NPS/005/003 – Technical Specification for Protection and Control Panels

1. Purpose

The purpose of this document is to detail the requirements for Protection and Control Panels to be utilised on the distribution networks of Northern Powergrid.

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

Document Reference	Document Title	Version	Published Date
NPS/005/003	Technical Specification for Protection and Control Panels	2.0	March 2018

2. Scope

This document includes the design specification, technical and construction requirements for Protection and Control Panels for use on the distribution networks of Northern Powergrid.

2.1. Contents

3. Technical Requirements

3.1. Compliance with other Specifications and Standards

Where reference is made within this document to any International Standard, British Standard, Energy Networks Association Technical Specification (ENA TS) or any other standard, this shall be to the latest version of that standard current at the time of supply.

3.2. General Protection Requirements

3.2.1. Protection Relays

All protection equipment is required to function satisfactorily in accordance with the manufacturers' declared performance levels and in the presence of electromagnetic phenomena appropriate to the environment. All relays should be within the scope of the IEC harmonised standard BS EN 60255 and BSEN 61810.

All protection relays shall be ENA assessed and approved by Northern Powergrid. Unless otherwise agreed in writing, all protection relays, Automatic Voltage Control (AVC) and control relays shall conform to Northern Powergrid's Approved Protection Relay List (see appendix 1). All other panel items shall conform to Northern Powergrid's Approved Ancillary Equipment List (see appendix 2).

Northern Powergrid will consider alternative equivalent products offered by the Supplier but the costs associated with assessment, re-engineering of protection schemes and general integration of alternative products will be borne by the Supplier. All products will be assessed in line with Northern Powergrid Code of Practice PRC/200/203, Management Process for the Assessment and Introduction of Network Plant, Equipment or Materials.

Unless otherwise agreed in writing, trip relays will be installed at all voltages. Separate main and back up relays will be installed on EHV and 132kV circuits. Trip relays will not have external trip levers.

For relays with electronic inputs, where the input voltage is not nominally 110/125V and there is no on-board field supply, the provision of any necessary input resistors shall be included with the relay. Inputs are required to be DC operated and be immune to interference from AC signals.

Relay output contacts shall be capable of initiating direct CB tripping, irrespective of whether a particular design indicates they are required to do so or not. In all other cases, relay contacts will be suitable for their prescribed duty including the capability to interrupt DC as required.

Interposing relays of any type will not have flag indication. Such relays will not have operating buttons when mounted on the front of a panel unless the buttons are lockable. Interposing relays mounted in the rear of panel may have operating buttons. Telecontrol interposing relays will be capable of operating at 87.5% of nominal voltage, typically 24V DC.

All relays will generally feature screw terminals. Spade terminals are not acceptable for protection circuits.

Any diodes associated with tripping and alarm flag relay circuits shall have varistor protection against back EMF. Any diodes utilised for Transformer trip duties shall be Siemens type 7XG1300 6A with built in varistor. Component board mounted diode/varistors may be used for other applications.

3.2.2. Protection Relay DC Supplies

All relays connected to nominal 110VDC systems will have an operating range of at least 87.5V to 137.5V. Additionally, such relays containing electronic power supplies will have an extended upper voltage limit of at least 200V.

All dc supplies to protection and control relays will be monitored. The last device in a dc supply spur to protection and control relays will be either a self-supervised protection and control relay or a supply

supervision relay. Discrete power supply isolation links may be required on non-isolatable relays, placed on the rear terminals, these would typically be Weidmuller WTL.

3.2.3. Protection Relay Functionality

Protection with numeric relays having self-monitoring capabilities shall be installed. Where protection functions are combined within a single protection relay, there shall be sufficient redundancy such that failure of a single protection relay will not affect the availability of plant (more details on relay functionality can be found in IMP/001/014 Code of Practice for the Protection of Distribution Networks).

The following list details the protection functions that can be utilised in a single multi-functional relay, no other combinations will be used.

- Feeder highset overcurrent and compensated earth fault protection.
- Feeder overcurrent and compensated earth fault protection incorporating directional, non-directional, highset and standby main protection stages.
- Feeder highset overcurrent and balanced earth fault protection.
- Feeder backup overcurrent and earth fault protection.
- Low frequency stage 1 and stage 2 protection.
- Feeder neutral voltage displacement protection stage 1 and stage 2.
- Transformer HV 2 stage overcurrent and balanced earth fault protection.
- Transformer bias differential, HV restricted earth fault, and LV restricted earth fault protection.
- Transformer LV Overcurrent and standby earth fault protection stage 1 and stage 2.
- Transformer LV directional overcurrent, restricted earth fault and overcurrent protection.
- HV feeder overcurrent and earth fault protection.
- Generator interface protection.

3.2.4. Testing Facilities for Protection Relays

Relay test blocks shall be provided; adequate test and isolation facilities shall be provided to facilitate all necessary maintenance and testing without the need to remove wired connections.

All test facilities shall be normally accessible from the front of the panel.

Sufficient maintenance test points are to be provided to allow main protection, back up protection, control and alarm equipment to be tested and maintained using automatic test equipment.

Protection relays will be designed to allow full relay or module replacement without the need to remove individual wired connections.

3.2.5. Alarms, Indications and Supervision

The layout of relay panel alarm and indication LEDs shall be approved by Northern Powergrid. The following local alarms will be provided as a minimum on the appropriate relay panel:-

- Non Trip Alarm – monitoring protection DC supplies and circuit breaker trip circuits or for transformers the operation of main Buchholz gas, auxiliary Buchholz gas, and winding temperature alarms.
- VT Supply Fail – monitoring voltage transformer circuits.

- Main Protection Faulty – monitoring relay field (auxiliary) supply voltage and protection relay status.
- Backup Protection Faulty – monitoring relay field (auxiliary) supply voltage and protection relay status.
- Trip Relay Operated / CB Auto Trip – monitoring status of CB trip relays.
- Low Frequency Alarm – monitoring low frequency protection operation.
- Voltage Control Faulty – monitoring transformer automatic voltage control relay.
- Main Buchholz Alarm (routed through and displayed on the main transformer protection relay where appropriate) – monitoring main transformer Buchholz Gas operation.
- Main Buchholz Trip (routed through and displayed on the main transformer protection relay where appropriate) – monitoring main transformer Buchholz Surge operation.
- Auxiliary Buchholz Alarm (routed through and displayed on the main transformer protection relay where appropriate) – monitoring auxiliary transformer Buchholz Gas operation.
- Auxiliary Buchholz Trip (routed through and displayed on the main transformer protection relay where appropriate) – monitoring auxiliary transformer Buchholz Surge operation.
- Selector Buchholz Trip (routed through and displayed on the main transformer protection relay where appropriate) – monitoring main transformer tap changer Buchholz Surge operation.
- Winding Temperature Alarm (routed through and displayed on the main transformer protection relay where appropriate) – monitoring transformer winding temperature operation.
- Winding Temperature Trip (routed through and displayed on the main transformer protection relay where appropriate) – monitoring transformer winding temperature operation.
- Winding Temperature Fail – monitoring status of winding temperature protection relay.
- Main Transformer Pressure Relief Alarm – monitoring main transformer pressure relief device operation.
- Auxiliary Transformer Pressure Relief Alarm – monitoring auxiliary transformer pressure relief device operation.
- Main and/or Tap Changer Oil Level Alarm – monitoring oil level in Transformer Main and Tap Change tanks
- Cooling Equipment Faulty – monitoring status of Automatic cooling control equipment including status of Cooling Plant
- SF6 Close Inhibit (only for SF6 circuit breakers) - indicating operation of the first stage of low pressure monitoring.
- SF6 Low Gas Pressure Lockout (only for SF6 circuit breakers) - indicating operation of the second stage of low pressure monitoring.
- Intertrip Faulty – monitoring status of intertripping equipment.
- Cable Pressure Low – monitoring the pressure of pressure assisted cables.

The following indications will be provided on the appropriate relay panel:-

- Disconnector Open

- Disconnector Closed
- Earth Switch Open
- Earth Switch Closed
- Circuit Breaker Open
- Circuit Breaker Closed
- Circuit Breaker Isolated
- HVOC High Setting Selected – this is only applicable to highset overcurrent protection fitted to transformers.

For details of SCADA alarms see IMP/007/003 - SCADA Code of Practice and IMP/001/017 – Standard for the Application of System Monitoring.

3.2.6. Substation Communications

Protection and control relays shall have remote data communications facilities appropriate to the type of relay.

Relays will have the ability to communicate directly with the RTU to provide analogues, digital indication and controls; DNP 3.0 via serial RS-485 connection will be the preferred protocol.

Consideration will be given for the utilisation of IEC61850 if the benefits of the protocol can be justified over existing systems

The SCADA and remote data communications will be capable of being in service at the same time.

The communications will be capable of operating in a normal substation environment under normal operating conditions, and will continue to operate during fault conditions if this is necessary for the correct operation of the protection and control scheme.

Disturbance recorder installations shall be arranged such that they can be remotely interrogated using suitable software packages.

3.2.7. Voltage and Current Transformers

Interposing current and voltage transformers should comply with the product standards BS EN 61869

The VT supply for protection relays will be supervised for all types of loss of VT input to the protection relay.

3.3. Drawings

The following drawings and schedules could be provided for each panel design for a given substation in accordance with established formats and protocols:

- Connections and Protection Drawings
- General Arrangement Drawings
- Circuit Diagrams
- Wiring Diagrams
- Logic Diagrams (including Programmable Scheme Logic)
- Buswiring Schedules

Drawings shall at least be in accordance with BS 8888 and BS 5070. Northern Powergrid will reserve the right to comment on all drawings. All submitted drawings shall have space for insertion of a Northern Powergrid drawing number.

The general arrangement drawing shall include details of all component parts, detail front and rear equipment positions including fuses, links, switches, buttons, LED indicators etc.

Connectivity with other substation components that are not part of the specified equipment shall be shown on circuit diagrams in the form of a "skeleton" circuit; the emphasis being on indicating the overview of the entire circuit functionality to the drawing viewer. In the process of carrying this out, any information submitted or obtained by the panel supplier will be vetted by the supplier for accuracy and conflicts.

Any provisional or generic isolation link requirements able to be submitted by Northern Powergrid, will be assessed by the panel supplier against the supplier's assessment of the project requirements and suggestions made for the particular project in question. Similarly, any provisional or generic cable termination or buswiring details for the specified equipment able to be submitted by Northern Powergrid will also be vetted by the panel supplier against the supplier's acquired knowledge of the peripheral substation components for the particular site.

