ENGINEERING DESIGN STANDARD

EDS 05-0002

PROTECTION AND CONTROL SCHEMES FOR CUSTOMER DEMAND AND GENERATION CONNECTIONS

Network(s): EPN, LPN, SPN

Summary: This standard provides guidance on protection and control schemes for customer demand and generation connections at 11kV, 33kV and 132kV.

Author: Colin Scoble Date: 28/02/2018

Approver: Barry Hatton Date: 15/05/2018

This document forms part of the Company’s Integrated Business System and its requirements are mandatory throughout UK Power Networks. Departure from these requirements may only be taken with the written approval of the Director of Asset Management. If you have any queries about this document please contact the author or owner of the current issue.

Applicable To

UK Power Networks
- ☒ Asset Management
- ☒ Capital Programme
- ☒ Connections
- ☐ Health and Safety
- ☐ Legal
- ☐ Network Operations
- ☐ Procurement
- ☐ Strategy and Regulation
- ☐ Technical Training

External
- ☒ G81 Website
- ☐ UK Power Networks Services
- ☐ Contractors
- ☒ ICPs/IDNOs
- ☐ Meter Operators
New standard to cover protection requirements for customer demand and generation connections. The relevant contents from EDS 08-0051, EDS 08-0149 and EDS 08-0151 have been incorporated.
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1 Introduction
This standard provides guidance on protection and control schemes for customer demand and generation connections at HV and EHV.

This standard should be read in conjunction with the HV and EHV network design and customer connection standards EDS 08-3100 and EDS 08-4100.

Note: The standard is currently based on the content previously published in EDS 08-0051 and EDS 08-0151 which have now been withdrawn.

2 Scope
This standard applies to customer demand and generation connections at HV and EHV voltages.

This document is intended to provide guidance on the differences in grid and primary protection requirements for customer demand and generation arrangements. It is not intended to cover guidance already covered in EDS 05-0001 and should be read in conjunction with that standard.

3 Glossary and Abbreviations

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACB</td>
<td>Air Circuit Breaker</td>
</tr>
<tr>
<td>ASC</td>
<td>Arc Suppression Coil</td>
</tr>
<tr>
<td>AVC</td>
<td>Automatic Voltage Control</td>
</tr>
<tr>
<td>BNO</td>
<td>Building Network Operator</td>
</tr>
<tr>
<td>CB</td>
<td>Circuit Breaker</td>
</tr>
<tr>
<td>CT</td>
<td>Current Transformer</td>
</tr>
<tr>
<td>CTU</td>
<td>Capacitor Trip Unit</td>
</tr>
<tr>
<td>DAR</td>
<td>Delayed Auto Reclose</td>
</tr>
<tr>
<td>DNO</td>
<td>Distribution Network Operator</td>
</tr>
<tr>
<td>DOC</td>
<td>Directional Overcurrent</td>
</tr>
<tr>
<td>EDNO</td>
<td>Abbreviation for the private network operator as a licence exempt distribution network operator, to differentiate these licence exempt distributors from IDNOs who hold a distribution licence</td>
</tr>
<tr>
<td>EF</td>
<td>Earth Fault (protection)</td>
</tr>
<tr>
<td>EHV</td>
<td>Above 22kV but less than 72kV rated equipment</td>
</tr>
<tr>
<td>EMF</td>
<td>Electro Motive Force</td>
</tr>
<tr>
<td>ENA</td>
<td>Energy Networks Association</td>
</tr>
<tr>
<td>GA</td>
<td>General Arrangement</td>
</tr>
<tr>
<td>GIS</td>
<td>Gas Insulated Switchgear</td>
</tr>
<tr>
<td>GSP</td>
<td>Grid Supply Point</td>
</tr>
<tr>
<td>HV</td>
<td>Above 1kV but less than 22kV rated equipment</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>ICP</td>
<td>Independent Connections Provider. An ICP can undertake contestable works. An ICP is a company that has been approved and included on the Lloyd's Register list of Contractors under the National Electricity Registration Scheme (NERS). These companies build electricity networks to the specification and quality necessary for them to be adopted (owned) by UK Power Networks</td>
</tr>
<tr>
<td>IDMT</td>
<td>Inverse Definite Minimum Time</td>
</tr>
<tr>
<td>IDNO</td>
<td>Independent Distribution Network Operator</td>
</tr>
<tr>
<td>LV</td>
<td>Low Voltage (also used for lower voltage side of a transformer)</td>
</tr>
<tr>
<td>LVAC</td>
<td>Low Voltage Alternating Current</td>
</tr>
<tr>
<td>MVA</td>
<td>Mega Volt Ampere</td>
</tr>
<tr>
<td>MVAR</td>
<td>Mega Volt Ampere reactive</td>
</tr>
<tr>
<td>MW</td>
<td>Mega Watt</td>
</tr>
<tr>
<td>NVD</td>
<td>Neutral Voltage Displacement</td>
</tr>
<tr>
<td>OC</td>
<td>Overcurrent (protection)</td>
</tr>
<tr>
<td>Operational Safety</td>
<td>Interlocking required to protect equipment and operators from the dangers of incorrect equipment operation</td>
</tr>
<tr>
<td>Interlocking</td>
<td></td>
</tr>
<tr>
<td>POC</td>
<td>Point of Connection</td>
</tr>
<tr>
<td>PSL</td>
<td>Programmable Scheme Logic</td>
</tr>
<tr>
<td>PSU</td>
<td>Power Supply Unit</td>
</tr>
<tr>
<td>REF</td>
<td>Restricted Earth Fault</td>
</tr>
<tr>
<td>RMU</td>
<td>Ring Main Unit</td>
</tr>
<tr>
<td>ROCOF</td>
<td>Rate of Change of Frequency</td>
</tr>
<tr>
<td>RTU</td>
<td>Remote Terminal Unit</td>
</tr>
<tr>
<td>SBEF</td>
<td>Standby Earth Fault</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition</td>
</tr>
<tr>
<td>System Interlocking</td>
<td>Interlocking required to prevent system parallel’s being created through private networks that have more than one source of supply from UK Power Networks</td>
</tr>
<tr>
<td>TLF</td>
<td>Time Limit Fuse</td>
</tr>
<tr>
<td>TS</td>
<td>Technical Specification</td>
</tr>
<tr>
<td>UK Power Networks</td>
<td>UK Power Networks (Operations) Ltd consists of three electricity distribution networks:</td>
</tr>
<tr>
<td></td>
<td>• Eastern Power Networks plc (EPN).</td>
</tr>
<tr>
<td></td>
<td>• London Power Network plc (LPN).</td>
</tr>
<tr>
<td></td>
<td>• South Eastern Power Networks plc (SPN).</td>
</tr>
<tr>
<td>VT</td>
<td>Voltage Transformer</td>
</tr>
</tbody>
</table>
## 4 Customer Connection Standards Overview

Table 4-1 provides a summary of the main standards applicable to customer connections.

