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MECHANICALLY SWITCHED CAPACITOR BAY FUNCTIONS

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PURPOSE AND SCOPE

The Technical Specifications for all new plant, equipment, apparatus and services, for use on the National Grid Electricity Transmission system, are contained in a three level hierarchy of documents. Level 1 covers ratings and general requirements, Level 2 covers major plant categories and Level 3 covers specific related plant functions.

This document is a Level 3 specification, which describes the functional and performance requirements for the protection, control and measurements and associated interconnectivity of Mechanically Switched Capacitors connected at 400 kV, 275 kV, 132 kV and 13 kV at National Grid substations. It also describes interfaces with other substation functions.

PART 1 – PROCEDURAL

1 FUNCTIONAL REQUIREMENTS

The MSC protection system shall comprise main protection, backup protection and mechanical protection. For 400 kV and 275 kV MSCs, the protection devices shall all operate into two independent circuit breaker tripping systems.

1.1 General

Informative: For the purposes of this Specification Mechanically Switched Capacitors incorporating damping networks (MSC) may comprise primary components (i) Capacitor Bank(s), (ii) Reactor(s), (iii) Resistor Bank(s) and Voltage Transformer. The arrangement of capacitor(s), reactor(s) and resistor(s) to form the MSC has not been specified as this may vary.

The Contractor shall specify the particular MSC design, meeting TS 2.21 or TS 2.26, to be offered under the contract and provide details of the protection, control and metering arrangements demonstrating compliance with this functional specification.

Informative: A typical primary circuit configuration of a MSC bay is given in Sheet 2 of Appendix A.

1.2 Main Protection

Main Protection shall comprise MSC Overall Protection function, Capacitor Protection functions, Thermal Overload Protection functions for reactors and resistors bank and Resistor Open Circuit Protection function.

Informative: The acceptable options for integration of protection functions are given in Appendix B.

1.3 MSC Overall Protection

An overall protection (see TS 3.24.65) shall be provided for all MSCs. The protection shall be responsive to both phase and earth faults.

The protection shall be stable for inrush or outrush transients and harmonics, and shall not give an unwanted operation under any normal operating conditions or external fault conditions.

The setting range of the protection shall include 10 % - 30 % of the rated current of the MSC.

If the overall protection is of high impedance type, duplicated overall protection driven from a common current transformer shall be provided for 400 kV and 275 kV MSCs.

1.4 Capacitor Protection

Capacitor protection functions shall be provided for each capacitor bank, e.g. the main (C1) and auxiliary (C2) capacitor bank forming an MSCDN. Each shall comprise excessive RMS overcurrent protection, overvoltage protection and out-of-balance protection unless the Contractor can demonstrate that the capacitor bank is adequately protected by alternative protection functions.

1.5 Capacitor Excessive RMS Overcurrent Protection

Two-stage three-phase excessive RMS overcurrent protection (see TS 3.24.77) shall be provided for each capacitor bank. The first stage is for alarm purposes and the second stage is for tripping, both of which are time delayed.

The current setting range of the protection shall include 100 % - 200 % of the rated current of the capacitor bank at rated sinusoidal voltage and frequency. The setting range of each time delay shall include 0.1 s - 5 s in steps of not greater than 0.1s.

1.6 Capacitor Overvoltage Protection

Two-stage overvoltage protection (see TS 3.24.77) shall be provided for each capacitor bank. The first stage is for alarm purposes and the second stage is for tripping, both of which are time delayed.

The voltage setting range of the protection shall include 100 % - 150 % of the rated voltage of the capacitor bank. The setting range of each time delay shall include 0.1 s - 5 s in steps of not greater 0.1 s.

The Contractor shall declare how the capacitor overvoltage protection is applied to each capacitor bank.

1.7 Capacitor Out-of-Balance Protection

Three-stage capacitor out-of-balance protection (see TS 3.24.77) shall be provided for each capacitor bank. The first stage is for alarm purposes and the second and third stages are for tripping, all of which are time delayed.

The requirements for the three stages of protection are defined for both externally and internally fused capacitor banks in TS 3.24.77.

The Contractor shall declare how the capacitor out-of-balance protection is applied to each capacitor bank.

Where the discharge current which occurs due to the short circuit of a capacitor unit is of sufficient magnitude to cause unacceptably high voltages on the secondary wiring of the out-of-balance protection, effective means of limiting this voltage shall be employed.