It is expected that this understanding is achieved by the panel supplier in order that the new equipment to be provided adequately fits the site. Following this understanding of any Northern Powergrid submissions and subsequent agreement, these will then be incorporated firstly into the circuit diagrams and following the drawing comment stage into the wiring diagrams.

Circuit diagrams should be numbered in the following hierarchical order on a circuit basis: AC overall, DC overall, intertripping DC (if separate from DC overall), trip relay reset, disconnector control, main protection, back up protection, low frequency trip, auto reclose, transformer voltage control, transformer winding temperature, alarms and indications, serial communications, disturbance recorders.

Drawing layouts and division of components on circuit diagrams shall be modelled on the existing established practice. Generally, drawings should be legible when printed at A3 size. European style multiple A4 drawing sheets are not acceptable.

Test module connections should be shown collectively only on the DC overall circuit diagram. Each individual programmable or complex relay shall have a dedicated circuit diagram detailing all input and output connections.

Circuit diagrams should differentiate between cable terminals and buswiring terminals. The number of circuit diagrams may be managed by incorporating minor technical differences between different circuits as notes to avoid producing unnecessary additional drawing sets. Common drawings for relay panels (i.e. those pertaining to multiple feeders of the same type at any given site) are acceptable for General Arrangements and Schematic Diagrams only; Individual wiring diagrams are required for each panel. Associated fuse and isolation link and equipment details will be provided on each circuit diagram. Whilst there should be cross referencing as necessary for wires shown on a different drawing, generically listing associated drawings on each drawing sheet is not required.

General arrangement, circuit diagrams and buswiring schedules shall be submitted simultaneously for comment. At such time it will be expected that full general arrangement detail will have been identified and completed.

3.4. Panel Design and Construction

3.4.1. Panel General Requirements

For the dimensions of standard panels see appendix 2, additional information regarding the specific details and requirements for key aspects of Control/Relay panel design/build is given in Appendix 3.

All cubicles, wall boxes and replacement front sheets shall generally have non-inset 19" rack profiling. In situations where a front sheet is to be replaced and the existing panel is not wide enough to accept 19" rack, then an alternative rack width may be provided subject to approval by Northern Powergrid.

All cubicles and wall boxes shall be constructed of steel; they shall be self-supporting and capable of being free standing. Cut-outs required for 19" racking shall not undermine the panel rigidity. Cut-outs will be provided for bus-wiring connections near the top of the panel and for inter-panel earth bar connections near the base of the panel. Removable covers will be fitted on end panels to facilitate future extension.

External cubicle and wall box colour shall be shade 7035 (light grey) of the European RAL Classic System with a semi-gloss finish. Internal side sheets to be gloss white, with a minimum paint thickness of 50 microns DFT. All cubicles for floor mounting shall also have a black or charcoal grey plinth of depth 80mm.

All cubicle metalwork shall be of mild steel construction with minimum steel thickness of 2mm.

The colour of replacement front sheets and metalwork supplied for modifications to existing panels shall match the colour of the existing panel.

Protective finishes shall be of such a standard that they will not require renewal during the lifetime of the equipment in the expected ambient conditions.

Panel suites will generally be assembled in an order to match the associated plant items, but in any case to match the authorised project layout drawings.

In general all materials used shall be non-ignitable or resistant to flame propagation in accordance with BS EN 60695. All contacts and mechanisms shall be protected from dust and cubicles shall meet the requirements of BS EN 60529.

Cubicles and wall boxes shall have four lifting eyes on the top of the panel capable of taking the entire panel weight complete with equipment. A label showing the date of manufacture and entire weight of the panel at the time of manufacture shall be fixed inside the panel.

Wiring within the panels will be managed by internal trunking of suitable size, integrity and practicality. Additional trunking will be provided for marshalling of field side wiring.

Fibre leads ran inside protection panels shall be ran external to the wiring trunking and supported such that the fibre is not under undue tension, and suitable supported over its entire length so as not to strain any connections.

Spaces devoid of relays on the panel front will be made good with removable blanking plates of the same shade of colour as the panel carcass. Gaps will not be evident between blanking plates and relays and between adjacent blanking plates.

The overall design shall be such that maintenance requirements are facilitated and can be carried out safely. For any items requiring removal for maintenance purposes, the design will be such that this can be carried out with the minimum disturbance to other equipment.

3.4.2. Additional Requirements For Wall Boxes

Unless otherwise specifically requested, wall mounted cubicles will have a left-hand hinged front door and have 19" rack profiling of a height compatible with the cubicle size and equipment to be mounted. Fuse and isolation link accommodation will be provided at the front-bottom.

3.4.3. Additional Requirements For Cubicles

The standard cubicle overall panel height is 2280mm. Racking shall be of fixed pattern. The standard racking datum level (0U) will be 130mm above floor level.

Where an existing panel suite containing 19" rack profiling is being extended with new panels, the 45U racking of the new panel is to match the height from floor level of the 45U racking of the existing panels. Thus a different 0U datum may be required under certain circumstances (e.g. 180mm)

Cubicles shall be capable of being bolted down and have non-inset 19" rack profiling encompassing an available height of 45U.

All cubicles will have multicore cable entry shall have three vermin-proof and corrosion-proof bottom and/or top entry cable gland plates.

Unless otherwise requested, rear access cubicles shall not be equipped with front doors and shall have single rear doors that are hinged on the left-hand side and can be lifted off the hinges. 900mm wide cubicles shall have two half width doors hinged at either side.

Front access cubicles hall have single internal swing door that is hinged on the left-hand side. These panels should be designed to be mounted against a wall, but will be fixed to the floor.

The internal swing door will be lockable to ensure that the door does not move in normal operation. The door should have a suitable 'stay' to ensure that once open the door can be held in the open position.

Doors shall be suitable for locking with either an external padlock or locking ring.

Internal side sheets shall be provided suitable for the mounting of auxiliary relays and other equipment such as metrosils. Where such equipment is provided in a cubicle that has more than one operational circuit, then the equipment shall be segregated per circuit.

No equipment/terminal blocks shall be mounted on the rear of the front plate/door without prior agreement.

Fuse and isolation link accommodation will be provided at the front-bottom for protection purposes and the rear-top for remaining control, alarm and indication purposes. Additionally, VT isolation link accommodation may be required at the front-top position.

The rear-top accommodation will allow for two rows with the rear door not covering these links.

Link spacing on the front and rear of the panel will be so as to allow 14 links across the full width of the panel with MP3 style plates being acceptable.

The cubicle shall be equipped with a plinth (height 80mm) and there shall be at least 200mm between the lowest cable terminal and the gland plates.

3.4.4. Layout of Control Plates

Where control plates are provided, they shall be mounted at mid-height for selector switches, control switches, push buttons, LED indicators etc. Where required, the plates shall incorporate the plant status indication into a mimic diagram representative of the busbar and feeder connections.

Where control switches are required on the control plate, these will be off set from selector switches and from each other both horizontally and vertically in accordance with established practice. Where a control switch is provided to operate a transformer HV circuit breaker on a transformer relay panel, the control switch with circuit breaker indications and telecontrol selector switch will be demarked by a durable 6mm white line forming a surrounding bezel and clearly labelled 66kV CB or 33kV CB control.

Control plates for primary transformer panels contained in a standalone transformer/common alarm panel suite will be 5U and positioned at a height of 25-30U above datum level.

Control plates for single switch, 3-circuit switch and supply point panel suites including busbar protection will be 7U and positioned at a height of 23-30U above datum level.

Control plates for double busbar grid supply point panel suites will be 10U and positioned at height of 22-32U above datum level.

3.4.5. Layout of Relays and Auxiliary Equipment

Relays fitted on the panel front will be flush-mounted based on a 19" racking system. Such relays will preferably be of height 4U (1U = 44.45mm) and be suitable for direct fitting into a 19" profile 4U high subrack.

Where intertripping and winding temperature relays, arc suppression coil controllers and disturbance recorders are designed for mounting on the front of the panel, they should preferably be less than or equal to 4U high. This is to allow fitment on a standard 4U high tier by a suitable adaptor plate. Alternatively, the equipment can be full 19" rack width.

The provision of relays having non-preferred dimensions is subject to approval by Northern Powergrid.

Relays shall be arranged in tiers as far as practicable. With the exception of panels having a 10U control plate, three 4U high tiers are available above the control plate and are generally used as follows:

- Feeder Circuit:

Overflow capacity, main protection and back up protection.

- Primary Transformers:

Overflow capacity, feeder protection or HV overcurrent protection and winding temperature.

- Supply Point Transformer HV panels:

Miscellaneous purposes, winding temperature and transformer protection.

- Supply Point Transformer LV panels:

Miscellaneous purposes, directional overcurrent and standby earth fault protection.

The remaining tiers below the control plate are used for the remaining protection relays including Surge-proof intertripping, auto reclose, auxiliary and tripping relays.

3.5. Ancillary Equipment

3.5.1. General

The design and application of electrical ancillary equipment shall generally be in accordance with ENA TS 50-18 except where outlined otherwise by this specification. All ancillary equipment shall conform to Northern Powergrid's Approved Ancillary Equipment List (see appendix 2).

Northern Powergrid will consider alternative equivalent products offered by the Supplier but the costs associated with assessment, re-engineering of protection schemes and general integration of alternative products will be borne by the Supplier.

All auxiliary components connected to nominal 110V DC systems, e.g. LED indicators, shall be able to withstand an operating voltage of 137.5V. All components attached locally to a 48V sub-system should be capable of withstanding an operating voltage of 60V.

3.5.2. Secondary Wiring Terminals

All terminal blocks except those for SCADA wiring shall be rail mounted feed-through terminal blocks of spring loaded screw clamp design. Terminal blocks for SCADA wiring shall be of the knife disconnecting type and shall accept 2.3mm test plugs. All other terminals shall be capable of accepting 4mm test plugs.

In all cases, terminals shall be specified correctly in both type and size (See Appendix 3, Section 4). The panel should be designed to provide accommodating space for all existing and future cabling.

CT and VT Terminals shall be segregated at the bottom of the TB1 rail, shrouded and fitted with suitable warning labels in line with ENA TS 50-18.

With the exception of telecontrol wiring terminal blocks, spare terminals will separate each group of ENATS 50-19 wire number prefixes. Additionally, four spare terminals will be provided at the end of each multicore and buswiring terminal blocks. Telecontrol terminal blocks shall be laid out to accommodate all cable pairs.