<table>
<thead>
<tr>
<th>Design</th>
<th>132/66kV</th>
<th>33kV</th>
<th>11/6.6kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection</td>
<td>EDS 08-4100</td>
<td>EDS 08-4100</td>
<td>EDS 08-3100</td>
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<tr>
<td>Network</td>
<td>EDS 08-4000</td>
<td>EDS 08-4000</td>
<td>EDS 08-3000</td>
</tr>
<tr>
<td>Substation</td>
<td>EDS 07-0105</td>
<td>EDS 07-0020</td>
<td>EDS 07-3102</td>
</tr>
<tr>
<td>Earthing</td>
<td>EDS 06-0019</td>
<td>EDS 06-0019</td>
<td>EDS 06-0019</td>
</tr>
<tr>
<td>Protection</td>
<td>EDS 05-0002</td>
<td>EDS 05-0002</td>
<td>EDS 05-0002</td>
</tr>
<tr>
<td>Substation Supplies</td>
<td>EDS 08-1112</td>
<td>EDS 08-1112</td>
<td>EDS 08-1112</td>
</tr>
<tr>
<td>IDNO</td>
<td>EDS 08-0133</td>
<td>EDS 08-0133</td>
<td>EDS 08-0133</td>
</tr>
<tr>
<td>Approved Switchgear</td>
<td>EAS 03-0000</td>
<td>EAS 03-0000</td>
<td>EAS 03-0000</td>
</tr>
<tr>
<td>Approved Protection</td>
<td>EAS 05-0000</td>
<td>EAS 05-0000</td>
<td>EAS 05-0000</td>
</tr>
<tr>
<td>Approved Metering</td>
<td>EAS 09-0000</td>
<td>EAS 09-0000</td>
<td>EAS 09-0000</td>
</tr>
<tr>
<td>Other Equipment</td>
<td>EDS 08-1152</td>
<td>EDS 08-1152</td>
<td>EDS 08-1152</td>
</tr>
</tbody>
</table>
5 Protection and Control General Requirements

5.1 Overview

Functional block diagrams for HV and EHV protection schemes are detailed in Appendix A, Appendix B and Appendix C. The diagrams include the UK Power Networks supply side equipment and interfaces required with the customer’s system for different supply configurations.

These are the standard protection requirements and shall be discussed with the customer at the earliest possible opportunity to take into consideration any specific protection requirements they may have to interface with UK Power Networks equipment. Any deviation from these standards shall be agreed as a derogation with Asset Management.

The design of protection systems for grid and primary substation apparatus and plant owned by, or to be adopted by UK Power Networks shall be in accordance with EDS 05-0001. The requirements of EDS 05-0001 take precedence over the requirements detailed in this document.

5.2 Protection Relays

All protection relays shall be specified in accordance with EAS 05-0000.

5.3 Protection Cubicles

All protection cubicles shall be specified in accordance with EDS 05-9008.

5.4 Auxiliary Supplies

5.4.1 Low Voltage AC Supplies

All low voltage AC supplies shall be provided in accordance with EDS 08-1112.

5.4.1 Battery Supply

Battery and charger requirements shall be as specified in ETS 05-0300 and ETS 05-0301. 132kV systems shall be black start compliant.

5.5 Directional Overcurrent (DOC) Relays – Parallel Primary or Grid Transformers

Some embedded generator installations may have sufficient output to cause incorrect operation of directional overcurrent relays. These are used in the protection of parallel transformers and to protect against the failure of inter-tripping to clear the low voltage circuit breaker should the incoming supply to one transformer be disconnected at source during fault conditions. This is particularly important in the event that a single transformer trips leaving the possibility of a cascade trip of further transformers as a result of reverse power from a generator or generators.

Under these circumstances a protection grading survey shall be carried out to ascertain if the relays can be re-set to provide capacity for the generation while still providing adequate protection in the event of transformer faults or any un-cleared feeder outage.
Other possible solutions to this problem will depend upon individual circumstances of each case, but may include:

- Duplication of transformer inter-tripping channels to allow de-commissioning of the DOC relays.
- Use of blocking schemes to prevent possible cascade tripping.
- Disconnection of connected generation to prevent the operation of DOC. This may require the installation of operational inter-tripping schemes between the UK Power Networks substation and one or more generation sites.
- Replacement of existing DOC protection and replacement with protective devices that can provide ‘load blinding’ functionality such that reverse power capabilities can be maximise whilst retaining sensitivity for remote end fault detection. The suitability of load blinding functionality shall be assessed on a project-by-project basis as the network topology and existing generation connections may preclude it from being an appropriate solution.
6 132kV Protection Schemes

6.1 Protection and Inter-tripping Alterations and Additions

132kV connection infrastructure provided for a generator installation or demand connection from a grid substation or from any other network location where communications networks are available, shall be installed with either a fibre-optic or pilot wire auxiliary cable (as appropriate to connect to the local system).

The auxiliary cable shall be used for protection, inter-tripping and in some cases to provide data, control and metering facilities. All 132kV cables are normally laid with an auxiliary cable and the cost of the cable installation shall be borne by the customer in the same way as the main cable.

6.2 Customer Interface Requirements

6.2.1 Point of Connection

The protection associated with the network connection shall be compatible with the existing network configuration to which the connection is made with protected zones overlapping.

Bus-zone protection may be required for new connections to unit protected circuits and will be dependent on the configuration of the incoming supply.

A direct connection to a grid substation would generally match the standard specification for 132kV switchgear at the point of connection unless there are exceptional circumstances to justify other arrangements.

Reference shall be made to UK Power Networks design standards for 132kV grid and primary system protection and control schemes.

The protection for UK Power Networks owned or adopted equipment shall not rely on equipment owned and/or operated by a third party with the possible exception of some communications routes.

