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## TECHNICAL SPECIFICATION ADDENDUM

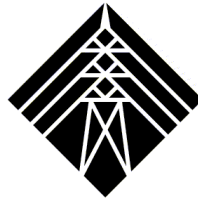
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This Technical Specification shall be read in conjunction with the following amendments:

Check appropriate boxes below

|                                                                                                                            |          |                    |  |                 |  |
|----------------------------------------------------------------------------------------------------------------------------|----------|--------------------|--|-----------------|--|
| <b>Addition</b>                                                                                                            | <b>X</b> | <b>Replacement</b> |  | <b>Deletion</b> |  |
| <b>AMENDMENTS</b>                                                                                                          |          |                    |  |                 |  |
| Insert the following at the end of paragraph 6.2.                                                                          |          |                    |  |                 |  |
| Also the Protection shall not mal-operate or issue an unwanted trip signal for any HV cable discharge ( where applicable ) |          |                    |  |                 |  |
| <b>Date Effective From</b>                                                                                                 |          |                    |  |                 |  |

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# National Grid

National Grid  
Technical  
Specification

NGTS 3.24.6  
Issue 1  
October 2001

## Mesh Corner Bay Functions (Incorporating the associated Feeder and Transformer HV Bay Functions)

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## MESH CORNER BAY FUNCTIONS

### FOREWORD

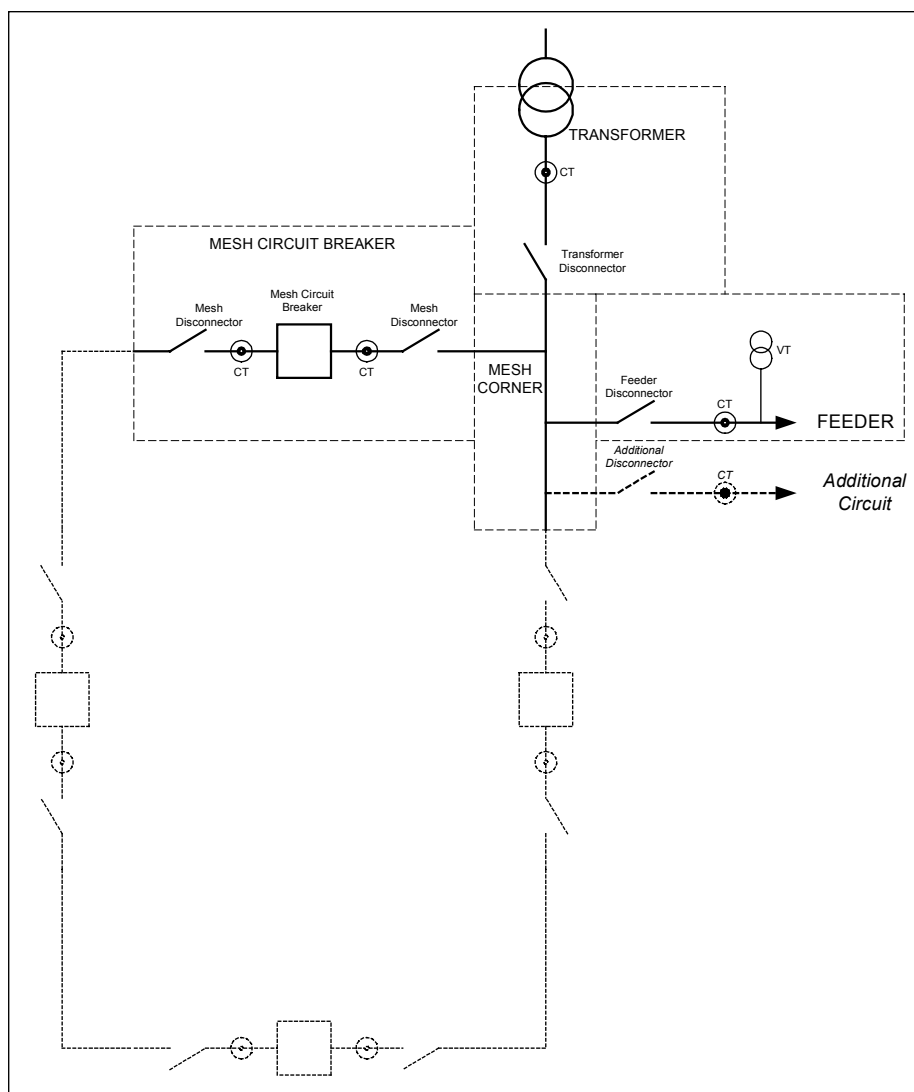
*This is a Bay Level Specification which is part of a suite of specifications that describe requirements for light current equipment on National Grid's transmission system.*

### 1 SCOPE

This specification, in conjunction with related functional specifications, details the protection, control and measurements functions and the associated interconnectivity which are required within light current systems on mesh corner bays at Mesh substations on National Grid's 400, 275 and 132kV transmission system. It also describes interfaces with other substation functions.

