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**Substation Interlocking
Schemes**

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SUBSTATION INTERLOCKING SCHEMES

FOREWORD

This document defines the requirements for interlocking schemes in National Grid Company substations.

1 SCOPE

This functional Specification is applicable to interlocking for air (AIS) and gas (GIS) insulated switchgear at substations connected to the National Grid Company system and with equipment installed rated at 145, 300 or 420 kV.

2 REFERENCES

This document makes reference to or shall be read in conjunction with the documents listed below:

NGTS 1	Overview, National Grid System
NGTS 2.1	Substations
NGTS 3.2.2	Disconnectors and Earthing Switches
NGTS 2.7	Substation Control Systems
NGTS 2.13	Electronic Equipment
NGTS 3.15.1	Delayed Automatic Reclosure and Plant Isolation

3 GENERAL REQUIREMENTS

3.1 Common Requirements

3.1.1 Substations shall be provided with a full interlocking scheme to ensure that all disconnectors, fixed earthing switches (or other interlocked earthing devices) and, where required, circuit-breakers are operated in the correct sequence so that personnel do not endanger themselves and/or the integrity of the transmission system by incorrect or inadvertent operation of equipment. Where necessary, such interlocking shall also be extended to cover limitation of access to areas where there is a risk that normal safety clearances may be infringed.

3.1.2 Interlocking schemes shall cover the following conditions:-

- (i) Interlocking between circuit-breakers and disconnectors to ensure disconnectors do not make or break load currents.
- (ii) Interlocking between disconnectors and earthing switches to ensure that earthing switches cannot be closed on to a locally energised circuit and cannot be energised, when closed, by operation of disconnectors.
- (iii) Interlocking between disconnectors and adjacent earthing switches to permit operation of the disconnector when earthing switches are closed on both sides of the disconnector. Such interlocking is not required for equipment rated at 145 kV and below.
- (iv) Ensuring correct sequence of on load busbar transfer switching operations at multiple busbar substations.

(v) Ensuring that a bus-coupler or bus-section circuit-breaker is only closed with its associated disconnectors both open or both closed.

(vi) Ensuring access to areas of the substation where safety clearances may be infringed unless appropriate safety measures, such as isolation and earthing, have been taken.

3.1.3 The interlocking of switching sequences involving only power operated switchgear shall be by electrical means. The correct interlocking status shall be confirmed automatically on initiation of an operation from any control position or from auto-switching or sequential-isolation equipment.

3.1.4 The interlocking of switching sequences involving manually operated switchgear may be by electrical or mechanical means. The interlocking shall be designed such that the correct interlocking status must be confirmed immediately before an operation.

3.1.5 Interlocking systems shall, where practicable, be fail-safe. They shall not be defeatable without the use of tools, clip leads etc or a purpose designed override facility which shall be lockable with safety locks to the approval of NGC.

3.1.6 Partial interlocking of earthing switches at circuit-entries to the substation is acceptable where it is not reasonably practicable to extend the interlocking to the remote end disconnectors. Any partially interlocked earthing switch shall be provided with a warning label, to the approval of NGC, stating 'WARNING, THIS EARTH SWITCH IS NOT FULLY INTERLOCKED'.

3.1.7 Interlocking shall be effective for switching and operating sequences when they are being followed in either direction (for example; if an earthing switch must be closed before an access gate can be opened then the gate must be secured closed before the earthing switch can be opened).

3.1.8 Interlocking schemes shall, where reasonably practicable, provide the maximum operational flexibility and shall not unnecessarily impose fixed operating sequences.

3.1.9 Where an interlocking scheme is being supplied for an extension to an existing substation at the same operating voltage then, unless otherwise agreed by NGC, the interlocking type and philosophy shall match that existing.

In all cases, interlocking for a substation extension shall be fully interfaced with the existing interlocking scheme to achieve the functional requirements specified in this document.

3.1.10 Interlocking may, in certain circumstances, have to be by-passed by auto-reclose schemes. The requirements for these are specified in NGTS 3.15.1.

3.1.11 Proposed interlocking schemes shall be submitted to NGC for project approval.

3.2 Mechanical Interlocking

3.2.1 Mechanical interlocking shall, unless otherwise agreed by NGC, be by key operated systems.

3.2.2 Interlock keys shall be of a non-masterable design (i.e no master key can be supplied or manufactured). Differs shall not be repeated on the same substation site.

Note: Differ is the term for the difference in a key which prevents it being interchangeable with another.

3.2.3 Interlock keys shall be engraved with an identifying reference which shall be unique to that substation site. The identifier shall, where appropriate, include the system number of the switching device where the key is located during normal operation and shall be to the approval of NGC. Key locations shall be marked with the identifier of the required key.

3.2.4 Where key exchange boxes are provided they shall be located in convenient positions with regard to normal substation operating sequences.

3.2.5 Where mechanical key interlocking is fitted to disconnecter and earthing switch mechanisms the requirements specified in Clause 3.4 of NGTS 3.2.2 shall apply.

3.3 Electrical Interlocking

3.3.1 A facility shall be provided to allow the interlock system of each disconnecter or earthing switch to be defeated. This may take the form of a self-resetting switch or push-button to bypass electrical circuits or by another means agreed by NGC. The override facility shall meet the requirements of Clause 3.1.5 above.

3.3.2 Disconnecter and earthing switch mechanisms which form part of electrical interlocking schemes shall meet the requirements of Clause 3.5 of NGTS 3.2.2.

3.4 Microprocessor Based Electrical Interlocking

In addition to the requirements of Clause 3.3 above the following shall apply:

3.4.1 The system shall operate in accordance with the agreed logic table for the application. Any combination of inputs for which an output has not been specified shall give no output.

4 PERFORMANCE REQUIREMENTS

4.1 Mechanical and hard-wired electrical interlocking schemes shall operate satisfactorily under the full range of environmental conditions specified for the associated primary equipment.

4.2 Microprocessor based interlocking systems shall comply with the relevant performance requirements of NGTS 2.7 and 2.13.

5 TEST REQUIREMENTS

5.1 Type Tests

5.1.1 Microprocessor based interlocking systems shall be type tested in accordance with the relevant requirements of NGTS 2.7 and NGTS 2.13.

5.2 Routine Tests

5.1.1 Microprocessor based interlocking systems shall be routine tested in accordance with the relevant requirements of NGTS 2.7 and NGTS 2.13.

5.3 Site Pre-Commissioning Tests

5.3.1 Site pre-commissioning tests shall be carried out to demonstrate the correct and satisfactory operation of the interlocking scheme. The detailed test programme shall be agreed with NGC.

5.3.2 For microprocessor based interlocking schemes the Contractor shall test all combinations of inputs to demonstrate the correct operation of the logic or shall carry out a test programme agreed by NGC.

6 TECHNICAL DATA REQUIRED FOR APPROVAL

6.1 Microprocessor based interlocking systems shall be subject to NGC's Type Approval procedure as defined in NGTS 1.

To gain approval, the specified type tests shall be performed, or test reports submitted in lieu, to demonstrate that the relevant performance requirements are satisfied. Any test reports offered shall be of a standard acceptable to NGC.

Suppliers shall also demonstrate that the relevant general requirements of this document, NGTS 2.7 and NGTS 2.13 are met by the equipment offered.

6.2 Mechanical and hard-wired electrical interlocking schemes will not be subject to Type Approval. However, the requirements for implementation of these schemes will be assessed during Type Approval of disconnectors and earthing switches.