Teeed connections to some distance and unit protected circuits could cause erroneous operations and unnecessary interruptions due to faults within a customer’s system. Individual assessments are required to ensure that the network configuration and protection arrangements are compatible. Teeed connections into distance protected circuits require a communication route to enable block signal initiation to allow time for the protection to operate at the tee. Wherever possible any blocking signals shall be derived from UK Power Networks owned or adopted devices.

Non-unit protected bleed off connections to unit protected feeders shall not be made.

A direct connection to a grid substation would generally have main and backup protection in accordance with current UK Power Networks standards for grid and primary system protection and control schemes, where it is compatible with existing protection schemes. If this cannot be satisfied, it will be necessary to match the specification for the existing switchgear at the point of connection unless this can be altered, at a marginal cost, to update the local system to the latest specification.
6.2.2 Delayed Auto-Reclose

Where delayed auto-reclose systems are installed on circuits with generation connected at 132kV, the time of the closing operation shall be sufficiently delayed to ensure that any possible island situation is removed before the first reclose is attempted.

If the generation has the capability to support an island network, inter-tripping shall be fitted at the point of supply to disconnect the generation or open the metering CB to ensure that the generation is disconnected in the dead time. The inter-trip signal may be arranged to trip CBs in the customer’s system, with a timed backup to trip the metering CB should the customer’s CBs fail to operate. Timing will be determined by the auto-reclose time of the first reclosing CB.

6.2.3 Check Synchronisation

Check sync relays shall be installed, at the DAR CB to ensure that an out of sync DAR operation is checked to prevent damage to generation plant or other equipment before reclosing.

6.2.4 132kV Protection at Point of Supply – Single Circuit and Metering Circuit-breaker

Switchgear and protective devices that provide supplies at 132kV to a customer shall be fitted with separate relays for each protection function, i.e. separate main and backup protection shall be configured in different devices. The connection via a circuit breaker at the grid substation will also have main and backup protection which would disconnect any un-cleared fault at the site.

All 132kV circuits shall be fitted with inter-tripping to ensure that circuits are fully disconnected in the event of protection operation under fault conditions. Fault throwing switches are no longer permitted to be installed for inter-tripping at 132kV.

In the majority of cases faults should be cleared by the customer’s protection and should only require operation of the metering CB where there is a fault on the customer’s transformer (if directly connected), cable/busbar connection to the customer’s system or if the customer’s main and backup protection has failed to operate.

Where a customer owned transformer is directly connected by busbar or cable to the UK Power Networks metering CB, fast acting unit protection shall be fitted to the customer’s system for transformer protection such as overall biased differential protection and/or restricted earth fault protection. CT inputs from the customer’s secondary and earthing systems will generally be required to operate the fast acting unit protection.

132kV busbar and switchgear connections that fall outside the transformer unit protected zone and the feeder zones shall have a separate fast acting main protection scheme which shall be of a unit type, will require CTs in the customer’s equipment and at the UK Power Networks owned or adopted circuit breaker. The main protection system for the customer’s equipment, where connected to the UK Power Networks system, shall have a maximum clearance time of 120ms.

All parts of circuits, plant and terminations owned or adopted by UK Power Networks shall be protected by overlapping, fully discriminating main protection schemes which are owned or adopted and maintained by UK Power Networks. The protected equipment shall also fall within the reach of a suitably discriminating backup protection scheme. To achieve this requirement there is likely to be a need to extend such protection schemes to customer owned equipment.
The overlap between the UK Power Networks main protection and the customer main protection is expected to be located at the closest practicable electrical part of the customer’s network. This will require the provision of appropriate CTs by the customer in their equipment; the rating, ratio and accuracy of the CTs shall comply to UK Power Networks’ specification.

The customer shall submit a protection design philosophy to enable UK Power Networks to fully assess the impact of the proposed connection. The protection requirements shall be discussed between UK Power Networks and the customer or the customer’s agent at an early stage to ensure that sufficient and appropriate CT sets are available.

A schedule of UK Power Networks standard protection CT ratings, ratios and accuracy is available from the UK Power Networks website, but individual project requirements shall be discussed and confirmed in writing.

The customer shall specify and install transformer local and low voltage protection to their own requirements, e.g. LV restricted earth fault, Buchholz, winding temperature, SBEF etc. An inter-trip receive relay shall be installed to enable the customer’s protection to trip the UK Power Networks metering circuit breaker to clear transformer faults where the transformer is directly connected to the UK Power Networks metering CB.

An interface pilot/auxiliary termination box shall be installed for the termination of cables from the customer’s installation. Where the customer installs their own 132kV main circuit breaker to control the installation, provision should be made for unit protection of the connection equipment between the customer’s incoming CB and the UK Power Networks metering CB. The main protection system for the customer’s equipment, where connected to the UK Power Networks system, shall have a maximum clearance time of 120ms.

Most 132kV metering circuit breakers will have some type of main circuit protection, e.g. unit protection, inter-tripping or blocking designed to fit into the existing incoming network protection scheme. The breaker shall also have the following protection:

- Unit protection for the HV Connections between the metering CB and the customer’s equipment.
- Where the customers transformer is directly connected to the metering CB, fast acting protection such as biased differential protection and/or restricted earth fault protection operating via a UK Power Networks inter-trip relay initiated by the customer’s protection.
- IDMT OC and EF.

6.2.5 132kV Protection at Point of Supply – Loop or Multiple Circuit

Where the incoming supply is a loop connection or where multiple feeders are connected to the same switchboard or busbar system the protection for the incoming supply CBs shall be main and backup protection to match the system to which they are connected. A loop into a distance or unit protected circuit shall include protection to match the existing circuit and shall ensure that the resulting reduced circuit or pilot lengths are suitable for the type of protection used.

A circuit with direct feeders from a primary or grid substation shall have similar characteristics to match the existing system. In all probability this would be unit or distance protection for multiple feeders running in parallel. All 132kV circuits shall be fitted with inter-tripping to ensure that circuits are fully disconnected in the event of protection operation under fault conditions. Bus zone differential protection shall be provided where busbars are not covered by the incoming circuit main protection.
In addition to distribution system main protection, e.g. unit or distance protection which shall be in a separate device, other protection requirements such as backup IDMT OC and EF and inter-tripping may be included in a separate multifunction backup relay if facilities are available. The protection for the tee off CB that supplies the customer’s installation shall be the same as the incoming CB in Section 6.2.4.

