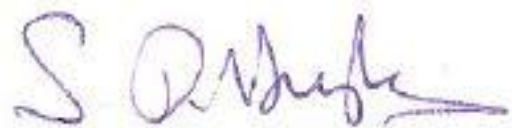


**Construction
Design Handbook**

**GUIDANCE ON APPLICATION
OF OPERATIONAL TRIPPING SCHEMES**

DH 23

Issue 2



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Technical Assurance Manager

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GUIDANCE ON APPLICATION OF OPERATIONAL TRIPPING SCHEMES

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1 PURPOSE AND SCOPE

The purpose of this Design Handbook is to provide application design guidance for Operational Tripping Schemes (OTS). The document is intended to be used to supplement the technical requirements which are detailed in National Grid Technical Specifications.

2 BACKGROUND

Operational Tripping Schemes (OTS) are used to reduce Transmission Constraint costs; the need for an OTS may be identified at the offer stage of a new Generation Connection or as a result of evolving Power System problems.

In the case of new connections, the Scheme Sponsor within ETAM System Design in conjunction with Customer Accounts Manager in Commercial, will identify the general requirements which will be incorporated into the Technical Appendices (F3) of the Supplemental Agreement.

In the case of evolving system conditions, ETAM System Design will identify the general requirements for an OTS.

In both cases, a System Design Specification will be produced by ETAM identifying the scheme requirements, this being supported by a Functional Requirements Specification (FRS) produced by the Control Support and Review team in Market Operation setting out its operational requirements.

3 DOCUMENTATION

The current specification for operational tripping systems is NGTS 3.24.64. However, the previous CEGB transmission plant specification covering operational tripping systems, TPS 5/31, is archived but still accessible on the National Grid intranet and provides useful background information on acceptable scheme architecture arrangements. It is available to external parties on request, either to National Grid Technical Assurance or National Grid document control via *.box.transmission.documentcontrol*.

4 POWER SYSTEM NEEDS

An OTS has traditionally been required to monitor the status of selected circuits and to initiate the tripping of generation to avoid instability or to alleviate thermal overloading.

The early installations were generally local schemes where monitoring of circuits at both local and remote ends resulted in tripping of generation local to the Logic Devices. More recently OTSs have become regional, a centrally located Logic Device monitoring selected circuits within an area and controlling the tripping of generation across a number of sites. Signalling then becomes a two-way, monitoring and tripping, requirement. Further OTS developments have included the controlled de-loading of generation and performing power flow control actions on DC links.

The number of monitoring sub-systems and the number of signalling systems will be determined by the system condition(s) which the OTS is designed to cater for.

As inadvertent scheme operation is likely to result in unwanted generator tripping/de-loading, special provisions were built in to OTS technical specifications to ensure that acceptable levels of security were achieved:

- Plant status monitoring is achieved via the use of complimentary double point logic inputs. These utilise both states of monitored contacts as independent inputs, the scheme logic requiring validation of both these inputs in any trip decision.
- Protection status monitoring is achieved via the use of double pole switching of logic inputs. The scheme logic input requiring both +ve and –ve dc legs to be switched per protection status monitored.

The necessary levels of dependability are achieved through appropriate duplication of monitoring equipments, signalling systems, logic circuitry and trip outputs. In general, a single failure of any system shall not cause non-operation of the OTS. Where duplicate systems are provided they shall, as far as possible, be fully independent of each other.

Early OTS schemes built in accordance with TPS 5/31 could either use electro-mechanical relays to carry out the scheme logic (Seabank OTS is a useful example) or microprocessors (Heysham OTS is a useful example). More recent OTS schemes built in accordance with TS 3.24.64 utilise substation automation units for scheme logic and either dedicated intertrip equipment or variations of numerical protection equipments for signalling (Sellindge OTS is a useful example).

5 OVERALL ARCHITECTURE

Appendix 2 shows an overview of a typical operational tripping scheme. The OTS comprises a number of elements as follows.

- (i) Plant status monitoring
- (ii) Signalling (Intertrip) systems
- (iii) Logic Devices

5.1 Plant Status Monitoring.

Circuit status may be monitored by switchgear status, protection operation or analogue quantities. Switchgear status monitoring should be via double point monitoring of circuit breakers and/or disconnectors.

5.1.1 Switchgear Status

Switchgear status shall be monitored at each substation using plant auxiliary contacts to establish the status of each circuit. Complementary double point contacts (i.e. open / closed) shall be used to validate status information used by the OTS software.

