NPS/001/009 – Technical Specification for 11kV, 20kV and 33kV Pole Mounted Auto-reclose Circuit Breakers and Enclosed Switch Disconnectors

1. Purpose

The purpose of this document is to specify the technical requirements for 11kV, 20kV and 33kV pole mounted Auto-reclose circuit breakers and Enclosed Switch Disconnectors for use on the overhead line distribution networks of Northern Powergrid.

This specification seeks to be functional and to clarify, or vary, existing national specifications and requirements only where necessary.

This document supersedes the following documents, all copies of which should be destroyed;

Document Reference	Document Title	Version	Published Date
NPS/001/009	Technical Specification for 11kV, 20kV and 33kV Pole Mounted Auto-reclose Circuit Breakers	6.0	July 2021

2. Scope

This specification includes design and operational requirements for 11kV, 20kV and 33kV Auto reclosers and Enclosed Switch disconnectors, including the control cabinet and all the associated equipment located within the cabinets.

Note – units for use at 11kV and 20kV shall be offered as a single unit designed for a U_r of 24kV.

New Auto reclosers and Enclosed Switch disconnectors are required to integrate into an extensive existing overhead line automation system, as such this specification also includes detailed information relating to the communication and control requirements utilised within the existing automation system.

The following appendices form part of this technical specification:

- Appendix 1 - Schedule of Requirements
- Appendix 2 - Schedule of Local Controls and Indications
- Appendix 3 - Schedule of Remote Controls and Indications
- Appendix 4 - Schedule of Protection or Detection Features required
- Appendix 5 - I/O DNP3 Maps / Points List
- Appendix 6A - 5D - Summary Declaration of Technical Parameters for Switchgear
- Appendix 7 - Self Certification Conformance
- Appendix 8 - Pre-commission Testing, Routine Inspection and Maintenance Requirements

2.1. Table of Contents

3. Technical Requirements

3.1. General

Pole mounted Auto Reclose Circuit Breakers and Enclosed Switch Disconnectors described within this specification shall comply with all the requirements of, the current version of ENA TS 41-46 "Pole Mounted, Metal Enclosed Switchgear", unless varied by this specification, in which case this specification shall take precedence.

Technical documents referenced within this specification refer to the latest versions of the relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENA TS) current at the time of supply.

3.2. Variation and Clarifications to ENA TS 41-46

The following clauses are variations, additions or clarifications to ENA TS 41-46, where practicable they have been numbered to aid reference to the applicable clause numbers used within ENA TS 41-46 Issue 1 or the closest new clause number where they are an additional requirement.

4.1 Normal Service Conditions

4.1.3 Outdoor switchgear and controlgear

Clause 4.1.3 of IEC 62271-111 is applicable with the addition that the ice coating does not exceed 10mm.

Additionally suppliers shall confirm that the associated control panels have been fully type tested in accordance with the requirements detailed in ENA TS 48-5 "Environmental test requirements for protection and control equipment and systems" see appendix 6 for details of these tests, or shall have a notice of conformity issued by the ENA Protection Assessment Panel.

4.3 System Earthing

Auto reclosers and Switch disconnectors are required for use on a system that has its neutral directly earthed, resistance earthed or earthed via an arc suppression coil.

The equipment shall be suitable for use on three phase, 50hz, 11kV, 20kV or 33kV electrical distribution networks in which the neutral point is earthed either directly with typical maximum earth fault passage levels of 2000A for 1.5 seconds or by means of a neutral earth resistor in which the earth fault passage levels have been limited to 1200A for 1.5 seconds.

On certain parts of the distribution system, the above earthing methods have been replaced by or supplemented with arc suppression coils.

The arc suppression coils have been installed to manage earth faults that are transient in nature. The protection system has been designed in such a way that the coil remains in circuit for a specific period of time limiting the flow of fault current. This action negates the requirement for an immediate circuit breaker operation and thus allows the system to operate normally for transient faults. If the fault is sustained, the protection system reverts back to the more traditional resistance earthed protection environment detailed above.

Note:

Whilst the arc suppression coil is in circuit, this exerts a high phase to earth voltage, typically 1.9x Uo on the system as such all equipment, internal VT's etc. should be able to withstand this temporary overvoltage.

5.3 Table 1 - Rated insulation level for pole-mounted equipment

Rated Voltage U_r kV(rms. value)	Rated short-duration power frequency withstand voltage U_d kV (rms. value) for 1 minute *				Rated lightning impulse withstand voltage U_p kV (peak) *	
	Common Value		Across the isolating distance		Common Value	Across the isolating distance
	Dry	Wet	Dry	Wet		
7.2/12	50	45	55	50	110	125
24	70	60 (50)	77	66 (60)	150 (125)	165 (145)
36	95	80 (70)	105	88 (80)	200 (170)	220 (195)

*Rated insulation values from Table 1 of IEC 62271-1:2017 for rated voltages of 24kV and 36kV (Shown in brackets) will be acceptable where ENA 41-46 table 1 cannot be achieved as Northern Powergrid has a proven experience with these values.

5.5 Table 2 - Rated continuous current (I_r)

Voltage (kV)	Normal Continuous Current (RMS) (A)
12	630
24	630
36	630

5.6 Rated Short-time withstands current (I_k) and rated duration (t_k) as detailed in Table 3 below:

Table 3

Voltage (kV)	Rated short-time withstand current I_k (kA)	Rated duration of short-time withstand current t_k (s)
12	12.5	3
24	12.5	3
36	16	3

5.300.101 Rated short-circuit breaking current (I_{sc})

The rated short-circuit breaking current, at the standard DC time constant of 45 ms, shall be not less than the rated short-time withstand (I_k) current in accordance with Clause 5.6 of this specification.

5.300.103 Rated short-circuit making current (I_{ma})

For time constants of 45 ms, the rated short-circuit making current shall be 2.5 times the r.m.s. value of the AC component of the rated short-circuit breaking current.

5.302 Disconnector and earthing switch requirements

5.303.101 Rated mainly active load-breaking current (I_{load})

The rated mainly active load breaking current values are equal to the rated continuous values in accordance with Clause 5.5

5.303.102 Rated closed-loop breaking current (I_{loop})

A distribution closed-loop breaking current equal to the rated continuous current (Ir) listed in accordance with Clause 5.5

5.303.103 Rated cable-charging breaking current (I_{cc})

The values of rated cable-charging breaking currents are specified in Table 7 of this specification.

5.303.104 Rated line-charging breaking current (I_{lc})

The values of rated cable-charging breaking currents are specified in Table 7 of this specification.

Table 7 – Values of rated cable-charging breaking currents and line-charging breaking currents

Rated voltage U_r (kV, r.m.s.)	Rated cable-charging breaking current I_{cc} (A)	Rated line-charging breaking current I_{lc} (A)
12	25	10
24	25	10
36	25	10

5.303.111 Switch Disconnector - Rated short-circuit making current (I_{ma})

The rated short-circuit making current shall be equal to the rated peak withstand current (I_p), which equals 2.5 x the short time withstand current as shown in clause 5.6, Table.

5.9 Rated supply voltage of auxiliary and control circuits (U_a)

The nominal supply voltage of the battery system to supply control circuits shall be 24 V or 48 V DC as required.

Switchgear shall be capable of all normal operations without any effect affecting its rated performance, within the voltage ranges specified in Table 4 of ENA TS 41-46.

The preferred nominal supply voltage for AC circuits is 240 V. Where necessary, the AC supply voltage may be 230 V single phase (+10%, -6% in accordance with, 'The Electricity Safety, Quality and Continuity Regulations 2002').

See also clause 6.4.301 of this specification for further requirements related to control cabinet power supplies.

6.0 Design and Construction

6.0.1.1 Auto reclosers

The insulation medium used in Auto reclosers shall be a solid dielectric insulation. Where epoxy insulation is used it shall be Hydrophobic Cycloaliphatic epoxy material.

Electrical operation of the switchgear shall be independent of the status of the HV supply and shall be via low voltage DC Source. The circuit breaker shall not be allowed to close unless there is sufficient stored charge available to allow the circuit breaker to be electrically tripped.

Provision shall be made to locally electrically open and electrically close the switchgear.

Provision shall be made to manually open the switchgear using insulated rods. The speed of opening of the contacts shall be operator independent. This shall normally be provided through the use of a yellow pull ring mounted on the exterior of the circuit breaker. The pull ring shall be designed to be operated from ground level with the use of standard insulated operating rods. Once the manual open procedure has been operated, it shall not be possible to close the circuit breaker either locally or remotely by electrical means without the pull lever being manually reset.

6.0.1.2 Auto reclosers – HV Terminations

Auto reclosers shall be supplied equipped with 630A mechanical parallel groove type connectors or double holed lugs to allow the connection of insulated jumpers to the HV terminals of the circuit breaker. The clamps shall be designed to allow the connection of flexible copper insulated jumpers of minimum cross section 70mm2. All HV terminals shall be provided with protective shrouds to protect against interference from birds or small animals.

On the 33kV units the PMAR shall be supplied equipped with 630A connectors and designed to allow the connection of flexible copper insulated jumpers of minimum cross section 120mm2.

6.0.1.3 Auto reclosers – HV Bushings

Insulator bushings shall be manufactured from light weight durable materials that are UV stable and comply with the rated insulation levels detailed in clause 3.4.2. Details of the external insulation material must be provided in the tender documentation. Where epoxy insulation is used it shall be hydrophobic cycloaliphatic epoxy.

The switchgear shall be suitable for application in areas with very heavy pollution levels as defined by IEC 60815. The minimum unified specific creepage distance (USCD) shall be 53.6kV/mm

6.0.1.4 Auto reclosers - Current Transformers and Voltage Sensors

Auto reclosers shall be supplied with three (one per phase) current transformers (CT's). CT's must have a maximum 5% error at the rated fault interruption current, and 1% error at rated current values

Auto reclosers shall be supplied with three voltage sensors (e.g. VTs, CVTs, RVDs, etc.), one per phase, It is preferable that the voltage sensors are an integral part of the PMAR where the error accuracy of the total voltage measurement system must not exceed 1%

6.0.2.1 Switch-disconnectors

Switch-disconnectors shall be fully enclosed and gas insulated. Whilst SF6-filled equipment is currently approved for use in overhead line switchgear, it seems likely that from 2025, new SF6-filled equipment will be banned. Suppliers are therefore also encouraged to provide details of SF6 alternatives they are planning to introduce if not being offered currently against this specification to demonstrate that they have an on-going resilient design solution.

The use of Vacuum Interrupters as a disconnector is not acceptable.

Electrical Operation of the switchgear shall be independent of the status of the HV supply and shall be via a low voltage DC Source.

Provision shall be made for local manual opening and closing of the switchgear using insulated operating rods. The speed of opening and closing of the contacts shall be operator independent. In addition there must be at least two distinct operations to open or close the switch. The lever shall incorporate an anti-reflex device to prevent reverse movement of the operation rod, operating the equipment. It should be designed for ease of operation, under all service conditions, e.g. severe weather.

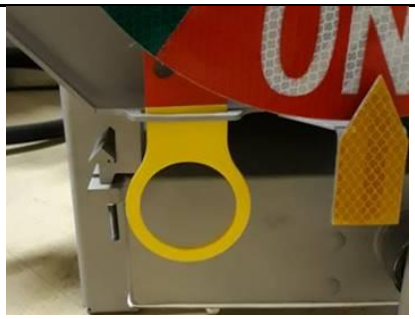
Provision shall also be made for local electrical opening and closing of the switchgear through the addition of an optional motor pack.

By default switch-disconnectors shall be supplied complete with the optional motor packs unless specified otherwise.

Switch-disconnectors shall be provided with a manual lockout facility which when applied, mechanically locks the status of the switchgear. The manual lock facility shall be used to provide a "Safety Lock" function. This lock function shall normally be provided through the use of a yellow pull ring mounted on the exterior of the switchgear with a red painted section with the words "Safety Lock" in white lettering which only becomes visible once the safety lock has been applied so as to clearly indicate the status of the mechanical lock.

The pull ring shall be designed to be operated from ground level with the use of standard insulated operating rods. Once the manual locking pull ring has been operated, it shall not be possible to change the status of the switchgear either locally or remotely by electrical means without the pull ring being manually reset.

Typical examples of this feature are shown below:

Engaged	NOT Engaged
	

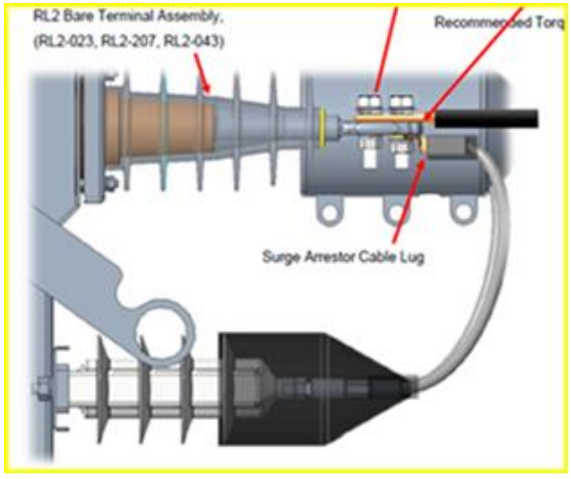
6.0.2.2 Switch-disconnectors – HV Terminations

The Switch disconnectors shall be supplied with 630A double-hole tinned copper NEMA lug 41mm centres terminals as detailed in (Figure 4 of ENA TS 41-16) and shown below. The terminals shall be suitable to accept aluminium or copper conductors.

The Switch disconnectors shall be supplied complete with 6 surge arrestor connection kits, where each kit consists of a PVC covered 35mm flexible copper jumpers of a suitable length to create a connection between the main HV switchgear terminal and the surge arrestors mounted directly below. (Surge arrestors are not required as they will be sourced as part of the existing Northern Powergrid arrestor contract). The lead shall be supplied with a pre-compressed, pre-insulated single copper lug (12mm hole) on one end and a pre-compressed, pre-insulated in-line connector with internal thread suitable for connection onto the 12mm stud of the surge arrestors.

In addition the switch-disconnectors shall be supplied with a set of protective vermin guards/shrouds to fully cover all electrical connections.

Typical arrangement for surge arrestor connection kits and associated shrouds:



6.0.2.3 Switch disconnector - HV Bushings

Insulator bushings shall be manufactured from lightweight durable materials preferably silicon rubber which are UV stable. Details of the external insulation material must be provided in the tender documentation. Where epoxy insulation is used it shall be a hydrophobic cycloaliphatic epoxy.

The switchgear must be suitable for application in areas with very heavy pollution levels as defined by IEC 60815. The minimum unified specific creepage distance (USCD) shall be 53.6mm/kV (Unless the solution has been field proven on the Northern Powergrid network or subjected to specific type testing mimicking the way the equipment is dressed with bushing guards, then the acceptable USCD may be reduced to 50.5mm/kV).

6.0.2.4 Switch disconnectors - Current Transformers & Voltage Sensors

Switch disconnectors shall be supplied with three (one per phase) current transformers (CT's). The CT's shall be suitable for both protection and metering purposes complying clause 6.301.1 of ENA TS 41-46, matching the short circuit rating of the switchgear with a short circuit duration of 3 seconds and a maximum 5% error at the rated RMS fault make current, and 1% error at rated current values.

