1 Amendment Summary

Issue No	Date	Description
(Note Amendment Summary only introduced from Issue 2 onwards)		
2	July 23	Amendment Summary Added as Section 1. Additional PPE added to Section 3 for Oil sampling. Risk Assessment Section updated to cover Good Hygiene Practices. New Section 6 added on PCBs. New Section 7 added on Good Hygiene Practices. Subsequent Sections re-numbered.
3	June 24	Procedure added for the Power Tech Labs oil sampling technique as used on Pole Mounted Transformers as Section 10. Missing Sample Oil Label added into Appendix A.
4	July 25	New Section 13 added for Limited HV LTOS added for potentially PCB contaminated distribution sample taking with no sampling valves fitted. Limited authorisation code 371 for this task will be given. Sections 3 and 5 updated as a result to cover the additional risks. Section 9 has been updated to include the new Section 13.

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2 Scope/Application

The reason for sampling oil used in transformers and switchgear is to check its electrical strength, moisture content, acidity and for the presence of fibres. An oil sample can also be used to determine the condition of insulation particularly in transformers, for instance by using dissolved gas in oil techniques Also samples may be required for detailed analysis during post fault investigations.

Great care must be taken during sampling to ensure that the sampling process itself does not contaminate the oil drawn off.

3 Safety Information

	**WARNING: Live Electrical Systems – Use Live Work Techniques/Procedures/PPE for those activities carried out or near equipment that could be live.**			
	**MANDATORY: Work shall be carried out in accordance with General Requirements in Section 1. Approved mandatory PPE and work wear shall be in accordance with General Requirements in Section 1. Additional Approved PPE and work wear required to complete this task are specified below.**			
		Disposable oil resistant coveralls over the Arc Resistant overalls for all Transformers pre-1987.		Full Face Visor whilst taking the sample.

		Oil resistant disposable gloves and barrier cream (to be used at the point of work where there is a risk of contact with insulating Oil).		HV Gloves for Section 13 only.

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The task covered by this procedure has significant hazards associated with it identified by the symbol and text **WARNING:** 

This procedure details the risk control measures that **Shall** be applied when carrying out the task. If the risk control measures in this procedure are implemented the risks will be controlled. This procedure also forms the method statement for the task.

4 Approved Equipment

Refer to Section 10 of this Manual for Approved tools and equipment. For PCB Sampling Using the Power Tech Labs System and Clor-N-Oil PCB Testers please see Sections 10 to 12 of this Technique.

5 Risk Assessment

	**The Point Of Work Risk Assessment (POWRA) shall be carried out for this work and shall detail what mitigation has being put in place regarding the hazards as detailed in Section 5 of this document. A copy of POWRA can be found on the Electricity North West Limited website (Volt) within the HSE Section.**

Risk:	Oil contact within Skin. Oil entering eyes. Ingestion of Oil. High Voltage as per Section 13.
Risk Level:	Moderate
Control Measure:	• PPE to be worn to cover exposed skin likely to be in contact with oil. • Eye washing facilities to be available adjacent to work area. Obtain medical attention if irritation persists. • Obtain medical attention urgently. Do not induce vomiting • Good Hygene Practices shall be used. • High Voltage present in testing in Section 13 – HV Gloves to be worn.

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6 PCBs (Polychlorinated Biphenyls)

The insulating oil in a small number of transformers may contain PCBs. In line with Environment Agency (EA) guidance only transformers made before 1987 are considered to be at risk of being contaminated with PCBs, Transformers manufactured in or after 1987 are not at risk of PCB contamination. If the age of a PMT is unknown it shall be treated as potentially PCB contaminated until positively tested or its age has been confirmed. PMTs can now be Sampled and Tested using CP430 Part 1 Section 2 OHLT 874.

PCBs are not effectively present in headspace gases but can be contained in oil spray, vapour released if a Transformer tank is punctured or a disruptive failure. PCBs can be absorbed through the skin, if in a vapour they can be inhaled and could be ingested if on a person's hand whilst eating, drinking, or smoking. The most significant risks are from skin contact and ingestion and hence the following control measures are required.