1.8 Reactor Thermal Overload Protection

Where the reactor supplied is of the dry type, two-stage thermal overload protection (see TS 3.24.78) shall be provided. The first stage is for alarm purposes and the second stage is for tripping.

The current setting range of the protection shall include 50 % - 150 % of the rated current of the reactor.

1.9 Resistor Thermal Overload Protection

Two-stage thermal overload protection (see TS 3.24.78) shall be provided for each resistor bank. The first stage is for alarm purposes and the second stage is for tripping.

The current setting range of the protection shall include 50 % - 150 % of the rated current of the resistor bank.

1.10 Resistor Open Circuit Protection

Informative: On National Grid's system each resistor bank consists of two parallel branches (see TS 3.11.2).

Resistor open circuit protection shall be provided for each resistor bank. The protection shall be able to detect resistor open circuit and high resistance fault conditions.

The protection shall be stable for inrush or outrush transients and harmonics and shall not give an unwanted operation under any normal operating conditions or external fault conditions.

The supplier shall declare the method of measurement employed by the protection.

The protection shall give a trip output after a time delay. The setting range for the time delay shall include 0.1 s – 5 s in steps of not greater than 0.1 s.

2 OPERATIONS OF MSC PROTECTIONS

2.1 400 kV and 275 kV MSCs

MSC Main protection functions shall be grouped into two systems (Main Protection 1 and Main Protection 2).

Informative: The contractor shall provide information on how the main protection functions are grouped. A typical example of the grouping of main protection functions is given in Sheets 3 and 4 of Appendix A.

Main Protections 1 and Main Protection 2 shall trip bay CB via both Trip System 1 & Trip System 2 interfaces.

Main protection functions shall on operation

- a) Trip the bay CB
- b) Initiate circuit breaker fail (CBF) protection (see section 3.4).
- c) Lockout Automatic Reactive Switching (ARS) control (see section 3.17).

2.2 132 kV MSCs

MSC Main protection functions shall be grouped into one system (Main Protection).

Main protection functions shall on operation

- a) Trip the bay CB.
- b) Lockout ARS control (see section 3.17).

2.3 13 kV MSCs (Transformer Tertiary Winding Connections)

MSC Main protection functions shall be grouped into one system (Main Protection).

Main protection functions shall on operation

- a) Trip the bay CB.
- b) Lockout ARS control (see section 3.17).

2.4 Back-Up Protection

For 400 kV, 275 kV and 13 kV MSCs, a back-up protection having an overcurrent function with a DTOC characteristic (see TS 3.24.38) shall be provided.

For 132 kV MSCs connected to common banking connections, a back-up protection having an overcurrent function with an IDMT characteristic (see TS 3.24.38) shall be provided.

The back-up protection function shall consist of three-phase overcurrent and a residually connected earth fault protection.

The DTOC function shall be provided with a current setting range of 50 % - 200 % and 20-80 % (based on 1 A secondary corresponding to approximately full load current of the MSC) for overcurrent protection and earth fault protection respectively and a time setting range of 0.1s – 5 s in step of not greater than 0.1 s.

The IDMT function shall be provided with a current setting range of 50 % - 200 % and 20 % - 80 % (based on 1 A secondary corresponding to approximately full load current of the MSC) for overcurrent protection and earth fault protection respectively.

The back-up protection shall be stable for any inrush or outrush transients.

For 400 kV and 275 kV MSCs the back-up protection functions shall trip bay CB via both Trip System 1 and Trip System 2 interfaces.

The back-up protection function shall on operation

- a) Trip the bay CB.
- b) Initiate CBF protection (see section 3.4) where appropriate.
- c) Lockout ARS control (see section 3.17).

3 OPERATIONS OF OTHER PROTECTIONS

3.1 Mechanical Protection

3.2 Reactor Oil Temperature Protection

Where the reactor supplied is of the oil filled type, oil temperature instruments (see TS 2.3), with alarm and trip stages shall be provided to protect each separate oil filled tank from oil over temperature.

3.3 Reactor Gas and Oil Actuated Protection

Where the reactor supplied is of the oil filled type, gas and oil actuated relays (see TS 2.3) shall be provided to protect each separate tank associated with the reactor against loss of oil and oil surge.

