Installation, Maintenance and Storage Guide

Oil-impregnated paper insulated transformer bushing upto 170 kV 3150 Amp

Content

0. Important safety notes

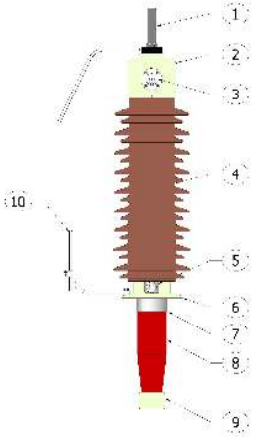
Test tap should be in closed condition during operation. Keeping the test tap cap/cover open can result into fatal high voltage appearing on test tap.

Always ensure that the power supply is switched off and high voltage terminal is earthed before doing any service or fitment/connection with bushing.

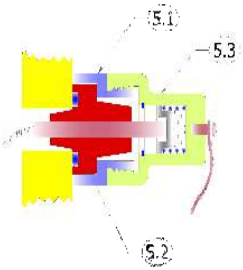
Do not remove Oil filling plug as it will temper the hermetic seal of bushing and hence will affect the performance of bushing.

National code of **safety** procedures and specific regional or local safety rules and regulations, safe working practices and good judgment must be used by the personnel when installing, operating, maintaining and disposing of this equipment.

1. Design description



Bushing part details



Sl.	Part	Material
1.	Air end terminal	Copper / Brass
2.	Conservator	Aluminum
3.	Oil level indicator	Polycarbonate
4.	Air end insulator	Porcelain
5.	Test tap	Epoxy
6.	Mounting flange	Aluminum
7.	Flange extension (CT space)	Aluminum
8.	Oil end insulator	Epoxy
9.	Oil end shield	Aluminum
10.	Arcing Horn	Steel
	Insulation	OIP
5.1	Test tap housing	Aluminum
5.2	Test tap bush	Epoxy
5.3	Test tap cover	Aluminum

Figure 1: Bushing construction

1.1 The Bushing is designed to meet the requirements of **IEC-60137:2017** and ambient
2.1 conditions thereof. The bushing is designed to operate with parts above mounting flange in air and parts below immersed in oil.

1.4 The bushing is self-contained with OIP Condenser core. The Condenser core is built by winding Insulating Kraft paper on center pipe with Aluminum grading foils inserted intermediately between paper layers in order to achieve uniform voltage and electrical field distribution.

1.5 The standard design consists of TEST TAP for measurement of Capacitance and (dielectric dissipation factor) Tan Delta. A cable is soldered on to the last layer of conducting foil of condenser & is crimped to the test tap stem to form TEST TAP. The test tap lead is embedded in an epoxy molded bush to insulate it all around from mounting flange. The test tap stem/stud is connected to mounting flange by means of a spring loaded test tap cover. The mounting flange in turn gets connected to Transformer Tank which is always earthed. Thus Test tap is also, ensured as earthed.

1.6 The bushing is housed in air end & oil end insulators, mounting flange & conservator.

1.7 Oil level: The annular space inside the bushing housing is filled with transformer oil up to Oil level glass and space above oil level is evacuated and flushed with Nitrogen (N_2) gas, which works as cushion to compensate volumetric changes in oil due to temperature variation on account of site ambient and current flow during Bushing in service.

1.8 Hermetic sealing: It is a sealing in which oil is prevented from communication with ambient air (atmosphere) so as to ensure healthy insulation throughout service life of bushing. This is achieved by above explained N_2 gas cushion, filled with positive pressure. This feature ensures the bushing as maintenance free equipment.

1.9 Oil is used as insulating media for impregnation of the condenser core as well as for cooling. The oil complies with IEC 60296.

1.10 The entire bushing assembly is held together by pre-stressed spring assembly in the conservator of the bushing. Spring assembly compensates the effect of change in length of central tube/stem due to temperature variation and maintains required sealing pressure on entire housing assembly.

1.11 The oil end shield is an integral part of bushing of rated voltage up to 170 kV & for current rating lower than or equal to 1250 A. The Bushing with rated voltage above 72.5 kV e.g. 123, 145 & 170 kV and current rating above 1250 A is provided with an aluminum shield, which has to be assembled on bottom nut by means of SS Allen Bolts.