6.2.6 132kV Customer Interface

The following facilities which may be required for a single circuit or loop/multi circuit supply:

- Inter-trip send to the customer’s G59/synchronising CBs and inter-trip receive from the external network – metering CB.
- Block signal to external protection where a fault is detected in the local zone.
- Inter-trip received from the customer’s transformer protection where the transformer is directly connected to the metering CB – metering CB.
- Electrical interlocking to prevent closure of the incoming or metering CB if the customer’s G59/Synchronising CBs are closed.
- Where the customer has their own local 132kV switchgear, electrical/mechanical interlocking to prevent earthing application towards the customer’s system unless the customer’s main incoming disconnector is open – metering CB/disconnector earth switch/customer’s disconnector.
- Where the customer’s transformer is located adjacent to the incoming supply and connected directly to the metering CB:
  - Electrical/mechanical interlocking to prevent selection of customer’s LV earthing function unless the UK Power Networks metering CB/disconnector is open.
  - Electrical/mechanical interlocking to prevent 132kV earthing application towards the customers system unless the customer’s transformer LV earthing Switch/CB is closed to earth.
  - Interlock fitted to metering CB/disconnector/earth switch/customers incoming CB.
- Customer’s emergency trip to incoming or metering CB via inter-trip relay.
- UK Power Networks SCADA alarm/control for customer’s generation depending upon agreement for security.
- UK Power Networks SCADA indication to customer for LV supply fail if the LV auxiliary supply is from the customer’s LV system.
- Import and export metering.
- Power quality metering.
- G59 protection installed by the customer to protect the incoming supply system from disruption related to the generation activity. To ensure that the protection operates correctly the voltage and current references used for G59 protection equipment shall only be derived from sources accurately representative of the incoming supply conditions. The use of a reference voltage from the customer’s LV network shall be avoided as the voltage and phase current relationship can be modified by load conditions or other factors within the customer’s network.

Details of protection and interlocking interfaces required from the customer’s system shall be discussed with the customer at an early stage to ensure that CT ratings, class and ratios are compatible with the HV connections protection. The resetting means for SCADA/auxiliary relays shall be agreed and included in the overall protection design. Interlocking arrangements, nomenclature and function for the 132kV metering CB/disconnector/earth switch shall also be specified and agreed.

Reference should also be made to protection block diagrams associated with this standard for other possible interface requirements and the most applicable scheme agreed between the customer and UK Power Networks.
7 SCADA Requirements

7.1 Local and Remote Control

Local and remote control shall be provided for:

- 132kV circuit breakers on switchgear panels and in compounds.
- 33kV circuit breakers on switchgear panels.
- 11kV indoor extensible switchgear.

Control shall be possible from the following locations:

- Local at the switchgear.
- Local from a distance using an electrical lanyard device.
- Standby control panel (where fitted).
- Remote control via the SCADA for all motor and electrically operated devices.

All switchgear controls shall be hardwired with facility for selection of control mode/location where local supervisory control is provided. Remote control of protection functions can be hardwired or achieved via serial communication.

Where SCADA operation is provided all control interposing relays shall be fitted with back EMF protection diodes with the cathode connected to common (positive). The location of any non-integral diodes shall be in the protection cubicle on the multi-pair cable termination.

Control interposing relays operated from the SCADA system shall be energised from a nominal 48V DC supply.

7.2 SCADA Communications

All EHV installations shall be provided with satellite communications in addition to GPRS.
8 Voltage Control

8.1 Refurbishment/Replacement

The proposed connection of a generation scheme may impact the correct operation of the automatic voltage control (AVC) scheme at a grid or primary substation.

Circumstances where this may arise are instances where:

- The grid or primary transformers are subjected to reverse power flow as a consequence of the generation connection.
- The generator provides a significant proportion of the site maximum demand and the AVC scheme relies on line/load drop compensation.

In both cases the scheme shall be assessed to determine whether it can or will continue to operate correctly.

This may result in the need to implement a full or partial replacement of the scheme, particularly where the generation scheme is not operating at unity power factor. In this event, Fundamentals SuperTAPP N+ relay (or equivalent) shall be used as this contains the load exclusion modules necessary to accommodate generation infeeds.

8.2 Tap Changers Rating

Reference shall be made to EA Technology Report No. 5769 which gives guidance to the reverse power capability of many types and models of tap changers. However, some units still in service do not have accurate reverse power rating information, although the majority are covered. Where the tap changer rating is not covered in the report the manufacturer or the current heritage owner of the brand shall be contacted for advice.

Where any necessary replacement, modifications or servicing are recommended by the manufacturer this work shall be carried out as a part of the new connection project prior to the generating plant being connected.

9 HV NVD Protection at the Generation Interface

The recommendations in ENA ER G59 regarding NVD protection were derived from a report produced by the ENA DCRP G59 NVD Working Group titled ‘Embedded generation interface protection: Assessment of risks arising from relaxation in the application of NVD interface protection’. Refer to these documents for a more detailed explanation of the issue.

The following paragraphs provide supplementary information, and guidance on the provision of NVD protection.

9.1.1 Factors Influencing the Risk of an Islanded Network (systems operating at 20kV or less)

There are a number of factors that determine the ability of a generator to sustain an islanded network. The higher the risk of this, the greater is the requirement to install NVD protection. It should be emphasised that NVD protection will not protect against island conditions where the islanded network is not faulty. Generation with NVD protection connected to a healthy island network, without a phase to earth fault, would not necessarily trip on NVD protection. Such conditions will need to rely upon inter-tripping or the operation of G59 relays.
The following sections covering the application of NVD should be read in conjunction with the guidance table shown in Figure 9.1.

### NVD Assessment for 11kV Connected Generation

<table>
<thead>
<tr>
<th>Network Islanding Conditions</th>
<th>Generating Plant</th>
<th>Existing Generation Site Export</th>
<th>With NVD Fitted Within Island</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Risk</td>
<td>High Risk</td>
<td>Medium / High Risk</td>
<td>1MVA - &lt;5MVA</td>
<td>Fit NVD</td>
</tr>
<tr>
<td>Less than two times the</td>
<td>Solid or Impedance</td>
<td>PV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>maximum combined output</td>
<td>Earthed, or short</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of new Embedded Generator</td>
<td>time rated ASC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Risk</td>
<td>Continually rated</td>
<td>PV</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Risk refers to the potential for a generator to supply an islanded network.