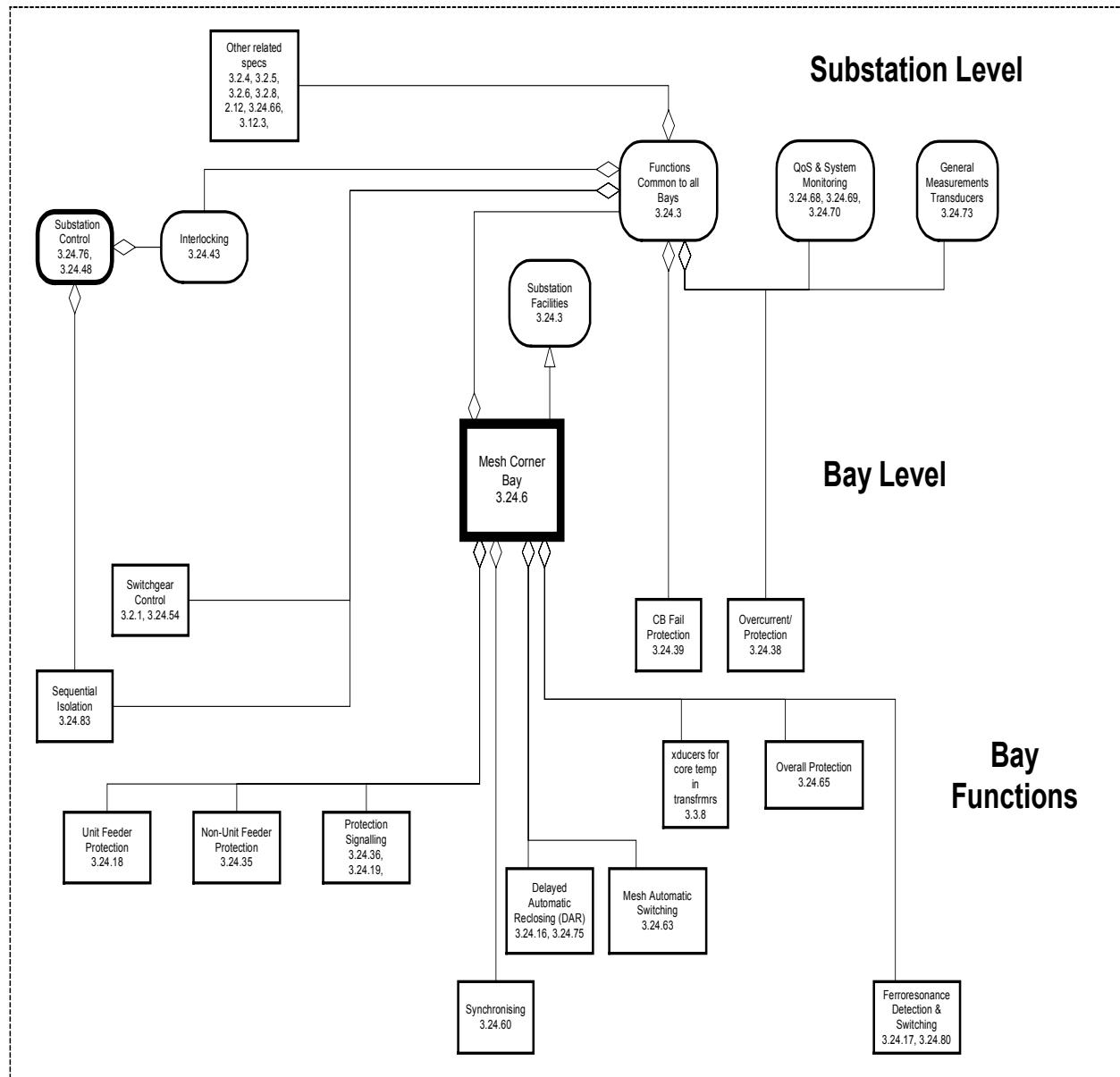
This specification, in conjunction with related functional specifications, also details the protection, control and measurements functions and the associated interconnectivity which are required within light current systems on feeder and transformer bays specific to Mesh substations.

