NPS/003/039 – Technical Specification for Substation DC Disconnection Schemes

1. Purpose

The purpose of this document is to detail the technical requirements of substation tripping battery DC Disconnection Schemes to be installed at specified sites in order to meet the requirements stated in ENA Engineering Recommendation G91 Substation Black Start Resilience.

The baseline requirement set out in ENA ER G91 is for primary and supply point substations to be designed so that they are resilient for a minimum period of 72 hours from the inception of a Black Start event. During this time substation protection, control and SCADA functions shall be available such that the site can be safely energised and subsequently used to restore customer supplies.

At specified sites, 72 hours resilience of the closing and tripping batteries shall be achieved by disconnecting the batteries by an appropriately rated device and re-energised prior to the restoration of supplies. SCADA batteries shall be reinforced to provide 72 hours continuous supply to control functions.

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

Document Reference	Document Title	Version	Published Date
NPS/003/039	Technical Specification for Substation DC Disconnection Schemes	1.2	February 2019

2. Scope

As specified in ENA ER G91, 72-hour resilience is required at all substations with a secondary voltage of 11kV and above, other than those supplying a single customer.

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.

The scope of this document is limited to the technical specification of tripping battery DC Disconnection Schemes. It includes a requirement for suppliers to provide periodic inspection and maintenance information.

Suppliers are requested to consider and include any project specific requirements as detailed in Appendix 2: Addendum to Supplier Requirements.

The following appendices form part of this technical specification:

Appendix 1: Technical Specification Conformance Declaration

Appendix 2: Addendum to Supplier Requirements

Appendix 3: Pre-Commission Testing, Routine Inspection and Maintenance Requirements

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3. Technical Requirements

3.2. General

The purpose of the DC disconnection scheme is to conserve the tripping/closing battery charge indefinitely whilst still maintaining supervision and control for 72 hours by sizing SCADA batteries appropriately. Following a widespread loss of supply, tripping batteries would be conserved by disconnecting the substation load by opening an appropriately rated DC contactor via SCADA.

The DC disconnection scheme will normally be set to remote operation, but shall have the functionality for local operation to facilitate maintenance. An isolating switch in parallel with the DC contactor shall allow the DC disconnection scheme to be bypassed.

3.3. DC Disconnection Scheme Specification

3.3.2. Electrical and Environmental Standards

Components that make up the DC disconnection scheme shall be resilient to extremes of temperature and humidity, electromagnetic interference and fluctuations in DC supply and shall broadly meet the requirements stated in ENA TS 48-5 Issue 5 2023 Environmental test requirements for protection and control equipment and systems.

Equipment supplied shall comply with the specification in Appendix 1 and any project specific requirements stated in Appendix 2.

The technical specification of the system must be declared using the table in Appendix 1.

3.3.3. Relays

The scheme control relays shall be of protection standard and shall meet the immunity test requirements for measuring relays and protection equipment in relation to continuous and transient, conducted and radiated disturbances, including electrostatic discharges as specified in BS EN 60255-26:2013 Measuring relays and protection equipment - Electromagnetic compatibility requirements.

The relays shall also meet the electromagnetic compatibility requirements to ensure that the disturbances generated by the equipment installed in a substation environment do not exceed the level specified in BS EN 60255-26:2013.

Users shall be protected against electric shock hazards by use of good constructional and engineering practice. Protection against contact with accessible hazardous live parts shall be provided. The testing of the equipment with regard to protection against electric shock shall be conducted as type tests and routine tests as defined in BS EN 60255-27:2014 Measuring relays and protection equipment - Product safety requirements.

The unit will withstand disturbances in the auxiliary supply, under normal operating conditions, without de-energising as required by BS EN 60255-26:2013.

With the exception of the 230V AC supply supervision relay, the relays shall be operated by the SCADA 24V DC supply.

The scheme shall specify relays with the minimum functional capability stated in table 1.

Function	Operating voltage	Specification	Rating
Contactor close & contactor open relays	24/27V	High integrity auxiliary relay: Self-reset mechanism with 4 **heavy duty** changeover contacts	Contact rating 10A continuous with ability to break 300W DC at 100V when L/R = 40ms.
Contactor status repeat relays & contactor interpose relays	24/27V	High integrity auxiliary relay: Self-reset mechanism with 4 **standard duty** changeover contacts	Contact rating 10A continuous with ability to break 100W DC at 100V when L/R = 40ms.
24V DC supply supervision relay	24/27V	Light duty repeat relay with operating current < 10mA at nominal voltage. Self-reset mechanism with at least 2 make and 2 break contacts.	Contact rating at least 2A continuous with ability to break 50W DC resistive at 125V.
230V AC supply supervision relay	230V	Single phase under and over voltage. 1 x SPDT.	Relay contact rating 8A.

