



Snowy Technical Standards

SHL-ELE-522

Power Transformer Oil Filling- TOPPING UP ONLY

Subject Matter Expert

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1. Executive Summary

This technical standard establishes the procedure and documents used to control all aspects of Transformer oil filling when Topping up Transformers.

2. Scope

This technical standard is relevant to Project and Maintenance staff and the Transformers that they are required to fill with top up oil. The scope of this document includes oil filling process for topping up Transformers. For full vacuum oil filling processes refer to SHL-ELE-521 Power Transformer Oil Filling.

- This Standard defines the process for oil filling transformers
- These requirements apply to all Snowy Hydro power transformers.

2.1. Applicable Standards

IEC 60422 and AS/NZ 60422	Mineral insulating oils in electrical equipment – Supervision and maintenance guide.
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3. Definitions

Power Transformers	A static piece of apparatus with two or more windings which, by electromagnetic induction transforms from one system voltage to another for the purpose of transmitting electrical power.
Large Transformers	Power transformers with a system highest voltage above 72.5 kV
Small Transformers	Power transformers with a system highest voltage up to 72.5 kV
Topping up	Adding oil to a transformer where the oil level has reduced over time due to leaks or repair work has been undertaken and oil level has not been reduced so as to expose the core and coils.

4. Technical Requirements

4.1. Safety

Prior to work commencing a Work Method Statement (WMS) must be completed as detailed within the Quality Verification Sheet design for the transformer

4.2. Environmental

There is a significant aspect or impact associated with transformers. These units contain a large volume of transformer oil and would pose a significant threat to the environment if a leak or spill were to occur.

4.3. Transformer Oil Filling Procedure - Top Up Only

Transformer Oil Filling

Unused oil added and in service oil returned to power transformers must comply with the requirements of SHL-ELE-520 Transformer Oil Supervision and Maintenance. For topping up, the requirements of Table 1 below for Dielectric Strength and Moisture can be applied instead of the requirement in SHL-ELE-520.

If oil is to be delivered to site in oil drums or palletised containers then they should be stored on-site in a temporary bund. It is mandatory that a spill-kit is supplied and available at all times. It is also a requirement that a spillage risk assessment and method statement be included with the work/ job safety assessment prior to commencing work.

Each oil delivery shall be accompanied by a document from the supplier specifying at least: supplier designation, oil classification, compliance certificate and oil Safety Data Sheets (SDS).

Oil tests shall be undertaken on every oil container to be used for topping-up the transformer. Testing should be performed on the oil container on the day of topping up. For oil delivered in pods, testing should also be performed when oil is received from the supplier. Portable dielectric strength breakdown and moisture content test units are suitable for the purposes of oil testing on site.

Time Between Receiving Oil and Using Oil	Oil stored in sealed drum	Oil stored in Pod or other container
Up to 1 Month	Test on day of use	Test on day of use
1 Month or more	Test on day of use	On receipt and day of use

Table 1 - When to test oil container

The criteria for oil being added to the transformer are outlined in Table 2 below.

Transformer Primary Voltage	Dielectric Strength (kV)	Moisture (ppm)
>145 kV	>50	< 10
72.5 to 145 kV	>40	<15
<72.5 kV	>35	<20

Table 2 - Criteria for adding oil to transformers.

Note: Cloudiness of oil is generally due to suspended solid matter such iron oxide or sludge or moisture. If this is observed, extensive treatment will be required to remove moisture and contaminants.

Oil of a muddy colouration is certain to be wet. Water and water saturated oil are both heavier than dry oil and sink to the bottom of any container. Oil samples should, therefore, be allowed to settle for 4 to 6 hours - in case of small transformer or drums, and for 10 to 12 hours - in case of large transformer.

Taking Oil Samples:

The following paragraphs are for reference and should be followed wherever possible. They should be read in conjunction with the paragraphs under the section titled "Method of Sampling of Oil for Tests" in the latter part of this document.

Samples from any tank: Dirt adhering to the valve or plug is to be removed ensuring the valve is very clean, and then a quantity of oil is allowed to flow into a separate container before collecting samples for testing. Samples should be collected in clear glass bottles, thus any water present in the oil will settle to the bottom and be clearly visible. Only use bottles with glass stoppers for sampling.

