

## 1. SCOPE

This document details the application of SOP 385 (Applicable to GEC Circuit Breaker VMX) issued by the Energy Networks Association.

## 2. ISSUE RECORD

This is a Reference document. The current version is held on the EN Document Library.

**It is your responsibility to ensure you work to the current version.**

Issue Date	Issue No.	Author	Amendment Details
May 2023	1	Patrick Dolan	Initial issue

## 3. ISSUE AUTHORITY

Author	Owner	Issue Authority
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## 4. REVIEW

This is a Reference document which has a 5 year retention period after which a reminder will be issued to review and extend retention or archive.

## 5. DISTRIBUTION

This document is not part of a Manual maintained by Document Control and does not have a maintained distribution list. It is published on the SP Energy Networks website.

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**7. SOP DETAILS**

<b>EQUIPMENT TYPE</b>	GEC Circuit Breaker VMX
<b>ORIGINATING COMPANY</b>	Northern Powergrid
<b>DATE</b>	11 <sup>th</sup> March 2013
<b>NUMBER INSTALLED IN ENERGY NETWORKS NORTH</b>	11
<b>NUMBER INSTALLED IN ENERGY NETWORKS SOUTH</b>	900
<b>REASON</b>	Potential partial discharge activity causing failure
<b>STATUS IN INITIATING COMPANY</b>	Access entry restriction to be applied to all substations housing GEC VMX 11kV Circuit Breaker. No restriction on remote operation of the switchgear (via Control or remote switch panel) Manual 'Open' or 'Close' operation of the 11kV circuit breaker whilst LIVE is prohibited until all units in the substation have been inspected and confirmed fit for service / remedial works completed. Isolation / de-isolation of the CB unit from the housing is permitted following an Ultra-TEV test immediately prior to undertaking the operation. All substations housing GEC VMX 11kV Circuit Breaker to be tested partial discharge by Technical Services. Any prolonged work in the substation will require partial discharge test verification (Ultra-TEV) at the start of each working day.
<b>SPEN APPLICATION</b>	<p>It is mandatory to confirm no notable<sup>1</sup> genuine PD activity on switchboard prior to all works &gt;30min duration in switchrooms with VMX equipment. Surveys are to be repeated to confirm switchboard is not discharging at least every 4 hours for periods of ongoing works.</p> <p>No manual live<sup>2</sup> switching operation (including racking VMX CB into or out of service) can be performed locally until (Ultrasonic and TEV) PD survey completed, and no notable<sup>3</sup> discharge confirmed using UltraTev+<sup>24</sup> device</p> <p>All manual post fault restoration operations shall be carried out remote from the VMX CB (independent of survey results).</p>
<b>ADDITIONAL INFORMATION</b>	See Appendix 1 & Appendix 2 for further guidance on PD activity
<b>UPDATE</b>	N/A
<b>REMEDIAL ACTION</b>	SOP will remain in force permanently – Subject to review of site conditions management regimes

<sup>1</sup> See Appendices for guidance, no entry to switchroom for high / audible PD levels

<sup>2</sup> This includes all manual switching actions of non-VMX CBs on the same board and switch-room. No restriction on racking in/out non-VMX CBs where access to switch-room permitted

<sup>3</sup> Refer to Footnote 1

<sup>4</sup> Permissible to use any device that is SPEN approved for TEV and Ultrasonic surveys