Vapour containing a high concentration of PCBs is a low risk as confirmed by a national study which investigated the air in the headspace of a transformer through the breather pipe to determine whether PCBs could be detected using the standard method for measuring PCBs in air. It was found that PCBs were only detectable when the test transformer was heated above its normal operating temperature, and, even then, they were only present in the headspace at very low PPT (Parts Per Trillion) levels, when the transformer contained at least 50 ppm of PCBs overall. By virtue of the exposed location of Transformers, vapours are therefore highly unlikely to contain PCBs or persist for more than a few seconds at the work location.

When sampling all pre-1987 transformers full PPE as detailed in Section 2 shall be worn. Good Hygiene practices as detailed in Section 6 shall always be followed when sampling Transformers.

7 Good Hygiene Practices

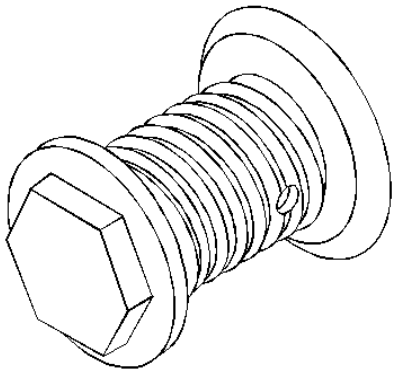
All Insulating oil is classified as hazardous and ingestion or contact with the skin should be avoided. Ensure you thoroughly wash your hands before eating, drinking or smoking after handling or inadvertent contact with oil. Whilst the use of PPE will minimise any contact with oil, good hygiene practises shall be followed to remove the risk. There shall be hand washing facilities available on site whilst handling and sampling oil.

8 Obtaining Samples for Testing

Because of the tendency of most contaminants to sink downwards, the poorest quality oil is usually found at the bottom of tanks. Therefore, samples for testing are best taken directly from the bottom, which is possible with transformers where either a bottom valve or a tapping point is normally fitted.

8.1 Sampling from Tapping Points

- An oil tapping point is a threaded device with centre and side drilled holes, welded into the side of an oil filled chamber. When the device is partly unscrewed, it allows a limited flow of oil for sampling purposes. These generally have a protective cap over the top which needs to be unscrewed first.



Oil tapping point partially unscrewed to allow an oil sample to be taken

8.2 Sampling Using an Oil Thief

- In the case of switchgear or other closed container, an 'oil thief' may be used, which is a long tube that can be lowered into the oil, then closed off and withdrawn.

8.3 Required Equipment

The following items of equipment will be required:

- A clean sampling device (oil thief) if the container has no sampling point or draw off valve.
- Sufficient brown clean GLASS sampling bottles (clear glass bottles to be used for Midel) with screw cone type caps and expansion insert as obtainable from CORD. Note that plastic containers shall not be used.
- Thermometer - (Digital thermometer -RS Components stock number 223-4918 is recommended.)
- Labels to mark up the samples.
- Approved PPE as detailed in Section 2.

8.4 Temperature of Sampled Oil

- It is important to measure and record the temperature of the oil being sampled. The amount of moisture and dissolved gases in the oil is directly proportional to its temperature.
- Over 90% of the moisture in transformers is contained within the insulation. This moisture migrates between the oil and the insulation as the temperature varies. The higher the temperature, the more moisture there will be in the oil.
- In order to understand the true condition of the oil following analysis the measured temperature is used to correct the measured moisture and gas contents to standard temperatures.

8.5 Procedure and Precautions For Oil Sampling

- All of the equipment used for oil testing must be kept very clean, otherwise the sample will be contaminated, giving false results.
- Take great care to avoid contamination; hands should not be allowed to come into direct contact with the surfaces of the sampling equipment.
- In wet or windy weather, outdoor sampling should only be carried out if precautions have been taken to avoid pollution of the oil. This will normally involve sheeting the equipment over. Any outlet used for sampling should be thoroughly cleaned externally with dry fibre free material approved wipes beforehand as specified in EPD 307.
- Run off oil to remove any contaminants from the sampling opening.
- Inspect the first oil run off for the presence of free water.
- If an oil thief is used care should be taken to:
    - Ensure that it is clean and
    - Introduce the tube with minimum disturbance to the oil.
- Rinse the bottle with the sample oil at least three times.
- Fill the sample bottle, allowing the oil to overflow down the sides of the bottle
- Fill the sample bottle allowing 25mm headspace above the oil to allow for expansion.
- Fit an Approved cap with expansion insert to the bottle. The cap should only be screwed on with light finger pressure.
- Write the appropriate data on the label, this **must** include:-
    - Site/Substation name.
    - Plant Identifier. (Ellipse plant ref.)