Cable terminals will be numbered top to bottom on a terminal number per wire number basis and ordered in, apart from those wires featuring number prefixes to identify sections of busbar (which will be positioned first), reverse alpha forward number (RAFN) order. This order will be based on the cable aspect where this differs from the panel aspect. Thus any additional terminals required for cable cores only (i.e. looping in and out) will need to be accommodated in the requisite cable order. Similarly, where the need arises to effect a wire number change on entering the relay panel, the terminal order will be based on the incoming wire number, with a wire change terminal below it, used to connect the changed number into the relay panel wiring.

Buswiring terminals will be numbered left to right or top to bottom, depending upon orientation but in a conventional forward alpha forward number (FAFN) order, but again with those wires featuring number prefixes to identify sections of busbar positioned first.

Telecontrol wiring terminal blocks will be wired in facility schedule order and numbered top to bottom. Numbering will be continuous for all facilities for a particular circuit panel and not related to individual cable wire numbers. Allowance shall be made for telecontrol cables to have insulated cable glands applied at the relay panel ends; the cable armouring will be earthed at the telecontrol outstation cubicle end only. Where DNP 3.0 communications are adopted telecontrol hardwired facilities will generally be reduced to plant control and status only.

Separate terminal blocks will be provided for termination of external pilot conductors. These will be insulated from earth to the same level as the corresponding pilot circuit and if necessary placed on stand-off insulators (See Appendix 3, Section 4).

Stud type terminals which cannot be made dead by the removal of panel isolating links shall be fitted with industry approved shrouds to prevent the possibility of electric shock or operational incident.

Terminal provision will conform to the current issue of the Northern Powergrid guidance for use of multicore cables. Certain cabling, such as that required for winding temperature probes and serial communications shall be taken direct.

3.5.3. Fuses and Links

Fuses and links shall be Eaton type RS20 or equivalent. Fuses and links shall have circuit labels positioned, preferably above the relevant fuse or link to prevent the installed wiring obscuring the labelling. The circuit label inscription shall include the fuse current rating.

Fuse bases and associated fuse carriers intended to accommodate solid links shall be coloured white. Fuse bases and associated fuse carriers intended to accommodate fuses shall be coloured in accordance with the following table:

Fuse Rating	Fuse Base & Carrier Colour	Additional Coloured Stripe
2 Amps	Black	Violet
4 Amps	Black	Blue
6 Amps	Black	-
10 Amps	Grey	-
16 Amps	Green	-

Each protection function shall have a dedicated trip isolation link between the protection relay and trip relay and a dedicated isolation link between the trip relay and circuit breaker trip coil.

Isolation links for pilot circuits will be heavy duty and mounted on an insulated plate so that the insulation to earth is at least to the level of the pilot circuit itself i.e. 5kV or 15kV.

3.6. Panel Wiring

All panel wiring shall be white PVC covered switchgear wire in accordance with ENA TS 50-18.

CT circuit wiring shall have a minimum cross sectional area of 2.5mm² to BS6231. J1/J2 DC Bus wiring shall have a minimum cross sectional area of 2.5mm² to BS6231. Other wiring shall have a minimum cross sectional area of 1.5mm² to BS6231.

Wiring will not be provided for future relays, but in certain special circumstances, e.g. busbar protection trip output connections, wiring may be required from relay contacts to terminal blocks as a future contingency. Generally, only wiring that will be put to immediate use shall be installed.

All panel wiring will be fitted with wire number markings at each terminated end and shall be in accordance with ENA TS 50-19. Wire number markings will be indelible and may be of the shrink-on printed sleeve type.

Industry standard matching tools and fittings shall be used for the fitment of crimped terminations. The right will be reserved to inspect such equipment. Loose crimped terminations or those showing bare conductors are not acceptable. If any such connections are discovered within a relay panel after delivery then it will be the responsibility of the relay panel supplier to rectify any such connections. In this situation Northern Powergrid will reserve the right to require all connections to be checked.

A shrouded low energy LED cubicle lamp (110VAC) switched via an individual door switch shall be fitted to each floor mounted cubicle.

Circuit labels will be fitted on the front, rear and inside rear of the relay panel and shall be of the engraved type. Labels shall have black lettering on a white background and be fixed with screws. Labels will be positioned unambiguously above the item in question, not obscured by any other item and have text that is consistent with the associated drawings.

3.7. Earthing

Earthing will be in accordance with ENA TS 50-18 as if the normal voltage exceeds 125V. Cubicles will be equipped with a 25 x 3mm continuous copper earth bar, extensible at both ends.

All metallic equipment within the cubicle will be connected to the earth bar in such a way that disconnection of any one item (e.g. during extension of the wiring) will not disconnect any other item.

Electrical continuity will be maintained by wiring or bar of not less than 2.5mm² between peripheral cubicle components such as doors, covers, gland plates etc. Wiring will be green/yellow in colour.

Three separate gland plates shall be provided, each with an individual earth bond to the main panel earth bar.

Provision will be made on the cubicle earth bar for the fitment of the necessary number of disconnectable CT earth links. These links will be of the captive type (bolted terminal with sliding link) with warning label.

3.8. Panel Testing

Wiring will be continuity tested from end to end on a wire number basis.

A 500V DC insulation test will be applied to all secondary wiring of a completed cubicle (with electronic relays withdrawn/disconnected).

Configuration settings will be applied to all programmable relays.

Protective equipment, switches, buttons, alarms and indications etc. will be subject to full functionality testing. If actual active relay settings are known at this time these should be applied, otherwise testing should be carried out with default active settings.

A test schedule will be produced and completed for the functionality testing.

Northern Powergrid will be given the opportunity to witness the functionality testing over a mutually agreeable period.

4. References

4.1. External Documentation

Reference	Title
BS 5070:1988	Drawing Practice for Engineering Diagrams
BS 6231:2006	Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000 V for switchgear and control gear wiring
BS 8888:2020	Technical Product Documentation and Specification
BS EN 60255-26:2013	Measuring relays and protection equipment. Electromagnetic compatibility requirements.
BS EN 60255-27:2014	Measuring relays and protection equipment. Product safety requirements.
BS EN 60269-1:2007	Low-voltage fuses. General requirements
BS EN 60529:1992	Degrees of protection provided by enclosures (IP code)
BS EN 60695-1-30:2017	Fire Hazard testing, Guidance for assessing fire hazard of electrotechnical products
BS EN 61810:2015	Electromechanical elementary relays. General and safety requirements
BS EN 61869-1:2009	Instrument Transformers – General requirements
ENA TS 48-5 Issue 4 2015	Environmental test requirements for protection and control equipment and systems
ENA TS 50-18 Issue 4 2013	Application of Ancillary Electrical Equipment.
ENA TS 50-19 Issue 2 2017	Standard numbering for small wiring.
IEC 61850 Edition 2.0	Communication Networks and system for power utility automation

4.2. Internal Documentation

Reference	Title
IMP/001/014	Code of Practice for the Protection of Distribution Networks
IMP/001/017	Standard for the Application of System Monitoring
IMP/007/003	SCADA Code of Practice
PRC/200/203	Management Process for the Assessment and Introduction of Network Plant, Equipment or Materials

4.3. Amendments to Previous Version

Reference	Description
3.2.1	Clarification to use of diodes and varistors for transformer tripping duties
3.2.6	Addition of the IEC61850 protocol
3.4.1	Additional detail for running of fibre patch leads in panels, minimum steel and paint finish added
3.4.3	Additional detail for the inclusion of swing frame design panels included
3.6	DC Buswire CSA clarified as 2.5mm
3.6	Clarification for use of low energy LED lamps for cubicle illumination
3.8	Panel IR test reduced from 2kV to 500V

5. Definitions

Term	Definition
AC	Alternating Current
CB	Circuit Breaker
DC	Direct Current
EHV	EHV refers to voltages greater than or equal to 33kV and less than 132kV.
HV	HV refers to voltages greater than 1000V and less than 33kV.
HVOC	High Voltage Over Current
kV	Kilo Volt
LED	Light Emitting Diode
LV	LV refers to lower voltage side of EHV transformer
RAL	RAL (gGmbH) European Colour Matching
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SF6	Sulphur Hexafluoride – Switchgear Insulating Medium
U	Unit of measure for Control panels, 1 rack unit of height equals 44.45mm
VT	Voltage Transformer

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	17/10/2022

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	
No	Period: 5 years	Reason: Update will be dictated by contract renewal date
Should this document be displayed on the Northern Powergrid external website?		Yes
		Date
Michael Crowe	Technical Services Manager (North)	12/10/2022

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
Andrew Scott	Technical Services Manager (South)	15/08/2022
Dave Marshall	Protection Applications Engineer	08/08/2022
Karl Young	Protection Applications Engineer	08/08/2022
Jim Paine	Technical Policy Manager	09/08/2022

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Paul Black	System Engineering Manager	25/08/2022

Appendix 1 - Northern Powergrid Approved Relay List

The following version of the Northern Powergrid Approved Relay List is that which is current at the time of writing. It is the Supplier's responsibility to ensure that all relays offered are in accordance with the version of the list that is current at the time of panel design submission.

