General Caution For Installation

1. PREPARATION
(1) Construct the foundation correctly in accordance with the foundation drawing or the outline drawing before the arrival of the main body.
(2) Prepare necessary equipment, tools and parts before starting the installation work.
(3) After arrival the main body and accessories at site, check the packages with the packing list and also investigate damages of the components.
(4) As the main body is transported filled with the insulating oil, be sure that the oil leakage is nothing and the internal pressure is positive value by reading of the pressure gauge mounted on the main body.
(5) It is preferable to store the accessories inside a building. However where they are outdoors, cover them with a suitable sheets. Don’t expose them to the weather.

2. INSTALLATION
(1) General
(a) Don’t give excessive forces or heavy shock to main body and accessories.
(b) Avoid installation under rain. (for outdoor installation)
(c) Exercise care so that dust, dirt and moisture will not enter inside of the main body and accessories.
(d) Cover the open places with vinyl sheets till just before installation in order to prevent entrance of dust.
(e) Handle gaskets with care so as not to injure.
(f) Don’t remove the cover plates of main body and piping till just before installation.
(g) Fasten bolts with adequate fastening torque. (Refer to following item “Application and torque of tightening bolts”.)

(2) Precaution against moisture absorption
This item “Precaution against moisture absorption” applies to the following jobs are carried out;
① Mounting the conservator.
(a) After opening, cleaning the surface of the connecting flange and attaching the gasket, cover the opening place with clean sheet to protect entering other things into the main tank till just before mounting the fitting parts as shown in Fig-1.

Fig-1 Covering
(3) Application and torque of tightening bolt

(a) Steel to steel fastening (See Fig-2.)

(b) Steel to non-ferrous material fastening (See Fig-3.)

(c) Standard tightening torque of bolts

Followings apply to the connection portions which are directly metal touched portions.

<table>
<thead>
<tr>
<th>Size</th>
<th>Steel “SS41” (kg-f・cm)</th>
<th>Brass “C3601BD” (kg-f・cm)</th>
<th>Stainless “SUS304” (kg-f・cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard</td>
<td>Range</td>
<td>Standard</td>
</tr>
<tr>
<td>M 5</td>
<td>35</td>
<td>32 – 39</td>
<td>19</td>
</tr>
<tr>
<td>M 6</td>
<td>60</td>
<td>54 – 66</td>
<td>32</td>
</tr>
<tr>
<td>M 8</td>
<td>140</td>
<td>130 – 150</td>
<td>76</td>
</tr>
<tr>
<td>M 10</td>
<td>280</td>
<td>250 – 310</td>
<td>151</td>
</tr>
<tr>
<td>M 12</td>
<td>480</td>
<td>430 – 530</td>
<td>257</td>
</tr>
<tr>
<td>M 16</td>
<td>1,200</td>
<td>1,100 – 1,300</td>
<td>620</td>
</tr>
<tr>
<td>M 20</td>
<td>2,200</td>
<td>2,000 – 2,500</td>
<td>1,210</td>
</tr>
<tr>
<td>M 24</td>
<td>3,900</td>
<td>3,500 – 4,300</td>
<td>2,200</td>
</tr>
<tr>
<td>M 30</td>
<td>7,700</td>
<td>6,900 – 8,500</td>
<td>4,400</td>
</tr>
<tr>
<td>M 36</td>
<td>13,000</td>
<td>12,000 – 14,000</td>
<td>7,700</td>
</tr>
</tbody>
</table>

Table – 1 For Structure
(4) The oil pipes should be connected according to the matching numbers (identical numbers) and aligning marks as shown in Fig-4.

![Fig - 4 Pipe connection](image1)

(5) Tighten the bolts gradually and uniformly as shown in Fig-5 and Table-1. And when tightening, make sure that the gasket is not slipped from the gasket groove and not damaged.

![Fig - 5 Bolt tightening](image2)
1. PREPARATION FOR INSTALLTION.

1. Determining location for installation of transformer.
   The location in which the transformer is to be installed must be accurately determined and preparations for
   which such as the concrete foundation, base, anchor etc. should be completed prior to the arrival of the
   transformer.
   (1) The foundation must be laid as to maintain a correct horizontal level. Less than 3 mm is required for flatter level.
   (2) It is necessary to secure the storage space of the parts and the installation equipment.

2. Equipment, tools and parts needed for installation
   The followings are required to satisfy the specification described below.
   (1) Mobile crane
      A mobile crane is used to lift the external parts up. It is necessary to use about 45 ton crane (according to
      requirement) for lifting general parts such as the connecting pipes, pressure relief device etc.
      For the heavy weight parts such as the cooler,
      conservator, bushing etc.
      The lifting capacity of the mobile crane
      should be decided by the weight of the parts, the
      setting height of the parts and the setting position of
      the mobile crane.
      Also a skilled operator of the mobile crane should be engaged.