*Informative: The Mesh Corner Bay Specification is based on a standard application, one feeder and one transformer connected to the corner, with provision for an additional circuit shown.*



## 2 REFERENCES

### Substation Information, Control, Protection and Metering Functional Relationships for a Mesh Corner Bay



#### Additional References:

- NGTS 2.3 Transformers and Reactors
- NGTS 3.3.4 Tap Changers
- NGTS 3.24.4 Hardware Platform
- NGTS 3.24.8 Transformer Bay Functions
- NGTS 3.24.61 Automatic Tap Change Control

### 3 DEFINITIONS

Mesh Corner bay: - The equipment at a substation that is dedicated to a mesh corner.

*Informative: The mesh corner bay shall also include an associated circuit breaker i.e. mesh corner 1 to include circuit breaker number 1 (X120 at 400kV, or S10 at 275kV).*

Mesh Corner: - a high voltage node, within a substation, to which a number of circuits, normally without a dedicated circuit breaker, are connected and where specific nodes are coupled via circuit breakers. The normal arrangement is a four-switch mesh, which consists of four nodes forming the corners of a square with adjacent corners coupled by circuit breakers. The circuits connected to a mesh corner may consist of generators, feeders, transformers and reactive plant, in any combination.

Feeder Circuit: - high voltage connections between two or more substations, including associated disconnector, 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.

Transformer: - a load carrying high voltage coupling between two dissimilar potentials, including disconnectors, earthing switches, instrument transformers, conductors and insulators, and light current equipment. The transformer may have a double or single (auto) main winding, a tertiary winding and a tap changer.

AIS:- Air Insulated Switchgear

BOR:- Blocked Over Reach

CB:- Circuit Breaker

CBF:- Circuit Breaker Fail

CT:- Current Transformer (Instrument)

DAR:- Delayed Auto Reclose

DTT:- Direct Transfer Trip

GIS:- Gas Insulated Switchgear

HV:- High Voltage

IM:- Integrated Monitor

LV: Low Voltage

PUR:- Permissive Under Reach

VT:- Voltage Transformer (Instrument)

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

## 4 MESH CIRCUIT BREAKER FUNCTIONAL REQUIREMENTS

*Informative: This section describes all of the functions that may be needed for a Mesh Circuit Breaker, and gives circumstances where functions may not be required.*

### Circuit Breaker Fail Protection

- 4.1 Circuit Breaker Fail (CBF) protection (see NGTS 3.24.39) shall be provided for the transformer HV Circuit Breaker (CB) at 275 and 400kV.
- 4.2 On operation CBF shall
- (a) Trip the circuit breaker in this mesh corner bay and the adjacent mesh circuit breakers
  - (b) Initiate the feeder and transformer HV DTT send functions of the mesh corners either side of the failed circuit breaker (see sections 6.19 and 7.12 respectively).
  - (c) Initiate Ferroresonance Scheme (see section 8.41)
  - (d) Lockout Mesh DAR (see section 8.33)

### CB Pole Discrepancy Tripping

- 4.3 A pole discrepancy tripping function shall be provided for the mesh circuit breaker.

*Informative: Pole discrepancy has traditionally been known as 'phases not together' within the UK electricity supply industry.*

### CB Phase Unbalance Alarm

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

### CB Trip Circuit Supervision

- 4.5 A trip circuit supervision function shall be provided to monitor the complete tripping circuit associated with each CB trip coil irrespective of the CB position. The complete tripping circuit shall include all associated fuses, links, wiring, resistors, trip coils, plant auxiliary contacts and relay contacts – excluding those relay contacts which initiate CB tripping.
- 4.6 The trip circuit supervision function shall initiate an alarm should a persistent fault be detected.

### Synchronising

- 4.7 Mesh circuit breakers shall be provided with check synchronising and system synchronising functions (see NGTS 3.24.60).
- 4.8 The bay VTs shall provide voltage inputs (incoming and running voltages) to the Synchronising functions mentioned in section 4.7.

### Voltage Selection

- 4.9 The bay VTs shall provide inputs to the substation voltage selection function.
- 4.10 The voltage selection function shall provide voltage reference inputs (incoming and running voltages) to the Synchronising functions mentioned in section 4.7. These inputs represent the voltages of the mesh corners to which the mesh bay CB is selected.

## 5 MESH CORNER FUNCTIONAL REQUIREMENTS

*Informative: This section describes all of the functions that may be needed for a mesh corner bay mesh corner, and gives circumstances where functions may not be required.*

### Mesh Corner Protection

- 5.1** Preferably single overall unit protection of the numeric type (see NGTS 3.24.65) with self-supervision and CT supervision (see NGTS 3.24.65), shall be provided at 400kV and 275kV.