Protection Relays

Reference	Duty	Voltage	Input No.	O/P Contact No.	Manufacturer	CORTEC/MLFB	Case Size
PR1.1	FEEDER BUP (Directional < 25kV)	24-250V DC	11	12	GE Grid	P14DB21C4C0550A	
PR1.2	OVERHEAD FEEDER BUP (Directional < 25kV)	24-250V DC	11	12	GE Grid	P14DL21C4C0550A	
PR1.3	FEEDER BUP (Non-directional < 25kV)	24-250V DC	11	12	GE Grid	P14NB21C4C0550A	
PR1.4	OVERHEAD FEEDER BUP (Non-directional < 25kV)	24-250V DC	11	12	GE Grid	P14NZ21C4C0550A	
PR1.5	UNIT FEEDER MAIN – 1 x 1300nm	110V-250V DC	8	8	GE Grid	P54A911B4S0910P	
PR1.6	UNIT FEEDER MAIN – 1 x 1300nm	30-220V DC	19	16	Siemens	7SR1813-1MC12-0CA0	
PR1.7	UNIT FEEDER MAIN - COPPER 1A	1A	-	3	Siemens	7PG2111-1DA30-0DB0	
PR1.8	UNIT FEEDER MAIN - COPPER 5A	5A	-	3	Siemens	7PG2111-1DA30-0DD0	
PR1.9	HV BBZ/CBF/VSR	110V-250V DC	24	16	GE Grid	P145911C4S0510J	
PR1.10	TRANSFORMER BIAS DIFF/REF	30-220V DC	19	14	Siemens	7SR2423-2MA12-0AA0	
PR1.11	TX or FEEDER HVOC/HSOC, HV BBZ BLOCKING	24-250V DC	8	8	GE Grid	P14NB11A4B0550A	
PR1.12	TRANSFORMER LVDOC/DAR	24-250V DC	13	12	GE Grid	P14DL11D4C0550A	
PR1.13	TRANSFORMER LVOC/SBEF	30-220V DC	19	16	Siemens	7SR2103-1MA12-0CA0	
PR1.14	FEEDER NVD	24-250V DC	8	8	GE Grid	P94VB11A4B0550A	
PR1.15	TRANSFORMER WINDING TEMP	110V	-	-	Ashridge	852Plus-P-V33c-DNPNpg	
PR1.16	LOW FREQUENCY	80-250V DC	6	8	Siemens	7SR1587-5GA12-2CA0	
PR1.17	EHV FEEDER DISTANCE	110V-250V DC	8	8	GE Grid	P445911A4S0490P	
PR1.18	EHV FEEDER DISTANCE - WITH C37.94	110V-250V DC	8	8	GE Grid	P445911E4S0490P	
PR1.19	EHV FEEDER DISTANCE - WITH 1300NM	110V-250V DC	8	8	GE Grid	P445911I4S0490P	
PR1.20	UNIT FEEDER MAIN – 2 x C37.94	110V-250V DC	8	8	GE Grid	P54A911A4S0910P	
PR1.21	UNIT FEEDER MAIN EXPANDED – 2 x C37.94	110V-250V DC	16	16	GE Grid	P54C911A4S0910M	

Reference	Duty	Voltage	Input No.	O/P Contact No.	Manufacturer	CORTEC/MLFB	Case Size
PR1.22	UNIT FEEDER MAIN EXPANDED – 1 x 1300nm	110V-250V DC	16	16	GE Grid	P54C911B4S0910M	
PR1.23	EHV FEEDER BUP	30-220V DC	9	8	Siemens	7SR2102-1MA12-0CA0	
PR1.24	EHV FEEDER BUP - DIRECTIONAL	30-220V DC	13	14	Siemens	7SR2203-1MA12-0CA0	
PR1.25	EHV HIGH Z DIFF	30-220V DC	9	8	Siemens	7SR2302-1MA12-0CA0	
PR1.26	CHECK SYNC	80-250V DC	3	5	Siemens	7SR1577-5GA12-2CA0	
PR1.27	EHV DAR/CAR	110V-250V DC	32	16	GE Grid	P145911F4S0510J	
PR1.28	GENERATOR INTERFACE	110V-250V DC	16	16	GE Grid	P341931F4S0380P	
PR1.29	AVC RELAY	110 - 230v AC/DC	10	8	Fundamentals	FP1034-AGG0000PDS-L05-30-04. FW Ver 8.3.1	E12
PR1.30	AVC RELAY	85 - 265v AC/DC	42	20	Siemens	6GC6435-1GB90-6AE9-L3K-R0A	19"
PR1.31	SINGLE CIRCUIT INTERTRIP RELAY – DIGITAL (C37.94)	38-150V DC	8	8	Vysiion	GARD3U-0-0-125-0-MP-TP-0-E-0-00-S-H0-RI-00 Logic Scheme: EDS_SSSS_2D	19"
PR1.32	DOUBLE CIRCUIT INTERTRIP RELAY – DIGITAL (C37.94)	38-150V DC	8	8	Vysiion	GARD3U-0-0-125-0-MP-TP-0-E-0-00-S-H0-RI-RI-0 Logic Scheme: EDS_SSSS_1D	19"
PR1.33	SINGLE CIRCUIT INTERTRIP RELAY – ANALOGUE (4 WIRE)	38-150V DC	8	8	Vysiion	GARD3U-0-0-125-0-MP-TP-0-E-0-00-S-AU-RI-00 Logic Scheme: EAS_MCII_1F	19"
PR1.34	DOUBLE CIRCUIT INTERTRIP RELAY – ANALOGUE (4 WIRE)	38-150V DC	8	8	Vysiion	GARD3U-0-0-125-0-MP-TP-0-E-0-00-S-AU-RI-RI-0 Logic Scheme: EAS_IIII_1F	19"

Reference	Duty	Voltage	Input No.	O/P Contact No.	Manufacturer	CORTEC/MLFB	Case Size
PR1.35							
PR1.36	CURRENT OPERATED - 3 PHASE	50mA	-	3	GE Grid	MCAG34	E4
PR1.37	VOLTAGE OPERATED - 3 PHASE	25-175V	-	3	GE Grid	MFAC34	E4
PR1.38	CURRENT OPERATED - 1 PHASE	50mA	-	3	GE Grid	MCAG14	E3
PR1.39	VOLTAGE OPERATED - 1 PHASE	25-175V	-	3	GE Grid	MFAC14	E3
PR1.40	VOLTAGE OPERATED - 1 PHASE	15-270V	-	3	Siemens	5B3	E3
PR1.41	CT SUPERVISION - 3 PHASE	1-7v	-	2	GE Grid	MVTP31	E4
PR1.42	COPPER PILOT INTERTRIP 15KV	30-110v	1	4	GE Grid	GCM05	-
PR1.43	ARC SUPPRESSION COIL CONTROLLER	100-240V AC/DC	6	7	Trench	EFC60	19"
PR1.44	COMPACT TRANSFORMER BIAS DIFF/REF	30-220V DC	9	6	Siemens	7SR2422-2AA12-0AA0	E8
PR1.45	EHV FEEDER DISTANCE – 2 x C37.94	110-250V DC	16	16	GE Grid	P445911G4S0490P	E12
PR1.46	SINGLE INTERTRIP RELAY – DIGITAL (Direct Fibre)	38-150V DC	8	8	Vysiion	GARD3U-0-0-125-0-MP-TP-0-E-0-00-S-F0-RI-00 Logic Scheme: EDS_SSSS_2D	19"
PR1.47	EHV FEEDER DISTANCE - WITH C37.94	110-250V DC	12	12	GE Grid	P443911E4S0910M	
PR1.48	DOUBLE INTERTRIP RELAY – DIGITAL (Direct Fibre)	38-150V DC	8	8	Vysiion	GARD3U-0-0-125-0-MP-TP-0-E-0-00-S-F0-RI-RI-0 Logic Scheme: EDS_SSSS_1D	19"
PR1.49	EHV FEEDER DISTANCE – 2 x C37.94	110-250V DC	12	12	GE Grid	P445911F4S0490P	
PR1.50	EHV FEEDER UP/DISTANCE–1x C37.94, 1x1300nm	110V-250V DC	24	32	GE Grid	P546911L4S0710M	

Reference	Duty	Voltage	Input No.	O/P Contact No.	Manufacturer	CORTEC/MLFB	Case Size
PR1.51	EHV FEEDER UP/DISTANCE – 2 x 1300nm	110V-250V DC	24	32	GE Grid	P546911C4S0710M	
PR1.52	EHV FEEDER MAIN UP – 2 x C37.94	110V-250V DC	8	7	GE Grid	P541911A4S0300J	
PR1.53	EHV FEEDER MAIN UP – 1 x 1300nm	110V-250V DC	8	7	GE Grid	P541911B4S0300J	
PR1.54	EHV FEEDER MAIN UP EXPANDED–2 x C37.94	110V-250V DC	16	14	GE Grid	P542911A4S0300J	
PR1.55	EHV FEEDER MAIN UP EXPANDED–1x 1300nm	110V-250V DC	16	14	GE Grid	P542911B4S0300J	
PR1.56	EHV UP/DOUBLE CIRCUIT INTERTRIP 2 x 1300nm	110V-250V DC	16	16	GE Grid	P54C911C4S0910M	
PR1.57	ASC CONTROLLER	110V-250V DC	8	8	GE Grid	P14DA11A4B0550A	20TE
PR1.58	FEEDER DAR	110V-250V DC	8	8	GE Grid	P94VR11A4B0550A	20TE
PR1.59	EHV FEEDER UP/DISTANCE–1x C37.94, 1x1300nm	110V-250V DC	24	32	GE Grid	P545911L4S0910M	
PR1.60	EHV FEEDER UP/DISTANCE – 2 x 1300nm	110V-250V DC	24	32	GE Grid	P545911C4S0910M	

Trip Relays

Reference	Duty	Contact Reset	Contact No.	Flag Reset	Manufacturer	CORTEC/MLFB	Case
TR1.1	Trip Relay - Hand Reset - 10C	Hand	10	Hand	GE Grid	MVAJ103	E2
TR1.2	Trip Relay - Hand Reset - 11C	Hand	11	Hand	Siemens	7PG1522-1xx70-1Ax0 (TR221)	E2
TR1.3	Trip Relay - Elec/Hand Reset - 10C	Electrical & Hand	10	Hand	GE Grid	MVAJ105	E2
TR1.4	Trip Relay - Elec/Hand Reset - 10C	Electrical & Hand	10	Hand	Siemens	7PG1524-1xx60-1Ax0 (TR241)	E2
TR1.5	Trip Relay - Self Reset - 10C	Self	10	Hand	GE Grid	MVAJ101	E2
TR1.6	Trip Relay - Self Reset - 10C	Self	10	Hand	Siemens	7PG1521-2xx60-1Cx0 (TR212)	E4
TR1.7	Trip Relay - Self Reset (2.5s) - 10C	Self (2.5s Delay)	10	Hand	GE Grid	MVAJ102	E2
TR1.8	Trip Relay - Self Reset (2.5s) - 10C	Self (2.5s Delay)	10	Hand	Siemens	7PG1521-4xx60-1Cx0 (TR214)	E4
TR1.9	Trip Relay - Self Reset - 5C	Self	5	Hand	GE Grid	MVAJ051	E2
TR1.10	Trip Relay - Self Reset - 6C	Self	6	Hand	Siemens	7PG1521-2xx30-1Cx0 (TR212)	E4
TR1.11	Trip Relay - Hand Reset - 5C	Hand	5	Hand	GE Grid	MVAJ053	E2
TR1.12	Trip Relay - Hand Reset - 7C	Hand	7	Hand	Siemens	7PG1522-1xx40-1Ax0 (TR221)	E2
TR1.13	Trip Relay - Elec/Hand Reset - 5C	Electrical & Hand	5	Hand	GE Grid	MVAJ055	E2
TR1.14	Trip Relay - Elec/Hand Reset - 6C	Electrical & Hand	6	Hand	Siemens	7PG1524-1xx30-1Ax0 (TR241)	E2
TR1.15	Trip Relay - Elec/Hand Reset - 20C	Electrical & Hand	20	Hand	GE Grid	MVAJ205	E4
TR1.16	Trip Relay - Elec/Hand Reset - 20C	Electrical & Hand	20	Hand	Siemens	7PG1821-2xx80-1Cx0 (TR-A212)	E4
TR1.17	Trip Relay - Compact 11/20kV Only	Self	2	None	Arteche	RD-2R + base	DIN

