1. SCOPE

This document specifies the Company requirements in respect of the technical and other requirements for the connection of new distributed generation to the SP Distribution and SP Manweb distribution networks.

It has been written to consolidate and harmonise existing practices and to incorporate recently withdrawn and issued ENA documents. Specifically, G98 and G99 have been issued, and G59 and G83 have been withdrawn.

This document is intended for the guidance of staff and agents of ScottishPower for the purposes of network design.

For further clarification on any issues contained within this document, contact the Network Design Group.

2. ISSUE RECORD

This is a Controlled document. The current version is held on the EN Document Library.

It is your responsibility to ensure you work to the current version.

Issue Date	Issue No.	Author	Amendment Details
February 2018	3	EA Technology & Keith Evans	General updates in line with other policies and national documents. Rationalise tables in section 16 to improve usability.
February 2021	4	M. Lyon	Introduction of G98 and G99 to replace G83 and G59 respectively. Diagram and table updates.

3. ISSUE AUTHORITY

Author	Owner	Issue Authority
Mark Lyon Lead Design Engineer	Steve Withell Distribution Network Manager (SPM)	Jim McOmish Head of Distribution Network pp............................. Date: .....03/02/2021................

4. REVIEW

This is a Controlled document and shall be reviewed as dictated by business / legislative change, but at a period of no greater than five years from the last issue date.

5. DISTRIBUTION

This document is part of the SP Distribution and SP Manweb Design Virtual Manuals and does not have a maintained distribution list. The reference numbers for the index documents are as follows:

SP Distribution	DOC-00-206
SP Manweb	DOC-00-310

CONTENTS

6. DEFINITIONS

The following definitions refer specifically to this policy document. For other, more general, definitions, please refer to ESDD-01-004 “Definitions”.

Term	**Description**
Company	SP Distribution (SPD) / SP Manweb (SPM)
Connection Point	Is the point where connection is provided from the **Company**’s final cut-out fuse, isolator, switch, metering switch fuse or metering circuit breaker. Unless otherwise stated the **Connection Point**(s) are the outgoing terminals of the **Company**’s final cut-out fuse, isolator, switch, metering switch fuse or metering circuit breaker.
Connection and Use of System Code (CUSC)	The Connection and Use of System Code (CUSC) constitutes the contractual framework for connection to, and use of, the GB high voltage transmission system.
Customer	The developer or owner of the distributed generation installation as the context so requires.
DNO	Distribution Network Operator
Embedded	Having a direct electrical connection to a Distribution System.
Generating Unit	Any apparatus that produces electricity. This includes **Micro-Generators** and Electricity Storage devices. Note that although Electricity Storage is in the scope of EREC G99, some aspects do not apply. The exclusions are noted where they apply in the text.
Micro-Generator	A source of electrical energy and all associated interface equipment able to be connected to an electric circuit in a Low Voltage electrical installation and designed to operate in parallel with a public Low Voltage Distribution Network with nominal currents up to and including 16 A per phase.

Network Voltage Levels: (ELV, LV, HV, EHV)

Term	Abbreviation	Phase – Phase Voltage
Extra Low Voltage	**ELV**	<50V
Low Voltage	**LV**	≥50V to <1kV
High Voltage	**HV**	≥1kV to <20kV
Extra High Voltage	**EHV**	≥20kV

Table 1: Definition of Voltages

SP Distribution and SP Manweb do not operate networks at Extra Low Voltage.
Low Voltage network are supplied via 11,000/433V three phase or 11,000/250V single phase transformers. Low Voltage supplies are provided with a nominal voltage of 400V three phase (phase to phase) or 230V single phase (phase to neutral).

Term	Description
	High Voltage networks are those operating with a nominal voltage of 6kV, 6.3kV, 6.6kV or 11kV (ph-ph). Extra High Voltage includes single phase 25kV traction supplies and three phase networks operating with a 22kV, 33kV or 132kV line voltage. These networks are also referred to as the primary networks. Since **EHV** is ambiguous it is a non-preferred term and reference to the nominal voltage shall be made, for example the 33kV network. 33kV is the highest distribution voltage in SP Distribution and 132kV is highest distribution voltage in SP Manweb.
Power Generating Facility	A facility that converts primary energy into electrical energy and which consists of one or more **Power Generating Module**s connected to a Network at one or more Connection Points.
Power Generating Module	Any apparatus which produces electricity.
Power Park Module (PPM)	A **Generating Unit** or ensemble of **Generating Unit**s (including Electricity Storage devices) generating electricity, which is either asynchronously connected to the network or connected through power electronics, and that may be connected through a transformer and that also has a single Connection Point to a Distribution Network.
Power Station	An installation comprising of one or more **Power Generating Module**s.
Type A	A **Power Generating Module** with a Connection Point below 110 kV and a Registered Capacity of 0.8 kW or greater but less than 1 MW.
Type B	A **Power Generating Module** with a Connection Point below 110 kV and Registered Capacity of 1 MW or greater but less than 10 MW.
Type C	A **Power Generating Module** with a Connection Point below 110 kV and a Registered Capacity of 10 MW or greater but less than 50 MW.
Type D	A **Power Generating Module** with a Connection Point at or greater than 110 kV, and/or with a Registered Capacity of 50 MW or greater.
Registered Capacity (P_{max})	**Module**, or of a **Power Generating Facility**, as declared by the **Generator** less the MW consumed when producing the same. This will relate to the maximum level of **Active Power** deliverable to the **DNO**'s **Distribution Network**. For **Power Generating Module**'s connected to the **DNO**'s **Distribution Network** via an **Inverter**, the **Inverter** rating is deemed to be the **Power Generating Module**'s rating.

7. REFERENCES

This document makes reference to the following documents:

7.1 Statutory Legislation

The Electricity Safety, Quality and Continuity Regulations 2002 (ESQCR).

The Electricity at Work Regulations 1989.

7.2 Industry Codes

The Grid Code

The Distribution Code

Metering Codes of Practice

7.3 Electricity Networks Association (ENA) documents

7.3.1 Relevant ENA Engineering Recommendations (ER/ EREC)

ER G5	Planning Levels for Harmonic Voltage Distortion & the Connection of Non-Linear Equipment to Transmission Systems & Distribution Networks in the United Kingdom.
ER G74	Procedure to Meet the Requirements on IEC909 for the Calculation of Short-Circuit Currents in Three-Phase AC Power Systems.
ER P2	Security of Supply.
ER P28	Planning Limits for Voltage Fluctuations Caused by Industrial, Commercial and Domestic Equipment in the United Kingdom.
ER P29	Planning Limits for Voltage Unbalance in the United Kingdom.
ER S34	A Guide for Assessing the Rise of Earth Potential as Substation Sites.
G12	Requirements for the Application of Protective Multiple Earthing to Low Voltage Networks
EREC G98	Requirements for the connection of Fully Type Tested Micro-generators (up to and including 16 A per phase) in parallel with public Low Voltage Distribution Networks on or after 27 April 2019.
EREC G99	Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019.
EREC G100	Technical Guidance for Customer Export Limiting Schemes

7.3.2 ENA Engineering Technical Reports (ETR)

ETR 124	Guidelines for actively managing power flows associated with the connection of a single distributed generation plant.
ETR 126	Guidelines for actively managing voltage levels associated with the connection of a single distributed generation plant.

7.3.3 ENA Distribution Generation Connection Guides

G98 Guidance:

1. 'A Guide to Connecting Domestic-Scale Type Tested Generation to the Distribution Network (Typically by Householders) in a Single Premise that Falls Under G98'
2. 'A Quick Reference Guide for Connecting Domestic Scale Type Tested Generation to the Distribution Network (Typically by Householders) in a Single Premise that Falls Under G98'
3. 'A Guide to Connecting Multiple Domestic-Scale Type Tested Generation to the Distribution Network (Typically by Developers, Landlords or Community Groups) in Multiple Premises that Falls Under G98'
4. 'A Quick Reference Guide to Connecting Multiple Domestic-Scale Type Tested Generation to the Distribution Network (Typically by Developers, Landlords or Community Groups) in Multiple Premises that Falls Under G98'

G99 Guidance:

5. 'A Guide to Connecting **Type A Power Generating Module**s that fall Under G99 to the Distribution Network (Typically by Developers, Industry, Commercial or Farms)'.
6. 'A Quick Reference Guide to Connecting **Type A Power Generating Module**s that fall Under G99 to the Distribution Network (Typically by Developers, Industry, Commercial or Farms)'.
7. 'A Guide to Connecting **Type B – D Power Generating Module**s that fall Under G99 to the Distribution Network (Typically by Developers, Industry, Commercial or Farms)'.
8. 'A Quick Reference Guide to Connecting **Type B – D Power Generating Module**s that fall Under G99 to the Distribution Network (Typically by Developers, Industry, Commercial or Farms)'.

7.3.4 Company Documents

PROT-01-012	11kV Protection and Control Application policy.
PROT-01-006	33kV Protection and Control Application policy
PROT-01-107	132kV Protection and Control Application Policy (IPAC)
PROT-03-019	Primary & Secondary Substations Protection and Control Equipment
PROT-03-020	Technical Specification for 33kV Protection and Control Equipment
PROT-03-033	Independence Requirements for Tele-protection Services

Distributed Generation Information Statement (DGIS)	An internet micro-site to provide users with appropriate guidance and information for the connection of **Embedded** generation to the SPM or SPD system. The site address is as follows: http://www.sppowersystems.co.uk/pages/dgis_contact_us.asp
EART-01-002	Low Voltage Earthing Policy and Application Guide
EART-03-003	Technical Specification for Earthing and Bonding at Secondary Substations
EART-03-004	Technical specification for earthing and bonding at primary substations
Statement of Methodology & Charges for Connection to SP Distribution Ltd and SP Manweb Plc's Electricity Distribution Systems	The Connection Charging Statement provides the basis of charges for the provision of a connection whilst the Connection Charging Methodology describes the methodology under which Customers will be charged for a connection to the SPD and SPM Distribution Systems
ESDD-01-001	Design Philosophy and Principles
ESDD-01-006	Standard Low Voltage Connection Arrangements
ESDD-01-008	Technical requirements for Customer Export Limiting Schemes
ESDD-02-004	Standard High Voltage Connection Arrangements
ESDD-02-007	Equipment Ratings
ESDD-02-011	Application of Overhead Line Switchgear and Protection Systems
ESDD-02-012	Framework for Design & Planning of LV Housing Developments, including U/G Networks and Associated HV/LV S/S
TRAN-05-009	An Assessment of the Capability of Distribution Tap Change Equipment to Carry Reverse Power Produced by Embedded Generation

8. INTRODUCTION

This document presents Company policy regarding the connection of distributed generation.

The term "distributed generation" includes "**Embedded** generation" and generally refers to generation plant connected to a distribution network.

All distributed generation installations and the associated connections to The **Company**'s network shall comply with the requirements of the ESQCR, the Distribution Code, the Grid Code, the appropriate Engineering Recommendations and Engineering Technical Reports, and the specific requirements of this document.

All distributed generator connections above 16A per phase require an appropriate Connection Agreement and Site Responsibility Schedule (connections at 11kV and above).

8.1 Industry Guidance

Guidance to the industry on the connection of the full spectrum of **Embedded** generation is provided by two ENA documents:

- Small scale, type tested generators are covered in EREC G98
- All other generation is addressed in EREC G99.

Further guidance on the application of export limiting schemes which may be used in conjunction with **Embedded** generators is provided within ENA document – To take effect on or after 27 April 2019.
A high-level summary of the documents is provided in the following sections:

8.1.1 EREC G98

This Engineering Recommendation provides guidance on the technical requirements for the connection of Type Tested, Micro-Generators in parallel with the public low voltage distribution networks. For the purposes of this document, Micro-Generator devices are those which provide a source of electrical energy rated up to (and including) 16 amperes per phase, single or multi-phase, 230/400V AC. This corresponds to 3.68kW on a single-phase supply and 11.04kW on a three-phase supply (based on a system nominal voltage of 230V).

8.1.2 EREC G99

This Engineering Recommendation provides guidance on the technical requirements for the connection of a Power Generating Facility (PGF) to the distribution systems of licensed DNOs. For the purposes of this document, a PGF is any source of electrical energy, irrespective of the prime mover and generator unit type and applies to any PGF which is not within the scope of EREC G98 or is not compliant with EREC G98 requirements.

8.1.3 EREC G100

This Engineering Recommendation provides guidance on the connection of Customer Export Limiting Schemes (ELS) that operate in parallel with the distribution systems of licensed DNOs. The guidance given is designed to facilitate the connection of ELS whilst maintaining the integrity of the Distribution System, both in terms of safety and supply quality. Whilst referred to in this policy, guidance in relation to the application of Export Limiting Schemes is given in ESDD-01-008.

9. CONNECTION REQUIREMENTS OVERVIEW

9.1 Overview

The decision flow diagram in Figure 1 gives a summary of the key factors which determine the appropriate requirements when connecting a distributed generator.

