temperature and loading but a steady drop may indicate a leak and should be addressed, The pressure/vacuum gauge will vary with temperature as well, but should never register zero for prolong periods of time (another indication of a leak).

9.3 Dielectric Fluid Sampling

Dielectric fluid samples should be taken at least on an annual basis and analyzed by DGA (Dissolved Gas Analysis}. Routine DGA testing is one of the best methods of determining the "Health" of a transformer. Although the ultimate failure of a transformer may be impossible to predict, routine oil testing can often indicate a detrimental internal condition before it destroys the unit

III, MANUAL FOR VOLTAGE 69KV AND HIGHER&AFTER SALES SERVICE

Transportation and Installation Handbook

1、Scope

The handbook as an universal technical documents on transportation, installation and acceptance of 110kv and above transformer, excluding the instruction for installation and usage of the special parts (about this part please find in the special operation instruction) that changed the production structure and some other components (about this part please find in the component's installation instruction)

2、Usage

2.1 During the process of transportation, loading & unloading, storing, installation and acceptance of transformer, it must be based on this handbook as a principle to avoid quality problem happened, and please make a record concerned.

2.2 During the process of work, the installation company and owner should follow the documents which we supplied such as various factory technical files, the operation handbook, special production instruction and other guide books of components. Please contact us directly when you have any queries.

3、Transportation of transformer main body

3.1 When lifting the main body it must be in accordance with the requirements in transformer outline drawing, keeping all of the lugs on the lifting tank lifted synchronously, and the angular between lifting rope and perpendicular should be ≤30°. For lifting sizes please find the outline drawing, and people should pay attention to the whole loading & unloading process. The following requests should be noticed.

3.1.1 The product center of gravity should be corresponding to the vehicle loading center.

3.1.2 The overall size after loading should be in the limitation of transportation bounds.

3.1.3 The binding rope should be tied down to the permitted position with a suitable rubber mat to avoid damaging the paint surface.

3.1.4 A clear mark of light paint should be done on the vehicle platform so as to check the displacement state during transportation.

3.1.5 Installing a 3D crash recorder on the transformer main body.

3.1.6 The construction side should make sure that the road to installation site is proper for transformer transportation (From the regular road to the substation).

3.1.6.1 The width of straight road≥3.5m

3.1.6.2 The width of crankle road ≥18m

3.1.6.3 The height of overhead line≥4.6m

3.1.6.4 Road gradient ≤15°

3.1.6.5 The road with good flatness, and no straight slope.

3.1.6.6 The road can bear total weight of transportation.

3.2 The transportation of transformer from factory to the installation site, if transported by railway it must be loaded strictly as per the railway department's relevant requirements, and during the road transport or manual handling, the inclination angle of vertical axis ≤15°, and the inclination angle of horizontal axis≤10°, and the inclination angle of main body should be≤15°when it transported by waterage, the following stipulation should be complied with.

3.2.1 When transported by road and manual handling, keeping it at a steady state as the normal transport.

3.2.2 During the road transport, keeping the speed at a suitable level to avoid a violent shock happened when sudden brake or shake fiercely owing to the rough road.

3.2.3 It needs enough rolling bars when transported by manual handling, and it should use the draw lugs at the bottom of tank, the speed ≤5m/min.

3.2.4 The braking device should be took off first before the pulling of the transformer on it's wheels on the rail, and the wheels need oiling, the pulling speed ≤5m/min.

3.2.5 All of the components, units and accessories which can not be transported together with the main body, they should be removed as per the" transformer transfer list", and packaged as per the "remove, sealed package of transformer accessories" strictly, then transported separated. And all of the spare parts and accessories that specified on the contract should be packaged as per the concerned packing list before transportation. And the accessory oil as required on the packing list also should be transported together.

3.2.6 Please note that it should be paid more attention to the bushing package during transportation owing to that the packages cannot bear impact too much.

3.3 The main body can be transported by filling nitrogen or oil as assembly drawing required.

3.3.1 When adopt the way of transport by filling nitrogen, nitrogen dew-point≤-40℃, nitrogen purity≥99.9%, inner pressure of tank≥30KPa. During the transportation, it should keep the inner pressure of tank at positive and control it up 10Kpa (at normal temperature), otherwise it should be filled with the above mentioned gas.

3.3.2 When adopt the way of transport by filling oil, it must be filled with the qualified oil and its brand is the same with that in the outline drawing, keep the oil line about 100 mm under the top of the tank, and a good seal performance is required. And the blind plates are needed for all the valves, oil leakage is forbidden.

3.3.3 The removed connecting pipe, bushing pedestal, conservator, radiator (cooler) and current transformer should be sealed and transport as per relevant stipulation.

4、Unloading and position of transformer main body

4.1 The position of transformer must be correct as the client's request, before the transport vehicle reach to the position platform it must realize the bearing situation of the ground first, and adopt some relevant measures to avoid the transformer sloping too much during the unloading process. The transport vehicle can leave after unloading.

4.2 Having crane, lifting is allowed, the lifting rope should be tied with the lugs for whole body of the transformer, tied the lugs of tank is forbidden. The angle of the lifting rope and perpendicular should be≤30°. If the angular is over 30°, it must use beam to make safety. If unload by manual handling, we have the jack plates on the tank, please get every jack bottom power equably, then lift synchro. Please find the jack plates on the outline drawing. And please noted that the lifting height of every operation should be≤30mm.

4.3 The moving speed of the main body in level should be controlled strictly. And every droop height should be≤30mm.

4.4 There is a 1.5％ gradient of the top connecting pipe of transformer, and it is no need to mat up of the main body on conservator side when the transformer is in position.

4.5 If having wheels, it is required to check if the screw holes of the wheels are complied with the holes of fixed plates under the tank before using. Keeping the wheels lubricating and make sure that all of the wheels installed at a straight line before normal working. Checking if the distance between the wheels is the same as the rails is very important before installing the transformer on the rail, finally complete the braking device.

5、Inspection and acceptance

5.1 The acceptance of main body and accessories

5.1.1 After the main body and accessories reach to the installation site, the installation company and the user should check them immediately, to see if the quantities and the appearance are in good conditions. And the manufacturer would also take part in the acceptance if necessary.

5.1.2 After the transformer reach to the installation site, the user should check the specification, type and quantity in the name plate if they are the same as required.

5.1.3 Checking that if there are some problems on transformer, such as damage, deformation, cracking etc. And please note that if there is any displacement happened between the truck and the transformer, some fixing rope fractured, it is required to inform the manufacturer and the transportation company at once if above cases happened.

5.1.4 For the transported transformer with impact recorder, the impact value of the acceleration g of the impact recorder should be checked, the largest vertical value does not exceed 4g, and other direction below 3g. The recording paper of the impact recorder should be kept in the archives of the user's units after it is signed and checked by both parties, the copy and the impact recorder should be returned to the owner. If there are some problems in the transporting process, such as the g value exceeds standard or the vehicle displacement, the user, the transport unit and the manufacturing company should find out the cause together and take measures to deal with it.

5.1.5 Check whether the technical file is complete full according to the transformer's "file list of the leave factory products".

5.1.6 Check the quantity of the packages or the number of the accessories according to the transfer list to see whether there are some damaged or not. Check the specifications of removal parts, and check whether the quantities is complete and have some defeats according to the "packing list", such as thermometers, bushing and so on.(the acceptance procedure could be completed either in the handing over process or the installation process.)

5.1.7 If there are spare parts or accessory equipments mentioned in the contract, check them for complete or damage in accordance with the list.

5.1.8 The damage or other abnormal phenomena found in the above checking and acceptance process should be recorded in detail, and be taken on-site photos. Provide the pictures, defecting parts list and the copy of record to the manufacturer and transportation company in time to find out the reasons and deal with it timely.

5.1.9 For the transformers with nitrogen, of which the pressure gauges should be checked, and the nitrogen pressure in the tank should be kept above 10Kpa (under normal temperature).As for the long-term storage nitrogen transformer which could not be installed in time, the evacuate the nitrogen and filling oil are required as earlier as possible (storage time not more than 15 days).

5.2 The acceptance of insulation oil

5.2.1 Take visual inspection of the insulation oil when it arrived at the site to see if there is some other material mixed in it.

5.2.2 Check the adding oil-test report in the handing over process

5.2.3 Check and calculate the quantity of the oil

5.2.4 The electric strength test of the insulation oil arrived at the site should meet: break down voltage ≥40kV/2.5 mm, and the water content≤20ppm

5.2.5 Different brands of transformer oil should be stored and kept separately.

5.2.6 The in & outlet of the oil barrel should be kept upward, and should be blocked up to prevent rain entering.

6、Save and storage of product(main body, components)

6.1 Storing of nitrogen-filed product

6.1.1 As for the nitrogen-filed products, check whether the nitrogen pressure in the main body meet the requirement of article 5.1.9 immediately when it is transported to the site. The test of the oil left in the tank base should be consistent with the requirement of break down voltage value ≥40kV/2.5mm, and water content ≤20ppm.

6.1.2 If it does not meet the requirement of article 6.1.1, the products can not be deposited with nitrogen, and must be determined further whether they got damp according to the article 6.4, and taken the appropriate measures.

