

CONTINGENCY PLANS IN CASE OF FAILURE OF NUMERICAL BUSBAR PROTECTIONS

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PURPOSE AND SCOPE

This procedure provides details for the preparation of contingency plans to be implemented in the event of a failure or unplanned outage of a complete numerical busbar protection system fitted at a 400 or 275kV double busbar substation.

PART 1 – PROCEDURAL

1 NUMERICAL BUSBAR PROTECTIONS

1.1 Introduction

Historically busbar protection systems have been installed with check & discriminating zones whereby both zones must operate to initiate tripping. This is generally referred to as a 2 out of 2 system. With the move to installing numerical busbar protections due to the increased reliability and self monitoring facilities available within modern systems this requirement has been relaxed to allow single units to be installed on a single CT per circuit.

However a consequence of this is that if one of the distributed units or the central unit of the numerical protection fails the entire busbar protection for one or more busbar sections is lost. The result is that a substantial number of circuits may have to be taken out of service until a repair is completed.

As this scenario is undesirable two options are possible to allow the busbar sections to remain in service:

- (i) Provision of a second central unit and associated fibre optic connections so that in event of failure of the first unit the busbar protection can be manually connected to the

second unit to enable it to remain in service. This option applies to all new numerical busbar protection installations at 400kV & 275kV.

- (ii) Adjusting the Protection arrangements on the infeeding circuits to provide **limited** protection for the busbars to allow them to remain in operational service. This applies to extensions of existing installations where the Contingency Plan has already been implemented in this way.

It is therefore required that a plan is in place for each new numerical busbar protection installation to detail the changeover methodology between the duplicate central units or to specify how the protections on each connected circuit can be configured to clear a busbar fault before it can cause instability to the system or unacceptable loss of demand.

This document provides guidance on the modifications required to the arrangement and settings of adjacent feeder and SGT protections to provide a limited form of protection coverage for busbar faults in the event of a busbar protection failure.

The method of implementing the contingency plan must be agreed by the Contractor Design Approval Engineer (P & C) and P & C Design Engineer (Assurance) and fully detailed in the DID.

The hierarchy of the documents governing busbar protection failure contingency plans is outlined in Appendix B.

1.2 Requirements

1.2.1 400kV & 275kV Main Interconnected System

For unplanned failures of a numerical busbar protection installed at substations on the 400kV & 275kV Main Interconnected System (MIS) a contingency plan is required for each installation.

A contingency plan is **not** required for Mesh Corner, HV Connections or any form of Copperwork protection numerical differential protection relays.

1.2.2 132KV and Lower Voltage Systems

A contingency plan is **not** required for unplanned failures of numerical busbar protections installed on 132kV or lower voltage substations unless specifically required by Market Operation. The P & C Design Engineer (Assurance) must confirm the specific requirements with Market Operation during the NDP Stage 4.3 Develop & Sanction stage of a project.

1.2.3 Application of Contingency Plan

A contingency plan is only required for the failure of a central processing unit of a numerical busbar protection or a complete failure of an entire numerical busbar protection system.

If a bay unit fails the primary circuit should firstly be switched out of service and then the busbar protection bay unit switched into maintenance. This allows the busbar protection installed on the remaining circuits to continue in normal operation. Generic guidance documents are available for each manufacturer's relays detailing the methodology of completing this task.

If the communications between the central unit and a bay unit fails (for example failure of a fibre), the central unit may need to be re-configured to remove the affected circuit from its calculations.

The contingency plan is required to be put into operation if ETAM Operations cannot return the busbar protection back into service within 30 minutes of confirmation of its failure.

The contingency plan must be complete & in service between 4 & 6 hours after the decision to implement it has been taken.

The implementation of a Contingency Plan involving settings changes or removing a busbar protection bay unit from service as described in TGN(E)249 must be completed by an Advanced Commissioning Engineer as defined in UKBP/TP141.

The implementation of a Contingency Plan involving changing over between busbar protection central units as described in TGN(E)246 must be completed by two Commissioning Engineers as defined in UKBP/TP141, one of whom must be Advanced.

1.2.4 Fault Clearance Time

To prevent disruption to the Power System it is desirable to remove all busbar faults within 300ms of the occurrence of the fault. This is the same time as for removing faults for a circuit breaker fail condition.

The contingency plan must meet these requirements.

Where the circuit protections need to be adjusted these fault detection systems backing up the busbar protection will be non discriminative and so will operate for both circuit and busbar faults. For this reason the protections should operate in a minimum time of 150ms to allow sufficient discrimination time for the high speed protections installed on each circuit to clear feeder & plant faults.

When aiming to achieve the target protection operation time of 150 ms, care should be taken to ensure the protection does not detect faults on the Distribution Network Operator (DNO) network.

There may be sites where a 150ms protection operation time (giving an overall fault clearance time of around 200ms) may not be achievable. This may particularly be the case at some older sites with slower acting circuit breakers. During the development of a contingency plan the fault clearance times must therefore be agreed with Market Operation.

1.2.5 Numerical Relay Settings Groups

Where the temporary settings are held within a different settings group within a numerical relay for consistency settings group C (or 3) should hold the settings to be used to apply the contingency plan.

