

**SPOORNET
(INFRASTRUCTURE) (ELECTRICAL)**

SPECIFICATION No. CEE.0229.95

**DRY-OUT AND REGENERATION OF INSULATING OIL AND RECLAIMING AND
DE-SLUDGING OF TRANSFORMERS**

This specification covers Spoornet's requirements for in situ dry-out and de-sludging of power transformers and reclaiming insulating oil by means of regeneration

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1.0 SCOPE

This specification covers Spoornet's requirements for the dry-out and de-sludging of power transformers and reclaiming of insulating oil by means of regeneration.

2.0 REFERENCE AND STANDARDS

The following publication is referred to herein.

South African Bureau of Standards

SABS 555 : Mineral Insulating Oil for Transformers and Switch gear.

3.0 METHOD OF TENDERING

3.1 Tendering shall be in accordance with Spoornet (Infrastructure) (Electrical) specification CEE.0012.

Complies/Does not comply

3.2 Tendering prices shall be based on cost of the process that will achieve the results required as per clause 9.0 for each individual transformer described in Appendix 1,2 & 3.

Complies/Does not comply

3.3 Tenderer's shall quote separately for the replacement of lost oil if required, (per litre).

Complies/Does not comply

3.4 Spoornet reserves the right to inspect the Tenderer's facilities prior to awarding the contract in order to ensure that suitable equipment is available for the type of operation.

Complies/Does not comply

4.0 APPENDICES

The following appendices form an integral part of this specification:

Appendix 1: Schedule of transformers to be regenerated.

Appendix 2: Schedule of transformers to be de-sludged.

Appendix 3: Schedule of transformers to be dried-out.

Appendix 4: Moisture content of oil leaving transformer at which dry-out process must be terminated for various transformers temperatures.

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5.0 TRANSFORMER DRY-OUT (DE-ENERGISED)

5.1 Note: Any moisture present in the transformer will be partly in the oil and partly in the layers of solid insulation. Normally more than 95 percent of moisture in the transformer is trapped in the insulation and less than 5 percent in the oil. Removal of moisture from the solid insulation in situ is a slow process due to the slow rate of diffusion of moisture between insulation and oil. No quick dry-out processes (eg 48 hours) will thus be accepted, as this will dry-out the oil only and not the solid insulation.

5.2 The dry-out plant shall include a vacuum type drier, or alternative dry-out method with suitable filter (see clause 6.2.1) to remove the solid particles and a suitable pump (see clause 6.2.2).

Complies/Does not comply

5.2.1 The hoses between the dry-out plant and the transformer shall have a built-in earth conductor to avoid static electricity to be charged to a high potential. The filter and tanks in the plant shall also be connected to earth.

Complies/Does not comply

5.2.2 The transformer tank shall not be subjected to a vacuum in excess of the maximum possible indication on the transformer name plate.

Complies/Does not comply

5.2.3 The oil temperature inside the transformer tank shall not exceed 90 degrees Celsius while the dry-out process is in progress.

Complies/Does not comply

5.3 The silica gel crystals in the transformer breather shall be replaced at the start of the dry-out process and the colour change shall be monitored during the process. New crystals shall be provided when more than 50 percent of the crystals are coloured pink.

Complies/Does not comply

5.4 ON LOAD DRY-OUT

5.4.1 When using an on load dry-out plant the Contractor shall work in close conjunction with the Regional Engineer Electrical staff, who will lay down the requirements for safe operation of the plant.

Complies/Does not comply

6.0 REGENERATION OF OIL (Purification)

6.1 In order to remove acidic and colloidal contaminants an activated clay or Fuller's earth process shall be used to achieve the results required as per clause 9.0.

Complies/Does not comply

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- 6.1.1 The purification plant shall include provision for heating, automatic vacuum degasser, and shall be able to draw a vacuum in the transformer as well as circulate the oil in the transformer.