Notes:
1. Potential trapped load within a protection zone that could be islanded following operation of protection. This may not be the whole feeder but could include load downstream of a PMR.
2. If NVD is used with short time rated ASC’s the NVD trip time setting needs to be set longer than the short time rating of the coil.
3. Generators operating in PV mode have fixed MW output and control the voltage by varying reactive power output. Generators operating in PQ mode have fixed real and reactive power output and are less able to support an islanded network if export pf is at unity.
4. When existing generation is connected within the same island and if an island were to be formed, then operation of existing NVD would result in a step load change on the other generators in the group which should then be detected by loss of mains protection.

Ref G59/2 10.4

### 9.1.1.1 Minimum Prospective Island Load

This is often referred to as trapped load and is a measure of the load that the generator(s) would need to supply in an islanded network. If the level of trapped load is equal to the output of the generator then there is a likelihood that conventional loss of mains protection such as ROCOF will not detect the island and the generator will continue to operate and supply the network.

In assessing the minimum trapped load, if this is greater than the generator is able to supply then the frequency and voltage provided by the generator will start to collapse. By using a safety factor of two this will ensure that even if the minimum load is reduced still further there should be a rapid collapse in voltage and frequency preventing a continued island operation. Therefore, if the generation is not capable of supporting an island, no NVD is required.

It shall be remembered that the island would normally be established at protection zone boundaries so even a small generator downstream of a pole-mounted recloser or second stage ring main unit may be able to support part of a feeder that is lightly loaded.

### 9.1.1.2 System Neutral Earthing

The method of system earthing will also determine the likelihood of an island developing. With effective (solid) system earthing, in the event of a feeder earth fault, the source protection would normally cause the feeder to trip. At this point the feeder is then isolated from the system neutral. Any generation connected to the network could continue to run and supply load. The generator has no HV neutral earth so it will not supply any zero sequence current and line to line voltages will stay at normal levels.
Two of the phases will now be at line potential to earth and the remaining phase will be at earth potential. No earth fault current will be flowing so the only way to detect this situation is with NVD protection.

When the system is earthed via an arc suppression coil (ASC), the coil will balance out the capacitive charging currents on the two healthy phases, no earth fault current will flow and the network will continue to operate in this condition until the fault is found, a second fault occurs or the network is switched out and tested. Due to the lack of earth fault current, no protection trips will occur on the feeder breaker therefore, the generator can continue to operate and will remain in synchronism with the network and no island is established.

NVD can be used with ASC earthed systems. However, under earth fault conditions, the neutral is displaced for the whole primary 11kV network so it shall not be used to trip generation. However, it can be used to provide an alarm that the network is running displaced. This is rarely used but has been provided in the past as an indication to customers who have extensive 11kV networks. In this case it is not specifically associated with generation.

If a site is equipped with a short time rated ASC (i.e. the coil is shorted to earth after a short period of time), then this is effectively the same situation as a solidly earthed system. However if NVD is required, it shall be set with a sufficient time delay to allow for the shorting of the ASC followed by the tripping time of the circuit breaker in order to avoid spurious trips.

9.1.1.3 Generator Size/Site Export

The larger a generator is the greater its inertia and the better the ability to supply an islanded network. For generators smaller than 200KVA it is not considered viable that they would be able to sustain an HV network for any period of time, without fluctuations in frequency, therefore no NVD is required below this limit. Export levels are normally consistent with the size of generation; however it may be possible to get, for example, a large embedded CHP generator that doesn’t export from the site. Under these conditions it would be possible to use reverse power relays to detect export from the site rather than NVD. For sites with export greater than 5MVA, NVD would normally be fitted as a matter of course.

9.1.1.4 Generation Type

The studies undertaken by others suggest that asynchronous and DFIG generation operating in isolation is unlikely to support an islanded network, due to the need to provide reactive power to the network. At the moment the effects of interaction between asynchronous and synchronous machines has not been studied. Going forward many of the new technologies are becoming capable of fault ride through, reactive power and frequency support. For the time being it is proposed that asynchronous machines >200kVA are treated in the same way essentially as synchronous machines but only have NVD fitted where the additional costs are marginal.

9.1.1.5 Generator Control Mode

The method of control used by a generator will also have a significant effect on the ability to sustain an island. Generation running in voltage control mode has the ability to supply a network with reactive power and thus help to keep it stable and therefore NVD protection is required for fault detection. A generator operating with unity power factor control would find it almost impossible to sustain an islanded network due to the lack of reactive power required to maintain voltage. A source of reactive power such as a capacitive compensator or long length of cable might allow a PQ generator to achieve a power balance.
9.1.1.6 Existing Generation within an Island

Where existing generation already equipped with NVD forms part of a potential island network this may provide a de-stabilising influence. If a number of small generators collectively are able to support an island but one of them subsequently trips on NVD protection this could result in a step change sufficient to operate loss of mains protection on the remaining generators.

9.1.1.7 Loss of Mains Protection

In order to mitigate against not installing NVD protection the existing loss of mains protection could be enhanced by the use of independent detection techniques. There is also more emphasis on regular testing of G59 protection schemes by customers.

9.1.1.8 Retrofit Sites

Where a site is undergoing an upgrade or increase in capacity in general the same approach shall apply as for a new scheme. The difference being, however, that the additional costs of fitting NVD are less likely to be marginal so NVD is less likely to be fitted to these schemes. To avoid the requirement to fit NVD it is more likely that a retrofit scheme would be run in PQ mode. If it is necessary to run a retrofit scheme in PV mode then NVD will have to be fitted for synchronous machines and with an assessment of mitigation and costs for asynchronous machines.

9.1.2 EHV NVD Protection

For 33kV connected generation it is expected that NVD will be provided as part of the standard interface protection. The majority of 33kV networks have interconnection via primary 11kV busbars. Tripping of the 33kV feeder CB will result in a 33kV unearthed system for a short period of time until the corresponding 11kV transformer CB’s trips. If inter-tripping is installed this will be for a minimal period. However without this where dependency is on primary NVD protection operates, this could take up to 10 seconds before the parallel is broken.

As the 132kV system is multiply earthed, the fitting of NVD is not required as the generation will provide current into the fault.

For all voltage systems, where there is any doubt or concern at the ability of NVD or G59 protection to satisfactorily detect the island condition, the provision of inter-tripping between the generator and the grid or primary source shall be considered. This shall be configured to cater for tripping of the feeder source circuit breaker, and for the dead bar condition that may arise through the operation of all transformer inomers at the UK Power Networks source site or the islanding of the busbar to which the generator is connected. Where it is necessary to utilise a rented pilot link then advice shall be sought from UK Power Networks Asset Management as to the appropriate solution.