Samples from an oil drum or large portable container: The drum or container should first be kept standing vertically upwards for at least 24 hours. The bung area should be cleaned. A clean glass or brass tube long enough to reach to within 12 mm of the base should be inserted, keeping the upper end of the tube sealed with the thumb whilst doing so. The thumb should be removed, allowing oil to enter the bottom of the tube. The tube is then resealed, and an oil sample withdrawn from the drum/container. The first samples should be discarded as there may be contaminants in the tube and these are flushed. Further samples shall be collected and emptied into a clean bottle for laboratory testing.

Testing: The oil after filtration should meet the requirements as laid down above. However, to establish the preliminary condition of the oil, the 'Break-Down Voltage' (BDV) Test shall be carried out as stipulated in AS 60422-2005 and results noted. For clarity a sample shall be tested 6 times and the value of each test recorded. The average value of the six tests shall be the final value of that sample.

Top-up oil complying with the required moisture content and breakdown strength can then be pumped via a filter unit into the transformer, usually via the conservator. There must be no risk of pushing air into the transformer and this can be achieved by purging any air from connecting pipes with new oil where possible.

The transfer pump must be capable of 3 micron particle filtration and removal of moisture to the requirements of Table 1 above.

Oil pipes or hoses should be connected to the transformer oil filler and filter valve at the end of the pipe that comes from the conservator.

Flexible steel hose is best for handling insulating oil, some kinds of synthetic rubber or PVC hoses are also suitable but only those known to be satisfactory shall be used. Ordinary rubber hose should NOT be used - oil dissolves the sulphur from the rubber and is thereby contaminated. Any hose used for handling oil must be clean and entirely free from loose rust, dirt and moisture. Cleanliness is essential as even small amounts of dirt and water will affect the accuracy of test results and may contaminate the transformer.

When transferring oil, temporary earthing on the tank and pipework should be used to eliminate the risk of static electricity build up.

4.4. Top Up Oil Level Procedure

1. Mobilise resources and equipment to the site
2. Job safety briefing and risk assessments for understanding safety, risks and work procedures
3. Receiving a permit to work after the transformer has been de-energised and made safe.
4. Erect any barricades and display warning signs if required.
5. Perform a visual inspection of the transformer noting any abnormal conditions, defects etc,

6. Note down the particulars of the transformer data from the nameplate, take note of the oil level and oil temperature gauges. An ambient temperature should be taken, and an oil temperature taken (separate from that shown on the gauge)
7. An oil dielectric and moisture test are required of a sample from any container, drum or tanker in which the top up oil is contained.
8. Position the oil pump near the transformer so that oil pipes can be connected to the filler/ filter valve Note: where there is no filler/ filter valve the bottom drain valve may be used.
9. Connect the flexible oil hose from the transformer filler/ filter or drain valve to the pump outlet and from the pump inlet to oil storage container. Now the oil pump is ready to pump oil from the container to the transformer. (the connections are reversed for draining a transformer)
10. Before pumping the oil, dismantle the breather so that the pressure inside the transformer tank can escape from through the breather pipe. If there is no breather then open a suitable pipe cap at the highest point on the transformer so that air pressure can escape, whilst being careful not to allow moisture or contaminants to enter the transformer.
11. Start the pump and drain the oil from the storage container to fill the transformer, making sure the air is coming out through the breather pipe.
12. If the existing oil level is above the Buchholz relay, then adding oil directly to the conservator is acceptable. Otherwise use designated filling point or drain valve.
13. Whilst filling the conservator or the main tank (as required) it is imperative that the oil level is monitored at the oil level gauge/s. The oil level should be slightly above 50% of the gauge located at conservator tank or equivalent to the level according to the temperature scale on the gauge and actual oil temperature.
14. Finally, if filling from the bottom drain valve, bleed out any air from radiators, buchholz relay and conservator through the air bleed valves, vents or pipes.
15. After completion of the transformer filling and removal of the filling equipment, the oil shall be tested and if it does not meet the moisture content or breakdown strength requirements, then it must be processed using a processing/filtration unit.
16. Once the oil fill is completed and the sample has passed the tests, close any valves, remove the oil hoses, replace pipe caps & the breather as required. Check the oil level and all the gauges, check for any oil leakage from gaskets, pipes or valves.
17. Collect another oil sample to be sent to an approved oil test laboratory for a full suite of tests to record the new oil test baseline.