Table 1 Relay Minimum Functional Capability

3.3.4. Battery Disconnect Contactor

The battery disconnect DC contactor is to be driven from the SCADA 24V DC supply.

The contactor shall be of single pole single throw design, with magnetically latching double breaking main contacts such that the contacts remain in the last energised state without the need for power.

To assist the breaking of arcs, the contactor shall be fitted with magnetic blow-out coils to give a rated fault current breaking capacity of at least 300A at 120V D.C.

The battery disconnect contactor shall have a minimum thermal current rating of 150A DC.

The contactor open/close handle shall allow the fitting of a padlock or Northern Powergrid ‘think ring’ in both open and closed positions.

3.3.5. Contactor Manual Bypass Switch

The manual bypass switch shall have a rated fault current breaking capacity of at least 300A at 120V D.C. and shall have a minimum thermal current rating of 150A DC.

The manual bypass switch handle shall allow the fitting of a padlock or Northern Powergrid ‘think ring’ in both the normal and bypass position.

3.3.6. Selector Switch

A selector switch shall facilitate maintenance of the DC disconnection scheme by allowing local control of the unit.

The selector switch shall be lockable in the ‘Local’ or ‘Remote’ position.

3.3.7. Panel wiring

The +24V DC supplies to the contactor, control system and panel indication shall be protected with GEC RS20P ‘red spot’ type fuses to BS EN 60269-1:2007 Low-voltage fuses - General requirements.

The panel wiring shall be tri-rated singles to BS 6231:2006 Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000V for switchgear and controlgear wiring.

The insulation between all circuits on the system directly connected to the 110V DC system shall withstand 2 kV A.C. (RMS) at 50 Hz for one minute between the appropriate terminal and earth and between all terminals of electrically separated circuits. The resistance measured at 500V DC after this test shall not be less than 20 MΩ between any terminal and earth or between terminals of electrically separate circuits.

3.3.8. Housing

The DC disconnection scheme housing shall meet the following requirements:

- The housing shall be available as a stand-alone cabinet or integrated into a battery charger cubicle if procured as part of the same contract.
- The unit shall have a permanent schematic diagram fixed to the front.
- All labels shall be black text on a white background using upper case letting throughout and suitably affixed.
- Stand-alone equipment shall be housed in lockable, wall mounted sheet steel cabinet. Equipment integrated into a battery charger cubicle shall be capable of being mounted on steel channels which run across an open trench as specified in NPS/003/016 – Technical Specification for 48V and 110V Battery and Charger Systems.
- The requirements stated below shall be met by both stand-alone and battery charger integrated variations.
- The housing shall comply with the requirements of ENATS 50-18 Application of Ancillary Electrical Equipment.
- The housing shall be so designed and constructed as to provide minimum ingress protection to classification IP32 in accordance with BS EN60529:1992 Degrees of protection provided by enclosures (IP code).
- The housing door shall be fitted with a handle which can be secured in the closed position by means of a padlock having a nominal hasp diameter of 8 mm.
- Internal wiring shall be ENA TS 50-18 compliant and where this is taken through steel panels shall be suitably and sufficiently protected.
- Suitable provision shall be made for earthing of the unit, i.e. 12mm external brass stud or similar.
- Connecting links and terminations shall be suitably shrouded to limit and reduce the amount of exposed current carrying conductor.
- The housing shall be polyester powder coated with a light colour, preferably grey (RAL7035 semi-gloss) on the outside and white on the inside.
- As a minimum, two 20 mm access holes shall be provided, in the side of the cabinet or within the floor of the cubicle, to facilitate external input and output wiring connections.

3.3.9. Terminals

- A dedicated group of terminals for SCADA (flip-link type) shall be provided for the associated interface with external paired cables to the substation RTU. Enough terminals shall be provided to terminate the full number of associated cable pairs.
- A dedicated set of through terminals shall be provided for all interfacing with Protection and Control associated multi-core cables. These terminals shall be of the spring-loaded type.