The settings applied to NVD protection shall be such that it operates within the reclose dead time of any upstream reclosing plant (source circuit breaker or pole-mounted recloser).

Therefore, a time delay of 5 seconds is recommended with a voltage setting of 3kV for systems less than 20kV and 7kV for 33kV systems.
10 Island Operation

10.1 Overview

An island network is any part of the UK Power Networks distribution system that may continue to be supplied by distributed generation if the connection to the public electricity supply is lost or disconnected by the operation of switchgear.

The operation of island networks that have not been specifically designed for that purpose may cause danger to the public or employees and may also result in damage to the privately owned generation plant or distribution network.

Island networks should be assumed to be out of phase with distribution network, possibly unearthed and/or faulty and shall be disconnected from generation to ensure safe operation of the distribution network.

10.2 Synchronous Generator Island Mode Assessment

The ability of synchronous generators to support an island network shall be assessed before formal connection offers are made to customers who wish to connect parallel-distributed generation to the UK Power Networks system, and all necessary precautions to prevent Island operation shall be included in the offer.

Points to be considered for assessment:

- The risk of island occurrence within a limited local network, e.g. following transient or erroneous operation of the feeder circuit breaker and leaving an unloaded or lightly loaded section of network supplied by one or more distributed generators.
- The largest possible island and the risk of occurrence, e.g. feeders and busbars at a grid substation possibly supported by multiple generators connected to the same or different feeders with common busbar connections, following the loss of infeed from the Grid incomers.
- Consider whether the generator, or aggregate generators, where more than one is connected, would be able to provide the required current, voltage, and reactive VAs to enable any part of the UK Power Networks system to be supported following switchgear operation.
- Consider what precautions are required including those to prevent danger when automatic re-closing/DAR schemes operate or where SCADA or local operations for planned or fault switching are carried out.

All available information about the proposed generating plant and distributed generators connected to the existing network shall be considered to ensure that adequate protection against island operation is installed.
This rate of change of frequency (ROCOF) can be determined using the following formula:

\[
ROCOF = \frac{\Delta L}{2 \times H \times S_g \times f}
\]

Key:
- \( \Delta L \) = Load block step change
- \( H \) = Generator Intertia constant
- \( S_g \) = Generation capacity
- \( f \) = Frequency

Or for the Load step change requirement for the rate of change of frequency protection to operate the formula can be transposed as follows:

\[
\Delta L = \frac{ROCOF \times 2 \times H \times S_g}{f}
\]

Example:
The UK Power Networks standard for the ROCOF setting is 1Hz per second and a customer wishes to connect a generator of 5MVA with an inertia constant of four. This shall be assessed as follows:

\[
\Delta L = \frac{ROCOF \times 2 \times H \times S_g}{f}
\]

\[
\Delta L = \frac{1 \times 2 \times 4 \times 5 \times 10^6}{50}
\]

\[
\Delta L = 800kVA
\]

Therefore the G59 loss of mains ROCOF protection will need to see a step change of 800kVA (16%) in order for the protection to remove the generator from the network in an islanded situation.

If the normal network arrangement determines that the generator will not see this step change then additional control measures shall be provided and shall be included in the connection offer.
10.3 Non-Synchronous Generator Island Mode Assessment

With the rapid changing capabilities of non-synchronous generation the customer who owns this technology or the equipment supplier is best placed to complete this assessment.

It is the responsibility of the generator owner to incorporate the most appropriate technique or combination of techniques to detect a loss of mains event. This shall be based on the knowledge of the generating unit, site and network load conditions.

UK Power Networks will provide information on the section of network to be studied to the generator owner and UK Power Networks shall review the study once complete. The study should include scenarios as described in Section 10.3 to cover all practical operating conditions of a potential island event.

If the generator owner identifies local loss of mains protection is not sufficient to identify an island event and requires inter-tripping from the primary or grid site then this shall be designed in co-ordination with UK Power Networks and the generator owner as per Section 10.4 of this document.

If UK Power Networks is not satisfied the generator will disconnect for an islanded scenario then additional anti-islanding protection shall be applied as per Section 10.4 of this document.

10.4 Distributed Generation Anti-Island Operation – Additional Control Measures Required

10.4.1 General

It is necessary to provide loss of mains protection to prevent damage to generating plant and the distribution system in the event of out of synchronism closure following an interruption of supply on the DNO network, where a generator continues to run and support an island network.

Where protection schemes which rely upon delayed auto-reclose are employed, additional precautions may be required to ensure that island operation of generation plant is prevented or otherwise terminated. In some circumstances, there may be a requirement to terminate generation activities for some time until normal and stable network conditions are returned.

10.4.2 Direct Inter-tripping

Point-to-point (hard wired) inter-tripping shall be installed for 132kV connections to cater for the normal operation of protection systems that would be designed to trip end-to-end. In most cases it should also be possible to use the inter-trip channel to prevent possible island operation of distributed generation to trip the Generators metering circuit breaker only.

Hard-wired inter-tripping, using direct copper, fibre pilot cables or tele-protection circuits, shall be installed where the inter-tripping function is required to operate as part of a protection scheme in order to remove faulty equipment from the system in the shortest possible time.

Some functions that require operational control operating at lower speeds, such as generator inhibit or anti-island schemes may employ alternative channels for communications and could in some situations use SCADA satellite or radio channels where no hard-wired channels are available. Operational inter-tripping schemes shall be designed to be fail safe in the event of sustained communications failure.
10.4.3 Generation Inhibit Scheme

10.4.3.1 Overview

Where network modelling indicates that the connection of generation presents a risk to thermal or fault level constraints in abnormal running arrangements the customer shall provide a means of reducing or removing the generation contribution when required.

This is referred to as a ‘customer generation inhibit’ or ‘operational tripping’ scheme.

10.4.3.2 Design

The generation inhibit scheme shall be achieved by means of a communication link between the UK Power Networks substation and the customer’s generator circuit breaker at their substation. If tripping the metering circuit breaker does not cause loss of supply to the customer normal load equipment then it is acceptable to trip the metering circuit breaker

During abnormal network running the generator inhibit shall be initiated either by an auto-switching scheme or manually by UK Power Networks’ Network Control via SCADA.

The following SCADA controls and indications shall be provided:

- Generator inhibit request.
- Generator control system or customer circuit-breaker status.