Switch disconnectors shall be supplied with six voltage sensors as an integral part of the switchgear (e.g. VTs, CVTs, RVDs, etc.), one per phase, located on the source and loads side of the switchgear and where the voltage sensors shall be suitable for both protection and metering purposes in accordance with IEC 60044-2 and a total voltage measurement system accuracy level not exceeding 1% at 20°C

6.0.3 Mounting arrangements

6.0.3.1 Auto reclosers

Auto reclosers shall be designed to be mounted onto single wood poles utilising lightweight, compact pole mounting frames that shall be supplied with each Auto recloser. The mounting frames shall be designed to be secured to the pole utilising two M20 pole bolts vertically spaced with 360mm centres. The fixings within the mounting frame shall be designed with a M22 hole for the top fixing and an M22 keyhole slot for the bottom fixing. The preferred mounting arrangement will result in the Auto reclosers being located vertically below the overhead conductors.

Auto reclosers units shall be supplied complete with manufactures data plates indicating the serial number and key technical parameters, including the weight of the Auto reclosers.

Adequately rated lifting eyes must be provided to allow the completely assembled switchgear (fitted with surge arresters (where applicable)) to be lifted without recourse to a sling spreader. The inside diameter of the lifting eyes must be a minimum of 20mm.

The Auto reclosers mounting bracket shall incorporate a 22mm hole to allow the bracket to be bonded to the pole earthing system.

Bolts and nuts associated with the support structures shall be hot-dip galvanized in accordance with BS EN 1461.

6.0.3.2 Switch disconnectors

Switch disconnectors shall be designed to be mounted onto wood single or H poles utilising lightweight, compact pole mounting frames that shall be supplied with each Switch disconnector. The interface between the pole and the mounting bracket shall have two M20 mounting holes. The mounting holes shall be designed such that it will be possible to slide the Switch disconnector into position without having to remove the nuts and washers from the threaded rods.

The preferred mounting arrangement will result in the Switch disconnector being located offset to one side of the pole. The Switch disconnector mounting bracket shall incorporate a 22mm hole to allow the bracket to be bonded to the pole earthing system.

Adequately rated lifting eyes shall be provided to allow the completely assembled switchgear (fitted with surge arresters and external voltage sensors to be lifted without recourse to a sling spreader. The inside diameter of the lifting eyes shall be a minimum of 20mm.

Bolts and nuts associated with the support structures shall be hot-dip galvanized in accordance with BS EN 1461.

6.202 Enclosure for Auto reclosers & Switch disconnectors

6.202.1 Materials & Finish

All exposed metal components of the switchgear (excluding the bushing terminals and mounting bracket) shall be manufactured from either an aluminium casting or stainless steel of grade 304 or 316.

The switchgear shall be protected from dust and water ingress to achieve an IP rating of IP 65 or better as per BS EN 60529.

All support structures (i.e. mounting brackets for the circuit-breaker, surge arresters, external voltage sensors, etc.) shall either be made of stainless steel, or shall be of a hot-dip galvanized mild steel construction. Galvanising shall be applied in accordance with BS EN 1461 to achieve a minimum thickness of 85 µm and an expected min. /max. Durability figure of 40/>100 for C3 or 20/40 for C4 corrosivity categories as detailed in BS EN 14713-1. Oversize tapping or re-tapping of female threads shall be provided where the bolt or male thread is hot dip galvanised. Nuts shall be tapped up to 0.4mm oversize after galvanising and the threads shall be oiled. Bolts and screwed rods shall be galvanised after thread forming.

Bolts and nuts associated with the support structures shall be hot-dip galvanized in accordance with BS EN 1461

6.303 Lightning protection

6.303.1 Auto Reclosers - Surge Arrestor Mounting

Mounting brackets for surge arresters shall be provided on the load side of the switchgear.

6.303.2 Switch disconnectors - Surge Arrestor Mounting

Mounting brackets for surge arresters shall be provided on the source and load side of the switchgear, adjacent and directly below the HV Bushings.

6.4 Auxiliary and control equipment

Auxiliary and control equipment shall comply with the requirements of clause 6.4 and the following additional clauses:

6.4.1 General

Each switchgear device shall be provided with a control cabinet which is separate from the switchgear (i.e. the switchgear and control cabinet shall not be integrated into a single device). Under normal circumstances the control cabinet is required to be mounted on a wood pole with the main display at average eye line height. As such it shall be provided with an umbilical control cable as detailed in clause 6.4.1.9

The control cabinet shall contain the switchgear control unit which shall be a microprocessor-based electronic device that interfaces the power equipment to a network management control system. It must include all the functions required to monitor and control the switchgear including an RTU for SCADA communications together with the associated radio communications and power supplies.

Preference shall be given to providers whose control unit is common between Auto reclosers and Switch disconnectors and which do not require alternative firmware to be loaded in the controller, rather the controller should automatically detect the switchgear type and display the appropriate settings and configuration screens.

6.4.1.2 Electromagnetic Compatibility

The equipment (including control and communication systems) shall comply with EMC Directive 89/336/EEC, and ENA TS 48-5 or shall have a notice of conformity issued by the ENA Protection Assessment Panel.

6.4.1.3 Heaters

The control cabinets shall be supplied complete with thermostatically controlled heaters designed to maintain the cabinet at 20°C to optimise the battery life. The heaters shall work solely from an external 230V +10% - 6% power supply. In the event of loss of external power supplies, they shall not impact on the standby capacity of the batteries.

6.4.1.4 Material & Finish

The control cabinet and doors shall be fabricated from 316 grade stainless steel and supplied with mounting brackets which may be manufactured from either 304 or 316 grade stainless steel.

6.4.1.5 Mounting Arrangement and Earthing Arrangement

The control cabinet mounting bracket shall be easily removable for control cabinet workshop repair purposes. The mounting bracket shall have at least two, vertically spaced, mounting holes. The holes shall be designed such that it shall be possible to slide the cabinet into position without having to remove the pole mounting bolts (or coach screws).

The mounting bracket shall have at least two sets of, vertically spaced, slots for temporary mounting by means of straps.

The control cabinet shall incorporate a 12mm stud mounted externally in the base to allow a minimum of 2 earth connections to be made to the cabinet.

6.4.1.6 Door

The cabinet shall have a hinged door fitted with a robust fastening arrangement which can be locked with a padlock that has a shackle of 7 mm diameter.

Means shall be provided to either secure the door in a fully open position (90° or more), or to easily remove (without the use of tools) the door completely during maintenance or similar activities.

Good electrical contact shall always be maintained between the door and the rest of the cabinet (excluding the condition when the door is completely removed).

The cubicle shall be alarmed such that when the door is opened a SCADA alarm shall be generated.

6.4.1.7 Control Cabinet – Degrees of Protection and Security

Protection Against Access - The degree of protection (BS EN 60529) of persons provided by the enclosure against access to hazardous parts and protection of the equipment against ingress of solid foreign objects shall not be less than IP3XD, (with the door closed).

Protection Against Ingress of Moisture - The degree of protection for pole-mounted enclosed equipment shall be not less than IP34 in accordance with BS EN 60529, (with the door closed). The weatherproofing test method shall be the method given in annex C of BS EN 60694. Cabinets shall be designed and internally treated to prevent moisture condensation.

All metal components of the control cabinet shall be electrically bonded.

In addition control cabinets shall be designed to meet the “Enhanced Security” requirements as detailed in clause 6.4.1.8 of this specification.

6.4.1.8 Enhanced Security to protect against Unauthorised Access

Cabinets shall be designed to reduce the likelihood of interference with the equipment located within the cabinet. Typical methods of achieving this requirement shall include, but not be limited to the following methods:-

- Multi-point locking system (minimum of 3 points)
- Reinforced cabinet doors
- Cabinets shall be tested in accordance with the LPS 1175 (Loss Prevention Standard) so that they achieve a minimum security rating classification of 2 (with options for class 3), tool category C. Manufactures shall provide details of their proposals to satisfy this clause and any testing they have carried out to verify the effectiveness of the design.
- Alternatively the controller must be compatible with the current range of “Retrofit Enhanced Security Enclosures used by Northern Powergrid” or the supplier must have a design for a similar accessory readily available.

6.4.1.9 Control Cable

An ultraviolet resistant, double insulated or armoured cable, 7m long as standard, (with options for longer lengths up to a maximum of 13m) must be provided to connect the switchgear to the control unit. Robust, multi-pin, weatherproof connectors must be provided on both ends of the control cable.

It must be possible to disconnect the control cable at the control unit while the switchgear is energised, live, and carrying load, without causing damage or mal-operation. Removing or connecting the control cable while the switchgear is in service must not result in the switchgear changing open/closed state. The system must also be such that it ensures that CTs are not open-circuited.

6.4.10 Cable Entry

The control cabinet shall make provision for the bottom entry of a least three cables including the external power supplies and communications aerials. In the case of the aerial connection, the cabinet shall be supplied with a bulkhead type TNC-TNC antenna fitting (installed in a M16 hole) with female sockets on each side. Additionally it shall incorporate an M22 hole to allow the LV supplies to be terminated onto an M20 cable gland (CW20S).

The spare hole in the blanking plate shall be blanked off with blanking plugs that are bolted or screwed in to position.

6.4.2 Test Sets / Switchgear Simulators

All device control units shall be suitable for testing with a compatible tank simulator test set for testing and commissioning purposes. Tank simulators must be supplied with all required cables for connection to switchgear.

Tank simulators shall be supplied with open/close contacts for switchgear status and shall be capable of secondary injection from a separate piece of test equipment via banana plug fittings. Tanks simulators must be capable of simultaneous injection via 3 current inputs and 6 voltage inputs to simulate 3 phase network events.

6.4.2.1 Simulated Current and Voltage Waveforms

To simplify commissioning tasks, it shall be possible to use the switchgear test sets/simulators detailed in clause 6.4.2 to simulate 3 phase currents and 3 phase voltages without the requirement for primary or secondary injection and the unit shall behave as if the power measurements were real. This is required to facilitate training, pre-commissioning and to simplify commissioning of protection, SCADA and automation features at site.

When currents and voltages are simulated all measurement, protection, automation, telemetry, waveform capture, event and history logging functions will treat the simulated waveforms as if they are real analogue values and the controller shall behave as if the analogue values are true real-time system measurements.

It shall be possible to simulate sinusoidal, triangular, square and saw tooth waveforms. The simulated phase currents shall be configurable independent of each other with a minimum setting range of between 0-16000A, in configurable steps of 1A or less.

The simulated phase current angles shall be configurable independent of each other with a minimum setting range for the phase current angles of between 0-360° in configurable steps of 1° or less.

The simulated phase voltages shall be configurable independent of each other; source and load side phase voltages must be configurable independent of each other.

The minimum setting range for the phase to ground voltages must be 0-38000V in configurable steps of 1V or less.

The simulated phase voltage angles shall be configurable independent of each other with the minimum setting range for the phase voltage angles of between 0-360° in configurable in steps of 1° or less.

6.4.103 Auxiliary Power Supplies to the control box

6.4.103.1 Power Supply

The control unit shall have an integral power supply.

The capacity of the power supply shall be rated to power all the electronic modules, operate the switchgear (tripping/opening and closing) and power the data communication equipment.

Adequately rated miniature circuit-breakers shall be provided for individually isolating the control unit from the following:

a) Auxiliary Supply

b) Battery Supply

6.4.103.2 Power Supply Input and protection

Generally the auxiliary supplies for the control cabinets shall be derived from an externally mounted auxiliary voltage transformers (system voltage / 230V (+10% - 6%), although they may also be supplied from local 400/230V (+10% -6%) 50Hz supply networks.

The device shall provide a visual indication, on the control panel and in the event log, of the status of the auxiliary supply.

An auxiliary supply fail function shall be provided; it shall operate an alarm output.

If the auxiliary power supply fails, the unit shall monitor the time of the failure and after a user settable time (timers shall be programmable up to 12 hours and by default the timers shall be set at 4 hours) shall disable the power supply to the radio. When the auxiliary power supply becomes available again, the RTU shall re-enable the power supply to the radio.

Disconnection of AC supply for maintenance or replacement purposes, or in the event of LV system failure, shall not cause a loss of stored data within the Relay or RTU unit. The control system should continue to operate without interruption until supply restoration.

Loss or restoration of the auxiliary supply voltage, and under-voltage conditions in the auxiliary supply shall not result in damage or spurious operation of the equipment.

The power supply shall include the necessary over-current protection to protect the supply from current excursions. The use of fuses for over-current protection on the auxiliary input circuit(s) is not acceptable.

The power supply shall include the necessary surge arresters and/or voltage limiting devices to inhibit damage due to voltage surges.

Manufactures shall provide details of the quiescent drain placed on the batteries when the LV auxiliary supplies are not available.

Disconnection of batteries for maintenance or replacement purposes, or in the event of battery/charger/supply failure causing the batteries to discharge, shall not cause a loss of stored data within the Relay or RTU unit

In addition to provide 12V power supplies and antenna connections for the radios, the manufacturers shall include for the following radio connections kits within the control panels:

- 1 x DB9 Cable RS Stock Number 0777621
- 1 x RG58 Cable RS Stock Number 4097171
- 1 x Non-Fused Terminal Block, 2 Way, Screw Down, Nylon, 630V RS Stock Number 1896010
- 1 x 650mm length of Lapp Single Core Control Cable CSA 0.75mm², -Red Bare Copper RS Stock Number 7244345

- 1 x 650mm length of Lapp Single Core Control Cable CSA 0.75mm², -Blue Bare Copper Stock Number 7244351

An electrical socket outlet designed for operation at 230V +10% - 6% shall be provided within the control cabinet. The socket shall be protected with a suitable MCB to limit the maximum current available to 500mA. (Suitable for powering typical laptop power supplies only).

6.4.103.3 Battery Backup Supply

A battery backup supply consisting of batteries and a constant voltage battery charger, with current limiting, shall be provided with the control unit. The batteries shall be low loss rechargeable 12V batteries that have a minimum operational lifetime of 10 years in an environment that complies with clause 4.1.

Note – Battery Types used in existing control cabinet types

- Legacy PTCC control cabinets require the use of 2 x DataSafe 12HX35FR batteries
- ADVC2/3 control cabinets require the use of 2 x Datasafe 12HX50FR, 12V, 10 year, 12Ah batteries

All battery terminals shall be provided with insulating shrouds to prevent inadvertent short circuiting of the terminals.

The Battery standby time shall be a minimum of 48h, allowing for the following:

a) 10 switchgear operations;

b) 1 Ah for the communications device and other accessories.

The switchgear shall be prevented from operating if the system does not have enough stored energy to complete the operation. Close operations shall also be prevented if the system does not have enough stored and complete the close operation an immediate trip operation.

Batteries shall be automatically disconnected at the manufacturer's specified minimum voltage and automatically reconnected when auxiliary power is restored.

Provision shall be made for an orderly shutdown when the battery voltage reaches the manufacturer's specified minimum limit.

6.4.103.4 Self-Monitoring

The battery charging system shall be temperature compensated.

The battery system shall incorporate a battery test facility. During the test the auxiliary power supply shall be disconnected and a load placed on the battery, rate of voltage drop and voltage recovery time etc. shall be analysed to determine the health of the battery. The battery test shall be configurable to occur periodically and shall be delayed during an operation or when the auxiliary supply has failed.

The power system shall incorporate means to prevent deep discharge of the batteries

The power supply shall deliver the following status to the SCADA.

a) Battery Supply Fail (Battery off or battery Low Volts or battery over Volts)

b) Absence of power input / Auxiliary Supply Fail

c) Battery End of Life (Battery Test Fail)

Electronic modules shall perform continuous diagnostic monitoring and shall contain hardware and software watchdog checking. An abnormal restart alarm shall be raised if the controller restarted unexpectedly.

