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Specification

Series Reactor Bay

NGTS 3.24.10
Issue 1
April 2001

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SERIES REACTOR BAY

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 series reactor bays at double busbar or other substations on National Grid's 400, 275 and 132 kV transmission systems. It also describes interfaces with other substation functions.

2 REFERENCES

This Specification makes reference to, or should be read in conjunction with the following documents:

NGTS 3.24.65 Overall Protection

NGTS 3.24.38 Overcurrent Protection

NGTS 3.24.39 CB Fail Protection

NGTS 3.24.34 Busbar Protection

NGTS 3.24.60 Synchronising

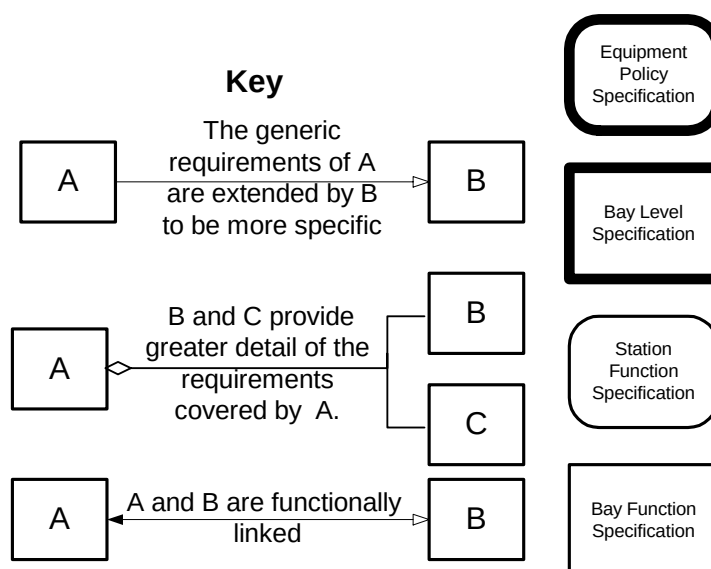
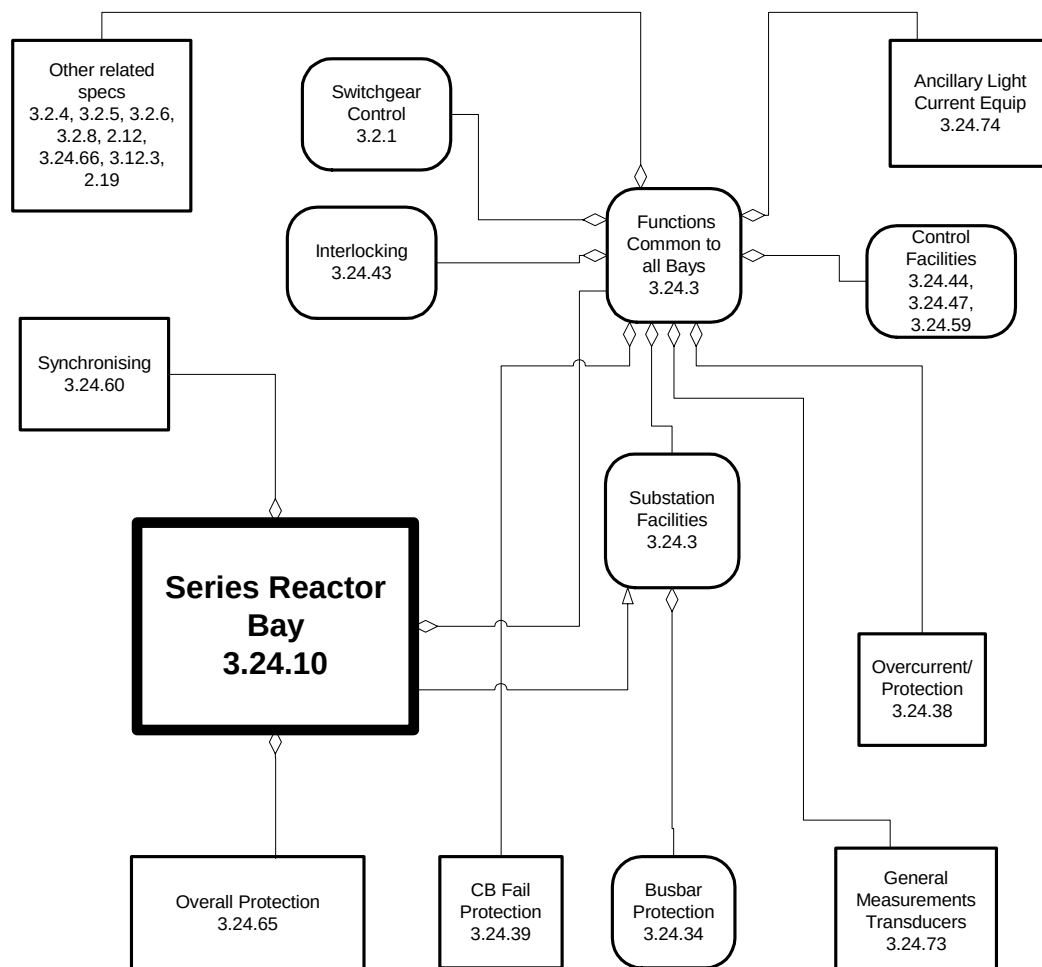
NGTS 3.24.43 Interlocking