Auxiliary Relays

Reference	Duty	Voltage	Contact Reset	Contact No.	Flag Reset	Manufacturer	CORTEC	Case Size
AR1.1								
AR1.2								
AR1.3								
AR1.4	TIMER	110V DC	Self	-	Hand	GE Grid	MVUA	E2
AR1.5	TEST BLOCK		-	-	-	GE Grid	MMLG01	E2
AR1.6	REPEAT FOLLOWER	110V DC	Self	6 or 4 c/o	Hand	GE Grid	MVAA11	E2
AR1.7	REPEAT FOLLOWER	110V DC	Self	4	Hand	Siemens	7PG1110-1xx10-0Ax1 (AR101)	E2
AR1.8	POWER SUPPLY SUPERVISION	110V DC	Self	4	Follow	GE Grid	MVAX12	E2
AR1.9	POWER SUPPLY SUPERVISION	110V DC	Self	4	Follow	Siemens	XR152	E2
AR1.10	INTERTRIP IN/OUT	24V DC	Electrical	-	Follow	GE Grid	MVAA14	E2
AR1.11	TCS	110V DC	Self	-	Self	GE Grid	MVAX31	E3
AR1.12	TCS	110V DC	Self	-	Self	Siemens	XR350	E3
AR1.13	REPEAT FOLLOWER	110V DC	Self	8	Hand	GE Grid	MVAA11	E2
AR1.14	REPEAT FOLLOWER	110V DC	Self	8	Hand	Siemens	7PG1110-1xx50-0Ax1 (AR101)	E2
AR1.15	TIMER	110V DC	Self	-	Hand	GE Grid	MVTT14	E2
AR1.16	PROTECTION IN/OUT	24V DC	Electrical & Hand	-	Follow	GE Grid	MVAZ04	E2
AR1.17	AUX RELAY - ELECTRICAL LATCHING	24V AC/DC	Electrical & Hand	3	Self	GE Grid	PRIMA PRH11N01TH+PSF3	DIN
AR1.18	AUX RELAY - SELF RESET	110V AC/DC	Self	4	Self	GE Grid	PRIMA PRS21N04TH+PSF3	DIN
AR1.19	CB INTERPOSE OPERATIONS	24V AC/DC	Self	4	Self	GE Grid	PRIMA PRS21N01TH+PSF3	DIN
AR1.20	AUX RELAY - ELECTRICAL LATCHING	110VAC/ DC	Electrical & Hand	3	Self	GE Grid	PRIMA PRH11N04TH+PSF3	DIN
AR1.21	REPEAT RELAY with BASE (1 Contact)	110V DC	Self	1 C/O	None	Wago	859-391	DIN
AR1.22	REPEAT RELAY with BASE (4 Contact)	48/55V DC	Self	4	None	Wago	286-337 + base	DIN

Reference	Duty	Voltage	Contact Reset	Contact No.	Flag Reset	Manufacturer	CORTEC	Case Size
AR1.23	REPEAT RELAY with BASE (1 Contact)	110V DC	Self	1 C/O	None	Phoenix Contact	PLC-RPT-24DC/21	DIN
AR1.24	REPEAT RELAY with BASE (2 Contact)	127v DC	Self	2 C/O	None	Arteche	RD-2SY DI LDL 110VDC OP00101+ FN-DE IP10 and 2x E0	DIN
AR1.25	REPEAT RELAY with BASE (4 Contact)	127v DC	Self	4	None	Arteche	RF-4SY DI LDL 110VDC OP00101+ FN-DE IP10 and 2x E0	DIN
AR1.26	REPEAT RELAY with BASE (8Contact)	127v DC	Self	8	None	Arteche	RJ-8SY DI LDL 110VDC OP00101+ JN-DE IP10 and 4x E0	DIN
AR1.27	REPEAT RELAY with BASE (4 Contact)	110v AC	Self	4	None	Arteche	RF-4SY V LDL 110VAC OP00101+ FN-DE IP10 and 2x E0	DIN
AR1.28	REPEAT RELAY - AC REJECTION	30V DC	Self	4	Self	GE Grid	MVAW11	E2
AR1.29	REPEAT RELAY - AC REJECTION	50V DC	Self	4	Self	GE Grid	MVAW11	E2
AR1.30	VOLTAGE SELECTION CHANGEOVER	110V DC	Electrical & Hand	8	Follow	Arteche	BJ-8BB LDL 110VDC+ JN-DE IP10 and E29	DIN
AR1.31	AUX RELAY - ELECTRICAL LATCHING	110V DC	Electrical & Hand	4	Follow	Arteche	BF-4BB LDL 110VDC+ FN-DE IP10 and 2x E31	DIN
AR1.32	VOLTAGE SELECTION / FUSE FAIL	AC	Self	4 C/O	Self	GE Grid	MVAP22	E4
AR1.33	SOLKOR SUPERVISION SEND -	110V AC	-	-	-	Siemens	7PG2120-0AA00-1CA0	E4
AR1.34	SOLKOR SUPERVISION RECEIVE - 5kV	110V DC	Self	4	Self	Siemens	7PG2144-1CC40-1CE0	E4
AR1.35	SOLKOR SUPERVISION SEND - 15kV	110V AC	-	-	-	Siemens	7PG2120-0AA00-2GA0	E12

Reference	Duty	Voltage	Contact Reset	Contact No.	Flag Reset	Manufacturer	CORTEC	Case Size
AR1.36	SOLKOR SUPERVISION RECEIVE B75 - 15kV	110V DC	Self	1	Self	Siemens	7PG2154-1BA10-2GA0	E12
AR1.37	SOLKOR SUPERVISION RECEIVE B74 - 15kV	110V AC	-	-	-	Siemens	7PG2164-1CC40-2AE0	E2
AR1.38	PILOT ISOLATION TRANSFORMER - 15kV					Siemens	7PG2112-0AA00-0AA0	
AR1.39	CB INTERPOSE OPERATIONS with BASE (4 Contact)	24v DC	Self	4 C/O	None	Arteche	RF-4SY DI LDL 24VDC OP00101 + FN-DE IP10 and 2x E0	DIN
AR1.40	ELECTRICAL RESET CONTROL RELAY with BASE (4 Contact)	24v DC	Electrical	4 C/O	None	Arteche	BF-4BB LDL 24VDC + FN-DE IP10 and 2x E31	DIN
AR1.41	REPEAT RELAY with BASE (4 Contact)	30V DC	Self	4 C/O	None	Arteche	RF-4SY DI LDL 30VDC OP00101+ FN-DE IP10 and 2x E0	DIN
AR1.42	ELECTRICAL RESET CONTROL RELAY with BASE (4 Contact)	30v DC	Electrical	4 C/O	None	Arteche	BF-4BB LDL 30VDC + FN-DE IP10 and 2x E31	DIN
AR1.43	AUX RELAY - ELECTRICAL LATCHING	110V AC	Electrical & Hand	4 C/O	Follow	Arteche	BF-4 LDL 110VAC+ FN-DE IP10 and 2x E31	DIN
AR1.44	MULTIFUNCTION TIMING RELAY	24V DC	n/a	4 C/O	n/a	Arteche	TDF-4 LDL 24VDC-VAC 000+ FN-DE IP10 and 2x E0	DIN
AR1.45	MULTIFUNCTION TIMING RELAY	110V DC	n/a	4 C/O	n/a	Arteche	TDF-4 LDL 110VDC-VAC 000+ FN-DE IP10 and 2x E0	DIN
AR1.46	REPEAT RELAY with BASE (2Contact)	24v DC	Self	2 C/O	None	Arteche	RF-2SY DI LDL 24VDC OP00101+ FN-DE IP10 and 2x E0	DIN
AR1.47	REPEAT RELAY with BASE (8Contact)	110v DC	Self	8	None	Arteche	RJ-8SY DI LDL 110VDC OP00101+ JN-DE IP10 and 2x E0	DIN
AR1.48	VOLTAGE SELECTION CHANGEOVER	110V DC	Electrical & Hand	8	Follow	Arteche	BJ-8BB LDL 110VDC+ JN-DE IP10 and E29	DIN

Appendix 2 - Northern Powergrid Approved Ancillary Equipment List

The following version of the Northern Powergrid Approved Ancillary Equipment List is that which is current at the time of writing. It is the Supplier's responsibility to ensure that all ancillary equipment offered is in accordance with the version of the list that is current at the time of panel design submission.