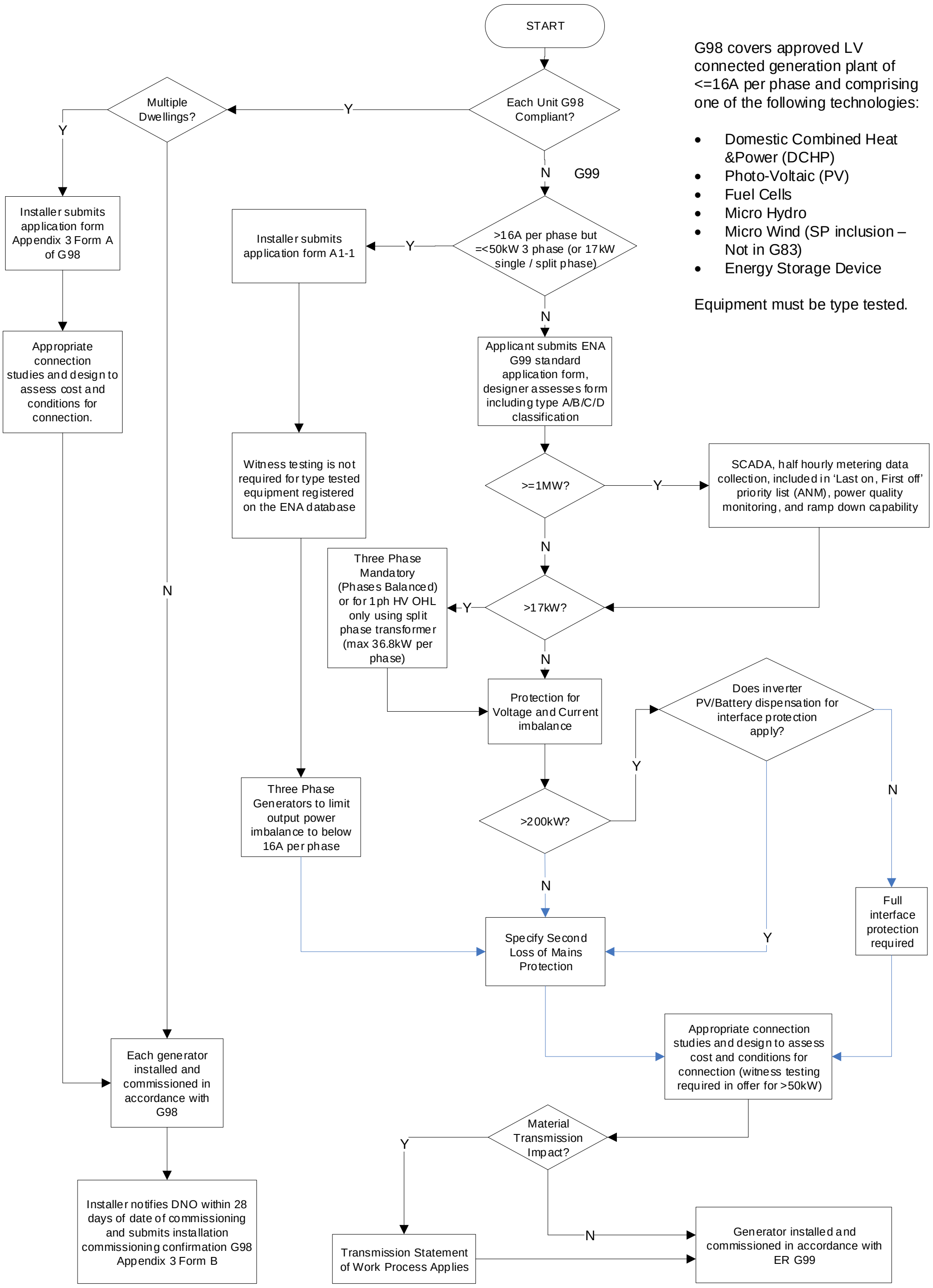


Figure 1: Generator Connection Decision Flowchart

9.2 EREC G98/G99 Connections

Connections at **LV** are connected according to either EREC G98 or EREC G99.

Generation above 17kW **shall** be connected three phase with load balanced across the three phases.

Where 'split phase' transformers are installed on single phase 11kV networks and they are in excess of 500m away from the nearest three phase main line it is permissible to connect single phase generation of up to 34kVA (2 x 17kVA) in accordance with the guidance notes detailed in Appendix B at the end of this document.

9.2.1 EREC G98 Connections

The principles of connection for single small-scale (up to 16A per phase, 3.68kW single phase or 11.04kW three phase, based on a system nominal voltage of 230V) distributed generation connections are covered by EREC G98. Type test certification to G98 requires no Company protection witness-testing requirements.

G98 compliant generation should also be one of the following technologies:

- Domestic Combined Heat and Power (CHP)
- Photo-Voltaic (PV)
- Fuel Cells
- Hydro
- Wind
- Energy Storage Device

The installer needs to notify the DNO and provide the information defined in the Installation Document in G98 Appendix 3 within 28 days of each **Generating Unit** that is installed and commissioned.

The location of all G98 connections shall be recorded on The **Company**'s GIS system at property level.

9.2.1.1 Stage 1 – Single Installation

No changes to network design are envisaged at present to permit single G98 connections. This will be subject to future review dependent on the penetration of distributed generation as will be the impact of generation "clusters" that appear.

From an operational diagram / PowerOn perspective, there is no requirement for labels to indicate the presence of G98 distributed generation as it accepted that distributed generation may be present on any part of the network. However, the location of all G98 connections shall be recorded on The **Company**'s GIS systems.

Refer to the following ENA documents, 'A Guide to Connecting Domestic-Scale Type Tested Generation to the Distribution Network (Typically by Householders) in a Single Premise that Falls Under G83 or G98'.

9.2.1.2 Stage 2 – Multiple Installations

Multiple G98 generators (e.g. Housing Estate) need consent from the DNO before they can connect.

It is expected that the developer discusses their plans with the DNO and then submits Form A contained within G98 Appendix 3.

Refer to the following ENA documents, 'A Guide to Connecting Multiple Domestic-Scale Type Tested Generation to the Distribution Network (Typically by Developers, Landlords or Community Groups) in Multiple Premises that Falls Under G98'.

9.2.2 EREC G99 connections

Export Capacity at the metered Connection Point shall be defined as follows for the purposes of establishing when SCADA and full interface protection is required:

> For inverter connected generation, the export capacity will be determined by the rating of the inverter(s), not the generating units. For non-inverter connected generation the aggregate capacity of the generator units shall be used. In either case, if a G100 compliant export limiting device is installed, the limited export capacity shall be used.

Distributed generation connections above 16A per phase are covered by EREC G99, along with generation plant which is less than 16A per phase but not fully type tested in compliance with G98.

The application arrangement requirements for G99 generators are:

- Total aggregate capacity ≤50kW 3-phase or 17kW single phase
    - Complete G99 Form A1-1
- Total aggregate capacity >50kW 3-phase or 17kW single phase
    - Complete ENA Connection of Power Generating Modules to DNO Distribution Networks in accordance with EREC G99.

The protection arrangement requirements for G99 generators are:

- ≤200kW dual Loss of Mains (LOM) protection ①
- >200kW full interface protection ②

① The dual loss of mains protection will be by differing manufacturer and/or technology to first LOM. Most modern relays already have this functionality built in and it is frequently only a matter of enabling the function and therefore there is a negligible cost penalty for the **Customer**.

② Full interface protection includes Overcurrent Earth Fault (OCEF) Supplemented by Neutral voltage displacement (NVD) protection. Larger **LV** connected generators can be accommodated with the actual connection at **LV** but the interface protection being established at **HV**. Using this mechanism, the requirement for interface protection does not mandate the metered connection to be at **HV**. In addition, as described in Section 9.2.2.1 below, subject to certain conditions a dispensation to the requirement for interface protection equipment at **HV** is allowed. This is only allowed for PV/Battery inverter connected generation with aggregate generation capacity over 200kW but less than 1MW.

The location of all G99 connections shall be recorded on the **Company**'s GIS systems and **HV** diagram (PowerOn) at the substation point of connection.

9.2.2.1 Dispensation for the need of Full Interface Protection

A dispensation to the requirement for NVD protection (requiring **HV** equipment) is allowed when a PV or Battery installation, having an aggregate Power Generating Facility in excess of 200kW but less than 1MW, is split into multiple separate strings with individual protection elements where:

- The PV/Battery is arranged as multiple strings of 50kW or less; and
- Each PV/Battery string is controlled by a type approved inverter; and
- Each PV/Battery string is protected by either
    - A type-approved inverter with dual loss of mains protection; or

- A type-approved inverter with single loss of mains protection with a separate, second[1] loss of mains protection device covering all the strings at the head of the array

Figure 2 and Figure 3 show the required components for the multiple PV/Battery array dispensation.

This dispensation applies only to PV and Battery installations. New connections and addition of generation to existing demand connections shall be treated in the same way. However, where new connections are being discussed, the opportunity should be taken to ensure the **Customer** understands that full interface protection will be required if any other type of generation is installed at a later date. This may require a different connection arrangement at further cost.

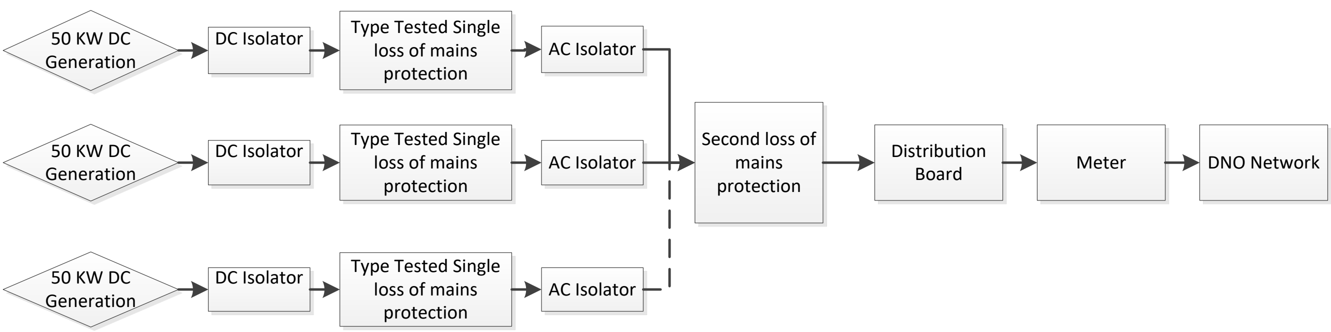


Figure 2 >50kW but <1000kW PV/Battery installations using inverters with single loss of mains protection

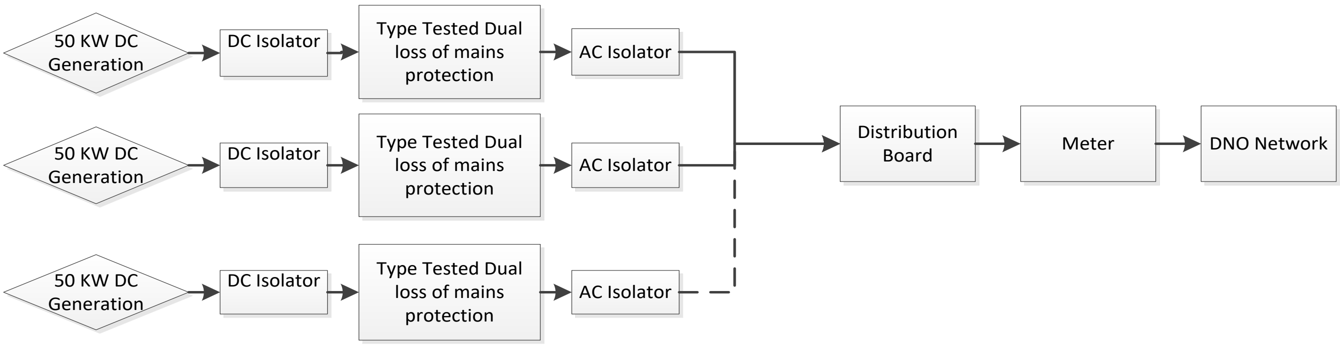


Figure 3 >50kW but <1000kW PV/Battery installations using inverters with dual loss of mains protection

9.2.2.2 Witness Testing

For all inverter connected generation ≤50kW (Type Approved and Registered on ENA Database) there is no requirement for Witness Testing. If there are single strings >50kW or not Type Approved & registered on the ENA Database, witness testing will still be required.

For inverter connected generation (PV and/or battery only) connections consisting of multiple strings each ≤50kW which are fully type approved, and where the total Power Generating Facility Registered Capacity is >50kW, a witness testing charge shall be included in the offer. This is to cover checks on site to confirm that the installation has been constructed as per the approved single line diagram.

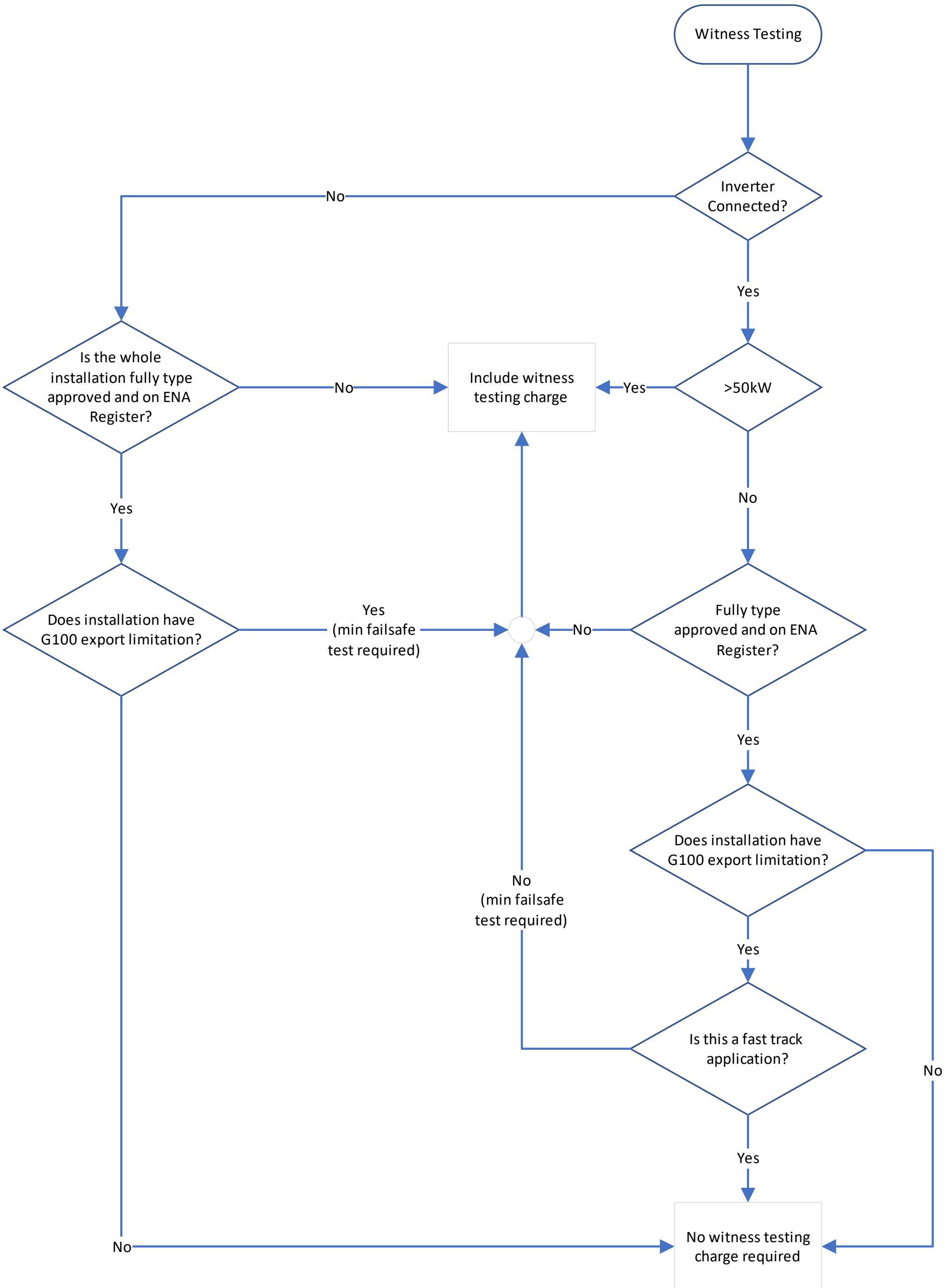
All non-inverter connections under G99, unless the whole installation has been type approved and registered on the ENA Database will require a witness testing charge to be included in the offer. As a

[1] Second LOM shall be separate, independent of and of different manufacture and/or technology to first LOM. If this cannot be achieved, then NVD protection or intertripping must be installed.

minimum this will cover checks on site to confirm that the installation has been constructed as per the approved single line diagram.