   (2) Oil storage tank
      It is necessary to provide the oil storage tank which has the
      capacity with enough oil volume for one transformer. The oil
      storage tank should be equipped with a filter valve, an oil
      sampling valve, an air release valve, a manhole, a breather
      and an oil level gauge and the inside is painted with the oil
      proof paint. The inside of the oil storage tank should be
      cleaned with insulating oil and clean waste rugs before
      using.
(3) Oil filter

The oil filter is used for filling oil into the oil storage tank from drums or tank lorry and pulling oil in/out between the oil storage tank and transformer. The oil filter must be capable of removing dirt and moisture from the oil. A press type or a cartridge type filter is generally used. If a filter press type is used, filter paper dryer is required. 200 L/min. oil filter is recommended.

![Fig-A3 Oil filter](image)

<table>
<thead>
<tr>
<th>Filtering capacity</th>
<th>200 L/min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtering accuracy</td>
<td>Less than 5 micron</td>
</tr>
</tbody>
</table>

Table-A1 Oil filter

(4) Oil treatment equipment (Oil purifier)

The oil treatment equipment is used for removing the gas and moisture from the oil while feeding the oil into the transformer. It is desirable for the equipment.

<table>
<thead>
<tr>
<th>Treating capacity</th>
<th>≥ 6000 L/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil characteristic after treatment</td>
<td>Moisture content</td>
</tr>
<tr>
<td></td>
<td>Gas content</td>
</tr>
<tr>
<td>Filling oil temp.</td>
<td>40℃ ~ 60℃</td>
</tr>
</tbody>
</table>

Table-A2 Oil treatment equipment

(5) Vacuum pump

The vacuum pump is used for pull vacuum the transformer at the final oil filling. It is desirable for the vacuum pump to have the specifications shown in table-A3 and mechanical booster.

<table>
<thead>
<tr>
<th>Ultimate vacuum degree</th>
<th>≤ 0.665Pa (≤ 5×10⁻³ Torr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull vacuum capacity</td>
<td>≥ 6000 L/min</td>
</tr>
</tbody>
</table>

Table-A3 Vacuum pump

(6) Dry gas

Dry gas with dew point of – 40℃ should be used. The cylinder is equipped with a regulator and a pressure gauge. As the cylinder is a high pressure vessel, special care must be taken in handling.

(7) Pressure gauge

The pressure gauge usually is used for measuring the gas pressure while an oil leakage test is being carried out. Measuring range: 0 ~ 1.0 bar (0 - 1.0 kg·f/cm²)

(8) Vacuum gauge

The vacuum gauge is used for measuring the vacuum degree at the final oil filling. Pirani type vacuum gauge is recommendable. Measuring range: Less than 13.3 Pa (0.1 Torr.)

(9) Electric power supply

The electric power supply should have sufficient capacity for using the oil treatment equipment, vacuum pump, oil filter etc. The cable should have enough capacity and length for each equipment.
(10) Oil tester

The oil tester should be prepared at site during installation because the oil tester is used to measure the breakdown voltage (dielectric strength) of the insulating oil when oil receiving, oil filling to main tank, before final oil filling to main tank etc. 0 – 80 kV/2.5mm. Gap oil tester is recommendable.

(11) Hoses

The hoses should have enough length for using. (See Table-A4.)

<table>
<thead>
<tr>
<th>Caliber</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil hose</td>
<td>40 / 50 mm</td>
</tr>
<tr>
<td>Vacuum hose</td>
<td>More than 40 mm</td>
</tr>
<tr>
<td>Vinyl hose</td>
<td>10 / 18 mm</td>
</tr>
</tbody>
</table>

Table-A4


2. RECEIVING INSPECTION

1. Inspection
   (1). Main body
   When the transformer has arrived at site, inspect the appearance of the main body, and also check the dry (or nitrogen) gas pressure in the transformer by the pressure gauge mounted on the main body.
   If there are any damages and rust on the main body, you should eliminate or repair them as soon as possible.
   In case that the damage is serious and the effective treatment can not be made by you, please inform the detailed damage condition to Shihlin Electric immediately.
   The transformer is generally filled with the dry gas according to the above Fig-B1 at the factory (In case of the transformer for cold district, this filling pressure is changed in accordance with their conditions.). The internal pressure of the main body changes according to the ambient temperature, so the relation between the temperature and the pressure is referred to above Fig-B1. If the pressure has gone down to less than 0.05 bar under the ambient temperature, the dry gas should be filled up according to Fig-B1 as soon as possible. (If the pressure is positive, it is not necessary to fill the dry gas to the main body.)
   If the pressure is decreasing, the leakage portion must be checked and repaired as soon as possible, and the dry gas must be filled up according to the above Fig-B1.
   Please inform the detailed condition to Shihlin Electric immediately if the dry gas is decreasing in spite of the above treatment.
   (2) Parts
   Check the parts name and quantity in the packages according to the packing list.
   If there are any shortage parts, please inform the case No. and item No. of them to Shihlin Electric immediately.
   Check the damage of the parts. If there are any damages on the parts, please try to repair them and report the damage condition to Shihlin Electric immediately.