3.4 Voltage Transformer Gas and Oil Actuated Protection

Where a wound oil-filled voltage transformer is installed on the MSC, then it shall be provided with a gas and oil actuated relay (see TS 2.3) to protect against gas accumulation, loss of oil and oil surge.

For 400 kV and 275 kV MSCs, mechanical protection functions shall trip bay CB via both Trip System 1 and Trip System 2 interfaces.

Mechanical protection functions shall on operation

- a) Trip the bay CB.
- b) Initiate CBF protection (see section 3.4) where appropriate.
- c) Lockout ARS control (see section 3.17).

3.5 Circuit Breaker Fail Protection

Circuit breaker fail (CBF) protection (see TS 3.24.39) shall be provided for the MSC bay circuit breakers at 400 kV, 275 kV.

On operation CBF protection shall: -

- a) Trip other CBs connected to the same busbar or mesh corner.
- b) Initiate the DTT send functions of each transformer and feeder connected to the same mesh corner where appropriate (see TS 3.24.6).
- c) Lockout ARS control (see section 3.17).

3.6 Busbar Protection

At 400 kV and 275kV busbar substations, the MSC bay shall interface with the substation busbar (BB) protection (see TS 3.24.34) where appropriate.

On operation, BB protection shall

- a) Trip the bay CB.
- b) Initiate CBF protection (see section 3.4) where appropriate.
- c) Lockout ARS control (see section 3.17).

3.7 Common Banking Connection Protection

For 132 kV MSCs connected to a common banking connection, the MSC bay shall interface with the common banking connection protection.

On operation common banking protection shall

- a) Trip the bay CB.
- b) Lockout ARS control of all MSCs connected to the common banking connection (see section 3.17).

3.8 MSC Direct Transfer Trip

3.8.1 For MSCs connected to 400 kV and 275 kV mesh substations, the MSC bay shall interface with the following

- a) Mesh corner protection (see TS 3.24.6).
- b) Protection functions associated with transformers connected to the same mesh corner where appropriate (see TS 3.24.8).
- c) Protection and DTT functions associated with feeder circuits connected to the same mesh corner where appropriate (see TS 3.24.6).

3.8.2 For MSCs connected to transformer LV connections or tertiary winding connections and the associated supergrid transformers are connected to 400 kV and 275 kV mesh corners, requirements stated in section 3.7 apply.

3.8.3 For MSCs connected to transformer LV connections or tertiary winding connections where the associated supergrid transformers are not connected to mesh corners, the MSC bay shall interface with the following

- a) Protection functions associated with transformers and transformer tertiary winding connections (see TS 3.24.8).

3.8.4 Receipt of MSC direct transfer trip (MSC DTT) shall

- a) Trip the bay CB.
- b) Initiate CBF protection (see section 3.4) where appropriate.
- c) Lockout ARS control (see section 3.17).

3.9 Phases Unbalanced Detector

A phases unbalanced detector function shall be provided to initiate an alarm for a sustained unbalanced load current.

3.10 Instrument Transformer Supervision

Functions which use signals from VTs shall be provided with a VT supervision function.

The VT supervision function shall initiate an alarm on VT failure.

CTs shall be supervised.

The CT supervision 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.

3.11 Operational Metering

Operational metering functions shall be provided to give indications to the Substation Control System (SCS) of

- a) System voltage.
- b) Reactive power.

3.12 System Monitoring

The following system monitoring functions shall be provided:

- a) Quality of supply monitoring.
- b) Fault recording.

3.13 Manual Control for MSCs

The MSC bay CB and disconnectors shall provide indications of position to all control points.

Earth switches shall provide 'closed' indication to local and standby control points.

The MSC's disconnector shall be provided with open and close controls that can be initiated from any control point.

At 400 kV and 275 kV busbar substations the MSC's main and reserve busbar disconnectors shall be provided with open and close controls that can be initiated from any control point.

The MSC's circuit breaker (CB) shall be provided with open and close controls that can be initiated from any control point.

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 earth switches provided. The contract will state when this is required.

3.14 Point-on-wave Switching Control

Point-on-wave switching control (POW) function (see TS 3.24.54) shall be provided for 132 kV MSCs where a damping network is not installed. The contract will state if the damping network is required for the MSCs.

The POW function shall control the CB closing instant such that the disturbances caused by the MSC switching are minimised.