NGTS 3.2.1 Switchgear Control

NGTS 3.24.3 Substation Facilities and Functions Common to all Bays

.....

Substation Information, Control, Protection and Metering Functional Relationships



3 DEFINITIONS

Series Reactor circuit – High voltage connections consisting of conductors, circuit breakers, disconnectors and a reactor connected between two busbars. Refer to Appendix A, sheet 2 for drawing.

Series Reactor Bay – The equipment at a substation that is dedicated to a Series Reactor circuit.

DTT – Direct Transfer Trip.

DAR – Delayed Auto-Reclose.

4 FUNCTIONAL REQUIREMENTS

Informative: This section describes all of the functions that might be needed on a series reactor bay, and gives circumstances where functions may not be required. The section also describes the functional requirements for a series reactor connected in a feeder.

Main Protection

- 4.1 Duplicate overall unit protection driven from separate current transformers shall be provided at 400 and 275 kV if non-numerical relays are offered.

Informative: An example of an acceptable scheme is two high impedance circulating current relays providing the first and second overall unit protection.

- 4.2 Each protection shall be responsive to both phase faults and earth faults on the series reactor and associated connections.

- 4.3 A single numerical relay is acceptable for providing the main protection. The relay shall provide an overall unit protection function which is responsive to both phase faults and earth faults on the series reactor and associated connections, and a unit protection function, as a minimum, responsive to earth faults on the series reactor and associated connections.

Informative: An example of an acceptable scheme is a single overall biased differential relay providing the first overall unit protection with a restricted earth fault protection function providing the second unit protection.

- 4.4 At 132 kV only a single overall unit protection is required. The protection shall be responsive to both phase faults and earth faults on the series reactor and associated connections.

- 4.5 If a biased differential principle is used, the protection shall comply with the requirements of IEC 255-13.

- 4.6 The primary operating current of the protection shall be between 10% and 30% of minimum fault current available for a fault at the reactor terminals if a high impedance scheme is offered.

- 4.7 The protection shall not give an unwanted operation under all normal operating conditions and all external fault conditions up to the maximum through-fault current limited only by the impedance of the series reactor itself.

- 4.8 Operation of a main protection function shall:

- (a) Trip bay 1 and bay 2 circuit breakers.
- (b) Initiate bay 1 and bay 2 CB fail protection where appropriate.
- (c) Initiate disconnector sequential isolation where required.
- (d) Initiate trip relay reset where required.

4.9 Where a series reactor is installed in a feeder, operation of a main protection function shall:

- (a) Trip the feeder bay circuit breaker.
- (b) Initiate feeder CB fail protection where appropriate.
- (c) Initiate DTT functions.
- (d) Block DAR.
- (e) Initiate disconnector sequential isolation where required.
- (f) Initiate trip relay reset where required.

Back Up Protection

4.10 Back up protection shall be provided in accordance with NGTS 3.24.38 and shall consist of two IDMT earth-fault protections, one on each side of the reactor.

4.11 Operation of either backup protection shall:

- (a) Trip bay 1 and bay 2 circuit breakers.
- (b) Initiate bay 1 and bay 2 CB fail protection where appropriate.
- (c) Initiate disconnector sequential isolation where required.
- (d) Initiate trip relay reset where required.

4.12 Where a series reactor is installed in a feeder circuit, account shall be taken of the back-up protection already provided for the feeder circuit.

Mechanical Protection

4.13 Gas and oil actuated relays specified in NGTS 2.3 shall be provided to protect each separate oil filled tank associated with the series reactor against loss of oil and oil surge.

4.14 The gas and oil actuated relay surge contact shall only be connected to trip where the supplier demonstrates that it is immune to operation on through faults and start of pumps. Where this is not demonstrated the surge contact is only required to be connected in parallel with the alarm contact.

4.15 Winding temperature instruments specified in NGTS 2.3 shall be provided to protect the series reactor from winding over temperature.