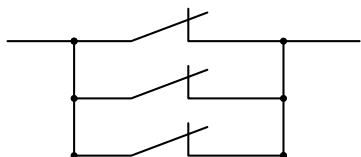
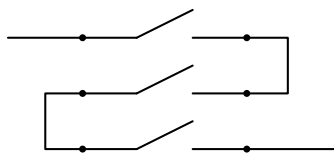
Where, due to a shortage of auxiliary contacts, follower schemes have been implemented, contacts from the follower relays must not be used as OTS scheme inputs. This may require

the migration of non-essential signals to the follower scheme to free up directly driven auxiliary contacts for OTS use.

Maintenance override facilities are required for operational reasons at mesh substations and on banked circuit connections (this includes three ended circuits) where a monitored circuit breaker could be out of service but closed. Such a condition could result in the failure of the OTS to operate correctly when required. The maintenance override facility is then used to force the circuit breaker status to OPEN. Site facilities should be clearly labelled with the override being switched IN whenever it is necessary to force the circuit breaker status to OPEN. The provision of an override facility on all monitored plant is not necessary but is acceptable if there is benefit in providing standard 'racks'. The override facility should be provided with a secure means of preventing unwanted operation.

5.1.1.1 Circuit-Breaker status monitoring

On circuit breakers fitted with individual mechanisms where contacts of each phase are made available, then all three contacts shall be monitored. The required contact arrangements are given in the table below:

Monitored contact group	All three Primary Contacts Closed state	Transition	Any one phase open state
	Logic input state = 0	Any one phase opening	Logic input state = 1
	Logic input state = 1	Any one phase opening	Logic input state = 0

The above contact arrangements ensure correct scheme operation for Circuit Breaker closed to open transitions.

5.1.1.2 Circuit Configuration Requirements

For Double Busbar connected circuit ends, Circuit Breaker status will provide adequate monitoring for both transient and persistent faults in most cases. However, for three-ended circuits connected to double busbar substations, provision of either line isolator monitoring or a maintenance override facility will be required to ensure correct scheme operation when circuit-breaker maintenance is carried out with the other circuit ends in service.

For Mesh connected circuit ends both mesh circuit breakers should be monitored and their status combined in a 'two out of two' logic sub-rack. As mesh circuit breakers will reclose for a persistent fault, it is also necessary to monitor the line disconnector status and, where provided, mesh splitting disconnector' status so that an operational trip signal can be

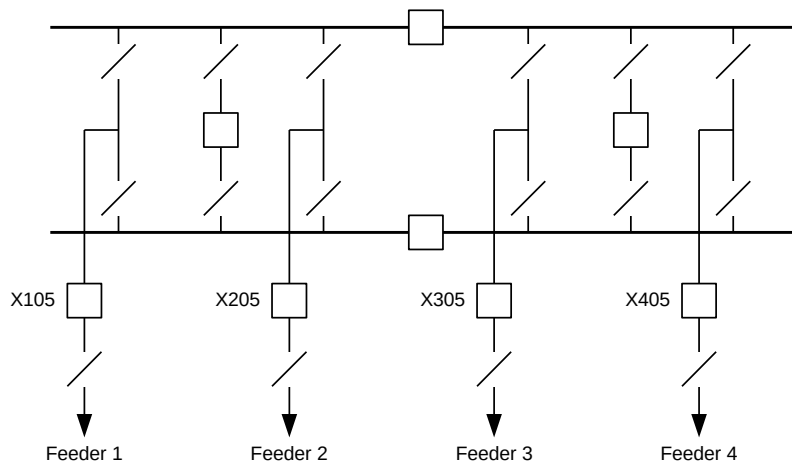
sustained for a persistent line fault. At Mesh substations it is also necessary to provide a maintenance override facility for each monitored circuit breaker so that the OTS can be made to operate correctly when one mesh breaker is out of service (e.g. as a result of an outage of the corner adjacent to the monitored circuit. This 'normal/override' switch can then be selected to override for an out of service breaker such that the 'two out of two' logic is maintained and an output is assured when the in-service breaker alone trips.

At Single Switch substations it is frequently necessary to distinguish between the two circuits which terminate there. In these circumstances, the Bus Section switch alone cannot be monitored, as its opening does not permit discriminative monitoring of the two circuits. In such circumstances in addition to monitoring of the Bus Section switch, it is essential to monitor the status of the two line disconnectors (to permit detection of persistent line faults and protection operations). In addition, maintenance override facilities on the Bus Section switch shall be provided.

At Double Busbar substations, the monitoring of Bus Section and Bus Coupler circuits may occasionally be requested.

5.1.1.3 Typical switchgear monitoring for each substation type

Double Busbar Substation -



Double busbar Line End Open (LEO) logic is as follows:

- Feeder 1 LEO = X105 Open
- Feeder 2 LEO = X205 Open
- Feeder 3 LEO = X305 Open
- Feeder 4 LEO = X405 Open

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