The witnessing in any situation however still remains at the discretion of the DNO and may be required in certain circumstances.

The following flow chart summarises where a witness testing charge should be applied in a connection offer.



9.2.2.3 Connection Agreement Requirements

A connection agreement is required for all G99 generation with one exception. See section on LV Generation Export Limiting Schemes (ELS) for further details.

9.2.2.4 IDNO Connections

The Competition in Connection Code of practice and EREC G88 requires that IDNOs notify the DNO of foreseeable load and generation capacity of the site that is to be supplied. Where a suitably accredited IDNO (or ICP) wishes to self-select a Point of Connection, it is expected that information regarding the standard means that the DNO designers would use to assess the impact of generation is shared with the IDNO or ICP.

Where IDNO connection applications include an **Embedded** generation component or retrospectively notify the connection (e.g. G98 generators), the location of all connections with associated generation shall be recorded on the **Company**'s GIS systems.

G99 or Multiple G98 generation connections to an IDNO network need consent from the DNO before they can connect. Where these connections require reinforcement of the DNO network, charges will apply with appropriate sharing of costs with the IDNO where applicable, in accordance with the charging methodology.

Single G98 connections to IDNO networks are required to be notified to the DNO by the IDNO following connection. Where, over time, single G98 connections on an IDNO network lead to a requirement to reinforce the DNO network, no individual charges apply and the cost is borne by all connected customers in use of system charges.

9.2.2.5 Changes to the Power Generating Facility or Power Generating Module

Modification to existing sites, including those installed and commissioned prior to the introduction of the G99 regulations , shall be notified to the DNO. Refer to the regulations set out in G99 section 20.3 and Annex A.6 for further information and examples.

Any increase in PGF ≥1MW shall require the installation of SCADA and telemetry in line with G99 requirements and any other requirements as specified by SPEN, even if the installation was originally commissioned without SCADA in place.

9.2.3 Generation Export Limiting Schemes (ELS)

When considering requirements for reinforcement because of a generation connection request, any generation export limiting deployed by the **Customer** shall be considered to ensure it:

- Reliably limits the export at the connection point to the Agreed Export Capacity
- Limits the effect of the combined scheme, which has the potential to cause disturbance to other customers connected to the same network, to comply within the power quality standards defined in ENA ER G5, P28 and P29.

The above conditions will be met by compliance with the ENA EREC G100 (Technical Guidance for Customer Export Limiting Scheme). Further policy guidance on accepting Customer Export Limiting Schemes onto the network is given in ESDD-01-008 Technical requirements for Customer Export Limiting Schemes.

Customers wishing to employ Export Limiting Schemes will be required to submit the information required in Appendix A (Enquiry – Export Limitation Scheme) of ESDD-01-008 with their enquiry. These are required in addition to G98 or G99 application paperwork. Furthermore, the commissioning sheet in Appendix B of ESDD-01-008 will be required to be completed.

Fail safe tests are not required at installations where all of the **Generating Units**[2] are Type Tested, inverter connected Micro-Generators, with a **Power Station** Capacity of not more than 7.36kW per phase (i.e. 32A per phase at 230V) and an Export Capacity of not more than 3.68kW per phase (i.e. 16A per phase at 230V), hence no witness testing is required (fast track process).
For fast tracked inverter connected **Power Station's** with a capacity ≤3.68kW there is also no requirement for a Connection Agreement. All other inverter connected generation >3.68kW does require a Connection Agreement.

For all non fast tracked export limited generation connected with a **Power Station** capacity greater than 7.36kW, or with a single **Generating Unit** capacity greater than 3.68kW will require as a minimum a failsafe test, hence witness testing will be applied and a Connection Agreement also required.

Appendix C illustrates the Fast Track and ELS Requirements.

As long as the installation is ≤3.68kW and the total single phase does/will not exceed 7.36kW and connection is within 200m of the source transformer then no network modelling or assessment is required (based on the minimum OHL conductor size of 50mm^2 Al ABC or UG 95mm^2 Al or equivalent).

Where the total **Power Generating Facility** or **Power Park Module** capacity >999kW but the total export at the Connection Point is limited by an Export Limiting Device or an inverter to 999kW or less, then no SCADA is required.

9.3 High Voltage (HV) & Extra High Voltage (EHV) Connections

Connections at **HV** and **EHV** are connected according to EREC G99.

All generation which is >= 1MW shall:

- be included in the **EHV** network models.
- be included in the Active Network Management (ANM) processes aimed at maximising network capacity for generation and load customers, where ANM is applied.
- be subject to a 'ramp-down' signal from SCADA.
- have half hourly metering data (MW/MVAr import and MW/MVAr export) collected and returned via SCADA.
- have Power Quality Monitoring.

Given the volatility and evolving nature of the network and connected generation, the assessment of trapped load may have little value as it only considers the possible conditions and configurations at the time of assessment. Future changes in system demand or generation may place customer connections at risk, give rise to risks to the system or require retrospective installation of interface protection. Therefore, interface protection (generally in the form of NVD protection) should be fitted for export >200kW at the connection point, except for generators fulfilling the dispensation set out within 9.2.2.1.

Where an existing **HV** customer is connecting generation to their network, the same principle applies but the most economic method of achieving the installation of the NVD protection (and associated VT requirements) should be identified.

Where customer **HV** connections are derived from a system switchboard and retro-fitting interface protection is impractical, replacement of the entire switchboard may be indicated. If the switchgear is not a prioritised project for refurbishment or replacement which can be advanced, alternative options should be considered, e.g.

- Establishment of separate customer interface switchgear arrangements (between existing metering circuit breaker and customer's installation) – this would render the existing metering

[2] Definition of Generation Units in EREC G100 includes Electrical Energy Storage Units

circuit breakers normal system equipment with the metering arrangements being located at the satellite switchgear along with interface protection arrangements.

- Replacement of the switchboards with appropriate sharing of costs with the **Customer** in accordance with the charging methodology.

10. DESIGN PRINCIPLES

Design studies appropriate to the connection voltage level shall be carried out to determine the suitability of the network and the proposed generation connection arrangement. These studies should consider limitations due to:

- Fault Levels, and the effects of generator fault current contribution (ER G74).
- Security of Supply to existing customers (ER P2).
- Voltage Fluctuations and unbalance (ER P28, P29).
- Voltage Rise (ESQCR).
- Harmonics (ER G5).
- Substation Rise of Earth Potential (ER S34).
- Protection Requirements (Refer to Section 12).
- Transformer tap changer reverse power restrictions.
- Thermal power flow limits of power system assets.

The design studies should indicate if there is a requirement to constrain or disconnect the generator during system outages. Automatic active network management guidance is provided in ETR 124 (power flows) and ETR 126 (voltage).

The connection design shall take account of any limitations and any constraints identified in the design study. As far as possible, the design shall utilise standard plant, apparatus and equipment. This may impose other restrictions (such as the capability of switchgear to make/break cable charging current).

The **Company** is responsible for providing a connection arrangement that can meet the Distribution Code and does not impact on existing customer's security of supply, provided the **Customer** complies with their obligations. When designing a new connection, it shall not compromise existing **Customer**'s network security or create an increase in **Customer** interruptions during outages or for network fault conditions.

Utilising existing and 'in use' **Company** assets to connect new **Customer** in a manner which depletes the existing system**'**s connection arrangement and operational flexibility shall not be allowed unless it can be clearly demonstrated that any such change does not introduce operational complexities, protection co-ordination issues and reduced quality of supply and supply security of the group.

System analysis shall be undertaken to ensure that the application of the generator(s) does not prevent the **Company** meeting its obligation to ensure voltages at all customer connection points remain within ESQCR limits during both normal and abnormal network running. Guidance on tolerable voltage rise from generation connections is given in ESDD-02-008. If system analysis indicates excessive voltage at any customer connection point, the **Company** will determine the appropriate technical and commercial connection design to maintain the voltage within acceptable limits. The studies should be undertaken at a range of power factors to determine if it is necessary to limit the generator's power factor via the Connection Agreement.

Where generation will connect to an **HV** single phase circuit, the voltage imbalance attributable specifically to the proposed new connection should be considered to ensure compliance with the limits specified within Engineering Recommendation P29.

Standard switchgear types and arrangements are given in Appendix A. For connection designs, the lowest cost, technically acceptable solution shall be used.

For proposals to install G98 compliant installations in multiple properties, the design assessment shall identify if any network reinforcement is required. Connection of G98 generation should be deferred until the reinforcement works are completed.

The **Company** undertake certain studies prior to issuing a connection offer and others prior to energisation of the connection.
Table 2 illustrates the studies required in addition to standard Fault Level, Thermal Capacity and Security of Supply.

Table 2: Typical System Studies

Voltage	**Scenario**	**Assessment**			
		Voltage Rise / Fluctuation /Unbalance /Apparatus Rating Check	**Rise of Earth Potential**	**Harmonics**	**Compliance Report By Customer**
LV	Single G98 Generator	✗	✗	✗	✗
	Multiple G98 Generators	✓	✗	✗	✗
	Multiple non-invertor G98 Generators	✓	✗	✗	✗
	Other	✓	✗	✗	✗
HV and Above	≤5MW	✓	☑	☑①	✗
	>5MW	✓	☑	☑①	☑

Key: ✗=No Requirement ✓=Prior to Connection Offer ☑=Prior to Energisation

Note ① - Background measurements should be taken at the earliest opportunity after acceptance of a Connection Offer to provide a baseline for future comparison following commissioning.

Larger generators will have Connection Offer conditions which will require remedial action by the developer if their installation on energisation has a detrimental impact on the system or other customers e.g. rise of earth potential or harmonic pollution. The terms of the contract will normally prohibit generation/operation until remedial action is agreed and implemented.

The **Company**'s standard earthing arrangements are as follows:

Table 3: Neutral Earthing Arrangements

Voltage	Earthing Arrangement
132kV	Solid earthing, single point at multiple locations
33kV	Resistance earthed, single point at multiple locations
11kV	Solid earthing, single point at multiple locations (with the exception of networks sourced from 132/11kV GSPs)
LV	Solid earthing. All new networks using Protective Multiple Earthing (PME)

All earthing shall be in accordance with the principles described in Engineering Recommendation G99.

If the **Customer** is intending to operate the generation independently of the **Company**'s network, the installation shall include an earthing system that does not rely on the **Company**'s earthing terminal. Note that where the **Customer** needs to earth a structure on the outside of their property (e.g. outside the equi-potential zone such as metal work supporting a PV array) it is not permitted to utilise The **Company**'s earthing terminal where the supply is **LV** PME (TN-C-S).

More detailed guidance for the design of connections, selection of the appropriate connection arrangement, technical operation and protection for / from generation **Embedded** within the distribution networks is provided in Section 15.

11. PROTECTION

11.1 Overview

The Customer must implement protection equipment required by the Electricity at Work Regulations or ESQCR to protect their network against faults therein. It must be ensured that protection grading and clearance times associated with the latter comply with the **Company**'s policies and will not give rise to unacceptable disturbances on the **Company**'s network if a fault occurs on the **Customer**'s network.

The **Customer** is responsible for providing protection equipment in accordance with EREC G98 or G99 as appropriate, arranged to trip their relevant circuit breaker in order to protect their installation, the **Company**'s network and other connected customers.

The Customer's generator control and protection equipment shall wherever practicable be housed separately from Company equipment. In circumstances where this is not possible, the equipment may be housed in the same building but shall be segregated with separate access/egress arrangements that prevent access to Company equipment

Interface protection (generally in the form of NVD protection) should be fitted for export >200kW at the connection point, except for generators fulfilling the dispensation set out within 9.2.2.1.