6.4.105 Control & Indication

In order to satisfy the control and indication requirements for this specification, the control panel shall comply with clauses 6.4.105, 6.4.106 and 6.4.107 of ENA TS 41-46 and the following additional clauses:

6.4.108.1 Configuration Software & Engineering Access

The control panel shall be fully configurable from a laptop, utilising manufacturer supplied configuration software. Configuration software is regarded as an integral part of the offer and shall be provided at no additional charge. Training on the configuration software will be provided by the manufacturer. Software support shall match the suppliers support duration of the device.

The configuration software shall be compatible with Microsoft Windows Operating System 10.

A configuration port shall be provided to facilitate remote configuration via standard Data Communication Equipment. The configuration port shall be a USB port or an Ethernet port.

It shall be possible to perform future controller firmware upgrades via local communication ports or remotely via the communications ports. Engineering access shall be possible locally and remotely using appropriate communications media.

Local wireless access to the (Bluetooth/WIFI/Zigbee) is not permitted, and any devices with this facility should be able to have the function switched off in the configuration.

It shall be possible to change settings by discreet functions for example it must be possible to write all protection settings without affecting telemetry settings or operator settings etc.

6.4.108.2 Control Panel Human Machine Interface

The operator interface shall be designed for ease of operation to minimise training and avoid operator error. Engineering access to all configuration parameters must be possible via an easy to use menu with dedicated menu navigation buttons.

Operator access to all status indicators, operator controls and logged data shall be possible via the operator interface. The operator interface must provide a facility to electrically disable any electrical operation of the switchgear. Disabling circuits must be by physically disconnecting the circuit from the close energy source.

The Trip/Open operation shall be via a dedicated green button. This button must also include the status indication.

The Close operation shall be via a dedicated red button. This button must also include the status indication.

Appendix 2 & 3 of this document details a full list of the minimum required control and indications functions

6.4.108.3 Local Controls & Indications

A customer configuration utility must also be provided to allow customisation of the status indications and command buttons on the HMI. The configuration utility must allow modification of the lamp and button text labels, lamp colours and logic functions to be enacted when the command button is operated and logic functions to drive the associated status the lamp output. The logic functions must support Boolean Logic.

Appendix 2 & 3 of this document details a full list of the minimum required control and indications functions.

6.4.108.4 Operator Close Mode (Auto Reclosers Only)

Operator Close whether affected locally or remotely, must always select the Non-Auto or Single Shot Mode characteristic. This characteristic must remain active (Auto-reclose must be prevented) for a user configurable time, the Non-Auto or Single Shot Timer.

The minimum setting range for the Non-Auto or Single Shot Timer must be 0 -180s

Selecting a time of zero should essentially disable the mode that is if 0 is selected, Auto Reclose Mode is ON, and if a fault exists on the line the recloser must execute the full configured Auto Reclose sequence. The Non-Auto or Single Shot Timer must be user configurable in steps of 1s or less.

6.4.108.5 Per Group Operator Settings (Auto Reclosers Only)

The control unit shall provide a facility to enable different operator settings on a per group basis i.e. it should for example be possible to have Auto-reclose enabled when one setting group is enabled and Auto-reclose disabled when a different group is selected.

6.4.108.6 Analogue Measurement Requirements

Shall be done via the three-phase-3-wire method and the quantities to be measured / calculated shall provide the following specified accuracy:

r.m.s. phase-to-phase and phase-to-ground voltage of all three phases	± 4%;
Positive phase sequence voltage	±5%;
Negative phase sequence voltage	±5%;
Zero phase sequence voltage	±5%;
R.M.S current per phase (within rated current range)	±2.5% ±1A;
Earth Current	±2.5% ±1A
Positive phase sequence current	±2.5% ±1A
Negative phase sequence current	±2.5% ±1A
three phase active power in kW	± 5%;
three phase reactive power in kVARs	± 5%;
total three-phase active energy in kWh	± 5%;
Power factor	± 5%;
Maximum demand	± 5%;

The real power energy and maximum demand measurement shall be integrated with respect to time. Energy values must be calculated with selectable time integration periods of 1min, 5 min, 15 min, 30 min or 60 min, in a rolling or fixed window. The data buffer must work on the FIFO principle and must store values for a minimum of 24 months on the 30 minutes integration period.

The switchgear and Control element shall have the facilities to record the cumulative number and duration of outages. The information must be assessable locally or remotely via telemetry messaging to a SCADA system. The following parameters must be recorded:

a) Cumulative total number of outages;

b) Cumulative total outage duration; and

c) Time and duration of each outage in the form of an event log.

6.4.108.7 Waveform Capture for Pre-Fault Identification or Harmonic Analysis

A Waveform Capture feature shall be provided. This feature shall be triggered when the recloser picks up, trips or closes, the control element must capture the phase voltages, phase currents and earth current. The captured waveforms must include pre-trigger and post-trigger data.

Initial Outline of Waveform Capture requirements:

1. Capture of at least 11 cycles of voltage & current.
2. Capture to be time stamped.
3. Range of current readings from 0 to 15kA. Allowing load monitoring up to say 1kA (19MVA) and faults current up to 15kA (286MVA).
4. Sampling rate of at least 8 kHz, with an upgrade path to move to 16 kHz.
5. Resolution of at least 16 bits per sample.

6. Ability to position trigger event at any point within the 11 cycle capture e.g. 5 cycles before and 5 after, 1 cycle before and 9 after etc.

Triggering requirements

1. On voltage by either:
    - Exceeding an absolute threshold voltage
    - Exceeding a voltage delta from one waveform cycle to the previous cycle.
    - Both to be remotely configurable
2. On current by either:
    - Exceeding an absolute threshold current
    - Remotely configurable
3. On a configurable combination of 1 & 2 above.

The captured data shall be available via PC for off line display and analysis. It must be possible to overlay the controller digital status points for pick up and trip request and lockout on the waveform capture view.

Harmonics to the16th harmonic and the Total Harmonic Distortion (THD) must be provided for the phase currents, and phase voltages. The captured harmonics must be available via PC for off line display and analysis. Harmonic values must be calculated with selectable time integration periods of 1min, 5 min, 15 min, 30 min or 60 min, in a rolling or fixed window. The data buffer must work on the FIFO principle and must store values for a minimum of 6 months on the 10 minutes integration period.

The magnitude and the phase angle between the corresponding voltages and currents of the analogues listed should be displayed:

a) Positive phase sequence voltage,

b) Negative phase sequence voltage,

c) Zero phase sequence voltage,

d) Positive phase sequence current,

e) Negative phase sequence current, and

f) Zero phase sequence current.

6.4.108.8 Protection or Detection Requirements for Auto Reclosers or Switch Disconnectors

General Requirements

The control unit shall provide the following protection or detection features depending upon the connected device type:-

Protection or Detection Features
Phase over current
Earth Fault (E/F)
Sensitive Earth Fault (SEF)
Negative Phase Sequence
Directional Phase over Current
Directional Earth Fault
Directional Sensitive Earth Fault
Directional Negative Phase Sequence
Broken Conductor Detection
Under Voltage
Over Voltage
Neutral Voltage Displacement (Auto Reclosers)
Under Frequency (Auto Reclosers)
Over Frequency (Auto Reclosers)
Rate of Change of Frequency (Auto Reclosers)
Loss of Phase (Auto Reclosers)

Each element should be individually settable in either Trip or Alarm, this will allow for certain elements to be used for fault flow indication via SCADA without operation of the circuit breaker.

6.4.108.9 Current Based Protection Elements Trip time Characteristics – (Auto Reclosers Only)

All current based protection Elements shall support a definite time characteristic.

All current based protection elements excluding Broken Conductor Detection shall support the following IDMT characteristics: normal inverse (NI), very inverse (VI) and extremely inverse (EI) in accordance with BSEN 60255.

An instantaneous characteristic shall be selectable either as the only curve for the selected trip or as an overlay on a definite time characteristic or an overlay on an inverse definite minimum time characteristic for all current based protection elements excluding Broken Conductor Detection.

Relays shall be equipped with a function to create and select user defined IDMT curves. It shall be possible to load at least 5 user defined curves for use in the control unit.

6.4.108.10 Voltage Based Protection Elements Trip time Characteristics – (Auto Reclosers Only)

All voltage based protection Elements must support a definite time characteristic.

An instantaneous characteristic must be selectable either as the only curve for the selected trip or as an overlay on a definite time characteristic where specified.

6.4.108.11 Phase Over Current Protection / Detection Requirements

The minimum setting range for pickup shall be 3 - 1260A in user selectable steps of 1A or less.

Phase Overcurrent shall support both definite time and IDMT characteristics with a minimum Setting Range for the Definite Time element of between 0.01s - 100s in user selectable in steps of 10ms or less.

An instantaneous characteristic shall be selectable either as the only curve for the selected trip or as an overlay on a time characteristic with an Instantaneous multiplier that is selectable over the range 1-30 in selectable steps of 0.1 or less.

A threshold or pick up multiplier shall be provided with a minimum setting range of 1.0 - 10.0 in user selectable steps of 0.1 or less.

The minimum setting range for the IDMT characteristic Time Multiplier shall be 0.01 –25.0. (A wider range is preferable) with user selectable steps of 0.01 or less.

The IDMT characteristics must be configurable with a Minimum Time Modifier and a minimum setting range of between 0 – 2s in user selectable steps of 10ms or less.

The IDMT characteristics must be configurable with a Maximum Time modifier with a minimum setting range of between 0.2 – 180s in user selectable of 0.1s or less.

The IDMT characteristics must be configurable with an Additional Time Modifier with a minimum setting range of between 0 – 30s in user selectable in steps of 0.01s or less.

6.4.108.12 Earth Over Current Protection / Detection Requirements

The minimum setting range for Pickup shall be 1 - 1260A in user selectable steps of 1A or less.

Earth Overcurrent shall support both definite time and IDMT characteristics with a minimum Setting Range of for the Definite time element of between 0.01s - 100s in user selectable steps of 10ms or less.

An instantaneous characteristic must be selectable either as the only curve for the selected trip or as an overlay on a time characteristic with an Instantaneous multiplier that is selectable over the range 1-30 in selectable steps of 0.1 or less.

A threshold or pick up multiplier must be provided with a minimum setting range of between 1.0 - 10.0 in user selectable steps of 0.1 or less.

The minimum setting range for the IDMT characteristic Time Multiplier shall be 0.01 –25.0 (A wider range is preferable) with user selectable steps of 0.01 or less.

The IDMT characteristics shall be configurable with a Minimum Time Modifier and a minimum setting range of 0 – 2s in user selectable of 0.01s or less.

The IDMT characteristics must be configurable with a Maximum Time modifier and a minimum setting range of between 0.2 – 180s in user selectable steps of 0.1s or less.

The IDMT characteristics must be configurable with an Additional Time Modifier and a minimum setting range of between 0 – 30s in user selectable steps of 0.01s or less.

6.4.108.13 NPS Over Current Protection / Detection Requirements

The minimum setting range for Pickup must be 1 - 1260A in user selectable steps of 1A.

The NPS (Negative Phase Sequence) Overcurrent shall support both definite time and IDMT characteristics with a minimum Setting Range for the Definite Time element of between 0.01s - 100s in user selectable in steps of 10ms or less.

An instantaneous characteristic must be selectable either as the only curve for the selected trip or as an overlay on a definite time characteristic with an Instantaneous multiplier that is selectable over the range 1-30 in user selectable steps of 0.1 or less.

A threshold or pick up multiplier must be provided with a minimum setting range for the Pick-Up Multiplier of between 1.0 - 10.0 in user selectable steps of 0.1 or less.

The minimum setting range for the IDMT characteristic Time Multiplier shall be 0.01 –25.0. (A wider range is preferable) with a user selectable steps 0.01 or less.

The IDMT characteristics must be configurable with a Minimum Time Modifier and a minimum setting range of 0 – 2s in user selectable in steps of 10ms or less.

The IDMT characteristics shall be configurable with a Maximum Time modifier and a minimum setting range of between 0.2 – 180s in user selectable in steps of 0.1s or less.

The IDMT characteristics shall be configurable with an Additional Time Modifier with a minimum setting range of between 0 – 30s in in user selectable steps of 0.01s or less.

6.4.108.14 SEF Protection / Detection Requirements

The SEF element shall support a definite time characteristic and IDMT characteristics.

The SEF function shall be equipped with harmonic filtering to prevent operation when harmonics are present in the primary residual earth currents. A low-pass filter must be supplied, with:

a) 2nd harmonic rejection > 6: 1;

b) 3rd harmonic rejection > 50: 1.

The SEF must be settable from 1 - 80A in user selectable steps of 1A or less.

The minimum Setting Range for the Definite Time element must be 0.1s- 999s in user selectable steps of 10ms or less.

The SEF element must support IDMT tripping characteristics and a threshold or pick up multiplier must be provided. The minimum setting range for the IDMT Pick-Up Multiplier should be between 1.0 - 10.0 with a user selectable steps of 0.1 or less.

The minimum setting range for the IDMT Time Multiplier shall between 0.01 – 25 in user selectable steps of 0.01 or less.

The IDMT characteristics shall be configurable with a Minimum Time Modifier and a minimum setting range of between 0.00 – 2s in user selectable steps of 10ms or less.

The IDMT characteristics shall be configurable with a Maximum Time modifier and a minimum setting range of between 0.2 – 180s in user selectable steps of 0.1s or less.

The IDMT characteristics shall be configurable with an Additional Time Modifier and a minimum setting range of between 0 – 30s in user selectable steps of 0.01s or less.

6.4.108.15 Fuse saving (Auto Reclose Only)

The protection features shall allow for “fuse saving” where it is possible to program a different current “pick up” threshold for each trip in the sequence. For example, it will be possible to select the first trip threshold for earth fault to be 40A on a fast or slow trip characteristic and the second trip to be at 200A on a fast or slow trip characteristic. It shall also be possible to select very fast or slow tripping characteristics for any or all trips in the sequence for each element.

6.4.108.16 Directional Protection / Detection

A Directional Protection / Detection feature shall be provided for Phase Overcurrent, Earth Fault, Sensitive Earth Fault and NPS elements.

It shall be possible to have auto-reclosing enabled independently for forward and reverse faults namely it must be possible to auto reclose for forward faults only, to auto reclose for reverse faults only or to auto-reclose for both forward and reverse faults or to disable auto reclosing for both forward and reverse faults where the minimum time to determine fault direction shall not exceed 20ms.

The relay minimum time to determine fault direction for SEF shall not exceed 20ms.

The relay shall have independent settings for each element for the following quantities:-

- Characteristic Fault Angle
- Forward Sector Width
- Reverse Sector Width
- Low Polarising Voltage Threshold

- Low Polarising Voltage (VTS) Action

The minimum setting range for the Characteristic Fault Angle for all elements shall be -179˚ to 180 ˚ in user configurable steps of 1˚.

The minimum setting range for Forward and Reverse Sector Widths for all elements shall be 45˚-90˚ in user configurable steps of 1˚

The Low Polarising Voltage decision must be configurable to use the forward characteristic, the reverse characteristic or "No Action". No Action means that the relay will ignore the fault condition and will not trip.

The Voltage Transformer Supervision (VTS) function is used to detect failure of the AC voltage inputs to the protection. This may be caused by voltage transformer faults, overloading, or faults on the wiring, which usually results in one or more of the voltage transformer fuses blowing.