2. Storage
   After the transformer has arrived at site, the transformer should be stored on the transformer foundation pad until the installation work will be started.
   The transformer main body and its parts should be stored as follows.
   (1) Main body
   The transformer main body should be stored by filling dry gas. Check the dry gas pressure periodically with the pressure gauge mounted on the transformer main body and inspect the leak of dry gas.
   As for dry gas inspection method, refer to the item Inspection.
(2) Parts

Put an wooden blocks under the package in order to prevent to enter rain-water as shown in Fig-B2.
Lay all the drums down in order to prevent to enter rain-water into drum as shown in Fig-B3.

As the parts to be printed the mark of “KEEP DRY” (See Table-B1.) on the package are influenced by wind and rain, it is necessary to make storage at indoor or to cover with a suitable water-proof sheet.

Care marks (symbol) for handling have been printed on the packing cases as follows.
Parts should be stored in accordance with the care marks which are shown in Table-B1.

<table>
<thead>
<tr>
<th>MARKS</th>
<th>FRAGILE</th>
<th>DON’T SHOCK</th>
<th>AVOID SHOCK</th>
<th>KEEP DAY</th>
<th>THIS SIDE UP</th>
<th>DON’T LAY THIS PART DOWN</th>
<th>GRAVITY POINT</th>
<th>SLING POINT</th>
</tr>
</thead>
</table>

Table-B1 Care mark (Symbol)

NOTE 1: On handling the parts, pay a careful attention as follows:

“BY CRANE “
(1) Put guide rope on the package to prevent swing of the package.
(2) Observe sling point mark on the package when hanging up the lifting rope.
(3) Don’t give any shock to the porcelain of the bushing.

“BY FREIGHT CAR, TRUCK AND FORKLIFT “
(1) Fix the package on them by lashing rope to prevent to let fall.
(2) Observe care mark on the package when handling.
(3) Don’t give any shock to the porcelain of the bushing.
(4) When the fork of forklift is inserted under the package, pay a careful attention to prevent any damage to the package.

NOTE 2: The order for storage of packages should be decided in consideration of the assembling procedure of transformer in order to facilitate the assembly of transformer.
3. MAIN BODY ON FOUNDATION

1. When the main body has been arrived site, check the appearance for any damage caused during transit.

(1) Checking of foundation

Before arrival of the main body, followings should be done;

(2) Check the level of the foundation. The horizontal level of the foundation should be within 3 mm.

(3) Clean the floor of the foundation and draw base lines on the foundation in accordance with the “FOUNDATION DRAWING” supplied by Shihlin Electric.

2. Positioning

(1) Align up three marks on the main body to the base lines from the front side as shown in Fig-C1.

※ Check the shock value of the impact recorder attached the main body after the main body alignment on foundation has been finished.

In case of shock value over 29.4m/s² (3G), inform in to Shihlin Electric representative immediately because further checking are needed.

(2) Install the foundation bolts to the transformer. (See Fig-C2)

Requires the concrete should be similar specifications to the transformer foundation floor for pouring it into foundation bolt pit.

Fig-C1 Aligning marks to be adjusted.

Fig-C2 Install the foundation bolts
4. RECEIVING OF INSULATING OIL

1. Oil receiving and storage
   The quality of the insulating oil should be checked before receiving from the oil drums.

(1) Measure the breakdown voltage of the oil from the drums or tank lorries, and confirm the breakdown voltage is over 30kV/2.5mm Gap (standard "ASTM" or "IEC").
   If from the drums, check in accordance with following procedure;
   (a) Check and confirm the trade-marks of all drums are same. And separate the damaged drums from the good condition drums.
   (b) Regarding good condition drums, samples should be taken from the bottom of 1/20 drums. And a composite sample can be made from 5 different oil drums. But regarding damaged drums, samples should be taken from the bottom of all drums. How to take the sample is shown in Fig-D1 for example.

![Fig – D1 How to take oil sample](image-url)
2. Clean all of the oil storage tanks and oil hoses.
   (1) Connect all of the oil hoses and clean the insides of all of the oil hoses with 100 litters of the clean insulating oil as shown in Fig-D2.

