NSP/003/002 – Code of Practice for Insulation Testing of Network Assets

1. Purpose

The purpose of this document is to specify the Northern Powergrid insulation testing requirements for all assets installed on the Company's licensed networks.

This document supersedes the following documents, all copies of which should be destroyed.

This document describes testing methods and tabulated testing criteria based upon asset class and operating voltage.

Ref	Version	Date	Title
Operation Instruction 0.755	N/A	1993	Insulation Testing of High Voltage Apparatus

2. Scope

This document applies to the insulation testing of cables, switchgear, transformers and equipment operating at voltages from 1 kV to 132 kV connected to the Company's licensed networks.

Excluded from this code of practice are factory tests (routine, type and special) as these are documented at the time of procurement, within the relevant specifications.

This code of practice applies to all Company employees, contractors and others installing or maintaining network infrastructure that is owned, operated, or is to be adopted by the Company.

2.1. Table of Contents

3. Insulation Testing of Network Assets

This code of practice details the requirements for the on-site insulation testing of high voltage assets including cables, switchgear and transformers, reactors and arc suppression coils. The purpose of on-site insulation testing is to confirm that the dielectric strength of electrical insulation is acceptable and so demonstrate that equipment can be safely connected to the Company's networks.

The test methods and values in this code of practice are based on current British Standards and International Standards together with industry best practice and specific requirements of the Company.

Dispensation to vary or modify test methods or values detailed in this code of practice can only be granted by the Company's Designated Engineer (in accordance with clause WE2.2.1.a of Northern Powergrid's Operational Practice Manual.

3.1. Types of Testing

3.1.1. Routine Tests

Routine tests carried out by the manufacturer prior to shipment, as prescribed in relevant British and International Standards, are excluded from this Code of Practice. Routine test criteria shall be included in the Company's relevant technical specifications (NPS).

3.1.2. Commissioning tests

Testing carried out after an asset has been installed, up to 24 hours prior to energisation.
Where energisation takes place more than 24 hours after the commissioning test, a documented risk assessment shall be undertaken by the Company's Senior Authorised Person based upon the guidelines stipulated in Section 3.1.5. Commissioning overvoltage testing values are typically 80% of test values quoted in relevant standards.

3.1.3. Post maintenance testing

Testing carried out after routine maintenance work has been carried out on an asset.
Post maintenance overvoltage testing values are typically 80% of test values quoted in relevant standards.

3.1.4. Post repair testing

Testing carried out after repair or modification work has been carried out on an asset which affects or may affect the integrity of the insulation.
Post repair overvoltage testing values are typically 80% of test values quoted in relevant standards.

3.1.5. Post de-energised testing

Testing carried out after a period of de-energisation where no work has been carried out on the asset.
The testing requirements in relation to time since last energisation are detailed in Table 1.

Time elapsed since energisation	Situation		
	Public Access	No Public Access Local Operation	No Public Access Remote Operation
≤ 24 Hrs.	None	None	None
> 24 Hrs. ≤ 7 Days	5 kV Insulation Resistance Test		

Time elapsed	Situation		
> 7 Days ≤ 28 Days	Overvoltage Test	5 kV Insulation Resistance Test	
> 28 Days		Overvoltage Test	

Table 1 – Post de-energised testing

Where testing is required, the test shall comply with the method and values relevant to the asset class. De-energised asset overvoltage testing values are typically 80% of test values quoted in relevant standards.

3.2. Recording

The results of any testing carried out on assets shall be recorded on an appropriate test results form (see Appendix 1) and retained by the Company's Senior Authorised Person (or supplied to The Company if carried out by a third party) with a copy recorded against the Company's asset records.

3.3. Methods of Testing

3.3.1. Insulation resistance (IR)

An insulation resistance test, sometimes referred to as a 'Megger' test, is used to provide a quantifiable resistance value for the insulation of an asset being tested. Unless otherwise stated, IR tests will be carried out at a test voltage of 5 kV DC, with each test lasting 1 minute. Unless otherwise stated, the following tests shall be carried out:

Phase to Phase
L1 – L2
L1 – L3
L2 – L3
Phase to Earth
L1 – Earth
L2 – Earth
L3 – Earth
All in (Transformer in circuit)
L1 + L2 + L3 – Earth

3.3.2. Overvoltage testing (OV)

A dielectric withstand test, typically referred to as an overvoltage test, measures leakage current between the conductor under test and earth. The voltage, frequency and duration of an overvoltage test will vary depending upon the asset class. OV tests are potentially destructive as they apply stresses to the dielectric that are in excess of normal operating stresses. For this reason OV tests are not generally required after routine maintenance work; they are required after repair work or during initial commissioning.

3.3.2.1. AC test

As most insulation is intended for use on power frequency assets, an applied test voltage at power frequency provides a more accurate test as it reproduces electric field patterns similar to normal operating conditions. Unless otherwise stated, the following tests shall be carried out:

Phase to Earth
L1 – Earth
L2 – Earth
L3 – Earth
Alternate Phase to Earth
L1 + L2 – Earth
L1 + L3 – Earth

L2 + L3 - Earth
All in (Transformer in circuit)
L1 + L2 + L3 – Earth
The voltage shall be applied to the conductor under test at a value sufficiently low to prevent any effect of overvoltages due to switching transients, this should ideally be zero. It should be raised as rapidly as is consistent with the measurement so as not to cause prolonged stressing of the asset under test, near to the final test voltage. It should then be maintained for the specified time before being rapidly decreased to zero and switched off. Any remaining electrical charge should be discharged to earth through an impedance to prevent any damage being caused to the insulation due to rapid voltage discharge. The applied test voltage should not be interrupted as this may generate switching transients that may cause damage to the asset or inaccurate test results.

AC testing at 66 kV and 132 kV shall be carried out in a frequency range of between 20 Hz and 300 Hz.

3.3.2.2. DC test

The advantages of DC testing are that test equipment is generally smaller and requires less power. Using DC testing also mitigates the impact of capacitance in the asset under test. DC tests shall be carried out with the test voltage at negative polarity to accommodate electroendosmosis.
Unless otherwise stated, the following tests shall be carried out:
Phase to Earth
L1 – Earth
L2 – Earth
L3 – Earth
Alternate Phase to Earth
L1 + L2 – Earth
L1 + L3 – Earth
L2 + L3 - Earth
All in (Transformer in circuit)
L1 + L2 + L3 – Earth
The voltage should be applied to the conductor under test at a value sufficiently low to prevent any effect of overvoltages due to switching transients, this should ideally be zero. It should be raised as rapidly as is consistent with the measurement so as not to cause unnecessary prolongation of the stressing of the asset under test, near to the final test voltage. It should then be maintained for the specified time before being rapidly decreased to zero and switched off. Any remaining electrical charge should be discharged to earth through an impedance to prevent any damage being caused to the insulation due to rapid voltage discharge. The applied test voltage should not be interrupted as this may generate switching transients that may cause damage to the asset or inaccurate test results.