3.15 Sequential Isolation

MSC bays shall be provided with MSC disconnecter sequential isolation where required. The contract will state if this is required.

3.16 Voltage Selection

Where appropriate the substation voltage selection function shall provide a reference voltage input that represents the voltage of the busbar to which the MSC bay is selected for the purpose of point-on-wave switching control.

3.17 Interlocking

An interlocking function shall be provided to ensure safe operation of MSC bay switchgear.

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

3.18 Automatic Reactive Switching

Automatic reactive switching (ARS) control function (see TS 3.24.42) shall be provided for all MSCs.

4 INTERFACE REQUIREMENTS

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

4.1 General

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 (see TS 3.24.4).

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 (see TS 3.24.4).

Each function shall be provided with a substation time reference.

Instrument transformer shall be conventional electromagnetic devices as specified in TS 3.2.4 and TS 3.2.5

Informative: National Grid will consider instrument transformers using other technologies.

4.2 Protection Trip Systems

Two separately energised independent tripping systems shall be provided.

The tripping systems shall be designed to operate from 110V DC battery systems specified in TS 3.12.4.

Each tripping system shall be provided with a separately fused supply fed from different batteries.

High burden self resetting trip relay(s) shall be provided for each tripping system.

Informative: Where the trip relays are used to lockout DAR for persistent faults, high burden electrically resetting trip relay(s) shall be provided for each tripping system.

The outputs of all MSC protections shall operate in to both tripping systems.

Operation of the tripping systems from the protections shall be conditioned by auxiliary switches on the appropriate primary disconnectors to inhibit tripping when the protected MSC is disconnected from the system.

4.3 Routine Protection Operation Tests

A secure test facility shall be provided to initiate the tripping of the MSC circuit from the MSC main protection by simulating an MSC fault. The facility shall initiate tripping, DTT, CBF, fault recorders etc.

Informative: The circuit shall be in service and energised, with all protection systems in service. Correct operation of primary equipment at all circuit ends shall be verified and the correct operation of intertripping, (remote) alarms, indications and shall be verified. The circuit shall be returned to service after the trip.

4.4 Test / Normal Facility

A Test / Normal facility shall be provided by means of a 'lockable' selector switch. When in the "Test" position the following shall apply;

- a) Isolate the Tripping functions
- b) Disable the DTT Send function (if applicable)
- c) Generate alarm(s) when in the "Test" position for each protection function affected

Informative: 'Lockable' shall be by means of a unique key or padlock facilities to accept a 5mm diameter and 30mm hasp.

4.5 Protection

MSC overall protection shall be connected to Type B current transformers or measurement/protection current transformers Class 5P20 as appropriate.

Capacitor excess RMS overcurrent protection shall be connected to measurement/protection current transformers associated with the capacitor bank.

Capacitor overvoltage protection shall be connected to MSC voltage transformers where appropriate.

Capacitor out-of-balance protection shall be connected to measurement/protection current transformers associated with the capacitor bank.

Reactor thermal overload protection shall be connected to measurement/protection current transformers associated with the reactor.

Resistor thermal overload protection shall be connected to measurement/protection current transformers associated with the resistor bank.

Resistor open circuit protection shall be connected to measurement/protection current transformers associated with the resistor bank where appropriate.

Back-up protection shall be connected to measurement/protection current transformers.

Mechanical protection shall be provided by oil temperature instruments and gas and oil actuated relays (see TS 2.3) as appropriate.

Circuit breaker fail protection shall be connected to measurement/protection current transformers.

Busbar protection function shall be connected to Type B current transformers or measurement/protection Class 5P20 current transformers as appropriate.

132 kV common banking connection protection shall be connected to Type B current transformers or measurement/protection Class 5P20 current transformers as appropriate.

Each protection function shall provide event input to the fault recorder function.

4.6 Operational Metering

VT inputs shall be derived from the MSC voltage transformers (capacitor discharge VTs) (see TS 3.2.5).

CT inputs shall be derived from the measurement/protection current transformers Class 5P20 (see TS 3.2.4) as appropriate. The CT ratio shall be chosen to give approximately 1 A secondary at MSC full load.

Outputs shall be provided to the SCS of analogue indications and alarms.

4.7 System Monitoring

VT inputs shall be derived from the MSC voltage transformers (capacitor discharge VTs) (see TS 3.2.5).

