

Substation Maintenance Instruction

Storage and handling of insulating oil

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Substation Maintenance Instruction

ASSET STANDARDS & DESIGN

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SMI 121 STORAGE AND HANDLING OF INSULATING OIL

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1.0 PURPOSE

To set out in detail the broad requirements for the storage and handling of insulating oil.

2.0 SCOPE

This instruction is to be read in conjunction with SMI 100 for transmission and zone substation equipment and SMI 101 for distribution equipment.

This instruction specifies the minimum requirements for the storage and handling of insulating oil for use in all company assets.

3.0 REFERENCES

Internal

- Company Policy 2.1 – Risk Management
- Company Policy 3.18- Work , Health and Safety
- Company Policy 4.0 – Environment
- Company Policy 9.9.1 (Network Asset Management) - Network Asset Maintenance
- Company Procedure GPE 0060 - Environmental Incident Response and Management
- Company Procedure GPE 0075 - Storage, Handling and Transport of Oil and Oil Filled Equipment
- Company Procedure GSY 1066 - Worksite Hazard and Risk Assessment
- Division Procedure GNV 1037 – Guide to onsite transformer refurbishment/drying and oil replacement
- Division Procedure GNV 1093.1 – Oil Laboratory Processes: Testing of insulating oil
- Division Procedure GNV 1093.3 – Oil Laboratory Processes: - Sampling of insulating oil
- Environmental Management Standard EMS 0007 - Waste management
- Equipment Technical Specification ETS 0029- Regenerated mineral insulating oil
- Equipment Technical Specification ETS 0010- Mineral insulating oil
- Equipment Technical Specification ETS 0032- Natural ester insulating oil
- Substation Maintenance Instruction SMI 100- Minimum requirement for maintenance of transmission and zone substation equipment
- Substation Maintenance Instruction SMI 101 - Minimum requirements for maintenance of distribution equipment
- Substation Maintenance Instruction SMI 156 - Breathers

External

- *Electricity Supply Act 1995 (NSW)*
- *Work Health and Safety Act 2011*
- *Work Health and Safety Regulation 2011*
- *ENA National Electricity Network Safety Code (Doc 01-2008)*
- *AS 1767.1:1999 - Specification for unused mineral insulating oil for transformers & switchgears*
- *AS 1767.2.3:1999 - Test methods of sampling dielectrics*
- *AS 1940:2004 - Storage and handling of flammable and combustible liquids*
- *IEC 60422:2005 - Mineral insulating oils in electrical equipment - Supervision and maintenance guidance*
- *IEEE Std C57.106:2006 - IEEE guide for Acceptance and Maintenance of Insulating oil in Equipment*

4.0 DEFINITIONS AND ABBREVIATIONS

Document control

Employees who work with printed copies of documents must check the Business Management System regularly to monitor version control. Documents are considered “UNCONTROLLED IF PRINTED”, as indicated in the footer.

DDF

Dielectric dissipation factor

Ellipse

Endeavour Energy's asset database

IFT

Interfacial tension

Insulating Oil

Insulating oil in this document means mineral oil, re-generated mineral oil and natural ester oil used in company assets.

ISO Tank

Temporary tank for filling oil at site for quantity greater than 1000 litres

PPE

Personal protective equipment

PCB

Polychlorinated biphenyls

SMI

Substation Maintenance Instruction

SDS

Safety data sheet, previously referred to as the material safety data sheet (MSDS)

Review date

The review date displayed in the header of the document is the future date for review of a document. The default period is three years from the date of approval. However a review may be mandated at any time where a need is identified due to changes in legislation, organisational changes, restructures, occurrence of an incident or changes in technology or work practice.

5.0 ACTIONS

5.1 General requirements

Insulating oil must be treated with extreme care to prevent any contamination. The most common contaminants are water, solid particles and chemical solvents. Water and solid contaminants are the easiest to filter, while separating chemical solvents is almost impossible.

Other chemicals, such as motor oils, are also impossible to remove and contamination must be avoided.

Storage facilities designed for receiving insulating oil in bulk must have totally dedicated hoses, lines, pumps and tanks.

A system for re-drying and filtering of the oil must also be provided.

The insulating oil must be tested for DDF, IFT, breakdown voltage, moisture, acidity, conductivity¹ and PCB levels upon delivery and prior to acceptance. Facilities to test insulating oil must also be available so that oil can be tested upon delivery and prior to acceptance. Refer to following standards for the acceptable oil test limits on different types of insulating oil:

- ETS 0010-New mineral insulating oil;
- ETS 0032- New natural ester insulating oil; and,
- ETS 0029 Regenerated mineral insulating oil.

Insulating oil must always be stored within a bunded area complying with GPE 0075.

