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BUS SECTION AND COUPLER BAY FUNCTIONS

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PURPOSE AND SCOPE

This Specification defines the protection, control and measurements functions and the associated interconnectivity which are required within light current systems on bus section and bus coupler bays at double busbar substations on National Grid's 400, 275 and 132 kV transmission system. It also describes interfaces with other substation functions.

This Specification describes the functional and performance requirements for the protection of 400 kV, 275 kV and 132 kV bus section and bus coupler circuits.

The detailed requirements for back-up protection for bus sections and bus couplers are specified in NGTS 3.24.38 Overcurrent Protection.

The detailed requirements for busbar protection are specified in NGTS 3.24.34 Busbar Protection.

PART 1 – PROCEDURAL

1 FUNCTIONAL REQUIREMENTS

This section describes all of the functions that might be needed on a bus section or bus coupler bay, and gives circumstances where functions may not be required.

1.1 Functions Common to All Bays

- 1.1.1 Unless otherwise stated herein, the requirements of NGTS 3.24.3, Functions Common to All Bays, are applicable to bus section and bus coupler bays.

1.2 Main Protection

- 1.2.1 Overlapping zones of Busbar Protection as specified in NGTS 3.24.34 shall provide the main protection for 400 kV, 275 kV and 132 kV bus sections and bus couplers.

1.3 Back Up Protection

1.3.1 Back-up protection shall be provided for 400 kV and 275 kV bus section and bus coupler bays as below:

- a) Residually connected IDMT earth-fault protection.
- b) 3-phase overcurrent protection for general commissioning purposes and a test socket suitable for connecting specific temporary commissioning protection equipment.

1.3.2 Back-up protection shall be provided for 132 kV bus section and bus coupler bays as below:

- a) Residually connected IDMT earth-fault protection.
- b) 3-phase IDMT overcurrent protection.

1.3.3 The back-up protection shall be supplied by a three phase set of measurements/protection class, or higher class, current transformers located on one side of, and immediately adjacent to, the bus section or bus coupler circuit breaker.

1.3.4 The back-up protection used shall comply with NGTS 3.24.38.

1.3.5 Each back-up protection shall be provided with outputs to trip the circuit breaker.

1.3.6 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 100 Ohm.
- 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 100 Ohm earth is largely independent of source impedances, and is shared between infeeds.

1.3.7 The phase Overcurrent shall be capable of being set to above the maximum emergency load requirements for the circuit.

1.3.8 The back up protection functions shall, on operation:

- a) Trip the bay CB.
- b) Initiate CB Fail (CB Fail should not be initiated by backup earth fault protection).
- c) Trigger the integrated monitor or fault recorder.

1.3.9 The outputs described in 1.3.8 shall be held on long enough for the receiving equipment to function as specified and shall, there after, reset automatically.

1.4 Circuit Breaker Fail Protection

1.4.1 Circuit Breaker Fail (CBF) protection (see NGTS3.24.39) shall be provided for bus section and bus coupler bay Circuit Breakers (CB) at 275 and 400 kV.

1.4.2 On operation, CBF shall cause all other CBs connected to the same busbars to trip.

1.5 Busbar Protection

1.5.1 Bus Section and Bus Coupler bays shall interface with the substation busbar (BB) protection system (see NGTS 3.24.34).

- 1.5.2 On operation, busbar protection shall cause all associated CBs to trip including any connecting bus section and bus coupler bay CBs.

1.6 Instrument Transformer Supervision

- 1.6.1 CTs shall be supervised.
- 1.6.2 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.

1.7 Operational Metering

- 1.7.1 Operational metering functions shall be provided to give indication to the substation control system of phase current.

1.8 System Monitoring

- 1.8.1 Event information is required from bus section and coupler bays. This can be monitored from the nearest suitable bay's integrated monitor or fault recorder with spare capacity or, where required, by a central common integrated monitor or fault recorder. A feeder bay fault recorder or integrated monitor is preferred.

1.9 Manual Control: – 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, usually referred to as the Standby Control Point. Remote is at the National Control Centre (NCC) or National Operations Centre (NOC).

- 1.9.1 Local In/Out switching facilities shall be provided for the commissioning overcurrent relay.
- 1.9.2 When switched out of service these facilities shall achieve the following:
- a) Isolation of the commissioning overcurrent trip, CBF, F/R and alarm outputs.
 - b) Short circuit of the A.C. current connections of the commissioning overcurrent relay, where not integrated with the back up E/F protection.

1.10 Manual Control: – Switchgear Functions

- 1.10.1 The bus section and coupler bay CBs and disconnectors shall provide indications of position to all control points.
- 1.10.2 Earth switches shall provide 'closed' indication to local and standby control points.
- 1.10.3 Bus section and coupler main/reserve disconnectors shall be provided with open and close controls that can be initiated from any control point.
- 1.10.4 Bus section and coupler circuit breakers shall be provided with open and close controls that can be initiated from any control point.
- 1.10.5 Close controls of the CB from standby and remote control positions shall allow closure:
- a) If either Busbar is dead.
 - b) If there is synchronism between the connecting Busbar voltages.