3.3.2.3. Very low frequency (VLF) testing

VLF tests shall be carried out at a frequency between 0.01 Hz to 0.1 Hz with a square wave shape (cosine rectangular). VLF testing is used as an alternative to DC testing on XLPE cables as it negates the premature ageing due to space charge.
Unless otherwise stated, the following tests shall be carried out:
Phase to Earth
L1 – Earth
L2 – Earth
L3 – Earth
Alternate Phase to Earth
L1 + L2 – Earth
L1 + L3 – Earth
L2 + L3 – Earth

The voltage should be applied to the conductor under test at a value sufficiently low to prevent any effect of overvoltages due to switching transients, this should ideally be zero. It should be raised as rapidly as is consistent with the measurement so as not to cause unnecessary prolongation of the stressing of the asset under test, near to the final test voltage. It should then be maintained for the specified time before being rapidly decreased to zero and switched off. Any remaining electrical charge should be discharged to earth through an impedance to prevent any damage being caused to the insulation due to rapid voltage discharge. The applied test voltage should not be interrupted as this may generate switching transients that may cause damage to the asset or inaccurate test results.

3.3.3. Frequency response analysis (FRA)

Frequency response analysis, sometimes referred to as sweep frequency response analysis (SFRA) is a comparative test used to analyse the mechanical condition of the core and winding within a transformer. Changes in the mechanical condition can occur during transportation or if the unit is subjected to significant fault current, therefore FRA testing shall be carried out on all CMR transformers and any CER transformer operating above 33 kV after relocation or clearance of fault current from an internal fault. As the test is comparative, the transformer must be disconnected from any conductors prior to the test taking place. Results shall be compared to original manufacturer FRA test results where available.

Tests shall be carried out in accordance with BS EN 60076-18: 2012 – *Power Transformers. Measurement of frequency response*.

3.3.4. Insulated cable sheath testing

To avoid induced voltages from adjacent live circuits, the following procedure shall be used.
The links providing the earth connection to the sheath shall, where practicable, be removed after the testing equipment has been connected to the sheath and replaced before the test equipment is disconnected.
IR tests on the serving of insulated sheath cables shall be carried out using a 1 kV DC insulation tester for 1 minute.
As this is not a test of primary insulation, low test results do not imply the circuit is unfit for reconnection to the Company's network. Where a cable serving insulation resistance of 50 kΩ or less is obtained, efforts should be made to locate the fault to prevent any further deterioration of the cable sheath.

3.3.5. Connected assets

Where two or more assets are electrically connected, where reasonably practicable, they shall be disconnected and tested separately. If the Company's Senior Authorised Person determines that the risks associated with disconnecting the equipment are greater than the risks associated with a reduced test value, the asset requiring the least onerous test shall determine the test value.

3.4. Asset Classes

3.4.1. Cables

Following installation and/or jointing work and before energising, cables shall be subjected to test voltages suitable to their type and rated voltage, detailed in Section 3.7.

11/20 kV cables are 11 kV rated cables operating at 20 kV and shall be subjected to a reduced test voltage (Table 3.7.1.4 and 3.7.2.4).

Where cable sections contain a mixture of PILC / Fluid Filled and XLPE, the section should be tested as XLPE (Section 3.4.1.1).

3.4.1.1. Cross Linked Polyethylene (XLPE) Cables

It is preferable for XLPE cables to be tested with VLF or AC test voltages. Research has shown that the application of DC voltage to aged XLPE insulated cable can cause premature failure by injecting space charge into degraded regions of the insulation. This trapped charge, if not discharged from the cable, leads to enhanced stress within the insulation once re-energized. Notwithstanding, this code of practice allows for DC testing of XLPE cables up to and including 33 kV where VLF or AC testing is not reasonably practicable.

3.4.2. Switchgear

Before commissioning or following repair which affects or may affect the integrity of the insulation, switchgear shall be subjected to the test voltages suitable to their rated voltages detailed in Section 3.8. AC test voltages shall be used where practicable; otherwise DC test voltages are acceptable.

Voltage transformers connected to switchgear shall be isolated during testing and tested separately as detailed in Section 3.4.3.2.

When testing across open contacts, the side not subjected to the test voltage shall be connected to earth.

When testing vacuum interrupters, to avoid any hazards associated with the potential presence of X-rays, no personnel shall approach within 3 metres of the vacuum interrupter which is subjected to the test voltage.

3.4.3. Transformers

Before commissioning or following repair which affects or may affect the integrity of the insulation, transformers shall where reasonably practicable be subjected to the test voltages suitable to their rated voltage detailed in Section 3.9.

3.4.3.1. Ground Mounted Transformers, Reactors and Arc Suppression Coils (ASCs)

For transformers, reactors and ASCs up to and including 20 kV, AC test voltages shall be used where practicable; otherwise DC test voltages are acceptable.

Where HV cables are directly connected to the unit and it is not reasonably practicable to remove them, they shall be tested as one unit using DC test voltages.