3.3.9.1. Fuses and Links

All fuses and links provided for the control scheme shall be of the heavy-duty type consisting of fixed bases with withdrawable fuse/link –carriers.

3.4. Functionality

The unit shall interface with SCADA and provide the following functionality:

- receive remote open and close commands from SCADA;
- provide remote and local indication of the DC contactor and bypass isolator status, and
- provide remote and local indication of health of the DC supply to the disconnection scheme.

The DC contactor control function shall be fitted with a 'Local' / 'Remote' selector switch, allowing the equipment to be controllable both remotely and locally.

The DC contactor control function shall be designed such that if it fails, the contactor remains in its pre-failure state.

The DC contactor control and status functions shall operate from the 24V SCADA battery and shall impose minimal standing load on the SCADA battery.

The DC contactor control function shall be monitored for loss of supply with an associated alarm locally and remotely via SCADA.

The DC disconnection system shall provide a double bit output of the contactor status. The outputs shall be monitored via discrepancy checking in the RTU.

To test or maintain the DC disconnection system whilst maintaining DC supplies to the substation, an appropriately rated locally operated by-pass isolator shall be fitted in parallel with the DC contactor.

The contactor open/close handle and the bypass isolator handle shall allow the fitting of a padlock or Northern Powergrid 'think ring' in both positions.

Remote Operation

The DC contactor shall open on receipt of a remote SCADA command when selected to remote operation **and** the LVAC supply to the battery charger is not healthy as measured by the voltage detection function.

The DC contactor shall close on receipt of a remote SCADA command when selected to remote operation **or** shall automatically close when the incoming voltage at the LVAC board supplying the battery charger is restored to nominal voltage (this function is disabled when selected to local operation).

Local Operation

Prior to maintenance/testing of the DC disconnection scheme, the selector switch shall be set to 'Local'.

In local operation the bypass switch may be closed; the status of the by-pass isolator shall be indicated locally (by switch position) and remotely via SCADA.

The DC contactor may then be opened or closed via local manual control for testing/maintenance whilst maintaining DC supplies.

4. References

4.2. External Documentation

Reference	Title
BS 6231:2006	Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000 V for switchgear and controlgear wiring
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 EN60529:1992	Degrees of protection provided by enclosures (IP code)
ENA ER G91	Substation Black Start Resilience.
ENA TS 48-5 Issue 52023	Environmental test requirements for protection and control equipment and systems
ENA TS 50-18 Issue 5 2023	Application of Ancillary Electrical Equipment.

4.3. Internal Documentation

Reference	Title
NPS/003/016	Technical Specification for 48V and 110V Battery and Charger Systems

4.4. Amendments from Previous Version

Reference	Title
3.2.1	Reference to 48-5 updated to latest version
References	Updated to latest versions of ENATS versions
Appendix 1 Table A4	Additions to comply with new version of ENA TS 48-5

5. Definitions

Reference	Definition
Black Start	The process of recovering from a shutdown of the entire GB electricity network

6. Authority for issue

6.2. 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
Paul Sherry	Governance Administrator	13/02/2025

6.3. 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: Less frequent formal review required due to contractual review.
Should this document be displayed on the Northern Powergrid external website?		Yes
		Date
Paul McAdoo	Lead Policy and Standards Engineer	04/03/2025

6.4. 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
Dave Marshall	Protection Engineer	13/02/2025
Joseph Helm	Lead Policy and Standards Engineer	26/02/2025

6.5. Authorisation

Authorisation is granted for publication of this document.

		Date
Paul Black	Head of System Engineering	07/03/2025

Appendix 1 - Technical Specification Conformance Declaration

Test requirements for the complete system

Standard	Requirement	Compliance Y or N	Actual test level	Remarks
BS 6231:2006	The panel wiring shall be tri-rated singles to BS 6231:2006 Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000 V for switchgear and controlgear wiring.			
BS EN 60255-26:2013	Meets the immunity test requirements BS EN 60255-26:2013 Measuring relays and protection equipment - Electromagnetic compatibility requirements.			
BS EN 60255-26:2013	Electrical disturbances generated do not exceed the level specified in BS EN 60255-26:2013 Measuring relays and protection equipment - Electromagnetic compatibility requirements.			
BS EN 60255-27:2014	Protection against electric shock shall be conducted as type tests and routine tests as defined in BS EN 60255-27:2014 Measuring relays and protection equipment - Product safety requirements.			
BS EN 60255-26:2013	The unit will withstand disturbances in the auxiliary supply, under normal operating conditions, without de-energising as required by BS EN 60255-26:2013			
BS 6231:2006	The panel wiring shall be tri-rated singles to BS 6231:2006 Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000 V for switchgear and controlgear wiring.			
ENATS 50-18	The housing shall comply with the requirements of ENATS 50-18 Application of Ancillary Electrical Equipment.			