1.12 Routine Testing at YASH test Lab.:

- All routine tests on bushings are conducted in accordance to IEC 60137:2017.
- After complete bushing assembly, the bushing is subjected to tightness test to ensure no oil leakages.
- Further, each bushing is subjected to a final electrical routine test. The test is made at room temperature with oil end of busing immersed inside test tank simulating the service condition.
- The Capacitance and Tan δ are measured in ascending & descending voltage steps up to the rated system voltage.
- Measurements for internal partial discharge (PD) are made after dry power frequency withstand voltage. Dry power-frequency voltage is maintained for one-minute duration.
- All routine tests test results of bushing are reported to customer by YASH standard test certificate with each supply lot.

2. Operating Conditions:

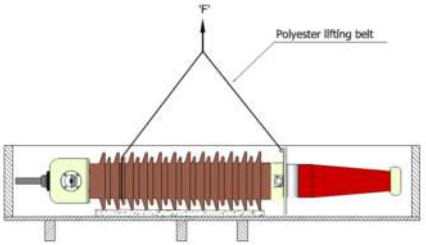
2.1	Application	: Transformers
2.2	Insulation	: Oil Impregnated Paper (OIP) Condenser
2.3	Application	: Oil to Air.
2.4	Ambient temperature	: -20 to + 40 °C
2.5	Oil Temperature	: ≤ 60 °C above ambient.
2.6	Altitude of site	: ≤ 1000 m.
2.7	Mounting angle	: ≤ 30° maximum to Vertical.
2.8	Oil level below Mounting Flange	: Always above BCT length

Special requirements are guaranteed in GA dwg.

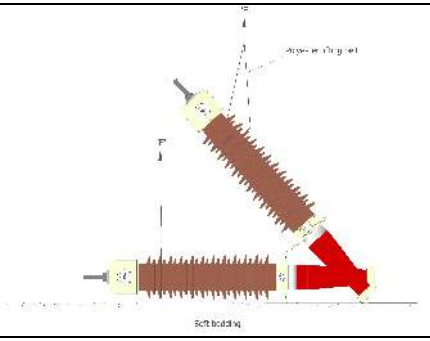
3. Unpacking and Handling:

3.1 Open the packing case carefully so as to preserve for re-use. Lift the bushing from packing case by a vertical lifting force applied at top side of upper insulator shed by hanging soft polyester rope into it. After unpacking, the bushing is always to be placed on SOFT BEDDING so as to avoid damage to oil end shield.

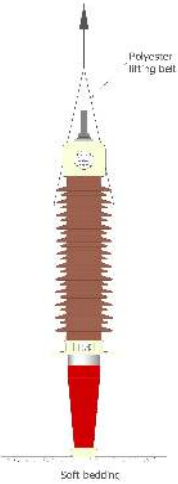
3.2 For bushings having flat termination at oil end, the bushing must not be stored vertically using only oil end terminal for mounting. Vertical storage should be done using mounting flange



Position-A1 Lifting from the packing box



Position-A2 Verticaly lifting the bushing



Position- A3 Mounting the bushing

Figure 2: Lifting the bushing

4. Do's and Don'ts before erection:

4.1 Visual Examination checks:

4.1.1 Bushing to be examined thoroughly for any damages incurred during transport viz. crack/chip off of Insulator, visible oil leakage from any of bushing part etc. If any of such damages noticed, bushing should not be used for commissioning purpose and should be reported to YASH HIGHVOLTAGE immediately.

4.1.2 Presence of Oil level in bushing to be checked through oil level sight glass. Oil should be visible in oil level glass by position of oil level float or prismatic indicator.

4.1.3 **Electrical tests: Capacitance & Tan Delta Measurement:**

4.1.3.1 **Capacitance C_1,C_2 and Tangent delta measurement of the received bushing to be carried out and compared with factory test results.**

4.1.3.2 If the measured value of capacitance is found to be higher or lower than 10% of value mentioned in Routine Test report, YASH HIGHVOLTAGE is to be consulted immediately and bushing must not be used till verified and cleared by YASH.

4.1.3.3 If the measured value of C_1 Tan δ varies more than 0.1% from the submitted routine test report or found to be greater than 0.007(absolute value)/0.7%, YASH HIGHVOLTAGE is to be consulted immediately and bushing must not be used till verified and cleared by YASH.

Special Note: Bushing must not be energized before the given value limits of Capacitance & Tan δ are achieved in site testing.