- Unit serial number.
- Date.
- Employee Number of sampler. (Signatures or initials are not always traceable).
- Sample temperature.
- Type of unit e.g. T/F, RMU
- Reason for sample.
- Person to whom the results should be sent.

Enter as much additional information as is practicable. An example of the Oil Sample Label is given in Appendix A.

- Place the sample bottle together with the label inside a securely tied black plastic bag.
- After sampling, ensure that all drain cocks are closed and any protective bungs and caps are replaced
- Return sample to Central Oil Reprocessing Depot (CORD) for testing.

8.6 Additional Requirements for Primary & Grid Transformer Samples And 'Gas-In-Oil' Samples

Where oil is being sampled from Primary Transformers or for 'gas-in-oil' analysis or post fault investigations of a transformer fault, additional equipment and a modified sampling process are required, as follows:

- Silicone rubber tubing approximately 600mm long, 6mm ID, to fit over ¼" OD copper tube.
- Facilities for connecting the pipes to the apparatus sample points - the exact details will depend on the form of sampling point. The following fittings should accommodate most situations:-
  - Sampling from flanged valves of the following bore:- 2 inch, 50mm, 1½ inch, 1 inch, 25mm:-
  - Use flange adapter as per Figure 1
  - Sampling from female screwed valves of the following bore :- 2 inch, 50mm, 1½ inch, 1 inch, 25mm:-
  - 2-inch BSP male to 1½ inch female steel pipe fitting.
  - 1½ inch BSP male to 1-inch female steel pipe fitting.
  - 1 inch BSP male to ¾ inch BSP female steel pipe fitting.

- ¾ inch BSP male plug fitted with ¼" OD hard copper tube * 50mm long or ¼" hose stem.
- These fitting to be assembled accordingly for each valve size.
- Sampling from tank mounted sampling devices or buchholz relay: -
- ⅛ inch BSP female brass fitting with ¼" OD hose stem.

- Many transformer tanks are fitted with a sampling device. However it is preferable for the sample be taken from the lowest point. This is more likely to be a flanged 2 inch or 50mm valve at the bottom of the transformer tank. These are usually provided for either oil draining or filtration. The main reason sampling devices were fitted to transformers was to eliminate the relatively large space which normally exists between a valve gate and the end of the valve body. Unfortunately on most transformers, these devices are not situated in the ideal place from which an oil samples should be taken.

- If it is suspected that there is a problem with a transformer, operate the oil pumps for 24 hours, to try and disturb any pockets of gas that may have accumulated.

- The inside of the sample bottle should be exposed to the atmosphere for as short a time as possible. The cap of each bottle should therefore be removed immediately before filling. In the event of adverse weather, the sample point and equipment should be protected.

- **Use of the Transformer Sampling Point.**
  Remove the ⅛" BSP end cap. Clean the ⅛" BSP screwed male end with the Approved wiper or synthetic sponge. Push fit the silicone tubing to the ⅛ inch BSP female brass fitting with ¼" OD hose stem and screw the fitting on to the sample device.

- **Use of valves for sampling**
  Remove the blanking plate or valve plug. Clean the flange / screwed end of the valve up to the valve gate using Approved wiper or synthetic sponge. If necessary crack the valve and flush a little oil through the valve end. Fit the appropriate flange and gasket or screwed fitting(s) to the valve, and fit the silicone tubing to the copper tube.

- Crack the valve until a steady stream of oil is obtained (about 2 litres minute) and run 2 to 3 litres to waste. This ensures that any remaining contamination in the end of the valve is flushed out. Do not change the rate of flow whilst taking a sample as this can dislodge dormant contaminants in the valve end.