A local control and status facility shall also be provided in the customer substation.

The generation scheme or customer circuit-breaker shall not be restored to normal until the inhibit signal is removed and normal running conditions are resumed.

The generator inhibit scheme shall be arranged to ensure that failure of the communications link will allow local operation. During communications failure conditions operation or inhibit of generation shall be arranged by verbal communication between UK Power Networks Network Control and the customer.
10.4.3.3 Generator Inhibit Installation

Overview

An example of a typical generation inhibit scheme is shown in Figure 10-1. Contact the UK Power Networks designer or project manager for further details.

Figure 10-1 - Customer Generation Inhibit Functional Block Diagram

10.4.4 Provision

UK Power Networks shall provide:

- A wall box powered from a battery-backed 230V ac mains supply.
- Two sets of volt-free contacts are provided to operate the trip. The contacts close to initiate a trip, unless otherwise specified.
- Five return indication inputs with one +12V common. Volt-free contacts shall be provided to switch the 12V common to the indication inputs selected. The two required indications are that the network circuit breaker is open and that the generation is running.
- Two terminals are provided for a BT pair to communicate with the UK Power Networks SCADA RTU at a grid or primary substation.
The customer shall:

- Install the inter-trip wall box provided by UK Power Networks in a suitable location for the customer generation system.
- Provide a single-phase 230V AC mains supply.
- Provide volt free contacts for sending indications back to UK Power Networks.
- Accepting a trip signal in the form of two sets of volt free contacts provided by UK Power Networks.
- Provide a leased communications line with a minimum 9.6k baud data rate between the customer and the UK Power Networks substation. The line shall have a two-wire line termination unit at each end.

10.4.5 Loss of Mains Protection

10.4.5.1 Medium and Large Power Stations

Medium (50 to 99MW) and large (100 MW and above) power stations shall rely upon inter-tripping with the UK Power Networks system to provide loss of mains protection, as opposed to G59 ROCOF or vector shift protection which is not permitted by ENA ER G59 for loss of mains protection for power stations of 50MW and above. If a simple inter-tripping scheme can be installed, in most situations this would in any case be the best solution to protect against island operation.

10.4.5.2 Small Power Stations

Small (below 50MW) power stations may employ G59 protection fitted to the customer’s equipment that will provide loss of mains protection, using ROCOF. G59 under/over frequency or under/overvoltage may also detect loss of mains. However, the ability of these systems to detect loss of mains has reliability issues.

Small power stations in relation to the point of connection to the distribution network, shall be assessed by UK Power Networks as per Section 10.2 and Section 10.3 of this document.

Where there is a realistic possibility that a small generating station could sustain, or contribute to aggregate distributed generation to sustain an island network, Operational inter-tripping shall be installed to disconnect the generator from the network in the event of a failure of the incoming supply.

ROCOF settings shall be applied in accordance with the requirements of the ENA ER G59 current version.
11 Customer Emergency Trip

11.1 Overview

A remote trip facility shall be provided in accordance with Regulation 12 of the Electricity at Work Regulations (Appendix D) to enable the customer to open the UK Power Networks’ circuit breaker in the event of an emergency unless the customer positively opts out. Notification of this opt out shall be received in writing and included within the project file and archived in accordance with UK Power Networks procedures.

An emergency trip installation is the customer’s responsibility and shall be at the customer's cost.

11.2 Design

The emergency trip shall be provided as follows:

- Where the UK Power Networks switchgear has a time limit fuse (TLF) or self-powered protection relay, the customer’s DC supply shall be used to energise the circuit-breaker trip coil and the emergency trip relay as shown Figure 11-1.
- Where UK Power Networks switchgear has a tripping battery, the emergency trip button shall energise the emergency trip relay, which will operate the circuit-breaker trip coil as shown in Figure 11-2.

![Figure 11-1 – Emergency Trip Schematic – TLF or Self-powered Relay](image-url)
11.3 Provision

The customer shall supply and install:

- A 30V DC supply from a battery and charger or 110V DC supply from a capacitor trip unit; the supply shall a maximum voltage of 110V and a maximum current of 10A to prevent damage to the switchgear trip coil.
- An emergency trip button.
- A suitable multicore cable (maximum length 30 metres) from the emergency trip button to UK Power Networks switchgear.

Note: The 110V output from the metering unit voltage transformer shall not be used to power the emergency trip function as required by this standard as only UK Power Networks or the appointed meter contactor has access to it.

Refer to EAS 05-000 for further details of each specific item.

UK Power Networks (or suitably authorised ICP staff) shall:

- Terminate the customer emergency trip multicore cable into the UK Power Networks circuit-breaker.
- Supply and install an approved emergency trip relay to match the customer's battery or capacitor trip unit voltage.

11.4 Maintenance

Inspection and maintenance of the emergency trip facility should be conducted in line with all LV equipment in secondary substation schedule as detailed in EMS 10-0002 and summarised below:

- Minor inspection carried out during routine site inspection.
- Major inspection carried out every 2 years.
- Maintenance carried out within 18 years.

A trip test is carried out on request of the customer or every 2 years with a major inspection if no provision for inspection has been made by the customer.
12 Parallel System Interlock

12.1 Overview

Where multiple HV supplies are provided to a customer, the customer shall provide a means to prevent the formation of a parallel between the supplies, unless specifically authorised to make parallels by UK Power Networks. Where electrical segregation of supplies is not feasible, a system interlock shall be used.

IDNOs may agree a suitable documented operation procedure with UK Power Networks in lieu of a system interlock; refer to NOP 10 015 for further information.

Refer to EDS 08-3100 for approved examples and requirements of parallel HV supplies.

12.2 Design

The system interlock design shall incorporate an open point on the interconnecting paths between each supply. These open points may be relocated on the network:

- To allow the customer to achieve the optimum load balance.
- To prevent loss of supply through fault or planned outage.

The system interlock shall:

- Ensure that a new open point is formed before the closure of an existing open point.
- Incorporate all pre-determined open points within the customer network.

The system interlocking arrangements may be achieved by utilising electrical and/or mechanical interlocking systems that are best suited to the particular application. Figure 12-1 shows a typical system interlocking arrangement.