   ![Fig - D2 Hose cleaning](image1)

   (2) Wipe off dirt and moisture from the inner surface of the oil storage tank with clean waste rugs.

3. If the breakdown voltage of oil is more than 30kV/2.5mm GAP (standard “ASTM” or “IEC”), store the oil in the storage tank through the oil filter as shown in Fig-D3 after cleaning all of the storage tanks and hoses.

   ![Fig - D3 Oil receiving](image2)

4. Oil treatment (Oil receiving) should be avoided on a rainy day, and as the insulating oil is inflammable, prepare the fire extinguishers.
5. FILTERING OF OIL & REPLACEMENT DRY GAS WITH OIL

After installing the transformer main body on the foundation, the dry gas in the tank should be replaced with treated oil. And before starting this job, confirm that the break down voltage of the stored oil is more than 50kV/2.5mm GAP.

If the breakdown voltage value is not satisfactory, circulate the oil in the oil storage tank using oil purifier as shown in Fig-E1.

1. Preparation.
   (1) After confirming the interiors of the hoses, pipes and valves are cleaned by insulating oil in advance, connect the main body and the oil storage tank with the hoses and the oil filter as shown in Fig-E2.
   (2) Make the oil level gauge using transparent vinyl hose as shown in Fig-E2 temporarily.
   (3) Take an oil sample through the oil sampling valves of the oil filter, and confirm the break down voltage of the oil is more than 30kV/2.5mm Gap by testing.

2. Oil filling (See Fig-E2.)
   (1) Open the valve V7 for releasing dry gas. And open the lower filter valve V4 for oil filling.
   (2) The oil should be filled in up to above the top of insulation washer in the main body leaving a small space for gas above (about 100mm lower than the attaching position of the valve V7). The oil level of the main body is monitored by the oil level indicator that attached above item "1- (2)". And if the oil filter ceases working due to electric failure etc., close the air releases Valve V7 immediately, as it is possible that the air will get into the main body.
   (3) After finishing the replacement of dry gas with oil, keep this condition more than 12 hours.
6. MOUNTING BUSHING TURRET (IF PROVIDED)

1. Removing transportation cover
(1) Remove a transportation cover from the mounting position of the main body.
(2) After cleaning the mounting position of the main body, the opening part of the main body should be covered with clean and dry sheets until just before mounting.
(3) Remove the transportation cover from the mounting position of the bushing turret and clean the mounting position.

<table>
<thead>
<tr>
<th>Check point:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Don’t remove two (2) transportation covers simultaneously.</td>
</tr>
<tr>
<td>(2) Don’t put foreign materials to the main body.</td>
</tr>
</tbody>
</table>

2. Mounting bushing turret
(1) Mount the bushing turret using mobile crane, with the gasket and varnish (adhesive) as shown in following Fig-F1.

<table>
<thead>
<tr>
<th>Check point:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Do not put foreign materials into main body and turrets.</td>
</tr>
<tr>
<td>(2) Do not slip the gasket from the gasket groove.</td>
</tr>
</tbody>
</table>

---

Fig–F1 Semi-confine gasket
7. MOUNTING COOLING EQUIPMENT

1. Mounting radiator
   (1) After unpacking the radiator package carefully, lift the radiator out from the package and place it in a convenient place for mounting.
   (2) Remove the blanking iron plates, gaskets from the mounting flanges of the radiator.
   (3) Set lifting wire rope to the upper hanger. And lift upright the radiator after putting timber underneath the lower hanger as shown in Fig-G1.
   (4) Lift the radiator up carefully about one-meter from ground and incline the radiator to drain the residual insulating oil in the radiator as shown in Fig-G1.
   (5) After removing the blanking iron plates and gaskets from the upper and lower radiator valves, confirm that the gaskets are not injured during transportation. And set the gaskets to the gasket grooves of the radiator valves after applying the varnish. (The gasket is replaced to new one which is supplied separately.)

3. Mounting cooling fan (if provided)
   3-1. Mount the cooling fans underneath the radiators as shown in Fig-G2.
8. MOUNTING CONSERVATOR FOR MAIN BODY AND O.L.T.C (IF PROVIDED)

NOTE
(1) As the transportation covers are attached to the ends of the oil pipes, the transportation covers must be removed and the inside of them must be cleaned with clean cloth before mounting.
(2) Never put foreign materials into the main tank, conservator and the oil pipe.