If there is a failure of the AC voltage input, the IED could misinterpret this as a failure of the actual phase voltages on the power system, which could result in unnecessary tripping of a circuit breaker.

The VTS logic is designed to prevent such a situation by detecting voltage input failures, which are NOT caused by power system phase voltage failure, and automatically blocking associated voltage dependent protection elements. A time-delayed alarm output is available to warn of a VTS condition.

The following scenarios are possible with respect to the failure of the VT inputs. The VTS must cater for all conditions

- Loss of one or two-phase voltages
- Loss of all three-phase voltages under load conditions
- Absence of three-phase voltages upon line energisation

The Operating Quantity for phase overcurrent faults must be the phase current where the means of polarisation must be quadrature voltage:

Fault Current	I_A	I_B	I_C
Quadrature Voltage	V_{B-C}	V_{C-A}	V_{A-B}

The quadrature voltage shall be the voltage quantity used for the low polarising voltage decision for phase overcurrent faults with a minimum setting range of between 150 - 15000 volts for phase faults.

A voltage memory feature shall be provided to enable direction to be determined for three phase overcurrent faults that may collapse the measured voltage; the minimum Setting Range for the Voltage Memory Time must be between 0 - 10s in user configurable steps of 0.01s or less.

Once the Voltage Memory time expires, the memorized polarizing voltage shall set to zero. If the protection element is in pickup when the Voltage Memory time expires, the direction that was determined using the memorized voltage must be maintained whilst the pickup is active.

Vzps (Zero Phase Sequence Voltage) shall be the polarising voltage used for the low polarising voltage decision for earth faults with a minimum setting range of between 15-15000 volts.

The relay shall support different means of polarisation for earth faults including:

- VZPS
- Wattmetric
- Ir Cos(Ø) or Ir Sin(Ø)

The Operating Quantity for the VZPS polarising method shall be Earth current.

The Operating Quantity for the Wattmetric polarising method shall be residual power, with a default characteristic angle of 180°.

The Operating Quantity for the Ir Cos(Ø) polarising method shall be 3 IZPS Cos(Ø), with a default characteristic angle of 180°

Vzps shall be the polarising voltage for Sensitive Earth faults where applicable, with a voltage quantity for the low polarising voltage decision with a minimum setting range of between 15 -15000 volts.

The relay shall support different means of polarisation for sensitive earth faults including:

- VZPS
- Wattmetric
- Ir Cos(Ø) or Ir Sin(Ø)

The Operating Quantity for the VZPS polarising method shall be Sensitive Earth current.

The Operating Quantity for the Wattmetric polarising method shall be residual power, with a default characteristic angle of 180°

The Operating Quantity for the Ir Cos(Ø) polarising method shall be 3 IZPS Cos(Ø), with a default characteristic angle of 180°

The Operating Quantity for NPS faults shall be the NPS current with Vnps as the polarising voltage with a voltage quantity used for the low polarising voltage decision with a minimum setting range of between 300 - 2000 volts.

6.4.108.17 Broken Conductor Protection / Detection

The relay shall provide a facility to detect a broken conductor downstream. Open circuit faults due to broken conductors or mal operation of upstream switchgear will not cause an increase in current allowing detection by standard over current protection. The Broken Conductor scheme must operate by checking the ratio of negative and positive phase sequence currents, INPS/IPPS with a minimum range for the NPS/PPS setting ratio of between 0.1 - 1.0 in user selectable steps of 0.1 or less.

The Broken Conductor protection function shall use a Definite Time Characteristic with a minimum setting range for the Broken Conductor Trip Delay Time of between 0.1s – 300s in user configurable steps of 0.01s or less.

The Reset Threshold should be configurable in the range 90%-100% in steps of 1%.

A reset timer shall be provided. Trip Timing must stop and start resetting when the INPS/IPPS value is less than the Setting Ratio. When the reset time has expired the Trip Time must be reset. If INPS/IPPS becomes greater than the Setting Rate before the reset time expires then the Trip Timing must resume timing.

The reset timer shall use a definite time characteristic. The minimum setting range Broken Conductor Reset Delay Time must be configurable over the range 0.0 – 100 seconds.

6.4.108.18 Protection Reset

It is preferable that the drop off current is less than the Pick Up current.

The Reset Threshold should be configurable in the range 10%-100% in steps of 1%.

Where the reset threshold is not configurable the ratio of drop-off current to pick-up current must be a maximum of 95 % and a minimum of 85% for all protection functions.

Once pick up has occurred, should the measured current fall below the Pick-Up Threshold but remain above the reset threshold the protection timing must be paused and re-started if the current once again exceeds the Pick Up.

A configurable protection reset time or time characteristic must be provided. The minimum definite characteristic shall be configurable in 10ms steps from 0ms to 100s.

It must be possible for the reset characteristic to simulate the reset of an electromechanical protection relay. The preferred method of disk reset must be according to IEC 60255-4 Class A, Class B, Class C, Long-time inverse and Short-time inverse reset curves.

6.4.108.19 Inrush Restraint

A harmonic current inrush restraint function shall be supplied. Transformer magnetising current is characterised by a significant percentage of second order harmonic current relative to the fundamental current. The trigger for the inrush restraint feature must not be zero Amps current but rather a user configurable percentage of second order harmonic current relative to the fundamental current.

The minimum range for the restraint period, the Inrush Restraint Time, shall be 50ms to 30s, in user selectable steps of 10ms or less.

The minimum range for the Inrush Restraint Multiplier shall be 1 to 30 in user selectable steps of 0.1 or less.

The minimum range for the percentage of second order harmonic relative to the fundamental, the Inrush Restraint Threshold, shall be 20% to 200% in user selectable steps of 1% or less.

6.4.108.20 Cold Load

A cold load pick-up (CLP) feature – when a typical load has been without supply for a period of time (hours) it loses its diversity and as such when power is restored the load may be higher than usual because many or all of the thermostatic controlled devices such as heaters, refrigeration, air conditioners etc. will turn on. The longer the period without supply the greater the loss of diversity and the higher the load current when suppliers are restored.

This feature shall be provided that allows user selectable modification of protection element characteristics under conditions of system power restoration.

The elements to be modified by the cold load function must be selectable.

This CLP feature should allow the Pick Up current of the selected elements to be raised to a user configured multiple of the Pick Up current, (Cold Load Multiplier), in a linear fashion over a user selectable time (Cold Load Time). The minimum setting range for the Cold Load Time should be 1 - 480 minutes in user configurable steps of 1 minutes or less.

The minimum setting range for the Cold Load Multiplier should be 1 -5 in user configurable steps of 0.1.

The vendor may propose an alternative arrangement for consideration by the purchaser.

6.4.108.21 Lockout Option for Three Phase Faults Auto Reclosers Only)

An option shall be provided to automatically lockout the auto-recloser in the event of a three phase fault.

6.4.108.22 High Current Lockout (Auto Reclosers Only)

A feature to lockout the recloser to prevent reclosing on high energy faults shall be provided. This feature shall allow the user to configure a maximum fault current level which if exceeded shall cause the recloser to lockout after the trip event.

Independent high current lock out settings shall be provided for phase and earth with the ability to select the trip for which the lockout request will become active.

The active trip for high current lock out shall be selectable from 1-3.

6.4.108.23 Auto-reclose operation parameters Auto Reclosers Only)

The number of sequential trips to reach lockout shall be selectable between 1, 2, 3 or 4.

Individual sequences should be settable for Overcurrent, Earth Fault and SEF trips.

The minimum setting range for Sequence Reset Time shall be selectable from 3s to 180s in user configurable steps of 1 s or less.

Reclose (Dead) times shall ideally be individually selectable for each overcurrent element. It shall be possible to choose a different reclose (dead) time for each element including selecting a different reclose (dead) time for phase faults than for Earth faults.

The minimum setting range for the first dead time shall be 0.5s to 1800s with the minimum setting range for subsequent dead times of between 2s to 180s in user configurable steps of 0.1s or less.

An operator close command initiated locally or remotely during a dead time shall result in lockout if a fault is present upon closure.

An operator trip command initiated locally or remotely during a protection sequence shall result in the sequence being aborted and a switchgear lockout (Any pending auto reclose command is aborted).

A user selectable Dead Lockout feature shall be provided to prevent a reclose attempt when the source and load side terminals of the reclosers are dead.

6.4.108.24 Sequence Co-ordination

A Sequence co-ordination feature shall be provided to ensure trip-close sequence co-ordination for combinations of rapid and delayed protection operations applied to Auto-reclosers in series. The Sequence co-ordination functionality must be such that:

- The sequence co-ordination feature shall be independently selectable for each protection setting group.
- The sequence co-ordination feature shall cause the circuit breaker to step to the next count in the reclose sequence on reset of all protection elements whether or not the recloser tripped.
- For multiple pick up excursions, the recloser shall advance sequentially to the last programmed trip and this characteristic must remain the active until the sequence resets.

6.4.108.25 Frequency Protection Requirements

The relay shall provide under frequency, over frequency and rate of change of frequency, ROCOF, protection elements with the ability to separately enable / disable the Over Frequency, Under Frequency and ROCOF protection functions.

The over frequency protection function shall detect frequencies above the normal system frequency with a minimum setting range from the nominal system frequency to the nominal system frequency plus 5Hz in user configurable steps not greater than of 0.1Hz.

The Over Frequency protection function shall use a Definite Time Characteristic with a minimum setting range for the Over Frequency Trip Delay Time of between 2 cycles – 1000cycles in user configurable steps of 1 cycle or less.

An Auto close function shall be provided to allow the user to configure the auto-recloser to close a configurable delay time after the frequency returns to normal. The minimum setting range shall be 1s – 1000s in user configurable steps of 1s or less.

The Under-Frequency protection function shall detect frequencies below the normal system frequency with a minimum setting range from the nominal system frequency minus 5Hz to the nominal system frequency in user configurable steps not greater than of 0.1Hz.

The Under-Frequency protection function shall use a Definite Time Characteristic with a minimum setting range for the Under-Frequency Trip Delay Time of between 2 cycles – 1000cycles in user configurable steps of 1 cycle or less.

An Auto close function shall be provided to allow the user to configure the Auto Reclosers to close a configurable delay time after the frequency returns to normal. The minimum setting range for the Auto Close Delay Time shall be 1s – 1000s in user configurable steps of 1s or less.

It must be possible to configure the unit to block operator close requests following an under frequency or over frequency trip unless the frequency is within the normal operating range.

A rate of change of frequency, ROCOF, protection function must be provided. The ROCOF function must detect changes to the rate of change of frequency per second with a minimum setting range for the ROCOF from 0.1Hz/s to 5Hz/s.

The ROCOF protection function shall use a Definite Time Characteristic with a minimum setting range ROCOF Trip Delay Time configurable over the range 0.1s – 100 seconds in user configurable steps of 0.01s or less.

A reset timer shall be provided. Trip Timing must stop and start resetting when the df/dt value is less than the Setting Rate. When the reset time has expired the Trip Time must be reset. If the df/dt becomes greater than the Setting Rate before the reset time expires then the Trip Timing must resume timing.

The reset timer shall use a definite time characteristic with a minimum setting range ROCOF Reset Delay Time configurable over the range 0 – 100 seconds in user configurable in steps of 0.1s or less.

It shall be possible to configure the ROCOF function to respond to increasing frequency, reducing frequency or both.

It shall be possible to inhibit the ROCOF element when the frequency is within the normal frequency range as defined by the Over and Under Frequency trip settings.

6.4.108.26 Voltage Protection Requirements

The relay shall provide under voltage, over voltage and neutral voltage displacement, NVD, protection elements with the ability to separately enable / disable the Over Voltage, Under Voltage and NVD protection functions.

The over voltage protection function shall detect voltages above the nominal phase to earth system operating voltage with the minimum Overvoltage trip threshold setting range of between 102% - 200% in user configurable steps of 1%, or less.

The Over Voltage protection function shall use a Definite Time Characteristic with a minimum setting range Over Voltage Trip Delay Time of between 0.01s -300s in user configurable steps of 10ms or less.

It shall be possible to configure the over voltage protection function to protect for over voltage on a single phase, all three phases or the average of all three phases.

A reset timer shall be provided. Trip Timing must stop and start resetting when the voltage is less than the Pick-Up Setting. When the reset time has expired the Trip Time shall be reset. If the voltage becomes greater than the Pick Up Setting before the reset time expires then the Trip Timing shall resume timing.

The reset timer shall use a definite time characteristic with a minimum setting range Over Voltage Reset Delay Time of between 0 – 10,000 milliseconds in user configurable steps of 1millisecond.

An Auto close function shall be provided to allow the user to configure the autorecloser to close a configurable delay time after the voltage returns to normal. The minimum setting range for the Auto Close Delay Time shall be 1s – 1000s in user configurable steps of 1s or less.

The Under-Voltage protection function shall detect voltages below the nominal phase to earth system operating voltage with a minimum setting range for the Under-Voltage Trip Threshold of between 50% - 98% in user configurable steps 1%, or less.

The Under-Voltage protection function shall use a Definite Time Characteristic with a minimum setting range Under Voltage Trip Delay Time of between 0.01s -300s in user configurable steps of 10ms or less.

It shall be possible to configure the Under-Voltage protection function to protect for low voltage on a single phase, all three phases or the average of all three phases.

A reset timer shall be provided. Trip Timing must stop and start resetting when the voltage is greater than the Pick-Up Setting. When the reset time has expired the Trip Time shall be reset. If the voltage becomes less than the Pick Up Setting before the reset time expires then the Trip Timing must resume timing.

The reset timer shall use a definite time characteristic with a minimum setting range configurable over the range 0 – 10,000 milliseconds in user configurable steps of 1millisecond.

An Auto close function shall be provided to allow the user to configure the auto-recloser to close a configurable delay time after the voltage returns to normal with a minimum setting range of between 1s – 1000s in user configurable steps of 1s or less.

The NVD protection function shall detect unbalanced voltages (neutral voltages) with the minimum setting range for the NVD Trip Threshold must of between 15V – 15,000V in user configurable steps of 1V.

The NVD protection function shall use a Definite Time Characteristic with a minimum setting range NVD Trip Delay Time of between 0.00s -100s in user configurable steps of 10ms or less.

An Instantaneous characteristic shall be provided with an Instantaneous multiplier selectable over the range 1-30 in user selectable steps of 0.1 or less.

A reset timer must be provided. Trip Timing shall stop and start resetting when the voltage is less than the Pick-Up Setting. When the reset time has expired the Trip Time shall be reset. If the voltage becomes greater than the Pick Up Setting before the reset time expires then the Trip Timing must resume timing.

The reset timer shall use a definite time characteristic with a minimum setting range NVD Reset Delay Time over the over the range 0 – 100s in user configurable steps of 10 milliseconds or less.

6.4.108.27 Loss of Phase Protection / Detection Requirements

The relay shall detect an open circuit upstream. This feature is typically referred to as Loss of Phase (LOP) Protection. The device shall be configurable to open and/or alarm for a loss of phase condition.

Loss of voltage on all three phases shall not generate a LOP alarm or LOP protection trip, the minimum setting range Loss of Phase Voltage threshold must be 2000- 15000V in user configurable steps of 1V.

When configured to open, the recloser shall trip to lockout if there is a loss of voltage on one phase upstream of the recloser.

The Loss of Phase protection / detection function shall use a Definite Time Characteristic with a minimum setting range Loss of Phase Time of between 0.1s -100s in user configurable steps of 100ms or less.