**8. SOP HEADER**

Field Name	Field Value	Field Size
<b>Name (SOPXXX)</b> *	<b>SOP385</b>	6
<b>The reason for the Operational Restriction</b> *	Potential insulation damage	30
<b>Nature of the Operational Restriction</b> *	Access and Live Op Restriction	50
<b>Comments</b> *	PD survey req for works > 30 min (repeat every 4hr) & prior to all live manual ops.  If issues found, works/access & manual ops suspended pending resolution.  Post fault live ops to be remote from the CB.	200
<b>Restricted Access to Substation Flag</b> *	Y	1
<b>SOP Impact Code</b> * <i>(highlight or underline the appropriate code)</i>	0 Temporary/Impact under assessment 1 Very minor operational/network impact 2 Moderate operational/network impact 3 Significant impact on system perf./measurable business costs <u>4 Inoperable without intervention</u> 5 Inoperable – no cost effective solution/must be replaced	N/A
<b>SOP component type</b> * <i>(highlight or underline the appropriate code)</i>	01 Bushing only <u>02 Circuit Breaker</u> 03 Fixed Portion only 04 Moving Portion only 05 Switch 06 RMU 07 Transformer only 08 Tap Changer only 09 Transformer & Bushing 10 Transformer & Tap Changer	N/A
<b>Search Criteria</b> *	Manufacturer: "GEC" Text Model: "VMX" and VMXC"  SOP to be applied to CB fixed portion, CB moving portion and Substation	N/A

\* This denotes a Mandatory Field

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## 9. APPENDIX 1 – GUIDANCE ON VMX ISSUES INVESTIGATION

### 9.1 Safety Notes

If on site entry, equipment is showing signs of distress, e.g. discharging audibly, **immediately withdraw from switch room and inform control room.**

Risk assessment shall be carried out prior to inspection of equipment. The presence of droplets on surfaces or metalwork or insulation should be assumed to be Nitric Acid (a by-product of discharge activity). As this substance is extremely corrosive, it is essential that contact with skin / or other items that skin may become in contact with is avoided. In order to avoid inadvertent contact, **appropriate gloves as per risk assessment must be worn for all equipment examination activities.**

### 9.2 Measurements

All measurements taken, PD (TEV / Ultrasonic), Insulation resistance readings, AC Pressure tests must be recorded

### 9.3 Access Restrictions

On arrival to sites with access restriction it is mandatory to inform the control room of purpose and duration of intended works. It is also mandatory to inform the control room when leaving site with access restriction.

In the context of this procedure, access is not permitted as per normal practices (works >30min) without PD surveys being completed.

Where ultrasonic levels are <25dBuV when measured from entrance to the S/S, access to the site is permitted to complete PD measurement / testing on individual bays. If results are satisfactory, works can commence. PD survey successful completion should be logged with the control room. PD surveys on all bays must be repeated on a maximum 4 hour interval.

Where **genuine** ultrasonic levels are >25dBuV when measured from entrance to the switch-room, access to the site is restricted, no access is permitted with all of the switchboard currently in service energised.

- All non-plant potential sources of ultrasonic activity should be eliminated as far as possible
- Under the condition of confirmed genuine PD activity, it is permissible for part of switchboard (not all) to be switched out remotely<sup>5</sup> and for measurement to be repeated<sup>6</sup>
- If the ultrasonic levels can be lowered by partial de-energisation (switch out of one bus section or de-energisation of individual feeders) to < 25dBuV, access to the switch-room for PD measurement / testing is permitted subject to the parts of the switchboard remaining de-energised

### 9.4 Visual Inspection of Insulation

Guidance on the inspection of insulation can be found in [EPS-12-004](#) which forms part of the plant maintenance manual. This document also gives guidance on the cleaning of insulation where appropriate.

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<sup>5</sup> Note there is always a risk that switching transients could exacerbate concentrated stress levels and initiate insulation breakdown to failure so this should be considered with the control room prior to any decisions on switching activities

<sup>6</sup> While the integral microphone is wide band it might be possible to determine which half bar is the source. The directional ultrasonic parabolic dish (where available) may be able to identify suspect panel for PD source.

Where insulation has suffered electrical damage, evidence may be visible on the insulation surface. It is also possible that there could be electrical damage which has permeated into the insulation material that may not be evident on visual inspection.

Some superficial insulation damage may be repairable by treatment to bushings. Any clean-up or repairs need to be verified by dielectric tests.

### 9.5 Visual Inspection of CB component parts

Where there has been discharge activity, discharge by-products can cause damage to other equipment components, hence an internal inspection of the circuit-breaker with covers removed is mandatory under an appropriate safety document.