Standard	Requirement	Compliance Y or N	Actual test level	Remarks
BS EN 60529	The housing shall be so designed and constructed as to provide minimum ingress protection to classification IP32 in accordance with BS EN 60529.			
ENA TS 50-18	Internal wiring shall be ENA TS 50-18 compliant and where this is taken through steel panels shall be suitably and sufficiently protected.			
ENA TS 50-19	Standard Numbering for Small Wiring for Switchgear and Transformers Together with their Associated Relay Panels			

Environmental test requirements for protection and control equipment and systems

Table A.1 — Atmospheric environment requirements

ENA Technical Specification 48-5 Clause	Preferred Standard/Procedure	Specified test level	Compliance Y or N	Actual test level	Remarks
5.1 - Temperature cold heat	BS EN 60068-2-1	-10 °C, 96 hours, operate OR -25 °C , 16 hours, operate			
		-25 °C, 96 hours, storage OR -40 °C, 16 hours, storage			
5.1 - Temperature dry heat	BS EN 60068-2-2	+55 °C, 96 hours, operate OR +70 °C, 16 hours, operate			
		+70 °C, 96 hours, storage			
5.2 - Relative humidity	BS EN 60068-2-78	93%, 40 °C, 56 days OR			
5.2 - Relative humidity (alternative)	BS EN 60068-2-30	93%, 40 °C, 6 off 24 hour cycles of +25 to +55 °C			
5.3 – Enclosure	BS EN 60529	IP50 Relay components shall be protected to IP50 (dust protected) but the external cabinet shall protect the system to IP32.			

Table A.2 — Mechanical environment requirements

ENA Technical Specification 48-5 Clause	Preferred Standard/Procedure	Specified test level	Compliance Y or N	Actual test level	Remarks
6.1 – Vibration	BS EN 60068-21-1	Response Class 1			
		Endurance Class 1			
6.2 – Shock	BS EN 60068-21-2	Response Class 1			
		Withstand Class 1			
6.2 – Bump	BS EN 60068-21-2	Class 1			
6.3 – Seismic	BS EN 60068-21-3	Class 1			

Table A.3 — Electrical environmental requirements

ENA Technical Specification 48-5 Clause	Preferred Standard/Procedure	Specified test level	Compliance Y or N	Actual test level	Remarks
7.1 - DC supply voltage - 24 V DC	BS EN 60255-1	Table 1, remain within claimed accuracy from 19 to 32 V with >35 V continuous withstand			
7.1 - DC supply voltage dips, short interruptions and voltage variations immunity test	BS EN 60255-26	2, 5 & 10 ms interruption, no affect			
		>10 ms interruption, no maloperation with any reset			
		15% a.c. ripple			
7.1 - DC supply voltage –General	ENA TS 48-5	Ramp up and down over 1 minute, or similar			
7.1 - DC Supply voltage -low burden trip relays	ENA TS 48-4	Capacitive Discharge			
7.1 - DC supply voltage -high burden trip relays	ENA TS 48-4	Capacitive Discharge			
7.2 - AC supply voltage	BS EN 60255-6	Min. and max. declared			

ENA Technical Specification 48-5 Clause	Preferred Standard/Procedure	Specified test level	Compliance Y or N	Actual test level	Remarks
7.3 - Thermal requirement - CT inputs	ENA TS 48-5	2.4 x I_n, continuous 3.0 x I_n, for 20 mins 3.5 x I_n, for 10 mins 4.0 x I_n, for 5 mins 5.0 x I_n, for 3 mins 6.0 x I_n, for 2 mins			
7.4 - Thermal requirements - VT inputs	ENA TS 48-5	120% of V_n, continuous			
7.5.1 – Insulation – Dielectric	BS EN 60255-27	Test values selected according to insulation voltage High Impedance circulating current schemes, test at 2.3 kV Circuits connected to instrument transformers or batteries, rated insulation not below 250 V, test at 2.0 kV a.c. r.m.s. for 1 minute Open output relay contacts 1 kV for 1 minute			
7.5.2 – Insulation – Impulse Voltage	BS EN 60255-27	Test at 5 kV peak, 0.5 J			