Information about LOP operation shall be recorded to include details of the affected phase(s).

6.4.108.28 Circuit Breaker Fail (Auto Reclosers Only)

A Circuit Breaker Fail Alarm feature must be provided to alert the operator if the switchgear fails to break all phase currents after a protection trip operation. The minimum setting range for the circuit breaker Fail Check Time must be 1s – 60s in user configurable steps not greater than 0. 1s.

6.4.108.29 Sectioning Function (Switch Disconnector only)

It shall be possible to use the Switch Disconnector to provide automatic sectionalising functions when the Switch Disconnector is used in conjunction with upstream Automatic Reclosers.

If a fault is detected and both the measured current and voltage drop to zero the Switch Disconnector shall count one Auto Reclosers operation and register a count of 1 in an interruption counter register.

Subsequent faults detected followed by both the measured current and voltage dropping to zero, then the Switch Disconnector shall further increment the interruption counter.

When a predetermined count is reached the Switch Disconnector shall automatically open to isolate the faulty circuit while the Auto Recloser is in the open position. The Auto Recloser can then restore power to the healthy part of the system.

The minimum setting range for the Interruption Counter shall be 1-3.

If the fault is of temporary nature and is cleared before the Switch Disconnector count reaches the predetermined number, the Switch Disconnector shall remain closed and shall reset to its pre-fault condition after the reset time is expired.

The minimum setting range for Sequence Reset Time shall be selectable from 3s to 120s in user configurable steps of 1 s or less.

6.4.109 Communications and Hardware

6.4.109.1 Configuration Port

A configuration port must be provided on the control panel to facilitate both local and remote configuration of all settings via standard Data Communication Equipment (DCE). The use of dongles is not acceptable. The configuration port must be either a 100Base-T Ethernet port or a USB B type port.

Where a USB B type port is used an alternative serial or Ethernet port must be provided to facilitate remote engineering access.

6.4.109.2 Communication Ports

The control panel must provide a minimum of two 100Base-T Ethernet ports and it must be possible to use either of these ports for engineering or telemetry communications with the ability to configure separate MAC addresses for each port.

Each port shall be capable of hosting multiple IP sessions. A minimum of three sessions shall be supported without interference to other sessions or communication speeds. It shall be possible to support reporting by two telemetry protocols as well as communications for engineering access simultaneously.

It shall be possible to use either Ethernet port to host both SCADA and engineering communications seamlessly.

Additionally a minimum of two RS-232 serial ports must be provided for telemetry communications with at least one RS-232 serial port being able to support hardware handshaking capabilities.

6.4.109.3 Remote Terminal Unit RTU

The Control panel shall include a Remote Terminal Unit RTU. The RTU must support telemetry messaging using the DNP3 protocol. Preferably the RTU will also support IEC 60870-5-104, IEC 60870-5-101, IEC61850 and Modbus protocols.

6.4.110.1 Additional Fast Trip Input Modules

The control panel shall include a facility to accept external control signals from optically isolated third party devices to interface external trip, close or block signals to the recloser controller e.g. fast trip commands from bucholtz protection fitted to externally located voltage regulators etc. This facility can be part of the hardware or through the provision of an additional FTIM (Fast Trip Input Modules). The trip inputs shall comply with the ENA TS 48-04 EB2 and shall be immune to AC interference and capacitance discharge via the use of external resistors or optical input design.

6.4.111 Communications Equipment

Provision must be made to mount communications equipment to include modems or radios in the control panel. The available space to mount equipment must be detailed. Provision shall also be made in the bottom entry gland plate for at least one keyed hole for the external antenna connection.

6.4.111.1 Communications Equipment Power Supply

A user programmable communications equipment power supply shall be provided with a minimum setting range of 5-15V dc in user configurable steps of not more than 1V.

The communications equipment power supply shall have a continuous rating of at least 20W and should support a peak demand of 50W with a 10% duty cycle.

6.4.112 Remote controls and Indications

The required remote controls, indications and analogues are detailed in Appendix 2 & 3.

The I/O map shall be user configurable to add or delete points.

By default the RTU shall be supplied with the I/O DNP3 point assignments map as detailed in Appendix 5 to allow new RTU units to integrate into the existing Northern Powergrid SCADA control system.

6.4.113 Indications

The I/O map shall be user configurable to invert the status of digital points, with each indication configurable to provide time stamping of status changes with an accuracy of 10ms or better.

Status changes shall be reported and recorded in the event log in the sequence in which they occur.

A facility shall be provided to invert the status of indications.

An event buffer to store all changes in configured SCADA points as time-stamped events shall be provided. The buffer must have a capacity of at least 250 events.

6.4.114 Controls

The control output sub-system shall support both Direct-Operate and Select-Before-Operate controls. The selection of type must be made at the master station.

Failure of any one component shall not result in an undesired control output.

It shall be possible to test the control subsystem by issuing a “dummy” control to the device with an internal logical CB operating to prove the control system, this logical CB will provide positive status of both open and closed.

6.4.115 Counters

At least two counters shall be provided (minimum 16 bits) with the ability to store counters in non-volatile memory.

It shall be possible to assign the counters to count different points in the device.

The counters shall have a user configurable report facility (time referenced to the hour or count based). If the counter’s capacity is exceeded then the accumulator must operate in a rollover fashion. It must be possible to configure jitter, reporting and other settings per counter.

6.4.116 Analogues

All analogues shall have a resolution of at least 16 bits.

A dead band facility shall be provided to report analogue changes on the transgression of a configurable setting range. This facility shall report the transgression of high and low analogue values as digital alarms.

6.4.117 Time Synchronisation Management

The control shall be equipped with a battery backed real time clock with leap year support.

It shall be possible to set the clock via the configuration software and via a SCADA master station to within 1 ms of the synchronisation clock. The clock time shall drift by less than 250ms per day with the precision of the clock being 1 millisecond or better.

The real-time clock battery, or other power source, must provide at least 20 days of total standby time. The power source should not need replacing more often than every ten years.

6.4.118 Custom Logic Functionality

6.4.119 Custom Logic Inputs and operations

The control system shall provide a CLF (custom logic functionality) to allow the creation of unique logic status monitoring functions. As such it must be possible to monitor the status of:

- Digital control data (Switchgear and controller status, Operator control settings, Protection events, External Inputs & Outputs, and protocol triggers)
- Analogue signals (Line Current and Voltage measurement, Counters and Timers)

It shall be possible to create logic expressions using Boolean Logic operands such as AND, OR, NOT to evaluate the status of digital and analogue database values. It shall be possible to create multiple logic expressions.

6.4.120 Self-Healing For Ring Circuits

The controller shall have embedded logic to facilitate the automatic restoration of supplies to healthy sections of network following a fault. The scheme must utilise voltage sensing, protection features and will utilise peer to peer communications.

The system must prevent the closing of the alternate feeder on to the fault that caused the loss of supplies.

The system must check the capacity of the back-feed circuit to assure it is greater than the lost load. If the load is greater than the available capacity the scheme will check the load lost on other switchgear closer to the normal open point and if the load lost by that switchgear is less than the available capacity then the scheme will open that switch before closing the normal open point to partially restore supplies. If supplies cannot be partially restored, closing of the normal open point will be prevented.

The system must be pre-engineered and require configuration only.

6.12.203 Creepage Distances For Outdoor Bushings And Environmental Considerations

Further information relating to applicable creepage levels and environmental class has been provided in clauses 6.0.1.3 and 6.0.2.3 of this specification for Auto Reclosers and Switch disconnectors respectively.

4. References

4.1. External Documentation

The products described within this specification shall comply with the latest versions of the relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENATS) current at the time of supply

Reference	Title
BS EN 1461	Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods
BS EN 14713-1	Zinc coatings —Guidelines and recommendations for the protection against corrosion of iron and steel in structures (General principles of design and corrosion)
BS EN 60044-2	Instrument transformers. Inductive voltage transformers
BS EN 60068-2-78	Environmental testing. Tests. Test Cab: Damp heat, steady state
BS EN 60255-1	Measuring relays and protection equipment. Common requirements
BS EN 60255-21-2	Electrical relays. Vibration, shock, bump and seismic tests on measuring relays and protection equipment. Shock and bump tests
BS EN 60255-26	Measuring relays and protection equipment. Electromagnetic compatibility requirements
BS EN 60255-27	Measuring relays and protection equipment. Product safety requirement
BS EN 60255-6	Electrical relays. Electrical disturbance tests for measuring relays and protection equipment. Immunity to conducted disturbances induced by radio frequency fields
BS EN 60529	Specification for degrees of protection provided by enclosures (IP code)
BS EN 60694	Common specifications for high-voltage switchgear and controlgear standards
BS EN 60834-1	Teleprotection equipment of power systems. Performance and testing. Command systems
BS EN 61000-4-10	Electromagnetic compatibility (EMC). Testing and measurement techniques. Damped oscillatory magnetic field immunity test
BS EN 61000-4-16	Electromagnetic compatibility (EMC). Testing and measurement techniques. Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz
BS EN 61000-4-9	Electromagnetic compatibility (EMC). Testing and measurement techniques. Impulse magnetic field immunity test
BS EN 61109	Insulators for overhead lines. Composite suspension and tension insulators for a.c. systems with a nominal voltage greater than 1000 V. Definitions, test methods and acceptance criteria
BS EN 62271-1	High-voltage switchgear and controlgear. Common specifications for alternating current switchgear and controlgear
BS EN 62271-100	High Voltage alternating current circuit breakers
BS EN 62271-102	High-voltage switchgear and controlgear. Alternating current disconnectors and earthing switches
BS EN 62271-103	High-voltage switchgear and controlgear. Switches for rated voltages above 1 kV up to and including 52 kV
BS EN 62271-111	High-voltage switchgear and controlgear. Part 111. Automatic circuit reclosers and fault interrupters for alternating current systems up to 38 kV
BS EN 62271-200	High-voltage switchgear and control gear. AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
BS EN 62271-214	Internal arc classification for metal-enclosed pole mounted switchgear and controlgear for rated voltages above 1kV and up to and including 52kV
BSEN 60068-2-1	Environmental testing. Tests. Test A. Cold
BSEN 60068-2-2	Environmental testing. Tests. Test B. Dry heat
EMC Directive 89/336/EEC	Electromagnetic Compatibility Directive

ENA TS 41-16	Apparatus terminations, conductor sizes and associated fittings (copper) used in outdoor and indoor substations with outdoor equipment
ENA TS 41-18	Partial discharge testing of bushings, capacitors, instrument transformers and switchgear of rated voltage 7.2 - 420kV inclusive
ENA TS 41-46	Pole Mounted Metal Enclosed Switchgear
ENA TS 48-4	DC Relays associated with a tripping function in protection systems
ENA TS 48-5	Environmental test requirements for protection and control equipment and systems
ENA TS 98-1	Technical Specification for the Surface Preparation of New Plant
IEC 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles
IEEE C37.112	IEEE Standard for Inverse-Time Characteristics Equations for Overcurrent Relays
LPS 1175	Requirements and testing procedures for the LPCB approval and listing of intruder resistant building components, strong points, security enclosures and free-standing barriers.

4.2. Internal Documentation

Reference	Title
N/A	

4.3. Amendments from Previous Versions

Changes from the last published version:

Clause	Amendment
Appendix 1	New commodity codes added for the RL38 Enclosed switch disconnector and a replacement SCEM card.

5. Definitions

Term	Definition
Arc Suppression Coil	(ASC), also known as **Petersen coil**, is used to compensate the capacitive earth fault currents supplied by outgoing feeders at a substation
Disconnector	A mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements Note – A disconnector is capable of opening and closing a circuit when either negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time currents under abnormal conditions such as those of short circuit
DNP3	(Distributed Network Protocol) is a set of communications protocols used between components in process automation systems
ENA TS	Energy Networks Association Technical Specification
Enclosed Switch Disconnector	An enclosed switch which, in the open position, satisfies the isolating requirements specified for a disconnector
Hot dip Galvanizing	Formation of a coating of zinc and/or zinc iron alloys on iron and steel products by dipping prepared steel or cast iron in a zinc melt
OC/EF	Overcurrent / Earth Fault
PMAR	Pole Mounted Auto reclosing Circuit Breaker
RTU	Remote Terminating Unit
SCADA	Supervisory control and data acquisition
SEF	Sensitive Earth Fault

6. Authority for Issue

6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.		
		Date
Liz Beat	Governance Administrator	11/03/2024

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.		
Review Period - This document should be reviewed within the following time period;		
Standard CDS review of 3 years?	**Non Standard Review Period & Reason**	
Yes	**Period: n/a**	**Reason: n/a**
Should this document be displayed on the Northern Powergrid external website?		Yes
		Date
Ged Hammel	Lead Policy & Standards Engineer	12/03/2024

6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.		
		Date
Michael Crowe	Technical Services Manager	20/03/2024
Steven Salkeld	Policy and Standards Engineer	11/03/2024

6.4. Authorisation

Authorisation is granted for publication of this document.		
		Date
Paul Black	Head of System Engineering	25/03/2024

Appendix 1 – Schedule of Requirements

Item	Commodity Code	Description
New Equipment		
1*	216123	11/20kV 630A 12.5kA PMAR c/w Control Cabinet, batteries and 7m Umbilical
2	216130	33kV 630A 16kA PMAR c/w Control Cabinets, batteries and 7m Umbilical
3	216145	11/20kV 630A 12.5kA Enclosed Switch Disconnector c/w Control Cabinet, batteries,7m Umbilical and motor pack
4	216134	33kV 630A 16kA Enclosed Switch Disconnector c/w Control Cabinet, 7m Umbilical and motor pack
5**	TBA	11/20kV 630A 12.5kA Enclosed Switch Disconnector c/w Control Cabinet, batteries, 7m Umbilical **(but without motor pack)**
6**	TBA	Replacement Motor pack for Enclosed Switch Disconnectors
Items related to supporting existing installed Equipment		
7	206124	ADVC3 Replacement Control Panel Only - (to replace existing PTCC or ADVC2 Cabinet)
8	206134	ADVC2 - ADVC3 Upgrade (ADVC3 CAPM5 Controller for use in existing cabinet)
9	226220	Replacement Door for existing Nulec ADVC Ultra-Set Vue type Control Cabinets
10	226223	Replacement 7m Umbilical for existing Nulec PMAR's & Enclosed Switch Disconnectors
11	226224	Replacement 9m Umbilical for existing Nulec PMAR's & Enclosed Switch Disconnectors
12	226226	Replacement 11m Umbilical for existing Nulec PMAR's & Enclosed Switch Disconnectors
13	226221	Replacement 13m Umbilical for existing Nulec PMAR's & Enclosed Switch Disconnectors
14	239745	Nulec 11/20 PMAR CB - Replacement SCEM card

Notes

*Logistically Northern Powergrid has a preference to receive units capable of dual voltage operation at both 11 and 20kV, but this does not preclude the offer of units for single voltage operation.

** Items 5 & 6 have been included to determine the merits of having all 11/20kV units supplied with a motor pack as default or to order units without the motor pack so that it is only installed were full remote control functionality is appropriate.

