OPERATION & MAINTENANCE MANUAL

DB Transformer, with an Edge

INSTALLATION, OPERATION AND MAINTENANCE FOR POWER TRANSFORMERS

DAELIM BELEFIC®

CONTENTS

01 SAFETY STATEMENT

The manuals 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.

02 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. Check if the transformer has suffered any accidental drops or if they are any twisted the reinforcements or pipes.
3. If the paint is damaged or if any metal pieces are rusted, used sandpaper and use an adequate anti-corrosive paint.
4. Check that all screws and nuts are not found loose.
5. Locate accessory parts that may have been shipped separately.
6. Carefully check the unit and associated protecting components of main tank 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.
7. 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:Ifacceptanceof the transformerismade and damageto the unit isnoticedat alatertime, it is extremely difficult to file a claim against the carrier.

02 GENERAL INFORMATION

Power Transformer Shipping Requirements

2.1 Lifting for transformer body

2. 1.1 The lifting equipment, spreaders and the foundation of the loading and unloading site must be able to withstand the lifting weight of the transformer.

2. 1.2 When hoisting the transformer, the rope should be hung in the hoisting position so that the four slings are stressed at the same time.

2. 1.3 The angle of the sling is not more than 60°during lifting. If this requirement cannot be met due to the limitation of the lifting height, the lifting beam should be used for lifting.

2. 1.4 If you need to change the direction of the trolley or add bars at the bottom of the box during transportation, you need to use a jack to jack up the transformer at the position specified in the outline dimension drawing before proceeding. The jack bracket on the lower fuel tank is used for jacking up the main body of the transformer. When jacking up the main body, all jack brackets must be used at the same time. All jacks should be raised and lowered synchronously to prevent the
main body from tilting and overturning.

2.2 Handling

When is necessary to transport the transformer to its installation site, please follow these steps in order to avoid any damages to its structure or accidents to the personnel responsible of such operation:

- Select preferably, as means of transportation a "trailer" of a low platform

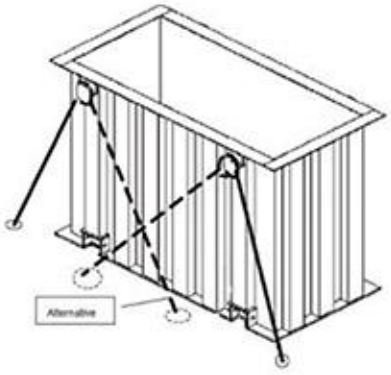

Figure 1. Tie-down hooks of the trailer

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• Before the delivery of the transformer is strongly recommended to make a detailed revision of the route in order to anticipate to any possible obstacles (low clearance bridges), dangerous slopes, conditions of the highway, etc.

• As indicated in figure 2 the transformer must go as centered as possible in relation to the trailer.

• Check the condition of the tie-down hooks of the trailer and verify that they are in good condition.

• The expansion tank (if it is to be delivered with the transformer), must be placed behind the cabin of the truck.

• In each corner there should be at least two (2) tie-down hooks to secure the tank.

• Use when possible a steel chain or cable properly tensed. Never use either rope or any other material that may stretch. Each cable must offer a minimal resistance to traction of 15 tons.

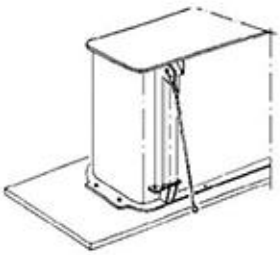

Figure 2. Position of the transformer on the trailer

• During transportation there should not be any slopes greater than 25° longitudinal and 30° transverse.

2.3 Unloading

• Before unloading the transformer from the vehicle observe if there are any missing pieces or deformations. If so, inform the manufacturer of these irregularities before starting any repair.

• When lifting the transformer, the suspension cables have to be maintained almost parallel to avoid any bending of the hooking bolts or other parts of the structure.

• When a transformer can not be handled by means of a crane, it may be moved by sliding it on skates or on rollers, but being careful of not to damage the base or of not to tilt it.

• The transformer should never be lifted or moved by placing levers or hydraulic jacks under the purge valve, cooling oil drainage, connections of the radiators or any other devices.

• When large transformers are moved on rollers, beams must be supplied to distribute the forces on the base.