For new or refurbished units at 25 kV, 33 kV, 66 kV and 132 kV, which have a valid test certificate, 5 kV IR tests or the following diagnostic tests shall be applied prior to energisation.
Ratio test at each tap position
Dissolved Gas Analysis test
10 kV AC insulation test
10 kV AC single phase excitation test
Frequency response analysis test

Following CT replacement where a valid manufacturer's test certificate is provided, bushing replacement or non-intrusive repair work to transformers, reactors, ASCs or tap-changers at 25 kV, 33 kV, 66 kV and 132 kV, the following diagnostic tests shall be applied prior to energisation.
5 kV IR test

Following intrusive repair work to transformers, reactors, ASCs or tap-changers at 25 kV, 33 kV, 66 kV and 132 kV, the following diagnostic tests shall be applied prior to energisation.
5 kV IR test
Ratio test at each tap position

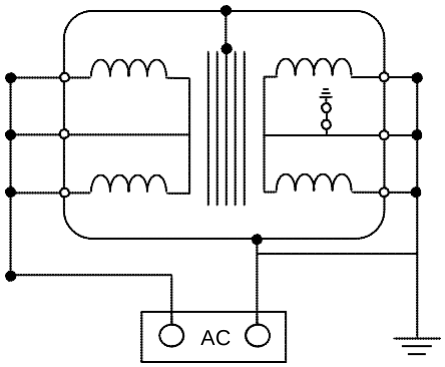
Following clearance of fault current from an internal fault for transformers, reactors, ASCs or tap-changers at 25 kV, 33 kV, 66 kV and 132 kV, the following diagnostic tests shall be applied prior to energisation.
5 kV IR test
Ratio test at each tap position
Dissolved Gas Analysis test
10 kV AC insulation test
10 kV AC single phase excitation test
Frequency response analysis test

3.4.3.2. Instrument Transformers

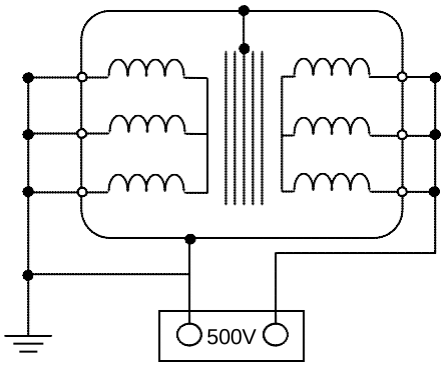
Before commissioning or following repair which affects or may affect the integrity of the insulation, instrument transformers shall be subjected to the test voltages suitable to their rated voltage described in section 3.9.2. AC test voltages shall be used to test the high voltage winding.

For the purpose of this Code of Practice, 'Instrument Transformers' shall refer to voltage transformers (VTs) and free standing current transformers (CTs)

The high voltage (HV) winding shall be tested to the low voltage (LV) winding and earth.



The low voltage (LV) winding shall be tested to earth at 500 V DC.



3.5. Overhead lines

Insulation testing of overhead lines is not considered reasonably practicable. However, prior to commissioning all insulators shall be checked for soundness and a visual inspection shall be made of new or modified sections of line.

Prior to an asset being connected to the Company's network using live line techniques, provided a valid manufacturer's test certificate is attached to the asset, a 5 kV IR test shall be applied as described in Section 3.3.1. The minimum values recorded shall be:
Phase to Earth – 100 MΩ
Phase to Phase – 200 MΩ
Transformer Phase to Earth – 50 MΩ

Should the asset test values be lower than those stated, or a valid manufacturer's test certificate is not present, the asset shall be insulation tested to the relevant criteria stated in this Code of Practice, relevant to its asset class.

Prior to re-energising an overhead line that has been out of service for an extended period of time, a risk assessment shall be undertaken by the Company's Senior Authorised Person to decide if a visual inspection is required.

3.6. Exceptions

Before connecting or reconnecting any assets to the Company's network, tests prescribed in this Code of Practice shall, where reasonably practicable be carried out, with the following exceptions.

3.6.1. Construction work

Certain classes of VT where the HV star point is permanently earthed and it is not reasonably practicable to remove the earth.

Overhead lines, providing Section 3.5 is adhered to.

3.6.2. Maintenance work

Certain classes of VT where the HV star point is permanently earthed and it is not reasonably practicable to remove the earth.

Overhead lines, providing Section 3.5 is adhered to.

Ground mounted equipment where exposed insulation is involved.

Any circuit where it is necessary to disconnect permanently bolted connections to the equipment prior to testing.

3.6.3. Cable connection sockets (e.g. Pfisterer connections) and test plugs/bushings

Testing is not required following removal and refitting of blanking plugs or test plugs/bushings. Before insertion each blanking plug or test plug/bushing shall be inspected and confirmed to be clean and undamaged. If there is any concern regarding the condition of the blanking plug or test plug/bushing it shall be replaced. As blanking plugs and test plugs/bushings are not interlocked, checks shall be made to ensure they are correctly inserted prior to energisation.

Where testing of the circuit is required, including a VT and/or other associated equipment:
Where reasonably practicable, test from the remote end.
Where test sockets are provided, the circuit may be tested by removing the blanking plugs from the test socket and inserting plugs attached to short test leads.

3.6.4. Switchgear

Where switchgear does not have a designated test orifice and the cable type is single core XLPE, the following procedure shall apply.
On completion of the termination, the HV terminations are left disconnected from the cable box stalks within the transformer or switchgear dry box.
Undertake the required testing directly onto the cable termination.
Complete the final connection of the termination under the personal supervision of the Senior Authorised Person.
Where practicable, re-energisation should be carried out remotely.

Where the switchgear does not have a designated test orifice and the cable type is not XLPE, does not lend itself to cable termination disconnection (PILC) and is supplying a transformer, the following procedure shall apply.
Remove the transformer lid and disconnect the transformer windings.
Carry out the required cable testing from within the transformer.
On completion of testing, reconnect transformer winding, adjust oil levels as necessary and replace the transformer lid under the Personal Supervision of the Senior Authorised Person.
Where practicable, re-energisation should be carried out remotely.

Where the design of switchgear incorporates a metering VT connection and does not have a designed test orifice to facilitate the testing of the circuit, the following procedure shall apply.
Access the VT by removing an access panel and disconnect the VT windings.
Carry out the required testing from within the VT chamber.
Upon completion of the testing, reconnect the VT windings and replace access panel u.
Where practicable, re-energisation should be carried out remotely.

3.7. Test Values

The following section contains tables detailing insulation testing requirements for all network connected assets, grouped by asset class and voltage.