Protection Panels

Reference	Mounting	Width (mm)	Depth (mm)	Overall Height (mm)	Available Tier Height (U)	Typical Uses
RP1.1	FLOOR MOUNT	600	720	2280	45	FEEDER PROTECTION/CAP/INT/AVC
RP1.2	FLOOR MOUNT	600	720	2280	45	FEEDER PROTECTION 3/3 SPLIT
RP1.3	FLOOR MOUNT	900	720	2280	45	FEEDER PROTECTION
RP1.4	FLOOR MOUNT	900	720	2280	45	FEEDER PROTECTION 6/3 SPLIT
RP1.5	FLOOR MOUNT	900	720	2280	45	FEEDER PROTECTION 3/3/3 SPLIT
RP1.6	FLOOR MOUNT	750	720	2280	45	TRANSFORMER PROTECTION
RP1.7	FLOOR MOUNT	1300	720	2280	45	COMMON CONTROL CUBICLE
RP1.8	WALL MOUNT (NON-GLAZED)	780	450	1000	18	G99 PROTECTION/INT
RP1.9	WALL MOUNT	600	550	480	9	INTERTRIP CABINET
RP1.10	WALL MOUNT	600	550	625	12	CIFWB/INT
RP1.11	WALL MOUNT	600	550	750	15	LOSS OF MAINS
RP1.12	WALL MOUNT	600	550	1010	21	G99 PROTECTION/INT
RP1.13	WALL MOUNT	350	180	450	N/A	EMERGENCY TRIP BOX
RP1.14	WALL MOUNT	406	92	305	N/A	FIBRE SPLICE BOX - 24CORE
RP1.15	FLOOR MOUNT FRONT ACCESS	800	800	2280	42	FEEDER PROTECTION/CAP/INT
RP1.16	FLOOR MOUNT	1000	720	2280	45	COMBINED TRANSFORMER/FEEDER PANEL

Miscellaneous Panel Items

Reference	Duty	Voltage/ Current	Contact Reset	Contact No.	Flag Reset	Manufacturer	CORTEC	Case Size
MP1.1	3 Phase MULTIFUNCTION TRANSDUCER (4 Out)	110V DC	-	-	-	GE Grid	I5MT	DIN
MP1.2	CURRENT TRANSDUCER (1 Out)	110V DC	-	-	-	GE Grid	I5MC	DIN
MP1.3	VOLTAGE TRANSDUCER (1 Out)	110V DC	-	-	-	GE Grid	I5MV	DIN
MP1.4	TIMER - SINGLE OUTPUT, MULTIFUNCTION	AC/DC		2C/O	None	Omron	H3DK-M2	DIN
MP1.5	TIMER - SINGLE OUTPUT, TRUE DELAY DROP OFF	AC		1C/O	None	IMO	TDAA	DIN
MP1.6	CT SHORTING BLOCK	-		3	-	GE Grid	CB Block	-
MP1.7	INTERPOSE 3 PHASE CT STAR/DELTA 1A	1A	-	-	-	-	-	DIN
MP1.8	INTERPOSE 3 PHASE CT STAR/DELTA 5A	5A	-	-	-	-	-	DIN
MP1.9	AC/DC CONVERTOR 1.3A 110/24V	110V	-	-	-			
MP1.10	AC/DC CONVERTOR 2A 110/24V	110V	-	-	-			
MP1.11	AC/DC CONVERTOR 4A 110/24V	110V	-	-	-			
MP1.12	Bus zone disconnect/short/aux test (9 current/4 aux terminals for relay panel mounting)					Owen Bros	22984	
MP1.13	Bus zone disconnect/short/star point (13 current terminals for circuit breaker mounting)					Owen Bros	22980	
MP1.14	15 CHANNEL ALARM MODULE	24V	-	15	-	Phoenix Contact	2905135 + 7x 2900313 + 2900299	DIN
MP1.15	16 CHANNEL ALARM EXTENSION	24V	-	16	-	Phoenix Contact	2905137 + 8x 2900313	DIN
MP1.16	BINARY INPUT RESISTOR ASSEMBLY (Intermittent Operation)	-	-	-	-	Siemens	VCE2435H90007	
MP1.17	7 DIODE MODULE, COMMON CATHODE	1A	-	-	-	Entrelec	EB7DC	
MP1.18	TERMINAL DIODE, SINGLE DECK	1A	-	-	-			
MP1.19	TERMINAL DIODE, DOUBLE DECK COMMON CATH.	1A	-	-	-			
MP1.20	SINGLE DIODE, WITH VARISTOR	2A	-	-	-	Entrelec		
MP1.21	DUAL DIODE, WITH VARISTOR	2A	-	-	-	Entrelec		

MP1.22	LIGHT DUTY DIODE, WITH VARISTOR	0.75A	-	-	-	Siemens	7XG1300-1AA00-0AA0	
MP1.23	HEAVY DUTY DIODE, WITH VARISTOR	6A	-	-	-	Siemens	7XG1300-2AA00-0AA0	
MP1.24	SELECTOR SWITCH 2 POSITION 1 WAFER	20A	-	-	-	Craig & Derricot		
Reference	**Duty**	**Voltage/ Current**	**Contact Reset**	**Contact No.**	**Flag Reset**	**Manufacturer**	**CORTEC**	**Case Size**
MP1.25	SELECTOR SWITCH 2 POSITION 2 WAFER	20A	-	-	-	Craig & Derricot		
MP1.26	SELECTOR SWITCH 2 POSITION 3 WAFER	20A	-	-	-	Craig & Derricot		
MP1.27	SELECTOR SWITCH 2 POSITION 4 WAFER	20A	-	-	-	Craig & Derricot		
MP1.28	SELECTOR SWITCH 2 POSITION 8 WAFER	20A	-	-	-	Craig & Derricot		
MP1.29	CB CONTROL SWITCH 3 POSITION 1 WAFER	20A	-	-	-	Craig & Derricot		
MP1.30	CB CONTROL SWITCH 3 POSITION 2 WAFER	20A	-	-	-	Craig & Derricot		
MP1.31	CB CONTROL SWITCH 3 POSITION 3 WAFER	20A	-	-	-	Craig & Derricot		
MP1.32	SELECTOR SWITCH 4 POSITION 2 WAFER	20A	-	-	-	Craig & Derricot		
MP1.33	SELECTOR SWITCH 4 POSITION 4 WAFER	20A	-	-	-	Craig & Derricot		
MP1.34	SELECTOR SWITCH 4 POSITION 6 WAFER	20A	-	-	-	Craig & Derricot		
MP1.35	PUSH BUTTON (ILLUMINATED)	110V DC	-	-	-	EAO Series 04		
MP1.36	PUSH BUTTON (1 CONTACT)	6A	-	-	-	EAO Series 04		
MP1.37	PUSH BUTTON (2 CONTACT)	6A	-	-	-	EAO Series 04		
MP1.38	PUSH BUTTON (3 CONTACT)	6A	-	-	-	EAO Series 04		
MP1.39	PUSH BUTTON (4 CONTACT)	6A	-	-	-	EAO Series 04		
MP1.40	LED INDICATOR (RED/AMBER/YELLOW/GREEN/BLUE)	110V DC	-	-	-	CML		
MP1.41	LED INDICATOR (RED/AMBER/YELLOW/GREEN/BLUE)	24V DC	-	-	-	Signal Construct		
MP1.42	LED SEMAPHORE (RED/GREEN)	110V AC	-	-	-	Tranilamp		
MP1.43	LED INDICATOR (RED/AMBER/YELLOW/GREEN/BLUE)	110v AC				Tranilamp		
MP1.44	PANEL RESISTOR 12K/3W	-	-	-	-	-		
MP1.45	PANEL RESISTOR 5K6/7W	-	-	-	-	-		
MP1.46	PANEL RESISTOR - HIGH Z STABILISING DUTIES	-	-	-	-	-		

MP1.47	PANEL RESISTOR - HIGH Z SETTING DUTIES	-	-	-	-	-		
MP1.48	SINGLE PHASE METROSIL 6 INCH	-	-	-	-	-		
MP1.49	THREE PHASE METROSIL 6 INCH	-	-	-	-	-		
Reference	**Duty**	**Voltage/ Current**	**Contact Reset**	**Contact No.**	**Flag Reset**	**Manufacturer**	**CORTEC**	**Case Size**
MP1.50	TCS RESISTOR	-	-	-	-	-		
MP1.51	INTERPOSING VT FOR VOLTAGE SELECTION	-	-	-	-	-		
MP1.52	2A MCB FOR VOLTAGE SELCTION WITH AUX CONTACT	-						
MP1.53	PANEL AUDIBLE WARNING	110V DC						
MP1.54	DISTURBANCE RECORDER – BUSBAR/FEEDER	110V DC	16	4		SUB-NET	SN-ACDC- GPSR with 2x IMVC+1xIMDC+HCT+ 2xM4TCT10 +GPSW+Cable	DIN
MP1.55	PQ RECORDER – HV GENERATOR	230V AC	0	4		SUB-NET	SN-SLVACB. with 1x IMVC+1xM4TCT10	DIN
MP1.56	GENERATOR RTU	230V AC	4	0		Nortech	Envoy RTU with PSU	DIN
MP1.57	PANEL FUSE LINKS					GE	RS20P	
MP1.58	PANEL CONTACTOR 3 POLE 4kW	110V AC		2NO AND 2NC		MOELLER	DILEM-10 (110V50HZ) +22DILEM	DIN
MP1.59	CONTACTOR INTERLOCK PLATE					MOELLER	MVDILE	DIN
MP1.60	MOTOR MCB WITH SHUNT TRIP	110V AC		1 NO 1NC		MOELLER	PKZM0-4 MCB +A-PKZ0 + NH11-PKZ0	DIN
MP1.61	6MM TERMINALS					WEIDMULLER	WDU10SL	G Rail
MP1.62	4MM TERMINALS					WEIDMULLER	WDU6SL	G Rail
MP1.63	TELECONTROL TERMINALS					WEIDMULLER	WTR4 STB	G Rail
MP1.64	CT EARTH LINKS					WEIDMULLER	STL5	G Rail
MP1.65	DISCONNECTABLE LINKS					WEIDMULLER	RSF2	G Rail
MP1.66	PQ RECORDER – LV GENERATOR	230V AC	0	4		SUB-NET	SN-SLVACB.M with 1x IMVC-LV+1xM4TCT10	DIN

Appendix 3 Further Guidance Notes on Small Wiring / Cubicle Build Practice

The notes below provide greater detail regarding cubicle design which will be of use to the relay panel build contractors.

Some of these notes are already given in the main body of the NPS document – but the notes below will provide clarity and/or additional information.

1. General

1.1 Rear access relay cubicles will be fitted with an 80mm plinth, front access relay cubicles will be fitted with a 200mm plinth.

1.2 Equipment or wiring operating at 400V AC shall not be fitted in relays panels.

1.3 Equipment or wiring operating at 230V AC should be avoided in relay panels where possible. If 230v AC is required then it should be suitably shrouded and labelled at any terminal blocks and ran in an additional plastic sleeve.

1.4 110V AC circuits will only be used for local switchgear indication (LED's) and for cubicle illumination. The associated incoming supplies should be fused in both legs.

1.4a Consideration should be made to utilising 24v DC for local switchgear indication (LED's). the supply will be taken from a 110V AC/24V DC) Switch Mode PSU.

1.5 110V Protection/Control DC supplies shall be distributed to all panels in any given suite as per NPG drawing Y028S1167.

1.6 All terminated wire should be left long enough for at least two future terminations, this loomed in the trunking. Adequate trunking shall be provided throughout.

2.1 Front Mounted Panel Equipment

2.1.1 All protection relays shall be suitable for fitment into standard 19" profile mounting plates, and are preferably 4U high.

2.1.2 All front mounted devices with readable displays, pushbutton or other such HMI should be positioned suitably to facilitate ease of operation (i.e. avoid fitting such devices on the top-most or bottom-most tiers where practicable).