03 STORAGE

After a transformer has been received at its final destination, it is advisable to put it (full of oil) on its permanent place, even if it is not going to be placed in operation immediately. If this is not possible, the transformer has to be placed in a dry place and the transformer must be filled with oil. If the unit is going to be located outdoors, the water vapor will condense inside the tank, due to the variations in temperature and humidity. This will be absorbed by the winding and it will be necessary to dry the unit before putting it on operation. Therefore, it is preferable to place the transformer in a place where the temperature is slightly high and stable, following the recommendations that are given below:

• The transformers for installation indoors have to be stored in a closed place. However, if it is going to be installed in open places, these places will have to be well covered to avoid the humidity and any foreign matters enter the tank.

• The transformers to be used outdoors must be stored whenever possible indoors.

• The base or the platform for the storage of the transformers must be sufficiently resistant as to withstand its weight and be perfectly flat.

• If the transformer is going to be stored outdoors, make sure that the area for storage has a good drainage system.

• Any incidental loss of oil will not harm the environment.

• To avoid any moisture from entering the tank, a periodic revision of the respirators of silica - gel and/or of the nitrogen pipes should be performed when the tank is partially filled with oil.

• Take the necessary steps to prevent that water condensation is formed in the accessories and parts that are delivered separately. Use the adequate protection against the weather elements. If it is necessary place Silica gel driers inside the bags and/or containers.

• Install all the necessary protection against corrosion and mechanical damages to the tank.

• Whenever possible, charge the control cabinets with their corresponding electrical tension to avoid any moisture from entering their interior.

03 STORAGE

After a transformer has been received from the factory, it is recommended to put it on service on the shortest possible time. If the transformer is not going to be placed on operation immediately, it must be stored indoors and in a dry place by following these instructions:

Storage of transformers with sealed tank

• Transformers completely assembled

Check the internal pressure of the transformer: If the pressure gauge indicates a vacuum or pressure lower than 0. 1 atm. (2 Psi), pressurize with 2 or 3 pounds of Nitrogen and check at least every month the internal pressure. In these conditions the transformer can be stored indefinitely. If the pressure is higher than 0.3 atm (5 Psi), let escape the excess pressure.

• Transformers with detachable radiators

The transformer should be assembled totally, fill up with oil and pressurize it with Nitrogen to a pressure of 0.2 atm (3 Psi); following the recommendations from the numeral 1. 1. In case of not being able to assemble it totally, the parts and pieces should be maintained sealed to avoid moisture from getting inside the parts.

WARNING

In the event of doubts or lack of knowledge of the qualities of the available oil and before filling the transformer, samples will be sent for tests to a competent laboratory. Oil that do not comply with our specifications, can not be used without our approval.

Transformers with expansion tank

• Fully Assembled

Place the silica gel breather following the instructions “Assembly of breathing silica gel".

WARNING

If during transportation the silica gel has absorbed any moisture (pink color), it will have to be dried in an oven to 150-180 °C, until it recovers its original blue color, or if it is possible to change it by a new silica gel.

In oil immersed transformers, the color of the silica gel will be controlled carefully every four (4) weeks, and in tropical climates every two (2) weeks. As it has been said previously, the silica gel will be replaced or will be dried in an oven, if more than half of the content of the present breather presents discoloration.

03 STORAGE

• Partially filled with oil

The expansion tank will be mounted and will proceed to fill it up with oil up to the corresponding level. Once the fill up is finished with oil, the silica gel breather will be mounted. A transformer completely full of oil can be stored indefinitely. This storage is preferable than a transformer filled with gas.

• Fill up with Nitrogen gas

Verify the internal pressure of the transformer; this must be maintained in 0.2 atm (3 Psi). If the nitrogen bottle is empty, you must use for the fill up, nitrogen of a purity of 0.3% of its volume and a degree of maximum humidity of 250 ppm. Storing a transformer filled with nitrogen is possible, without other manipulations for a period of three (3) months. For longer periods of storage, instructions to fill with oil will be requested. Each four (4) weeks the pressure of the main tank and of the bottle will be controlled

Storage of insulating oil

Insulating oil will be kept exclusively in clean containers and will be protected against humidity by placing the containers in a place where the temperature is maintained unchanged and on horizontal position. It will be avoided carefully any mixture with other liquids (oil for cables, lubricating and heating) or with solid particles. Small quantities of impurities can highly alter the qualities of the insulating oil. All the containers for storage are carefully checked and a detailed record will be kept of cleanliness and of perfect impermeability. It will be the responsibility of the selling company whenever possible to wash the dirty and/or used containers. In the event that becomes necessary a cleaning at the same installation site, these steps will be followed:

• The container will be sprayed with unleaded gasoline or with refined petroleum, until the cleaning liquid does not present some coloration.

