

This document is for internal and contract specific use only.

Disclaimer

NGG and NGET or their agents, servants or contractors do not accept any liability for any losses arising under or in connection with this information. This limit on liability applies to all and any claims in contract, tort (including negligence), misrepresentation (excluding fraudulent misrepresentation), breach of statutory duty or otherwise. This limit on liability does not exclude or restrict liability where prohibited by the law nor does it supersede the express terms of any related agreements."

Copyright © National Grid plc 2011, all rights reserved

All copyright and other intellectual property rights arising in any information contained within this document are, unless otherwise stated, owned by National Grid plc or other companies in the National Grid group of companies. No part of this publication may be reproduced in any material form (including photocopying and restoring in any medium or electronic means and whether or not transiently or incidentally) without the written permission of National Grid plc

This information should not be forwarded to third parties.

Document ID: NG TS 3.24.07 2000



National Grid

National Grid Technical Specification

NGTS 3.24.7
Issue 1
May 2000

Feeder Bay Functions

CONTENTS	Page
Foreword	1
Scope	1
References	1
Definitions	3
Functional Requirements	3
Interface Requirements	10
Implementation	
Requirements	27
Contract Specification	
Requirements	27
Appendix A Interconnections	
Diagrams	29
Appendix B Acceptable	
Integration Options	41

Authorised for Issue by:

John Scott
Director of Engineering
Engineering & Technology

Unless this document is printed on grey paper, it will not be controlled (updated automatically). If printed from an electronic master (e.g. Intranet), this document will be valid on the day of printing only

© National Grid 2000

"No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means electronic, mechanical, photocopying, recording or otherwise, without the written permission of the National Grid obtained from the issuing location.

The contents of National Grid engineering documents are based on the needs of National Grid and the conditions under which it operates. It should not therefore be assumed that the specifications and requirements stated therein necessarily meet the particular circumstances and requirements of other organisations. The principles set out in this document are for information only and therefore National Grid is not liable to customers / suppliers for any loss or damage resulting from reliance on the contents. It is the responsibility of such external organisations to check that the document is the latest version and is appropriate for their purposes."

(National Grid Legal Services. November 1999)

Registered Office
National Grid House
Kirby Corner Road
Coventry
CV4 8JY

Registered in
England and Wales
No. 2366977

Published by:

National Grid
Kelvin Avenue
Leatherhead
Surrey KT22 7ST

Unless this document is printed on grey paper, it will not be controlled (updated automatically). If printed from an electronic master (eg intranet), this document will be valid on the day of printing only.

Administrative enquiries regarding this document should be directed to:

ET Business Resources at Leatherhead, Telephone: 01372 383818

Contact name: D Humphreys (author)
Network Control and Telecommunications
Telephone: 01372 383647