Asset Class	Asset Sub-Class	Voltage	Table Number	Page Number
Cables	PILC	3.3 kV	3.7.1.1	17
		6.6 kV	3.7.1.2	19
		11 kV	3.7.1.3	21
		11 / 20 kV	3.7.1.4	23
		20 kV	3.7.1.5	25
		25 kV	3.7.1.6	27
		33 kV	3.7.1.6	29
		66 kV	3.7.1.8	32
		132 kV	3.7.1.9	35
	XLPE	3.3 kV	3.7.2.1	38
		6.6 kV	3.7.2.2	40
		11 kV	3.7.2.3	42

Asset Class	Asset Sub-Class	Voltage	Table Number	Page Number
		11 / 20 kV	3.7.2.4	44
		20 kV	3.7.2.5	46
		25 kV	3.7.2.6	48
		33 kV	3.7.2.7	50
		66 kV	3.7.2.8	53
		132 kV	3.7.2.9	55
Switchgear	Isolatable	3.3 kV	3.8.1.1	57
		6.6 kV	3.8.1.2	59
		11 kV	3.8.1.3	60
		20 kV	3.8.1.4	61
		25 kV	3.8.1.5	62
		33 kV	3.8.1.6	63
		66 kV	3.8.1.7	64
		132 kV	3.8.1.8	65
	Non-Isolatable	3.3 kV	3.8.2.1	66

Asset Class	Asset Sub-Class	Voltage	Table Number	Page Number
		6.6 kV	3.8.2.2	68
		11 kV	3.8.2.3	69
		20 kV	3.8.2.4	70
		25 kV	3.8.2.5	71
		33 kV	3.8.2.6	72
		66 kV	3.8.2.7	73
		132 kV	3.8.2.8	74
Transformers	Ground Mounted Transformers	3.3 kV	3.9.1.1	75
		6.6 kV	3.9.1.2	77
		11 kV	3.9.1.3	79
		20 kV	3.9.1.4	81
		25 kV	3.9.1.5	83
		33 kV	3.9.1.6	84
		66 kV	3.9.1.7	85
		132 kV	3.9.1.8	86

Asset Class	Asset Sub-Class	Voltage	Table Number	Page Number
	Instrument Transformers	3.3 kV	3.9.2.1	87
		6.6 kV	3.9.2.2	88
		11 kV	3.9.2.3	89
		20 kV	3.9.2.4	90
		25 kV	3.9.2.5	91
		33 kV	3.9.2.6	92
		66 kV	3.9.2.7	93
		132 kV	3.9.2.8	94

3.7.1. Paper insulated lead covered (PILC)

3.7.1.1. 3.3 kV PILC Cable

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Commissioning	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
3.3 kV	Commissioning	OPM 2015 WE4.1.3	Overvoltage	DC	6 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 80 % of test value
3.3 kV	Post Maintenance	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Post Maintenance	OPM 2015 WE4.1.3	Overvoltage	DC	6 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 80 % of test value
3.3 kV	Post Repair	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Post Repair	OPM 2015 WE4.1.3	Overvoltage	DC	6 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 80 % of test value

3.7.1.2. 6.6 kV PILC Cable

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Commissioning	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
6.6 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	DC	12 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 80 % of test value
6.6 kV	Post Maintenance	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	DC	12 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 80 % of test value
6.6 kV	Post Repair	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	DC	12 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 80 % of test value

3.7.1.3. 11 kV PILC Cable

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11 kV	Commissioning	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
11 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	DC	20 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 80 % of test value
11 kV	Post Maintenance	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	DC	20 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 80 % of test value
11 kV	Post Repair	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	DC	20 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 80 % of test value

3.7.1.4. 11 / 20 kV PILC Cable

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11/20 kV	Commissioning	OPM 2015 WE4.1.2	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
11/20 kV	Commissioning	OPM 2015 WE4.1.2	Overvoltage	DC	28 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	Company Requirement
11/20 kV	Post Maintenance	OPM 2015 WE4.1.2	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11/20 kV	Post Maintenance	OPM 2015 WE4.1.2	Overvoltage	DC	28 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	Company Requirement
11/20 kV	Post Repair	OPM 2015 WE4.1.2	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11/20 kV	Post Repair	OPM 2015 WE4.1.2	Overvoltage	DC	28 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	Company Requirement

3.7.1.5. 20 kV PILC Cable

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Commissioning	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
20 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 80 % of test value
20 kV	Post Maintenance	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 80 % of test value
20 kV	Post Repair	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 80 % of test value

3.7.1.6. 25 kV PILC Cable

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
25 kV	Commissioning	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
25 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 Reduced value
25 kV	Post Maintenance	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
25 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 Reduced value
25 kV	Post Repair	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
25 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7870 - 4.10: 2011 Clause 6.5 Reduced value

3.7.1.7. 33 kV PILC Cable

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
33 kV	Commissioning	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
33 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	DC	50 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7922: 2004 Clause 15.1, Table 15 Reduced value
33 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	VLF	36 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
33 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	VLF	50 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
33 kV	Post Maintenance	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
33 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	DC	50 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7922: 2004 Clause 15.1, Table 15 Reduced value
33 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	VLF	36 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
33 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	VLF	50 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
33 kV	Post Repair	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
33 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	DC	50 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7922: 2004 Clause 15.1, Table 15 Reduced value
33 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	VLF	36 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
33 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	VLF	50 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value

3.7.1.8. 66 kV PILC Cable

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Commissioning	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
66 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	DC	100 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7922: 2004 Clause 15.1, Table 15 Reduced value
66 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	VLF	66 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
66 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	VLF	94 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	AC PF	72 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	Company Requirement
66 kV	Post Maintenance	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
66 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	DC	100 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7922: 2004 Clause 15.1, Table 15 Reduced value
66 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	VLF	66 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	VLF	94 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
66 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	AC PF	72 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	Company Requirement
66 kV	Post Repair	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
66 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	DC	100 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7922: 2004 Clause 15.1, Table 15 Reduced value

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	VLF	66 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
66 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	VLF	94 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
66 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	AC PF	72 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	Company Requirement

3.7.1.9. 132 kV PILC Cable

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
132 kV	Commissioning	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
132 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	DC	200 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7922: 2004 Clause 15.1, Table 15 Reduced value
132 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	VLF	141 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
132 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	VLF	200 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
132 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	AC PF	132 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	BS 7912: 2012 Clause 18.1.2
132 kV	Post Maintenance	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
132 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	DC	200 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7922: 2004 Clause 15.1, Table 15 Reduced value
132 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	VLF	141 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
132 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	VLF	200 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
132 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	AC PF	132 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	BS 7912: 2012 Clause 18.1.2
132 kV	Post Repair	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
132 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	DC	200 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 7922: 2004 Clause 15.1, Table 15 Reduced value

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
132 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	VLF	141 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
132 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	VLF	200 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
132 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	AC PF	132 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	BS 7912: 2012 Clause 18.1.2