Complies/Does not comply

- 6.2 In the event of reclaiming of oil only being required, the complete volume of oil in the transformer may be replaced with new or factory regenerated oil as alternative to clause 6.1. When pumping oil into electrical equipment, the following precautionary measures shall be taken:

- 6.2.1 A paper filter (0,5 micron) shall always be installed between the pump and the equipment.

Complies/Does not comply

- 6.2.2 Pumps shall not have metal-to-metal friction which can release conductive metal particles into the oil.

Complies/Does not comply

- 6.2.3 The Contractor shall ensure that no air is trapped in the transformer while new oil is being added to the transformer. The tenderer shall indicate what method will be used to prevent air being trapped.

Complies/Does not comply

7.0 DE-SLUDGING OF TRANSFORMERS

- 7.1 The transformer shall be de-sludged in situ, completely filled with oil in accordance with the following process:-

Complies/Does not comply

- 7.1.1 The oil shall be heated and maintained at a temperature of approximately 90 degrees Celsius in the transformer, where the sludge in the transformer will go from a solid to a solution, re-entering the oil. A temperature of approximately 80 degrees Celsius should be reached in the core of the transformer and shall then be subjected to multiple passes of hot oil, for sufficient time to dissolve the sludge inside the transformer. The dissolved sludge is to be removed from the oil by passing the oil through an activated clay or Fuller's earth medium.

Complies/Does not comply

- 7.2 If required, and in agreement with SpoorNet, the transformer may be kept on load to minimise the amount of external energy to obtain the laid down temperature of approximately 80 degrees Celsius in the core.

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8.0 REPLACEMENT OF LOST OIL

On completion of the process the oil level in the conservator shall be at the original level prior to the commencement of the dry-out, reclaiming or the de-sludging processes.

Complies/Does not comply

9.0 TESTS ON OIL

9.1 The oil shall be tested by Spoor-net immediately after completion of the process to confirm compliance with the requirements of SABS 555 for both reclaiming and de-sludging. The requirements for dielectric strength shall be 65kV.

Comply/Does not comply

9.2 During the filtration dry-out process the oil shall be tested by the contractor periodically and the process shall be stopped if the moisture content in the oil leaving the transformer core is in accordance with the moisture content values as stipulated in appendix 4.

Complies/Does not comply

9.2.1 Tests shall be carried out 2 weeks after termination of the dry-out process to ensure that the moisture content in the oil is still within the permissible limits (see Appendix 4).

Complies/Does not comply

10.0 PRECAUTIONARY MEASURES

10.1 If reclamation is done on the transformer oil in the main tank with positive head pressure, a non-return check valve shall be installed between the transformer and the outlet hose from the filtration plant, in order to prevent excessive spilling of oil in the event of failure of the outlet hose.

Complies/Does not comply

10.2 An automatic isolating valve must be coupled to the transformer valve on the inlet side of the plant which will be closed automatically, in the event of a plant malfunction or when the oil level in the tank drops due to an inlet hose failure.

Complies/Does not comply

10.2.1 The following protection alarms must be provided on the dry-out plant if not attended full time:

10.2.1.1 Thermal motor failure.

Complies/ Does not comply

10.2.1.2 Pressure loss by using pressure switches.

Complies/ Does not comply

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- 10.2.1.3 The plant must have a leak proof base, with an automatic detection device to shut off the plant.

Complies/ Does not comply

- 10.2.2 The above alarms can be coupled via the Spoornet tellecontrol to give an alarm indication to Electrical Control.

- 10.2.3 Precautionary measures shall be taken to prevent environmental pollution.

Complies/Does not comply

11.0 INSPECTION

- 11.1 Spoornet reserves the right to be present during any stage of the process and must be timeously advised of dates of recommencement of any process.

Complies/Does not comply

12.0 GUARANTEE

- 12.1 The Contractor shall guarantee the transformer oil for a period of 12 months after the reclaiming and de-sludging process has been completed to comply with the requirements of clause 9.1, except for dielectric strength and water content.

Complies/Does not comply

- 12.2 The moisture content of the transformer shall be guaranteed to comply with the requirements of clause 9.2.1.