6.1.3 When storing nitrogen-filed products, the requirement for nitrogen and pressure is the same as article 3.3.1.

6.1.4 During the process of nitrogen-filed storage, the inspections should be at least twice a day. Make a record of the pressure within the tank and adding nitrogen. If the pressure drops very fast, it shows there is some leakage, check and handle it in time and prevent strictly the body of the transformer getting damp.

6.1.5 If it meets the requirement, the nitrogen-filed storage is allowed. But the nitrogen transport product which has been stored more than 15 days should be filled with oil. The work procedure and requirement are as follows:

6.1.5.1 The residual oil should be discharged out of the tank.

6.1.5.2 Oil filling and nitrogen emission. Open the butterfly valve on the top of the tank (prevent moist air and some other material from entering).Meanwhile, fill the qualified transformer oil from the drain valve at the bottom of the tank. (the oil's break down voltage≥40kV/2.5mm ， water content≤20ppm)

6.1.5.3 When the body is under oil-filled state, judge further whether the products got damp after they left factory according to the article 6.4. It can not be transferred to the next process until the confirmation that they are not got wet.

6.1.5.4 Install conservator system (including a breather) and go on to fill the oil. Adjust the oil surface to be slightly above the normal oil level. Discharge the air from the conservator according to the installation instruction handbook of the conservator.

6.1.5.5 During the oiling storage process, check the transformer's appearance once every 10 days, handle the leakage in time. Take oil samples from the main body and conduct a test every 20 days. The performance should meet the following requirements: break down voltage≥40kV/2.5mm ， water content≤20ppm.

6.2 Storing of transportation product with oil

6.2.1 As for the transporting products with oil, take samples from the original product when it is transported to the site and conduct a test. The performance should meet the following requirements: break down voltage ≥40kV/2.5mm. Then it can be stored with oil, if the oil sample does not meet thee requirement, judge whether it is wet according to the article 6.4 and contact with the manufacturer.

6.3 Save and storage of components

6.3.1 The storage of removal parts such as the conservator, the radiator, the cooler should take rain protection, dustproof, and antifouling measures. The storage sites must be solid and should be approximately 100mm above the surrounding ground, the spare parts is not allowed to be rusted and dirty caused by storage. Their bottom should be heightened about 200mm to prevent them from being rusted.

6.3.2 All the bushings and accessories (such as measuring instruments, displayers, relays, terminal box, controlling cabinets, on-load tap changer's operating mechanism, wires, cables and seals, etc.) should be kept within a dry and ventilated room.

6.3.3 Adding oil: the cover of dump oil must be screwed and affixed a seal. When it is stored outdoors, the mouth should be put upwards, and put a waterproof cloth on it. The sealing of tank's mouth should be guaranteed good, and covered

with rainproof cloth.

6.4 Damp judgement and treatment of product

6.4.1 The signation of not got damp of the transformer is that the core-to-ground, winding-to-ground and winding-to-winding should meet the following requirements (tested after oiling):

① Insulation resistance value≥ 70% of the data of leave factory;

②The core-to-ground insulation resistance is not equal to zero;

③The moisture content in nitrogen is not greater than 100ppm;

④The moisture content in oil is lesser than 20ppm;

If it cannot meet these requirements, it cannot be put into installation and operation. Please contact with the manufacturer for advice..

7、Site installation of transformer

7.1 Preparation before installation

7.1.1 Checking that if the accessories are complete, and in good condition. If it needed, please take experiment in advance. It mainly included: the dielectric dissipation factor of oil paper condenser bushing, the polarity and ratio of bushing current transformer, the inspection and adjustment of gas relay, the inspection and adjustment of temperature controller and so on. Winding thermometer should take current matching according to specification.

7.1.2 Do well at the preparation of oil filling, draining and filtering in advance, and check whether the quantity of transformer oil is enough, and the specification of oil is qualified.

7.1.3 Preparing device for transformer installation: vacuum oil filter (oiling machine), oil tank, oil tube, crane and other tools.

7.2 Stipulation of ambient and time of transformer core lifting inspection

7.2.1 Air humidity below 65%, exposure time of active parts ≤16h.

7.2.2 Air humidity within 65%～75%, exposure time of active parts ≤12h.

7.2.3 Ambient temperature ≥5℃, machine body temperature should above ambient temperature 5～10℃.

7.2.4 When environment temperature is below normal (below 0℃), you should rise the active parts's temperature above 10℃ by hot-oil circulation in advance.

7.2.5 Air humidity ≥75%, it is not suitable to take Core lifting inspection or nitrogen drainage installation.

7.3 Requirements and notices of transformer cover lifting

7.3.1 Don't perform lifting cover inspection if user request no need to lift tank cover in contract.

7.3.2 Before perform lifting tank cover inspection, the product need to complete working routine & requirement as clause 7.1

7.3.3 While top fix position of the body of transformer have mechanical connection with oil tank, relevant joint parts must be loosen or taken off, after that the operation of lifting tank cover can be carry out.

7.3.4 disassembling the on-load tap changer should according to instruction manuals of on-load tap changer。

7.3.5 The product of no need to lift tank cover in contract should perform lifting core inspection if it was crash or other unexpected accident was occurred during transportation.

7.4 Main equipments and tools needed at installation site

S/N	Name	QTY	Specification & description
1	Oil test equipment	1Set	oil withstand voltage、liquid water content、tgδ etc
2	Lifting appliance （including slings for lifting loads）	1Set	lifting ability according to the weight of general assembly drawing , while it is lifting core inspection
3	Vaccum Oil filter(oiling machine)	1Set	for filling transformer oil
4	pipeline、tube union	right amount	Joints & flange should comply with valve size which was shown on the general assembly drawing
5	oil storage tank	1Set	base on oil mass，almost 1.1 times of transformer oil mass.
6	ladder	2	5m、3m、 one for each
7	nylon rope	2 pieces	use for lifting bushing, radiators, oil conservator, etc
8	lifting lug	2 sets	use for lifting radiators, oil conservator, etc
9	bolt，screw& general tools	1 set	
10	megameter（2500V）	1 set	measuring insulation resistance
11	Facility of lighting	1 set	
12	water-proof cloth or plastic cloth	right amount	
13	fire extinguisher	right amount	use for extinguishing oil fire
14	white cotton cloth	right amount	For cleanning

7.5 Core lifting inspection of oil-filled transportation product

S/N	item & procedure	job scope & requirement

1	oil analysis test	1.1 Take oil from sampling valve, specific performance test shall conform to the requirements of clause 6.2.1, if they do not conform to the requirements, should according to 6.4 clause and judge whether body has been affected with damp； 1.2 when a vacuum filter was used for filtering oil, oil temperature must be control at 75 ± 5 ℃ range。
2	oil storage facility cleaning and connection	2.1 oil filter and oil storage tank must be clean without any particle. 2.2 Inner of nylon pipeline must be clean and no moisture
3	discharge of oil	3.1 Drain the oil inside the transformer tank to oil storage tank , Through bottom valve of transformer tank by oil filter 3.2 When oil discharge, at first it must open the sealing plate on the tank's top and then use 5kg of cleaned silica gel and placed it into a small bag which was made of screen mesh ,diameter about 200mm, put it on the tank top oil pipe and then discharge oil. In order to prevent transformer body was affected with damp。 3.3. To avoid oil tank has any abnormalities, please open the relief plug if oil conservator has be installed.
4	disassemble joint part &fixed position device	4.1 Open sealing plate of bushing flange and fixed lead wire on suitable position of transformer body； 4.2； Refer to general assembly drawing, please open fixing position device of transformer body, the bolt must be separated smoothly from fixed position part. 4.3 According to tap changer instruction manual, separate tap changer from oil tanks& joint parts of transformer body, action bars must be separate reliably from connection parts .tapping position need to record down when disassemble the tap changer.； 4.4 Disassemble joint bolt of oil tank edge. 4.5 lifting the cover of tank
5	Lift up tank cover	5.1 According to assembly drawings to choose the right sling hanging in the clamping unit of lifting lug, at beginning to test intermittent lifting, adjusting the hook position to match the center of gravity of the body in the same vertical line, through the trial and then the oil tank can be lifted； 5.2 Placing the oil tank on the cleaned material.