12.3 Provision

The customer shall provide a system interlocking scheme that incorporates the following criteria:

- A loss of AC or DC supply shall not result in the system interlock being rendered ineffective.
- Blocking coils fitted to switchgear closing mechanisms shall be energised to prevent a circuit breaker that forms a normal open point from being closed.
- Push button overrides fitted to electrical interlocking systems shall not be permitted in the design.
- Electrical interlocking systems shall have hard-wired functionality and shall not be reliant upon software based controllers.
Figure 12-1 - Typical System Interlock across Two Intake Positions
13  Customer interface Commissioning

Emergency trip button testing shall occur prior to energisation of the customer supply.

Interlock design requirements shall be incorporated into the overall customer supply and shall be demonstrated to UK Power Networks as sufficient, prior to energisation of the customer supply.

Generator inhibit function shall be demonstrated to UK Power Networks prior to energisation of the customer supply.

Demonstrations shall take place during the final commissioning stage.

A failure to meet the requirements may result in refusal to make the connection live until the identified remedial actions necessary to achieve this have been satisfactorily completed.

Successful demonstration and details of the emergency trip, interlock scheme and generator inhibit shall be recorded in the site responsibility schedule.
14 References

14.1 UK Power Networks Standards

- EAS 03-0000: Approved Equipment List - Switchgear
- EAS 05-0000: Approved Equipment List - Protection Relays
- EAS 13-0000: Approved Equipment List – LV Plant and Metering
- ETS 05-0300: Specification for Battery and Charger for Grid, Primary and EHV Customers Substations
- ETS 05-0301: Black Start Controller for Grid and Primary Substation Battery Charger Systems (internal document)
- EDS 05-0001: 132kV Grid and Primary System Protection and Control Schemes
- EDS 05-9008: Protection and Control Cubicles Specification
- EDS 07-0020: Civil Requirements for New Customer Supplies and Generator Connections
- EDS 07-0105: Grid and Primary Civil Design Standard
- EDS 07-3101: Secondary Substation Pre-design Requirements
- EDS 07-3102: Secondary Substation Civil Designs
- EDS 08-1112: Provision of LVAC Supplies to Distributed Generation Sites
- EDS 08-0113: Guidance for the Application of ENA Engineering Recommendation G88 and G81 Inset Networks (IDNOs and other Licensed DNOs)
- EDS 08-1152: Introduction of New Technology and Equipment
- EDS 08-0150: London 33kV Distribution Network Design
- EDS 08-3000: HV Network Design
- EDS 08-3100: HV Customer Demand and Generation Supplies
- EDS 08-4000: EHV Network Design
- EDS 08-4100: EHV Customer Demand and Generation Supplies
- EMS 10-0002: Inspection and Maintenance Frequency Schedule
- NOP 10 015: HV Site Responsibility Schedules (Internal Only)

14.2 National and International Standards

- ENA ER G59: Recommendations for the Connection of Generating Plant to the Distribution Systems of Licenced Distribution Network Operators
- ENA TS 48-4: D.C. Relays Associated with a Tripping Functions in Protection Systems
- ENA TS 48-5: Environmental Test Requirements for Protection and Control Equipment
- ENA TS 50-18: Application of Ancillary Electrical Equipment
- IEC 60870-105-3

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## Dependent Documents

The documents below are dependent on the content of this document and may be affected by any changes.

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<td>HV Network Design</td>
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Appendix A – 11kV Protection Functional Block Diagrams

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<th>Description</th>
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<td>EDS 05-0002-101</td>
<td>Generic block diagram 11kV Single Circuit HV Customer/Generation ring main unit</td>
</tr>
<tr>
<td>EDS 05-0002-102</td>
<td>Generic block diagram 11kV single circuit HV customer/Generation</td>
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Appendix B – 33kV Protection Functional Block Diagrams

<table>
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<tr>
<th>Drawing Number</th>
<th>Description</th>
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<tr>
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<td>Single Circuit 33kV Tee/Direct Feeder</td>
</tr>
<tr>
<td>EDS 05-0002-202</td>
<td>Loop connection – 33kV Unit Protected</td>
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<td>EDS 05-0002-203</td>
<td>Single Circuit 33kV Tee/Direct Feeder Unit Protected</td>
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<td>EDS 05-0002-204</td>
<td>33kV Loop Distance Protection</td>
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Appendix C – 132kV Generic Protection Schemes

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<th>Description</th>
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<td>132kV Customer's Supply – Symbols &amp; Index</td>
</tr>
<tr>
<td>EDS 05-0002-302</td>
<td>132kV Customer’s Point of Supply – AIS, with Auto Disconnector at Point of Connection</td>
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<tr>
<td>EDS 05-0002-303</td>
<td>132kV Customer’s Point of Supply – AIS, with CB at Point of Connection</td>
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<tr>
<td>EDS 05-0002-304</td>
<td>132kV Customer's Point of Supply – GIS, ABB PASS Unit, with Auto Disconnector at Point of Connection</td>
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<tr>
<td>EDS 05-0002-305</td>
<td>132kV Customer's Point of Supply – GIS, ABB PASS Unit, with CB at Point of Connection</td>
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<td>EDS 05-0002-306</td>
<td>132kV Customer's Point of Supply – Auto Disconnector &amp; CB, without additional switchgear at the Point of Connection</td>
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<tr>
<td>EDS 05-0002-307</td>
<td>132kV Customer’s Supply – AIS, Point of Connection with Auto Disconnector</td>
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<td>EDS 05-0002-308</td>
<td>132kV Customer’s Supply – AIS, Point of Connection with CB</td>
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<td>132kV Customer’s Supply – GIS Point of Connection with ABB PASS Unit</td>
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<td>EDS 05-0002-310</td>
<td>132kV Customer's Supply – AIS Points of Connection with in-line Loop Disconnectors</td>
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<td>EDS 05-0002-311</td>
<td>132kV Customer's Supply – AIS Points of Connection with in-line Loop CB</td>
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Appendix D – Quote from the Electricity at Work Act

Regulation 12 of the Electricity at Work Act states:

**Means for cutting off the supply and for isolation**

12.—(1) Subject to paragraph (3), where necessary to prevent danger, suitable means (including, where appropriate, methods of identifying circuits) shall be available for—

(a) cutting off the supply of electrical energy to any electrical equipment; and .

(b) the isolation of any electrical equipment .

(2) In paragraph (1), “isolation” means the disconnection and separation of the electrical equipment from every source of electrical energy in such a way that this disconnection and separation is secure.

(3) Paragraph (1) shall not apply to electrical equipment which is itself a source of electrical energy but, in such a case as is necessary, precautions shall be taken to prevent, so far as is reasonably practicable, danger.