4.5. Top up Procedure for added volume less than 50 litres

This Section of this procedure document aims to ensure the safe transfer of oil Products for **Distribution Transformers** of less than 33kV or where the top up oil volume may be less than 50 litres in total. The procedure is for application under site conditions and to reduce the risk of spillage to the environment. All areas of Transferring of Oil are covered by this procedure, that is top up of a transformer or removal of oil from a transformer.

Pre-Start Procedure - for use of oil pump

1. Identify any oil that shall be used for the top up procedure. This oil may be tested for moisture and BDV in the Snowy Hydro workshop prior to use. It is acceptable to transfer acceptable oil to smaller sealable containers if a pump is not to be used in the top up.
2. Ensure there is an Emergency Oil Spill Kit on hand and in close proximity at all times (Recommended kit to suit Diesel and Oil).

3. Read the MSDS for the type of oil being used. Wear appropriate PPE.
4. All Hoses/Fittings must be inspected prior to use and will be fitted with ball valves at each end and fitted with female Camlock connections. Plugs must be fitted when not in use.
5. Ball valves fitted to hoses will help reduce spillage when Connecting/Disconnecting, and also function as Emergency shut off in case main valve fails at Source-Destination points. They also may be required if flow direction needs to be reversed at pump.
6. Flange adaptors will be required to be fitted to Source-Destination valves fitted with male Camlocks.
7. Pump will be inspected for damage and be fitted with male Camlock fittings. Caps must be fitted when not in use and must have current electrical test tag. Earth leakage protection must be used.
8. Containers will be installed under all connection points and each will be able to hold 110% of the combined volume contained in the hoses and pump. Allow for displacement caused by the pump body.
9. Lay protective plastic sheets over unsealed ground
10. All items that can build up a static charge (eg hoses & pumps etc) shall have an earth lead connected to it so that it is fully grounded and at the same potential as the equipment to which it is connected.

Procedure using an oil pump.

1. Place the container under the source valve and check that it is fully closed. Remove the cover plate from the valve flange and fit the flange adaptor with a male Camlock. Repeat procedure at destination valve.
2. Place the pump in a container and remove caps.
3. **Connecting the hose to the source valve.** When connecting, position the hose over the container and make sure the ball valve is closed and remove the plug. Fit the hose and check that the connection is secure. Repeat the procedure when connecting to the pump inlet.
4. **Connecting the hose to the destination valve.** When connecting, position the hose over the container and make sure the ball valve is closed and remove the valve plug. Fit the hose and check that the connection is secure. Repeat the procedure when connecting to the pump outlet.
5. Open the atmospheric ports at the source (Located at top of the oil supply tank) and the destination (Bung located on top of the Transformer lid). Protect the atmospheric port at the source as air will be drawn in and so will any foreign particles. Wrapping several layers of cloth (Close weave) around the source port will help prevent this.
6. **If a Dial Type Oil Level Indicator is fitted:** Check that the Oil Level Indicator is operating correctly by removing the screw cap at the top. This will give you access to the Needle at the top of the float, gently push down and release, the float should return to its position. It is important to check the float does not become stuck when filling. Correct oil level is obtained when the Red portion is just out of view.
7. **If a Sight Glass Oil Level Gauge is fitted:** When the transformer has a simple sight glass gauge fitted the clean the front of the glass to ensure the oil level can be seen. Check there is a marker on the side of the gauge for 15°C. If the gauge has more temperature markings then this will help with to achieve the correct levels.
8. **Connecting the pump to the power.** Make sure the pump operating switch is in the off position before connecting to power via earth leakage protection.
9. Recheck all connections.