1. Mounting conservator for main body.
(1) Mount the conservator supports and their reinforcements on the position.
(2) Lift the conservator up with mobile crane and mount it on its supports.
(3) Connect the Buchholz relay and the pipes between the conservator and the main body using the gaskets and bolts. (See Fig–H1.)
(4) Adjust the conservator position with moving the conservator and tightening the bolts between the bushing turret and conservator supports, and between the conservator supports and conservator.
(5) After confirming the conservator position is adjusted correctly, connect the conservators and the bushing turret.

Fig–H1 Main tank Conservator
2. Mounting conservator for OLTC. (if provided)

(1) Mounting oil level gauge. (See Fig. H2)
   ① Confirm that the contact operations, ON/OFF of the oil level gauge are correct.
   ② Confirm that the insulation resistance is more than 100 MΩ by 500V megger.
   ③ Mount the assembled oil level gauge on the conservator with gasket and bolts on the floor.

3. Mounting conservator for OLTC. (See Fig. H3)

(1) Mount the conservator on the main tank temporarily. And mount the oil pipes from the OLTC protective relay using the bolts and gaskets.
(2) Connect the conservator and OLTC protective relay using the oil pipe, bolts and gasket.
(3) Fasten the bolts between the main body and conservator.
9. MOUNTING THE BUSHING

1. Attaching bushing.
   As bushing is made by porcelain, care should be taken when handling.
   (1) Unpack the package of bushings by the assembly floor. And confirm that the bushings are not broken.
   (2) Before attaching, clean the porcelain surface and the terminal portion on oil immersed side should be cleaned carefully with a clean and dry cloth or with solvent.
   (3) After cleaning, measure the insulation resistance of the bushing and make sure the insulation resistance is more than 1000 MΩ by 1000 V Megger as shown in Fig-I1.
   (4) Lifting up the bushing.
      (a) When lifting up the bushing, protect the porcelain to avoid direct touch with wire rope.
      (b) Make sure of the direction of bushing oil level gauge according to the outline drawing.
   (5) How to lift up to 300 kV class bushing.
      (a) Two cranes are used to lift up the bushing as shown in Fig-I2.
      (b) Lift up the bushing horizontally about 2 m in height by crane #1 and #2 as shown in Fig-I2, and then raise the bushing gradually with crane #1. After putting upright the bushing, remove the rope from the crane #2.

Fig–I1 Measurement of insulation resistance

Fig–I2 Lifting up of bushing
(6) How to lift up the bushing below 300 kV class is shown in Fig-I4, the bushing can be lifted up with one crane.

(7) The flange blind covers on the tank side taken off when bushings are attached, they should be taken off, if possible, just before attaching bushings and be covered with vinyl sheet or some such material until the moment the lower porcelain bushing tubes are put into the transformer.

(8) The bushing is lowered gradually and take care against hitting the lower porcelain tube against the flange and B.C.T. Depending on the circumstances, it may be necessary for the worker to get inside the tank for inserting the bushing.

(9) After the lower porcelain is inserted inside the bushing flange, the attaching position shall be accurately fixed. Before that, apply varnish to the gasket on the flange portion.
10. INTERNAL LEAD CONNECTION

1 Preparation and precautions for internal leads connection

(1) During internal job the insulation materials are exposed to open air. Therefore it is essential to do this work on NON-rainy day.

(2) Oil level is lowered till bottom of the main body.

(3) Clean around the hand hole before opening the hand hole, and before starting the internal job.

(4) Never allow anyone to do the internal job before measuring the oxygen density of the main tank. The internal job should be carried out after confirming that the oxygen density is shown more than 18%.

(5) Only nominated workers from the Shihlin Electric supervisor can work the internal job. And they should carry out the internal job under supervision of the Shihlin Electric supervisor.

(6) Name and quantity of tools used internal job should be recorded before starting the job and checked after finishing the job as shown in Fig-J1.

<table>
<thead>
<tr>
<th>Tool</th>
<th>Quantity</th>
<th>Before Job</th>
<th>After Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanner</td>
<td>4</td>
<td>Record</td>
<td>Record</td>
</tr>
<tr>
<td>Hammer</td>
<td>2</td>
<td>Record</td>
<td>Record</td>
</tr>
<tr>
<td>Flashlight</td>
<td>1</td>
<td>Record</td>
<td>Record</td>
</tr>
<tr>
<td>Knife</td>
<td>1</td>
<td>Record</td>
<td>Record</td>
</tr>
<tr>
<td>Sheet</td>
<td>10</td>
<td>Record</td>
<td>Record</td>
</tr>
</tbody>
</table>

Fig–J1 Tool List

(7) The tools used internal job should be attached to line made of clean cotton tape or string so that they can not be lost. (See Fig-J2.)

(8) Clothes must be clean. Before starting the job, brush work clothes off and empty all pockets. And the worker should take wrist watch off and confirm that screws of glasses are not loosened.