Verdigris on conductors in itself typically does not materially affect their functionality however it is indicative on presence of Nitric Acid. Where Verdigris is found particular attention should be afforded to inspecting the Vacuum bottle for signs of damage (corrosion on metal parts – corrosion on fixing bolts). The condition must be recorded in SAP as a defect and reported so that it can be addressed.

Should this issue be found, the CB must be considered as degraded and must be subjected to AC pressure test as detailed below to prove it could be returned to service. Whilst the Vacuum Interrupter is expected to pass this test, the longevity of the component may be compromised.

### 9.6 Electrical Testing

#### 9.6.1 DC Testing

DC insulation test with 5kV Megger shall be performed as part of the investigation to give an indication of the integrity of the insulation prior to mandatory AC Pressure Tests

Insulation under test in reference to Earth should have resistance in the G Ohm range (exact values dependent on site conditions). If a lower value is measured, works to improve environment conditions should be completed and tests repeated.

Progression to AC Pressure Tests should only be completed upon satisfactory DC insulation resistance test. Where this cannot be achieved further investigation is required.

#### 9.6.2 AC Pressure Testing Insulation

Reference should be made to [SUB-02-613](#) when completing AC pressure testing of insulation. As equipment previously in service, testing should be at 12kV RMS for 1 min.

Insulation resistance in the G Ohms range, should have leakage currents below 12mA (expected to be much lower for healthy insulation).

#### 9.6.3 AC Pressure Testing Vacuum Interrupter

Where any evidence of corrosion is noted as detailed previously, AC pressure tests shall also be conducted across each of the phases with CB in open position. One pole of the CB shall be earthed and 20kV RMS applied to the adjacent pole of the CB for 1 min to test the integrity of gap within the Vacuum Bottle when in open position.

The leakage current should be neglectable for a healthy Vacuum Interrupter. If issues are found, the CB needs to be returned to the OEM for repair. **It cannot be returned to service.**

### 9.7 Investigation of Repair and Replacements Options

If damage is found on insulation, it will likely require replacement (aside from minor issues). Clean-up and repairs of minor damage are permissible, subject to test of AC pressure test post repair. If there is any doubt, consult the OEM (Schneider).

If issues are found on CB moving portion, typically the problem can be resolved with use of a traveller CB. This traveller CB may need modification/replacement of auxiliary contact blocks to be installed.

The recovered CB should be sent to OEM to determine if repairs are possible or if equipment is beyond repair.

If issues are found on the switchgear spouts, typically installation of a replacement set of spouts is required.

Where issues are detected with vacuum bottles, the CB should be returned to the OEM for refurbishment including Vacuum Interrupter replacement.