• Once the container has been emptied thoroughly, will be placed to an oven or will be let to dry by means of a dried air flow for several hours. (Warning: There is explosion risk).

• After drying the container(s) will be closed hermetically, so no air would enter the container.

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4.1 Preparation before installation

4.1.1

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.

4.1.2

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.

4.1.3

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

4.2 Stipulation of ambient and time of transformer core lifting inspection

4.2.1

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

4.2.2

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

4.2.3

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

4.2.4

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

4.2.5

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

4.3 Requirements and notices of transformer cover lifting

4.3. 1

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

4.3.2

Before perform lifting tank cover inspection, the product need to complete working routine & requirement as clause 7. 1

4.3.3

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.

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4.3.4

Disassembling the on-load tap changer should according to instruction manuals of on-load tap changer.

4.3.5

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.

4.4 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、 tg δ 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 (oilingmachine)	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

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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.

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S/N	Item & procedure	Job scope & requirement
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 re-positioned 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.

04 INSTALLATION

4.6 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 ϕ 80 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.

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S/N	Item & procedure	Job scope & requirement
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.

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S/N	Item & procedure	Job scope & requirement
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.

04 INSTALLATION

4.7 Universal operating provision of overall installation

4.7.1

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.

4.7.2

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).

4.7.3

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

4.7.4

As for 69KV and above class lead wire,lead wire's insulation inclined tip must packed into the mouth of voltage-sharing ball of the bushing.

4.7.5

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

4.7.6

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.

4.7.7

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

4.7.8

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

4.7.9

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.

4.7.10

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.

4.7.11

Installation of On-load tap changer,should pay more attention to the horizontal axis and vertical axis equipment,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).

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4.8 Installation accessories

4.8.1 Notices of bushing installation

4.8.1.1

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

4.8.1.2

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.

4.8.1.3

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.

4.8.1.4

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

4.8.1.5

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.

4.8.1.6

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.

4.8.1.7

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

4.8.1.8

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.

4.8.1.9

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

4.8.1.10

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

4.8.1.11

The direction of oil level indicator of bushings should be same in order to observe conveniently.

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4.8.2 Installation of 69KV and above bushing and lead-wire

4.8.2.1

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.

4.8.2.2

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.

4.8.2.3

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.

4.8.2.4

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.

4.8.2.5

Porcelain bushing must be double-check whether have any cracks and leakage, the oil level indicator whether is working properly I, 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.

4.8.2.6

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.

4.8.2.7

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.

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4.8.2.8

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.

4.8.2.9

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.

4.8.2.10

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.

4.8.3 Installation of cable-style bushing on LV side

4.8.3.1

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.

4.8.3.2

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.

4.8.3.3

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.

4.8.3.4

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.

4.8.3.5

Lift bush can use single hook bundling, no bumping.

4.8.3.6

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.

04 INSTALLATION

4.8.3.7

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.

4.8.4 Installation of through-shaft bushing on LV side

4.8.4.1

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.

4.8.4.2

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.

4.8.4.3

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.

4.8.4.4

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

4.8.4.5

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

4.8.4.6

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.

4.8.4.7

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

4.8.5 Installation of Core earthing bushing

4.8.5.1

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.

4.8.5.2

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.

04 INSTALLATION

4.8.5.3

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.

4.8.5.4

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

4.8.6 Installation of Cooling equipment

4.8.6.1

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.

4.8.6.2

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.

4.8.6.3

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.

4.8.6.4

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

4.8.7 Installation of pressure relief valve

4.8.7.1

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.

4.8.7.2

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.

4.8.7.3

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.

04 INSTALLATION

4.8.8 Installation of gas relay

4.8.8.1

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

4.8.8.2

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).

4.8.8.3

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

4.8.8.4

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.

4.8.9 Installation of no-load tap changer

4.8.9.1

Install transmission connecting rod.