(10) The top of the coil group should be covered completely with clean cotton/vinyl sheet as shown in Fig-J3, so that foreign materials do not enter the coil group.
2. Connect all of the internal leads and the bushings according to the instructions of the Shihlin Electric supervisor.
   (1) Connect the internal lead and the lower terminal of the bushing with the bolts and nuts.

   (2) After finishing all of the internal lead connections, confirm that all of the fastening points are tightened correctly.

   (3) Wrap the internal lead and the connection point according to the instruction of the Shihlin Electric supervisor.

   (4) Bring all of the tools out and take all of the sheets out from the main body. And inspect following items;
       ① Insulation distances between the internal lead and the other internal lead, the internal lead and the main body
           and the internal lead and core are maintained.
       ② Damaged point and dirty point is nothing.

   (5) Close the hand hole and fill the main body with oil up to the level that the coil group is immersed.
11. FINAL OIL TREATMENT.

1. Carry out the oil leakage test in accordance with following procedure; (See Fig-K1.)

(1) Fill the main body with the oil up to level “2” of the conservator of the main body after opening V4.

(2) Remove the filter breather from the filter breather pipe for main body. And attach the valve V17, 22, 23 and V24.
(V17, 22, 23 and V24 is used for installation work only.)

(3) Arrange the nitrogen gas cylinder, pressure regulator, compound gauge and the hoses.

(4) Apply pressure to the main body at 0.1-0.2kg/cm² with the nitrogen gas and release the air from the conservator through the V4 up to the oil is discharged from the V4.

- **Valve situations**:
  - Closed valve → V5, V6.

- **NOTE**: Attend watchmen by the compound gauge and the V4 because the injection speed of the nitrogen gas should be controlled by the pressure of the compound gauge. And the V4 should be closed immediately when the oil is discharged.

(5) After removing the hose from the nitrogen gas cylinder and opening the V24, fill again the main body with the oil up to the oil level is “6”.

(6) Apply pressure to the main body at 0.5kg/cm² with the nitrogen gas and after closing the V24, jot down the pressure and the oil temperature. And sit the main body this condition for 24 Hours.

(7) Check the transformer for air leaks with soapy water and oil leaks after 24 hours from the time when the pressure was applied. And then put all of the oil out from the main body.

**NOTE**: Don’t put the foreign materials into the main body.
2. Carry out the final oil filling according to following procedure as shown in Fig- K3.

(If conservator rubber bag is non-vacuum type)

(1) Arrange the oil purifier, oil storage tank, vacuum pump, vacuum gauge, pipe adapter, oil hoses, vinyl hoses and valves (V18 – V20 are valves for only installation) as shown in Fig- K3.

NOTE: It should be used that the vacuum hoses should be as short and large in diameter as possible.

(2) Check the “VACUUM OIL” of the vacuum pumps for the vacuum pump set and oil purifier.

(a) Vacuum oil level of the vacuum pump.
(b) No water in the vacuum oil.

(3) After confirming the following valve situations, pull vacuum the main body till following criteria.

<table>
<thead>
<tr>
<th>Valve situations</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed valve → V2, V3, V4, V5, V11, V12, V13, V14, V15.</td>
<td>Vacuum hold time → More than 4.0 Hours</td>
</tr>
</tbody>
</table>

(4) After closing the V16, V8 and V19, carry out the vacuum leakage test for 30 minutes and confirm the result is satisfactory the criterion. Again pull vacuum after finishing the vacuum leakage test.

Criterion: \( V \) (Leakage value) → Less than 110 L · Torr/Min.
\[
V = \frac{(P_2 - P_1)/30 \times V_1}{V_i}
\]

- \( P_1 \): Vacuum degree at 5 minutes later from the valves closing (Torr.)
- \( P_2 \): Vacuum degree at 30 minutes later from the \( P_1 \) measured time (Torr.)
- \( V_i \): Oil volume of main body (Litters)
3. Carry out the final oil filling according to following procedure as shown in Fig- K4.

(If conservator rubber bag is vacuum type)

Arrange the oil purifier, oil storage tank, vacuum pump, vacuum gauge, pipe adapter, oil hoses, vinyl hoses and valve as shown in Fig- K4.

3.1 Preparation

(1) Remove the breather (Both transformer and OLTC)

(2) Use “transparent glass vacuum vein pipe” to connect valve⑦ and valve⑧.

For the purpose of :

(a) Vacuum pulling and oil filling.

(b) To inspect oil level during oil filling.

(3) Use “transparent glass vacuum U pipe” to connect valve⑨ and valve⑩.

Make sure that :

(a) The length of pipe must be enough for 500m/m of oil pillar.