Appendix 2 – Local Controls and Indications

The attached schedule shall be completed by Suppliers to confirm the local controls and indications provided:-

Function	Feature	Comment	Provided (Y/N)
Close	Control & Indication	A dedicated Red Button with associated status indication must be provided	
Trip / Open	Control & Indication	A dedicated Green Button with associated status indication must be provided	
Local / Remote	Control & Indication	A dedicated switch or Key Pad Button with associated Status LED must be provided or must be configurable	
Earth Fault in / out	Control & Indication	A dedicated switch or Key Pad Button with associated Status LED must be provided or must be configurable	
Sensitive Earth Fault in / out	Control & Indication	A dedicated switch or Key Pad Button with associated Status LED must be provided or must be configurable	
Auto Reclose On / Off	Control & Indication	A dedicated switch or Key Pad Button with associated Status LED must be provided or must be configurable	
Setting Group Selection	Control & Indication	Menu field and / or programmable switch or Key Pad Button with associated Status LED	
Protection Group A	Control & Indication	Menu field and / or programmable switch or Key Pad Button with associated Status LED	
Protection Group B	Control & Indication	Menu field and / or programmable switch or Key Pad Button with associated Status LED	
Protection Group C	Control & Indication	Menu field and / or programmable switch or Key Pad Button with associated Status LED	
Protection Group D	Control & Indication	Menu field and / or programmable switch or Key Pad Button with associated Status LED	
Protection Group E	Control & Indication	Menu field and / or programmable switch or Key Pad Button with associated Status LED	
Phase A Live	Indication	Menu field and / or Dedicated or Programmable LED	
Phase B Live	Indication	Menu field and / or Dedicated or Programmable LED	
Phase C Live	Indication	Menu field and / or Dedicated or Programmable LED	
Load Current On	Indication	Menu field and / or Dedicated or Programmable LED	
A Phase OC Fault	Indication	Menu field and / or Dedicated or Programmable LED	
B Phase OC Fault	Indication	Menu field and / or Dedicated or Programmable LED	
C Phase OC Fault	Indication	Menu field and / or Dedicated or Programmable LED	
Earth Fault	Indication	Menu field and / or Dedicated or Programmable LED	
Sensitive Earth Fault	Indication	Menu field and / or Dedicated or Programmable LED	
Negative Phase Sequence Fault	Indication	Menu field and / or Dedicated or Programmable LED	
Under Frequency Fault	Indication	Menu field and / or Dedicated or Programmable LED	
Over Frequency Fault	Indication	Menu field and / or Dedicated or Programmable LED	
Under Voltage Fault	Indication	Menu field and / or Dedicated or Programmable LED	
Over Voltage Fault	Indication	Menu field and / or Dedicated or Programmable LED	
High Current Lockout	Indication	Menu field and / or Dedicated or Programmable LED	
Lockout	Indication	Menu field and / or Dedicated or Programmable LED	
Operator Trip	Indication	Menu field and / or Dedicated or Programmable LED	
Maintenance	Indication	Menu field and / or Dedicated or Programmable LED	

Required			
Auxiliary Supply Fail	Indication	Menu field and / or Dedicated or Programmable LED	
Battery Not Healthy	Indication	Menu field and / or Dedicated or Programmable LED	
Battery End of Life (Battery Test Fail)	Indication	Menu field and / or Dedicated or Programmable LED	
Switchgear Locked	Indication	Menu field and / or Dedicated or Programmable LED	
Contact Life Low	Indication	Menu field and / or Dedicated or Programmable LED	
Close circuit Isolated	Indication	Menu field and / or Dedicated or Programmable LED	
Trip Circuit Isolated	Indication	Menu field and / or Dedicated or Programmable LED	
Dummy Circuit Breaker Closed	Indication	Menu field and / or Dedicated or Programmable LED	
A Phase Current	Analogue	Menu field	
B Phase Current	Analogue	Menu field	
C Phase Current	Analogue	Menu field	
A Phase Voltage	Analogue	Menu field	
B Phase Voltage	Analogue	Menu field	
C Phase Voltage	Analogue	Menu field	
kWatts	Analogue	Menu field	
kVars	Analogue	Menu field	
Power Factor	Analogue	Menu field	
Maximum Demand	Analogue	Menu field	

Appendix 3 – Remote Controls and Indications

The attached schedule shall be completed by Suppliers to confirm remote controls and indications available:-

Function	Feature	Provided (Yes/No)
Close	Control & Indication	
Trip / Open	Control & Indication	
Earth Fault in / out	Control & Indication	
Sensitive Earth Fault in / out	Control & Indication	
Auto Reclose On / Off	Control & Indication	
Auto Sectionalise On / Off	Control & Indication	
Setting Group Selection	Control & Indication	
Protection Group A	Control & Indication	
Protection Group B	Control & Indication	
Protection Group C	Control & Indication	
Protection Group D	Control & Indication	
Protection Group E	Control & Indication	
Local / Remote	Indication	
Phase A Live	Indication	
Phase B Live	Indication	
Phase C Live	Indication	
Load Current On	Indication	
A Phase OC Fault	Indication	
B Phase OC Fault	Indication	
C Phase OC Fault	Indication	
Earth Fault	Indication	
Sensitive Earth Fault	Indication	
Negative Phase Sequence Fault	Indication	
Under Frequency Fault	Indication	
Over Frequency Fault	Indication	
Under Voltage Fault	Indication	
Over Voltage Fault	Indication	
High Current Lockout	Indication	
Lockout	Indication	
Operator Trip	Indication	
Maintenance Required	Indication	
Auxiliary Supply Fail	Indication	
Battery Not Healthy	Indication	
Battery End of Life (Battery Test Fail)	Indication	
Switchgear Locked	Indication	
Contact Life Low	Indication	
Close circuit Isolated	Indication	
Trip Circuit Isolated	Indication	
Dummy Circuit Breaker Closed	Indication	
A Phase Current	Analogue	
B Phase Current	Analogue	
C Phase Current	Analogue	
A Phase Voltage	Analogue	
B Phase Voltage	Analogue	
C Phase Voltage	Analogue	
kWatts	Analogue	
kVars	Analogue	
Power Factor	Analogue	

Maximum Demand	Analogue	

Appendix 4 – Schedule of Protection or Detection Features Required

The attached schedule shall be completed by Suppliers to confirm the availability of the following Protection or detection features within their control relay:-

Protection or Detection Feature	Related Clause	Equipment Type	Provided (Y/N)
Waveform Capture for Pre-Fault Identification or Harmonic Analysis	6.4.108.7		
Current Based Protection Elements Trip time Characteristics	6.4.108.9	A/R only	
Voltage Based Protection Elements Trip time Characteristics	6.4.108.10	A/R only	
Phase Over Current Protection / Detection Requirements	6.4.108.11		
Earth Over Current Protection / Detection Requirements	6.4.108.12		
NPS Over Current Protection / Detection Requirements	6.4.108.13		
SEF Protection / Detection Requirements	6.4.108.14		
Fuse saving	6.4.108.15	A/R only	
Directional Protection / Detection	6.4.108.16		
Broken Conductor Protection / Detection	6.4.108.17		
Protection Reset	6.4.108.18		
Inrush Restraint	6.4.108.19		
Cold Load	6.4.108.20		
Lockout Option for Three Phase Faults	6.4.108.21	A/R only	
High Current Lockout	6.4.108.22	A/R only	
Auto-reclose operation parameters	6.4.108.23	A/R only	
Sequence Co-ordination	6.4.108.24		
Frequency Protection Requirements	6.4.108.25		
Voltage Protection Requirements	6.4.108.26		
Loss of Phase Protection / Detection Requirements	6.4.108.27		
Circuit Breaker Fail	6.4.108.28	A/R only	
Sectioning Function	6.4.108.29	S/W Only	

Appendix 5 – I/O DNP3 Maps / Points List

	PMAR – (Auto Recloser)		(Enclosed Switch Disconnector)	
DNP3.0 Alarms	**Application**	**Notes**	**Application**	**Notes**
POINT 0	Switchgear Tripped - Open	BINARY INPUTS	Switchgear Tripped - Open	BINARY INPUTS
POINT 1	Protection On/Off	BINARY INPUTS		BINARY INPUTS
POINT 2	Earth/Ground Protection Enabled	BINARY INPUTS		BINARY INPUTS
POINT 3	SEF/SGF Protection Enabled	BINARY INPUTS		BINARY INPUTS
POINT 4	Auto Reclose Enabled	BINARY INPUTS		BINARY INPUTS
POINT 5	Dummy Circuit Breaker	BINARY INPUTS	Dummy Circuit Breaker	BINARY INPUTS
POINT 6	Accumulated Phase Overcurrent Trip	BINARY INPUTS		BINARY INPUTS
POINT 7	Accumulated Earth/Ground Overcurrent Trip	BINARY INPUTS		BINARY INPUTS
POINT 8	Accumulated SEF/SGF Overcurrent Trip	BINARY INPUTS		BINARY INPUTS
POINT 9	Lockout	BINARY INPUTS		BINARY INPUTS
POINT 10	Controller Mode	BINARY INPUTS	Controller Mode	BINARY INPUTS
POINT 11	Auxiliary Supply Fail Delayed	BINARY INPUTS	Auxiliary Supply Fail Delayed	BINARY INPUTS
POINT 12	Maintenance Required	BINARY INPUTS	Maintenance Required	BINARY INPUTS
POINT 13	Switchgear Closed	BINARY INPUTS	Switchgear Closed	BINARY INPUTS
POINT 14	Loss of Phase Alarm	BINARY INPUTS	Loss of Phase Alarm	BINARY INPUTS
POINT 15	Broken Conductor Alarm	BINARY INPUTS	Broken Conductor Alarm	BINARY INPUTS
POINT 16	Any Phase Overcurrent Pickup	BINARY INPUTS	Any Phase Overcurrent Pickup	BINARY INPUTS
POINT 17	Earth/Ground Overcurrent Pickup	BINARY INPUTS	Earth/Ground Overcurrent Pickup	BINARY INPUTS
POINT 18	SEF/SGF Overcurrent Pickup	BINARY INPUTS	SEF/SGF Overcurrent Pickup	BINARY INPUTS
POINT 19	Battery Test Fail	BINARY INPUTS	Battery Test Fail	BINARY INPUTS
POINT 20	Controller Door Open	BINARY INPUTS	Controller Door Open	BINARY INPUTS
POINT 21	Work/Hot Line Tag Enabled	BINARY INPUTS		BINARY INPUTS
POINT 22	Protection Group A	BINARY INPUTS		BINARY INPUTS
POINT 23	Protection Group B	BINARY INPUTS		BINARY INPUTS
POINT 24	Protection Group C	BINARY INPUTS		BINARY INPUTS
POINT 25	Protection Group D	BINARY INPUTS		BINARY INPUTS
POINT 26	Protection Group E	BINARY INPUTS		BINARY INPUTS
POINT 27		BINARY INPUTS		BINARY INPUTS
POINT 28		BINARY INPUTS		BINARY INPUTS
POINT 29		BINARY INPUTS		BINARY INPUTS
POINT 30		BINARY INPUTS		BINARY INPUTS

Appendix 5 – continued I/O DNP3 Maps / Points List

	PMAR – (Auto Recloser)		(Enclosed Switch Disconnector)	
DNP3.0 Controls	**Application**	**Notes**	**Application**	**Notes**
POINT 0	ACR/LBS Control	BINARY OUTPUTS	ACR/LBS Control	BINARY OUTPUTS
POINT 1	Protection Control	BINARY OUTPUTS		BINARY OUTPUTS
POINT 2	Earth/Ground Protection Control	BINARY OUTPUTS		BINARY OUTPUTS
POINT 3	SEF/SGF Protection	BINARY OUTPUTS		BINARY OUTPUTS
POINT 4	Auto Reclose	BINARY OUTPUTS		BINARY OUTPUTS
POINT 5	Reset Fault Flag and Current	BINARY OUTPUTS	Reset Fault Flag and Current	BINARY OUTPUTS
POINT 6	Dummy CB Control	BINARY OUTPUTS	Dummy CB Control	BINARY OUTPUTS
POINT 7	Work/Hot Line Tag Control	BINARY OUTPUTS		BINARY OUTPUTS
POINT 8	Protection Group A	BINARY OUTPUTS		BINARY OUTPUTS
POINT 9	Protection Group B	BINARY OUTPUTS		BINARY OUTPUTS
POINT 10	Protection Group C	BINARY OUTPUTS		BINARY OUTPUTS
POINT 11	Protection Group D	BINARY OUTPUTS		BINARY OUTPUTS
POINT 12	Protection Group E	BINARY OUTPUTS		BINARY OUTPUTS
POINT 13		BINARY OUTPUTS		BINARY OUTPUTS
POINT 14		BINARY OUTPUTS		BINARY OUTPUTS
POINT 15		BINARY OUTPUTS		BINARY OUTPUTS
POINT 16		BINARY OUTPUTS		BINARY OUTPUTS
POINT 17		BINARY OUTPUTS		BINARY OUTPUTS
POINT 18		BINARY OUTPUTS		BINARY OUTPUTS
POINT 19		BINARY OUTPUTS		BINARY OUTPUTS

	PMAR – (Auto Recloser)		(Enclosed Switch Disconnector)	
DNP 3.0 ANALOGUES	**Application**	**Notes**	**Application**	**Notes**
POINT 0	A-Phase Inst Current	ANALOGUES	A-Phase Inst Current	ANALOGUES
POINT 1	B-Phase Inst Current	ANALOGUES	B-Phase Inst Current	ANALOGUES
POINT 2	C-Phase Inst Current	ANALOGUES	C-Phase Inst Current	ANALOGUES
POINT 3	ABi Phase to Phase Volts	ANALOGUES	ABi Phase to Phase Volts	ANALOGUES
POINT 4	BCi Phase to Phase Volts	ANALOGUES	BCi Phase to Phase Volts	ANALOGUES
POINT 5	CAi Phase to Phase Volts	ANALOGUES	CAi Phase to Phase Volts	ANALOGUES
POINT 6	3 Phase Inst Watts	ANALOGUES	3 Phase Inst Watts	ANALOGUES
POINT 7		ANALOGUES		ANALOGUES
POINT 8		ANALOGUES		ANALOGUES
POINT 9		ANALOGUES		ANALOGUES
POINT 10	HALF HOURLY A Current	ANALOGUES	HALF HOURLY A AMPS	ANALOGUES
POINT 11	HALF HOURLY B Current	ANALOGUES	HALF HOURLY BAMPS	ANALOGUES
POINT 12	HALF HOURLY C Current	ANALOGUES	HALF HOURLY C AMPS	ANALOGUES
POINT 13	HALF HOURLY A-Bi VOLTS	ANALOGUES	HALF HOURLY A-Bi VOLTS	ANALOGUES
POINT 14	HALF HOURLY B-Ci VOLTS	ANALOGUES	HALF HOURLY B-Ci VOLTS	ANALOGUES
POINT 15	HALF HOURLY C-Ai VOLTS	ANALOGUES	HALF HOURLY C-Ai VOLTS	ANALOGUES
POINT 16	HALF HOURLY WATTS	ANALOGUES	HALF HOURLY WATTS	ANALOGUES
POINT 17	HALF HOURLY VA	ANALOGUES	HALF HOURLY VA	ANALOGUES
POINT 18	HALF HOURLY VARS	ANALOGUES	HALF HOURLY VARS	ANALOGUES
POINT 19	HALF HOURLY PF	ANALOGUES	HALF HOURLY PF	ANALOGUES

Appendix 6A - Summary Declaration of Technical Parameters for 11/20kV PMAR's

Technical requirements and ratings for pole-mounted auto reclosing circuit-breakers