4.8.9.2

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

4.8.9.3

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

4.8.10 Installation of conservator and moisture absorber (breather)

4.8.10.1

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

4.8.10.2

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

4.8.10.3

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

04 INSTALLATION

4.8.10.4

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.

4.8.10.5

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

4.8.10.6

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.

4.8.10.7

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

4.8.11 Installation of thermometer

4.8.11.1

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.

4.8.11.2

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.

4.8.11.3

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

4.8.12 Installation of on-load tap changer

4.8.12.1

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

4.8.12.2

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

4.8.12.3

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.

04 INSTALLATION

4.8.12.4

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

4.8.12.5

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

4.8.12.6

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.

4.8.12.7

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).

4.8.12.8

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

4.8.12.9

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.

4.8.12.10

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.

4.8.13 Installation of control cable

4.8.13.1

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

4.8.13.2

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

4.8.13.3

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

04 INSTALLATION

4.8.14 Installation of fans

4.8.14.1

Move and place in accordance with the package marks.

4.8.14.2

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

4.8.14.3

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.

4.8.14.4

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

4.8.14.5

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

4.8.14.6

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.

05 TESTS IN FIELD AND START UP OPERATION

Checking before field tests

5.1.1

Check whether the tap switch position and the three-phase connection position of the excitation free switch are consistent.

5.1.2

Check the insulation distance of transformer outer space, which shall not be less than the provisions in the table below.

05 TESTS IN FIELD AND START UP OPERATION

Nominal voltage (kV)	Busing to ground distance(mm)	Bushing to bushing distance(mm)
10	125	125
35	340	340
66	630	630
110	880	830
220	1800	1920
260	2210	2210

Note: the data in the table are the data when the altitude is not more than 1000m. When the altitude is more than 1000m and less than 2500m, the data in the table will be increased by 1% for every 100m.

5.1.3

Check the height of oil storage surface for false oil level. If the oil level of the oil conservator is lower than the normal oil level, the oil can be filled from the oil filling pipe under the oil conservator. When filling, the air plug on the valve of the oil filling pipe should be opened first, and then the oil can be filled after the oil flows from the vent plug.

5.1.4

Check whether the grounding system is reliable and correct.

5.1.5

Check the iron core grounding, ensure one point grounding, and do not form a loop.

5.1.6

check whether the oil tank is reliably grounded.

5.1.7

Check whether the valves of the operating components (except emergency oil drain valve and vacuum oil filling valve) are in the open position, and exhaust again (such as gas relay, lifting seat, etc.).

5.1.8

For the detection of temperature controller, set the limit of temperature controller to the user's demand value according to the instruction manual.

5.1.9

For the detection of secondary line, short circuit the nodes of high and low oil temperature, or short circuit the nodes of overload current relay, and the fan operates normally after power on.

5.1.10

Check whether the alarm and trip circuits of oil level gauge, pressure relief valve, gas relay and temperature controller are unblocked.

05 TESTS IN FIELD AND START UP OPERATION

5.2 Tests in field

5.2.1

Measure the insulation resistance of coils at each side.

5.2.2

The coil connection group shall be checked for three-phase transformer and polarity.

5.2.3

Measure the DC resistance of coils at each side.

5.2.4

Measure the voltage change ratio of each tap position. The error of the voltage ratio at rated tap position shall be less than ± 0.5%, when the voltage ratio is less than 3, the error shall be less than 1%. The ratio of other tap positions shall be within 1/ 10 of the impedance voltage value, but not more than 1%. Pay attention to whether the position of the operating mechanism is in accordance with the actual situation.

5.2.5

Take oil samples from the bottom sampling device of oil tank for test, which shall conform to u ≥ 50kV, water content ≤ 15ppm, air content ≤ 1.5%, when 90℃ tg δ < at 0.5%, gas chromatography was performed.

5.3 Checking before start up operation

5.3.1

Inspection before operation.

5.3.2

Check whether the neutral point on the live side of the transformer has been reliably grounded (it should be directly grounded in case of impact).

5.3.3

Check whether the setting value and action sensitivity of each protection device and circuit breaker are good.

5.3.4

Check protection. Such as gas relay, thermometer, pressure release device and bushing current transformer measurement circuit, protection circuit and control circuit wiring is correct, if necessary, short-circuit linkage test. Record all thermometer readings.

5.3.5

Check whether the bushing type current transformer without load has been short circuited, and open circuit operation is not allowed.