Table A.4 — Electromagnetic compatibility (EMC) requirements

ENA Technical Specification 48-5 Clause	Preferred Standard/Procedure	Specified test level	Compliance Y or N	Actual test level	Remarks
8.1 Oscillatory waves immunity test (High Frequency Disturbance)	BS EN 60255-26 Clause 7.2.6	1 MHz, 2.5 kV common, 1 kV differential Applied to all ports, except differential on communications ports at the discretion of the PAP			
8.1 Oscillatory waves immunity test (High Frequency Disturbance)	BS EN 61000-4-18	Level 3 (2.5kV) at 3, 10 and 30MHz. Meets the requirements of BS EN 61000-4-18 for fast damped oscillatory waveforms. Tests are applied to all ports.			
8.2 Electrostatic Discharge immunity tests	BS EN 60255-26 Clause 7.2.3	6 kV, contact, 8 kV air Applied to enclosure			
8.3 Radiated electromagnetic field disturbance test (RFI)	BS EN 60255-26 Clause 7.2.4	Meets the requirements of BS EN 60255-26 Clause 7.2.4.			
8.4 Electrical fast transient/burst immunity	BS EN 60255-26 Clause 7.2.5	Zone A, 4 kV Applied to all ports			
8.5 Surge immunity test	BS EN 60255-26 Clause 7.2.7	In accordance with BS EN 61000-4-5, installation level 4			

ENA Technical Specification 48-5 Clause	Preferred Standard/Procedure	Specified test level	Compliance Y or N	Actual test level	Remarks
8.6 Conducted electromagnetic field disturbance tests	BS EN 60255-26 Clause 7.2.8	10 V r.m.s., 80% mod, 1 kHz. 0.15 to 80 MHz sweep and 27 and 68 MHz spot frequencies Applied to all ports			
8.7.1 Power frequency magnetic field immunity test	BS EN 61000-4-8	Test Level 5, 1 000 A/m for 1 sec and 100 A/m for 1 min Applied to the enclosure			
8.7.2 Power frequency – General	BS EN 61000-4-16 BS EN 60255-26	Test Level 4, 300 V, 50 Hz common mode for 1 second. Tests are applied to all power supply ports. Zone A			
8.8 Pulse magnetic field immunity test	BS EN 61000-4-9	Test Level 5, 8/20 µs magnetic pulse, 1 000 A/m Applied to enclosure			
8.9 Damped oscillatory magnetic field immunity test	BS EN 61000-4-10	0.1 and 1.0 MHz, 100 A/m Applied to enclosure			
8.10 Teleprotection equipment of power systems	BS EN 60834-1 & BS EN 60834-2	Only applicable for teleprotection equipment			

ENA Technical Specification 48-5 Clause	Preferred Standard/Procedure	Specified test level	Compliance Y or N	Actual test level	Remarks
8.11 Conducted and radiated emission	BS EN 60255-26	Zone A, Conducted, power supply: 0.15 to 0.5 MHz, 79 dB (µV) quasi peak, 66 dB (µV) average 0.5 to 30 MHz, 71dB (µV) quasi peak, 60 dB (µV) average Radiated, Enclosure at 10 m: 30 to 230 MHz, 40 dB (µV/m) quasi peak, 230 to 1 000 MHz, 47 dB (µV/m) quasi peak 1 Hz to 3 GHz, 56 dB (µV/m) average 3 GHz to 6 GHz, 60 dB (µV/m) average			

Appendix 2 – Addendum to Suppliers Requirements

Project specific installation and protection requirements will be provided by Primary Engineering Projects for inclusion in this appendix.

Appendix 3 - Pre-commission testing, Routine Inspection and Maintenance requirements

Tenderers shall provide details of the recommended pre-commission testing and inspection required.

Details of the Test Voltage Levels, duration, pass/fail criteria, etc. shall be provided.

Tenderers shall state any maximum voltage that may be applied or any other limitations that may apply.

Tenderers shall provide information regarding detailed and periodic inspection and maintenance requirements to be undertaken during the lifetime of their product.