Additional protection such as operational intertripping schemes may be required to be applied dependent upon the risk of island networks being inadvertently created. The requirements for intertripping are summarised in Figure 4 below:

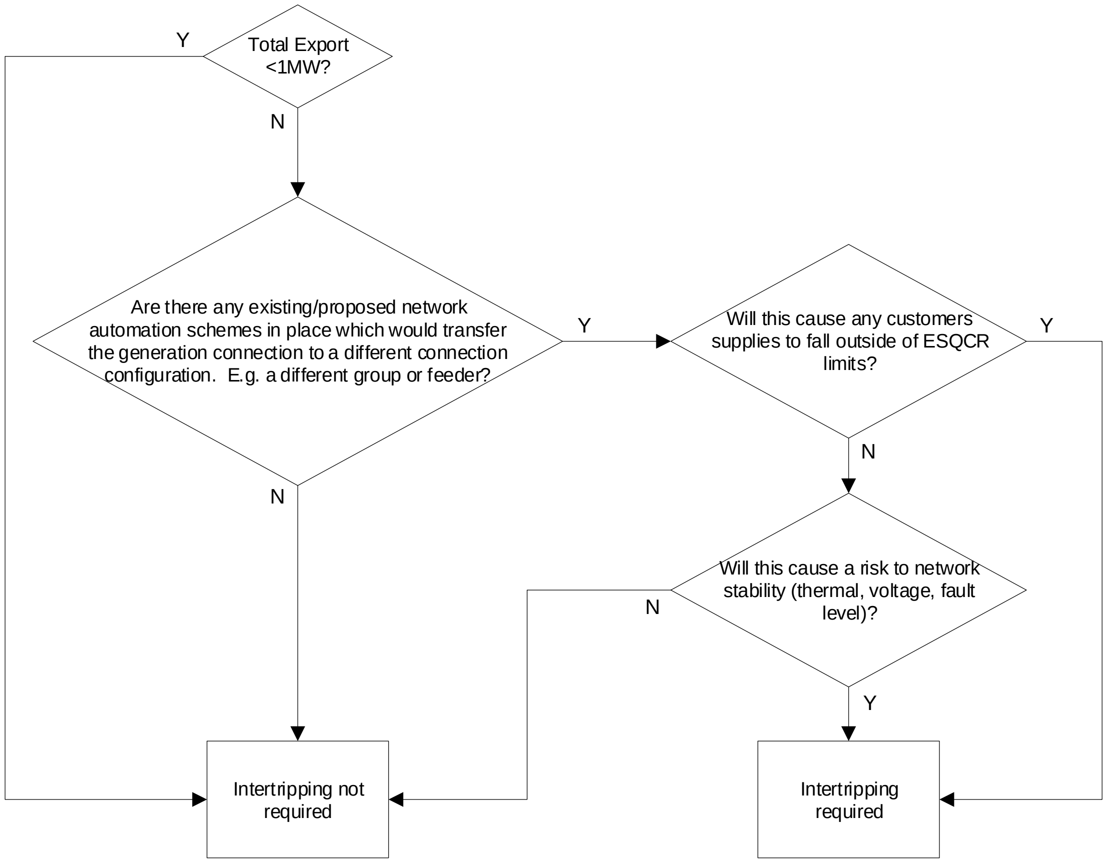


Figure 4: Operational Intertripping Requirements

Before the protection configuration is ascertained[3], consideration must be given to:

- The type of generation being connected.
- Existing or planned clusters of mixed generation being connected into the same network, possibly with a variety of asynchronous and synchronous equipment.
- Auto reclose and intertripping methods that may already exist on the network (for example Fault Throwers).
- Net export of primary substations, grid substations, or grid supply points exceeding the existing directional protections.
- The necessary addition of Voltage Controlled Directional Overcurrent or additional and/or diverse intertripping.

[3] Any schemes that require "hardware" changes (extra devices / changes to panel wiring) or relay logic configurations shall be approved by SPEN Engineering Standards as part of the detailed design process.

Further guidance on the **Company** protection requirements can be found in the following documents[4]:

HV

PROT-01-012	11kV Protection and Control Application Policy.
PROT-03-019	Primary & Secondary Substations Protection and Control Equipment

33kV

PROT-01-006	33kV Protection and Control Application Policy.
PROT-03-020	33kV Protection & Control Equipment.

132kV

PROT-01-107	132kV Protection and Control Application Policy (IPAC).

11.2 Requirement for Customer Series Circuit Breaker

The **Company** will provide connections at **HV** and above via Company-owned circuit breakers. The purposes of such circuit breakers are to[5]:

- Ensure safety by providing a means of disconnection for faults on the **Company** distribution network [6] and ensure that the fault is not fed by the generation (where not cleared by the **Customer**'s protection).
- Provide a means of disconnection during normal operation or for a fault or over current situation on the connection (where not cleared by the **Customer**'s protection).
- Provide facility for metering (where required).

The **Customer** will therefore normally provide their own circuit breaker to provide the following main benefits:

- Provide the ability to energise / de-energise / synchronise their network (**i.e.** the **Company's circuit breaker shall not be used for the purposes of synchronising**).
- Provide a point of isolation and earthing for the **Customer** to work on the **Customer**'s network.
- Provide a means of disconnection for operation of the **Customer**'s main protection (including the G99 protection functions of under/over voltage, under/over frequency and loss of mains).
- Provide back-up protection for faults on the **LV** side of the **Customer**'s transformers.

In cases where a Customer has a very short **EHV** or **HV** network (for example a single adjacent cable or transformer within 100m on land owned by the **Customer** or the **Company**) it may not be practicable for them to install their own means of isolation, and they may agree to rely on the **Company** to provide isolation. The **Customer** will not be allowed to close the **Company** circuit breaker or to use this circuit breaker for generator synchronising. The **Customer** must seek The **Company**'s agreement to this arrangement at the earliest opportunity. The **Customer** must be made aware and formally accept that attendance on site to operate the circuit breaker in a post fault condition may not be a priority for Scottish Power Energy Networks and other system events may take precedence.

[4] If a scheme requires a modification to a bay type or additional functions to be incorporated it may require a special order on current framework contracts which will increase costs. Costs associated with any such works shall be identified where reasonably practicable or estimated before a formal offer is issued.

[5] The GB Distribution Code DPC4.4.4 - c, the Company's protection system applied by Company metered circuit breaker(s) is limited to that needed to meet statutory requirements in respect of the Company's Distribution System.

[6] Regulation 6 of the ESQCR requires the Company to apply protective devices in order to prevent, so far as is reasonably practicable, current from flowing in any part of the distribution network for such a period that that part of the network can no longer carry that current without danger.

11.3 Reverse Power

Where the penetration of generation increases to a point where the local demand is matched and exceeded by the generation output, the excess will flow in the reverse direction through the connecting transformers. On an interconnected network with transformer groups, this may result in reverse power being experienced through one or more of the transformers in the group. Due to the integrated nature and operational principles for voltage control of the SP Manweb EHV and HV networks, significant reverse power through EHV(grid) & HV(primary) transformers can prove problematic.

Three transformer specific factors affect the ability of the network to facilitate the connection of **Embedded** generation, if that generation results in transformers experiencing reverse power flows under credible scenarios such as maximum generation and minimum demand:

- Tap changer capability.
- Transformer Reverse Power Protection.
- Transformer Automatic Voltage Control (AVC) Systems.

These aspects are considered in the following sections.

11.3.1 Tap Changer Capability

From a primary apparatus perspective, the tap changer must have reverse power capability. Some tap changer types have full reverse power capability, some have partial capability and some have no reverse power capability at all. The Transformer Reverse Power Capability document (TRAN-05-009) provides some guidance on types, locations and capabilities. In the absence of definitive information, a zero-reverse power capability should be assumed.

11.3.2 Transformer Reverse Power Protection

Typically, the only relevant protection schemes which may be impacted by reverse power scenarios are 11kV 3-phase Directional Overcurrent and SPM 132/33kV transformer DOC. These protections have historically been set at 50% of the transformer rating but may be increased subject to system studies. A review of the applied setting should be undertaken to confirm that the reverse power flow will not cause unwanted operation.

Where transformer reverse power is now deemed necessary and notwithstanding the AVC issues in the following sections, the system protection schemes should be reviewed to ensure safe and reliable operation. This may require removal or disabling of existing reverse power schemes[7] and replacing protection schemes. Where this work is triggered by an identifiable generator or generation connection application, the connection should be contingent on the works and the generator subject to the apportioned remedial costs in accordance with the charging methodology.

11.3.3 Automatic Voltage Control (AVC)

The performance of an AVC system is dependent on the magnitude and power factor of the transformer load. The presence of generation will affect the loading of the transformer and will therefore alter the performance of the AVC systems accordingly.

11.3.3.1 Radial Networks

For single transformer sites, the impact of reverse power is unlikely to have a significant effect on the AVC and is considered acceptable up to the maximum reverse power capability of the transformer.

[7] Removal or depletion of reverse power protection **shall** require the establishment of a second intertrip with 'diverse' communications or a SPEN 'Approved' alternative protection solution as a replacement. A diverse communication scheme is defined in PROT-03-033.

Where two transformers occupy the same site and have an underlying radial network, then a circulating current scheme can be implemented between the two transformers. Operation in this manner generally requires both transformer AVC schemes to be directly coupled together and therefore, if this is not pre-existing, the generation connection may be contingent on retrofitting such a system or a full AVC change may be required.

11.3.3.2 Interconnected HV Networks

The connection of generation which triggers transformer reverse power greater than 500kVA on any of the transformers in the group is not permitted.

11.4 IDNO Interface

The interface between all DNO and IDNO networks should be designed to be identical to a similar wholly owned and operated DNO network. Therefore, provided that the interface between individual customers and the IDNO network are compliant, no additional protection requirements are required at the DNO/IDNO interface, i.e.

- **LV** connected G99 generators are connected in accordance with section 9.2.2.
- **HV** (and above) connected G99 generators are connected in accordance with section 9.3

11.5 Loss of Mains Protection

11.5.1 Below 30MW (SPD) and 50MW (SPM)

Reference should be made to EREC G99 for guidance on protection requirements.

Loss of Mains Protection is installed, operated and maintained by the **Customer** and is designed to disconnect the generator from the SP Network under fault conditions. It is not intended to maintain statutory voltages but detect islanding conditions or serious network abnormalities. It should be noted that G99 requires that all protection equipment is capable of operating in the environment in which it is placed. The appropriate standards are:

BS EN 61000	Electromagnetic Standards
BS EN 60255	Electrical Relays
BS EN 61810	Electromechanical Elementary Relays
BS EN 60947	Low Voltage switchgear and control gear
BS EN 60044	Instrument Transformers

There is always a risk that low voltage connected generators may back-energise the high voltage network under fault conditions. As detailed in Section 9.2.2, all **LV** connected G99 generation shall have (at least) dual loss of mains protection to mitigate the risk of maintaining supply to a section of the network which contains standing demand.

11.5.1.1 Trapped Load Assessment

Trapped load 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.

Due to the penetration of **Embedded** generation of differing technologies and the dynamic nature of demand and system configuration, trapped load assessments to determine the requirements for interface protection are no longer required. Instead, standardised protection requirements are applied as follows:

- All G99 generation (i.e. >16A per phase) shall be fitted with (at least) dual Loss of Mains protection.
- Generators over 200kW will require the addition of interface protection which will generally require the establishment of 5-limbed VTs to provide NVD protection.

Section 9.2.2 describes the means whereby **HV** protection elements can be used to support an **LV** metered connection requiring interface protection (i.e. over 200kW). The same section also describes the special conditions which need to be met in relation to dispensing with the requirement for interface protection for a PV array connected in multiple strings.

No trapped load assessment is required in the case of a multiple G98 generator connection where the generators are type-tested units which comply with the requirements of G98.

11.5.2 30MW and Above (SPD) and 50MW and Above (SPM)

Above 30MW in SPD or 50MW in SPM, intertripping is mandatory and the Grid Code requires any protection arrangement to allow the generator to ‘ride through’ local transmission system faults.

12. METERING CONTROL MONITORING AND COMMS

12.1 Settlement Metering

Customer metering shall comply with the relevant Metering Code of Practice[8] .

These documents explain the terms ‘Import/Export’ and list the allowable ‘Defined Metering Point’ for each type of connection.

It should be noted that if the output from generation is to be traded in the Settlement System, for generators larger than 30kW, it will usually require a separate metered point of connection with the distribution system. Where an existing supply is being modified to accommodate a generator (larger than 30kW) the existing Import MPAN is usually retained with a new Export MPAN issued (upon receipt of acceptance and payment). In addition to the new Import MPAN for new connections, a new Export MPAN (for generators larger than 30kW) will be issued.

Where CT or CT/VT operated metering is required, the authorised Meter Operator will own the meters and expect others to provide CTs, VTs, test blocks and metering panels in accordance with the appropriate Metering Code of Practice.

If these CTs/VTs are installed on the **Company** distribution system, the **Company** will provide the test block and metering panels. If the CT’s/VT’s are installed on the **Customer**’s installation (adjacent to the connection point such that there are no electrical losses) then the **Customer** shall provide the test block and metering panels. This helps ensure the proper management, safety and integrity of the

[8] These are issued under the Balancing and Settlement Code of the **CUSC** and available via the Elexon website

metering system. A single party (either the **Customer** or the **Company**) owns the metering panels, the CT's/VT's and the circuit breakers associated with the CT's/VT's.

12.2 Control and Monitoring

An approved disturbance recorder shall be fitted at all distributed generator connections where the generator output ≥1MW.

All new and amended **HV** connected generation ≥1MW shall have SCADA facilities. The Generator shall have the capability to 'ramp-down' at an agreed rate upon receipt of a SCADA signal from SPEN (this facility might not be immediately used by SPEN). A maximum response time for management control signals must be agreed for the Generator to adhere to when such signals are received. This is separate to the Protection Related response times. These limits shall be recorded in the Connection Agreement.

Real-time MW & MVAr measurement data shall be collected and returned via SCADA. Where the **Generator** supplies **Customer** demand (other than that demand consumed when producing the generated power) these measurements shall be separate from those made at the **Connection Point** interface. Some installations may operate multiple technology types (e.g. wind and battery). Such installations shall have separate measurements for each technology type.

An assessment must be made for the impact of **HV** and **EHV** connected generators on the network for system abnormal conditions. In addition, **HV** and **EHV** connected generators should have direct control via telecontrol or SCADA on appropriate **Company** circuit breakers (or switches such as Soule) to enable rapid remote-control disconnection under depleted system conditions.

12.3 Communication Links

Telecommunications links shall be acquired by the **Company** to suit the requirements of the SCADA installation and protection schemes installed.

Table 4: SCADA/Comms Requirements

Generator Capacity	SCADA/Comms Requirements
<1MW	No Requirement[9]
≥1MW	Tele-control functionality to be provided on: Circuit breakers, Ring Switches, PMAR's, or PMSW's Metering signals to be provided. (Via fibre optic or pilot cable. Otherwise via radio or 3rd party comms system). Telecontrol: customer metered CB open (CB close to be provided for multi-panel switchboard arrangements). Statistical metering: MW/MVAr import/export. DNO metered CB status: open/closed. Customer Gen CB status: open/closed (per technology/array)[10].

[9] Where the total Power Generating Facility or Power Park Module capacity >999kW but the total export at the Connection Point is limited by an Export Limiting Device or an inverter to 999kW or less then no SCADA is required.
[10] Applicable where a specific constraints scheme is required.

Table 4 presents a guide to the minimum SCADA/Comms requirements required for the connection of generators. Additional functionality may be required where constraints management is required or to interface with an Active Network Management Scheme (ANM).

13. DISTRIBUTION CODE AND GRID CODE COMPLIANCE

13.1 Overview

The Schedules of the Distribution Code that apply to different class of user are set-out in Annex 1 of the Distribution Code. The **Customer** should consult this to confirm the application, connection and operational technical requirements. For example, Schedule 5a is applicable to every **Power Station**, whilst Schedule 5b is applicable to all **Embedded Power Generating Module**s. The Schedules set out the extra information required to meet Grid Code requirements.