6	Lifting core inspection and checking item	6.1 The tools for inspectors need to carry out ID registration, everyone's pocket are not allowed to bring metal objects, it is strictly prohibited for dust, debris into the tank of transformer; 6.2 After operation, the operating personnel are asked to confirm no debris inside, after go out tank and it is needed to check all the tools in accordance with registration. 6.3 Main check item: 6.3.1 Overall check Whether the body of transformer have any displacement or serious distortion 6.3.2 Check whether the top pad of winding has any movements. 6.3.3 Check whether lead wire has any open weld and break, lead wire insulation still in good condition. 6.3.4 Check whether press bolt and screw have any loosening 6.3.5 Check whether standard fastener have any loosening; 6.3.6 Check the condition of oil tank and the body, any other obstacle and water are not allowed. 6.3.7 Check the tap changer contact with the wire connections, tighten in good condition. 6.3.8 Check whether the core is one point leads to earth and the insulation's in good condition。
7	installation of the oil tank	7.1 Clean-up of residual oil of bottom tank ,check whether have any tools or debris left; 7.2 Check if the sealing gasket of the tank is intact, the installation is correct. 7.3 Lifting of the oil tank must be stable, the putting down speed should be gentle, it is necessary to guard against bumps the leads, the body of transformer; 7.4 As the oil tank drop near the tank gasket. some stick should be used to penetrate in the screw holes, at the time, as much as possible the bolt should be put into the screw holes to position the tank to prevent twisting of the gasket; 7.5 If the upper and lower of oil tank fit not properly, upper part of oil tank should be lifted and repositioned again; 7.6 After check the tank gasket's placed suitable, penetrate all the bolts, operators divided into two groups, fastening the bolt diagonally, when fastening the bolt, it can not be a fastened too tight at one time, it should be fastened in turns, finally all the screws achieve an appropriate tightness; 7.7 Locking and seal the fixed position device。
8	Accessories installation	Accessories installation in accordance with the part of General operating requirements

7.6 **Core lifting inspection of Nitrogen-filled products（Oiling and nitrogen emission）**

S/N	item & procedure	job scope & requirement

1	oil analysis test	1.1 Take the transformer oil samples to laboratory tests, specific performance should meet the requirements of clause 6.2.1, if it do not meet the requirements, should determine whether the body was effected with damp according to clause 6.4. 1.2 When oiling, oil temperature should be increased higher than ambient temperature for 10-15℃。
2	oil storage facility cleaning and connection	2.1 oil filter and oil storage tank must be clean without any particle. 2.2 Inner of nylon pipeline must be clean and no moisture
3	drain out residual oil of tank bottom	3.1 Drain oil plug near tank bottom will be used to release residual oil into a small container； 3.2 Untreated residual oil shall not be re-injected into the product。.
4	Oiling and drain of nitrogen	4.1 install a temporary oil level indictor； 4.2 Open ϕ80 butterfly valve on top of the tank cover to exhaust the nitrogen, at same time inject qualified transformer oil into the oil tank by ϕ80 sluice valve at the bottom of oil tank. 4.3 After finish to inject oil, the height of oil level should lower than tank cover for 100mm
5	Drain out of oil	5.1 after stay for 1 hour, all the oil in the tank should be drained out into oil storage tank through drain valve at the bottom of the oil tank by the oil filter； 5.2 When oil discharge, at first it must open sealing plate of the outlet on the top the tank, then cleaning up 5kg of silica gel, placed the silica gel into a small bag which was made of screen mesh ,diameter 200mm, put it on the outlet of the tank top and then discharge oil. In order to prevent transformer body was affected with damp。 5.3 To avoid oil tank has any abnormalities, please open the relief plug of oil conservator if it has be installed.。
6	Disassemble joint part &fixed position device	6.1 Open sealing plate of bushing flange and fixed lead wire on suitable position of transformer body； 6.2 Refer to general assembly drawing, please open fixed position device of transformer body, the bolt must be separated smoothly from fixed position part 6.3 According to tap changer instruction manual, separate tap changer from oil tanks& joint parts of transformer body, action bars must be separate reliably from connection parts .tapping position need to record down when disassemble the tap changer.； 6.4 Disassemble joint bolt of oil tank edge. 6.5 lifting the cover plate
7	Lift up tank cover	7.1 According to assembly drawings to choose the right sling hanging in the clamping unit of the lifting lug, at beginning to test intermittent lifting, adjusting the hook position to match the center of gravity of the body in the same vertical line, through the trial and then the oil tank can be lifted；

8	Lifting core inspection and check item	8.1 The tools for inspectors need to carry out ID registration, everyone's pocket are not allowed to bring metal objects, it is strictly prohibited for dust, debris into the tank of transformer； 8.2 After operation, the operating personnel are asked to confirm no debris inside, after go out tank and it is needed to check all the tools in accordance with registration. 8.3 Main check item： 8.3.1 Overall check Whether the body of transformer have any displacement or serious distortion 8.3.2 Check whether the top pad of winding has any movements. 8.3.3 Check whether lead wire has any open weld and break, lead wire insulation still in good condition. 8.3.4 Check whether press bolt and screw have any loosening 8.3.5 Check whether standard fastener have any loosening； 8.3.6 Check the condition of oil tank and the body, any other obstacle and water are not allowed. 8.3.7 Check the tap changer contact with the wire connections, tighten in good condition. 8.3.8 Check whether the core is one point leads to earth and the insulation's in good condition。
9	installation of the oil tank	9.1 Clean-up of residual oil of bottom tank ,check whether have any tools or debris left； 9.2 Check if the sealing gasket of the tank is intact, the installation is correct. 9.3 Lifting of the oil tank must be stable, the putting down speed should be gentle, it is necessary to guard against bumps the leads, the body of transformer； 9.4 As the oil tank drop near the tank gasket. some stick should be used to penetrate in the screw holes, at the time, as much as possible the bolt should be put into the screw holes to position the tank to prevent twisting of the gasket； 9.5 If the upper and lower of oil tank fit not properly, upper part of oil tank should be lifted and repositioned again； 9.6 After check the tank gasket's placed suitable, penetrate all the bolts, operators divided into two groups, fastening the bolt diagonally, when fastening the bolt, it can not be a fastened too tight at one time, it should be fastened in turns, finally all the screws achieve an appropriate tightness； 9.7 Locking and seal the fixed position device。
10	Accessories installation	Accessories installation in accordance with the part of General operating requirements.

7.7 **Universal operating provision of overall installation**

7.7.1 Before general installation, please counting the number of components of each to be installed (including bolts, nuts, washers), careful inspection, cleaning accessories, joint tube from other obstacles, dirt, dust etc.

7.7.2 Parts and components which have installation signs must follow the instructions to re-installed on the site (such as high-voltage, medium voltage, low voltage bushings, pedestals, pressure release devices etc, more attention should be payed to their relative position and angle to the tank, and also note the sequence of the joint pipe, etc).

7.7.3 Installation of bushing shall not be dead lift and twist the lead wire。

7.7.4 As for 110kV and above class lead wire, lead wire's insulation inclined tip must packed into the mouth of voltage-sharing ball of the bushing。

7.7.5 Check the fixing position parts, install and seal it in accordance with technical requirements.

7.7.6 While assemble oil conservator joint pipe, should start from gas relay side, fastening bolts incomplete until all the parts has been assembled and then began to tighten from the gas relay side.

7.7.7 The pedestals of thermometer should be inject 2/3 transformer oil

7.7.8 Installing all components, parts and spare parts which have been disassembled in accordance with transformer overall dimension (assembly drawing) .

7.7.9 As to there have air drain plug on the top of components (eg, L.V bushing, gas relays, oil conservator, radiators, etc.) after injected transformer oil, the upper part of air drain plug should be opened to release accumulated air, please don't close the air drain plug until oil overflow.

7.7.10 Before sealing gaskets put into the slot or the flange, Please keep metal surface cleaning, and sealing surface must be grease seal and make the sealing gasket correctly seated. Fasten the bolt diagonally and stress should be made uniformly。

7.7.11 Installation of On-load tap changer, should pay more attention to the horizontal axis and vertical axis equippement, concern about the sealing of head flange of tap changer in good condition, use handle to turn round flexibly to see if the tapping indication is correct (refer to instruction manual of on-load tap changer for more details).

8、Installation accessories

8.1 Notices of bushing installation

8.1.1 When bushing installation, the location of cranes should be located in which is convenient for bushing lifting and installation .

8.1.2 While bushing was lifted by cranes, please use nylon rope or wirerope with protection sleeve and take special care of

bushing in order to prevent crashing with packing container or other objects.

8.1.3 Please check oil leakage carefully After take out bushing from the box. At the same time checking the oil level inside oil meter whether it is normal. Before installation, please cleaning flange surface and stretching into the bushing pedestals & the inner to clean with a clean white cloth.

8.1.4 When bushing installation, the bushing slant angle should be consistent with the slant angle of the bushing pedestals .

8.1.5 While 40kV class connecting plate connected to the conducting rod of the bushing , please ensure sufficient contact. double-sided access can't be connected single-sided. connecting plated bent part should be maintained and the distence between the oil tanks and the core clip should meet the requirements.

8.1.6 Install 40kV class and below cable-style bushing, first screw tightening clamping ring and nuts and then straighten the lead wire to make sure stop collar to seat in the locating slot of bushing, then sealed it and fastening the conduct head.

8.1.7 Before Condenser bushing lifting, please removed the top terminal block and Covers.

8.1.8 After bushing put into mounting pedestal ,please observed from holes of tank wall to make sure the cone tip of lead wire were pressed into voltage-sharing ball of the bushing.

8.1.9 The inner lead wire of bushing should keep straight, no twisted, no Bend。

8.1.10 Do not doing dead lift when straighten the lead wire in order to prevent wire insulation damage or wooden clip pull cut.