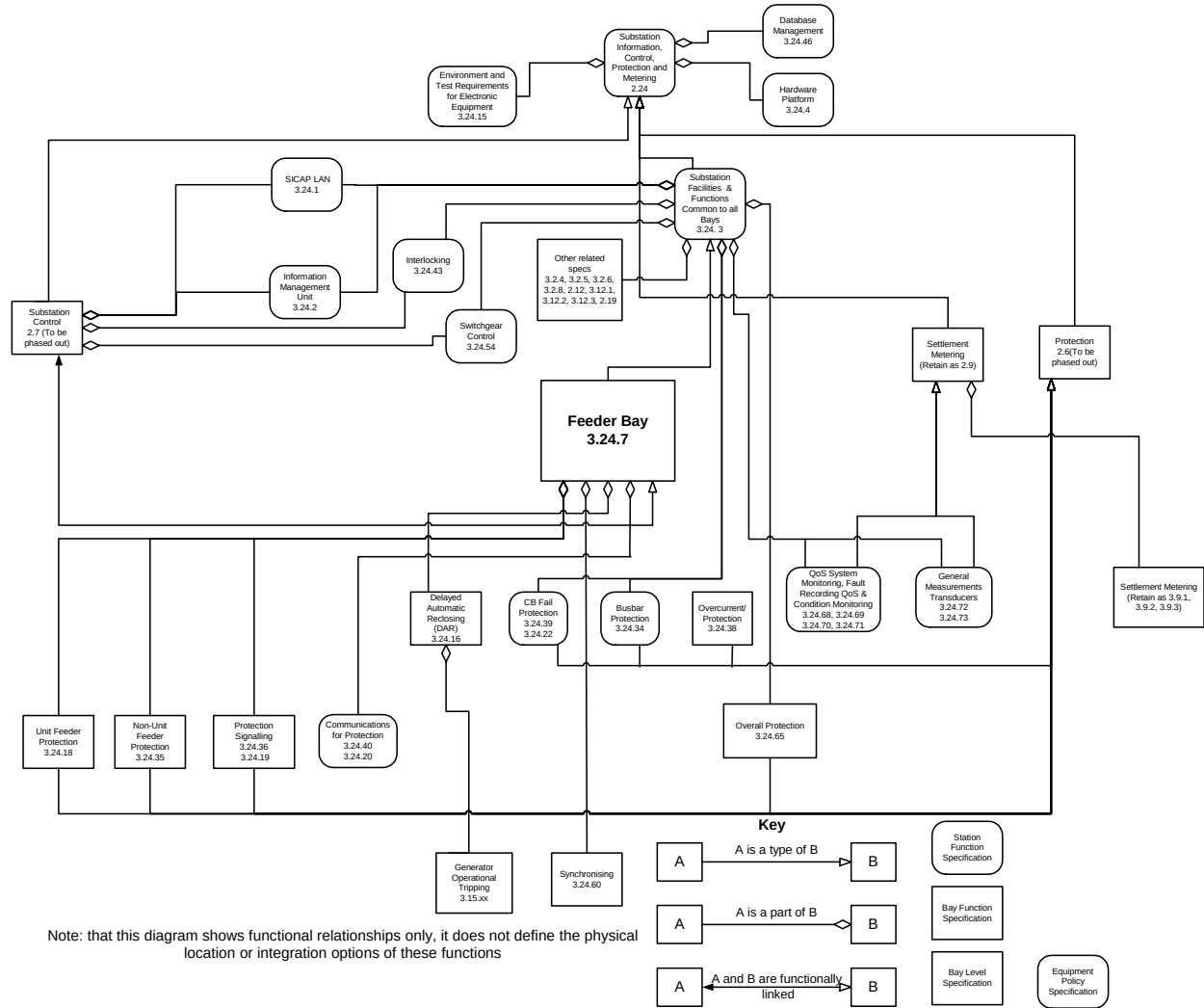
FOREWORD

1 SCOPE

2 REFERENCES

NGTS 3.24.7
Issue 1
May 2000

SUBSTATION INFORMATION, CONTROL PROTECTION AND METERING FEEDER BAY FUNCTIONAL RELATIONSHIPS



3 DEFINITIONS

Feeder Circuit: - high voltage connections between two or more substations, including associated circuit breakers (CB), disconnectors, earthing switches, instrument transformers, conductors and insulators, and light current equipment. The circuit may consist of overhead line, underground cable, or a combination of the two.

Feeder bay: - The equipment at a substation that is dedicated to a feeder.

DTT:- Direct transfer trip

PTT:- Permissive transfer trip

BOR:- Blocked over reach

PUR:- Permissive under reach

4 FUNCTIONAL REQUIREMENTS

Informative: This section describes all of the functions that might be needed on a busbar feeder bay, and gives circumstances where functions may not be required.

Main Protection

4.1 Two separate, discriminative, high-speed protection functions shall be provided at 400 and 275 kV.

4.2 The preferred arrangement is for a feeder to have one of these discriminative, high-speed protection functions working on a unit protection principle (see NGTS 3.24.18) and the other on a non-unit protection principle (see NGTS 3.24.35). This shall be the arrangement provided unless the contract asks for another arrangement. The circumstances under which different arrangements are required follow.

4.3 The circumstances in which two unit protection functions shall be provided under Section 4.1 are where:

(a) The circuit consists entirely of cable;

or

(b) The circuit is a very short overhead line.

Informative: A short circuit is one whose impedance is small compared to the minimum setting on available non unit protections; ie, a reach setting of 80% of the circuit impedance cannot be achieved.

4.4 The circumstances in which two non-unit protection functions shall be provided under Section 4.1 are where:

(a) The circuit is greater than 10km;

and

(b) Communication channels suitable for use with unit protection are not available.

4.5 If both protections provided under Section 4.1 are of the non-unit type, then one shall preferably be a Blocked Over Reach (BOR) scheme. A Permissive Under Reach (PUR) scheme may be used as an alternative.