1.2.6 Changes to Protection Arrangements required to Implement a Contingency Plan.

When changes are made to protection arrangements which are included within a Contingency Plan at a substation either due to a Capital Delivery Project or an individual relay replacement the Contingency Plan must be reviewed. Typically if a protection is replaced on one of the infeeding circuits which forms part of the Contingency plan the setting and tripping arrangements from the new protections must be included and if required the plan should be revised and published to the timescales in section 1.2.7. The requirement to update an existing plan must be identified in the DID.

1.2.7 Process

The methodology to produce a contingency plan in case of failure of numerical busbar protections is as follows:

- a) 4 WEEKS after contract award during NDP Stage 4.4 Execute Project the Settings Engineer (Assurance) must request Market Operation to produce diagrams detailing the preferred running arrangements to be implemented in the event of a failure of the numerical busbar protection being installed.

- b) 8 WEEKS after contract award Market Operation are to produce diagrams showing the preferred running arrangements to be implemented at the substation in the event of failure of the numerical busbar protection. These plans should be consistent with maintaining system stability and minimising potential demand loss.
- c) Prior to the freezing of the Design Intent Document (DID) the Settings Engineer (Assurance) and the Settings Engineer (Verification) are to agree the proposed actions required to protect the busbars for the running arrangements proposed for a busbar protection outage. This should include any modifications to an existing plan as a result of substation extension or protection replacement work. These actions will be outlined in the DID. Capital Delivery must liaise with Market Operation to ensure the proposed busbar protection contingency arrangements meet the operational requirements as identified in UKBP/TP105, Operational Liaison and Practice.
- d) 20 WEEKS in advance of the first energisation of the busbar protection system a draft schedule detailing the actions to be taken in event of a busbar protection failure shall be issued to National Grid by the Contractor. The schedule will then be circulated by the Settings Engineer (Assurance) within National Grid for comments.
- e) 16 WEEKS in advance of the first energisation of the busbar protection system the Settings Engineer (Assurance) will collate and pass any comments on the schedule to the Contractor.
- f) 12 WEEKS in advance of the first energisation of the busbar protection system the Contractor will submit the final version to the Settings Engineer (Assurance). The Settings Engineer (Assurance) checks this document and sends it to the Asset Policy Engineer for publication on the National Grid Intranet Electricity Transmission Asset Management (ETAM) Sharepoint site.

1.2.8 Process for Generic Contingency Plans

TGN(E)246 hold the generic plans for the removal of busbar protection bay units from service and to carry out the changeover between duplicated central units. If a new numerical busbar protection is type registered or a change is made to a type registered numerical busbar protection new documents must be produced for inclusion within TGN(E)246 as part of the type registration process.

2 RESPONSIBILITIES

2.1 Capital Delivery

2.1.1 Settings Engineers (Assurance) are responsible for:

- a) Agreeing and publishing new and revised contingency plans.
- b) The temporary settings to be applied during the enactment of the contingency plan.
- c) Issuing and agreeing the settings for the bay units and central unit(s) associated with digital busbar protection.
- d) Issuing the completed schedule to all relevant parties within National Grid.

2.1.2 The Technical Assurance Substation Engineering Manager is responsible for:

- a) Ensuring that all operational risks are clearly identified in the busbar protection contingency plan and agreed with the Control Support & Review Manager, Market Operation.

- b) Responsible for the issue, review and update of Busbar Protection Contingency Plans for individual suppliers protections.

2.2 Contractor

2.2.1 The Contractor Design Manager is responsible for:

- a) Responsible for keeping the Technical Assurance Substation Engineering Manager informed of any changes to their numerical busbar protection solutions that will necessitate an update to the respective contingency plan.

2.3 Electricity Transmission Asset Management (ETAM)

2.3.1 Operations

- a) The Operations Managers North & South are responsible for:
 - (i) Ensuring that suitably trained and authorised Commissioning Engineers implement and remove the temporary settings outlined in the contingency plans.
 - (ii) Ensuring suitable provisions for repair and re-commissioning of faulty numeric busbar protection are put in place.
- b) Commissioning Engineers (National Grid) are responsible for:
 - (i) Applying the temporary settings or swapping the connections between Central Units to enable the implementation of a contingency plan on instruction from Market Operation.
 - (ii) Repair and re-commissioning of faulty numeric busbar protection equipment under a Post Delivery Support Agreement (PDSA) or similar arrangements as appropriate.
 - (iii) Removing the temporary settings on instruction from Market Operation once the Numerical Busbar Protection system is returned to normal service.

2.3.2 ETAM Electricity Network Investment

- a) The System Development Manager is responsible for:
 - (i) Ensuring the requirements for a contingency plan are included within the Substation Design Specification (SDS) at NDP Stage 4.3 Develop & Sanction prior to scheme sanction whenever a numerical busbar protection is required to be fitted.
- b) The Asset Policy Manager is responsible for:
 - (i) Ensuring the contingency plans for the failure of numerical busbar protection systems within TGN(E)246 & TGN(E)249 are maintained.
- c) The Asset Integrity Manager is responsible for:
 - (i) Ensuring the published contingency plans are reviewed five years after publication or five years after the last revision date to ensure they are still applicable.

2.3.3 Market Operation

- a) The Control Support & Review Manager is responsible for: