

**1. SCOPE**

This document is a general Specification applicable to all oil filled transformers and reactors for connection to the Company network and operated and maintained by other operators. The requirements of this specification are supplementary to the system parameters given in SPTS1.

**2. ISSUE RECORD**

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**3. ISSUE AUTHORITY**

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**4. REVIEW**

This document will be reviewed as and when required.

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## **6. INTRODUCTION**

This document is a Level 2 Specification defining the performance requirements for Transformers to be connected to the Company System. All testing and certification should be conducted in accordance with the relevant IEC standards, unless explicitly specified otherwise. Deviations from the requirements listed here will only be acceptable if Approved by the Company, and it can be shown that no extra risk is posed to the Company network.

## **7. REFERENCES**

This specification makes reference to and should be read in conjunction with the latest edition of the following documents:

### **7.1 International Standards**

IEC 60076	Power Transformers (all relevant parts)
IEC 60214	On-Load Tap Changers
IEC 60289	Reactors
IEC 60050	International Electrotechnical Vocabulary
IEC 60296	Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchgear
IEC 60137	Insulated bushings for alternating voltages above 1000V
IEC 60270	Partial Discharge Measurements

### **7.2 Company Documentation**

SPTS1	Ratings and General Requirements for Plant, Equipment and Apparatus for The ScottishPower System and Connection Points to it.
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## **8. DEFINITIONS**

The terms used in this document are defined in IEC 60050 or as below.

### **Apparatus**

Physical components of, or associated with, the Company system which are required in support of the plant and Equipment. Examples are substation structures, auxiliary plant and portable test Equipment.

### **Company**

Refers to SP Transmission Ltd, SP Distribution Ltd, and SP Manweb plc including all associated design and planning practices.

### **Equipment**

Secondary (LV) elements of the Company System such as those for control, measurements, protection and auxiliary supplies.

### **Plant**

Primary (HV) elements of the company system such as the circuit breakers, transformers, overhead lines and cables.

### **PowerSystems**

SP Power Systems Ltd. Operator of the network on behalf of the Company.

### **SP Distribution Ltd.**

The distribution Licence Holder for the Distribution service area formerly known as Scottish Power.

### **SP Manweb Plc**

The distribution Licence Holder for the Distribution service area formerly known as MANWEB (Mersey And North Wales Electricity Board).

### **SP Transmission Ltd.**

The distribution Licence Holder for the Transmission service area formerly known as Scottish Power.

## **9. GENERAL REQUIREMENTS**

### **9.1 Overall Requirements**

All transformers shall comply with IEC 60076 (all relevant parts).

The projected lifespan of all transformers shall not be less than 40 years.

The connector shall make the Company aware of the maintenance requirements and procedures that are required with any transformer that is to be connected to the Company System.

Suitable provision shall be made to allow condition monitoring, diagnostic testing and on site tests to be facilitated.

### **9.2 Oil**

Mineral insulating oil shall be tested in accordance with IEC 60296, and shall be uninhibited and of a pure naphthenic base.

### **9.3 Tap Changers**

Where tap changers are fitted they shall be tested in accordance with all relevant parts of IEC 60214

### **9.4 Operating Mechanisms, Ancillary Equipment and their Enclosures**

The local control and monitoring apparatus shall be accommodated at the transformer that it controls (this is termed the LCC, or Local Control Cubicle). Such accommodation shall be clearly labelled to indicate the apparatus it contains and the transformer controlled.

The LCC shall be located at ground (floor/fixed access) level.

Indication of the operational position of the apparatus being controlled (such as tap changers) shall be unambiguous and clearly visible from ground (floor/fixed access) level.

### 9.5 Bushings

High Voltage (HV) bushings shall be tested in accordance with IEC 60137. All HV bushings shall have a minimum pollution rating of class III as defined in IEC 60137. Where the intended installation location has a particularly adverse environment, then higher creepages shall be specified.

### 9.6 Current Transformer Test Loops

A CT Primary test loop of an Approved type shall be made available on the Transformer intended for connection, to allow the Company to verify protection configurations in order to ensure that the Company can verify any integrated protection schemes operate as intended.

## 10. TEST REQUIREMENTS FOR TRANSFORMERS

### 10.1 General

Tests shall be carried out in accordance with all relevant sections of IEC 60076, except for those additional tests listed below.