4.6 On short circuits any non-unit protection provided shall be BOR. The contract will state if this is the case.

4.7 One high-speed feeder main protection system shall be provided at 132 kV.

Informative: This will work on either a unit protection principle (see NGTS3.24.18) or a non-unit protection principle (see NGTS3.24.35). The contract will make it clear what arrangement is needed.

4.8 Unit feeder main protection functions shall, on operation:

(a) Trip the bay CB.

- (b) Initiate DTT send functions (see Section 4.16).
 - (c) Initiate CB Fail (see Section 4.25).
 - (d) Initiate DAR (see Section 4.53 to 4.55).
- 4.9** Non-unit feeder main protection functions shall, on operation
- (a) Trip the bay CB.
 - (b) Initiate DTT send functions (see Section 4.16).
 - (c) Initiate Circuit Breaker (CB) Fail (see Section 4.25).
 - (d) Initiate or lockout Delayed Auto Reclose (DAR) as appropriate. (see Section 4.53 to 4.55).

Back Up Protection

- 4.10** A back up protection using an overcurrent function with an IDMT characteristic (see NGTS 3.24.38) shall be provided on all feeders.
- 4.11** The back up protection function shall consist of a residually connected earth fault (E/F) protection where at least one non-unit protection is provided under Clause 4.1.
- 4.12** The back up protection function shall consist of two-phase overcurrent and a residually connected earth fault protection where the protections that are provided under Clause 4.1 are both unit protection functions, and for all 132 kV feeders.
- 4.13** The residually connected E/F shall be capable of being set:
- (a) To operate for an earth fault whose resistance to earth is up to 100Ω .
 - (b) Not to operate for currents up to 17.25% of the maximum emergency load requirements.
- Informative: It should be noted that the fault current for a 100Ω earth is largely independent of source impedances, and is shared between infeeds.*
- 4.14** The phase overcurrent shall be capable of being set to above the maximum emergency load requirements for the circuit.
- 4.15** The back up protection functions shall, on operation:
- (a) Trip the bay CB.
 - (b) Initiate CB Fail (see Section 4.25).

Protection Signalling; Command Based

- 4.16** All feeders shall have a Direct Transfer Tripping (DTT) function (see NGTS3.24.36) to each remote circuit end.

4.17 All DTT receive functions shall, on operation:

- (a) Trip the bay CB.
- (b) Initiate CB Fail (see Section 4.25).

Informative: DTT has traditionally been known as 'Intertripping' within the UK electricity supply industry.

4.18 A second method for transferring a trip between ends of a circuit shall be provided at 400 kV and 275 kV.

4.19 The second method shall also be a DTT if other plant is connected to the circuit.

Informative: Examples of the 'other plant' mentioned are, Transformer, Quadrature Boosters, Shunt Reactor, etc.

4.20 Where no other plant is connected to the circuit, the second method shall be Permissive Transfer Trip (PTT) using one of the following:

- (a) A Blocked Over Reach (BOR) function, associated with a non-unit protection provided under Clause 4.2, which has the ability to have its block send inhibited by an external source.
- (b) A Permissive Under Reach (PUR) (see NGTS 3.24.36) associated with a non-unit protection provided under Clause 4.2, which has the ability to have a permissive signal send initiated by an external source.
- (c) A unit protection function provided under clause 4.1, capable of being unstabilised by an external source.

4.21 Where both main protection functions reside on the same platforms as DTT functions, both of the DTT functions shall be used whether or not other plant is connected to the circuit (see Sections 4.18 to 4.20).

4.22 Where one main protection function resides on the same platform as a DTT function, but the other does not, a separate DTT shall be used.

Stub Bus Protection

4.23 Stub bus protection shall be provided if feeder protection CTs are situated on the line side of the line disconnector. Figure 4.1 shows the logic for this.

Informative: Stub Bus protection caters for a fault between the CT and the open line disconnector, which would not be cleared by the local feeder protection.