It should be noted that the Annex 1 of the Distribution Code references several ENA documents that form part of the Distribution Code, including G99.

The Distribution Code and Grid Code classify **Power Stations** as Small, Medium and Large depending on its Registered Capacity. These classifications are different in SP Distribution and SP Manweb, as shown in Table 5.

Table 5: Power Station Size Classifications

Classification	Registered Capacity	
	SP Manweb	SP Distribution
Small **Power Station**	<50MW	<30MW
Medium **Power Station**	50 to 100MW	-
Large **Power Station**	≥100MW	≥30MW

Note that the Registered Capacity is measured at the 'User System Entry Point' i.e. the maximum export capability. Refer to Grid Code definition for further details.

13.2 Small Power Stations

All small **Power Station**s need to comply with the Distribution Code. The Grid Code compliance is not normally relevant.

13.3 Medium Power Stations

All Medium **Power Station**s (only applicable for connections to the England & Wales network) need to comply with the Distribution Code and relevant sections of the Grid Code.

Power Stations within this category can elect not to hold a Generator Licence. Such installations are known as Licence Exempt **Embedded** Medium **Power Station**s (LEEMPS) and this generally means that there are no direct contractual arrangements between the **Customer** and National Grid. SP Manweb (Medium **Power Station**s are not applicable in the SPD franchise area) must ensure compliance with the relevant Grid Code technical performance requirements and this is usually achieved ensuring the **Customer** provides relevant information to National Grid so they can check Grid Code compliance. The **Company** would need to ensure Distribution Code compliance.

13.4 Large Power Stations

All Large **Power Station**s need to comply with the Distribution Code and relevant sections of the Grid Code.

The **CUSC** requires a Large **Power Station** to sign a Bilateral Agreement with National Grid, which binds the **Customer** to the requirements of the Grid Code. Under these circumstances the Grid Code compliance process is driven by National Grid. The **Company** would still need to ensure Distribution Code compliance.

13.5 Grid Code Compliance Process

13.5.1 Introduction

Where the **Company** receives a generation Connection Application which may materially affect the National Grid Transmission System it is a Grid Code requirement for the **Company** to formally advise National Grid.

The **Company** will deem the generator connection to be 'material' if it is 'Medium' or 'Large' as defined in the Distribution Code, or if it causes the potential for reverse power at a Grid Supply Point. National Grid may specify site-specific technical requirements for such generation.

In order to assess whether a generator connection will result in a reversal of power at a Grid Supply Point and thereby be deemed to have a 'material' impact on the transmission system, the site-specific conditions for the generation should be considered by studying the system with the measured minimum Grid Supply Point demand with the maximum anticipated generation.

13.5.2 Request for a Statement of Works

For such generators **The Company** (when necessary) is required to submit a Statement of Works request or Modification Application to National Grid.

An application would normally be submitted upon receipt of a formal acceptance of an offer for connection for such a generator (However a customer could request that it is submitted earlier).

National Grid charges a fee for these applications and they shall always be recovered from the **Customer** <u>before</u> any application is submitted. National Grid has 20 working days (from when the application is deemed 'Competent') in which to provide the Statement of Works which will indicate if the new connection triggers any works on the GB Transmission Network. For a Modification Application National Grid has three months (from when the Application is deemed 'Competent') in which to provide a formal offer to SPM which will indicate the extent and indicative cost of works on the GB Transmission Network.
In some circumstances, depending upon the restrictions or known issues at the GSP providing supplies to the group into which a generator wants to connect, a Project Progression application may be required rather than a Statement of Works.

13.5.3 Confirmation of Project Progression

The Statement of Works is valid for 3 months. If the **Customer** has accepted the Connection Offer and wishes to proceed, a "Confirmation of Project Progression" has to be sent to National Grid, which initiates the formal Modification Application (Modification Application) process. National Grid also charge for this application, which is in addition to the Statement of Works fee. The Modification Application will formalise the necessary amendments to the Bilateral Agreement between National Grid and **The Company** for the particular Grid Supply Point, including any site-specific technical requirements.

13.5.4 Site-Specific Technical Requirements

The Grid Code enables National Grid to impose certain technical requirements on generators in the technical schedules contained within their "Statement of Works" or "Modification Offer". This covers issues such as:

- Voltage Control (steady state and transient).
- Reactive Power Capability.
- Fault Ride Through.
- Frequency Response.
- Operational Metering.

These aspects are described in more detail within the Grid Code.

13.5.5 Grid Code Technical Compliance Report

Compliance with the Grid Code is ensured via the Grid Code Compliance Report. This contains the design information, including modelling results, for the Generator. This is compiled by the **Customer** during the design phase using a pro-forma available from the **Company**. The compliance report is submitted to the **Company**, who forwards it on to National Grid for comment. This needs to be done at least three months before energisation. Following energisation, the theoretical design studies are supplemented by on-site measurements to verify the original design studies. The results of these studies are forwarded on to National Grid in order to finalise the compliance report and complete the formal connection process.

13.5.6 Interim Operational Notification (ION)

The Interim Operational Notification is issued by the **Company** to the **Customer** prior to initial energisation once the design has been established to be Grid Code compliant (via the compliance report). The ION may impose some temporary operational restrictions on the Generator, pending the issuing of the Final Operational Notification.

The Connection Agreement should be signed and the connection can be energised to enable the commissioning of the generator turbines.

13.5.7 Final Operational Notification (FON)

The Final Operational Notification can be issued after the successful commissioning of all the turbines and the submission and acceptance of the on-site Grid Code compliance measurements to National Grid.

13.5.8 Notification of Completion of Works

National Grid should be sent a Notification of Completion of Works, including any outstanding data submissions prior to the issue of the FON.

14. TESTING AND COMMISSIONING

Table 6 presents a summary of the testing and commissioning requirements for various types of generation installations.

The objective of witness testing is to allow the **Customer** to demonstrate appropriate settings have been applied, that the relevant control actions are initiated, each protection element operates and the relevant circuit breakers are tripped in accordance with the control and protection scheme design.

The results of the tests and protection settings shall be recorded and filed with the site Connection Agreement or appropriate Data Management repositories.

Table 6: Overview of Testing and Commissioning Requirements

Generator Voltage	Scenario	Requirements		
		Compliance Report by Customer (in format reflecting G99 tables)	Scheme Drawings and Settings	SPEN to Witness Customer Control and Protection Operation
LV	Single G98 Generator	✗	✗	✗
	Multiple G98 Generators	✗	✗	✗
	G99 Generators ≤50kW	✗	✓	Refer to Section 9.2.2.2
	G99 Generators >50kW	✗	✓	✓
	Other	✗	✓	✓
HV and Above	≤5MW	✗	✓	✓
	>5MW	✓	✓	✓
	Medium and Large **Power Stations**	✓	✓	✓

Key: ✗=No Requirement ✓=Required

15. TECHNICAL ASSESSMENT FOR CONNECTION OF DISTRIBUTED GENERATION

In order to develop an economic and efficient connection for generators, the connection assessment process is subdivided into a number of sub-categories, i.e.:

Table 7: Connection Assessment Summary

Generation Type	Relevant Section
LV Connected Generation	15.1
HV Connected Generation	15.2

In the following sections, the process and technical areas which may require consideration for the subcategories in Table 7 are listed together with issues or actions to be considered during the assessment. While the lists are comprehensive, there may be additional considerations in some circumstances and therefore should be considered a generic starting point as opposed to an exhaustive and definitive list of issues.

An assessment of the required assessment for each of the above categories follows:

15.1 LV Connection

Where a generator is planned for connection to the **LV** network can be considered in three phases:

- Data acquisition – understand the generator requirements and the characteristics of the local system.
- Generator Specific Data – equipment types, operational regimes and potential impact.
- Connection Assessment – development with lowest cost solution which is in accordance with Policy and compliant with obligations. This may be an iterative process.

Assessment for individual G98 generator connections is not required. Where a multiple G98 connection is required, assessment follows a similar methodology to that for larger generators though there is no requirement for consideration of harmonics or for witness testing.

In the specific case of a Y-type bleed off in a Solkor zone, up to a total maximum of 200kW of inverter connected generation is permitted. Any non-inverter connected generation connected to the bleed off transformer may cause the Solkor protection to become unstable due to fault current contribution

Data Acquisition

Table 8: LV Generation Data Acquisition Assessment

Project Area	Assessment
Customer Status	New Customer? Existing customer? IDNO?
Standard ENA Application Form	Competent in terms of data and content, including type test compliance reference number as registered on ENA database?
Customer's proposed equipment	Approved or acceptable?
Location	Assess which circuit could feed **The Customer**, is there a preferred POC indicated by **The Customer.**
Existing network parameters	Measure the proposed circuit to enable entry to network modelling tool.
	Confirm network using GIS, internet resources etc.
	Identify network thermal capacities.
Distance of site to existing system	Estimate route length of network extension using the smallest SPEN approved conductor size appropriate for the generator capacity.
Fault Level	Establish Primary fault level from system modelling.
Establish network constraints	e.g. need to consider the fault level capability of other plant and apparatus on the network. List of overhead line equipment rating as these can be less than 250MVA.
Circuit / system minimum demand	Derive from PI/SAP – if unavailable use 10% of connected transformer capacity of u/g network and 5% of connected transformer capacity of OHL network.
Source voltage	Check voltage setting on **HV** network and off-circuit tap changer setting at **HV**/**LV** Transformer.
Generator Type	Synchronous? Fixed speed induction generator with power factor correction? Inverter connected?
Operation	Permanent parallel operation? Short term parallel operation? Standby?
Power Factor	Power factor Lead/Lag capability.

Project Area	Assessment
Import / Export	Requirement or potential for the generator installation to export to the system?
Fault Level	Assess contribution of fault level by new generator - if not advised assume 6 times generator size.
Generator Connection Arrangement	Single Phase / Three Phase / Split Phase.
Generator Connection Voltage	**LV.**
Generator Metering Voltage	**LV.**

Using the generic data obtained in using Table 8 as a background, a minimum scheme for connection should be designed taking due cognisance of the following aspects:

Table 9: Typical LV Generation Assessment

Project Area	LV Generator Assessment
System Model	Develop an accurate analytical model.
Connection arrangements	Compliant with policy or standards.
Voltage rise	Assess feeder / transformer loads and consider the impact of the generator on the voltage profile of the feeder and **LV** side of the transformer. Impact on the 11kV network should also be considered.
Thermal capacity	Assess the existing network, together with the existing system duty to identify the existing thermal capability and the available headroom.
Voltage fluctuations	Consider the implications on other customers of the generator starting up and dropping off.
Reverse power flow	Connection of generation at **LV** is likely to be limited by voltage rise considerations but the impact and capability of the system to accommodate reverse power flows through the transformer should be considered.
Harmonics	Consider whether harmonics will be an issue or problematic.
Metering, control and communications	Identify the method of metering and location of boundary. Identify the control and communication requirements.
Protection arrangements	Identify protection requirements for the system and for the interface.
Witness of Testing	Consider requirement / necessity / advisability of witnessing generator testing.
Operational limitations	Parallel operations? Thermal issues? Voltage issues?

The conclusions and recommendations arising from the above assessment should be developed and supported by the typical connection arrangements summarised in the following tables and the associated schematic arrangements provided in Appendix A.

Table 10: Connections from running mains (with Metering on Customer Premises)

Maximum connection capacity (kVA) [11]	Phases	Transformer rating (kVA)	Service cable	Cut-out rating (A)	Maximum fuse rating (A)	Appendix A arrangement
17	1	-	35mm² single phase	100	80[12]	A.1
Max available by network assessment	3	-	Min 35mm² three phase	TBC	TBC	A.1/A.2

Table 11: Pole Mounted Substation Connections (with Metering on Customer Premises)

Maximum connection capacity (kVA) [11]	Phases	Transformer rating (kVA)	Service cable	Cut-out rating (A)	Maximum fuse rating (A)	Appendix A arrangement
17	1	25 Single Phase	35mm² single phase	100	80**Error! Bookmark not defined.**	A.3
50	3	50	35mm² three phase	100	100	A.3
2x17	2 (split phase)[13]	50 (2x25)	95 mm² 3c WF	200	100	A.5
2x17	2 (split phase)[15]	100 (2x50)[14]	95 mm² 3c WF	200	160	A.5
100	3	100	95 mm² 3c WF	200	160	A.4
138	3	200	95 mm² 3c WF	200	200	A.4
200	3	200	185 mm² 3c WF	400	315[15]	A.4

Table 12: Three-Phase Ground Mounted Substation Connections

Maximum connection capacity (kVA) [11]	Transformer rating (kVA)	Service cable	Cut-out rating (A)	Fuse rating (A)	Appendix A arrangement
138	500	95 mm² 3c WF	200	200	A.4
217*	500	185 mm² 3c WF	400	315	A.4
276*	500	300 mm² 3c WF	500	400	A.4

[11] Subject to acceptable voltage profile / voltage rise and assume no changes to transformer tap changer position or regime. All power calculations are based on a nominal system voltage of 230V and unity power factor.
[12] The rating indicated is the maximum rating and assumes that a fuse size of 80A is applied in standard 100A cut-out installations. However, where otherwise indicated or required lesser rated fuses and fuse carriers may be deployed with the consequential impact on the available connection capacity.
[13] Split phase transformers only to be used for a single customer on single phase overhead lines. G99 limits to 17kVA/ph.
14 Where 100kVA transformer capacity is installed for demand purposes (in line with ESDD-01-006 Low Voltage Connection Arrangements) any connected generation shall be limited to 2 x 17kVA.
[15] Calculations to be carried out to confirm LV fuses grade correctly with HV fuses or new customer to be installed on a dedicated HV spur line.

