Electricity Distribution

nationalgrid

Company Directive

STANDARD TECHNIQUE: TP1B

Loss of Mains Intertripping for ER G99 and G59 Compliance

Summary
This directive contains requirements for intertripping schemes that are used to meet the requirements of Engineering Recommendations G99 and G59 for loss of mains protection.

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Implementation Date: **August 2022**

Approved by

Carl Ketley-Lowe
Engineering Policy Manager

Date: **16th August 2022**

Target Staff Group	**Staff responsible for the design, recording, commissioning, maintenance and sufficiency assessment of Loss-of-Mains intertripping schemes.**
Impact of Change	**Amber – the changes affect the design and maintenance of National Grid Electricity Distribution' s networks**
Planned Assurance checks	**Author to review ongoing and issued design work for a selection of schemes 6 months after issue.**

IMPLEMENTATION PLAN

Introduction

This directive contains requirements for intertripping schemes that are used to meet the requirements of Engineering Recommendations G99 and G59 for loss of mains protection.

Main Changes

This is a new directive, implementing the existing requirements of Engineering Recommendations G99 and G59.

Impact of Changes

Target Staff Group	**Staff responsible for the design, recording, commissioning, maintenance and sufficiency assessment of Loss-of-Mains intertripping schemes.**
Impact of Change	**Amber – the changes affect the design, commissioning and maintenance of certain components of National Grid Electricity Distribution' s networks**

Implementation Actions

Managers responsible for members of the Target Staff Group shall ensure that their staff are aware of the requirements of this new directive.

A briefing presentation is available <here>

Implementation Timetable

Design requirements shall be applied to new schemes from the date of issue. Where design work for a scheme has already begun, the requirements shall be applied in so far as is reasonably practicable.

Commissioning and maintenance requirements shall be applied from the date of issue.

REVISION HISTORY

Document Revision & Review Table		
Date	**Comments**	**Author**
August 2022	• Initial issue of ST:TP1B	Stephen Quinn

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1.0 INTRODUCTION

ER G99 normally requires Loss of Mains (LoM) protection for Power Generating Modules operating in long-term parallel mode.

LoM protection is used to detect the loss of incoming supply to generation from the wider network. It disconnects the generation from the distribution network to prevent an island from forming. This ensures that:

- ESQCR requirements for neutral earthing of distribution networks are met;
- ESQCR requirements for voltage and frequency of supplies to customers are met;
- Circuit breakers are not subjected to out-of-synchronism closure, which could damage the DNO's equipment or the generator's equipment; and
- ESQCR requirements for fault clearance are met where these will not be met by other protection.

In some circumstances LoM protection relying upon local measurements (e.g. rate of change of frequency) is not appropriate, so intertripping is required by ER G99.

Note: As of ER G99 Issue 1 Amendment 8, LoM intertripping is required for Power Generating Facilities with a Registered Capacity exceeding 50MW, and is expected for Type D Power Generating Modules. A Power Generating Module is classified as Type D Power Generating Module if its Connection Point Voltage is at or above 110kV or its Registered Capacity is 50MW or greater. LoM intertripping may also be used in other circumstances where rate of change of frequency protection is not appropriate.

This intertripping is required to detect credible fault outages on the DNO or upstream network that could result in an island forming, by monitoring of switchgear statuses and/or protection trip signals. In the event of such an outage, a signal is sent to the Power Generating Facility, causing circuit breaker(s) to open to disconnect the Power Generating Module(s) from the distribution network.

2.0 DEFINITIONS

2.1 Selection Control

A scheme input which can, as part of a switching schedule, be selected to one of two positions to modifying the scheme behaviour. A typical Selection Control will mimic the statuses of disconnectors in a bay, and be selectable between:

1. **Normal**, indicating that all series disconnectors and (where present) at least one busbar selector disconnector are closed; and

2. **Outage**, indicating that one or more disconnectors has been opened to render the bay open-circuit.

2.2 Total System

The integrated system of connected Power Generating Modules, Transmission System, Distribution Networks and associated electrical demand.

[From Engineering Recommendation G99 Issue 1 Amendment 8]

2.3 Secured Outage

An outage or combination of outages after which specified requirements must be satisfied in design studies.

The following types and combinations of outages are included:

- Each circuit fault outage
- Each busbar fault outage
- Each circuit arranged outage
- Each circuit arranged outage followed by each circuit fault outage
- Each circuit arranged outage followed by each busbar fault outage
- Each busbar arranged outage
- Each busbar arranged outage followed by each circuit fault outage
- Each busbar arranged outage followed by each busbar fault outage

Outages at all voltage levels relevant to the network in question shall be considered, including outages on the transmission network and other third-party networks where applicable.