2.1.3 Where a relay panel is equipped with a Control Plate, where possible all pushbuttons, switches, sockets etc., which do not form part of proprietary devices (such as Test Modules) shall be located on the Control Plate.

2.1.4 To facilitate front-of-panel communications access to dedicated internally mounted Disturbance Recorders, Fault Loggers or Power Quality Monitor devices, front panel mounted RJ-45 socket and associated patch cable should be provided. This socket shall be clearly labelled and will have an integral dust cover.

2.2 Test Modules

2.2.1 Test Modules shall be equipped with a screwed cover and should be fitted adjacent to the associated Protection Relay. The following types are acceptable:

Function	Type
Test Blocks	GE type MMLG01 or equivalent

2.2.2 Test points shall be provided for all Trip and Close outputs; these will generally be in series with the output contact but may be in a 'tag off' connection. Test points should be available on both sides of the contact.

2.2.3 Any connections which are open circuited by the removal of a cover must not be used for series connections.

2.2.4 All Trip Relays will have the operate coil available at test block connections to enable injection of the coil. These will generally be in a 'tag off' connection.

2.2.5 Where test points terminals are numbered, the even terminal numbers shall face the relay panel equipment and the odd numbers shall face the plant /field side.

2.3 Control Plates, Mimics, Rotary Switches, Push buttons & LED's

2.3.1 Control plates shall be fitted on all relay panels involved in the Control and Annunciation of associated Primary Plant – and laid out as detailed in this NPS.

2.3.2 Mimics are generally required on bespoke Control Panels or in 132kV double busbar applications where multiple plant items are controlled from any one panel. The specific details of the Mimic shall be approved by NPG prior to completion of the panel design/build.

2.3.3 All switches shall be pad-lockable (or fitted with suitable isolation ring), be suitably rated for the associated function, and compliant with ENA TS 50-18. At least two sets of spare contacts shall be available in each switch position.

2.3.4 All Control and Selector switches shall be labelled using horizontal text on a proprietary traffolyte type bezel (black text on white background), with switch function and position identification all clearly legible.

2.3.5 Control switches (for CB and Disconnector Control) shall be spring return to centre, with 45 degree indent to the operate position, and of the 'long-handle' type. The switch should be labelled in three positions ('OPEN', 'N' and 'CLOSE'), with the switch at rest in the 'Neutral' 12 o'clock position.

2.3.5 Selector switches shall be of the stay-put type, with 90 degree indent and of the 'short-handle' type. These switches are used to provide many functions so a full definition of the requirements is not given here, but in general, the switch should be in the 12 o'clock position for normal running conditions, i.e. 'TELECONTROL/REMOTE', 'IN SERVICE', etc.

2.3.6 All pushbutton shall be of the momentary (self-reset) type, and where required may need to be fitted with a shroud or pad-lockable cover. All pushbuttons shall be compliant with ENATS 50-18.

2.3.7. All pushbutton contacts shall be suitably rated for the associated function, and spare contacts shall be available in each switch position.

2.3.8 Pushbuttons shall labelled above the device using horizontal text on a suitable label (black text on white background), with function and position identification all clearly legible. The label should denote the action of the pushbutton in the operated position, i.e. 'TRIP RELAY RESET'. Illuminated pushbuttons are acceptable, but must not be operated at a nominal voltage above 110V.

2.3.9 Local alarms and indications may be provided by LEDs on protection relays (or other approved IED's) and these need to be clearly labelled.

2.3.10

The following colour coding practice shall be used for all panel LED's:

Equipment	Status	LED Colour
General Network / System Status	On / In Service	Red
	Off / Out of Service	Green
Circuit Breaker	Close	Red
	Open	Green
	Isolated	White
	Closing Spring Charged	Blue
	CB Mechanism Faulty	Yellow / Amber
Disconnector	Close	Red
	Open	Green
Earth Switch	Close	White
	Open	White
	Selected	White
Bus Zone Protection	In service	Light Not Required
	Out of Service	Amber / Yellow
General Alarm	On (Abnormal Sate)	Amber / Yellow

2.4 Fuses and Links

2.4.1 All fuse and link tiers shall be 3U high (two rows combined on one 5U plate is not acceptable).

2.4.1.1 Red insulating boots will be fitted on the studded connections at the rear of all projecting fuses and links.

2.4.2 Mounted at Front Bottom (FB) of Panel – Used for DC Supplies and Protection Circuits

2.4.2.1 Two rows, punched for 14-way provided at the bottom on the 19" rack. Unused ways shall be blanked off using suitable plastic grommets so as not to leave any unplugged holes.

2.4.2.2 Fuses and links fitted at the bottom of the relay panel should be numbered starting from the LH side of the top row (FB1 to FB14), following on to the second row (FB15 to FB28).

2.4.2.3 On rear access panels a 3U blank plate will be provided at the very bottom of the 19" profile, which will provide future space for additional front mounted fuses and links.

2.4.2.4 On swing frame panels the bottom 3U row will be allocated to Control, Alarm and Indication Circuits

2.4.2.5 Label carrier strips shall be affixed over the top of the fuses and links with angle bracket pointing downward to facilitate the viewer looking downward from head height.

2.4.3 Mounted at Rear Top (RT) – Used for Control, Alarm and Indication Circuits (Not Applicable to Swing-frame Type cubicles)

2.4.3.1 Two rows, punched for 14-way provided above the rear door. Unused ways shall be blanked off using suitable plastic grommets so as not to leave any unplugged holes.

2.4.3.2 Fuses and links shall be numbered starting from the LH side of the first row (RT1 to RT14), following on to the second row (RT15 to RT28).

2.4.3.3 Label carrier strips shall be affixed over the top of the fuses and links with angle bracket pointing upward to facilitate the viewer looking upward from head height.

2.4.4 Mounted at Front Top (FT) – Used for VT Circuits

2.5.4.1 One row, punched for 14-way provided at the topmost part of the 19" profile. Unused ways shall be blanked off using suitable plastic grommets so as not to leave any unplugged holes.

2.4.4.2 Fuses and links shall be numbered starting from the LH side (and FT1 to FT14),

2.4.4.3 Label carrier strips shall be affixed over the top of the fuses and links with angle bracket pointing upward to facilitate the viewer looking upward from head height.

2.4.5 Mounted Front Middle (FM) – Used for Pilot Isolation

2.4.5.1 Use of Fuses mounted on tiers in the middle of the panel is non-standard, and should only be provided in conjunction with design reviews with NPG.

2.4.5.2. Pilot isolation links, or Trip Links associated with Intertrip Send and Receive circuits should be mounted adjacent to the associated Protection or Signalling equipment, and are therefore assigned references FM1-FM2, FM3-FM4 etc.

2.4.5.3 For Surge Proof Pilots (such as those used for copper pilots (i.e. Solkor Rf or GCM05), the Pilot isolation links shall be mounted on 15kV insulated board. This board should be fixed to the 19" profile on the associated tier.

2.4.5.4 Remote Trip Receive/Send links associated with Radio type Signalling (e.g. RTR and RTS links) should be mounted on the associated Channel Test tier. These do not need to be mounted on insulated board (as they are not connected to any copper pilot circuits).

2.4.6 Fuses / Links inside Panel (IP)

2.4.6.1 Where fuses are required to be mounted inside relay panels then these should be terminal-rail mounted type (e.g. SAKS3) separately mounted on horizontal rail on the RHS sheet. These should not be RS20P type.

3. Internally Mounted Ancillary Equipment (Auxiliary Relays, Resistors, Etc.)

3.1.1 Heaters shall not be fitted in relay panels.

3.1.2 Normal access into the panel (such as required for minor wiring modifications) should not be hindered by the equipment located in the rear of the panel, or on either internal side sheet. Given this, care needs to be taken at the panel design stage to ensure that all items (i.e. plug-in relays, transducers, interposing CT's etc.) are not unduly protruding or at risk of being dislodged or otherwise adversely interfered with during normal access.

3.1.3 For rear access panels, when viewed from rear, the LHS side-sheet of the cubicle should be populated with the multi-core, multi-pair, communications cabling and pilot cable terminal rails (see Terminal Rails / Terminal Blocks below). When viewed from rear, the RHS side-sheet of the cubicle should be populated with auxiliary relays (plug-in type, Prima, Arteche, etc.) and all other ancillary equipment.

3.1.3a For front access panels when viewed from front, the rear sheet of the cubicle should be populated with the multi-core, multi-pair, communications cabling and pilot cable terminal rails (see Terminal Rails / Terminal Blocks below). When viewed from front, the RHS side-sheet of the cubicle should be populated with auxiliary relays (plug-in type, Prima, Arteche, etc.) and all other ancillary equipment. The LHS side sheet must not be used due to the door swing.

3.1.4 Setting resistors for High Impedance circulating current type protection should be of the variable type. These Resistors should be accessible on the RHS sheet.

3.1.5 Metrosils should be accessible, but mounted out of the way as far as possible – preferably high up on the RHS sheet.

3.1.6 If the RHS sheet becomes over-populated with relays and equipment then NPG will accept ancillary relays fitted onto rail on the back of blanking plates on un-populated areas of the panel.

3.1.7 Small components (such as varistors, diodes, interposing CT's) may be provided in or on propriety rail mounted enclosure and these shall be equipped with screw terminals. Small axial components (such as resistors) should be mounted on suitable component holders, which provide soldered connections to the components and ring connections for the panel wiring.

4. Terminal Blocks / Terminal Rails

4.1 The manufacturer recommended tool shall be used for the termination of all wiring. Particular attention needs to be paid to this where terminal screws contain 2.3mm test sockets (which requires a proprietary slot-head screwdriver (e.g. Weidmuller SDIZ 0.6X3.5X 100).

4.2 In all cases, the field (cable) side of all terminal blocks shall be left vacant to be populated by the multi-core and multi-pair cables during site installation. No common wiring loops (or wiring of any type) shall be made on the field side of the cabling interface terminal blocks.

4.3 Multi-core, multi-pair and pilot cables will be terminated on suitable terminals (defined below) on the LHS sheet when viewed from the rear. Vertical rail(s) of TS35 'G' type din rail will be provided, accommodating all terminals, each set labelled TBx (as defined below) and labelled with a suitable header (e.g. type SCHT5).

4.4 To facilitate the external cabling connections and to make observation of the terminal blocks easier all terminal rails will be mounted at a 45 degree angle to the side sheet.