4.16 Operation of the mechanical protection shall:

- (a) Trip bay 1 and bay 2 circuit breakers.
- (b) Initiate bay 1 and bay 2 CB fail protection where appropriate.
- (c) Initiate disconnector sequential isolation where required.
- (d) Initiate trip relay reset where required.

4.17 Where a series reactor is installed in a feeder, operation of the mechanical protection shall:

- (a) Trip the feeder bay circuit breaker.
- (b) Initiate feeder CB fail protection where appropriate.
- (c) Initiate DTT functions.
- (d) Block DAR.

- (e) Initiate disconnector sequential isolation where required.
- (f) Initiate trip relay reset where required.

Tripping Arrangements

- 4.18** At 400 and 275 kV, the tripping system shall be arranged as follows if two high impedance circulating current relays are offered for the main 1 and main 2 protection:

Tripping system 1 of bay 1 and bay 2 circuit breakers:

- (a) First overall unit protection
- (b) Earth fault protection 1
- (c) Gas and oil actuated protection

Tripping system 2 of bay 1 and bay 2 circuit breakers:

- (a) Second overall protection
- (b) Earth fault protection 2
- (c) Winding temperature protection

- 4.19** At 400 and 275 kV, the tripping system shall be arranged as follows if a single numerical relay is offered for the overall biased differential protection and REF protection:

Tripping system 1 of bay 1 and bay 2 circuit breakers:

- (a) Overall biased differential protection and REF protection
- (b) Earth fault protection 1

Tripping system 2 of bay 1 and bay 2 circuit breakers:

- (a) Overall biased differential protection and REF protection
- (b) Earth fault protection 2
- (c) Winding temperature protection
- (d) Gas and oil actuated protection

- 4.20** The auxiliary supply for the single numerical relay shall be from the battery system that supplies the tripping system 1.

- 4.21** At 132 kV all series reactor protection shall operate into a single tripping system.

Circuit Breaker Fail Protection

- 4.22** Circuit Breaker Fail (CBF) protection (see NGTS 3.24.39) shall be provided for the bay 1 CB and bay 2 CB at 400 and 275 kV.

- 4.23** Operation of the CB fail protection shall initiate tripping of all CBs capable of providing fault infeed to the busbar including the CB connected to the remote side of the reactor.

Busbar Protection

- 4.24** The series reactor bay 1 and bay 2 shall interface with the substation Busbar (BB) protection systems (see NGTS 3.24.34).

- 4.25** Operation of the busbar protection shall initiate tripping of both bay 1 and bay 2 CBs and, if appropriate, initiate circuit breaker fail protection of bay 1 and bay 2 CBs.

- 4.26 Where a series reactor is installed in a feeder, refer to feeder bay specification (NGTS 3.24.7) for the busbar protection requirements.

Phase Unbalanced detector

- 4.27 A phase unbalance detector function shall be provided that initiates an alarm for a sustained unbalanced load current where required. The contract will state when this is required.

Instrument Transformer Supervision

- 4.28 CTs shall be supervised.
- 4.29 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

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

Manual Control for Series Reactors: – Switchgear 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 Control Centre (NCC) or National Operations Centre (NOC)

- 4.31 The circuit breaker and disconnectors of series reactor bays shall provide indications of position to all control points.
- 4.32 Earth switches shall provide 'open and closed' indication to local and standby control points.
- 4.33 The reactor's main and reserve busbar disconnectors shall be provided with open and close controls that can be initiated from any control point.
- 4.34 The reactor bay circuit breaker shall be provided with open and close controls that can be initiated from any control point.
- 4.35 Close controls of the CB from substation and remote control positions shall allow closure:
- (a) If the reactor is dead.
 - (b) If there is synchronism between the reactor and the Busbar voltages.
 - (c) If electrically separate systems are to be connected and the slip frequency between the reactor and the Busbar voltages 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 reactor and Busbar voltages is carried out by the synchronising function (see section 4.39).

- 4.36 Close controls of the CB from the local control positions need not be conditioned by the requirements in section 4.35 (a), (b) and (c).
- 4.37 In some cases bay earth switches may be motor operated. The open and close controls shall be available 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 Series Reactors

Sequential Isolation

- 4.38** Series Reactor Bay shall be provided with disconnecter sequential isolation where required. The contract will state if this is required.

Synchronising

- 4.39** Series Reactor Bay shall be provided with check synchronising and system synchronising functions (see NGTS 3.24.60).

