

## 1. SCOPE

This document details the application of SOP 411 issued by the Energy Networks Association applicable to the following:

- AEI JW420 275 kV circuit-breakers
- AEI OW410 132 kV circuit-breakers
- Ferguson Palin XOPR60 132 kV circuit-breakers
- VLS 132 kV wound VTs
- Any other asset which is fitted with BL barrier bushings.

## 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
October 2020	1	Ryan Miller	First Issue
June 2021	2	Kevin Butter	SOP 411 applied in SPEN.
November 2021	3	Kevin Butter	Revised to include other assets with BL Barrier Bushings.

## 3. ISSUE AUTHORITY

Author	Owner	Issue Authority
Kevin Butter Lead Engineer	Fraser Shaw Substations Manager	Fraser Ainslie Head of Engineering Design and Standards

## 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.

6. CONTENTS

1. SCOPE.....	1
2. ISSUE RECORD.....	1
3. ISSUE AUTHORITY .....	1
4. REVIEW .....	1
5. DISTRIBUTION.....	1
6. CONTENTS .....	2
7. SOP DETAILS .....	3
8. SOP HEADER .....	6

**7. SOP DETAILS**

<b>EQUIPMENT TYPE</b>	AEI JW420 275 kV, AEI OW410 132 kV and Ferguson Palin XOPR60 132 kV circuit-breakers. Type VLS 132 kV wound VT. Other assets with BL barrier bushings.
<b>ORIGINATING COMPANY</b>	National Grid
<b>DATE</b>	17 <sup>th</sup> June 2019
<b>NUMBER INSTALLED IN ENERGY NETWORKS NORTH</b>	28
<b>NUMBER INSTALLED IN ENERGY NETWORKS SOUTH</b>	33
<b>REASON</b>	Failure of a BL barrier bushing on an AEI JW420 circuit-breaker.
<b>STATUS IN INITIATING COMPANY</b>	Following an investigation into the failure of an AEI JW420 circuit breaker, National Grid have taken the decision to cease life extension activities for all circuit breakers using BL barrier type bushings ( AEI JW420, GEC Alstom (AEI) JW421, 132kV AEI OW410, 66kV AEI OW407, 132kV Ferguson Palin XOPR60). The remaining population of the identified circuit breakers will be Risk Managed through to replacement.
<b>SPEN APPLICATION</b>	<p>A Risk Management Zone (RMZ) of 10 metres shall be applied around the following asset types with BL barrier bushings under the conditions described below:</p> <ul style="list-style-type: none"> <li>• AEI JW420 275 kV circuit-breakers</li> <li>• AEI OW410 132 kV circuit-breakers</li> <li>• Ferguson Palin XOPR60 132 kV circuit-breakers</li> <li>• Type VLS 132 kV wound VT at Dumfries 132 kV substation.</li> <li>• Any other asset with BL barrier bushings.</li> </ul> <p>When switching is carried out which will energise any of the above assets, a 10 metre RMZ shall be applied around that asset.</p> <p>Access to any RMZ around any of the above assets shall not be permitted under "Lightning Risk 1" conditions.</p> <p>During any work which may involve encroaching within 10 m of any of the above assets, suitable PD monitoring shall be employed. (This does not apply to passing through, inspections or switching which does not involve energisation of the asset).</p> <p>Notices shall be posted at access gates to substations containing these assets to warn staff of the restricted access to these sites.</p> <p>This SOP shall remain in place until assets have been replaced.</p>

<b>ADDITIONAL INFORMATION</b>	<p>This SOP has been updated in SPEN based on findings from forensic examinations and on site oil sampling of BL barrier bushings on AEI JW420 275 kV circuit-breakers and AEI OW410 132 kV circuit-breakers as part of the SOP 416 investigations. These bushings were found to have particulate levels higher than acceptable limits.</p> <p>National Grid's investigation into the failure covered by SOP 411 found similar particulate matter in the bottom of the bushing. This led to an internal flashover at the bottom of the bushing inside the circuit-breaker tank. The flashover resulted in fragmentation of the bushing inside the tank and fracture/collapse of the external part of the bushing.</p> <p>Unlike the failure mode described in SOP 416, no parts of the bushing were ejected across the substation.</p>
<b>UPDATE</b>	<p>Based on the similarities of the findings in SPEN to the findings from the SOP 411 investigation by National Grid, SOP 411 shall now be applied in SPEN.</p> <p>This SOP has been updated in Issue 3 to include other asset types (other than list of identified circuit-breaker and VT models identified) where it is established that the asset is fitted with BL barrier bushings.</p>
<b>REMEDIAL ACTION</b>	<p>All AEI JW420, AEI OW410, Ferguson Palin XOPR60 circuit-breakers and wound VT Type VLS will be replaced and managed until replacement programme has been completed.</p> <p>Where other assets have been identified as being fitted with BL barrier bushings, an asset condition assessment shall be carried out to determine if asset requires to be replaced.</p> <p>Oil samples shall be taken from the top cap and main body of the bushing every 3 years. The test pass criteria for the oil is shown in table below.</p> <p>Particulate count alone is not sufficient criteria to declare that an asset must be removed from service. The presence of another key end-of-life indicator from the table is necessary before this is required.</p>

	<b>Top Cap Oil Testing</b>	
	Moisture	<40 ppm
	Break down Voltage	$\geq$ 40 kV
	Hydrogen	<130 ppm
	Acetylene	<0.3 ppm
	Particulate count	$\leq$ Good
	<b>Main Body Oil Testing</b>	
	Moisture	<30 ppm
	Break down Voltage	$>$ 50 kV
	Hydrogen	<1000 ppm
	Acetylene	<2 ppm
	Particulate Count	$\leq$ Low
	<p>If the particulate in any bushing is found to be metallic then consideration is required to determine if the asset is suitable to be returned to service.</p> <p>If the particulate count is above “low” in the main body and the oil sample fails another of the key indicators from the table, then the asset shall not be returned to service unless in the event of an emergency and appropriate mitigation is taken. This shall be sanctioned by the relevant Senior Manager. In SPT the owner of that decision shall be the Substation Operations Manager and in SPM the Head of 132 kV Operations or equivalent or their nominated stand ins.</p>	

**8. SOP HEADER**

Field Name	Field Value	Field Size
<b>Name (SOPXXX)</b> *	SOP411	6
<b>The reason for the Operational Restriction</b> *	Bushing failure on JW420 275kV circuit-breaker	30
<b>Nature of the Operational Restriction</b> *	10m RMZ during live switching or Lightning Risk 1	50
<b>Comments</b> *	PD monitoring to be used when carrying out work which may require access to RMZ	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 <b>1 Very minor operational/network impact</b> 2 Moderate operational/network impact 3 Significant impact on system perf./measurable business costs 4 Inoperable without intervention 5 Inoperable – no cost effective solution/must be replaced	N/A
<b>SOP component type</b> * <i>(highlight or underline the appropriate code)</i>	<b>01 Bushing only</b> 02 Circuit Breaker 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> *	JW420, OW410, XOPR60, VLS SOP shall also be applied to individual Assets in cases where it has been established that the individual asset is fitted with type BL barrier bushings.	N/A

\* This denotes a Mandatory Field