5. Dos & Don'ts before Commissioning/Energizing:

5.1 *Before commissioning/energizing the bushing, it must be kept in vertical position for minimum 12 hours if the storage period is 1 month or lower; however, in case of longer than 1-month storage period, bushing must be re-kept in vertical position for a minimum 1-week prior energizing.*

5.2 Before commissioning, inspect bushing once again for any abnormality as explained in visual checks (4.1).

Lift the bushing vertically up & slowly lower it into transformer turret. Care must be taken so as to avoid impact of bushing on transformer tank while lowering.

Mounting bolts to be appropriately tightened to seal the transformer as per the transformer manufacturer's Instruction manual.

5.3 Recommended torque values are tabulated below in order to provide adequate gasket compression for mounting flange sealing.

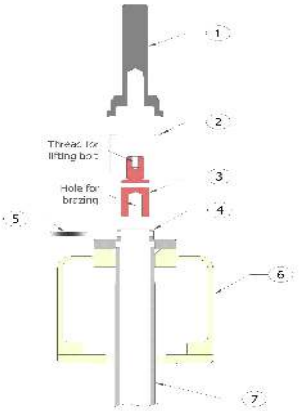
Bolt size	M12	M16	M20
Torque for mounting bolts in (N-m)	30	40	50

6. Terminal – Thimble and Transformer Lead connections:

For bushings with rated current ≤800 A:

6.1 Thimble (Item 3 in Figure B1) is provided with bore for ease of brazing. Thimble design can be customized upon request.

6.2 Draw lead type bushings are provided with thimble/cable adapter suitable for brazing connection with transformer lead (Refer Figure B1 though B3)



1.	Air end terminal
2.	Sealing gasket
3.	Thimble/Draw rod (Cable adapter)
4.	Terminal cover
5.	Lock-pin
6.	Conservator
7.	Centre tube
8.	Transformer lead

Figure-B1: General assembly of thimble/draw rod with air end terminal

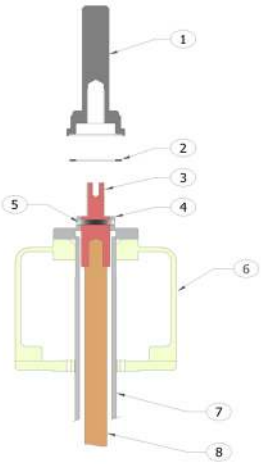


Figure-B2 Drawing the lead through centre tube (≤800 A)

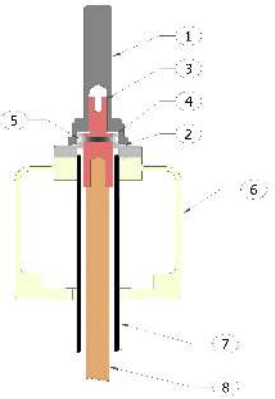


Figure-B3 Connection of terminal and thimble(≤800 A)

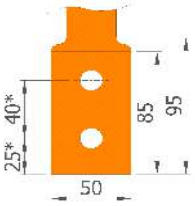


Figure C1: For 1250 Amp

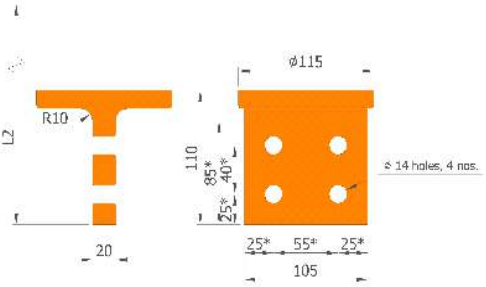


Figure C2:For 2000 & 3150 Amp

For bushings with rated current >1250 A:

6.3 Draw rod type and solid stem type bushings are provided with solid palm, suitable for direct connection with transformer lead below stress shield at oil end. (Refer Figure C_1 and C_2) as per appropriate current rating of bushing procured.

6.4 *Air end terminal connection*: Hand tighten the air end terminal (Item 1: Fig. B1-B3) manually till fully possible on thimble/draw rod/solid stem of the bushing as per applicable type of bushing.
After this, rotate and fix the air end terminal further using spanner by max ½ half to ¾ turn. **Note: Spanner to be strictly applied on base portion of air end terminal as shown below.**

Leakage test of transformer to be conducted in this condition only. In case of any leakage from terminal joint, YASH HIGHVOLTAGE must be consulted with immediately without further attempt for tightening the HV terminal.