3.7.2. Cross linked polyethylene (XLPE)

3.7.2.1. 3.3 kV XLPE Cable

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Commissioning	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
3.3 kV	Commissioning	OPM 2015 WE4.1.3	Overvoltage	DC	6 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6622: 2007 Clause C 7.1.3 80% of value
3.3 kV	Post Maintenance	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Post Maintenance	OPM 2015 WE4.1.3	Overvoltage	DC	6 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6622: 2007 Clause C 7.1.3 80% of value
3.3 kV	Post Repair	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Post Repair	OPM 2015 WE4.1.3	Overvoltage	DC	6 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6622: 2007 Clause C 7.1.3 80% of value

3.7.2.2. 6.6 kV XLPE Cable

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Commissioning	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
6.6 kV	Commissioning	OPM 2015 WE4.1.3	Overvoltage	DC	12 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 80% of value
6.6 kV	Post Maintenance	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Post Maintenance	OPM 2015 WE4.1.3	Overvoltage	DC	12 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 80% of value
6.6 kV	Post Repair	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Post Repair	OPM 2015 WE4.1.3	Overvoltage	DC	12 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 80% of value

3.7.2.3. 11 kV XLPE Cable

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11 kV	Commissioning	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
11 kV	Commissioning	OPM 2015 WE4.1.3	Overvoltage	DC	20 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 80% of value
11 kV	Post Maintenance	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11 kV	Post Maintenance	OPM 2015 WE4.1.3	Overvoltage	DC	20 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 80% of value
11 kV	Post Repair	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11 kV	Post Repair	OPM 2015 WE4.1.3	Overvoltage	DC	20 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 80% of value

3.7.2.4. 11 / 20 kV XLPE Cable

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11/20 kV	Commissioning	OPM 2015 WE4.1.2	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
11/20 kV	Commissioning	OPM 2015 WE4.1.2	Overvoltage	DC	28 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	Company Requirement
11/20 kV	Post Maintenance	OPM 2015 WE4.1.2	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11/20 kV	Post Maintenance	OPM 2015 WE4.1.2	Overvoltage	DC	28 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	Company Requirement
11/20 kV	Post Repair	OPM 2015 WE4.1.2	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11/20 kV	Post Repair	OPM 2015 WE4.1.2	Overvoltage	DC	28 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	Company Requirement

3.7.2.5. 20 kV XLPE Cable

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Commissioning	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
20 kV	Commissioning	OPM 2015 WE4.1.3	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 80% of value
20 kV	Post Maintenance	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Post Maintenance	OPM 2015 WE4.1.3	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 80% of value
20 kV	Post Repair	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Post Repair	OPM 2015 WE4.1.3	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 80% of value

3.7.2.6. 25 kV XLPE Cable

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
25 kV	Commissioning	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
25 kV	Commissioning	OPM 2015 WE4.1.3	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 Reduced value
25 kV	Post Maintenance	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
25 kV	Post Maintenance	OPM 2015 WE4.1.3	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 Reduced value
25 kV	Post Repair	OPM 2015 WE4.1.3	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
25 kV	Post Repair	OPM 2015 WE4.1.3	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 Reduced value

3.7.2.7. 33 kV XLPE Cable

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
33 kV	Commissioning	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
33 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	DC	50 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 Reduced value
33 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	VLF	36 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
33 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	VLF	50 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
33 kV	Post Maintenance	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
33 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	DC	50 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 Reduced value
33 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	VLF	36 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
33 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	VLF	50 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
33 kV	Post Repair	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
33 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	DC	50 kV peak	15 min	Test voltage applied to each individual phase for test duration with other phases connected to earth. Alternatively test voltage applied to two phases with the third phase connected to earth for 7.5 mins, changing connections between tests so each phase is subjected to test voltage for 15 min duration.	No breakdown	BS 6626: 2007 Clause C 7.1.3 Reduced value
33 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	VLF	36 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
33 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	VLF	50 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value

3.7.2.8. 66 kV XLPE Cable

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Commissioning	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
66 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	VLF	66 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
66 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	VLF	94 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
66 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	AC PF	72 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	BS 7912: 2012 Clause 18.1.2 Table 11
66 kV	Post Maintenance	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	VLF	66 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
66 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	VLF	94 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
66 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	AC PF	72 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	BS 7912: 2012 Clause 18.1.2 Table 11
66 kV	Post Repair	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
66 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	VLF	66 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	VLF	94 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
66 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	AC PF	72 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	BS 7912: 2012 Clause 18.1.2 Table 11

3.7.2.9. 132 kV XLPE Cable

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
132 kV	Commissioning	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
132 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	VLF	141 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
132 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	VLF	200 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
132 kV	Commissioning	OPM 2015 WE4.1	Overvoltage	AC PF	132 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	BS 7912: 2012 Clause 18.1.2 Table 11
132 kV	Post Maintenance	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
132 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	VLF	141 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
132 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	VLF	200 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
132 kV	Post Maintenance	OPM 2015 WE4.1	Overvoltage	AC PF	132 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	BS 7912: 2012 Clause 18.1.2 Table 11
132 kV	Post Repair	OPM 2015 WE4.1	IR	DC	5 kV peak	1 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	> 500 MΩ ph-E > 1 GΩ ph-ph	Company Requirement
132 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	VLF	141 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
132 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	VLF	200 kV peak	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	IEEE 400.2 Reduced value
132 kV	Post Repair	OPM 2015 WE4.1	Overvoltage	AC PF	132 kV rms	60 min	Test voltage applied to each individual phase for test duration with other phases connected to earth.	No breakdown	BS 7912: 2012 Clause 18.1.2 Table 11

3.8. Switchgear

3.8.1. Isolatable

3.8.1.1. 3.3 kV Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
3.3 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	6 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
3.3 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	5 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
3.3 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	6 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
3.3 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	5 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
3.3 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
3.3 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	6 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
3.3 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	5 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.1.3. 6.6 kV Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
6.6 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	12 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
6.6 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	10 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
6.6 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
6.6 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	12 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	10 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
6.6 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
6.6 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	12 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
6.6 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	10 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.1.4. 11 kV Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
11 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	20 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
11 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	16 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
11 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
11 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	20 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
11 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	16 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
11 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	20 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
11 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	16 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.1.5. 20 kV Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
20 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	37 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
20 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
20 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
20 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	37 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
20 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
20 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	37 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
20 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.1.6. 25 kV Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
25 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
25 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	37 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
25 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
25 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
25 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	37 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
25 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
25 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
25 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	37 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
25 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.1.7. 33 kV Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
33 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
33 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	50 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
33 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	50 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
33 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
33 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	50 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
33 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	50 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
33 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
33 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	50 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
33 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	50 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.1.8. 66 kV Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
66 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	100 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
66 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	85 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
66 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
66 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	100 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	85 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
66 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
66 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	100 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
66 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	85 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.1.9. 132 kV Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
132 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
132 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	200 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
132 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	150 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
132 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
132 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	200 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
132 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	150 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
132 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 2 GΩ ph-E > 4 GΩ ph-ph or > 1 GΩ all in	BS 6626: 2010 Clause 24.2 Table 1
132 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	200 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
132 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	150 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.2. Non-Isolatable