5.2 Insulating oil quality verification tests

The insulating oil supplier will be approved by the Network Substations Manager, Asset Standards & Design.

The supplier's oil quality test certificate must be relied upon to certify that the quality of the oil supplied to Endeavour Energy is as specified.

Endeavour Energy employee must verify the quality of each batch (each delivery) of oil supplied and non-conformances will be communicated to the Network Substations Manager, Asset Standards & Design, the supplier and the supplier relations manager. Verification tests must be conducted by Endeavour Energy after delivery and will not restrict the delivery process.

Oil may be supplied in one of three forms:

- as a bulk oil delivery from a suppliers bulk container such as an oil tanker;
- in 1,000 litre pallecons or;
- in 205 litre drums.

Samples must be collected as follows:

Table 1 Oil Sampling

Method of delivery	Sample collection method
Bulk oil supplied in supplier's container/compartments and delivered to Endeavour Energy bulk container.	Collect a one (1) litre oil sample from each container/compartments (from supplier) before decanting to Endeavour Energy container and a one (1) litre sample from Endeavour Energy bulk container, as set out in GNV 1093.3.
Bulk oil supplied in supplier's container/compartments, which will remain on site until the oil is used.	Collect a one (1) litre oil sample from each container/compartments (from supplier), as set out in GNV 1093.3.
1,000 litre pallecons	Collect a one (1) litre oil sample from one (1) pallecon in each batch (each delivery) as set out in GNV 1093.3.
205 litre drums	Collect two (2) x one (1) litre oil samples from two (2) different drums in each batch (each delivery) supplied, as set out in GNV 1093.3. These drums must be labelled as having been opened and the oil in them must be used as soon as possible.

¹ Test based on IEC 61620 - Insulating liquids - Determination of the dielectric dissipation factor by measurement of the conductance and capacitance –Test method

Oil to be used from Endeavour Energy's bulk containers will be subjected to further verification tests before it is used in equipment (to verify the cleanliness of Endeavour Energy's bulk containers).

The sequence of tests is shown in Annexure 1.

5.2.1 Test certificate

Oil suppliers must provide a test certificate for each delivery. For bulk delivery, the certificate must provide adequate proof of the oil quality in the storage vessel immediately prior to departure from the supplier's site to Endeavour Energy's delivery site.

A certificate must be provided for oil delivered in drums to indicate the quality of the oil in each drum. As a minimum, test certificates must provide the following:

- Type of the oil
- Batch number
- Oil filled date (for drums and 1,000 litre containers)
- Supplier's brand description
- Water content
- Neutralisation number (acidity)
- Corrosive sulphur
- Furan levels
- PCB level
- Dielectric dissipation factor
- Electric strength
- Interfacial tension
- Conductivity

5.2.2 Oil quality verification tests

The oil will also be tested for DDF, IFT, breakdown voltage, moisture, acidity, furan, conductivity and PCB levels at the company's site for quality verification.

Oil in drums and 1,000 litre containers must be randomly batch sampled using the *Oil Thief* sampler, as specified in GNV 1093.3 and table 1.

Oil test results that do not comply with the requirements of the ETS; must be notified to the Network Substations Manager, Asset Standards & Design.

5.2.3 Final testing

For bulk oil supply, the oil sample from the temporary ISO tank at site will be tested for DDF, IFT, breakdown, acidity, conductivity, water content, furan level and PCB, prior to the filling of transformer. If any problems are detected in the test, the acceptance bulk oil samples as specified in table 1 (clause 5.2) must be tested and compared with temporary ISO tanker oil test results.

Oil in drums and 1,000 litre containers more than three (3) months after the supplier fill date must be tested for breakdown and moisture prior to use. This oil must be used only for circuit breakers.

Oil in drums or containers that have been opened for sample collection and that will not be used within one (1) month, or oil left over from other jobs, must be used only for 11kV circuit breakers after breakdown and moisture tests. Oil more than one (1) year old may be used only in circuit breakers after complete testing.

If test results do not meet the acceptable limits, it must be brought to the attention of the Network Substations Manager, Asset Standards & Design.

5.3 Storage

Storage and handling of different types of insulating oil must be done separately. Any pipes, drums or storage tanks are to be kept separate for each type of the insulating oil to avoid any contamination.

5.3.1 Drum storage

Drums must be stored ***under shelter and must not be directly exposed to the sunlight or rain.***

Clean empty drums must be at ambient temperature or above to prevent moisture or dirt entering when opened. To allow for expansion, drums must be filled to within about 70mm of the top gaskets, and the bungs must be checked to ensure that leakage cannot occur.

Prior to opening, full drums must be left in the sun to allow air at the top to pressurise to prevent entry of contaminants.