To be completed by Suppliers

Information	Clause of this technical specification/ ENA TS 41-46 or IEC 62271-1	NPg Equipment Requirements (acceptable)	Supplier Equipment details
Particulars of System			
Rated Voltage kV	5.2	24kV	
Frequency Hz	5.4	50 Hz	
Number of Phases		3	
Neutral earthing	4.3	Resistive, Solid & Peterson Coil	
Environment	4.1.3/	Outdoor (10mm Ice coating)	
Auto Reclosers Characteristics			
Number of Poles		3	
Class	4.1.101/	N/a	
Equipped with disconnector Y/N	4.1.101/	No	
Switchgear Mounting Position	6.0.3.1/	Central mount vertically below Conductors	
Control Box Mounting Arrangements a)Pole-top, b)Mid-pole, c)Down Pole	6.0.3/	Down Pole (below ACD)	
Auxiliary Power Supply	6.4.103 6.4.103/2	External VT 500VA	
Rated Voltage	5.2/	24 kV	
Rated Lightning Impulse Withstand Voltage - Common Value	5.3/Table1	150 kV (125kV)	
Rated Lightning Impulse Withstand Voltage - Across Isolating Gap	5.3/Table1	165 kV (125kV)	
1 min PF Voltage Withstand voltage - Common Value (dry/wet)	5.3/Table1	70kV / 60 kV (50kV)	
1 min PF Voltage Withstand voltage - across isolating Gap (dry/wet)	5.3/Table1	77kV / 66 kV (50kV)	
Rated Frequency	5.4/	50Hz	
Rated Continuous Current	5.5/	630 A	
Rated short-time withstand current	5.6/	12.5kA	
Rated duration of short Circuit	5.6/	3 sec	
Rated supply voltage of closing and opening devices and auxiliary and control circuits, a) Closing and Tripping b) Indication c) Control	5.9/	24V or 48V DC	
Rated short-circuit breaking current – equal to rated short-time withstand current @ 45ms time constant	5.300.101/	12.5 kA	
Rated short-circuit making current	5.300.103/	31.5 kA	
Rated operating sequence	5.300.104/	O - 0.3 s - CO – 10 s – CO	

Rated Capacitive switching current class	5.300.107/	Class C2	
Rated Mainly Active load breaking current (0.7pf)	5.303.101/	630 A	
Rated Cable Charging breaking Current	5.303.103/	25 A	
Rated Line Charging Breaking Current	5.303.104/	10 A	
Classification of mechanical Ops	5.300.110/	Class M2 (5,000 ops)	
Classification - Electrical Endurance	5.300.111/	Class E2	
Operating time – Close operation (ms)			
Operating time – Open operation (ms)		<50 ms	
Interrupting Time		<70 ms	
Fault Clearing Time – Instantaneous Protection		<90 ms	
Arc Interruption Medium		Vacuum Bottle	
Insulation Medium		Solid	
Mass of complete unit (kg)			
Dimensions (m)			
AIS bushing details Phase to Phase separation (mm) Phase to Earth Creepage Distance (mm)			
Material of switchgear enclosure	6.202/	Stainless Steel grade 303 or 316	
Type and number and accuracy of CT's provided with this switchgear	6.301/	One per phase min 5% accuracy	
Type and number and accuracy of Voltage sensors provided with this switchgear	6.301.2/	Min of one VT/CVT per phase, error accuracy should not exceed 1%	
Bushing Shroud Details			
Mass of Control Cabinet (kg)			
Dimensions of Control Cabinet			
Battery Type in Control Cabinet	6.4.103.3	DataSafe – 10 Year design Life	

Appendix 6B - Summary Declaration of Technical Parameters for 33kV PMAR's

Technical requirements and ratings for pole-mounted auto reclosing circuit-breakers

To be completed by Suppliers

Information	Clause of this technical specification/ ENA TS 41-46 or IEC 62271-1	NPg Equipment Requirements (acceptable)	Supplier Equipment details
Particulars of System			
Rated Voltage kV	5.2	36kV	
Frequency Hz	5.4	50 Hz	
Number of Phases		3	
Neutral earthing	4.3	Solid Engineering	
Environment	4.1.3/	Outdoor (10mm Ice coating)	
Auto Reclosers Characteristics			
Number of Poles		3	
Class	4.1.101/	N/a	
Equipped with disconnector Y/N	4.1.101/	No	
Switchgear Mounting Position	6.0.3.1/	Central mount vertically below Conductors	
Control Box Mounting Arrangements a)Pole-top, b)Mid-pole, c)Down Pole	6.0.3/	Down Pole (below ACD)	
Auxiliary Power Supply	6.4.103 6.4.103/2	External VT 500VA	
Rated Voltage	5.2/	36 kV	
Rated Lightning Impulse Withstand Voltage - Common Value	5.3/Table1	200 kV	
Rated Lightning Impulse Withstand Voltage - Across Isolating Gap	5.3/Table1	220 kV	
1 min PF Voltage Withstand voltage - Common Value (dry/wet)	5.3/Table1	95 kV / 80 kV	
1 min PF Voltage Withstand voltage - across isolating Gap (dry/wet)	5.3/Table1	105 kV / 88 kV	
Rated Frequency	5.4/	50Hz	
Rated Continuous Current	5.5/	630 A	
Rated short-time withstand current	5.6/	16kA	
Rated duration of short Circuit	5.6/	3 sec	
Rated supply voltage of closing and opening devices and auxiliary and control circuits, a) Closing and Tripping b) Indication c) Control	5.9/	24V or 48V DC	
Rated short-circuit breaking current – equal to rated short-time withstand current @ 45ms time constant	5.300.101/	16 kA	
Rated short-circuit making current	5.300.103/	40 kA	
Rated operating sequence	5.300.104/	O - 0.3 s - CO – 10 s – CO	

Rated Capacitive switching current class	5.300.107/	Class C2	
Rated Mainly Active load breaking current (0.7pf)	5.303.101/	630 A	
Rated Cable Charging breaking Current	5.303.103/	25 A	
Rated Line Charging Breaking Current	5.303.104/	10 A	
Classification of mechanical Ops	5.300.110/	Class M2 (5,000 ops)	
Classification - Electrical Endurance	5.300.111/	Class E2	
Operating time – Close operation (ms)			
Operating time – Open operation (ms)		<50 ms	
Interrupting Time		<70 ms	
Fault Clearing Time – Instantaneous Protection		<90 ms	
Arc Interruption Medium		Vacuum Bottle	
Insulation Medium		Solid	
Mass of complete unit (kg)			
Dimensions (m)			
AIS bushing details Phase to Phase separation (mm) Phase to Earth Creepage Distance (mm)			
Material of switchgear enclosure	6.202/	Stainless Steel grade 303 or 316	
Type and number and accuracy of CT's provided with this switchgear	6.301/	One per phase min 5% accuracy	
Type and number and accuracy of Voltage sensors provided with this switchgear	6.301.2/	Min of one VT/CVT per phase, error accuracy should not exceed 1%	
Bushing Shroud Details			
Mass of Control Cabinet (kg)			
Dimensions of Control Cabinet			
Battery Type in Control Cabinet	6.4.103.3	DataSafe – 10 Year design Life	

Appendix 6C - Summary Declaration of Technical Parameters for 11/20kV Enclosed Switch Disconnectors

Technical requirements and ratings for pole-mounted auto reclosing circuit-breakers

To be completed by Suppliers

Information	Clause of this technical specification/ ENA TS 41-46 or IEC 62271-1	NPg Equipment Requirements (acceptable)	Supplier Equipment details
Particulars of System			
Rated Voltage kV	5.2	24kV	
Frequency Hz	5.4	50 Hz	
Number of Phases		3	
Neutral earthing	4.3	Resistive, Solid & Peterson Coil	
Enclosed Switch Disconnector Characteristics			
Number of Poles		3	
Class	4.1.102/	Class M2	
Environment	4.1.3/	Outdoor (10mm Ice coating)	
Equipped with earthing switch Y/N	6.0.2/		
Switchgear Mounting Position	6.0.3.2/	Offset to one side of the pole	
Control Box Mounting Arrangements a)Pole-top, b)Mid-pole, c)Down Pole	6.0.3/	Down Pole (below ACD)	
Auxiliary Power Supply	6.4.103 6.4.103/2	External VT 500VA	
Rated Voltage	5.2/	24 kV	
Rated Lightning Impulse Withstand Voltage - Common Value	5.3/Table1	150 kV	
Rated Lightning Impulse Withstand Voltage - Across Isolating Gap	5.3/Table1	165 kV	
1 min PF Voltage Withstand voltage - Common Value (dry/wet)	5.3/Table1	70 kV / 60 kV	
1 min PF Voltage Withstand voltage - across isolating Gap (dry/wet)	5.3/Table1	77kV / 66 kV	
Rated Frequency	5.4/	50Hz	
Rated Continuous Current	5.5/	630 A	
Rated short-time withstand current	5.6/	12.5kA	
Rated duration of short Circuit	5.6/	3 sec	
Rated supply voltage of closing and opening devices and auxiliary and control circuits, a) Closing and Tripping b) Indication c) Control	5.9/	24V or 48V DC	
Rated Mainly Active load breaking current (0.7pf)	5.303.101/	630 A	
Rated Closed Loop breaking Current	5.303.102	630A	
Rated Cable Charging breaking Current	5.303.103/	25 A	
Rated Line Charging Breaking Current	5.303.104/	10 A	
Rated short-circuit making current	5.303.111/	31.5 kA	
Mechanism type (give details)	6.6/		

Arc Interruption Medium			
Insulation Medium			
Mass of Gas (kg)			
Volume of Compartment (m3)			
Mass of gas (kg) that would be lost if gas leaked until compartment pressure equals the standard atmospheric conditions (+20°C and 101,3 kPA), without air entering the chamber.			
Method(s) of monitoring pressure and achieving temperature compensation			
Maximum compartment pressure when switchgear running continually at full load, under maximum ambient temperature, with received solar gain of 1000W/m2 [kPA AND Bar(g)]			
Minimum compartment pressure to operate pressure relief device [kPA AND Bar(g)]			
Minimum compartment pressure when switchgear not carrying any load, at minimum ambient temperature and without any solar gain. [kPA AND Bar(g)]			
Mass of complete unit (kg)			
Dimensions (m)			
AIS bushing details Phase to Phase separation (mm) Phase to Earth Creepage Distance (mm)			
Type and number and accuracy of CT's provided with this switchgear	6.301/	One per phase min 5% accuracy	
Type and number and accuracy of Voltage sensors provided with this switchgear	6.301.2/	one per phase on source and load sides error accuracy should not exceed 1%	
Material of switchgear enclosure	6.202/	Stainless Steel grade 303 or 316	
Bushing Shroud Details			
Mass of Control Cabinet (kg)			
Dimensions of Control Cabinet			
Battery Type in Control Cabinet	6.4.103.3	DataSafe – 10 Year design Life	

Appendix 6D - Summary Declaration of Technical Parameters for 33kV Enclosed Switch Disconnectors

Technical requirements and ratings for pole-mounted auto reclosing circuit-breakers

To be completed by Suppliers

Information	Clause of this technical specification/ ENA TS 41-46 or IEC 62271-1	NPg Equipment Requirements (acceptable)	Supplier Equipment details
Particulars of System			
Rated Voltage kV	5.2	36kV	
Frequency Hz	5.4	50 Hz	
Number of Phases		3	
Neutral earthing	4.3	Solid Earthing	
Enclosed Switch Disconnector Characteristics			
Number of Poles		3	
Class	4.1.102/	Class M2	
Environment	4.1.3/	Outdoor (10mm Ice coating)	
Equipped with earthing switch Y/N	6.0.2/		
Switchgear Mounting Position	6.0.3.2/	Offset to one side of the pole	
Control Box Mounting Arrangements a)Pole-top, b)Mid-pole, c)Down Pole	6.0.3/	Down Pole (below ACD)	
Auxiliary Power Supply	6.4.103 6.4.103/2	External VT 500VA	
Rated Voltage	5.2/	36 kV	
Rated Lightning Impulse Withstand Voltage - Common Value	5.3/Table1	200 kV	
Rated Lightning Impulse Withstand Voltage - Across Isolating Gap	5.3/Table1	220 kV	
1 min PF Voltage Withstand voltage - Common Value (dry/wet)	5.3/Table1	80 kV	
1 min PF Voltage Withstand voltage - across isolating Gap (dry/wet)	5.3/Table1	88 kV	
Rated Frequency	5.4/	50Hz	
Rated Continuous Current	5.5/	630 A	
Rated short-time withstand current	5.6/	16 kA	
Rated duration of short Circuit	5.6/	3 sec	
Rated supply voltage of closing and opening devices and auxiliary and control circuits, a) Closing and Tripping b) Indication c) Control	5.9/	24V or 48V DC	
Rated Mainly Active load breaking current (0.7pf)	5.303.101/	630 A	
Rated Closed Loop breaking Current	5.303.102	630 A	
Rated Cable Charging breaking Current	5.303.103/	25 A	
Rated Line Charging Breaking Current	5.303.104/	10 A	
Rated short-circuit making current	5.303.111/	40 kA	
Mechanism type (give details)	6.6/		

Arc Interruption Medium			
Insulation Medium			
Mass of Gas (kg)			
Volume of Compartment (m3)			
Mass of gas (kg) that would be lost if gas leaked until compartment pressure equals the standard atmospheric conditions (+20°C and 101,3 kPa), without air entering the chamber.			
Method(s) of monitoring pressure and achieving temperature compensation			
Maximum compartment pressure when switchgear running continually at full load, under maximum ambient temperature, with received solar gain of 1000W/m2 [kPA AND Bar(g)]			
Minimum compartment pressure to operate pressure relief device [kPA AND Bar(g)]			
Minimum compartment pressure when switchgear not carrying any load, at minimum ambient temperature and without any solar gain. [kPA AND Bar(g)]			
Mass of complete unit (kg)			
Dimensions (m)			
AIS bushing details Phase to Phase separation (mm) Phase to Earth Creepage Distance (mm)			
Type and number and accuracy of CT's provided with this switchgear	6.301/	One per phase min 5% accuracy	
Type and number and accuracy of Voltage sensors provided with this switchgear	6.301.2/	one per phase on source and load sides error accuracy should not exceed 1%	
Material of switchgear enclosure	6.202/	Stainless Steel grade 303 or 316	
Bushing Shroud Details			
Mass of Control Cabinet (kg)			
Dimensions of Control Cabinet			
Battery Type in Control Cabinet	6.4.103.3	DataSafe – 10 Year design Life	

Appendix 7 - Self Certification Conformance Declaration:

Pole Mounted Auto-reclose Circuit Breakers, Enclosed Switch Disconnectors and their associated control cabinets shall comply with the latest issues of the relevant ENA technical specifications, international and British Standards.

This check sheet identifies the clauses in the aforementioned Standards relevant to Pole Mounted Auto-reclosers Circuit Breakers, Enclosed Switch Disconnectors and their associated control cabinets for use on the Northern Powergrid distribution networks.
The manufacturer shall declare conformance or otherwise, clause by clause, using the following levels of conformance declaration codes.
A separate set of sheets shall be completed for each equipment type being offered

Conformance declaration codes
N/A = Clause is not applicable/ appropriate to the product
Cs1 = The product conforms fully with the requirements of this clause
Cs2 = The product conforms partially with the requirements of this clause
Cs3 = The product does not conform to the requirements of this clause
Cs4 = The product does not currently conform to the requirements of this clause, but the manufacturer proposes to modify and test the product in order to conform.