- Allow waste oil to run over the outside of the silicone tubing to remove any traces of contaminating material. Measure and record the temperature of the oil stream using the thermometer (not the sample itself, to avoid contamination) to the nearest degree C.

- Insert the silicone tubing in the sample bottle. The tubing should initially reach the bottom of the bottle, and should be slowly withdrawn as the oil reaches the neck. At no time should the stream of oil be allowed to take air bubbles into the oil sample. Fill the bottle to overflowing and screw on the cap immediately, until just finger tight. There must be between 6mm and 12mm of air above the top of the oil. Clean the outside of the bottle.

- When sampling is complete, remove the tube from the bottle, close the valve and immediately screw on the cap.

- **Use of the Transformer Sampling Point.**
  On completion disconnect the sampling apparatus and replace the cover on the sampling point.

- **Use of valves for sampling**
  On completion disconnect the sampling apparatus and refit the screwed plug or blanking plate. If the flange / blanking plate gasket or plug seal is in poor condition, replace it. Put all four bolts in the blanking plate; only using two can result in contamination of the inside of the valve end in the intervening period between samples.

- The outside of the sampling tube must be kept clean. It should not be allowed to trail on the ground between samples, or contamination may occur.

- Examine the sample by holding it up to the light. If it is satisfactory, place it in the black polythene bag. Label the samples as described earlier in this module, but also include the reason for the test.