8.1.11 The direction of oil level indictor of bushings should be same in order to observe conveniently

8.2 **Installation of 110kV and above bushing and lead-wire**

8.2.1 Please clean flange sealing cover with a clean cloth, please open cover plate and then unfix the lead wire cable standby for install. Flange sealing surface should wipe clean.。

8.2.2 Open the bushing packing container and then remove anti-vibration material. Please adopt suitable rope to tie up at one third of upper and lower of the bushing, and put it on the clean ground by cranes. Please Wipe dust and grease on the porcelain surface &jointing surface with cloth or cotton yarn, if it have dirt seems like paint, you should use solvent scrubbing until all porcelain skirt showing original color. Any metal surface or surface of ceramic insulation which is contact with oil must use high quality white cloth to clean until can't see any dirt and impurities particles on the white cloth.

8.2.3 Disassemble the bushing electric conduction head and other parts , wipe clean and wrap it with plastic cloth as standby application. Checking "O" type sealing gasket carefully, if it have damage or ageing and leak tightness is not reliable, please replace it and it can't be used again. checking voltage-sharing ball whether has any loosening , please

tighten up if it has been loosen.

8.2.4 Inside Brass tube of bushing, white cloth ball tie steel wire must be used to pull back and forth until no dirty colour show on the white cloth .Even leave factory it is clean and sealed dispatching to the site, it should be checked it again in order to insure its really clean. After that wrap it with plastic cloth.

8.2.5 Porcelain bushing must be double-check whether have any cracks and leakage, the oil level indicator whether is working properly l, please pay special attention to the tip of porcelain bushing whether has cracks and oil leakage. Check whether porcelain enamel of bushing have blackspot , check whether have small piece of porcelain shedding. If it have blackspot and shedding which is permitted under the national standard range, Porcelain bushing can be installed as normal. But it need to record down for future reference.

8.2.6 Installation of bushing pedestal according to assembly mark if it has bushing pedestal。After installation, position of air drain plug should be located on the top of mounting barrel. nameplate of current transformer should place on the position where is easy to read.

8.2.7 To sling a little, tied up at the central of bushing and lift it by cranes, please pull out the pulling rope with M12 bolt from the bottom of bushing and screw down M12 bolt in the screw hole of conduct head of lead wire. At the same time borrowing manpower to make the bushing gradually to vertical direction. Please place smooth wood under the voltage- sharing ball and make sure voltage- sharing ball can't be extruded while lifting. The corresponding dip angle of bushing must be adjusted if transformer's bushing pedesta is tilted.

8.2.8 After moving the bushing above the mounting flange of oil tank, take straight the cable lead out of the oil tank, drop the bushing slowly, at the same time pull up the pulling rope, and make the cable lead up synchronously with the bushing down until the bushing in position. The oil level indicator of bushing should be outward.

8.2.9 Check up the insulation cone tip of lead wire, make sure it have entered into voltage-sharing ball of the bushing. If it is qualified, drop the bushing in position. Lift the terminal of lead wire above the top of bushing, no tugging, in case of damaging lead wire or wooden clip pull cut. Remove the pulling rope, screw on position nut, the circular termination should be upward, and the square termination should be downward. When the position nut has been screwed direct at the hole of lead wire joint, please insert straight pin. Put seated of "0" type sealing ring, and lock the position nut with a special wrench, screw on conductive tip, make the conductive tip and position nut screwed tight with the special wrench. Remove special wrench, fix the conductive tip on the conductive holder with bolt, make sure that the "0" sealing ring has been pressed at suitable place, so that the sealing will be well.

8.2.10 During the bushing in position, one of installation personnel should keep watch on whether the bushing has taken its place or whether the lead wire is straightness by the hand hole. Meet any problem, adjust timely.

8.3 Installation of cable-style bushing on LV side

8.3.1 Wipe away dust and greasy dirt on the surface of ceramic bushing with cloth or cotton yarn. If wiping cannot make it clean, please use solvent.

8.3.2 Wipe bushing sealingk ring, conductive tip, rubber gasket, and pack with plastic cloth for standby. Check “0” type sealing gasket carefully. If you discover damage or ageing, must replace it.

8.3.3 Wipe inside the conduit of the bushing with white cloth ball until you cannot see smudge on white cloth. After that, pack it with plastic cloth.

8.3.4 Check whether there are crack on ceramic case, specially the termination. Check whether porcelain enamel of bushing have blackspot , check whether have small piece of porcelain shedding. If it have blackspot and shedding which is permitted under the national standard code range, you can install and use, but you should make a record.

8.3.5 Lift bush can use single hook bundling, no bumping.

8.3.6 Straighten out L.V. lead wire, and drop down bushing slowly. When the bushing is nearby lead wire, use the lead wire enter inside bushing, drop down direct at install hole until the bushing is in position.

8.3.7 Put the sealing ring, ceramic cap and gasket down on conducting rod, and screw on nut. After that, put the ceramic bushing down on sealing gasket, compact with screw nuts. After fastening the ceramic bushing, screw the nut until the sealing ring has been compacted.

8.4 Installation of through-shaft bushing on LV side

8.4.1 Install after radiator installation, open radiator butterfly valve to make the oil under hand hole, then open the hand hole cover plate.

Wipe away dust and greasy dirt on the surface of ceramic bushing, If wiping cannot make it clean, please use solvent.

8.4.2 Check whether there are crack on ceramic case, specially the termination. Check whether porcelain enamel of bushing have blackspot , check whether have small piece of porcelain shedding. If it have blackspot and shedding which is permitted under the national standard code range, you can install and use, but you should make a record.

8.4.3 Wipe the section where the oil contact(including the conduit of bushing, conducting rod) with white cloth until you cannot see smudge on white cloth. After that, pack it with plastic cloth.

8.4.4 Lift bush can use single hook bundling, no bumping. Drop down direct at install hole until the bushing is in position.

8.4.5 Connect lead-wire and conducting rod. Fasten the bolt of bushing flange.

8.4.6 Bare expandable lead-wire use soft sheet copper. After connecting, the distence between the phase and the earthe should be enough according to the standard.

8.4.7 When put splint, it should be press outside, not between of two pieces of lead-wire. Make sure of that electric contact is well.

8.5 Installation of Core earthing bushing

8.5.1 Wipe clean inside and outside surface of ceramic bushing. Check up and make sure that there is no damage on porcelain, and sealing surface is smooth, and parts are all in readiness.

8.5.2 Dismount the sealing plate of flange. Check whether the bottom end of earthing lead-wire has inserted iron yoke firmly through flange hole, and whether the upper end welded with conducting rod of bushing reliably, and whether the insulation of lead-wire is well. If exist problem, you need repare it and then install.

8.5.3 Clean the flange which install earthing bushing, lay up sealing rubber gasket. Take the conducting rod pass through the ceramic bushing, and then put sealing ring, ceramic cap and gasket down on the conducting rod, then screw on nut. After that, put the ceramic bushing down on sealing gasket, compact with screw nuts. After fastening the ceramic bushing, screw the nut until the sealing ring has been compacted.

8.5.4 Put the core earthing lead-wire of the substation on tip of conducting rod, and then screw nut firmly.

8.6 Installation of Cooling equipment

8.6.1 Butterfly valve should be in off state, dismount transportation sealing plate of butterfly valve, clear the oil dirt & rust in seal groove and valve, check whether the valve is well.

8.6.2 The cooler has been checked whether there is leakage under pressure and has been oil-washed before ex-work. Open the transportation sealing plate of cooler, to see if it is polluted inside, and if it needs oil-washed or not.

8.6.3 Install cooler according to the part number and installation marks. When lift cooler, you should keep it up-right, and then move it on installation position, assemble with the connecting pipe of oil tank.

8.6.4 Install strengthening steel, adjust the parallel and verticality of cooler.

8.7 Installation of pressure relief valve

8.7.1 Open transportation sealing plate and cover of installation hole of pressure relief valve (when it has the cover). Wipe the inner wall with white cloth until you cannot see smudge on white cloth.

8.7.2 Open the installation box of the pressure relief valve, and then take appearance inspection. If there is a ex-work test report and no other abnormal phenomena, you can install it on flange. But if the pressure relief valve has not taken start test, you should take it firstly.

8.7.3 Require good sealing and reliable installation. If it has cover, the oil outlet of the cover should be direct at wide ground. If it has oil-guiding pipe, please install it.

8.8 Installation of gas relay

8.8.1 Check whether the appearance is in good condition, and test whether the signal contact and trip contact is reliable.

8.8.2 Dismount transportation sealing plate, clear installation flange, remove cotton rope which fix the float cup of the gas relay in transportation, install the gas relay between oil tank and oil conservator. During installation, you should be in accordance with the marked direction on appearance (arrowhead point to oil conservator).

8.8.3 Install pipes of all the bushing pedestal, make all the inner gas of the pipes get together to connecting pipe to the gas relay.

8.8.4 Install the guidance gas box and conduit, the conduit cannot be bended in a sharp angle in case of making oil-way un-blocked. Redundant conduits must be bended like a Φ250mm tray， then fixed them on the tank wall.

8.9 Installation of no-load tap changer

8.9.1 Install transmission connecting rod.

8.9.2 When install the transition connection through oil tank, pay attention to whether the sealing is well in case of avoiding leakage.