05 TESTS IN FIELD AND START UP OPERATION

5.3.6

Check whether the respirator of oil conservator is unblocked and whether the oil level is correct.

5.3.7

Check the setting value of the protection device. When the system voltage is unstable, adjust the setting value of the protection system appropriately, so as to effectively protect the transformer, such as relay, temperature controller, pressure relief valve and bushing current transformer. Check whether the wiring of the measurement circuit, protection circuit and control circuit is correct, and conduct short-circuit linkage test when necessary.

5.3.8

When no-load impact closing, the signal contact of gas relay (if any) shall be connected to the heavy gas action contact (i.e. power tripping circuit).

5.3.9

For the test of on load tap changer: the on load tap changer shall be tested according to the operation manual of on load tap changer.

5.3.10

The no-load tap changer should continuously change the tap gear in the non excitation state to eliminate the influence of oil film on the contact resistance, and then align the gear. At this time, the contact DC resistance between the moving and static contacts of the switch is less than 500 μΩ， All tap changers should be in the same gear and consistent with the line voltage.

5.4 No load tests

5.4.1

The following tests can be carried out only when the above inspection and test items meet the requirements.

5.4.2

The transformer should be connected with voltage from the power supply side, because the power supply side is equipped with protection device to cut off the power supply under abnormal conditions.

5.4.3

No load boost test

The power supply side of the transformer is connected with the power supply (due to the protection device on the power supply side, the power supply can be cut off quickly in case of abnormal conditions). After connecting to the power supply, slowly increase to the rated voltage and keep it for 30min.

05 TESTS IN FIELD AND START UP OPERATION

No load impact closing

5.5.1

Before no-load switching on, the transformer shall be allowed to rest for more than 24 hours, and the rising seat and bushing equipped with vent plug shall be deflated regularly. Before no-load impact closing, the over-current action shall be set to zero, and the signal circuit of gas relay shall be connected to the opening circuit temporarily.

5.5.2

when the bus protection circuit breaker is closed, the three-phase synchronous time difference shall not be greater than 0.01s, the closing shall be protected by lightning arrester, and the neutral point of transformer shall be reliably grounded (direct grounding).

5.5.3

No load impact closing test

The impact closing power supply is the rated voltage of the system, which shall not exceed 5% of the indicated voltage of the transformer. The maximum number of closing impulses is 5 times. The duration of the first voltage should not be less than 20min, and the closing interval should not be less than 5min. In the process of closing impulses, if the voltage value reaches the maximum value once, the test will not be continued, and it will be regarded as qualified (including the first time). If the maximum value does not appear for 5 times, it will also be regarded as qualified, and the test will not be carried out.

5.5.4

The time limit of over-current protection is set to instantaneous action. Switch on the transformer suddenly with rated voltage for 30 minutes. Listen carefully and observe the condition of the transformer in this case. No load operation for a long time. Under the rated voltage, the cooler can not be turned on when the oil top temperature rise does not exceed 50K and the no-load continuous operation is 6h.

5.5.5

Cut off the power after the test. The oil was measured by gas chromatography and compared with the data before the test.

Loading operation

5.6.1

If the test result of transformer connecting voltage is good and there is no abnormality in no-load operation for 24h, the transformer can be transferred to on load operation. The load should be increased step by step. The transformer should be transferred to 50% load operation after 5min of 25% load operation, 75% load operation after 5min of operation, 100% load operation after 5min of operation, and put into operation after the cooling system is turned on.

5.6.2

After 24 hours of continuous trial operation with load, the main body and accessories of the transformer are normal, and the transformer will turn into normal operation.

06 ACCESSORIES

DAELIM power transformers are available with many optional features and accessories to satisfy a customer's special needs for the operation, protection, monitoring, and maintenance of their equipment. The following list contains the most frequently requested options. Check with the factory for the availability of other optional features and accessories not listed below.