VT input shall be derived from single phase CVT connected to the incoming side of the MSC circuit breaker (see TS 3.2.5) where appropriate.

CT inputs shall be derived from the measurement/protection current transformers Class 5P20 (see TS 3.2.4). The CT ratio shall be chosen to give approximately 1 A secondary at MSC full load.

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.

4.8 Point-on-wave Switching Control

VT inputs shall be derived from substation voltage selection system (see section 3.15)

CT inputs shall be derived from measurement/protection current transformers where appropriate.

Inputs from transducers located at the MSC circuit breaker shall be provided to the POW function where appropriate.

Inputs from circuit breaker main contact proximity sensors shall be provided to the POW function where appropriate.

4.9 Manual Control for MSCs

The Substation Control System (SCS) shall provide control outputs for switchgear operation.

The 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.

4.10 General

The performance requirements for other protections are given in the appropriate level 3 Technical Specifications.

The protection shall perform correctly in accordance with the requirements of this TS, for the range of power system conditions specified in TS 1 and the range of environmental conditions specified in TS 3.24.15.

5 INTERCONNECTION DETAILS - TABLES FOR 400 KV AND 275 KV MSCS

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 e.g. the table headed Sheet 3 MP1 refers to drawing MP1-Sheet 3. On that drawing is shown a connection number 'MP1 2' and labelled 'CB Trip 1 & 2' which is the tripping signal to the circuit breaker's Trip Circuit 1 & Trip Circuit 2 (shown on Sheet CB) and is initiated by the 'MP 1 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.

5.1 Sheet 3 MP1

Spec Ref	This Sheet Ref	Other Sheet Ref	Label	Initiations	Comments
5.1.1	MP1 1	ARS 7	LOCKOUT ARS	MP 1 Operated	TRIP output to lockout Automatic Reactive Switching.
5.1.2	MP1 2	CB 1	CB TRIP 1 & 2	MP 1 Operated	TRIP output to the MSC circuit breaker – via Trip Circuit 1 & Trip Circuit 2.
5.1.3	MP1 3	BB 9 or CBF 10	START CBF	MP 1 Operated	TRIP output to initiate the CB fail function.
5.1.4	MP1 4	IM 8	FR TRG	MP 1 Operated	TRIP output to trigger the fault recorder.
5.1.5	MP1 5	CB 17	MSC disc closed	MSC disconnecter closed	Closed position indication from the MSC disconnecter if required.
5.1.6	MP1 6	CB 7	CT		Input from 3 phase measurement/protection current transformers.
5.1.7	MP1 7	CB 8	VT		Input from 3 phase MSC VT (if required by the Capacitor Protection)
5.1.8	MP1 A1	SCS A4	EVENTS/ALARMS/INDICATIONS		The alarms and indications are described in TS 3.24.65 and TS 3.24.77

5.2 Sheet 4 MP2

Spec Ref	This Sheet Ref	Other Sheet Ref	Label	Initiations	Comments
5.2.1	MP2 1	ARS 7	LOCKOUT ARS	MP 2 Operated	TRIP output to lockout Automatic Reactive Switching.
5.2.2	MP2 2	CB 2	CB TRIP 1 & 2	MP 2 Operated	TRIP output to the feeder circuit breaker – via Trip Circuit 1 & Trip Circuit 2.
5.2.3	MP2 3	BB 9 or CBF 10	START CBF	MP 2 Operated	TRIP output to initiate the CB fail function.
5.2.4	MP2 4	IM 9	FR TRG	MP 2 Operated	TRIP output to trigger the fault recorder.
5.2.5	MP2 5	CB 17	MSC disc closed	MSC disconnecter closed	Closed position indication from the MSC disconnecter if required.
5.2.6	MP2 6	CB 6	CT		Input from 3 phase measurement/protection current transformers.
5.2.7	MP2 7	CB 9	VT		Input from 3 phase MSC VT (if required by the Capacitor Protection)
5.2.8	MP2 A1	SCS A5	EVENTS/ALARMS/INDICATIONS		The alarms and indications are described in TS 3.24.77 and TS 3.24.78