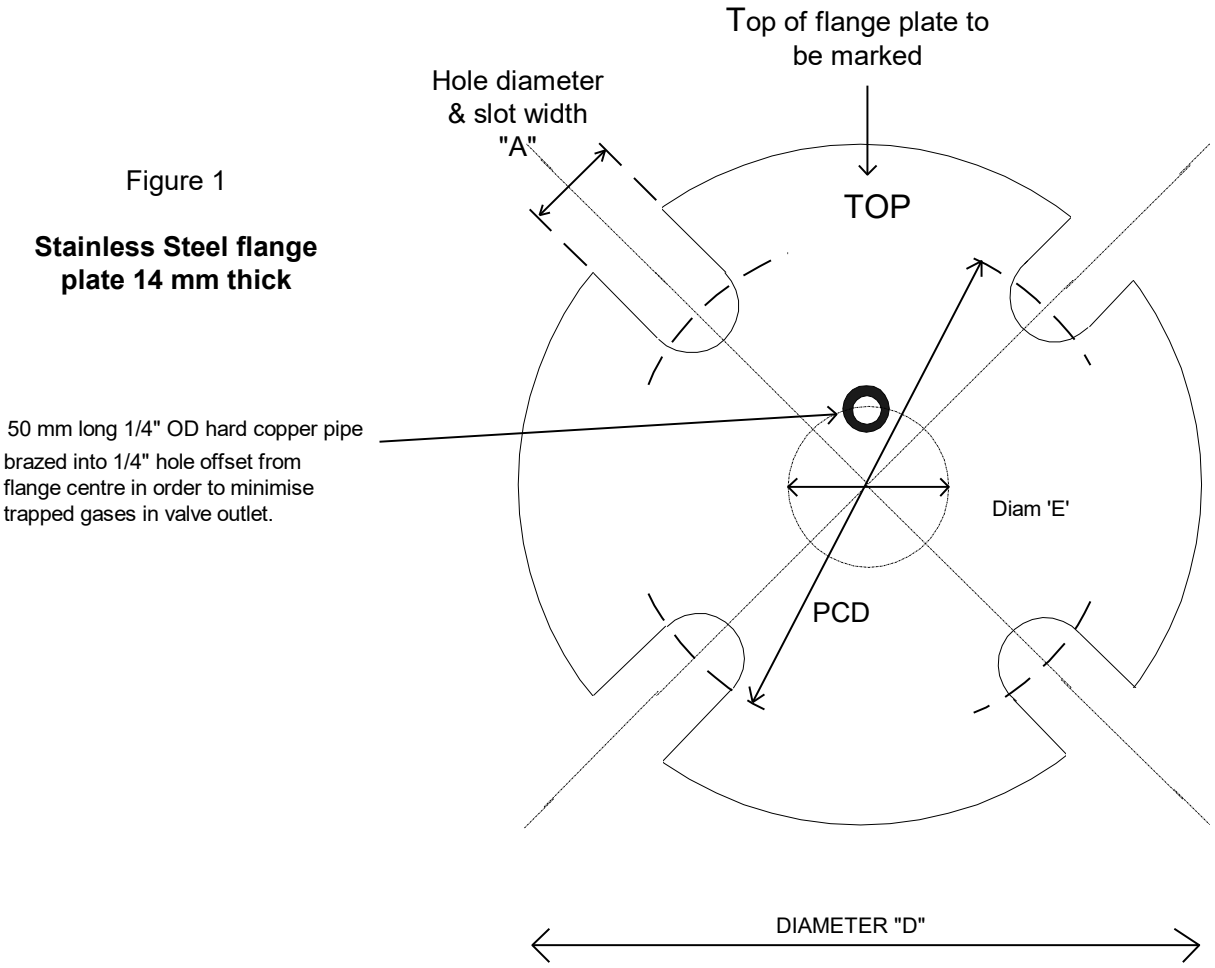
- **Examination of samples**

  Samples should always be examined for visual contaminants before they are placed in their black plastic bags. It is no good if the sample is grossly contaminated by external matter, such as dirt, water or air. It is also not very cost effective, as in most of these cases, a return to site has to be made for a repeat sample. If for instance a sample has gross amounts of free water in it, take another sample to confirm that the water is coming from the equipment being sampled and not elsewhere. Do not confuse air bubbles for water droplets. By inverting a sample, water droplets will travel down the bottle whereas air bubbles will travel upwards. Be wary that contamination has not come from the inside end of a screwed or flanged valve. There have been many cases where samples have given poor results due to contamination being introduced from sample valve end.

- Send to an approved laboratory without delay for analysis.

Figure 1

Stainless Steel flange plate 14 mm thick



Nominal Bore of valve from which sample is to be taken	Flange Diam"D"	PCD of Sample pipe hole 'E'	PCD of bolt holes	No of bolt holes	Hole dam. & slot width "A"
1.0" & 25mm	115mm	19mm	85mm	4	14mm
1.5 "	5.25 inch	1.25 inch	3.875 inch	4	9/16 inch
2" & 50mm	165mm	44mm	114mm	4	18mm

9 Ground Mounted Transformers without Drain Valves or Points.

This Technique has been developed to remove any Pole Mounted Transformers (PMT) from the overhead network with oil contaminated with PCB (Polychlorinated biphenyls). Whilst this OHLT has been written for PMT's the same process and principles can be used on Ground Mounted Transformers (GMT). This process is currently Dead Work Only. The process from Power Tech Labs can be used to withdraw any oil samples where there are no Drain Valves or other caps that can be removed to use the Vacuum Filled Tube or a syringe to remove the sample. The Clor-N-Oil 50 Test held within CP306 FM5_004 can be completed.

For staff with Authorisation Code 371 – Section 13 for Live Tank Oil Sampling may also be followed.

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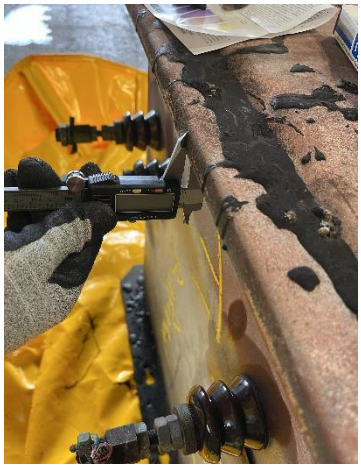
10 Materials and Consumables for Power Tech Lab System Sampling

Materials and Consumables	
Item	**Commodity Code / Reference No.**
Requires sample/seal kits for proper use	Powertech Labs Inc
Cordless Power Riveting Tool	Powertech Labs Inc
6mm sharp HSS drill bit with 10mm depth stop	Powertech Labs Inc
Transformer Punching Tool	Powertech Labs Inc
Cordless Drill	
Plastic Mallet	
Oil Thief collection device	Powertech Labs Inc
CORD Glass sample bottle	
Clor-N-Oil 50 PCB Screening Kit	50ppm CC 250843
Grey Paint	
Oil Seal Rivet	Powertech Labs Inc
T10 Hex tool to tighten depth stop.	
Hazardous Waste Bag	
Cable Ties	