8.9.3 Install operation device, and operate a positive circulation and a inverse circulation, confirm that the operation device of tap changer is flexible, indicating correctly.

8.10 Installation of conservator and moisture absorber (breather)

8.10.1 Lift oil conservator bracket, fix it on installation bearing of oil tank firmly with bolt, and then install the oil conservator on bracket.

8.10.2 Connect pipe line and install gas relay on the butterfly valve beneath the oil conservator.

8.10.3 Install gas outlet pipe line, oil inlet pipe line and oil outlet pipe line, and deploy stop valves at their bottom ends.

8.10.4 Install connecting pipe of moisture absorption type breather, install breather at the bottom end of connecting pipe. The sealing gasket for storage and transport in breather must be dismounted. Filling transformer oil in oil sealing box, the oil level should immerse blocking air ring.

8.10.5 The connection of pipe of oil conservator should be reliable, and the sealing is well.

8.10.6 Before diaphragm type oil conservator installation, you must fix the connecting rod of oil level indicator and diaphragm with dowel pin, the dowel pin must be bended in case of droping.

8.10.7 Oiling for different structure oil conservator please operate in accordance with the relevant oil conservator operation instruction.

8.11 Installation of thermometer

8.11.1 The thermometer holder located at the cover of oil tank, nearby oil conservator. Open the cap of thermometer holder, and then fill with defined amount transformer oil.

8.11.2 Screw the mercury thermometer in holder gently. after installing pressure gauge thermometer bulb, Redundant conduits bended like a tray， and then fixed them on the oil tank wall.

8.11.3 After screwing the thermometer firmly, splice the connection with waterproof adhesive tape

8.12 Installation of on-load tap changer

8.12.1 After installing oil tank, you should check and clear the oil chamber of selector switch again, and then install oil suction pipe.

8.12.2 Lift tap changer with a special hanger plate, resume the connection of middle flange and support flange, and make them seal well.

8.12.3 Lift selector switch, put into oil chamber carefully. In order to make union axle close, please rotate the insulation axle of selector switch gently, and make coupling inset, and make sure that the selector just be in position.

8.12.4 Reassembly the nut of fixing bolt on the support plate, fix the selector and support plate.

8.12.5 Reassembly the position indicator, and install locking plate of axle head

8.12.6 Reassembly the switch head cover board, fasten all the bolts, make it connect with switch head flange firmly, and make sure of that the sealing is well.

8.12.7 Install pass-by pipe on the oil return pipe of switch head flange and the connecting pipe of transformer oil tank. The oil chamber of change switch should be connected with transformer oil tank inside in order to take vacuum oiling at the same time (when the oil reach up to the air relief valve on switch head cover plate, you should remove the pass-by pipe. And then add sealing plate, and take vacuum oiling continuesly).

8.12.8 Install worm gear box and bevel gear box, and the install horizontal axle and vertical drive axle with coupling clip.

8.12.9 Operate positive and reverse change by hand. Check the symmetry of drive mechanism. If not, loosen vertical drive axle, and adjust it until the rotation of positive and reverse change differ less than one rotation.

8.12.10 Firstly change the taps by hand, and then change it by motor. Check every tap position, and make sure that the position of tap indication and motor device indicator are the same.

8.13 Installation of control cable

8.13.1 Check all the cable groove and its connection, make sure of that there are no arris, rag, corrosion, water and other

foreign matter.

8.13.2 Assemble according to drawing paper and fitting marks. If the dimension of some of cable groove is improper, please make repair.

8.13.3 Seal the connection of cable groove with polyvinyl fluoride or other bonding material in case of water seepage.

8.14 Installation of fans

8.14.1 Move and place in accordance with the package marks.

8.14.2 It should avoid impact strength vibration in transport process in case of damage.

8.14.3 Storage location should be ventilated, dry, clean and there are no corrosive gas. It should not be caught in the rain when transport and storage.

8.14.4 If you need not to use it for a long time, unpack. If the packing-case is broken, please open-case inspection.

8.14.5 Check whether the impeller is out of shape before installation. If it is abnormal, please adjust it.

8.14.6 Install fan and its support. The thickness of rubber mat for installation should be uniform. The tips of both ends of threaded rod should be uniform. The central position of suspension fan located at one third of the top of cooler.

※ Transformer installation should be in accordance with transformer operation rules.

9、Filling oil for transformer(oil compensation)

9.1 In order to decrease the workload of refining oil at site, the transformer oil have been refined in plant. It should be transported by special oil tank. When it need long distance transportation or long item storage, you should use oil drum. Before oiling, you must take oil analysis test again. If it is qualified, you can take oiling.

9.2 Connect the oil filter(oiling machine) and oil feeding valve, start oil filter, the oiling speed should be controlled at 4-5t/h. before oiling, open all the connection valve, the air relief plugs on cooler and oil conservator must be open.

9.3 When oiling, overlook the oil level indicator at a certain time. The level of oil should be in accordance with the marks on oil conservator at the matching conditions of temperature. 1-2 hours after oiling, overlook oil level indicator. If the oil height falls off obviously, add oil reach up to the matching temperature line.

9.4 The transformer oil is inflammable liquid, so no smoking or no naked light on installation site. If you need to use gas welding or electric welding, you must pay attention to fire prevention. Before installing, you should setup fire protection equipment, and have specially-assigned person take charge of it.

9.5 The paper sheet and cotton cloth which immersed in transformer oil should be collected with waste oil. After installation, make a unified dispose.

10、Notice

10.1 Before oiling, you should open the air-bleeder plug on cooler in case of the air is detained in the cooler.

10.2 After oiling, check whether all of the connection valve is easily to open. All of them should be keep in “on” position.

10.3 Before installing thermometer, you should fill a little of transformer oil into the thermometer holder.

10.4 When field installation, you must obey the following preventive measure:

10.4.1 Before installation, the commander in chief and safety principal call up all installers to open work safety meetings, make safety education and declare safety rules.

10.4.2 Irrelevant personnel must not enter the installation field.

10.4.3 Transmit tools and other matters up and down, you should tether transmit, no throwing.

10.4.4 When you install or take down parts which easily drop on high, you need two persons cooperate in case of accident.

11、Handover acceptance

11.1 Check and confirm the transformer main body and accessories.

11.1.1 The main body and accessories should assemble completely, and in good condition. Phase position and marks of every phase is correct.

11.1.2 Oil tank and all parts should be wiped clearly, no oil leakage.

11.1.3 The oil level indicator of oil conservator and bushing indicate clearly and truly. The difference should be in measurement error range.

11.1.4 Run cooling device, check whether the oil pump and fan operate normally, and control circuit is well.

11.1.5 The installation direction of gas relay should be right. Oil normally, gas drain out completely.

11.1.6 The moisture absorber（breather） has been filled with allochroic silicagel. Oil is clear and oil level is suitable in oil cup.

11.1.7 Tap changer operated flexibly, the target of tap position is accurate, the tap position of three phases is identical.

11.1.8 Ground lugs of core, oil tank, bushing and ground shield are complete, they are grounding reliably.

11.1.9 The no-load terminal of bushing type current transformer are short circuit and earthed.

11.2 Technical data and spare parts inspection and acceptance

11.2.1 Before delivery, take technical disclosure, and deliver the technical data to the user.

11.2.2 Technical data contents including:

（1） Manufacturer’s operation instruction, test records, certificate, installation drawing and other technical documents original.

（2）Installation records (machine body and accessories inspection record included), adjustment test record and test report of insulation oil.

（3）List of spare parts

（4）Other documents: technical regulation of order, technical paper of altered design and major meeting summary.

11.2.3 Spare parts

（1）Besides the item in contract, spare parts also should include special tools, transportation sealing plate and so on.

（2）The spare parts with equipment, please reckon in equipment schedule.

（3）The spare parts bought by consumer should make tabulation and hand over.

（4）After checking and handing over, sign at equipment list.

11.3 After transformer installation, check and accept by GB50150—1991《The Electric Equipment Delivery Test Standard of Electric Equipment Installation Project》

11.4 After transformer installation, paint the falling parts caused by transportation and installation. But first you need clear out these parts.

11.5 After installing the nitrogen-filled product, the on-site guidance service staff should bring the nitrogen-filled equipment back to company.

After-sales service information

Information type	□extra urgent □urgent □anxious □general □know □reply				
Order unit		Contact name		telephone	
Product type		Drawing no.		Serial number	
Address		Feedback person			
Time		Telephone			
Contents need to feedback（remark that whether it is in accordance with technical regulation）					
Consumer’s requirement and suggestion					
Department’s suggestion					
Corporation’s suggestion					
Processing result					

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MAINTENANCE & OPERATION INSTRUCTIONS

1. PERMISSIBLE OPERATING CONDITIONS

1.1 Rated operating condition:

1.1.1 The transformer can operate according to the specification of the name plate under specified cooling condition.

1.1.2 In operating oil-immersed power transformer, the permissible temperature are checked on the top of oil. The permissible values of the top oil temperature should follow the specified values of the transformer manufacturer. But , the maximum temperature is not allowed to exceed 95℃. In order to prevent violent aging of the transformer. The top oil temperature always exceeding 85℃ is not suitable.