- Cooling/insulating fluid
- Bushing-mounted current transformers
- Surge arresters and mounting brackets
- High-voltage and/or low-voltage terminal compartments
- Wye-delta or series multiple terminal connections
- Forced-air cooling with automatic control system or provisions for forced-air cooling
- Control cabinet
- Nitrogen gas fluid preservation system
- Dial-type winding temperature gauge (standard for forced-cooled transformers)
- Electronic temperature indicator
- Fiber-optic winding temperature indicator
- De-energized tap changer with padlocking provisions
- On-load tap changer with microprocessor-based control
- Special exterior paint color
- Galvanized or stainless-steel radiators
- Cover-mounted fall-protection device

6.1 INSULATING/COOLING FLUID

6.1.1 Type II Mineral Oil

Power 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 (H2O = 1): 0.84 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 Mineral odor

closed cup flash point: > 145°C Boiling point: >238°C

Vapor pressure (mm Hg): < 0.01 @ 20°C Vapor density (air = 1): N/A

Solubility in water: negligible; < 0. 1% Viscosity: 4.3 TO 4.5 CsT at 40°C

06 ACCESSORIES

6.1.2 High Fire Point Dielectric fluid

Power 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 (H2O = 1): 0.42

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

6.2 SELF-COOLED RATING

Power transformers rated for selfcooled operation (ONAN class) are designed to operate at rated load with natural cooling by ambient air flow outside the transformer and natural oil convection within the transformer tank. Heat is radiated from the transformer tank and from tank-mounted radiator panels.

6.3 FORCED-AIR COOLED RATINGS

A single-stage forced air cooling system may be supplied to increase the transformer load capacity (ONAFclass). Sealed motor-driven fans are mounted on radiators to provide increased air flow. Fan operation may be manual or may be controlled automatically by temperature sensors mounted inside the transformer. Fans are connected to a weatherproof control box with weatherproof cable and a separable connector.

A second stage of forced-air cooling may be used (ONAF/ONAF class) to provide a further increase in load capacity beyond that provided by single-stage forced-air cooling. Stages one and two are operated automatically by heat sensors mounted inside the transformer tank and a control panel mounted inside the control cabinet.

06 ACCESSORIES

6.4 FLUID PRESERVATION

A sealed-tank fluid preservation system is standard on all Howard medium power transformers. The interior of the tank is sealed from the ambient atmosphere, such that the gas-plus-oil volume remains constant throughout the range of normal

operating temperatures. An automatic pressure relief device is provided to vent excessive pressure that might build up gradually during extreme overloads or fault conditions. A pressure/vacuum gauge is provided to measure internal pressure.Prior to shipping the gas space is pressurized with a dry air or nitrogen blanket.

6.5 INERT GAS SYSTEM

An optional nitrogen inert-gas system provides a constant nitrogen atmosphere in the gas space of the transformer (Figure14). The nitrogen blanket protects the transformer fluid from deterioration that could occur from exposure to moisture or oxygen. Main system components include a nitrogen cylinder, pressure regulators,valves, and gauges. The system also includes provisions for various pressure alarms. A lockable weatherproof enclosure protects the system.

Standard Cabinet
Nitrogen tank mounted externally
(tank NOT included)

06 ACCESSORIES

6.6 BUSHINGS

Standard bushings are oil-filled condenser-type with porcelain housings. All bushings meet the requirements of the IEEE C57.14 series of standards.

6.7 CURRENT TRANSFORMERS

Current transformers (CTs) are bushing-mounted in the main tank interior. All CTs meet the requirements of the IEEE C57. 13 series of standards.

6.8 SURGE ARRESTERS

Surge arresters are porcelain or polymer housed, gapless metal oxide-varister (MOV) type, externally mounted on heavy steel brackets. All arresters meet the requirements of IEEE C62.11.

6.9 GAUGES

All gauges are dial-type and are located for convenient viewing at ground level (Figure 18).Fluid temperature and winding temperature gauges have re-settable maximum temperature drag hands.

06 ACCESSORIES

6.1.0 ELECTRONIC MONITORING

Various sophisticated electronic monitoring systems are available as options, including those that monitor oil temperature, winding temperature, pressure, moisture, gases, apparent charge, arrester surge count, and leakage current. Contact the factory for these and other monitoring systems that may be available.

6.1.1 CONTROL CABINET

The control cabinet provides a weatherproof enclosure for accessory items such as fan controls, OLTC controls, and terminal blocks for customer connections.with three-point latch and padlock provisions. The cabinet interior is painted white to improve visibility and is equipped with a work light and accessory power outlet.

6.1.2 PRESSURE RELIEF DEVICE

A cover-mounted automatic pressure relief device is provided to vent excessive pressure that might build up gradually during extreme over loads or fault conditions. The standard device has a 6" throat and a cracking pressure of 10 psi. Devices with other pressure and flow characteristics are available with nonstandard operating character istics. Options include alarm contacts, indicating flag, and discharge diverter.

