

## **GAS INSULATED TRANSMISSION LINE (GIL) SYSTEMS**

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### **PURPOSE AND SCOPE**

This document contains the National Grid specified site commissioning tests and checks to be performed on the installation of a gas insulated transmission line (GIL) system using GIL to TS 3.2.13 "Gas Insulated Transmission Line". The supplier is to specify any amendments or additional site commissioning tests and checks that are required.

### **PART 1 - REQUIREMENTS**

#### **1 GENERAL REQUIREMENTS**

On completion of the site commissioning tests and checks the forms contained in the schedules of this document shall be completed and handed over to the relevant National Grid Representative as specified in the contract.

Schedule A - Signature Sheet  
Schedule B - Document Schedule Hand Over Date Record  
Schedule C - General Data  
Schedule D - Gas Insulated Transmission Line (GIL) Ratings  
Schedule E - Calibrated Test Equipment  
Schedule F - Commissioning Tests  
Schedule G - Site Installation Checks

#### **2 SITE TEST REQUIREMENTS**

Following installation the following commissioning tests shall be made on the completed GIL system and recorded on the relevant forms in Schedule F or equivalent as agreed with National Grid:

- 2.1** Enclosure Gas Tests (Clause 2.1)
- Insulation Tests (Clause 2.2)
- GIL Parameter Tests (Clause 2.3)
- Tests on Corrosion Protection for Directly Buried GIL Systems (Clause 2.4)
- Earth Bonding Tests (Clause 2.5)
- Temperature Monitoring Fibre Tests (Clause 2.6)

Backfill Materials (Clause 2.7)  
Earth Electrode Resistance (Clause 2.8)

## 2.2 Enclosure Gas Tests

### 2.2.1 Pneumatic Pressure Test (Form F.1)

Prior to filling the enclosure with the insulating gas; a pneumatic pressure test shall be made on each gas zone using dried nitrogen. The test pressure shall be 1.1 times the GIL system rated design pressure. This pressure shall be maintained for at least 1 hour. No detectable leakage is permitted.

Provision shall be taken to ensure that any pressure relief device will not operate during the test.

### 2.2.2 Gas Tightness Test (Form F.2)

Leakage detection by using a sniffing device shall be used. The sensitivity of the sniffing device shall be at least  $10^{-8} \text{ Pa} \times \text{m}^3 \text{s}^{-1}$ .

### 2.2.3 Gas Moisture Content Test (Form F.3)

The moisture content of the insulating gas shall be determined for each gas zone once pressurised to the rated design pressure. In order to get a reliable measurement, the moisture content shall be checked at least 5 days after final filling of the gas. The moisture content shall be such that the dew point at 20°C, when measured at rated filling density, is not higher than -5°C. Adequate correction shall be made for measurements at other temperatures.

## 2.3 Insulation Tests

### 2.3.1 Insulation Voltage Withstand Test (Form F.4)

The GIL shall withstand a power frequency test voltage applied between the conductor and enclosure, with the enclosure earthed. The requirements of the test are summarised in Table 1. No breakdown of the insulation shall occur.

| System Voltage (kV) | Site Test Voltage (kV rms) | Frequency (Hz)  | Duration (min) |
|---------------------|----------------------------|-----------------|----------------|
| 132                 | 220                        | $50^{+15}_{-5}$ | 1.0            |
| 275                 | 368                        |                 |                |
| 400                 | 520                        |                 |                |

**Table 1 – Site Test Voltages for GIL**

### 2.3.2 Partial Discharge Test (Form F.5)

During the power frequency voltage test described in Clause 2.2.1, the GIL system shall be monitored for partial discharge using a method agreed with National Grid. The GIL system should be free from detectable partial discharge and any partial discharge should be brought to the attention of the National Grid commissioning engineer immediately and included in the site test report. Where other plant interferes with the partial discharge measurements this plant shall be, where practicable, removed or its influence otherwise eliminated.

*Note: In agreeing the partial discharge monitoring method National Grid will expect to be provided with evidence that shows that the method offers adequate sensitivity whilst not increasing the likelihood of GIL system faults.*

### 2.3.3 Dielectric Tests on Auxiliary and Control Circuits (Form F.6)

Auxiliary and control circuits shall be subjected to short-duration power-frequency voltage withstand tests. Each test shall be performed

- between the auxiliary and control circuits connected together as a whole and the GIL enclosure;

- b) if practicable, between each part of the auxiliary and control circuits, which in normal use may be insulated from other parts, and the other parts connected together and the GIL enclosure.

The test voltage shall be 1 kV with duration of 1 s.

The auxiliary and control circuits shall be considered to have passed the tests if no disruptive discharge occurs during each test.

## 2.4 GIL Parameter Tests

### 2.4.1 GIL Conductor Resistances (Form F.7)

The ambient temperature and DC conductor resistance of each completed circuit shall be measured to at least three significant figures.

### 2.4.2 Circuit Positive and Zero Sequence Impedances (AC GIL Only Form F.8)

Where the route length exceeds 400 m, the positive and zero sequence impedances shall be measured and allowance made for conductor temperature with the enclosure bonding and earthing connections as for normal circuit operation. For these measurements a three-phase current injection test set is required, preferably in the range 25-100 A. The measurement shall be carried out as follows:

#### a) Positive Sequence Impedance

If the three-phase supply star point can be isolated from earth the three single phase conductors shall be linked together and earthed at the end remote from the test. If the three-phase supply star point cannot be isolated from earth the three single-phase cores must be bonded together and left free of any earth at the end remote from the test. A current shall be injected into each conductor, the magnitude of which should be equalised so far as is possible. Measurement of current, voltage and either power or phase angle shall be made on each of the single conductors. From these arrangements, the following are calculated:

Using Wattmeter

$$Z_p = \frac{V_p}{I_p}$$

$$R_p = \frac{W_p}{I_p^2}$$

$$X_p = \sqrt{Z_p^2 - R_p^2}$$

Using Phase Angle Meter

$$Z_p = \frac{V_p}{I_p}$$

$$R_p = \left( \frac{V_p}{I_p} \right) \cdot \cos \theta$$

$$X_p = \left( \frac{V_p}{I_p} \right) \cdot \sin \theta$$

and

$$Z_1 = \frac{\sum Z_p}{3} \Omega/\text{phase} \quad R_1 = \frac{\sum R_p}{3} \Omega/\text{phase} \quad X_1 = \frac{\sum X_p}{3} \Omega/\text{phase}$$

Where  $V_p$  = Measured phase voltage (V)  
 $I_p$  = Measured phase current (A)  
 $W_p$  = Measured phase power (W)  
 $\theta$  = Measured phase angle (degrees)

#### b) Zero Sequence Impedance

For measurements of zero sequence impedances the three single phase conductors at the test end are linked together and at the remote end linked together and bonded to the GIL enclosure. Single-phase currents are injected into the conductors at the test end to return via the metallic enclosure. Measurements of current, voltage and either power or phase angle shall be made from which the following are calculated.