Oil in dented drums must not be used in transformers as metal particles and sulphur from the creased metal may contaminate the oil. Even though filtering of oil will remove metal particles, it will not remove the sulphur contaminants. However, the oil can **only** be used in **oil insulated** circuit breakers after proper filtering.

5.3.2 1,000 litre plastic containers

Moisture entry into containers must be minimised by the use of plastic collapsible bladder linings in the container. Material used in bladders must be compatible with insulating oil and must not affect the properties of the insulating oil.

Where the tank is sealed, the tank will be capable of withstanding the positive and negative forces due to expansion and contraction of the oil.

5.3.3 Tankers

Insulating oil transported in bulk is subject to many sources of contamination, and must be transported in dedicated tankers. It is desirable to have the tanker compartments equipped with desiccant breathers or dry gas blanketing to minimise moisture contamination.

Tankers that have been used for compounded oils (such as motor and turbine oils), solvents, vegetable and animal oils, must not be used to carry insulating oil. These and other products adversely affect the insulation properties of the oil and can be detected, as the oil will have a high DDF.

Experience shows that tanks that have been used for transporting other liquids are almost impossible to clean adequately for transporting **insulating oil for used in company assets.**

5.3.4 Tank storage

All storage tanks must be equipped with a dehydrating breathing system. The breather charges must not consist of material containing heavy metals or other material with occupational safety concerns.

A safety data sheet (SDS) must be made available to all employee handling breather charging material. Dehydrating breathing systems must be monitored **in accordance with SMI 156** to avoid moist ingress in the tank.

Aluminium or stainless steel tanks must not be used for long-term storage as oil contamination may occur.

Employee receiving bulk oil must obtain a sample to verify the quality of the insulating oil before it is unloaded. **The sample must be tested and test results must be recorded.**

5.3.5 Bulk Oil Storage

The tanks in bulk oil storage facility must be equipped with a dehydrating breathing system. The breather charges must not consist of material containing heavy metals or other material with occupational safety concerns.

A safety data sheet (SDS) must be made available to all employees handling breather charging material. Dehydrating breathing systems must be monitored in accordance with SMI 156 to avoid moist ingress in the bulk oil storage facility.

Employees receiving bulk oil must obtain a sample to verify the quality of the insulating oil before it is unloaded. The sample must be tested and test results must be recorded for later use.

5.4 Labels

Permanent, clearly legible, non-fading labels must be affixed to all insulating oil storage containers. Labels on storage drums must be painted on the top and side of each container.

Ideally, the text in the labelling must have a minimum height of 4mm. Each label must include the supplier's company name, oil identification code/name, oil filled date, type of oil (uninhibited/natural ester oil/passivated oil/re-generated oil) and batch number.

5.5 Oil and empty containers disposal

Small quantities of oil collected in buckets or bottles after sampling must be salvaged into 205 litre drums and returned to the depots for reuse or disposal. The drums must be clearly labelled to indicate that they contain dirty used oil.

Under no circumstances this or any other oil to be poured onto the ground. Disposal of oil, empty drums and containers must be in accordance with Endeavour Energy's asset disposal policies, procedures and EMS 0007.

6.0 AUTHORITIES AND RESPONSIBILITIES

General Manager Asset Management has the authority and responsibility for approving this instruction.

Manager Asset Standards & Design has the delegated authority and responsibility for approving this instruction.

Maintenance Manager, Asset Standards & Design is responsible for keeping that the content of this instruction is kept up to date.

Regional Transmission Managers have the authority and responsibility for:

- verifying that the oil supplier's test certificate, verification test results and final test results are complying with company's specifications;
- confirming that company's employees and/or contractors engaged to perform the work have appropriate qualifications;
- monitoring that work performed is carried out in accordance with local and statutory requirements;
- managing public safety so that it is not compromised; and,
- overseeing that employee are conversant with and work in accordance with, the Electrical Safety Rules.

The **Disposal Manager** must be responsible for overseeing that all contaminated waste products are disposed of in an efficient method that complies with organisational and legislative requirements.

All **Endeavour Energy employees and contractors** have the authority and responsibility for:

- meeting the requirements of this instruction;
- working in accordance with local and statutory requirements;
- maintaining the public safety so that it is not compromised;
- working in accordance with Endeavour Energy's Electrical Safety Rules;
- recording maintenance and test data in Endeavour Energy's electronic databases;
- using appropriate PPE, when handling oil;
- communicating any abnormalities found to the Regional Transmission Manager and the Substations Manager; and,
- verifying that employees engaged to perform work have appropriate qualifications.

7.0 DOCUMENT CONTROL

Documentation Content Coordinator : Maintenance Manager, Asset Standards & Design

Documentation Distribution Coordinator : Branch Process Coordinator

Annexure 1: Insulating oil testing flowchart