* Generators >200kVA will require protection in line with 9.2.2

Table 13: Summary of Appropriate Connection Options from Ground Mounted Substation

Maximum Connection Capacity (kVA) [16]	Connection Type [17]	Transformer Size (kVA)	Connection Diagram Y-Type and Unit Substations	Connection Diagram X-Type Substations
≤276	Single customer circuit from metered way in customer S/S fuse board	500	A.7	A.7
>276, ≤500	2 fused ways on the LV board ganged together onto a single metered way (4 single core customer cables – 1 neutral and 3 ph)	500	A.8	A.8
>500, ≤1,000[18]	3 fused ways on the LV board ganged together onto a single metered way (7 single core customer cables – 1 neutral and 6 ph)	1,000[19]	A.9	N/A
>500, ≤1,000	2 or 3 fused ways ganged together onto a single metered way on each of the two LV boards (2 x 4 single core customer cables – 1 neutral and 3 ph or 2 x 7 single core customer cables – 1 neutral and 6 ph)	2x500	A.10 / A.11	A.10 / A.11
≤1,000	**LV** connection with interface protection at **HV**.	500 or 1,000	A.12 / A.13	A.12[20]

15.2 HV Connection

Where a generator is planned for connection to the **HV** network the process is fundamentally the same irrespective of generator size or location and can be considered as three phases:

- Data acquisition – understand the generator requirements and the characteristics of the local system
- Generator Specific Data – equipment types, operational regimes and potential impact
- Connection Assessment – development with lowest cost solution which is in accordance with Policy and compliant with obligations. This may be an iterative process.

The following tables apply to both generators operating in parallel with the distribution network with export capacity and those generators operating in parallel to the distribution network that are

[16] Subject to acceptable voltage profile / voltage rise and assume no changes to transformer tap changer position or regime.
[17] Connection capacity and type are fundamentally dependent on the type of cable utilised. As this will generally be customer provided and owned, the above is provided for approximate guidance only.
[18] This is the maximum capacity from a primary apparatus perspective. Where protection stability needs to be considered, the maximum capacity may be 500kVA.
[19] Where the transformer can be accommodated into the existing **HV** protection arrangements without a detrimental impact on the existing protection scheme.
[20] Limited to situations where the bleed off limit is not exceeded in the unit protected zone.

Embedded within **HV** connected customer's sites where the generation capacity is less than the site minimum demand (and therefore do not export).

Data Acquisition

Table 14: HV Generator Data Acquisition Assessment

Project Area	HV Generator Assessment
System Model	Develop an accurate analytic model.
Customer Status	New Customer? Existing customer? IDNO?
Standard ENA Application Form	Competent in terms of data and content, including type test compliance reference number as registered on ENA database?
Customer's proposed equipment:	Approved or acceptable? Secure statement from customer ensuring compliance with G98/G99.
Location	Assess which circuit could feed **The Customer**-is there a preferred POC indicated by **The Customer**? Confirm location of generator site.
Existing network parameters	Measure the proposed circuit to enable entry to network modelling tool.
	Confirm network using GIS, internet resources etc.
	Identify network thermal capacities.
Distance of site to existing system	Estimate route length of network extension using the smallest SPEN approved conductor size appropriate for the generator capacity.
Fault Level	Measure the proposed circuit to enable entry to network modelling tool.
Establish network constraints	Consider thermal and fault level capability of other apparatus on the network. Assess OHL & UGC and switchgear ratings to determine the lowest fault level capability. Identify any special circumstances or operation requirements from Control.
Circuit / system minimum demand	Derive from data system (PI) – if inadequate data, use 10% of connected transformer capacity of u/g network and 5% of connected transformer capacity of OHL network.
Source voltage	Check voltage at Primary using PI – if not available use nominal **HV** Voltage +1%.
Generator Type	Synchronous? Fixed speed induction generator with power factor correction?
Operation	Permanent parallel operation? Short term parallel operation? Standby? Inverter Connected?
Power Factor Range	Power factor Lead/Lag capability
Import / Export	Requirement or potential for the generator installation to export to the system?
Fault Level	Assess contribution of fault level by new generator - if not known assume 6 x generator size.
Generator Connection Arrangement	Single Phase / Three Phase / Split Phase?
Generator Connection Voltage	**LV**, **HV**
Generator Metering Voltage	**LV**, **HV**

Using the generic data obtained in using Table 13 as a background, a minimum scheme for connection should be designed taking due cognisance of the following aspects:

Table 15: Assessment for HV Generators

Project Area	HV Generator
System Model	Develop an accurate analytical model.
Connection arrangements	Compliant with policy or standards.
Voltage rise	Start using a local connection then work toward primary to find closest connection point to generator – use route length of network extension with the smallest conductor size fit for the generator capacity.
Thermal capacity	Assess the existing network, together with the existing system duty to identify the existing thermal capability and the available headroom.
Voltage fluctuations	If customer has a transformer to step up to 11KV unlikely to cause a 1% or 3% dip on 11kV network. If individual turbine 1MVA or greater investigate starting current and customer's transformer size.
Reverse power flow	Refer to Section 11.3
Harmonics	Consider whether harmonics will be an issue or problematic.
Metering, control and communications	Identify the method of metering and location of boundary. Identify the control and communication requirements.
Protection arrangements	Identify protection requirements for the system and for the interface.
Witness of Testing	DNOs obliged to witness test All **HV** Connections.
Operational limitations	Parallel operations? Thermal issues? Fault level limitations? Voltage issues?
Fault level at Connection Point	Identify fault level from system model or documents (e.g. LTDS).
Fault level at POCC	Use approved system modelling software or validated spreadsheet tools.

The conclusions and recommendations arising from the above assessment should be developed and supported by the typical connection arrangements summarised in the following table and the associated schematic arrangements provided in Appendix A.

Table 16: Summary of Appropriate Connection Options[21]

Maximum generator capacity (KVA)	Connection Type	Connection Equipment	Connection Diagram
<200	**HV** Underground cable circuits from an existing **HV** cable network	RMU (VIP protection) and **HV** metering. <=200kW of generation connected to a Y-type bleed off in a Solkor zone must be limited to inverter connected generation only.[22]	-

[21] Depending upon the operational/protection requirements of a connection a ring main unit solution may be required to be replaced by a multi-panel switchboard.

[22] Customer to be advised that any increase in generation ≥200kW would require interface protection which would require a change of the RMU and potentially a new substation building.

Maximum generator capacity (KVA)	Connection Type	Connection Equipment	Connection Diagram
>200 <1000	**HV** Underground cable circuits from an existing **HV** cable network	3-panel switchboard / RMU (self-powered [VIP] protection for O/C & E/F). NVD protection. **HV** metering. No requirement for directional O/C.	A.14-A.17 (exclude reference to SCADA monitoring / inter-tripping)
≥1000 ≤5000	**HV** Underground cable circuits from an existing **HV** cable network	3-panel switchboard with O/C, E/F and NVD protection. **HV** metering. No requirement for directional O/C. Monitoring & constraint scheme/SCADA/intertripping. G-Type RMU cannot be used where SCADA comms are required as the protocol is not compatible with the existing primary RTU specification.	A.14-A.17
≥1000 ≤5000	**HV** Generators Dedicated HV circuit breaker(s) in existing primary substation	2-panel or 5-panel switchboard with O/C, E/F and NVD protection. **HV** metering. No requirement for directional O/C. Monitoring & constraint scheme/SCADA/intertripping. G-Type RMU cannot be used where SCADA comms are required as the protocol is not compatible with the existing primary RTU specification.	A.18-A.20
≥1000 ≤5000	**HV** Generators At Existing Primary Substation Via a New 3-panel Board Substation in the Substation Compound	2-panel switchboard with O/C, E/F and NVD protection. **HV** metering. No requirement for directional O/C. Monitoring & constraint scheme/SCADA/intertripping. G-Type RMU cannot be used where SCADA comms are required as the protocol is not compatible with the existing primary RTU specification.	A.21
≥200 ≤5000	**HV Generators**, Overhead Circuits from underground networks (No existing OHL in circuit)	2-panel switchboard with O/C, E/F and NVD protection. **HV** metering. No requirement for directional O/C. Monitoring & constraint scheme/SCADA/intertripping. G-Type RMU cannot be used where SCADA comms are required as the protocol is not compatible with the existing primary RTU specification.	A.22-A.23
>200 but no more than 70% of the circuit rating	**HV** Generators, Overhead Line Teed Circuit from Overhead Main Line	2-panel switchboard with O/C, E/F and NVD protection. **HV** metering. No requirement for directional O/C. Monitoring & constraint scheme/SCADA/intertripping. G-Type RMU cannot be used where SCADA comms are required as the protocol is not compatible with the existing primary RTU specification.	A.24-A.25

Maximum generator capacity (KVA)	Connection Type	Connection Equipment	Connection Diagram
≤953	**HV Generator**, Overhead Line Teed Circuit from Existing Overhead spur Line	G-Type RMU.	A.26
>5000 up to circuit continuous summer thermal rating.	**EHV** Generators fed from Underground Circuits looped into overhead or underground main line	Bespoke – metering CB(s) with intertrip Remote tx monitoring / Monitoring & Constraint scheme/SCADA/Intertripping	A.27 – A.30
>5000 up to circuit or transformer continuous summer thermal rating.	**EHV** Generators fed from Circuits direct from Grid or GSP Substation	Bespoke – metering CB(s) with intertrip Remote tx monitoring / Monitoring & Constraint scheme/SCADA/Intertripping Diverse communications required for intertripping	A.31 – A.33
Upon Application	**132kV** (SPM only) fed from Overhead Line or Underground Cable Circuits or GSP Substation	Bespoke – metering CB(s) with intertrip Remote tx monitoring / Monitoring & Constraint scheme/SCADA/Intertripping. Diverse communications required for intertripping	A.34 – A.40

For the case of **Embedded** generators with no export capacity, the connection arrangements should fundamentally address the demand condition of **The Customer**. The conclusions and recommendations arising from the above assessment should however be developed to address any implications arising from the presence and operation of the generator. This is likely (but not exhaustively) to be confined to additional interface or protection requirements at the boundary.

The resultant connection arrangements will be similar to the corresponding arrangements in Table 15 contained in Appendix A as well as the demand connection arrangements contained in the Standard **HV** Connection Arrangements document (Section 6 of the Design Manual).

16. GENERATORS WITH SHORT-TERM TEST PARALLEL OPERATION

Note: For the purposes of this document, the definition of 'Short-term' in the context of parallel operation is consistent with that stated in G99 which is 'no more than 5 minutes in any month and no more frequently than once per week'.

Generators which only operate in parallel with the network on an operational testing basis (whether occasional or frequent) will, by definition, have a lesser impact on the system than a full-time merchant generator. However, the impact on the system nevertheless requires careful consideration to avoid unexpected or detrimental consequences. The **Company**'s equipment must not be used for synchronisation purposes or for system connection recovery following on-load island operation.

The assessment of connection arrangements and system impact must therefore take account of the three operational conditions:

- Normal operation of demand with generator in the quiescent state
- Generator in operation, and
- Transition between the two operational states.

Assessment of a minimum scheme for connection should, using the generic data obtained in Table 13 as a background, be designed taking due cognisance of the aspects noted in Table 14 with the addition that a safe means of synchronisation of the generator is provided and that this achieved using **The Customer**'s own equipment.

The conclusions and recommendations arising from the above assessment is not likely to be significantly dissimilar from the typical connection arrangements previously summarised and as indicated by the schematic arrangements provided in Appendix A. However, consideration also requires to be given to the operational regime for the installation.

17. SCHEME TECHNICAL APPROVAL

In order to ensure that offers for connection of generation developments are consistent, robust, economic and compliant with Policy and Specifications, verification and validation of the technical proposals is essential.

Where projects are complex or have wider implications, approval should be sought from the appropriate technical experts within the Business and approved by System Review Group. Projects which do not require SRG approval will be technically approved by delegated authority which will generally be in the form of Line Management.

The criteria which determine the relevant approval level are summarised in the following sections:

17.1 System Review Group Approval

Any scheme which contains any of the following components or scenarios, should seek Technical Approval from the relevant System Review Group:

- 33kV or 132kV connections
- Application of dynamic components such as Voltage Regulators, Reactive Compensation devices (StatCom, SVCs)
- 11kV connections requiring works at Primary Substation (excluding comms only work) or works at 33kV
- Circuits where HV automation scheme is impacted
- Reinforcement driven by generation connection
- Operational reconfiguration of network (HV or above)

17.2 Delegated Authority

All other projects which therefore do not meet the above criteria can therefore be technically approved by the delegated authority of line management. In order to be considered for delegated authority approval, the project therefore must:

- Comply with Company Policy.
- Employ standard equipment and deploy in accordance with specification.
- Ensure that the system and all equipment will be operated within specification and legislative or licence obligations.

APPENDIX A: STANDARD CONNECTION DESIGNS

LV CONNECTIONS

Generators Connecting to Existing Network Distributor (Figures A.1 to A.2) or single substation fuseway (A.3 to A.4)

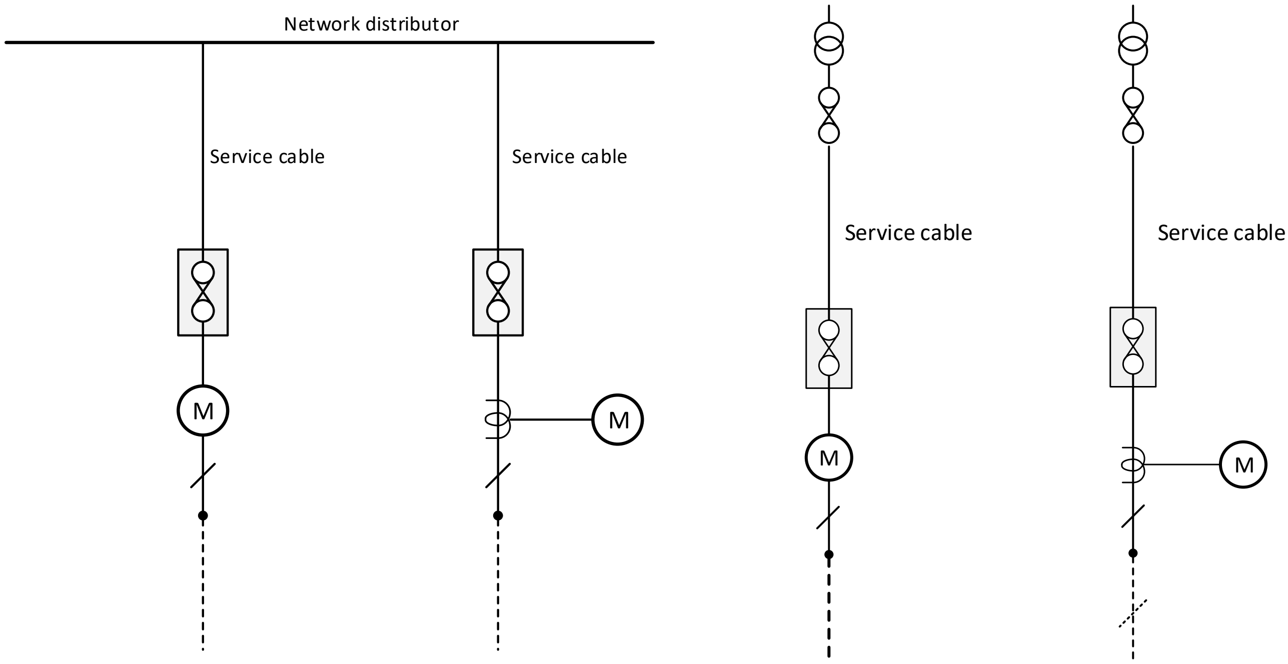


Figure A.1 Whole Current Metering (<=100A)

Figure A.2 CT Metering

Figure A.3 Whole Current Metering (<=100A)

Figure A.4 CT Metering

Small Generators ≤17kW Connecting to LV of Split Phase PM Substation (Figure A.6)

Where rural customers with small generation installations wish to connect in an area supplied by a single phase 11kV network, connection by the means of a standard 50kVA split phase pole mounted transformer is possible. This is intended for instances where it is cost prohibitive to extend the three phase 11kV network and provide a conventional 3 phase connection - typically this will be where a three phase 11kV network is greater than 500m from the proposed point of supply.