11 Procedure for extracting oil for Sampling using the Powertech Lab System.

1	Ensure all oil collection equipment being used to collect the oil sample is clean and free from previous oil or substance residue by rinsing in known clean oil. Assemble the oil thief device. Connect the blue long pipe to the white pipe needle assembly. Do not connect the vacuum filled test tube at this point.	
2	Check the general condition of the GMT looking for any leaks or weeps, cracked/ damaged bushings and any signs of corrosion of the main body around the proposed drilling area.	

3	Establish the oil level position within the GMT and identify a suitable point for drilling a 6mm diameter hole for oil extraction which is above the oil level and away from any bushings. Ensure there is space for using a riveting tool later in this technique.	
4	Mark the position of the hole, use a hole punch as a guide for the drill bit. Clean the surface of the GMT around the drilling point.	
5	Measure the thickness of the GMT lid and use this measurement to set the depth stop on the drill bit. You will need a T10 hex tool to set the stop. This thickness is important as it prevents you from drilling through the tank wall.	
6	Using a cordless power drill, carefully drill a 6mm diameter hole into the GMT tank to the depth stop on the drill bit.	

7 If the depth stop has been correctly set the drill will not penetrate the tank.	
8 Use the transformer punching tool to punch through the GMT tank. Ensure the punch is fully through the tank but not in as far as the shoulder on the punch. Remove the punch.	
9 Using the oil thief, collect enough oil for the Clor-N-Oil 50 sample (5ml). Ensure a sufficient sample has been taken before proceeding to the next instruction. This is completed by inserting the blue pipe into the GMT tank. Once the pipe is inserted, push the Test Tube firmly into the open end onto the needle. This will break the vacuum seal and allow the oil to be withdrawn from the tank. Hold the tube as per the image and allow the oil to fill up to the top of the label as a minimum.	
10 Remove the oil thief from the GMT tank. Dispose of the pipe into a hazardous waste bag to dispose of in contaminated waste barrels in stores with bunds. The oil thief will self-seal once removed from the pipe work. Wipe any drips from the GMT tank wall with fibre free oil wipers.	

11 Insert a sealing rivet into the riveting tool and insert the rivet into the 6mm hole on the GMT tank. Ensure the sealing rivet in fully up against the tank before operating the riveting tool. Operate the riveting tool to shear off the rivet.	
12 Clean and paint the rivet seal.	
13 Perform Clor-N-Oil test and prepare the CORD bottle sample as described in following Section.	
14 Dispose of all PPE and the Clor-N-Oil Test Kits in an Orange Hazardous Waste Bag and Cable Tie Closed. Place all Hazardous Waste Bags into the Blue PCB Barrels in Stockport, Oldham, Blackburn, Kendal or Workington Depot.	

12 Carry out the Clor-N-Oil 50 PCB test.

The Clor-N-Oil 50 Test Procedure is held within CP306 FM5_004.

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13 Materials Required and Procedure for extracting oil for PCB Sampling on Ground Mounted Distribution Transformers using Live Tank Oil Sampling.

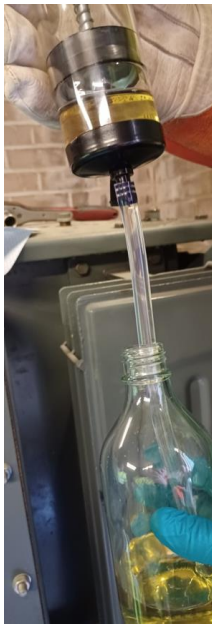
This procedure is only to be used by Senior Authorised Persons (SAP) with the Authorisation Code 371. No other SAP shall attempt to follow this procedure.

Two people shall always be on site at all times during this Procedure.