(b) The pipe is used for inspecting the pressure difference of both sides of rubber bag to avoid it from crack due to over-pressure.

(4) Connect valve⑪ to vacuum oil pump.

(5) Connect flange○12 to vacuum gauge.

(6) Open valves①②③④⑤⑥⑦ and close valves⑧⑨○⑩

3.2 Pull vacuum

(1) Start vacuum oil pump.

(2) Open valve⑪ slowly. (The rubber bag is capable of withstanding internal vacuum pumping)

(3) After finishing vacuum pumping of rubber bag, open valve① and valve⑩ slowly to make them interflow with the rubber bag, and at this time the valve② is opening. (Keep monitoring U-transparent pipe and adjusting valve⑦. The pressure difference in U-pipe should be maintained in 300 m/m of oil pillar)

(4) Hourly records shall be maintained for the vacuum state. (There may be a leaking problem when vacuum pumping is not finished completely, inspect weather all valves are good and the screws are all locked.)

(5) After reach the specified vacuum (below 5 torr) , oil filling can be done after 5 hours.

3.3 Oil filling

(1) Make recirculation degassing of transformer oil in oil fitter, and open valve⑩ after confirming there is no bubbles in the transformer oil, then fill the oil into transformer. (Before filling oil, pull vacuum in oil filter and oil filling pipe first.)

(2) When the transformer oil level reaches standard value, close valve⑧⑨⑩.

(3) When transformer oil level gauge reaches value “2.0~2.5”, close valve① and valve⑩, and then stop the vacuum oil pump.

(4) Fill oil and stop oil filling when the oil level gauge of conservator indicates value “3”, and close valve⑩. Then open valve⑪ slowly to release the vacuum in rubber bag.

(5) After reaching the atmospheric pressure, filling the degassing oil into transformer to achieve adequate oil level in accordance with the temperature of transformer oil level curve and oil temperature. Close valve⑩ after oil filling is completed.
(6) In the meanwhile, filling the oil into OLTC to achieve adequate oil level in accordance with the temperature of oil level curve of OLTC and oil temperature. At this time remove the transparent glass vacuum U pipe between valve② and⑧, and open valve⑤. Then open valve② and valve⑧ slowly to adjust the oil level of OLTC.

(7) Close valve② and⑧. Remove the transparent glass vacuum U pipe that connect valve② and valve⑧, and then tighten up valve② and valve⑧ with covers. Finally, assemble the OLTC breather on valve⑤.

4. Oil level adjustment

(1) Open valve⑤ and close valve②. Fill dry air or N₂ through breather flange on transformer. Pressurize the internal of rubber bag to pressure of 0.03~0.04 kg/cm², in the meantime, open valve① slowly. When oil exudes from valve①, close it right away. (Continuously pressurize the internal of rubber bag till oil exudes.) If oil level exceeds the specified value of oil level gauge, use valve⑤ to release oil during oil level adjustment.

(2) Remove vacuum gauge and vacuum oil pump and seal the flanges with covers.

(3) Open valve③, then open valve③ to release air which is collected in air collecting device. After air is released, close valve③.

(4) Open valve⑤ after installing the breather onto its flange on transformer.
12. INSPECTION.

1. Electrical test
   A number of tests can be used to determine the condition of the transformer.
   The most typical tests are as follows.

1-1. Insulation resistance
   The insulation resistance of winding to ground measured by more than 1000V megger.
   As the insulation resistance changes according to the temperature and humidity, it is necessary to measure
   and record the oil temperature at that time.

1-2. Checking protective circuit
   (1) Measure the insulation resistance of the protective circuits and their devices. And be sure that the insulation
       resistance is more than 10 MΩ.
   (2) Check the protective devices operations are correct in accordance with the sequence diagram.

2. General inspection. Check following items
   ① Oil and gas leakage.
   ② Bolt connection.
   ③ Discoloration.
   ④ Abnormal noise and vibration of fan.
   ⑤ Direction of rotary of fans.
   ⑥ Reading and setting value of protective relays
   ⑦ All valves situations. (Opened or closed.).
13. TOUCH-UP PAINTING.

This item applies to the external surface painting of the main tank or the parts which are damaged or welded during transportation and erection.

1 Treatment for under coating
(1) Damaged portion
(a) Wash away the oil, grease, dirt and dust using the organic solvent for removing fat and wipe out by the waste rags, then dry it up.
(b) Polish the surface to be painted using emery cloth #200 - #320, and then clean the surface again.
(c) After cleaning, mix and stir the wash primer base and additives (Weight ratio 8 VS 2), add the thinner of 10-20% (Weight percent) for arrangement of the viscosity of necessary.
(d) Paint the materials by the brush uniformly.
(e) Drying time: Summer season (20°C or more) : Natural drying more than 2-3 hours.
   Winter season (Less than 20°C) : Natural drying more than 4-5 hours.