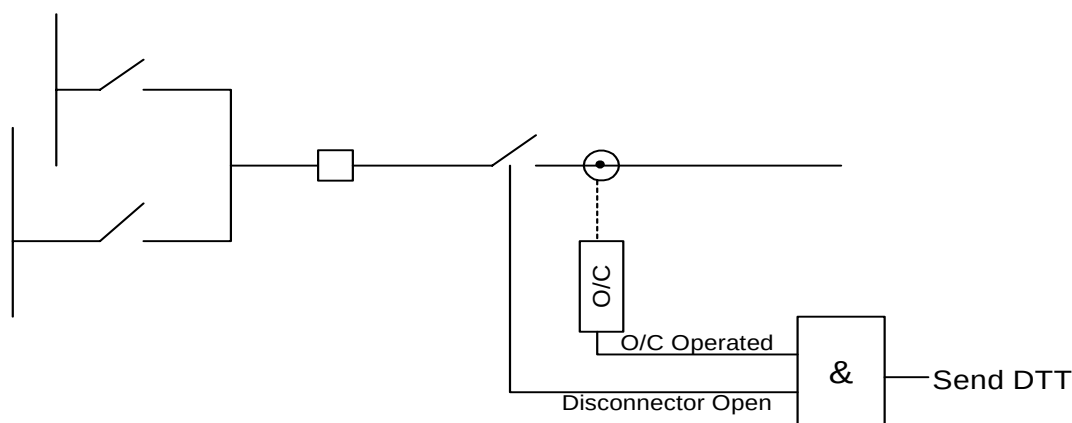


Figure 4.1 Stub Protection Logic

4.24 The stub bus protection functions shall, on operation:

- (a) Initiate DTT send functions (see Section 4.16).

Circuit Breaker Fail Protection

4.25 Circuit Breaker Fail (CBF) protection (see NGTS 3.24.39) shall be provided for the feeder bay Circuit Breaker (CB) at 275 and 400 kV.

4.26 On operation CBF shall:

- (a) Cause other CBs connected to the same busbars to trip.
- (b) Initiate DTT send to each remote end of the circuit, (see Section 4.16).
- (c) Initiate PTT send to each remote end of the circuit, (see Section 4.20).

Busbar Protection

4.27 The feeder bay shall interface with the substation Busbar (BB) protection system (see NGTS 3.24.34).

4.28 On operation, busbar protection shall:

- (a) Cause the bay CB to trip;
and be selectable to
- (b) Initiate DTT send to each remote end of the circuit. (see Section 4.16).
- (c) Initiate PTT (see Section 4.20).

Phases Unbalanced Detector

4.29 A phase unbalance detector function shall be provided that initiates an alarm for a sustained unbalanced load current.

Instrument Transformer Supervision

4.30 Functions that use signals from VTs shall be provided with VT supervision function.

4.31 The VT supervision functions shall be capable of being selected to:

- (a) Inhibit operation of the function on VT failure and alarming the inhibited condition.
- (b) Giving an alarm on VT failure.

Informative: National Grid's policy for non-unit protection functions implemented in numerical devices is for the function to be inhibited on detection of VT failure.

4.32 The VT supervision function shall be capable of distinguishing between a failure of the VT supply and the circuit being dead.

4.33 CTs shall be supervised.

4.34 The CT supervision functions shall be capable of being selected to:

- (a) Inhibit operation of the function on CT failure and alarming the inhibited condition.
- (b) Giving an alarm on CT failure.

Operational Metering

4.35 Operational metering functions shall be provided to give indication to the substation control system of:

- (a) System voltage.
- (b) Phase current.
- (c) Active and Reactive Power.
- (d) Frequency.
- (e) Voltage phase angle.

System Monitoring

4.36 The following system monitoring functions shall be provided:

- (a) Dynamic System Monitoring.
- (b) Quality of Supply monitoring.
- (c) Disturbance recording.
- (d) Fault Locator.

Manual Control for Feeders: - Light Current Functions

Informative: The available control points are local, substation and remote. Local is at the plant being controlled. Substation is at some central point in the substation. Remote is at the National Grid Control Centre (NCC) or Network Operation Centre (NOC).

4.37 The functions in Sections 4.38 to 4.41 shall have local In/Out switching.

4.38 Initiation of the In/Out switching facilities for protection functions provided under Section 4.1 shall be from any control point where the contract requires it.

4.39 If required, initiation of the Zone 2 Override switching facilities for non-unit protection functions provided under Section 4.1 shall be from any control point where the contract requires it.

4.40 Initiation of the In/Out switching facilities for Blocking channels for BOR functions provided under Section 4.1 shall be from any control point where the contract requires it.

4.41 Initiation of the In/Out switching facilities for DTT functions provided under Section 4.16 shall be from any control point where the contract requires it.

4.42 Test/Normal switching facilities shall be provided where it is necessary to carry out end to end tests on the DTT, BOR or PUR function with the primary circuit in service.