1.1.3 The externally applied primary voltage of the step-up transformer and step-down transformer can be higher than their rated voltage respectively. But, generally, the value should not exceed the 105% of the rated voltage. No matter what position of the voltage tapping is ,if the applied primary voltage does not exceed 105% of its rated voltage respectively, then the secondary side of the secondary side of the transformers can carry their rated current respectively. In certain particular case, according to the constructional specialty (the core saturated degree, etc.). through testing or with the confirmation of the manufacturer, the applied primary voltage of the transformer is permitted to raise up to 110% of the rated voltage at that tapping position,. In this occasion, the permitted current value should obey the specified values given by manufacturer, or according to test results.

1.2 Permissible over-load

1.2.1 The transformer can operate under the conditions of normal over-load and accident over-load. At the normal over-load, it can operate often and its permissible values are confirmed according to loading curve of the transformer, the temperature of the cooling medium and the carried load of the transformer before the over-load. At the accident over-load the transformer can operate under accident condition only (e.g. in operation condition, one of the transformer is damaged , and no standby transformer is available, then the remaining transformers are permitted to operate according to the accident over-load condition).

1.2.2 The allowable values of the accident over-load of the transformer should be obey the specification of the manufacturer. For the oil immersed power transformer with natural cooling and forced air cooling, pleased refer to table 1.

The ratio of the accident over-load to the rated load	1.3	1.6	1.75	2.0	2.4	3.0

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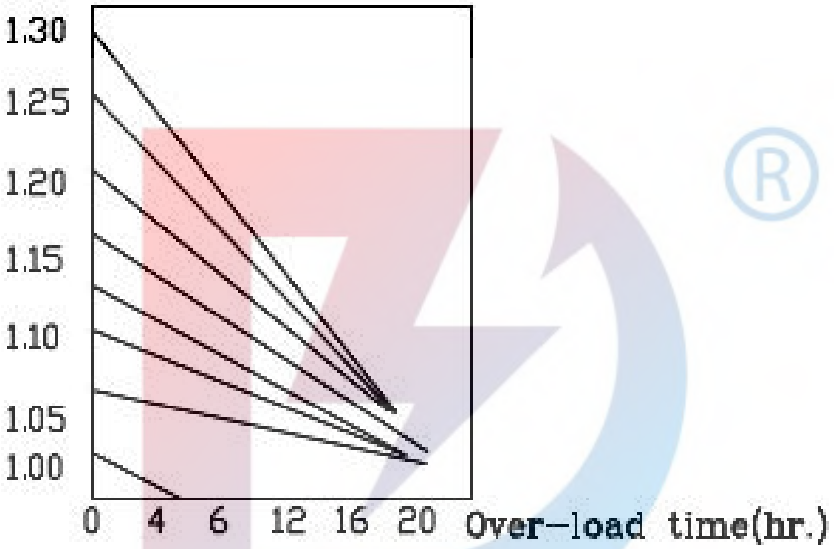
The allowable sustained time of the over-load(min.)	120	30	15	7.5	3.5	1.5

1.2.3 For the oil-immersed power transformer with natural cooling and forced air cooling, the allowable values of the normal over-load and the allowable sustained time are specified as following:

1.2.3.1 If the day-night load factor of the transformer is less than 1, then during the period of load peak of the transformer, the allowable sustained time duration can be determined from the curves shown in fig.3.

Fig. 3 For transformer with the load factor less than 1, the allowable over-load and time duration curve.

Over-load ratio load factor k=0.6-0.95



If the load factor is unknown beforehand, then the specified over-load can be referred to table 2.

Table 2 The allowable time duration of over-load (for oil immersed transformers with natural cooling or forced air cooling)

Over-load ratio	The allowable time sustained duration (hr.-min)(when the temp. rise ℃ of the top oil having the following values before over-load)						
	17	22	28	33	39	44	50
1.0	CONTINUOUSLY OPERATING						
1.05	5-50	5-25	4-50	4-00	3-00	1-30	-----
1.10	3-50	3-25	2-50	2-10	1-25	0-10	------
1.15	2-50	2-25	1-50	1-20	0-35	-----	-------
1.20	2-50	1-40	1-15	0-45	------	-----	-------

1.25	1-35	1-15	0-50	0-25	-------	------	-------
1.30	1-10	0-50	1-15	------	-------	-------	-------
1.35	0-55	0-35	-----	-------	-------	-------	--------
1.40	0-40	0-25	-----	-------	-------	-------	--------
1.45	0-25	------	------	-------	-------	-------	--------
1.50	0-15	----	------	--------	--------	--------	--------

1.2.3.2 If it is in summer time, according to the typical load curve of the transformer, the maximum load is below the rated capacity of the transformer, then for each 1% lowering load can be exchanged by 1% overload in winter time, but it is limited at 15%.

If the value of the total over-load does not exceed 30%, then the over-load of above (two items 1.2) can be used accumulatively.

1.2.4 For oil-immersed power transformer with forced air cooling, when the fans are stopped, then the allowable load and sustained time duration should obey the specification of the manufacturer.

1.2.5 If the cooling conditions are different from their specified by the original manufacturer, then the rated capacity of the transformer should be changed (according to the specification of the manufacturer or through the related tests), and then the over-load is based on the rated capacity after changing.

1.2.6 After the accident over-load of the transformer, the magnitude and the time duration of the accident over-load should be recorded on the technical file.

1.3 Permissible operating conditions of transformer with artificial-cooling units.

1.3.1 For the transformer with forced air cooling, then the fans stopped the allowable over-load should obey the specification of the manufacturer.

1.3.2 For forced oil water cooling transformer, no matter how the load is , the transformer must operated together with the water-cooling units. But if the manufacturer has special specifications or confirmations by experience, then this is not confined.

1.3.3 The operation mode with artificial-cooling units of the transformer, should be specified in the field regulations.

1.4 Permissible short-circuit current and unbalancing current.

1.4.1 The short-circuit current of the transformer should not exceed 25 times of the rated current, the sustained time duration of the short-circuit current should not exceed the values calculated from the following formula:

$$T=900/k^2(second)$$

K- the ratio of the short-circuit current to the rated current

1.4.2 For three windings transformer, the short-circuit current of the middle winding should not exceeded 25 times of the rated current of the said winding. Otherwise, the current limiting reactors should be added and installed, or the middle winding with larger capacity should be chosen.

1.4.3 The winding connection of the transformer being Y/Y. -12, the current flowing through the neutral line should not exceed the 25% of the rated current of the low voltage winding. Where the manufacturer has particular specification, then should obey the statement of the manufacturer.

2. MAINTENANCE DURING NORMAL OPERATIONS

2.1 The checking of the insulation of transformer windings

2..1.1 At installing or after repairing, before putting in service (generally after drying) or after stopping to use (stored) for along time, then the transformer should be measured its insulating resistance of the winding. The measured values and the oil temperature should be recorded on the antecedent cards. To measure the insulating resistance , the Meg-ohm meter with the voltage 1000-2000 volts should be used.

The allowable values of the insulating resistance are not fixed.

The insulating resistance measured during the operating period are compared with the values measured at installing, or after repairing and drying, before putting into service. This is the main basis of jugging the insulation situation during the operating of the transformer. The insulating resistance should be measured at the same temperatures as far as possible, and use the Meg-ohm meter of same operating voltage.

2.1.2 If the insulating resistance of the transformer is lower, then it is necessary to measure tgδ, capacitance ratio and E60/R15, as the same time, take the oil sample to test(including the volume air resistivity and tgδ). The final conclusion of the insulation situation of the transformer should be made by summarizing all of the tested data, and by comparing with the data of the former operating records.

2.2 The checking of the transformer

2.2.1 The operation of the transformer installed at power generating station and in the substation, where always supervised by the personnel on duty, is supervised by means of the meters on the controlling panels,

and are recorded once an hour. If the transformer is operating at over-load, then records are made once half an hour, at least. If the number of records may reduce to some extents, but at least two times per shift.

Thermometers set on the transformer and its reading should be recorded during inspecting the transformer. For a no-personnel on duty substation, during inspecting of fixed period, the voltage, current and temperature of top oil should be recorded every time. In addition, for the distribution transformation the loads of three phase should be measured at the maximum loading period. If the unbalance load is observed, then the new distribution of loads should be done.

The time periods of measuring should be stated by the regulations of the field supervision procedures.

2.2.2 Power transformer should be checked externally at a definite time period, in general, the time periods can be determined according to the following regulations.

2.2.2.1 The transformers installed at the power generating station and in the substation having personnel on duty all the time, should be checked at least once a day, and once a week in the night.

2.2.2.2 In the power substation without personnel on duty and in room, the transformers having capacity of 3,2 (0 KVA and above, should be checked at least once per 10 days and should be checked also before putting into service and after stopping to operate.

2.2.2.3 In the power substation without personnel on duty or installed in small transformer room, the transformers and pole-mounting type with capacity of 320KVA and below should be checked at least once every two months.

According to the actual conditions (dust mud, freezing, etc.) the number of the checking should be increased and these conditions should be stated in the field supervising regulations. When the weather are changing violently (cold, hot), the give alarm signals, the external parts of the transformer should be checked.