(2) Welding portion
(a) Remove the paint film burned by the welding using the wire brush and steel chisel.
(b) Remove the scale and rust on the welded portion using the wire brush and steel chisel.
(c) Wash away the oil, grease, dirt and dust using the organic solvent for removing fat and wipe out by the waste rags, then dry it up.
(d) Polish the surface to be painted using emery cloth #200 - #320, and then clean the surface again.
(e) After cleaning, mix and stir the wash primer base and additives (Weight ratio 8 VS 2), add the thinner of 10-20% (Weight percent) for arrangement of the viscosity of necessary.
(f) Paint the materials by the brush uniformly.
(g) Drying time: Summer season (20°C or more) : Natural drying more than 2-3 hours.
   Winter season (Less than 20°C) : Natural drying more than 4-5 hours.

2 Finish painting (General, acidity and oceanic environment.)
(1) Paint the material with the brush using the phthalic acid resin enamel which is arranged the viscosity.
(2) Drying time;
   Summer season (20°C or more) : Natural drying more than 3-4 hours.
   Winter season (Less than 20°C) : Natural drying more than 6-8 hours.

3 Inspections
Check the painted condition of the surface.
(1) Lack of uniformity of paint
(2) Beauty of paint surface
(3) Paint drops
(4) Unpainted parts and section
14. ADJUSTMENT OF OIL LEVEL.

This “OIL LEVEL ADJUSTMENT” work should be carried out more than 24 hours later from the time when final oil filling is finished. And also this work should be carried out morning time because the oil temperature relay doesn’t show the average oil temperature after the main body is exposed to the direct rays of the sun.

(1) Remove the oil pot from the filter breather bottom.
(2) Drain the oil from the main body and OLTC gradually as shown in Fig-N1 in accordance with the drawing Fig-N2 “OIL TEMP. – OIL LEVEL CURVE”.
(3) Re-mount the oil pot on the position.

NOTE: Don’t use any oil pump (filter press and oil purifier) for oil draining.
NOTE: This is for reference only.
If there is any oil level curve attached on the transformer, please refer to it.
## 15. INSTALLATION CRITERIA

<table>
<thead>
<tr>
<th>Item</th>
<th>The contents of management</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>On base of main body</td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td>Leveling of foundation</td>
<td>Within 3mm</td>
</tr>
<tr>
<td>2)</td>
<td>Adjusting center lines of 3 point</td>
<td>Within ±3mm</td>
</tr>
<tr>
<td>2</td>
<td>Insulated oil relation</td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td>Breakdown voltage(At the acceptance of insulation oil)</td>
<td>More than 30kV/2.5mm Gap</td>
</tr>
<tr>
<td>2)</td>
<td>Breakdown voltage(At the oil filling to the main body)</td>
<td>More than 30kV/2.5mm Gap</td>
</tr>
<tr>
<td>3)</td>
<td>Breakdown voltage(After the final oil filling)</td>
<td>More than 50kV/2.5mm Gap</td>
</tr>
<tr>
<td>4)</td>
<td>Moisture content(Final)</td>
<td>Less than 20 ppm</td>
</tr>
<tr>
<td>3</td>
<td>Insulation resistance relation</td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td>Insulation resistance of bushing</td>
<td>More than 2000MΩ/1000V megger</td>
</tr>
<tr>
<td>2)</td>
<td>Insulation resistance of protective relay &amp; device</td>
<td>More than 100MΩ/500V megger</td>
</tr>
<tr>
<td>3)</td>
<td>Insulation resistance of protective circuit</td>
<td>More than 10MΩ/500V megger</td>
</tr>
<tr>
<td>4</td>
<td>Oil leakage test relation</td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td>Pressurization value</td>
<td>0.5bar(0.5kg/cm²)</td>
</tr>
<tr>
<td>2)</td>
<td>Pressurization time</td>
<td>More than 24 Hours</td>
</tr>
<tr>
<td>5</td>
<td>Vacuum relation</td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td>Vacuum degree</td>
<td>Less than 665Pa(5.0 Torr)</td>
</tr>
<tr>
<td>2)</td>
<td>Vacuum hold time</td>
<td>More than 4 Hours</td>
</tr>
<tr>
<td>3)</td>
<td>Sitting time for the energize</td>
<td>More than 36 Hours</td>
</tr>
<tr>
<td>6</td>
<td>The shock under transportation</td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td>Impact recorder</td>
<td>Less than 29.4m/S²(3G)</td>
</tr>
</tbody>
</table>