4.5 For terminal blocks mounted on the left hand side of the panel the internal panel wiring connected to the LHS of the block, For terminal blocks mounted on the right hand side of the panel the internal panel wiring connected to the RHS of the block. The panel wiring will be looped around the back of the rail and the multicore trunking and into the panel trunking. The other side of the blocks are left free for multicore cabling, along with a free multicore trunk 100mmx100mm in size.

4.5 Terminals should not be so close to the bottom of the panel that cable glanding (and looming of cores into the trunking) becomes a problem.

4.6

TB1 – Multicore Terminal Block Rail

4.6.1 This group of terminals shall be located on the bottom portion of the rail, and generally be either screw or stud type for use with an approved ring type crimped termination or spring loaded insertion type incorporating an approved hook type crimped connector.

All multi-core terminal types shall be as follows:

Function	Type
AC/DC Terminal Blocks	Weidmuller type WDU6SL or equivalent
CT/VT Terminal Blocks	Weidmuller type WDU10SL or equivalent
Supply Terminal Blocks	Weidmuller type WDU10SL or equivalent

4.6.2 Wires/cable cores shall be terminated with the 'A' numbers at the bottom of the rail and then alphabetically upwards to the top of the rail e.g. 'W' numbers at the top. The associated numeric part of the ferrule number however always increments down as you read down the rail.

4.6.3 The CT and VT circuits will naturally be located at the bottom of the rail (A, B, C, D and E numbered circuits). These terminal blocks shall be segregated from the rest of TB1, labelled 'CTs & VT's', shrouded and fitted a hazard warning label (as detailed in ENATS 50-18).

4.6.4 Where switchgear aux contacts are wired into the relay panel for the purpose of Loss-of-Mains initiation, these should be terminated on plug-isolation terminals (RSF2 or equivalent) and located within the TB1 rail. This avoids over-populating the front of the panel with expensive RS20P type terminals.

4.6.5 CT Earth Link terminals should be STL5 (or equivalent) and should be fitted beneath TB1. Only a single connection should be made from this link to the CT wiring. The CT sliding link shall be installed such that the link slides towards the earthed side of the block.

4.6.6 Each CT Earth links shall be clearly labelled (either using a label affixed to the STL terminal, or with a header block) carrying the associated circuit-diagram reference label, such that there is no ambiguity where multiple sets of CT's are earthed in any one relay panel.

4.6.7 VT Earth links are not required in relay panels (as these are provided locally at the VT).

4.7 TB2 - Telecontrol rail

4.7.1 The Telecontrol terminal blocks shall be grouped together and should be located on the upper portion of the LHS sheet – and labelled TB2. All Telecontrol terminals shall be of the flip link type, and equipped with 2.3mm Test sockets.

Function	Type
SCADA Terminal Blocks	Weidmuller type WTR4 STB or equivalent

4.7.2 The terminations on this rail should be laid out to accord with the approved Telecontrol Schedules. The rail should be laid out in the order 'Controls', 'Indications', 'Alarms' and 'Analogues' from top-to-bottom. Terminals should be provided to enable all cable pairs to be terminated (even those not in use).

4.7.3 Although not of concern at relay panel build stage, note that the incoming paired cables will be terminated in standard pair colour order, and the pair cores will be terminated without ferrules or crimps.

4.8 TB0 – Pilot Wire Terminations

4.8.1 A dedicated group of through terminals shall be provided on the LHS sheet to facilitate the termination of pilot cables, and these shall be labelled TB0.

Function	Type
Pilot Wire Terminal Blocks	Weidmuller type WDU10 SL or equivalent

4.8.2 Regardless of nominal circuit voltage (i.e. 132kV, 66kV, 33kV etc.) TB0 should comprise terminals to facilitate the termination of all active pilot pairs (any un-used pairs will be tied back as site installation stage). These terminals shall be mounted on suitable 15kV insulating board, and this whole assembly shall be mounted on a dedicated set of angle brackets. This is to ensure that 15kV insulation is provided for these terminations, which is not compromised by screw fixings to the panel rail/earth.

4.8.3 The whole assembly shall be shrouded and warning label fitted.

4.8.4 Again regardless of nominal circuit voltage, the internal panel wiring from the pilot terminals to the respective RS20P isolation links (which are also fitted on insulated board) shall use high-tensile cable with red insulation.

4.9 BTB – Bus-wiring Terminal Blocks

4.9.1 These terminals and used for the required AC and DC connections between relay panels.

Function	Type
Bus-wiring Terminal Blocks	Weidmuller type WDU10 SL or equivalent

4.9.2 CT circuits shall not be bus-wired.

4.9.3 Bus-wiring should only be terminated in the panels in which the required signals are required, i.e. a signal between panel 1 and panel 3 should not terminate in panel 2.

4.9.4 On multi-panel protection suites the panel manufacturer will supply all interpanel buswiring and fibre/ethernet connections

5. Crimps & Preferred Termination Methods

5.1 In all cases, wires shall be terminated using the method prescribed by the associated device/terminal manufacturer. No more than two wires shall be terminated in any one terminal.

5.2 Where practicable, bare-wire terminations should be avoided.

5.3 Where no guidance on the manufacturer approved termination method is available then guidance should be sought from ENATS 50-18. When the terminal is not of the cage-clamp type then the following preferred hierarchy shall be observed (starting with (i) as the most preferable).

i) Ring crimps on screw terminals

ii) Hooked blades in spring loaded terminals

iii) Flat bladed crimps

iv) Pin crimps

v) Boot-lace crimps

5.4 Forked (open spade) crimps shall not be used unless recommended by the manufacturer.

5.5 For pin crimps and boot-lace crimps, only one wire per terminal is permitted.

5.6 Where ring crimps and bladed crimps can be arranged back-to-back in any one terminal, then this needs to be done in conjunction with the terminal manufactures recommendation.

5.7 Crimps shall not be clipped, trimmed, or made to fit where they are not intended.

5.8 Insertion spade crimps may be used if recommended by the manufacturer, but shall not be used in protection circuits.

5.9 Where 90 degree ring crimps are used (typically for terminations on the rear of protection relay), these shall be procured as such, and shall not be normal ring crimps bent by the panel builder.

5.10 Red coloured crimps shall be used for 1.5mm^2 wire, blue coloured crimps shall be used for 2.5mm^2 wire and yellow crimps shall be used for wire size between 4mm^2 and 6mm^2.

6. Labelling

6.1 All labels (with the exception of Warning labels, or as otherwise directed by NPG) will be black text on white background) and use capitalised text.

6.2 Main Circuit / Relay Panel labels must be traffolyte type and fixed to the panel using screws.

Three Main Circuit / Relay Panel labels are required in total:

- One fixed on the Front Top of the Panel (above the 19" profile),
- One fixed on the Rear Top of the Panel (above the door),
- One fixed on the rear door itself.

6.3 Ancillary labels may be of the self-adhesive type, must be fit for purpose (i.e. must not be easily removed by hand or lose adhesion over long periods of time).

6.4 Front mounted Relays and Test modules should be labelled on the cover, front face and rear with the associated circuit diagram reference.

6.5 For all Control Switches, push buttons, lamps and all internally mounted equipment there shall be a label mounted on or adjacent to the device visible from inside the panel with the associated circuit diagram reference.

6.6 All plug-in relays must be labelled on the relay itself and on base with circuit diagram reference.

7. DNP 3.0 Communications and Associated Connections

7.1 All IED's with SCADA communication interface facilities that function with DNP 3.0 capability will use RS485 hardware.

7.2 Multiple relays can be connected on any one RS485 (DNP 3.0) loop, to a maximum of 8 devices on any one loop. The general principles for RS485 architecture across typical NPG substations is given in drawings Y028S38100 and Y028S38101.

7.3 The specific inter-relay loop connections in any one panel or across a suite of panels at any given substation shall be designed in compliance with 7.4, 7.5 and 7.6 below and submitted to NPG along with the relay panel schematic drawings for review/approval. Note that tee's and stubs are not permitted in multi-drop loops.

7.4 The incoming RS485 cable from the RTU shall terminate onto dedicated flip link terminals (WTR4 STB or equivalent), labelled as 'TB2a'. This shall then be wired onto the relay that is designated first in the DNP 3.0 loop, typically the lowest relay. All inter relay wiring in the panel will be via BS5308 Part 2 Type 1 Single twisted pair with overall screen and earth wire. The earth wire will be terminated at each relay onto a designated earth free position (note that the screen will be earthed at the RTU end only).

7.5 Inter-panel RS485 cabling will run from the last IED in the panel (uppermost) to the next panels first (lowermost) relay via a continuous cable (not terminated onto the bus-wiring terminal block).

7.6 A 120 Ohm termination resistor shall be provided at the end of any RS485 loop; this resistor may be integral to the IED, or it may be a simply 0.25W axial resistor connected across the RS485 terminals.

8. WTI Connections

8.1 The incoming cable connections to the WTI from the remote transformer PT100 thermocouple and from the cooler motor circuit interposing CT's should be direct onto the rear of the WTI unit. The connection wires from the WTI unit to the local Test Block can be a standard 1.5mm^2 wire. The incoming cable screen shall be earthed at the panel only, so a specific terminal block will be provided for this duty.

9. IEC61850 Communications and Associated Connections

9.1 All IED's with SCADA communication interface facilities that function with IEC61850 capability will use fibre optic hardware capable of HSR/PRP redundancy protocols. If this is not possible a redundancy box will be mounted as close as physically possible to the device, connected via UTP cabling as short as possible

9.2 Multiple relays can be connected on any one IEC61850 station bus; however there should be a maximum of 20 devices on any one HSR ring. Multiple HSR rings are permissible, but these should be cross connected via Quad box connections or via PRP switch pairs to ensure complete redundant connectivity between devices.

9.3 The specific inter-relay fibre connections in any one panel or across a suite of panels at any given substation shall be designed in compliance with 7.4, 7.5 and 7.6 above and submitted to NPG along with the relay panel schematic drawings for review/approval.

9.4 All cabling across a panel or switchgear suite should terminate on a suitable switch. This switch will marshal all cross suite connections, so a duplex pair (or redundant pair of) fibres are taken away from that suite.

9.5 Inter-panel fibre patch cables will be run fully supported inside the panels, but shall not be run inside the protection wiring ducts. Care should be taken when crossing doors that open to ensure that kinks or breaks are not caused by opening and closing doors.

9.6 Inter suite fibre connections shall be ran via 'KOPEX' style conduit with a single duplex fibre cable in each conduit to maintain redundancy for conduit damage.