[Adapted from POL:SD2/8]

2.4 System Frequency Integrity

The ability of the GB system to operate within acceptable frequency-related technical limits under both Intact Network and outage conditions.

System Frequency Integrity is primarily managed by National Grid, but it can be affected by the operation of NGED's network and customers. This includes but is not limited to:

- Low Frequency Demand Disconnection
- Interface Protection associated with Power Generating Modules
- Changes in net Load caused by protection operation, manual intervention or the operation of Load Management Schemes.

[Adapted from POL:SD2/8; the term System Integrity was used previously and may be found in existing directives]

3.0 SCOPE

This directive applies to LoM intertripping schemes required for compliance with ER G59 and G99.

Although providing LoM protection is the responsibility of the generator, where LoM intertripping is required the intertripping scheme shall be designed and owned by NGED. Where a Power Generating Module requiring LoM intertripping is connected to the network of an Other Authorised Distributor (as defined in the Distribution Code) that is in turn connected to NGED's network, the parts of the intertripping scheme relating to NGED's network shall be designed and owned by NGED in coordination with the Other Authorised Distributor. This directive contains requirements for such intertripping schemes.

Where retrospective application of a LoM intertripping scheme is proposed for an existing Power Generating Module, the author shall be consulted.

Where allowing Power Generating Modules to form or supply islands of distribution network is proposed, the author shall be consulted.

The generator's Interface Protection device(s) (for Under Voltage, Over Voltage, Under Frequency, Over Frequency and, where provided, non-intertripping Loss of Mains protection) are outside of the scope of this directive.

Where any difficulty is encountered with the application of this policy, the author shall be notified, who will consider if a variation is appropriate.

4.0 SCHEME BEHAVIOUR

The scheme shall be designed to disconnect the Power Generating Module(s) from NGED's network for Secured Outages that would result in loss of synchronising path from the Total System to the Power Generating Module(s).

Note: A boundary across which three or more independent circuits operate in parallel will not typically have Secured Outages which result in the loss of synchronising path across the boundary, but due account should be taken of factors including:

1. *The disposition of circuits onto busbars;*
2. *Split running to mitigate constraints such as fault level; and*
3. *The behaviour of load management schemes.*

The scheme may omit arranged outages for which the Power Generating Module(s) are disconnected from NGED's network before the outage is taken.

The scheme design shall, in so far as is reasonably practicable, take account of credible future changes in running arrangements.

The designer of the scheme behaviour shall document the necessary inputs and combinatorial logic in an unambiguous format (e.g. logic diagram, logic equation or logic table) for use by the designer of the scheme configuration.

4.1 Sufficiency Assessment

The sufficiency of the scheme shall be proved by calculating its behaviour for each pertinent Secured Outage to confirm that either:

1. The Power Generating Module(s) retain a synchronising path to the Total System;

2. The Power Generating Module(s) are disconnected from NGED's network in response to a switching instruction *before* the outage is taken; or

3. The scheme identifies the loss of the synchronising path to the Total System and disconnects the Power Generating Module(s) from NGED's network.

The impact of switching instructions and Load Management Schemes shall be taken into account when determining the network topology for each Secured Outage.

If a load-flow program is used to assist in sufficiency assessment, the user shall determine whether the program includes functionality that automatically disconnects islanded generation. If it does, the user shall take steps to ensure that it is the LoM intertripping scheme rather than the load-flow program functionality that disconnects islanded generation in simulations. If in doubt, a network modelling and analysis specialist should be consulted.

Note: Siemens PSSE's TREE routine disconnects all buses and branches that do not have an in-service path to at least one Type 3 (swing/slack) bus. This routine is run automatically for each outage in PSSE's contingency analysis routines. It will disconnect islanded generation regardless of the presence (or absence) of a LoM intertripping scheme.

5.0 SCHEME CONFIGURATION

5.1 Inputs

The scheme may be triggered by one or more of:

- Circuit breaker secondary contacts

- Disconnector secondary contacts

- Protection trip signals

- Signals from associated LoM intertripping schemes on upstream transmission or distribution networks

Where protection trip signals are used, the designer shall ensure that all protection schemes that can trip a circuit breaker (e.g. backup protection and busbar protection) are considered in addition to circuit main protection.

Where the status of a manually operated (whether local, remote or supervisory) disconnector is required, Selection Controls may be used in lieu of disconnector secondary contacts. These Selection Controls shall be made available as both:

- Supervisory controls with status indication on the Network Management System; and

- Local push buttons with status indicator lamps on site.