Equipment Required	Number Required.	Commodity Code
Oil Sampling Bottle	1 per sample	
HV Class 2 Gloves	1 pair	792801 to 792807 791122 to 791128
HV Class 2 Gloves Protection Gauntlet.	1 pair	VPP-ENWL-003
Large Oil-Resistant Suction Gun with 280mm flexible hose	1 per sample	790105
Fibre Free Wipers	As required.	250300
Gasket Sealant tube with gun	1	
Oil Resistant Gloves	As required	VPP-ENWL-015 or 791089
Hazardous Waste Bag	1	100153
Spanners	Assorted to suit sampling points.	
Cable Ties	1 per bag	299510 or similar

Procedure

1 Check the Ground Mounted Transformer for signs of corrosion. ***Where the GMT is deemed too corroded and that there is a risk of metal debris dropping from the underside of the lid or opening orifices then this procedure shall not be followed. A shut down will be required to remove the lid and sample taken.***	
2 Ensure the location for oil sampling is away from all High Voltage (HV) and Low Voltage (LV) conductors. These normally come up from the windings directly onto the bushings. Therefore, the sampling points shall always be in the corners of the tank.	
3 Wearing full PPE suitable for oil sampling, HV Gloves and a Visor carefully open the sampling point. ***Note should the HV Gloves Gauntlet get oil on them then they shall be disposed of into the Hazardous Waste Bag.***	
4 Using the large oil resistant suction gun and fitted hose. Carefully take an oil sample.	

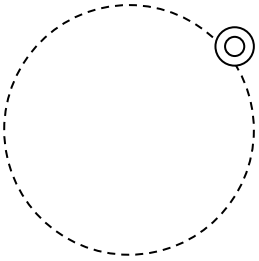
5 Carefully remove the pipe from the Ground Mounted Distribution Transformer and decant the sample into an Oil Sampling Bottle. Any excess oil can be pushed back into the Transformer slowly via the sampling point.	
6 Dispose of the syringe into the Hazardous Waste Bag.	
7 Replace the filling point cap and tighten. ***Note a new gasket may be required using the gasket sealing gun.***	
8 Label the sample bottle with the label in Appendix A.	

9 Return the Oil Sample to the Central Oil Reprocessing Plant in Whitebirk Depot for PCB analysis. ***Depending on the results a PCB label in ES356 may need to be applied.***	
10 Dispose of all PPE with the syringe and Cable Tie Closed. Place all Hazardous Waste Bags into the Blue PCB Barrels in Stockport, Oldham, Blackburn, Kendal or Workington Depot.	

APPENDIX A Oil Sample Label

PLEASE COMPLETE ALL DETAILS

SAMPLES MAY BE RETURNED IF THIS DATA IS NOT COMPLETED CORRECTLY



PLEASE LEAVE 2.5CM

HEADSPACE

Send to
CORD
WHITEBIRK DEPOT
BLACKBURN **Tel: 01254 688848**
LANCASHIRE **Fax:01254 688952**
BB1 3HT

Plant / Sub. Reference **ESSENTIAL**							
Plant Identifier **e.g. 4TX01**							

Substation Name **Voltage**			
Unit Identifier/ Circuit Name			
Sample date		**Sampled by**	
Serial No. **Or Van Reg. No:**			
CMS Agrt. No:		**Oil Temperature**	**°C**

Equipment	**O/S : F/S**	**OCB**	**RMU**	**T/F**	**Other,**	**Van**	**Or Tank**
Reason	**Maint**	**Fault**	**Invest**	**Other**			

Sampled from	**Sample Point**		**Drain valve**		**Other**	

Oil Sample Label - Front

TICK BOX FOR TESTS REQUIRED			
TESTS		FOR LABORATORY USE	
Colour		Amber | Light | Black | V Dark | Brown | Yellow | Clear | Other |	
Appearance		Cloudy | Free Water | Other | Satisfactory |	
Smell			
Sediment			
Moisture			ppm
Acidity			(mg KOH/g)
Breakdown			kV
Fibre			
PCB's		1260 | 1242 | 1254 |	ppm
Dissolved Gas Analysis			
Resistivity		Tan δ	@ °C
Furfural			ppm
Region/ Location			
Contact/Results to Fax No Exchange			
Lab Vial No.	(Lab use only)	Date of PCB TEST (Lab use only)	

Oil Sample Label - Reverse