Informative: End to end tests may be required for instance where the DTT, BOR or PUR function does not measure and display communications channel receive levels and channel delay times.

- 4.43** Initiation of the In/Out switching facilities for DAR functions provided under Section 4.53 shall be from any control point.

Manual Control for Feeders: - Switchgear Functions

- 4.44** The feeder bay CB and disconnectors shall provide indications of position to all control points.
- 4.45** Earth switches shall provide 'closed' indication to local and standby control points.
- 4.46** The feeder's line disconnector shall be provided with open and close controls that can be initiated from any control point.
- 4.47** The feeder's main and reserve busbar disconnectors shall be provided with open and close controls that can be initiated from any control point.
- 4.48** The feeder's circuit breaker (CB) shall be provided with open and close controls that can be initiated from any control point.
- 4.49** Close controls of the CB from standby and remote control positions shall allow closure:
- (a) If the feeder or Busbar is dead.
 - (b) If there is synchronism between the feeder and the Busbar voltages.
 - (c) If electrically separate systems are to be connected and the slip frequency between the two circuits is within the limits set in the synchronising function.
 - (d) If the control engineer decides to close the CB regardless of conditions.

Informative: The check of synchronism between feeder and Busbar voltage is carried out by the synchronising function (see Section 4.57).

- 4.50** Close controls of the CB from the local control positions need not be conditioned by the requirements in Section 4.49, (a), (b) and (c).
- 4.51** In some cases bay earth switches shall be motor operated with open and close controls that can be operated from local and substation control points.

Informative: This depends on the type of switchgear provided. The contract will state when this is required.

Control for Feeders

Sequential Isolation

- 4.52** Feeder bays shall be provided with Line disconnector sequential isolation where required. The contract will state if this is required.

Delayed Auto Reclose (DAR)

- 4.53** Feeder bays shall be provided with Delayed Auto Reclose (DAR).
- 4.54** DAR of the CB shall allow closure:
- (a) If the feeder or Busbar is dead, or;
 - (b) If there is synchronism between the feeder and the Busbar voltages.

Informative: The check of synchronism between feeder and Busbar voltage is carried out by the synchronising function mentioned in Section 4.57.

DAR Conditioning

4.55 A DAR conditioning function shall be provided that will:

- (a) Inhibit local end DAR on receipt of a signal from the remote end.
- (b) Inhibit local and remote DAR on detection of a Ferro-resonance condition.
- (c) Lockout DAR on receipt of a signal from the remote end.
- (d) Lockout both local and remote DAR on operation of the local busbar protection or CB fail protection.
- (e) Lockout both local and remote DAR for faults on underground cable sections of the feeder.
- (f) Lockout both local and remote DAR for faults that are cleared by unaided overreaching zones of a non unit protection.
- (g) Lockout both local and remote DAR if a fault is detected on DAR re-closure.
- (h) Lockout both local and remote DAR if the synchronising function detects a system split condition.
- (i) Lockout both local and remote DAR for a short, settable period after manual closure of the bay CB.

Informative: The DAR Conditioning function has traditionally been performed on National Grid's system by electrically reset trip relays and the associated trip relay reset schemes and the use of DTT signals maintained for different, predetermined times.

4.56 Neither DAR nor the DAR conditioning function is required where the circuit consists entirely of cable and there is no banked plant at the remote end of the circuit.

Synchronising

4.57 Feeder Bays shall be provided with check synchronising and system synchronising functions (see NGTS 3.24.60).

4.58 The bay VT shall provide a voltage input (incoming voltage) to the Synchronising functions mentioned in Section 4.57.

Voltage Selection

4.59 The bay VT shall provide inputs to the substation voltage selection function.

4.60 The substation voltage selection function shall provide a voltage reference input (running voltage) that represents the voltage of the busbar to which the bay is selected to the Synchronising functions mentioned in Section 4.57.

Cable Fault Detector

4.61 A Cable Fault Detector function shall be provided for sections of cable in the circuit if required.

Informative: A cable fault detector is required where the cable passes through a tunnel to which people have access, and in other circumstances where it is deemed unacceptable for a re-closure to occur following a fault. The contract will say if this is the case.

4.62 On operation the cable fault detector shall:

- (a) Lockout DAR.
- (b) Initiate an alarm.