*Informative: If the protection is of the high impedance type, then duplicate overall protection with CT supervision and driven from a common CT, shall be provided. Voltage limiting devices shall also be provided if the voltage developed across the relay circuit during maximum internal fault conditions is greater than 3kV. The characteristic of the voltage limiting device provided shall be declared by the supplier.*

- 5.2** At 132kV a single overall unit protection (see NGTS 3.24.65) shall be provided.

- 5.3** Mesh corner overall unit protection functions shall, on operation

- (a) Trip the mesh corner circuit breakers
- (b) Initiate feeder and transformer HV DTT send functions (see sections 6.19 and 7.12 respectively).
- (c) Initiate CB Fail (see section 4.1)
- (d) Initiate Ferroresonance Scheme (see section 8.41)
- (e) Initiate auto switching and, if required, lockout DAR (see section 8.33)

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## 6 FEEDER FUNCTIONAL REQUIREMENTS

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

### Main Protection

- 6.1** Two separate, discriminative, high-speed protection functions shall be provided at 400 and 275kV.
- 6.2** 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.
- 6.3** The circumstances in which two unit protection functions shall be provided under section 6.1 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.*

- 6.4** The circumstances in which two non-unit protection functions shall be provided under section 6.1 are where
- (a) the circuit is greater than 10km
  - And
  - (b) Communication channels suitable for use with unit protection is not available.
- 6.5** If both protections provided under section 6.1 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.
- 6.6** On short circuits any non-unit protection provided shall be BOR. The contract will state if this is the case.
- 6.7** One high-speed feeder main protection system shall be provided at 132kV.

*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*

- 6.8** Unit feeder main protection functions shall, on operation
- (a) Trip the mesh corner circuit breakers
  - (b) Initiate feeder and transformer HV DTT send functions (see sections 6.19 and 7.12 respectively).
  - (c) Initiate CB Fail (see section 4.1)
  - (d) Initiate Ferroresonance Scheme (see section 8.41)
  - (e) Initiate auto switching (see section 8.33)

**6.9** Non-unit feeder main protection functions shall, on operation

- (a) Trip the mesh corner circuit breakers
- (b) Initiate feeder and transformer HV DTT send functions (see sections 6.19 and 7.12 respectively).
- (c) Initiate CB Fail (see section 4.1)
- (d) Initiate Ferroresonance Scheme (see section 8.41)
- (e) Initiate auto switching (see section 8.33)

**Feeder Back Up Protection**

**6.10** A back up protection function having an IDMT characteristic (see NGTS 3.24.38) shall be provided for all feeders connected to the mesh corner.

**6.11** 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 for the feeder.

**6.12** The back up protection function shall consist of two-phase overcurrent and a residually connected earth fault protection where the protections that are provided for the feeder are both unit protection functions, and for all 132kV feeders.

**6.13** The residually connected E/F protection 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 feeder's 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.*

**6.14** The phase Overcurrent shall be capable of being set to above the feeder's maximum emergency load requirements.

**6.15** The back up protection functions shall, on operation

- (a) Trip the mesh corner circuit breakers
- (b) Initiate transformer HV DTT send function (see section 7.12)
- (c) Initiate CB Fail (see section 4.1)
- (d) Initiate Ferroresonance Scheme (see section 8.41)

**Feeder Stub Bus Protection**

**6.16** Stub bus protection (see NGTS 3.24.38) shall be provided.

*Informative: Stub bus protection caters for a fault between the feeder CT and the open disconnector, which would not be cleared by the feeder main protection.*

**6.17** Stub bus protection shall remain blocked while the feeder disconnector is closed.

**6.18** The stub bus protection shall, on operation

- (a) Initiate feeder DTT send functions (see section 6.19)

### Feeder Direct Transfer Tripping (DTT) Functions - Protection Signalling; Command Based

**6.19** All feeders connected to the mesh corner shall have dual Direct Transfer Tripping (DTT) functions (see NGTS 3.24.36) to each remote circuit end.

**6.20** The feeder DTT function shall have the facility to enable initiation inputs to be individually selectable for conditioning by the feeder disconnector, should this be required. The contract will specify this.