3.8.2.1. 3.3 kV Non-Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
3.3 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	6 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
3.3 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	5 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
3.3 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
3.3 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	6 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	5 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
3.3 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
3.3 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	6 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
3.3 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	5 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.2.2. 6.6 kV Non-Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
6.6 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	12 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
6.6 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	10 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
6.6 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
6.6 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	12 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	10 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
6.6 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
6.6 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	12 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
6.6 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	10 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.2.3. 11 kV Non-Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	
11 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
11 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	20 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
11 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	16 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
11 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
11 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	20 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	
11 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	16 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
11 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
11 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	20 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
11 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	16 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.2.4. 20 kV Non-Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
20 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	37 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
20 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
20 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
20 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	37 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
20 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
20 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	37 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
20 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.2.5. 25 kV Non-Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
25 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
25 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	37 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
25 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
25 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
25 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	37 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
25 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
25 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
25 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	37 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
25 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.2.6. 33 kV Non-Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
33 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
33 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	50 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
33 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	50 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
33 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
33 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	50 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
33 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	50 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
33 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
33 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	50 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
33 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	50 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.2.7. 66 kV Non-Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
66 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	100 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
66 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	85 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
66 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
66 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	100 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	85 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
66 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
66 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	100 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
66 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	85 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.8.2.8. 132 kV Non-Isolatable Switchgear

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
132 kV	Commissioning	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
132 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	DC	200 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
132 kV	Commissioning	OPS 2015 WE4.2	Overvoltage	AC PF	150 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
132 kV	Post Maintenance	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
132 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	DC	200 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
132 kV	Post Maintenance	OPS 2015 WE4.2	Overvoltage	AC PF	150 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11
132 kV	Post Repair	OPS 2015 WE4.2	IR	DC	5 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	> 500 MΩ ph-E > 1 GΩ ph-ph or > 150 MΩ all in	BS 6626: 2010 Clause 24.2 Table 1
132 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	DC	200 kV peak	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	Company Requirement
132 kV	Post Repair	OPS 2015 WE4.2	Overvoltage	AC PF	150 kV rms	1 min	Test voltage applied between each phase and earth, between phases and across open contacts.	No breakdown	BS EN 62271-1: 2008 Clause 6.2.11

3.9. Transformers

3.9.1. Ground mounted transformers

3.9.1.1. 3.3 kV Ground Mounted Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	DC	6 kV peak	15 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	Company Requirement
3.3 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	AC PF	5 kV rms	1 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	BS EN 60076-3: 2013 Clause 8 Reduced value
3.3 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	DC	6 kV peak	15 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	AC PF	5 kV rms	1 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	BS EN 60076-3: 2013 Clause 8 Reduced value
3.3 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	DC	6 kV peak	15 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	Company Requirement
3.3 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	AC PF	5 kV rms	1 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	BS EN 60076-3: 2013 Clause 8 Reduced value

3.9.1.2. 6.6 kV Ground Mounted Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	DC	12 kV peak	15 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	Company Requirement
6.6 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	AC PF	10 kV rms	1 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	BS EN 60076-3: 2013 Clause 8 Reduced value
6.6 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	DC	12 kV peak	15 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	AC PF	10 kV rms	1 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	BS EN 60076-3: 2013 Clause 8 Reduced value
6.6 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	DC	12 kV peak	15 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	Company Requirement
6.6 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	AC PF	10 kV rms	1 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	BS EN 60076-3: 2013 Clause 8 Reduced value

3.9.1.3. 11 kV Ground Mounted Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	DC	20 kV peak	15 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	Company Requirement
11 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	AC PF	16 kV rms	1 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	BS EN 60076-3: 2013 Clause 8 Reduced value
11 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	DC	20 kV peak	15 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	AC PF	16 kV rms	1 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	BS EN 60076-3: 2013 Clause 8 Reduced value
11 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	DC	20 kV peak	15 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	Company Requirement
11 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	AC PF	16 kV rms	1 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	BS EN 60076-3: 2013 Clause 8 Reduced value

3.9.1.4. 20 kV Ground Mounted Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	Company Requirement
20 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	BS EN 60076-3: 2013 Clause 8 Reduced value
20 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	Company Requirement

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	BS EN 60076-3: 2013 Clause 8 Reduced value
20 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	DC	37 kV peak	15 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	Company Requirement
20 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	AC PF	30 kV rms	1 min	Test voltage applied to windings and tested to earth with all other windings earthed. Where HV cables are connected, they shall be tested as one unit using the DC test voltage to earth.	No breakdown	BS EN 60076-3: 2013 Clause 8 Reduced value

3.9.1.5. 25 kV Ground Mounted Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
25 kV	Commissioning	OPS 2015 WE4.3.1	IR	DC	5 kV peak	1 min	Test voltage applied to windings and tested to earth with all other windings earthed.	> 150 MΩ	Company Requirement
25 kV	Post Maintenance	OPS 2015 WE4.3.1 OPS 2015 WE4.3.2	IR	DC	5 kV peak	1 min	Test voltage applied to windings and tested to earth with all other windings earthed.	> 150 MΩ	Company Requirement
25 kV	Post Repair	OPS 2015 WE4.3.1 OPS 2015 WE4.3.2	Diagnostic	AC PF	10 kV rms	N/A	Single phase excitation tests	Comparative	Company Requirement
25 kV	Post Repair	OPS 2015 WE4.3.1 OPS 2015 WE4.3.2	Diagnostic	DGA	N/A	N/A	Dissolved gas in oil.	Comparative	Company Requirement
25 kV	Post Repair	OPS 2015 WE4.3.1 OPS 2015 WE4.3.3	Diagnostic	FRA	N/A	N/A	Frequency response analysis.	Comparative	Company Requirement