Note: the use of Selection Controls can reduce the design and commissioning complexity of a scheme, at the expense of increased operational complexity. Where their use is proposed, the Control Centre should be consulted on their operational implications.

5.2 Communications Links

Each communications link shall either:

1. Meet at least Category 3 of POL:TP20; or

2. Be a NGED-owned metallic pilot pair.

Regardless of the type of communications link used:

- Intertripping relays shall be approved in EE98 for function **IT** and incorporate pilot supervision; and

- The requirements of POL: TP20 for separation and segregation of communications links shall be met.

This does not preclude the use of SCADA facilities for supervisory operation of Selection Control.

5.3 Combinatorial Logic

Combinatorial logic may be implemented using one or more of:

1. Series and parallel connection of input contacts;

2. Auxiliary relays approved in EE136; and

3. Numerical relays approved in EE98 with appropriate programmable logic elements. A numerical relay may be used for both combinatorial logic and intertripping. Where existing approved relays are not suitable, alternative devices may be submitted to Engineering Policy for evaluation in accordance with POL: TP25.

Combinatorial logic may be distributed across the sites at which inputs and outputs are located. Logic elements should be local to their inputs where reasonably practicable, to minimise the number of intertripping channels required and to facilitate testing.

5.4 Outputs

The scheme shall trip one or more generator-owned circuit breakers to fully disconnect all Power Generating Modules from the distribution network. It shall operate without deliberate time delay, and at least 500ms before any auto-reclose or auto-close scheme could reconnect the Power Generating Module(s) to the wider network for Secured Outage Conditions.

The trip output from the scheme shall be presented to the customer as a normally-open volt-free contact marked **LoM Intertrip** at the interface substation. Outputs shall be presented to the customer in the Connection Control Interface Panel.

The **LoM Intertrip** contact shall remain closed until a synchronising path has been re-established between the interface substation and the Total System. The Power Generating Module(s) shall not be reconnected to the distribution network until after the **LoM Intertrip** contact has opened.

The trip output from the scheme shall be annunciated in the Control Centre as an unambiguously described high-priority alarm that unambiguously indicates that a Loss of Mains intertripping scheme has operated.

5.5 Test Facilities

The scheme shall incorporate sufficient facilities (e.g. test blocks, links, switches and buttons) to facilitate the commissioning test requirements in clause 7.1 and maintenance test requirements in clause 8.1.

Note: LoM intertripping is typically requires inputs from multiple interdependent circuits. Since it would not be reasonably practicable to take simultaneous outages of all circuits for testing, it will typically be necessary to test the scheme as a series of overlapping subassemblies.

5.6 **Failure Mitigation**

Detectable scheme failures (including but not limited to communications failure alarms, relay/controller watchdog alarms and battery system alarms) shall be annunciated in the Control Centre as an unambiguously described high priority alarm.

If the following criteria are met, the customer may choose whether or not to trip in the event of detectable scheme failure:

1. There are no Secured Outage Conditions that would leave network energised without an earthed neutral meeting the requirements of the TP2, TP3 and TP21 series; and

2. All auto-reclose and auto-close schemes that could reconnect the Power Generating Module(s) to the wider network for Secured Outage Conditions are configured to prevent reclosing against an out-of-sync network (e.g. sync check, dead line charging or dead bus charging).

In this case, a second normally-open volt-free contact marked **LoM Scheme Failure Alarm** shall be presented to the customer at the interface substation to indicate detectable scheme failure. The conditions that can cause this contact to close shall be explained to the customer to assist their risk assessment of how to respond to it closing.

In all other cases, the scheme shall be configured to operate the **LoM Intertrip** output without deliberate time delay in the event of detectable scheme failure.

5.6.1 <u>System Frequency Integrity</u>

The aggregate export capacity of all Power Generating Modules connected to a LoM intertripping scheme or to multiple schemes that share components shall not exceed the System Frequency Integrity limits in POL:SD2, POL:SD3 and POL:SD4.

5.7 **Labelling and integration with other schemes**

Scheme panels and devices shall be clearly labelled with the name and purpose of the scheme. To avoid confusion with other forms of intertripping, the term **Loss of Mains Intertrip** shall be used on labels. Wiring shall be ferruled in accordance with ENA TS 50-19.

Where a Power Generating Facility requires both a LoM intertrip in accordance with this directive and an operational intertrip in accordance with ST: SD11A, both may be integrated as a single scheme meeting the requirements of both directives.

LoM intertripping shall be independent of any protection intertripping scheme for the purpose of fault clearance.

LoM intertripping schemes for multiple Power Generating Facilities may share components.

6.0 SCHEME RECORDS

Schemes shall be recorded in accordance with POL: TP10. To avoid confusion with other forms of intertripping, the term **Loss of Mains Intertrip** shall be used in records.