5.3 Sheet 5 MEP

Spec Ref	This Sheet Ref	Other Sheet Ref	Label	Initiations	Comments
5.3.1	MEP 1	ARS 7	LOCKOUT ARS	MEP Operated	TRIP output to lockout Automatic Reactive Switching.
5.3.2	MEP 2	CB 1	CB TRIP 1	MEP Operated	TRIP output to the MSC circuit breaker – via Trip Circuit 1.
5.3.3	MEP 3	CB 2	CB TRIP 2	MEP Operated	TRIP output to the MSC circuit breaker – via Trip Circuit 2.
5.3.4	MEP 4	BB 9 or CBF 10	START CBF	MEP Operated	TRIP output to initiate the CB fail function.
5.3.5	MEP 5	IM 10	FR TRG	MEP Operated	TRIP output to trigger the fault recorder.
5.3.6	MEP 6	CB 17	MSC disc closed	MSC disconnecter closed	Closed position indication from the MSC disconnecter if required.
5.3.7	MEP 7	CB 13	TRANSDUCERS		Oil temperature instrument, and/or gas and oil actuated relay for mechanical protection if required (See TS 2.3)
5.3.8	MEP A1	SCS A6	ALARMS/ INDICATIONS		The alarms and indications are described in TS 2.3.

5.4 Sheet 6 BU

Spec Ref	This Sheet Ref	Other Sheet Ref	Label	Initiations	Comments
5.4.1	BU 1	ARS 7	LOCKOUT ARS	BU Prot Operated	TRIP output to lockout Automatic Reactive Switching.
5.4.2	BU 2	CB 1	CB TRIP 1	BU Prot Operated	TRIP output to the MSC circuit breaker – via Trip Circuit 1.
5.4.3	BU 3	CB 2	CB TRIP 2	BU Prot Operated	TRIP output to the MSC circuit breaker – via Trip Circuit 2.
5.4.4	BU 4	BB 9 or CBF 10	START CBF	BU Prot Operated	TRIP output to initiate the CB fail function.
5.4.5	BU 5	IM 11	FR TRG	BU Prot Operated	TRIP output to trigger the fault recorder.
5.4.6	BU 6	CB 17	MSC disc closed	MSC disconnecter closed	Closed position indication from the MSC disconnecter if required.
5.4.7	BU 7	CB 5	CT		Input from 3-phase protection class current transformers.
5.4.8	BU 8	CB 10	VT		Input from 3-phase MSC VT. For operational metering.
5.4.9	BUA1	SCS A7	Events/Alarms/Indications		The alarms and indications are shown in TS 3.24.38
5.4.10	BUA2	SCS A10	Operational Metering Data		This shall give an output of operational metering data to the SCS (sheet 9).
5.4.11	BUA3	SCS A7	Events/Alarms/Indications		The alarms and indications are shown in TS 3.24.72 and TS 3.24.73

5.5 Sheet 7 BB (400 kV and 275 kV Busbar Substations)

Spec Ref	This Sheet Ref	Other Sheet Ref	Label	Initiations	Comments
5.5.1	BB A1	SCS A2	EVENTS/ALARMS/ INDICATIONS	Busbar protection	Alarms and indications are defined in TS 3.24.34
5.5.2	BB 1	IM 6	FR TRG	Busbar prot operated	Initiates and marks Fault Recorder function
5.5.3	BB 2	CB 1	CB TRIP1	Busbar prot operated CB Fail operated	Trips Bay CB via Trip Circuit 1
5.5.4	BB 3	CB 2	CB TRIP2	Busbar prot operated CBF operated	Trips Bay CB via Trip Circuit 2
5.5.5	BB 4	ARS 7	LOCKOUT ARS	Busbar prot operated CB Fail operated	TRIP output to lockout Automatic Reactive Switching.
5.5.6	BB 5	IM 7	FR TRG	CB Fail operated	Initiates and marks Fault Recorder function
5.5.7	BB A2	SCS A3	EVENTS/ALARMS/ INDICATIONS	CB Fail	Alarms and indications are defined in TS 3.24.37
5.5.8	BB 6	CB 18	MB DISC POSITION	MB disconnecter position	
5.5.9	BB 7	CB 19	RB DISC POSITION	RB disconnecter position	
5.5.10	BB 8	CB 3	CT		3 Phase Class X type B CTS
5.5.11	BB 9	MP1 3 MP2 3 MEP 4 BU 4	START CBF	MP 1 operated MP 2 operated MEP operated BU prot operated	All bay tripping initiates CB fail protection