3.9.1.6. 33 kV Ground Mounted Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
33 kV	Commissioning	OPS 2015 WE4.3.1	IR	DC	5 kV peak	1 min	Test voltage applied to windings and tested to earth with all other windings earthed.	> 150 MΩ	Company Requirement
33 kV	Post Maintenance	OPS 2015 WE4.3.1 OPS 2015 WE4.3.2	IR	DC	5 kV peak	1 min	Test voltage applied to windings and tested to earth with all other windings earthed.	> 150 MΩ	Company Requirement
33 kV	Post Repair	OPS 2015 WE4.3.1 OPS 2015 WE4.3.2	Diagnostic	AC PF	10 kV rms	N/A	Single phase excitation tests	Comparative	Company Requirement
33 kV	Post Repair	OPS 2015 WE4.3.1 OPS 2015 WE4.3.2	Diagnostic	DGA	N/A	N/A	Dissolved gas in oil.	Comparative	Company Requirement
33 kV	Post Repair	OPS 2015 WE4.3.1 OPS 2015 WE4.3.3	Diagnostic	FRA	N/A	N/A	Frequency response analysis.	Comparative	Company Requirement

3.9.1.7. 66 kV Ground Mounted Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Commissioning	OPS 2015 WE4.3.1	IR	DC	5 kV peak	1 min	Test voltage applied to windings and tested to earth with all other windings earthed.	> 150 MΩ	Company Requirement
66 kV	Post Maintenance	OPS 2015 WE4.3.1 OPS 2015 WE4.3.2	IR	DC	5 kV peak	1 min	Test voltage applied to windings and tested to earth with all other windings earthed.	> 150 MΩ	Company Requirement
66 kV	Post Repair	OPS 2015 WE4.3.1 OPS 2015 WE4.3.2	Diagnostic	AC PF	10 kV rms	N/A	Single phase excitation tests	Comparative	Company Requirement
66 kV	Post Repair	OPS 2015 WE4.3.1 OPS 2015 WE4.3.2	Diagnostic	DGA	N/A	N/A	Dissolved gas in oil.	Comparative	Company Requirement
66 kV	Post Repair	OPS 2015 WE4.3.1 OPS 2015 WE4.3.3	Diagnostic	FRA	N/A	N/A	Frequency response analysis.	Comparative	Company Requirement

3.9.1.8. 132 kV Ground Mounted Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	
132 kV	Commissioning	OPS 2015 WE4.3.1	IR	DC	5 kV peak	1 min	Test voltage applied to windings and tested to earth with all other windings earthed.	> 150 MΩ	Company Requirement
132 kV	Post Maintenance	OPS 2015 WE4.3.1 OPS 2015 WE4.3.2	IR	DC	5 kV peak	1 min	Test voltage applied to windings and tested to earth with all other windings earthed.	> 150 MΩ	Company Requirement
132 kV	Post Repair	OPS 2015 WE4.3.1 OPS 2015 WE4.3.2	Diagnostic	AC PF	10 kV rms	N/A	Single phase excitation tests	Comparative	Company Requirement
132 kV	Post Repair	OPS 2015 WE4.3.1 OPS 2015 WE4.3.2	Diagnostic	DGA	N/A	N/A	Dissolved gas in oil.	Comparative	Company Requirement
132 kV	Post Repair	OPS 2015 WE4.3.1 OPS 2015 WE4.3.3	Diagnostic	FRA	N/A	N/A	Frequency response analysis.	Comparative	Company Requirement

3.9.2. Instrument transformers

3.9.2.1. 3.3 kV Instrument Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
3.3 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	AC PF	2 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
3.3 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	AC PF	2 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
3.3 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	AC PF	2 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value

3.9.2.2. 6.6 kV Instrument Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
6.6 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	AC PF	3.8 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
6.6 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	AC PF	3.8 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
6.6 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	AC PF	3.8 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value

3.9.2.3. 11 kV Instrument Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
11 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	AC PF	6.4 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
11 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	AC PF	6.4 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
11 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	AC PF	6.4 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value

3.9.2.4. 20 kV Instrument Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
20 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	AC PF	11.5 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
20 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	AC PF	11.5 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
20 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	AC PF	11.5 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value

3.9.2.5. 25 kV Instrument Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
25 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	AC PF	14.4 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
25 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	AC PF	14.4 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
25 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	AC PF	14.4 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value

3.9.2.6. 33 kV Instrument Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
33 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	AC PF	19 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
33 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	AC PF	19 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
33 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	AC PF	19 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value

3.9.2.7. 66 kV Instrument Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
66 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	AC PF	38 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
66 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	AC PF	38 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
66 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	AC PF	38 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value

3.9.2.8. 132 kV Instrument Transformers

System Voltage	Test Cycle	NPg Reference	Test Class	Test Type	Test Voltage	Test Duration	Test Application	Pass/Fail Criteria	Justification of Values
132 kV	Commissioning	OPS 2015 WE4.3	Overvoltage	AC PF	76 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
132 kV	Post Maintenance	OPS 2015 WE4.3	Overvoltage	AC PF	76 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value
132 kV	Post Repair	OPS 2015 WE4.3	Overvoltage	AC PF	76 kV rms	1 min	Test voltage applied to high voltage winding with low voltage winding earthed. Low voltage winding tested to earth at 500 V DC.	No breakdown	BS EN 61869-1: 2009 Clause 7.3.1. Table 2 Reduced value

4. References

4.1. External Documentation

Reference	Title
IEC 60502-2: 2014	Power cables with extruded insulation and their accessories from 1 kV up to 30 kV.
BS EN 60060	High voltage test techniques.
BS EN 60076-3: 2013	Power transformers. Insulation levels, dielectric tests and external clearances in air.
BS EN 60076-18: 2012	Power transformers. Measurement of frequency response.
BS EN 61869-1:2009	Instrument transformers. General requirements.
BS EN 62271-1: 2008 + A1: 2011	High voltage switchgear and control gear. Common specifications.
BS 6622: 2007	Electric cables – Armoured cables with thermosetting insulation for rated voltages from 3.8/6/6 kV to 19/33 kV – Requirements and test methods.
BS 6626: 2010	Maintenance of electrical switchgear and control gear for voltages above 1 kV and up to and including 36 kV. Code of practice.
BS 7870 – 4.10: 2011	LV and MV polymeric insulated cables for use by distribution and generation utilities. Specification for distribution cables with extruded insulation of rated voltages of 11 kV to 33 kV. Single-core 11 kV to 33 kV cables.
BS 7912: 2012	Power cables with XLPE insulation and metal sheath, and their accessories, for rated voltages from 66 kV to 132 kV.
BS 7922: 2004	
IEEE 400.2-2013	Guide for field testing of shielded power cable systems using VLF.