2.2.3 The general items of the external checking of the transformer should be checked.

2.2.3.1 Check the color of the oil in transformer conservator and in the oil-filling bushing(in case of the construction of the oil filling bushing suitable for checking), the height of the oil level and whether there is oil-leakage or not.

2.2.3.2 Check the transformer bushings:

Whether clean or not, broken and cracks; trace of electric discharging and other phenomena;

2.2.3.3 Check the characteristics of “ hum, hum” sound, whether the loudness is increasing or not : whether new tones are occurring or not, etc.

2.2.3.4 Check the operating conditions of the cooling units, whether normal or not;

2.2.3.5 Check the power cable and bus bars, whether they are normal or not;

2.2.3.6 Check the oil temperature of the transformer;

2.2.3.7 If the transformer is installed in room, then it is necessary to check whether the door, windows and door bolts perfect or not; whether the room has rain-leakage or not; whether the illumination and air temperature are suitable or not;

2.2.3.8 Check the pressure-relief vent whether the isolating membrane is perfect or not;

2.2.3.9 Check the value of the gas relay and valve of connecting pipe. Whether the valves are opened or not.

According to the special points of the transformer constructions, when some supplementary items of checking are necessary, then these items should be specified by the field regulation.

2.2.4 The responsible person for operation of the electric department should, in addition, check the following items:

2.2.4.1 The grounding conditions of the outer casing of the transformer;

2.2.4.2 The conditions of the punching-type protector;

2.2.4.3 The operating conditions of the hot siphon oil filter;

2.2.4.4 Check the trap device of oil conservator; whether there are water or dirties. If there are, then they should be taken off;

2.2.4.5 The ventilation condition of the transformer installed in the room;

2.2.4.6 By using the controlling valve to check the oil level; whether there is blocking phenomena or not;

2.2.4.7 Check the dehydrating agent in the dehydrating breather, whether it absorbs the moisture to a saturated condition;

2.2.4.8 Check the leads-seals of the valves and other parts;

2.2.4.9 The indicating mark plates and the paint of " phase color" should be clean and bright.

2.2.5 The transformer of forced oil circulating water cooling type, the following items should be checked;

2.2.5.1 The oil pressure in the oil-cooler should be higher than the water pressure (in general, it should be higher with a pressure value of 1-1.5 atmospheric pressure);

2.2.5.2 The outlet water of the oil-cooler should not content oil, if there are, then it means that the oil-cooler has oil-leakage phenomena;

2.2.5.3 The bearings of the pumps and motors should be in good conditions;

2.2.6 The transformer with forced water circulating to cool the oil, the following items should be checked;

2.2.6.1 Maintaining the necessary vater pressure, but should not exceed 2(two) atmospheric pressure;

2.2.6.2 The cooling system should not have the phenomena of freezing. Therefore in winter time when the transformer is stopped to operate, then the water stored in the snakelike piping.

2.3 Switching-on, switch-off and changing the tapping of the transformers.

2.3.1 Before closing the switch of the transformer(i.e. switch-on) the personnel on duty must check the transformer are carefully, to make sure that the transformer is in perfect status, and check all of the temporary grounding wires, indicating mark plates and obstructs, whether they are taken off or not. After repairing during preparing to switch-on, the work-permitting-ticket should be checked also whether it has been handled out. Then measure the insulating resistance (the transformers, frequently switch-on and switch-off or frequency operating may not be measure every time. If the cable has no isolating switch, then the insulating resistance of the transformer winding can be measured together). During measuring procedure, the potential transformer must be disconnected off. If the insulating resistance is below some allowable limits, then it should be reported to the leaders of higher rank, so that to make a decision, whether putting it in service or not.

2.3.2 All of the standby transformers should be ready to put in service at any time. While the standby transformer stopped to operate for a long time should be excited at a fixed time period.

2.3.3 The transformers of forced oil-circulating water-cooling type, before putting in service, should start the oil pumps and then start the water pumps and then start the water pumps.

2.3.4 The operating procedure of switching-on and switching-off of the transformer should be specified in the field regulation, and should obey the following items:

2.3.4.1 The excitation of the transformer should be connected from the power supply, equipped with protecting devices, when the transformer is damaged, then the protecting devices can switch-off;

2.3.4.2 When there are switches, then the switches must be used to make switching-on and switching-off;

2.3.4.3 When on switch is available, then the isolating switches may be used to switching-on and switching-off the transformer with no-load current does not exceed 2(two) atmosphere pressure.

When it is intended to switch-off the no-load current of the transformer at a voltage of 20KV and above, then a three parable knife-switch must be used, which are equipped with arc-suppressing horns and

mechanical driving mechanism, and should be installed outside of the room.

If it is limited by the field condition and must be installed in the room, then the difficult-combustible insulating material should be installed between the phase to phase spaces, to isolate among themselves, to prevent that when the arcing of one phase may lead to the short-circuiting of the neighboring phase.

According to the operating experiences or special test results and the approval of the chief-engineer of the department, the actual conditions may be differed slightly with the above mentioned conditions.

2.3.5 When the transformer newly installed or after large repairing of changing the windings, and the generator make a unit connector, then during putting in service, the exciting voltage should start from zero. The other transformers may perform the suddenly switching-on excitation;

2.3.6 The transformers, after large repairing and accident repairing as well as replacing oil ,need not to wait for the elimination of the air-bubbles in the oil , are excited and carry load (but, except to make the sustained voltage test). The transformer fitted with the oil conservator, before switch-on should exhaust the residual air staying at upper portion of the tank and radiators.

2.3.7 If the tap changer of the transformer cannot regulate the voltage under carrying load condition, then before changing the tapping positions, all of the switch and isolating switch are used to make the transformer disconnecting from the electric power supply. During changing the tapping, the correctness of the position of tapping must be considered and observed.

After changing the tapping position the performance of the circuit and the homogeneity of the resistance of three phase must be checked by means of the ohm-meter or the measuring bridge.

The transformer is equipped with the on-load tap changer (to regulate voltage under leading condition), then according to documents of the manufacturer, the special specifications and procedure should be composed, for the convenience of personnel on duty, that, they can work according to the special specification and procedures.

The conditions of changing the tapping position of the transformer should be recorded on the operating record note book on duty.

The position of the tapping of the transformer should be recorded on its special note book, for the convenience of the checking at any time.

2.4 The operation of the gas relay protecting units

2.4.1 When the standby single-unit transformer, for replacing the operating transformer, is intended to put

into service, then the personnel on duty should use the reverse switch to make the gas relay protecting devices switched to the signal and tripping coils. And then trip off power supply, the gas relay protecting devices of the transformer are disconnected off.

2.4.2 When the operating transformer is intended to change to a standby one, then the gas relay protecting units should be connected with signals as usual. The objects are that to discover the lowering of oil level of the not-yet-operate transformer in time, so that to fill addition oil in time. And when it is intended to join in operating by turns, the transformer has connected to the relay protecting units already.

2.4.3 For the operating transformer, when it is intended to make oil-filtering or oil-filing, then the gas relay protecting units should only be connected with the signals, to prevent the accident which relay lead to wrong trip-off. In this case the other relay protecting units (such as differential protecting, current switch-off devices etc.) of the transformer should be connected still to the trip-off coils. After the transformer oil has been filled or filtered, when the air bubbles in the protecting units are allowed to put into service again.

2.4.4 When the oil level, indicated on the oil level meter, has the violent rising phenomena, in order to find out the causes of the rising oil level, before taking off the connecting plates of the tripping circuit, it is forbidden to open the various gas or oil exhausting plugs, to clean the eye-holes of the dehydrate breather or other work etc. to prevent the wrong tripping-off of the gas relay.

2.5 Operation in parallel of the transformer

2.5.1 The conditions for parallel operations of the transformers are the following:

2.5.1.1 The connection group of the winding must be same.

2.5.1.2 The voltage ratios are equal.

2.5.1.3 The short-circuit voltage are equal.

The transformers with different voltage ratios and different short-circuit voltages, when any one of them does not over-load, may be operated in parallel. When the transformers with different short-circuit voltages, the secondary voltage of the transformer with large short-circuit voltage should be raised properly, so that the capacities of two transformers could be utilized sufficiently.

2.5.2 After installing and some work (e.g. the wiring has been detached) which may cause change of phase order, the phase of transformer must be tested and confirmed. Then they are allowed to operate in parallel.

2.5.3 Three phase transformer with all of the odd number connection groups, after changing the external wiring terminals only, then they may operate in parallel. The three phase transformers, with all of the even

number connection groups (e.g. the phase differences are 120℃ or 240℃). After changing the external wiring terminals , then they may operate in parallel; but in cases of the phase difference are 60℃, 180℃ or 300℃, after changing the internal connection, then they may operate in parallel.

The transformer with odd number connection group and the transformer with the even number connection group cannot connect in parallel.

The table 3 Gives some examples of parallel operation: the three phase transformers with odd number connection is after changing the external wiring can operate in parallel.

Table 3. Three-phase transformer with odd number connection groups, after changing the phase difference symbols, can operate in parallel.