Complies/ Does not comply

- 12.3 Should the oil fail the tests as stated in clause 9.0, the Contractor shall repeat the process at his own cost.

Complies/Does not comply

TENDERER'S SIGNATURE

DATE

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(ELECTRICAL)

APPENDIX 1

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SCHEDULE OF TRANSFORMERS TO BE REGENERATED

Identification / Location: _____			
1. Type of transformer: _____			
2. Volume of oil inside transformer: _____ litres.			
Oil Properties	Before	After	After 12 Months
3. Acid content (mg KOH/g oil):	_____	_____	_____
4. Moisture content (ppm):	_____	_____	_____
5. Dielectric strength (kV):	_____	_____	_____
6. Sludge content (< 0,02%):	_____	_____	_____

Identification / Location: _____			
1. Type of transformer: _____			
2. Volume of oil inside transformer: _____ litres.			
Oil Properties	Before	After	After 12 Months
3. Acid content (mg KOH/g oil):	_____	_____	_____
4. Moisture content (ppm):	_____	_____	_____
5. Dielectric strength (kV):	_____	_____	_____
6. Sludge content (< 0,02%):	_____	_____	_____

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REFERENCE :

SCHEDULE OF TRANSFORMERS TO BE DE-SLUDGED

Identification / Location: _____			
1. Type of transformer: _____			
2. Volume of oil inside transformer: _____ litres.			
Oil Properties	Before	After	After 12 Months
3. Acid content (mg KOH/g oil):	_____	_____	_____
4. Moisture content (ppm):	_____	_____	_____
5. Dielectric strength (kV):	_____	_____	_____
6. Sludge content (> 0,02%):	_____	_____	_____

Identification / Location: _____			
1. Type of transformer: _____			
2. Volume of oil inside transformer: _____ litres.			
Oil Properties	Before	After	After 12 Months
3. Acid content (mg KOH/g oil):	_____	_____	_____
4. Moisture content (ppm):	_____	_____	_____
5. Dielectric strength (kV):	_____	_____	_____
6. Sludge content (> 0,02%):	_____	_____	_____

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REFERENCE :

SCHEDULE OF TRANSFORMERS TO BE DRIED-OUT

Identification / Location: _____			
1. Type of transformer: _____			
2. Volume of oil inside transformer: _____ litres.			
3. Maximum permissible tank vacuum: _____ torr			
Oil Properties	Before	After	After 2 Weeks
4. Moisture content (ppm):	_____	_____	_____
5. Transformer oil temp (deg C)	_____	_____	_____
6. Dielectric strength (kV):	_____	_____	_____

Identification / Location: _____			
1. Type of transformer: _____			
2. Volume of oil inside transformer: _____ litres.			
3. Maximum permissible tank vacuum: _____ torr			
Oil Properties	Before	After	After 2 Weeks
4. Moisture content (ppm):	_____	_____	_____
5. Transformer oil temp (deg C)	_____	_____	_____
6. Dielectric strength (kV):	_____	_____	_____

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APPENDIX 4

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**MOISTURE CONTENT OF OIL LEAVING TRANSFORMER AT WHICH DRY-OUT PROCESS
MUST BE TERMINATED FOR VARIOUS TRANSFORMER TEMPERATURES.**

Oil Temperature Degrees Celsius	Moisture Content of Oil ppm (mg/kg)	Oil Temperature Degrees Celsius	Moisture Content of Oil ppm (mg/kg)
10	1,5	55	16,0
15	2,0	60	21,0
20	2,5	65	28,0
25	3,3	70	35,5
30	4,2	75	44,0
35	5,5	80	54,0
40	7,2		
45	9,3		
50	12,0		

Note 1: This table is based on moisture content of not more than 2,0 percent in the paper.

Note 2: The oil temperature shall be the top oil temperature of the transformer.

Note 3: For temperatures falling in between the numbers in the table, use the next lower value.

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REFERENCE :