6.1 Specific Requirements

The scheme record shall include:

1. A logic diagram unambiguously documenting the scheme logic represented as logic gates, with: the geographic location of subsystems clearly identified. The nature of all communications links shall be clearly marked, including the identities of communications bearers where these may be shared with other schemes.

2. An operating procedure to be included in the operating instructions submitted to the Control Centre for the applicable area of network. This shall clearly state:

    a. How to operate Selection Controls in response to arranged outages;

    b. Any potential running arrangements that are not catered for by the scheme and so must not be entered into with the Power Generating Module(s) synchronised;

    c. How the scheme is expected to behave in the event of detectable scheme failures such as loss of communications or a relay watchdog alarm; and

    d. The extent to which any components such as relays or communications bearers are shared with protection or load management schemes.

    Any potential running arrangements that are not catered for by the scheme and so must not be entered into with the Power Generating Module(s) synchronised must be clearly indicated in NGED's connection agreement with the customer.

7.0 COMMISSIONING

Schemes shall be commissioned in accordance with POL: TP11 and ST: TP11A.

7.1 **Test Requirements**

Where it is not reasonably practicable to take outages to test the scheme as a whole, the commissioning engineer may test the scheme as a series of overlapping subassemblies.

7.1.1 Inputs

The correct operation of each switchgear status input shall be proved by operation of the associated primary switchgear.

The correct operation of each protection trip input shall be proved by operation of the associated protection relay or trip relay.

The correct operation of each Selection Control shall be proved be operation of both local and supervisory controls.

7.1.2 Communications Links

All communications links shall be tested to prove correct behaviour.

7.1.3 Combinatorial Logic

The full scheme logic shall be tested comprehensively by signal injection to prove correct behaviour. If this test is carried out off-site prior to installation, then a representative sample of logic tests shall be carried out following installation to confirm the validity of off-site tests.

7.1.4 Outputs

The NGED commissioning engineer shall witness the customer demonstrating their circuit breaker(s) correctly responding to a signal from the scheme.

8.0 MAINTENANCE

Schemes shall be maintained in accordance with POL: TP12 and POL: SP2.

8.1 **Test Requirements**

Where it is not reasonably practicable to take outages to test the scheme as a whole, the maintenance engineer may test the scheme as a series of overlapping subassemblies.

Note: it is recognised that the maintenance testing of overlapping subassemblies may be carried out at different times under different outages.

8.1.1 Inputs

The correct operation of each switchgear status input shall be proved by operation of the primary switchgear. This test may be aligned to the maintenance cycle of the associated primary switchgear instead of the LoM scheme to suit operational requirements.

The correct operation of each protection trip input shall be proved by operation of the associated protection relay or trip relay. This test may be aligned to the maintenance cycle of the associated protection scheme instead of the LoM scheme to suit operational requirements.

The correct operation of each Selection Control shall be proved be operation of both local and supervisory controls.

8.1.2 Communications Links

All communications links shall be tested to prove correct behaviour.

8.1.3 Combinatorial Logic

A representative sample of logic tests shall be carried out by signal injection to confirm correct behaviour.

8.1.4 Outputs

The NGED maintenance engineer shall witness the customer demonstrating their circuit breaker(s) correctly responding to a signal from the scheme.

9.0 MITIGATION OF FUTURE NETWORK CHANGES

There is a risk that changes to the design or running arrangements of the network could render a scheme incapable of meeting the requirements of this directive.

9.1 Ongoing Sufficiency Assessment

The sufficiency and applicability of the scheme logic in the context of network changes shall be confirmed by the methods given in 4.1 (Sufficiency Assessment):

1. During the design of any material modification to the applicable area of network; and

2. Not less than once every two years as part of the periodic assessment of the network.

9.2 **Reporting and Resolution of Deficiencies**

Any deficiencies identified by Ongoing Sufficiency Assessment shall be:

1. Reported immediately to the Control Centre, who shall be responsible for operational mitigation; and

2. Reported to Primary System Design for redesign and modification/reimplementation to meet the requirements of this directive.

APPENDIX A

SUPERSEDED DOCUMENTATION

This is a new document and no document is superseded by its issue.

APPENDIX B

RECORD OF COMMENT DURING CONSULTATION

Comments – ST: TP1B

APPENDIX C

ANCILLARY DOCUMENTATION

ER G99 (as amended)
ER G59 (as amended)
ENA TS 50-19 (as amended)

APPENDIX D

KEY WORDS

G99, G59, Intertrip, LoM, Loss of Mains, Loss-of-Mains, Synchronise, Synchronising, Island, Islanding.