Instructions for completion

- When Cs1 code is entered no remark is necessary
- When any other code is entered the reason for non-conformance shall be entered
- Prefix each remark with the relevant IEC, 'BS EN' or 'ENATS' as appropriate

Manufacturer:
Product Reference:

Name: **Signature:** **Date:**

Type Testing – Auto Reclosing Circuit Breakers					
Standard	Clause/Sub-clause	Requirement	Conformance Code	Actual Test Value	Remarks
BS EN 62271-1. IEC 62271-103. IEC 62271-200. BS EN IEC 62271-102.	Clause 7.2 Clause 6.2 Clause 6.2 Clause 7.2	Dielectric Type Test			
IEC 62271-200 ENA TS 41-18 [N3]	"partial discharge measurement" Clause and Annex B	Partial Discharge $\leq$ 10pC			
BS EN 62271-1, Clauses of BS EN 62271-100 BS EN 62271-200	Clause 7.4 "resistance measurement"	Measurement of Main Circuit Resistance			
BS EN 62271-1 BS EN 62271-100 & BS EN 62271-200	Clause 7.5 "temperature-rise tests"	Temperature Rise			
BS EN 62271-1 Clauses of BS EN 62271-100 & BS EN 62271-200.	Clause 7.6 "Short-time withstand current and peak withstand current tests"	Short-time and Peak Withstand Current			

Type Testing Continued - Auto Reclosing Circuit Breakers					
Standard	Clause/Sub-clause	Requirement	Conformance Code	Actual Test Value	Remarks
BS EN 62271-1 BS EN 62271-100 BS EN 62271-200 ENA TS 41-46 BS EN 62271-1. ENA TS 41-46	Clause 7.7 Annex C, "Verification of the degree of protection" "Verification of the protection" Clauses *Clause 6.14.2* Clause 7.2 Clause 6.14.3	Verification of protection. - Verification of IP coding (outdoor – IP4X minimum) (operational fascia IP3X) (Enclosure doors open IPXXB) (Partitions of HV compartment IP3XD) (Mechanism IP2X) - Verification of IK coding (Mechanical impact. indoor – IK07 (2J))			
BS EN 62271-1 BS EN 62271-100 and BS EN 62271-200.	Clause 7.8 "Tightness tests"	Tightness Test			
BS EN 62271-1 BS EN 62271-100.	Clause 7.9 "Electromagnetic compatibility tests"	EMC Test			
BS EN 62271-100 and BS EN 62271-200. ENA TS. 41-46	"Mechanical operations" Clauses, table 8 Clause 7.102. Clause 7.102	Mechanical operations - Circuit-breaker. a) Auto-reclosing circuit-breaker -min 5000 ops, class M2 - 10,000 ops, auto-reclosing sequences without lubrication 10% specified operating cycles with manual (production) handle. 50 manual operating cycles			
Type Testing Continued - Auto Reclosing Circuit Breakers					
Standard	Clause/Sub-clause	Requirement	Conformance Code	Actual Test Value	Remarks

BS EN 62271-100	"Arrangement of circuit-breaker for tests" Clause	Low and High Temperature Tests			
BS EN 62271-100 ENA TS. 41-46	"Arrangement of circuit-breaker for tests" Clause Clause 7	High Temperature Test – subject to design			
BS EN 62271-100 IEC 6271-102	6.101.5 6.103	Operation Under severe Ice conditions			
BS EN 62271-100. BS EN 62271-200. ENA TS 41-46.	"Miscellaneous provisions for making and breaking tests", "Basic short-circuit test duties" & "Special requirements for making and breaking tests on class E2 circuit-breakers" "Verification of making and breaking capacities" Clauses Clause 5.300.111	Short-circuit making and breaking tests - Circuit-breaker class E2. Auto-reclosing circuit-breaker - tested for duty as specified in BS EN62271-100 Table 33, list 1.			
Type Testing Continued - Auto Reclosing Circuit Breakers					
Standard	Clause/Sub-clause	Requirement	Conformance Code	Actual Test Value	Remarks
BS EN 62271-100.	"Capacitive current	Cable Charging Current Break Test			

ENA TS 41-46	switching tests” Clause 5.300.107				
BS EN 62271-100. ENA TS 41-46	“Capacitive current switching tests” Clause 5.300.107	Line Charging Current Break tests			
IEC 62271-214. ENA TS 41-46	IEC 62271-214. Clause 6.201	Internal Arc			
IEC 62271-200.	Clause 7.103	Gas Filled Compartment Pressure withstand			
IEC 61109	Annex C	Ageing test for outdoor composite bushings and insulation materials – minimum of 5,000 hours duration.			
ENA TS 98-1	Performance to ENA TS 98-1	Finish			

Type Testing – Enclosed Switch Disconnectors					
Standard	Clause/Sub-clause	Requirement	Conformance Code	Actual Test Value	Remarks
BS EN 62271-1. BS EN 62271-103. BS EN IEC 62271-102.	Clause 7.2 Clause 6.2 Clause 7.2	Dielectric.			
BS EN 62271-1 BS EN 62271-103. BS EN IEC 62271-102.	Clause 7.5.4 Clause 6.4 Clause 7.4.	Measurement of the resistance of main circuit.			
BS EN 62271-1. BS EN 62271-103. BS EN IEC 62271-102.	Clause 7.5.4 Clause 6.5 Clause 7.5.	Temperature Rise.			
BS EN 62271-1. BS EN 62271-103. BS EN IEC 62271-102.	Clause 7.6 Clause 6.6 Clause 7.6.	Short-time withstands current and peak withstands current tests.			
BS EN 62271-1. BS EN 62271-103. IEC 62271-102.	Clause 7.7 Clause 6.7 Clause 7.7	Verification of protection Weatherproofing for outdoor equipment. (outdoor IP4XDW minimum) Mechanical impact. (outdoor – IK10 (20J))			
Type Testing Continued – Enclosed Switch Disconnectors					

Standard	Clause/Sub-clause	Requirement	Conformance Code	Actual Test Value	Remarks
BS EN 62271-1 BS EN 62271-103 BS EN IEC 62271-102	Clause 7.9 Clause 6.9 Clause 7.9	EMC tests.			
BS EN 62271-103 BS EN IEC 62271-102 ENA TS 41-46	Clause 6.102 Clause 7.102. Clause 7	Mechanical operations - Disconnector / Switch-disconnector - 1000 operations. (Class M0 disconnector - IEC 62271-102 Clause 3.4.101.1). (Class M1 general purpose switch - IEC 62271-103 Clause 3.4.103.4). 100 operating cycles with manual handle			
BS EN 62271-103 BS EN IEC 62271-102	Clause 6.102.5. Clause 7.103.	Operation under severe ice conditions (10mm thickness			
BS EN 62271-103	Clauses 6.101, (TDload, TDloop, TDcc, TDlc, & TDma,, Table 3).	Short-circuit making and breaking tests - Switch-disconnector (Class E1 general purpose switch - IEC 62271-103. Sub-clause 3.4.103.1).			
BS EN IEC 62271-214 ENA TS 41-46	 Clause 6.201	Internal Arc.			
BS EN 62271-200	Clause 7.103	Gas-filled Compartment.			

		Pressure Withstand.			
Type Testing continued – Enclosed Switch Disconnectors					
Clause/Sub-clause	Requirement	Conformance Code	Remarks	Actual Test Value	Remarks
IEC 61109	Annex C	Ageing test for outdoor composite bushings and insulation materials – minimum of 5,000 hours duration			
ENA TS 98-1	Performance to ENA TS 98-1	Finish.			
Protection Relay Type Testing – Atmospheric Environment Requirements					
Standard	ENA TS 48-5 Test	Requirement	Conformance Code	Actual Test Value	Remarks
BSEN 60068-2-1	Clause 5.1- Temperature Cold Heat	-10°C, 96 hours, operate or -25°C, 16 hours, operate			
		-25°C, 96 hours, operate (for outdoor equipment)			
		-25°C, 96 hours, storage or -40°C, 16 hours, storage			
BS EN 60068-2-2	Clause 5.1 - Temperature Dry Heat	+70°C, 96 hours, operate (for outdoor equipment)			
		+70°C, 96 hours, storage			
BS EN 60068-2-78	Clause 5.2 Relative Humidity	100% RH, 40ºC, 56 days (Outdoor equipment)			
BS EN 60529	Clause 5.3 Enclosure	IP54 (for outdoor equipment)			
Protection Relay Type Testing Continued – Mechanical Environment Requirements					
Standard	ENA TS 48-5 Test	Requirement	Conformance Code	Actual Test Value	Remarks
BS EN 60255-21-1	Clause 6.1 -	Response Class 1			

	Vibration	Response Class 2 (Where integral with PMAR or Switch)			
		Endurance Class 1			
BS EN 60255-21-2	Clause 6.2 - Shock	Response Class 1			
		Response Class 2 (Where integral with PMAR or Switch)			
		Withstand Class 1			
BS EN 60255-21-2	Clause 6.2 - Bump	Class 1			
BS EN 60255-21-3	Clause 6.3 – Seismic	Class 1			
Protection Relay Type Testing Continued – Electrical Environmental Requirements					
Standard	ENA TS 48-5 Test	Requirement	Conformance Code	Actual Test Value	Remarks
BS EN 60255-1	Clause 7.1 24 V DC Supply Voltage	Table 1, remain within claimed accuracy from 19.2 to 28.8 V with > 30V maximum continuous withstand			
BS EN 60255-1	Clause 7.1 48 V DC Supply Voltage	Table 1, remain within claimed accuracy from 38.5 to 53 V with > 60 V maximum continuous withstand			
BS EN 60255-26	Clause 7.1 Voltage Dips, Short Interruptions and Voltage Immunity Test	2,5 & 10 ms interruption, no affect			
		>10ms interruption, no mal operation with any reset			
		15% AC ripple			
ENA TS 48-5	Clause 7.1 - DC Supply Voltage General	Ramp up and down over 1 minute or similar			
ENA TS 48-4	Clause 7.1 DC Supply voltage Low Burden Trip Relays	Captive discharge			
Protection Relay Type Testing Continued – Electrical Environmental Requirements					
Standard	ENA TS 48-5 Test	Requirement	Conformance Code	Actual Test Value	Remarks
ENA TS 48-4	Clause 7.1 DC Supply voltage High Burden Trip Relays	Captive discharge			
BS EN 60255-6	Clause 7.2 – AC supply	Min. and Max. declared			

	voltage				
ENA TS 48-5	Clause 7.3 - Thermal requirement of CT inputs	2.4 x I_n, continuous 3.0 x I_n, 20 mins 3.5 x I_n, 10 mins 4.0 x I_n, 5 mins 5.0 x I_n, 3 mins 6.0 x I_n, 2 mins			
ENA TS 48 – 5	Clause 7.4 Thermal requirements of VT inputs	120% of Vn, continuous			
BS EN 60255-27	Clause 7.5.1 – Insulation - Dielectric	Test values selected according to insulation voltage. High Impedance circulating current schemes, test at 2.3kV. Circuits connected to instrument transformers or batteries, rated insulation not below 250V, test at 2.0kV for 1 minute Open output relay contacts 1kV. for 1 minute			
BS EN 60255-27	Clause 7.5.2 – Insulation – Impulse Voltage	Test at 5kV peak, 0.5J			
Electromagnetic Compatibility (EMC) Requirements					
Standard	ENA TS 48-5 Test	Requirement	Conformance Code	Actual Test Value	Remarks
BS EN 60255-26	Clause 8.1 - Oscillatory waves immunity test (High Frequency Disturbance)	1MHz 2.5kV common, 1 kV differential. Applied to all ports, except differential on communications ports at the discretion of the purchaser			
BS EN 60255-26	Clause 8.2 - Electrostatic Discharge Immunity Tests	6kV, contact, 8kV air. Applied to the enclosure			
BS EN 60255-26	Clause 8.3 - Radiated electromagnetic Field	10V/m, measured in accordance with BS EN 61000-4-3			

	Disturbance test (RFI)				
BS EN 60255-26	Clause 8.4 - Electrical fast transient/burst immunity	Zone A, 4kV. Applied to all ports			
BS EN 60255-26	Clause 8.5 - Surge immunity test	In accordance with BS EN 61000-4-5, installation level 4			
BS EN 60255-26	Clause 8.6 - Conducted electromagnetic field disturbance tests	10Vrms, 80% mod, 1kHz. 0.15 to 80MHz sweep and 27 and 68 MHz spot frequencies. Applied to all ports			
BS EN 61000-4-8	Clause 8.7.1 - Power frequency magnetic field immunity test	1000 A/m for 1 sec and 100 A/m for 1 min. Applied to all ports			
BS EN 61000-4-16 BS EN 60255-26	Clause 8.7.2 - Power Frequency - General	Test Level 4, 30V, 50Hz, common mode. Zone A			
BS EN 61000-4-9	Clause 8.8 - Pulse magnetic field immunity test	6.4/16 µs magnetic pulse, 1000 A/m. Applied to enclosure.			
Electromagnetic Compatibility (EMC) Requirements					
Standard	ENA TS 48-5 Test	Requirement	Conformance Code	Actual Test Value	Remarks
BS EN 61000-4-10	Clause 8.9 - Damped oscillatory magnetic field immunity test	0.1 and 1.0 MHz, 100A/m. Applied to the enclosure.			
BS EN 60834-1	Clause 8.10 – Tele protection equipment of power systems	Only applicable for tele protection equipment			
BS EN 60255-26	Clause 8.11 - Conducted and radiated Emission	Zone A, conducted, power supply: 0.15 to 0.5 MHz, 79dB(µV) quasi peak, 66dB (µV) average, 0.5 to 30 MHz, 71dB(µV) quasi peak, 60dB (µV) average. Radiated, enclosure at 10M: 30 to 230 MHz, 40dB(µV/m) quasi			

		peak, 1 HZ to 3 GHz, 56 dB (µV/m) average 3 GHz to 6 GHz , 60dB(µV/m) average,			

Appendix 8 - Pre-commission Testing, Routine Inspection and Maintenance Requirements

Suppliers shall provide details of the recommended pre-commission testing and inspection required. They shall also provide information regarding periodic inspection and maintenance requirements to be undertaken during the lifetime of their product and provide a list of spare parts necessary to support the products through its expected lifecycle.

Appendix 9 – Protection, Packaging & Test Certificates

The equipment shall be suitably packaged and protected with each unit marked with the following information:

i) Manufacturers name.

ii) Manufacturer's product type and unique unit serial number.

iii) Description of item.

iv) Date of supply.

v) Company order number.

vi) Purchasing Companies Stock Catalogue Number.

vii) Weight of each unit.

All auto reclosers, switch disconnectors and control cabinets shall be supplied complete with a copy of the routine tests carried out on the equipment during its manufacture. The test cards shall be enclosed in a waterproof document holder and be tied to the switchgear.

Appendix 10 - Technical Information Check List

The following information shall be provided by the supplier for review by Northern Powergrid.

Additional information shall be provided if requested.

Requirement	Provided
Full product descriptions and part number/reference	
Complete set of drawings for each item	
Appendix 1 - Schedule of Requirements	
Appendix 2 – Schedule of Local Controls and Indications	
Appendix 3 – Schedule of Remote Controls and Indications	
Appendix 4 - Schedule of Protection or Detection Features required	
Appendix 5 – I/O DNP3 Maps / Points List	
Appendix 6A – 5D - Summary declaration of technical parameters for switchgear	
Appendix 7 - Self Certification Conformance	
Appendix 8 - Pre-commission testing, Routine Inspection and Maintenance requirements	
Appendix 9 – Protection, Packaging & Test Certificates	