7. Final Checks Before Energizing of Bushing:

7.1 Measurement of Capacitance & Tan Delta (As per cl 4.1.3)

7.2 Verification of oil level inside bushing (As per cl 4.1.2)

7.3 Flange earthing is recommended with transformer tank with ≥50 mm^2 copper braided wire, to avoid spark between tank & flange under normal service operation.

7.4 Effectiveness of test tap earthing by means of fully closing TEST TAP CAP/COVER.

7.5 Properly fitted HV terminal connection (As per cl 6.4)

7.6 Tightness test between bushing flange & transformer tank.

7.7 Waiting time before energizing (As per cl 5.1)

8. Minimum clearances to earth on oil end of Bushing

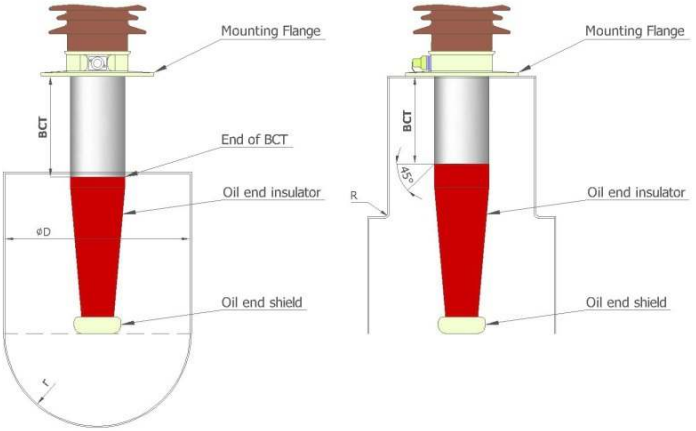


Figure 6: Oil end clearance

Rated Voltage (kV)	Insulation Level		Diameter (D) Minimum	Radius (r) Minimum	Radius (R) Minimum
	AC 1 min. withstand(kV)	Lightning Impulse withstand (kVp)			
36	77	170	130	65	4
52	105	250	250	125	6
72.5	140	350	300	150	8
145	275	650	500	250	12
170	355	750	550	275	14

Table – 1 – Dimensions for maintaining minimum earth clearances on oil end side

8.1 Failure to provide minimum clearances will result into increase of voltage stress inside & outside of oil end insulator & can result into flash over between live part of bushing & transformer turret or tank.

8.2 If the radius R of the turret & tank joint is less than that recommended, it can also result into high voltage stress external & internal to the bushing & hence can lead to flashover.
Both the above cases can result into damage to bushing or its **failure**.

9. Repacking and Storage.

9.1 **The original wooden case of the bushing shall be retained and stored in dry condition.**

9.2 It is recommended to repack the bushing in original packing case only. Packing should be done as per original packing scheme i.e. covering of Air end insulator, Terminal assembly etc. using layered foam sheet or other appropriate cushioning to avoid any impact damage to these parts. Oil indicator position should be facing the side wall of packing case, i.e. 90 degree rotated from top view when bushing placed inside wooden box.

Storage:

9.2.1 It is recommended that the bushing should be stored in vertical condition with the firm mounting, if storage period is less than 2 months.

9.2.2 For prolonged storage period the bushing is recommended to be stored at a incline position at least 10 degrees from horizontal, with the conservator on higher and oil end of bushing on lower side.

9.2.3 Storage place should be clean, dry & adequately ventilated, such that bushing remains dry. Stacking of bushing should be such that there is no damage to packing case & hence to bushing.

10. Routine checks and maintenance

10.1 Bushing is self-contained & hermetically sealed, hence is practically maintenance free. However periodic cleaning & checking as explained below should be practiced.

DANGER!!!" ***No work at all can be performed on bushing, while it is energized or not earthed."***

10.2 Periodic cleaning of air end insulator must be done in order to remove deposited dust particles & moisture drops on it.

10.3 Capacitance & Tan Delta measurement and records as per procedure explained in cl. 4.1.3 must be carried out at regular intervals (Recommended at least six months per year).

10.4 For the reference, initial reading recorded before commissioning should be considered as base. The next values of test results are to be compared with these results.

10.5 Any variation in C_1 Capacitance values more than 10% of base value should be reported immediately to YASH HIGHVOLTAGE.

Any variation in C_1 Tan Delta more than 0.01% of previously recorded value (6 monthly) should be reported immediately to YASH HIGHVOLTAGE.

10.6 NOTE: On completion of service period of Bushing, it can be disassembled and components can be recycled or disposed as per the local regulations of the region.
Details of part given in design description.

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