4.2. Internal documentation

Reference	Title
OPM 2015	Northern Powergrid Operation Practice Manual 2015

4.3. Amendments from Previous Version

Reference	Title
None	

5. Definitions

Reference	Title
IR	Insulation resistance
OV	Overvoltage
AC	Alternating current
DC	Direct current
VLF	Very low frequency
FRA	Frequency response analysis
SFRA	Sweep frequency response analysis
PILC	Paper insulated lead covered
XLPE	Cross linked polyethylene
DGA	Dissolved gas analysis
CT	Current transformer
VT	Voltage transformer
HV	High voltage (> 1000 V)
LV	Low Voltage (< 1000 V)
OPM	Northern Powergrid Operation Practice Manual 2015
The Company	Northern Powergrid
Designated Engineer	The Person appointed by The Company to be responsible for the application of these Safety Rules. *(Definition D.3 in Northern Powergrid Distribution Safety Rules 2015)*
NPS	Network Product Specification *Northern Powergrid's technical specifications for network assets.*

6. Authority for issue

6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		Sign	Date
Sarah Phillips	CDS Administrator	Sarah Phillips	03/02/16

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

Review Period - This document should be reviewed within the following time period.

Standard CDS review of 3 years	Non Standard Review Period & Reason	
Yes	Period:	Reason:

		Sign	Date
Iain Ross	Threepwood Consulting	N/A	03/02/16
David Blackledge	Senior Policy and Standards Engineer	David Blackledge	

6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

		Sign	Date
Ged Hammel	Senior Policy and Standards Engineer	Ged Hammel	03/02/16

6.4. Approval NOTE: Section 6.4 is not mandatory

Approval is granted for publication of this document.

		Sign	Date
Chris Holdsworth	Policy & Standards Manager	Chris Holdsworth	03/02/16

6.5. Authorisation

Authorisation is granted for publication of this document.

		Sign	Date
Mark Nicholson	Head of System Strategy	Mark Nicholson	09/02/16

Appendix 1 – Testing Forms

A.1 Non-isolatable Switchgear

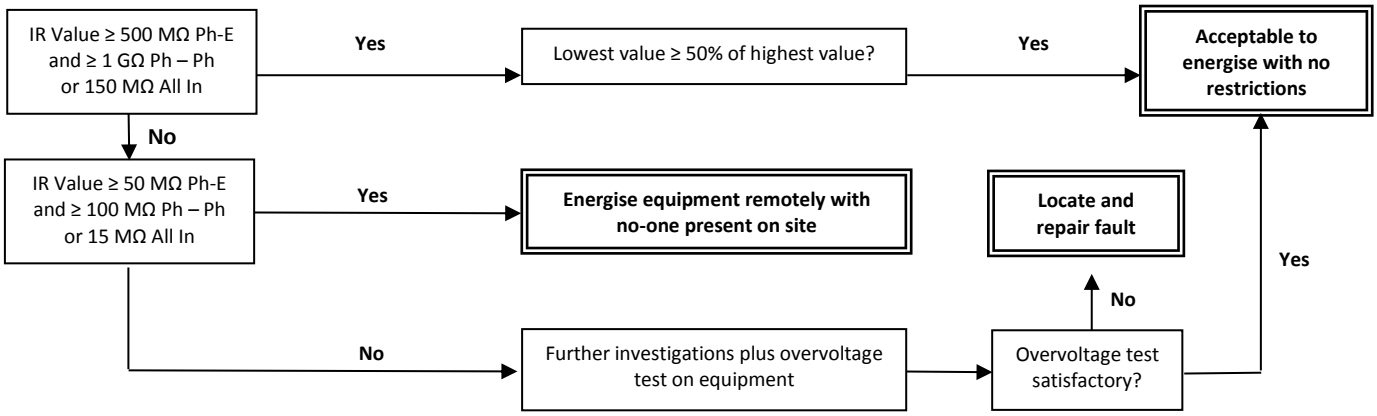
A.2 Isolatable Switchgear

A.1 HV Equipment Test Sheet (Non-Isolatable)

Substation:		Voltage (kV):			
Manufacturer/ Type:		I/D or O/D			
Weather:		Temp:		Humidity:	

Test Voltage / Duration: 5kV for 1 Min
Indicate if readings are kΩ, GΩ or MΩ

Non-Isolatable Equipment



Phase	Feeder Route Excluding Txs	Transformer Loop	Feeder Route Including Txs
L1 – E			
L2 – E			
L3 – E			
L1 – L2			
L1 – L3			
L2 – L3			
All In			

Where the equipment is connected to an Overhead Line (which would not normally be tested), sufficient testing is required to prove as much of the maintained equipment as practicable

For Pole Mounted equipment the following values are acceptable;

Switchgear	
Phase - Earth	100 MΩ
Phase - Phase	200 MΩ
Transformer	
All In	50 MΩ

For values below these, engineering judgment will be exercised taking into account environmental

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Overvoltage Testing

Description	Phases	Voltage	AC/DC/ VLF	Duration	Leakage

Details of Testing

Test Equipment	Serial #	Calibration Due

Signature of Tester:

Date:

A.2 HV Equipment Test Sheet (Isolatable)

Substation:		Voltage (kV):			
Manufacturer/ Type:		I/D or O/D			
Weather:		Temp:		Humidity:	

Test Voltage / Duration: 5kV for 1 Min
Indicate if readings are kΩ GΩ or MΩ

Isolatable Equipment

IR Value ≥ 2 GΩ Ph-E and ≥ 4 GΩ Ph – Ph or 1 GΩ All In for Transformer or VT

No → Where practicable, change unit. If not practicable, overvoltage test and recommission with further investigation as soon as possible

Yes → Acceptable to recommission with no restrictions

Circuit Name					**Switch Position**	**Transformer / VT**	
Serial #						**HV**	**LV**
L1 – E							
L2 – E							
L3 – E							
L1 – L2					**Closed**		
L1 – L3							
L2 – L3						**All In**	
Continuity ☑☑☑							
L1 – L1							
L2 – L2					**Open**		
L3 – L3							

Overvoltage Testing

Description	Phases	Voltage	AC/DC/ VLF	Duration	Leakage

Details of Testing

Test Equipment	Serial #	Calibration Due

Signature of Tester:	Date:

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