- c) If electrically separate systems are to be connected and the slip frequency and phase angle 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 Busbars' voltages is carried out by the synchronising function.

1.10.6 Close controls of the CB from the local control positions need not be conditioned by the requirements in a), b) and c) of section 1.10.5.

1.10.7 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.

1.11 Control for Bus Sections and Couplers

1.11.1 Sequential Isolation

Section and coupler bays shall be provided with disconnector sequential isolation where required. The contract will state if this is required.

1.11.2 Synchronising

- a) Bus section and bus coupler bays shall be provided with check synchronising and system synchronising functions (see NGTS 3.24.60).
- b) The synchronising function shall be provided with suitable voltage reference signals which are representative of the voltages on each side of the circuit breaker, across which synchronisation is to be checked.

1.11.3 Voltage Selection

- a) Where a dedicated busbar VT is supplied, then this VT shall be used in preference to a voltage selection scheme.
- b) Where a dedicated bus bar VT is not available, then a voltage selection scheme shall be provided to supply equivalent representative system voltage to the synchronising function.

1.11.4 Interlocking

- a) An Interlocking function shall be provided to ensure safe operation of bay switchgear, ensuring that a bus section or bus coupler CB is only closed with its associated disconnectors both open or both closed. See NGTS 3.24.43.
- b) The bay shall provide outputs to the substation interlock system to ensure safe operation of other substation switchgear.

2 INTERFACE REQUIREMENTS

Informative: The required interconnections between the bay functions and between the bay and the rest of the substation for a 'typical' bus section and bus coupler bay are shown in the series of diagrams in Appendix A.

2.1 General

- 2.1.1 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).

- 2.1.2 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).

- 2.1.3 Each function shall be provided with a substation time reference.

- 2.1.4 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.

2.2 Protection

- 2.2.1 Busbar protection functions shall be connected as described in NGTS 3.24.34.

- 2.2.2 Backup protection functions shall be connected to protection class current transformers such as class 5P20 (see NGTS 3.2.4).

- 2.2.3 Each protection function shall also provide events inputs to the fault recording function.

2.3 Operational Metering

- 2.3.1 CT inputs shall be derived from the Measurement/Protection class current transformers such as class 5P20 (see NGTS 3.2.4).

- 2.3.2 Outputs shall be provided to the SCS of analogue indication and alarms.

2.4 System Monitoring

- 2.4.1 Switchgear position indications, protection function outputs and other plant status and condition indications shall be provided to the System Monitoring functions ie integrated monitor or fault recorder.

- 2.4.2 Specifically, bus section and bus coupler circuit breaker position and busbar and back up protection trip commands shall be monitored.

- 2.4.3 Only the operation of bus section and bus coupler trip relays (not change of switchgear position) shall trigger a recording of the system monitoring function.

- 2.4.4 Reserve bus bar section isolators, without a bus section circuit breaker (X166 and X169), shall be monitored for position, eg by series connection of their auxiliary switches.

2.5 Control for Bus Sections and Bus Couplers

- 2.5.1 CB closing via substation control shall be conditioned by the Synchronising functions.

2.6 Manual Control for Bay Plant

- 2.6.1 Substation control (SCS) shall provide control outputs for switchgear operation, and switching protection and control functions as required.

- 2.6.2 SCS shall receive alarms and indications (including analogue) from plant items and control, operational metering and protection functions. The specifications for these functions list the required inputs.

2.7 Interconnection Detail Tables

Informative: The following tables should be read in conjunction with the diagrams shown in Appendix A. Each table entry refers to a connection on the drawing to which it relates, eg the table headed Sheet 3 BU refers to drawing BU-Sheet 3. On that drawing is shown a connection numbered 'BU 1' and labelled 'CB Trip 1' which is the tripping signal to the circuit breaker's first trip system (shown on sheet CB) and is initiated by the 'BUP operated' output. In the table this is described in line Spec Ref which shows both the connection number (sheet ref) and label. It also shows, under 'Other Ref', the connection number when it arrives at sheet CB.

Sheet 3 BU

Spec Ref	This Sheet Ref	Other Sheet Ref	Label	Initiations	Comments
2.7.1	BU1	CB 1	CB TRIP1	Back up Protection operated	TRIP output to the bay circuit breaker first trip system.
2.7.2	BU2	CB 2	CB TRIP2	Back up Protection operated	TRIP output to the bay circuit breaker second trip system.
2.7.3	BU3	BB 8	START CBF	Back up Protection operated	TRIP output to initiate the CB fail function.
2.7.4	BU4	IM 5	FR TRG	Back up Protection operated	TRIP output to trigger the fault recorder function and to mark an event record.
2.7.5	BUA1	SCS A3	Events/Alarms/Indications		The alarms and indications are shown in NGTS 3.24.38
2.7.6	BUA2	SCS A5	Operational Metering Data		This shall give an output of operational metering data to the SCS (sheet 6).
2.7.7	BUA3	SCS A3	Events/Alarms/Indications		The alarms and indications are shown in NGTS 3.24.72/73
2.7.8	BU5	CB 7	CT		Input from 3-phase protection class current transformers such as 30VA, class 5P20.