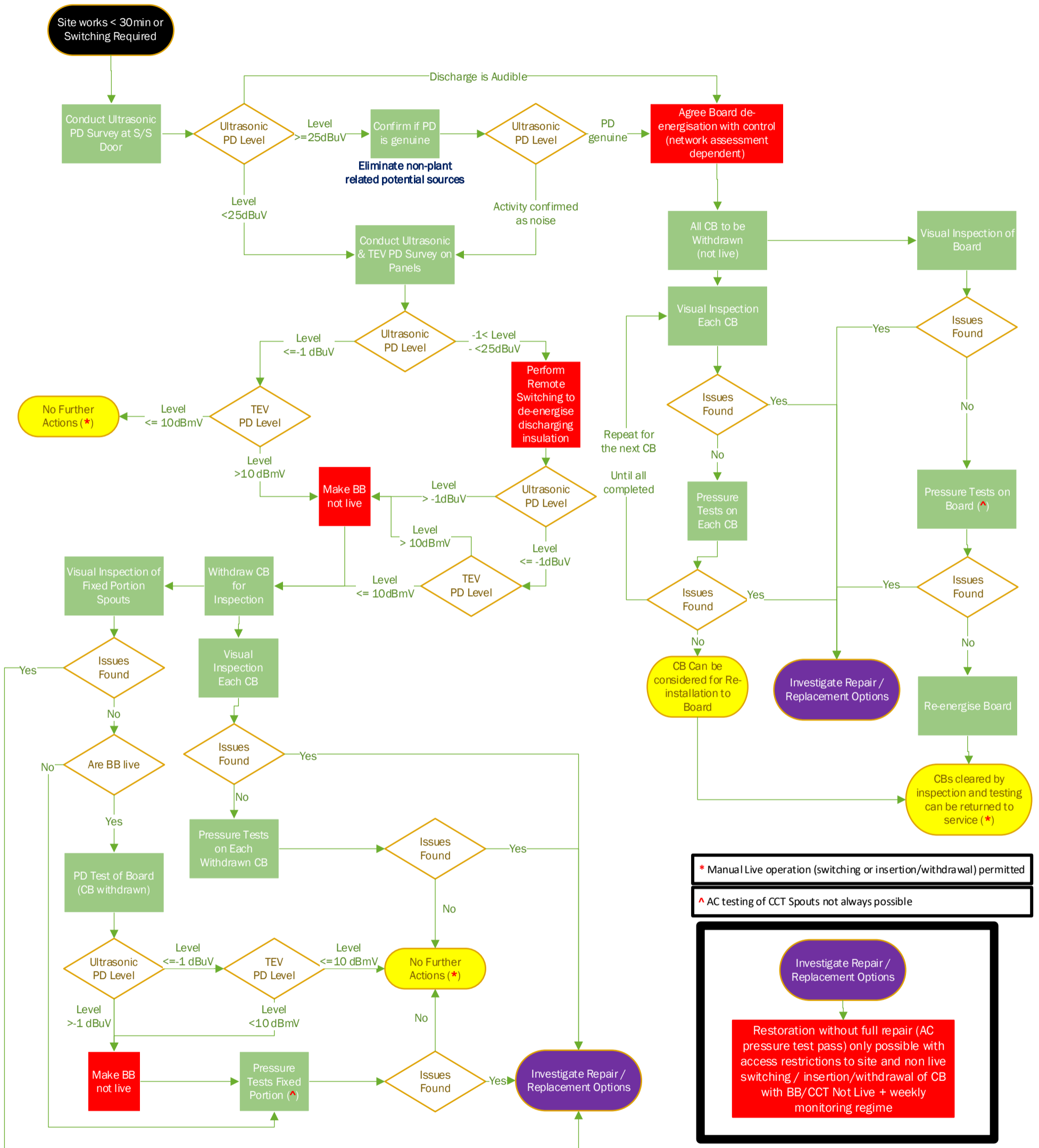
### 9.8 Restoration Considerations

Equipment which has switched out for investigation can typically be returned to service upon successful completion of an AC pressure test. Upon energisation (Ultrasonic and TEV) PD surveys shall be repeated and results recorded in SAP. If there are any doubts over visual appearance of insulation or where repairs have been completed, consideration should be given to follow-up PD surveys (1, 2 and 4 weeks after restoration) or installation of online monitoring.

Equipment which has switched out for investigation and is unable to pass an AC pressure test should typically not be returned to service. In the event that there is a requirement for emergency restoration, this can only be permitted if CB is racked in with the BB and CCT not live and where restoration is carried out remotely with all personnel clear of the switch-room. Upon restoration, a full access restriction would remain in place on the switchboard whilst equipment is live.

In the event that restoration is carried out on equipment which has passed tests but where corrosion is noted on the vacuum bottle or adjacent fixings, the OEM shall be engaged to plan future repair of the unit (replacement of the vacuum bottle) as damage has the potential to cause early life failure of the bottle. There should be a live ban on all local switching operations on the unit and there shall be a full access restriction to the switch-room where CB is located whilst the equipment is live.

10. APPENDIX 2 – VMX INVESTIGATION FLOWCHART



\* Manual Live operation (switching or insertion/withdrawal) permitted

^ AC testing of CCT Spouts not always possible

Investigate Repair / Replacement Options

Restoration without full repair (AC pressure test pass) only possible with access restrictions to site and non live switching / insertion/withdrawal of CB with BB/CCT Not Live + weekly monitoring regime