Table 1 below lists the Test Voltages that shall be used.

<b>Rated Voltage Between Phases (kV)</b>	<b>400</b>	<b>275</b>	<b>132</b>	<b>33</b>	<b>11</b>
Minimum Lightning Impulse Voltage withstand (Full Wave)	As Specified in SPTS1				
Minimum Induced Overvoltage Withstand (kV rms)	630	460	230	66	22
Minimum Applied Voltage Withstand (kV rms)	38	38	38	70	38
Minimum Switching Impulse withstand (kVp)	As Specified in SPTS1				

Table 1: Test Voltages

## **10.2 Additional Test Requirements**

### **10.2.1 Sound Power Level**

Transformer Noise shall be specified in terms of sound power level in accordance with IEC 60076-10.

### **10.2.2 Magnetic Circuit Insulation**

Transformer core and frame to earth insulation shall be capable of withstanding:

- a) 16kV for 1 minute under oil, or
- b) 6kV for 1 minute in air

### **10.2.3 Induced Overvoltage**

Induced overvoltage tests shall be carried out in accordance with the requirements for the ACSD test of IEC 60076-3 at the levels specified in table 1 appropriate to the highest voltage winding. A three phase test is not required if the test configuration for the single phase tests is in accordance with IEC 60076-3 figure 3. Partial discharge measurements according to IEC 60076-3 are specified in clause 10.2.4.

The induced overvoltage tests shall be arranged so that in addition to the requirements of IEC 60076, the voltage appearing between all terminals, windings, sections and turns of windings and connections of the phase under test is at least twice normal working voltage for any tapping position.

### **10.2.4 Partial Discharge Measurement**

Partial discharge measurements shall be made at the HV and LV line terminals of each phase of the transformer during the induced overvoltage routine test using an instrument complying with the requirements of IEC 60270 using a wide bandwidth measurement.

The test circuit and method of calibration shall be to the requirements of IEC 60076, Appendix A.

Measurements of partial discharge shall be made at 1.2 pu and 1.6 pu of rated phase to earth voltage, during periods of increasing and decreasing the test voltage and at the full overpotential test voltage. The partial discharge measurement at the 1.2 pu voltage levels shall not exceed 200 pico-coulombs (pC). These measurements shall not be corrected for background level. The background level shall be measured immediately before and after the

induced overvoltage test with all apparatus and the circuit connected as for the test but with the transformer not energised. The background level so measured shall not exceed 50pC.

The intention of the partial discharge measurement is to demonstrate that the transformer or reactor is discharge free at system highest voltage. Any significant discharge determined to be coming from the unit under test at the 1.2 pu voltage level shall be investigated to the satisfaction of the Company.

#### 10.2.5 Switching Impulse Voltage Test

The switching impulse voltage test shall be carried out in accordance with IEC 60076 at the voltage level stated in SPTS1, appropriate to the highest voltage winding.

#### 10.2.6 Lightning Impulse Voltage

The lightning impulse voltage test shall be performed in accordance with IEC 60076 by direct application of the impulse voltage to each line terminal in turn. Where a tertiary winding is to be earthed at one corner in service it shall be earthed at one corner only during the HV and LV impulse tests. If the tertiary winding is designed to be capable of being brought out for loading then directly applied impulse tests are required on this winding unless otherwise agreed. The sweep times or sampling rate and record length of oscillographic records shall be to the approval of the PowerSystems Engineer witnessing the tests and shall be according to the relevant IEC standards.

The test sequence, at the voltage specified in SPTS1, shall be as follows:

1. Reduced Full wave application (between 50% and 75%)
2. 100% full wave application
3. 110% chopped wave applications (2 off)
4. 100% full wave application (2 off)
5. Reduced full wave application (between 50% and 75%)

For each voltage application, oscillographic records, which maybe digital, shall be taken of the applied voltage and of the current at the neutral end of the winding under test or, for a delta connected winding, at the two terminals not under test. If the recording method is analogue, at least two current records shall be taken. All records shall be of a standard acceptable to the Company Engineer witnessing the tests.





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There shall be no evidence of complete or incipient failure as indicated by audible indications from within the transformer or by changes in the voltage and/or current records, apart from intended amplitude changes.