Connection group	H.V. side, phase difference symbol	L.V. side phase difference symbol
Y/Δ-11	ABC	abc
Y/Δ-1	BAC, ACB, CBA	bac, acb, cba
Y/Δ-5	BAC, ACB	acb, bac

2.6 Economical operation of transformer

2.6.1 The power generating station and power substation always have the personnel on duty is should be specified to use the quantity of the transformers according to the load conditions.

The distribution transformers in city, according to condition of annual winter and summer two seasons load curves, specified the used quantity of transformers respectively, in order to diminish the electric energy losses of the transformers.

2.6.2 In composing the stopping and delivering electric power plan of the transformer, in order to diminish the operating action number in one day and night, the stopping time of the transformer generally is not less than 2-3 hrs. in this case, it is allowed to have a certain difference between the economical operating mode. The mutual deployment of the loads must be considered. Individually operating transformer should be considered to have the economical load distribution, so that in a definite time interval the total losses approach the minimum values.

3 ABNORMAL PHENOMENA AND ACCIDENTS OF TRANSFORMER

3.1 Abnormal phenomena is operations

3.1.1 The personnel on duty, who discovered and abnormal phenomena in the operating transformers (such as oil-leakage, insufficient height of the oil level in the oil conservator, abnormal heating, abnormal noise), should adept every means to eliminate the abnormal phenomena, and reports these things to the leader of higher rank, record the happened things to the operating record note book and equipment damages record note-book.

3.1.2 If the discovered abnormal phenomena cannot be eliminated except stopping the operation of the transformer, and it may threaten the security of the whole system, then should shut down to repair. If the spare transformer is available, then firstly it should be put into service as far as possible.

The transformer, having one of the following cases, should be shut down and repaired, and replaced by the spare transformer;

3.1.2.1 The noise inside the transformer is very loud, every non-uniform, and with cracking sound;

3.1.2.2 Under normal cooling conditions, the temperature of the transformer is abnormal and continuously rising.

3.1.2.3 Oil spurts out of the oil conservator or from pressure release vent;

3.1.2.4 Leakage of oil causes a dropping of the oil level down to (below) the limiting level indicated by the oil level meter;

3.1.2.5 The change of the oil-color is too serious, the carbon particles appear in the oil;

3.1.2.6 The bushing have serious damage and discharge phenomena.

3.2 non-permissible over-load, abnormal temperature rises and oil levels

3.2.1 When the transformers over-load exceeds the allowable values, the personnel on duty should adjust the transformer according to the specification approved by the field regulation.

3.2.2 When the rising of the oil temperature of the transformer exceeds the permissible limitations, the personnel on duty should judge the causes and adopt effective means to diminish it , therefore must do the following works:

3.2.2.1 Inspecting the loading and the cooling temperature of the transformer, and check the oil temperature, which should be attained under these conditions;

3.2.2.2 Check the thermometers;

3.2.2.3 Check the artificial-cooling units of the transformer or the ventilating conditions of the transformer

room.

If the causes of the rising of temperature are due to the damages of the cooling system, and it must be shut down and repaired. If it could be repaired without shutting down the transformer (such the damages of the fans, etc.), then the personnel on duty, according to the specification of the field regulations temporarily adjust the loads of the transformer of capacity corresponding to the transformer with shutting down the artificial cooling units.

If the discovered oil temperature is higher than the usual temperature at the same load and cooling temperature with 10℃ and more. Or, the load of the transformer remains unchanged, but the oil temperature raised continuously, while the results of checking show that the cooling units stand the ventilation of the transformer room is good and the thermometers are normal, then it damages (such as the firing of the core, the short-circuit between the inter-layers of the windings, etc,), but the protecting units of the transformer do not act due to some causes. In this case, the transformer should be shut down and repaired.

3.2.3 If the oil in the transformer is frozen, then it is permitted to put the transformer into service operation and to carry load, but there after the oil temperature of the upper layers and the oil circulating conditions (whether circulating or not) must be noticed.

3.2.4 When the oil level of the transformer is discovered to be lowered apparently (in comparing with the oil level which should be maintained corresponding to the oil temperature during that time), then the oil should be filled.

If the oil level lowers rapidly it due to the oil leakage with large quantity of oil, then it is forbidden to change the connection of gas relay to the action of signal only, while it must be done rapidly to adopt means of stopping the oil leakage with large quantity of the oil, and to fill the transformer with oil.

3.2.5 When the oil level, due to the rising of the temperature, is rising gradually, if the oil level, corresponding to the maximum oil temperature, may be higher than the oil level indicator, then it should drain the oil, to cause the oil level descended to proper height, to prevent overflowing of the oil.

3.3. Treatment of the actions of gas relay protecting units

3.3.1 When the gas relay protecting units are acting, the personnel on duty should stop the sound signals, and check the transformer (if the spare transformer is available, if requiring, the spare transformer could be repaired first), find out the causes of the signal action of the gas relay. Whether due to the air into the transformer, or due to the lowering of the oil level, or due to the damage of the secondary circuits, if the

checking of the transformers cannot find out the reason of the abnormal operation, then the characteristics of the collected gas in gas relay should be identified. If the gas is colorless and in-combustible, then transformer can operate continuously.

If the gas is combustible, then no matter the spare transformer is available or not, the transformer must be shutdown to facilitate to find out the causes of action more carefully. To check whether the gas is combustible or or not, it must be done very carefully, do not bring the fire too close to the top terminal of the gas relay, just to the 5-6cm. over the top terminal.

If the cause of the action of the gas relay is found out not due to the air entering into the transformer, then the flashing point of the oil should be checked. If the flashing point, comparing with former record, is decreased more than 50℃, then transformer must be shut down.

If the signal action of the gas relay protecting units is due to the residual air in the oil, then the personnel on duty should exhaust the gathered and collected in the gas relay, and notice the time interval between this signal action and the following one. If the time intervals of the signal actions shorten step by step, this shows that the switch will be tripping off soon later, in this occasion the gas relay should be connected with signal alone, and report these things to the leader of high rank. But if the spare transformer is available, then the spare transformer should replace the defective one, but it is not allowed to use the gas relay of the operating transformer connected to the signal only.

3.3.2 If the transformer is tripped off due to the action of gas relay, and having the checked results due to combustible gas, leading to the action of the protecting unit, then the transformer. Before checking and passing the tests, is not permissible to put into service again.

3.3.3 The action of the gas relay protecting units, according to the various property of the damage, in general, have two kinds: One is signal acting but not tripping off, other is both action at the same time.

The signal acting but not tripping off, usually have following causes:

3.3.3.1 Due to the non-tightness of oil-filtering, oil filling or cooling systems, so that the air enters into the transformer.

3.3.3.2 Due to the descending of the temperature, or the leakage of oil, so that the oil level is decreasing slowly;

3.3.3.3 Due to the slight damage of the transformer, the small amount of gas is evolved;

3.3.3.4 Because of the occurrence of the jumping discharge and short-circuiting, which causes the oil

rushing through the gas relay (protecting units give the wrong action).

3.3.4 Signal and switch act simultaneously, or only switch-acting inside the transformer may occur serious damage, oil level decreasing too quick or the secondary side of the protecting unit existing closed circuit, etc. Under certain conditions, such as: after repairing, the air in oil is releasing out so quick that is causes the switch to tripping-off. The causes of the action of the gas relay protecting units and property of the damage can be identified by the gas gathered and collected in the gas relay, the amount, the color and chemical composition of the gas, etc.

According to the amount of the gas (large or small), the large or small of the damage could be estimated.

If the gathered and collected gas is of colorless, no smell and not combustible, then the cause of the action of gas relay is due to the gas released out of the oil.

The identification of the gas color must be done very rapidly, otherwise after a certain time the color will disappear (the colored matter may precipitated).

The property of the damage of the transformer can be determined according to the following table:

Gas Property	Transformer Damage Property
Yellow-Gray, Difficult combustible	Wood-Damage
Light Gray, Strong smell, Combustible	Pater or Press-board Damage
Gray and Black, Combustible	Oil-damage

3.4 Self-tripping-off and fire-extinguishing of the transformer

3.4.1 Treatment of the self-tripping-off

When the transformer is self-tripping-off, if the transformer is available, then the personnel on duty should put it into service. And then immediately check the cause of transformer self-tripping-off. If the spare transformer does not available, then according to the dropping-down of the indicating-plate find our which kind of the protecting unit acting, and during the transformer tripping-off what external phenomena (e.g. Short circuit of the net work, transformer overload and other, etc.). If the checking results show that the transformer tripping-off does not due to the inner damage, while it is due to over-load, external short-circuit, or duce to the damage of secondary circuit of the protecting units. Then the transformer without external checking can be put into service again. Otherwise, must perform external checking to find out whether the

sign of internal damage exists or not, and to measure the insulation resistance of the windings in order to find out the causes of the transformer tripping-off.

3.4.2 Treatment of the firing and extinguishing of transformer

When the transformer is firing, firstly all of the switches and isolating switches should be opened, and put the spare transformer in service. If the transformer oil is over-flowing to the top of the transformer and firing, then it must open the valves, located at the bottom of the transformer to drain-off the oil, so that the oil level can be lowered than the firing place.