6.1.3 DE-ENERGIZED TAP CHANGER

A de-energized tap changer can be provided to adjust the transformer voltage ratio to meet system requirements. An external operating handle is mounted on one end of the transformer near ground level.The handle can be locked in any switch position and has provisions for a padlock.

06 ACCESSORIES

6.4 ON-LOAD TAP CHANGER

A three-phase on-load tap changer (OLTC) provides automatic voltage regulation in an energized transformer while serving load (Figure 22).OLTC's typically operate over a range of thirty-two 5/8% voltage steps, sixteen above and sixteen below rated secondary voltage. The total tap range is typically 20% (10% above and 10% below rated secondary voltage). Standard OLTC's provided on Howard transformers use vacuum interrupter technology manufactured by Reinhausen or Huming.

The OLTC switch mechanism is sealed in an oil-filled enclosure welded to one end of the main transformer tank. A motor drive and switch position indicator are housed in a weatherproof cabinet mounted below the switch mechanism. A crank lever is provided to operate the tap changer manually. OLTC control panels are housed in the control cabinet .

A variety of microprocessor-based controls are available, including those manufactured by Beckwith, ICMI, and Reinhausen. In addition to the automatic regulation of secondary voltage,control systems can also be equipped to provide communication,data storage,and power quality analysis. All controls are provided with manual override capability

6.5 RADIATORS

Panel-type radiators provide additional cooling to supplement heat radiation from the transformer tank. The number and size of radiators is determined by the design. Radiators are typically detachable and are provided with individual shutoff valves. Standard radiators are made of cold-rolled mild steel that is primed and finished with a durable polyurethane top coat. Stainless steel and galvanized radiators are available as options.

6.6 OTHER FEATURES AND ACCESSORIES

Contact the factory for other features and accessories that are not discussed here but may believable as options.

07 MAINTENANCE DURING NORMAL OPERATIONS

7.1 The checking of the insulation of transformer windings

7.1.1

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.

7.1.2

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.

7.2 The checking of the transformer

7.2.1

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.

07 MAINTENANCE DURING NORMAL OPERATIONS

7.2.2

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

7.2.2.1 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.

7.2.2.2 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.

7.2.2.3 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.

7.2.3

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

7.2.3.1 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.

7.2.3.2 Check the transformer bushings: Whether clean or not, broken and cracks; trace of electric discharging and other phenomena.

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

7.2.3.4 Check the operating conditions of the cooling units, whether normal or not.

7.2.3.5 Check the power cable and bus bars, whether they are normal or not.

7.2.3.6 Check the oil temperature of the transformer.

7.2.3.7 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.

7.2.3.8 Check the pressure-relief vent whether the isolating membrane is perfect or not.

7.2.3.9 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.

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7.2.4

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

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

7.2.4.2 The conditions of the punching-type protector;

7.2.4.3 The operating conditions of the hot siphon oil filter;

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

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

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

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

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

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

7.2.5

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

7.2.5.1 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);

7.2.5.2 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;

7.2.5.3 The bearings of the pumps and motors should be in good conditions.

7.2.6

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

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

7.2.6.2 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.

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

7.3.1

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.

7.3.2

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.

7.3.3

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.

7.3.4

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:

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

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

7.3.4.3 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.

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7.3.5

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;

7.3.6

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.

7.3.7

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.

7.4 The operation of the gas relay protecting units

7.4.1

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.

7.4.2

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.

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7.4.3

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.

7.4.4

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.

Operation in parallel of the transformer

7.5.1

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

7.5.1.1 The connection group of the winding must be same.

7.5.1.2 The voltage ratios are equal.

7.5.1.3 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.

7.5.2

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.

7.5.3

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.

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

Economical operation of transformer

7.6.1

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.

7.6.2

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.

DB Transformer, with an Edge

Quality ISO 9001 | Environment ISO 14001 | Health&Safety ISO 45001

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Safety Instructions

- For your safety,please read user's manual thoroughly before operating.
- Contact the nearest authorized service facility for examination,repair,or adjustment.
- Please contact qualified service technician when you need maintenance.
  Do not disassemble or repair by yourself!
- Any maintenance and inspection shall be performedby the perseanel having expertise