10. Open all valves in order from the oil source to the oil destination.
11. **Pumping Oil.** Before starting the pump, it is important that at least two people be required, one to keep an eye on the fill level (Checking float for movement or gauge for correct level), and the other to operate the pump. Communication is essential, set up a verbal and hand signal system to stop the pump. If the line of site is obstructed a spotter will be required to relay the signal to the pump operator.
12. Start pumping to the required level. Note that if the transformer has only a gauge with a 15°C marking then the oil should be filled to a level that is 1- 2mm per 6°C of oil temperature above that mark. For Clarity: if the oil temperature in the transformer is 27°C ($27 - 15 / 6 = 2$) then the oil level in the gauge should be approximately 2mm and not more than 4mm above the 15°C mark.
13. Stop the pump and close all the valves in reverse order from the destination to the source.
14. Close all the atmospheric ports and refit the screw cap to the Oil Level Indicator (if removed refer 6 above).
15. Disconnect the power from the pump.
16. **Disconnecting the hoses.** When disconnecting the hoses make sure the ball valve is still closed and replace the plugs while over the container and clean any oil residue from the hoses and fittings.
17. Remove the flange adaptors and refit the cover plates and remove earth connectors.
18. **Empty the remaining oil from the hoses.** Hold the ends of one hose over the container and remove the plugs, then open the ball valves. Have someone assist to drain all the oil from the hose. Close the ball valves and replace the plugs. Wipe the hoses clean and store them in the hose storage box.
19. **Empty any remaining oil from the pump.** Carefully drain the pump in its own container and then replace caps. Place alongside it a clean container with an oil absorbent pad in it. Lift the pump and allow the oil to drain from the pump body. Place it in the clean container, wipe down thoroughly and return it to the storage box.
20. Collect all the waste oil and pour it into one single container for disposal, wipe clean all the containers. Collect all Cloths, rags and oil absorbent pads and place them into a sealed bag for disposal.
21. Mark both the waste container and bag with the oil product name from MSDS and list contents – it is often important to identify that the contents are PCB Free (or Not).
22. Disposal of all waste shall be as per Snowy Hydro Environmental management procedures.

Procedure using a pouring device.

1. Open the atmospheric ports at the source (Located at top of the oil supply tank) and the destination (Bung located on top of the Transformer lid). Protect the atmospheric port at the source as air will be drawn in and so will any foreign particles. Wrapping several layers of cloth (Close weave) around the source port will help prevent this.
2. **If a Dial Type Oil Level Indicator is fitted:** Check that the Oil Level Indicator is operating correctly by removing the screw cap at the top. This will give you access to the Needle at the top of the float, gently push down and release, the float should return to its position. It is important to check the float does not become stuck when filling. Correct oil level is obtained when the Red portion is just out of view.
3. **If a Sight Glass Oil Level Gauge is fitted:** When the transformer has a simple sight glass gauge fitted the clean the front of the glass to ensure the oil level can be seen. Check there is a marker on the side of the gauge for 15°C. If the gauge has more temperature markings then

this will help with to achieve the correct levels. - refer step 12 above for calculation of correct final oil level.

4. Using an appropriate drum lifting and pouring device, pour oil into a clean dry pouring vessel. It is preferable that the vessel be no larger than 20 litres to ensure the weight is within normal manual handling criteria. If the receiving vessel is a small drum then the use of a clean dry funnel may be required. **Note:** This step may be performed at the workshop in a controlled environment if desired. All containers in this case must be sealed for transport to site.
5. **Filling the transformer.** Where there is clear and safe access to the top filler valve on the transformer, open the filler pipe fit a clean dry funnel (or that previously used in step 4 above) and pour the oil into the top of the transformer. The rate should be steady and not so fast as to create turbulence or bubbles. Note: precautions should be taken to prevent a static charge building and therefore it is advisable to connect flexible earths if possible. If flexible earths are a hindrance or not possible then all surfaces should be in contact with one another during the pouring processes.
6. It may be necessary to perform step 5 more than once to achieve the desired oil level. Cease pouring oil into the transformer once the desired level reached.
7. Collect all the waste oil (if any is split) and pour it into one single container for disposal, wipe clean all the containers, funnels and surfaces. Collect all Cloths, rags and oil absorbent pads and place them into a sealed bag for disposal.
8. Mark both the waste container and bag with the oil product name from MSDS and list contents – it is often important to identify that the contents are PCB Free (or Not).
9. Disposal of all waste shall be as per Snowy Hydro Environmental management procedures

4.6. Transformer Oil Filling Pre-Commission/ Return to Service Checks

Refer to the manufacturer's manual for minimum requirements.

1. Check radiator and buchholz valves are in the open position.
2. Bleed transformer at points stated in manual if not previously done.
3. Check the tightness of flange bolts and couplings if leaks are present. Repairs may be required if a significant leak is observed.
4. Check Transformer work site is cleared away of all tools and rubbish.
5. Sign off access permit and inform SMCC or Plant Access Coordinator that work is complete and the transformer is ready for return to service.
6. Test results should be sent to the asset engineer for review and recording.