4.63 The cable fault detector shall discriminate between faults on the cable and faults elsewhere on the circuit.

Informative: A suitable cable fault detector would be a current differential protection relay as shown in Figure 4.2. Other solutions may be acceptable.

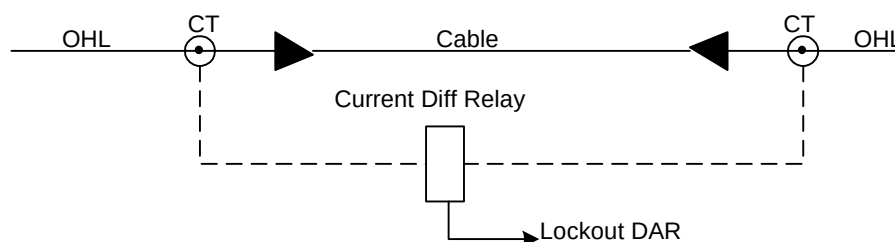


Figure 4.2 Cable fault detector logic using a current differential protection

Interlocking

4.64 An Interlocking function shall be provided to ensure safe operation of bay switchgear.

4.65 The bay shall provide outputs to the substation interlock system to ensure safe operation of other substation switchgear.

Ferro Resonance Detection

4.66 A Ferro-resonance detection function shall be provided if required. The contract will state where this is required.

5 INTERFACE REQUIREMENTS

Informative: The required interconnections between the feeder bay functions and between the feeder bay and the rest of the substation for a 'typical' feeder bay are shown in the series of diagrams in 0. For instance, they show the two high speed discriminative protections as a unit and a non-unit protection. Where protections of the same type are used (ie, either unit or non-unit) then the same principles as shown in the diagrams should be used.

General

5.1 Each function shall provide alarms and indications as appropriate, to the substation control system (SCS).

Informative: The alarms and indications that are to be provided are described in the individual functional specifications and the Hardware Specification (NGTS 3.24.4).

5.2 Informative interface: - each function shall provide information that can be accessed via a communications port.

Informative: The information that is to be provided is described in the individual functional specifications and the Hardware Specification (NGTS 3.24.4).

5.3 Each function shall be provided with a substation time reference.

- 5.4 Instrument transformers shall usually be conventional electromagnetic devices as specified in NGTS 3.2.4 and NGTS 3.2.5. However National Grid will consider using other technologies.

Protection

- 5.5 Each high speed discriminative feeder protections functions shall be connected to class X type A current transformers, or to protection/measurements class current transformers (Class 5P20) where it can be demonstrated that the protection offered will work satisfactorily with this class of CT for all system conditions.
- 5.6 Busbar protection functions shall be connected to Class X type B current transformers where these exist, or to protection/measurements class current transformers (Class 5P20) on new installations. (See NGTS 3.2.4).
- 5.7 Backup protection functions shall be connected to protection class current transformers such as Class 5P20 (See NGTS 3.2.4).
- 5.8 Non-unit feeder protection and where appropriate unit protection functions shall receive 3 phase voltage transformer signals.
- 5.9 The voltage transformer signals required by Section 5.9 shall be independent of voltage transformer signals provided for other functions.
- 5.10 Unit feeder protection, DTT and other teleprotection functions shall be provided with communications circuits as specified in NGTS 3.24.20 for voice frequency and digital communications, or NGTS 3.24.19 for power line carrier equipment.
- 5.11 Each protection function shall also provide events inputs to the fault recorder) function.
- 5.12 A 'Closed' signal from the line disconnector, if required, shall be provided to each of the protection functions described in Section 4.1 and to the DTT functions shown in Section 4.16. The contract shall say if it is required.

Operational Metering

- 5.13 CT inputs shall be derived from the Measurement/Protection class current transformers such as Class 5P20. (See NGTS 3.2.4).
- 5.14 VT inputs shall be derived from the circuit 3 phase voltage transformers.
- 5.15 Outputs shall be provided to the SCS of analogue indication and alarms

System Monitoring

- 5.16 CT inputs shall be derived from the Measurement/Protection class current transformers such as Class 5P20. (See NGTS 3.2.4).
- 5.17 VT inputs shall be derived from the circuit 3 phase voltage transformers.
- 5.18 Where a high accuracy wound VT is available on site it shall provide a signal to the system monitoring functions.
- 5.19 Switchgear position indications, protection function outputs and other plant status and condition indications shall be provided to the System Monitoring functions. The specifications for these functions list the required inputs.