Voltage Selection

- 4.40** Where a dedicated bay VT is installed, it shall provide a voltage input (incoming voltage) to the Synchronising functions for the incoming voltage signal.
- 4.41** Where a bay VT is not available, the voltage selection scheme shall provide a voltage reference for the incoming voltage signal.
- 4.42** 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 4.39.

Interlocking

- 4.43** An Interlocking function shall be provided to ensure safe operation of bay switchgear – see NGTS 3.24.43.
- 4.44** The bay shall provide outputs to the substation interlock system to ensure safe operation of other substation switchgear.

5 INTERFACE REQUIREMENTS

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

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** The main overall protection 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 Each high impedance busbar protection function shall be connected to class X type B current transformers. Where on new installations, each low impedance busbar protection function shall be connected to protection class current transformers such as class 5P20 (See NGTS 3.2.4) where it can be demonstrated that the protection offered will work satisfactorily with this class of CT for all system conditions.
- 5.7 Backup protection functions shall be connected to protection class current transformers such as class 5P20 (See NGTS 3.2.4).

Operational Metering

- 5.8 CT inputs shall be derived from the Measurement/Protection class current transformers such as class 5P20. (See NGTS 3.2.4).
- 5.9 Outputs shall be provided to the SCS of analogue indication and alarms.

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 Overall Protection – OAP refers to drawing OAP-Sheet 3. On that drawing there is a connection numbered 'OAP 1' and labelled 'CB1 Trip 1' which is the tripping signal to the bay 1 circuit breaker's first trip system (shown on sheet CB1) and is initiated by the 'OAP1 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 Sheet Ref', the connection number when it arrives at sheet CB1.

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SHEET 3 Overall Protection – OAP

Spec Ref	This Sheet Ref	Other Sheet Ref	Label	Initiations	Comments
5.10	OAP 1	CB1 1	CB1 TRIP 1	Overall Prot. 1 operated Mechanical Prot. operated	TRIP output to the bay 1 circuit breaker first tripping system.
5.11	OAP 2	CB2 1	CB2 TRIP 1	Overall Prot. 1 operated Mechanical Prot. operated	TRIP output to the bay 2 circuit breaker first tripping system.
5.12	OAP 3	BB1 14	Start CB1F	Overall Prot. 1 operated Overall Prot. 2 Operated Mechanical Prot. Operated Winding Temp operated	Any bay 1 tripping initiate bay 1 CB fail.
5.13	OAP 4	BB2 14	Start CB2F	Overall Prot. 1 operated Overall Prot. 2 Operated Mechanical Prot. Operated Winding Temp operated	Any bay 2 tripping initiate bay 2 CB fail.
5.14	OAP 6	CB1 2	CB1 TRIP 2	Overall Prot. 2 operated Winding Temp operated	TRIP output to the bay 1 circuit breaker second tripping system.
5.15	OAP 7	CB2 2	CB2 TRIP 2	Overall Prot. 2 operated Winding Temp operated	TRIP output to the bay 2 circuit breaker second tripping system.
5.16	OAP 8	CB1 11	CT		Input from 3 phase class X type A bay 1 current transformers.
5.17	OAP 9	CB2 11	CT		Input from 3 phase class X type A bay 2 current transformers.
5.18	OAP A1	SCS1 A3	EVENT/ALARMS INDICATIONS		The alarms and indications are described in NGTS 3.24.65.
5.19	OAP A2	SCS1 A9	EVENT/ALARMS INDICATIONS		The alarms and indications are described in NGTS 3.24.65.



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SHEET 4 BU1 (bay 1)

Spec Ref	This Sheet Ref	Other Sheet Ref	Label	Initiations	Comments
5.20	BU1 1	CB1 1	CB1 TRIP1	Back up Protection 1 operated	TRIP output to the bay 1 circuit breaker first tripping system.
5.21	BU1 2	CB2 1	CB2 TRIP1	Back up Protection 1 operated	TRIP output to the bay 2 circuit breaker first tripping system.
5.22	BU1 3	BB1 14	START CB1F	Back up Protection 1 operated	Backup tripping initiate bay 1 CB fail.
5.23	BU1 4	BB2 14	START CB2F	Back up Protection 1 operated	Backup tripping initiate bay 2 CB fail.
5.24	BU1 6	CB1 12	CT		Input from 3-phase protection class current transformers such as 30VA, class 5P20.
5.25	BU1 A1	SCS1 A4	Events/Alarms/Indications		The alarms and indications are shown in NGTS 3.24.38
5.26	BU1 A2	SCS1 A7	Operational Metering Data		This shall give an output of operational metering data to the SCS.
5.27	BU1 A3	SCS1 A4	Events/Alarms/Indications		The alarms and indications are shown in NGTS 3.24.72/73