Some high-level details of split phase transformer configuration are provided in Section 10 of the SPD, SPM Design Manuals (Equipment Ratings), specifically document ESDD-02-007.

This option enables generation applicants up to 34kVA (i.e. 2 x 17kVA) to connect to a single phase 11kV overhead networks.

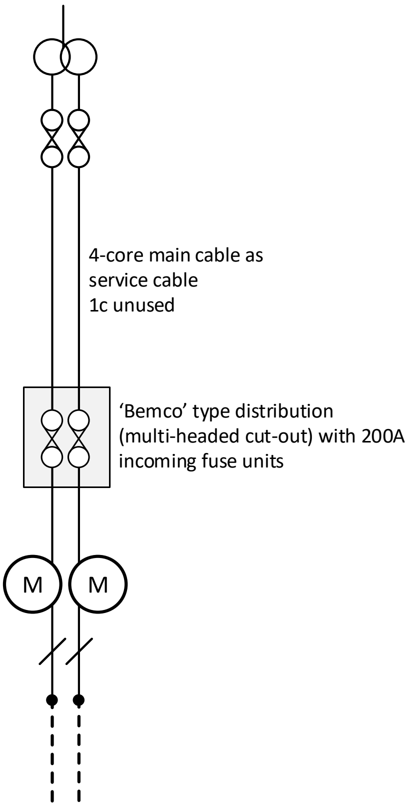

4-core main cable as
service cable
1c unused
'Bemco' type distribution
(multi-headed cut-out) with 200A
incoming fuse units
M
M

Figure A.5

Generators Connecting to LV of Ground Mounted Substation (Figures A.7 to A.11)[23]

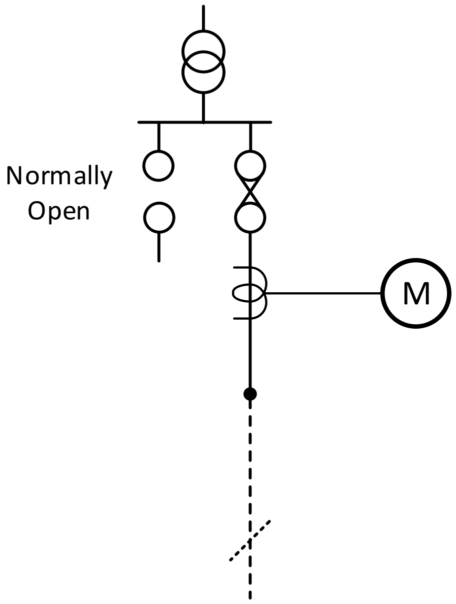


Figure A.7

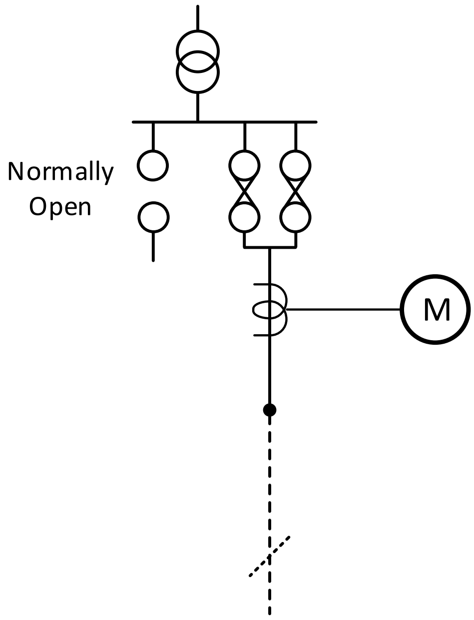


Figure A.8

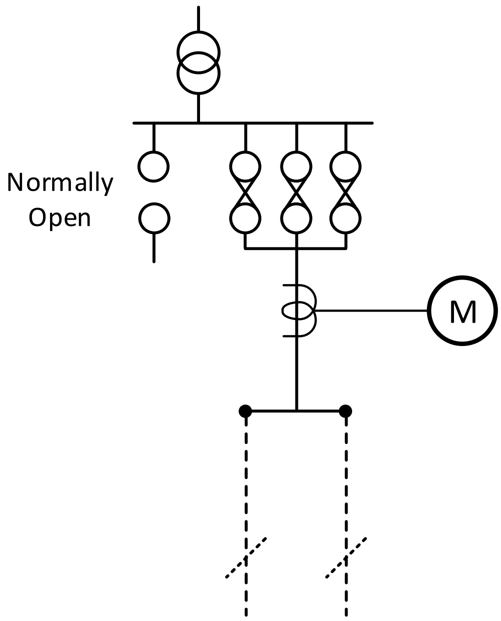


Figure A.9

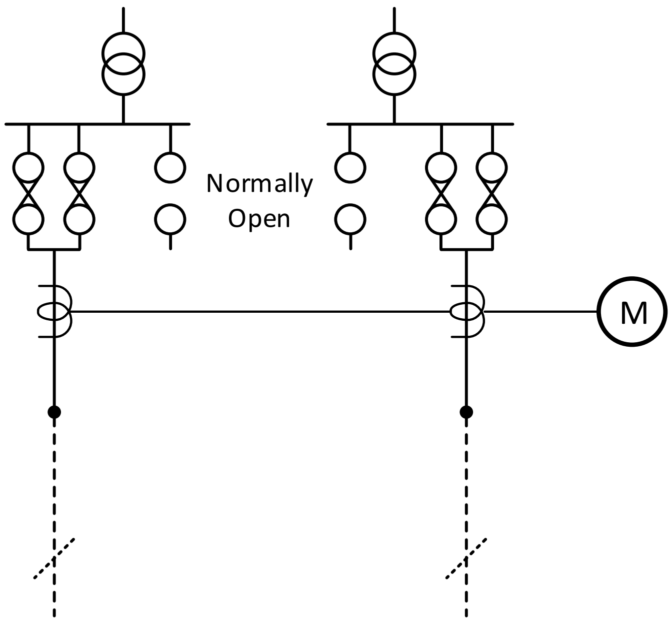


Figure A.10

23 The requirement for interface protection may modify or invalidate these options. Application of these schemes assumes that the generator threshold has not been met but the demand requirements dictate this type of connection methodology. Alternatively, as discussed in Section 11 interface protection at **HV** can be provided for **LV** customers with significant generation.

Generators Connecting to LV of Ground Mounted Substation (Figures A.7 to A.11)[24]

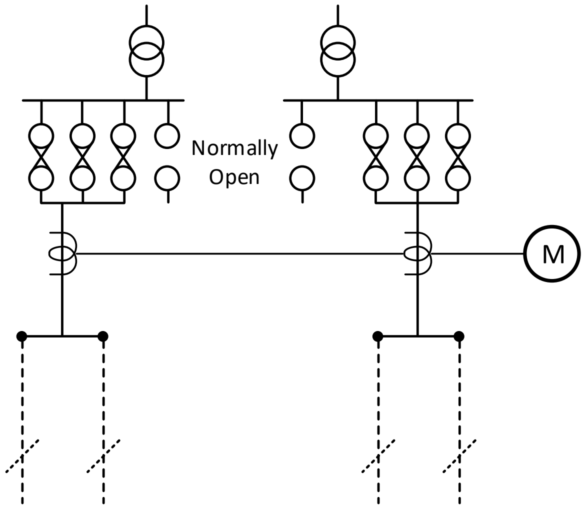
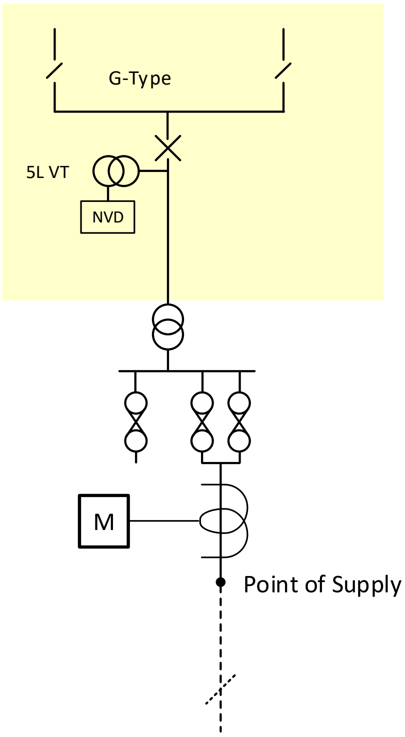


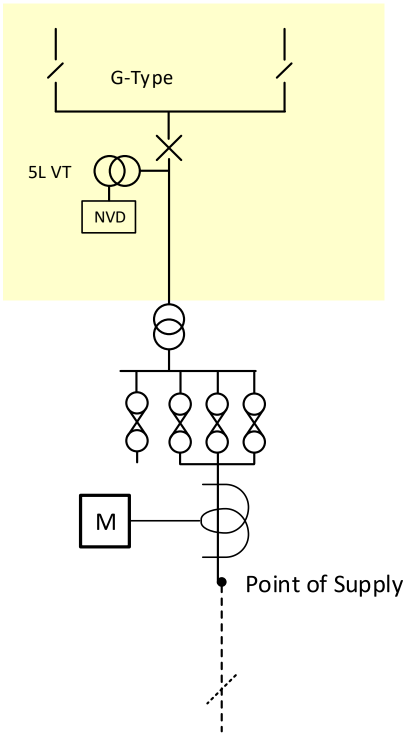
Figure A.11

Generators Connecting at LV of Ground Mounted Substation where interface protection is required at HV (Figures A.12 to A.13)



Generator size <=500kW

Figure A.12



Generator size <1MW

Figure A.13

24 The requirement for interface protection may modify or invalidate these options. Application of these schemes assumes that the generator threshold has not been met but the demand requirements dictate this type of connection methodology. Alternatively, as discussed in Section 11 interface protection at **HV** can be provided for **LV** customers with significant generation.

HV CONNECTIONS

Underground Circuits from Underground Networks

HV Generators >200kW and ≤5MW but no more than 70% of the circuit rating, underground circuits (Figures A.14 to A.17)[25]

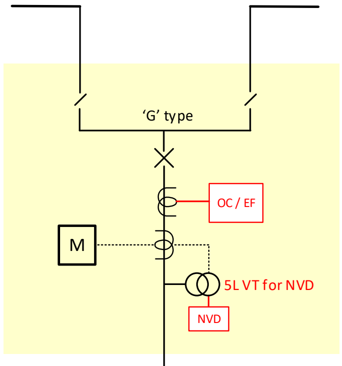


Figure A.14 Point of Supply

Max generation to be 999kW

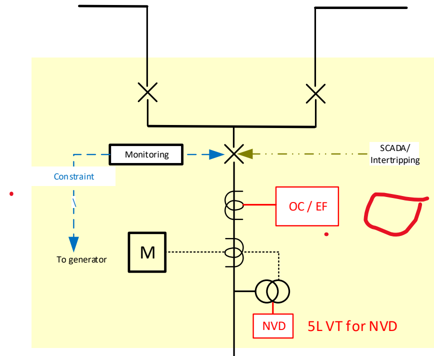
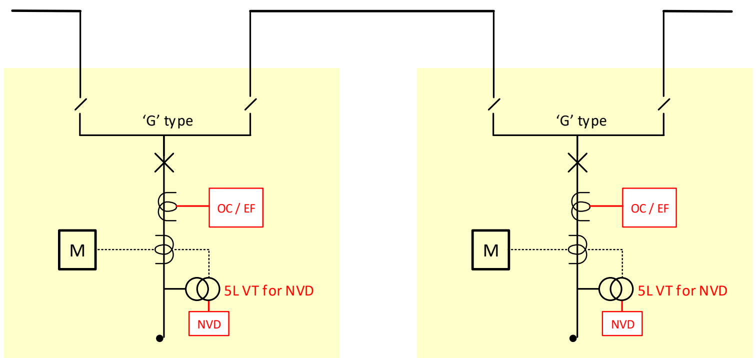


Figure A.15 Point of Supply

Max generation to be 5MW
or 70% of circuit rating
SCADA required for >= 1MW

Figure A.16



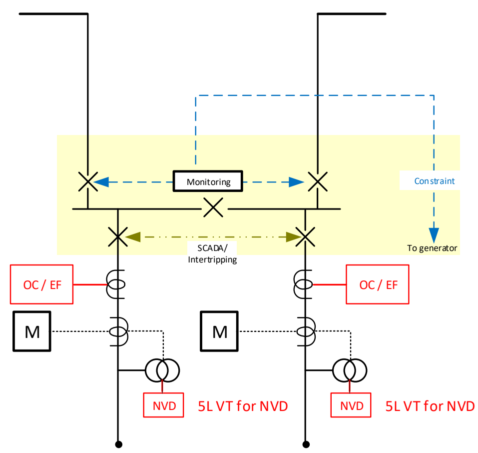
Point of Supply

Point of Supply

Double G-Type RMU arrangement
where customer requests
additional security of connection

Max generation to be 999kW

Figure A.17



Max generation to be 5MW
or 70% of circuit rating
SCADA

Multi-panel switchboard where customer
requests additional security of connection

---

25 Refer to ESDD-02-012 for when a connection can be breeched or must be looped in. Constrain to 70% of the circuit rating to allow sufficient safety margin for unquantifiable LV generation.