*Informative: This facility could be applicable for teed feeder circuits.*

**6.21** The feeder DTT receive function shall, on operation

- (a) Trip the mesh corner circuit breakers
- (b) Initiate transformer HV DTT send function (see section 7.12)
- (c) Initiate CB Fail (see section 4.1)
- (d) Initiate Ferroresonance Scheme (see section 8.41)
- (e) Initiate auto switching (see section 8.33)

**6.22** 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.

## 7 TRANSFORMER HV FUNCTIONAL REQUIREMENTS

*Informative: This section describes all of the functions that may be needed on a mesh corner bay transformer HV, and gives circumstances where functions may not be required. Details of the transformer LV and tertiary functions are contained NGTS 3.24.8.*

### Transformer Main Protection

- 7.1** A main protection, preferably of the numeric type, providing two protection functions driven from a common CT, shall be provided. At least one protection shall be an overall unit protection, which is responsive to both phase to phase and phase to earth faults on the transformer and its associated connections. The other protection shall, as a minimum, be sensitive to earth faults on both HV and LV windings. The protection shall be provided with self-supervision and CT supervision (see NGTS 3.24.65).

*Informative: An acceptable example is a combination of an overall biased differential protection (see NGTS 3.24.65) and a restricted earth fault protection (see NGTS 3.24.65). For double wound transformers there would be separate HV and LV restricted earth fault protection but for auto-transformers there would be a common restricted earth fault protection.*

*Informative: If the protection is of the high impedance type, then duplicate overall protection driven from a common CT, shall be provided. Voltage limiting devices shall also be provided if the voltage developed across the relay circuit during maximum internal fault conditions is greater than 3kV. The characteristic of the voltage limiting device provided shall be declared by the supplier.*

- 7.2** The protection shall be capable of accommodating a change of transformer ratio of  $\pm 20\%$  of nominal and shall not produce an unwanted operation for any transformer energising conditions such as inrush or magnetising conditions.
- 7.3** The primary operating current for earth faults shall be between 10% and 60% of the full load current for the HV winding and, for double wound transformers, between 10% and 25% of the full load current of the LV winding. The protection shall not give an unwanted operation under any normal operating conditions or external fault conditions.
- 7.4** Transformer overall unit protection functions shall, on operation
- (a) Trip the mesh corner circuit breakers
  - (b) Initiate feeder and transformer HV DTT send functions (see sections 6.19 and 7.12 respectively).
  - (c) Initiate CB Fail (see section 4.1)
  - (d) Initiate Ferroresonance Scheme (see section 8.41)
  - (e) Initiate auto switching (see section 8.33)

### **Transformer HV Back Up Protection**

**7.5** Back up protection functions having the following characteristics (see NGTS 3.24.38) shall be provided.

- (a) Two stage HV 3-phase IDMT overcurrent protection
- (b) HV 3-phase instantaneous overcurrent protection with low transient overreach characteristics

**7.6** The back up protection functions shall, on operation have the selectable option to

- (a) Trip the mesh corner circuit breakers
- (b) Initiate feeder and transformer HV DTT send functions (see sections 6.19 and 7.12 respectively).
- (c) Initiate CB Fail (see section 4.1)
- (d) Initiate Ferroresonance Scheme (see section 8.41)
- (e) Initiate auto switching (see section 8.33)

*Informative: The first stage of the two stage overcurrent (7.5(a)) would normally be selected to trip the transformer LV CB only and not initiate Automatic Switching and HV CB Fail.*

### **Transformer HV Stub Bus Protection**

**7.7** Stub bus protection (see NGTS 3.24.38) shall be provided if the transformer is likely to be energised from the LV, for any length of time, with the HV disconnector open. The contract will specify this.

*Informative: Stub bus protection caters for a fault between the CT and the open HV disconnector, which would not be cleared by the transformer main protection.*

**7.8** Stub bus protection shall remain blocked while the transformer HV disconnector is closed.

**7.9** The stub bus protection shall, on operation

- (a) Initiate transformer HV DTT send functions (see section 7.12)

### **Transformer, combined CT/VT and HV Wound VT Mechanical Protections**

**7.10** Mechanical protection functions shall be provided for a number of the following devices, all or some of which are supplied on transformers, combined CT/VT units and wound VTs.

- (a) Gas accumulation and oil surge detector devices
- (b) Winding temperature devices
- (c) Oil level devices

**7.11** Mechanical protection functions shall, on operation have the selectable option to

- (a) Trip the mesh corner circuit breakers
- (b) Initiate feeder and transformer HV DTT send functions (see sections 6.19 and 7.12 respectively).
- (c) Initiate CB Fail (see section 4.1)
- (d) Initiate Ferroresonance Scheme (see section 8.41)
- (e) Initiate auto switching (see section 8.33)

*Informative: The winding temperature (7.10(b)) would normally be selected to trip the transformer LV CB only and not initiate Automatic Switching and HV CB Fail.*