SCADA / Telecoms required for >= 1MW.

G-Type RMU cannot be used where SCADA comms are required as the protocol is not compatible with the existing primary RTU specification.

HV Generators >200kW and ≤5MW, connection to dedicated HV circuit breaker(s) in existing primary substation (Figures A.18 to A20)

Figure A.18

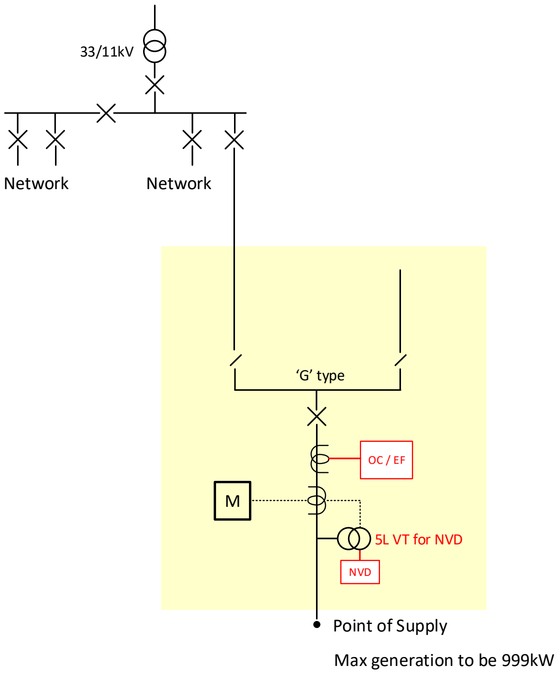


Figure A.19

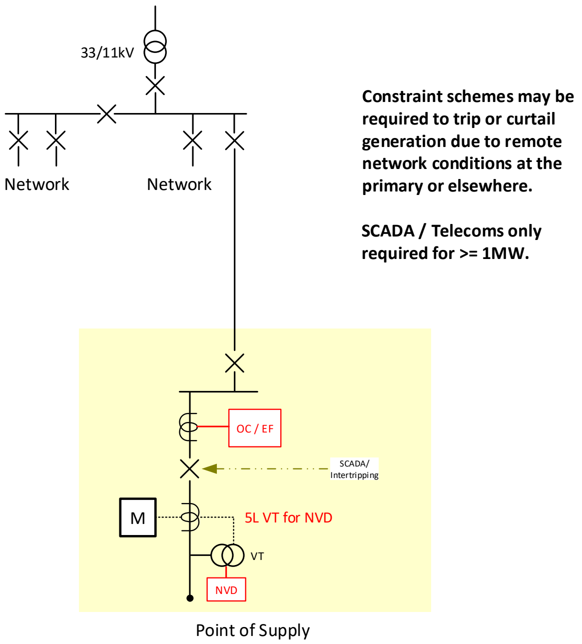
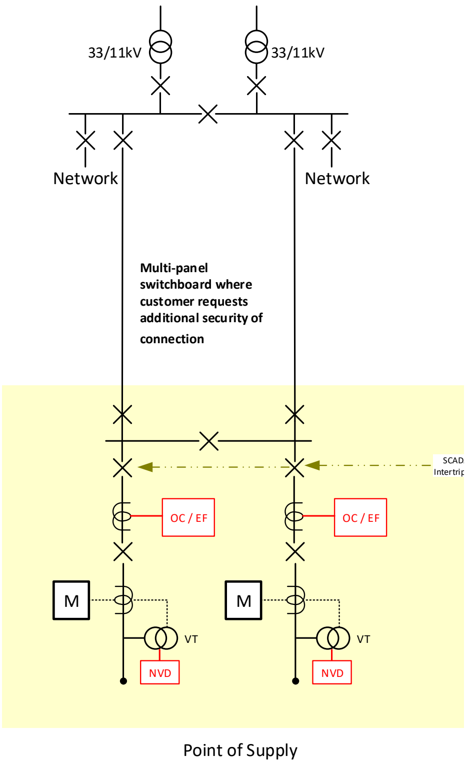
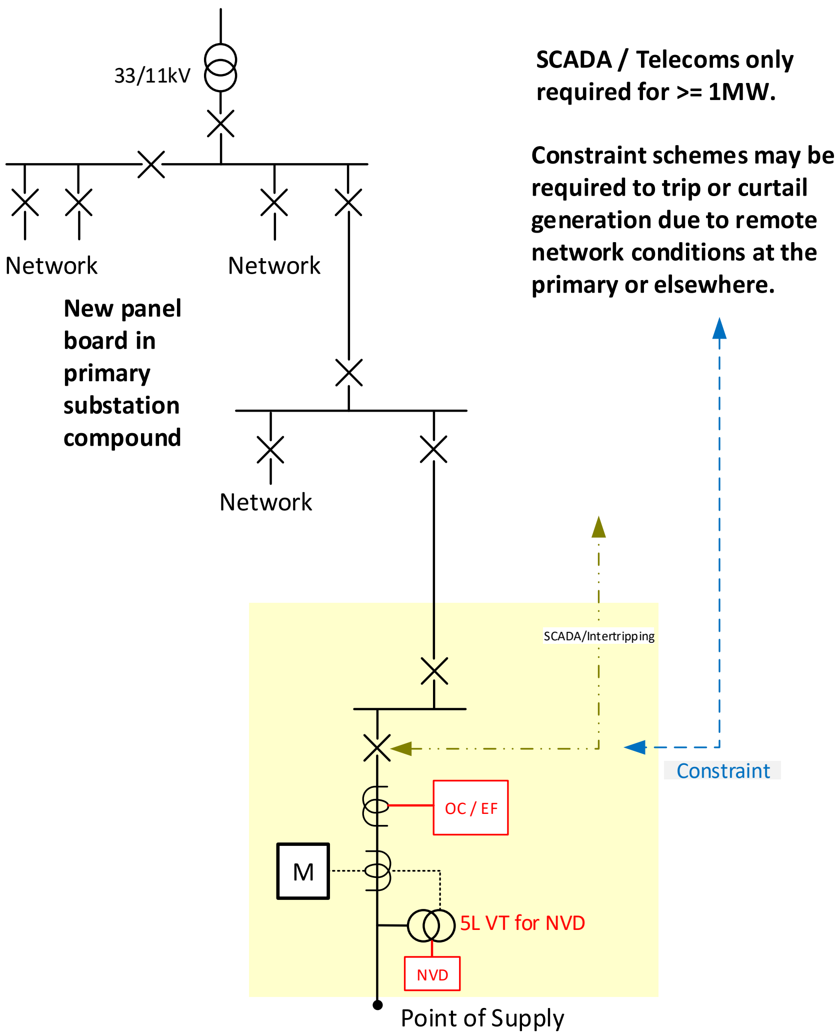


Figure A.20



HV Generators ≥1MW ≤5MW, HV Board Extensions At Existing Primary Substation Via a New 3-panel Board Substation in the Substation Compound (Figures A.21)[26]

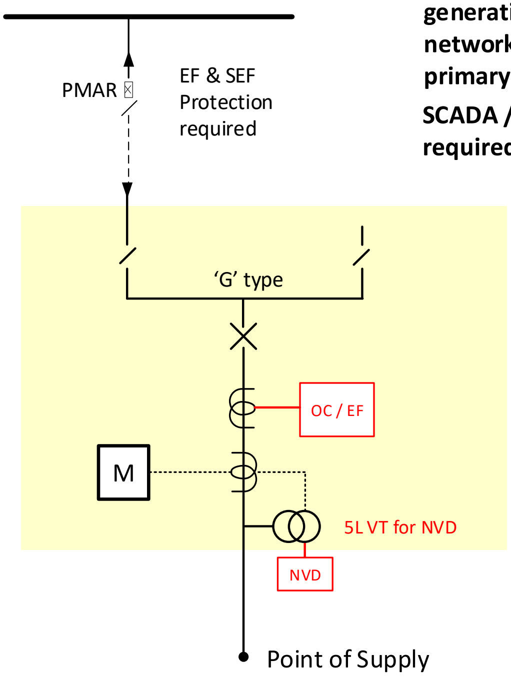
Figure A.21



[26] This option may be used where it is not economical to loop in a new generation within an existing network feeder. It may also apply when it's necessary to avoid excessive voltage rise for existing customers by providing connection direct from the primary substation and it is not possible to extend the primary board.

HV Generators ≥200kW and ≤5MW, Overhead Circuits from Underground Networks (No Existing OHL in Circuit) (Figures A.22 to A.23)[27]

Figure A.22

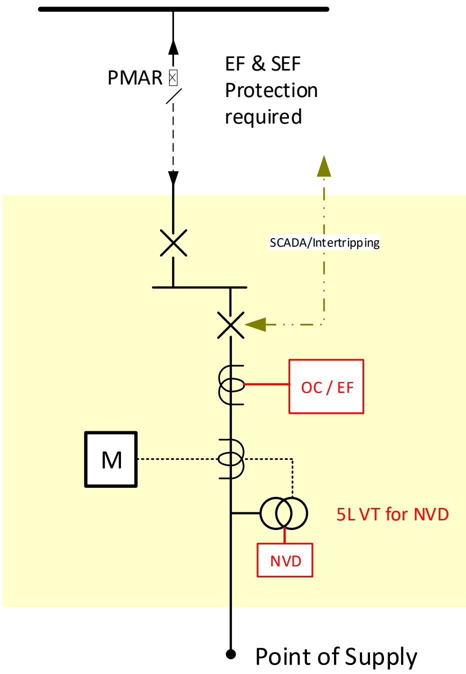


Max generation to be 999kW

Constraint schemes may be required to trip or curtail generation due to remote network conditions at the primary or elsewhere.

SCADA / Telecoms only required for >= 1MW.

Figure A.23



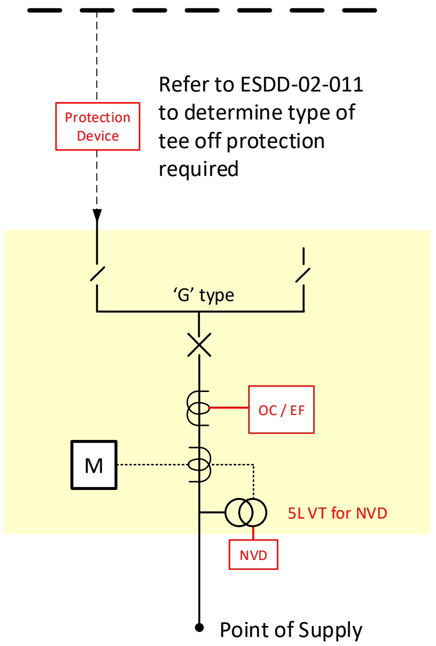
[27] Existing network protection at the source primary substation will not have sensitive earth fault or earth fault protection installed. A pole mounted auto recloser is required to provide this protection.

SCADA / Telecoms required for >= 1MW.

Refer to ESDD-02-012 to determine if a breeched connection is acceptable.

HV Generators >200kW but no more than 70% of the circuit rating, Overhead Line Teed Circuit from Overhead Main Line (Figures A.24 to A.25)[28]

Figure. 24

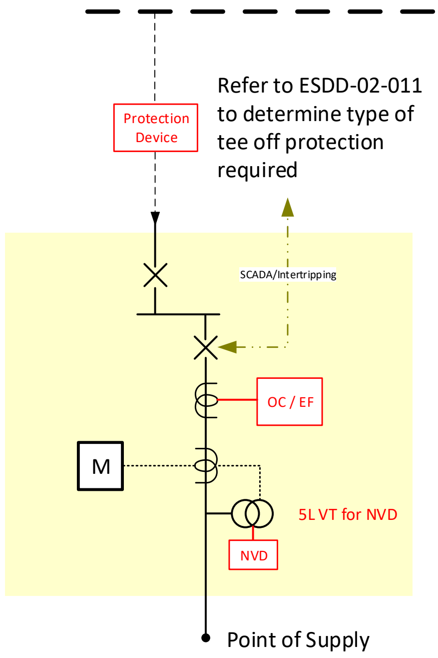


Max generation to be 999kW

Constraint schemes may be required to trip or curtail generation due to remote network conditions at the primary or elsewhere.

SCADA / Telecoms only required for >= 1MW.

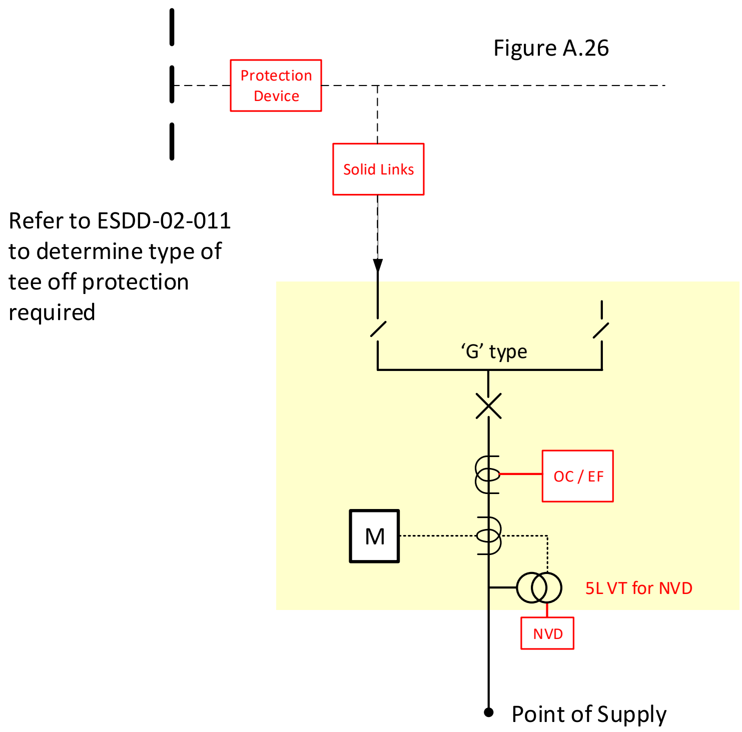
Figure. 25



[28] Should comply with application of overhead line protection policy and consideration should be given to potential for sectionaliser mal-ops arising from transformer mag inrush which may require capping transformer capacity.

Constrain to 70% of the circuit rating to allow sufficient safety margin for unquantifiable LV generation.

HV Generators ≤953kW, Overhead Line Teed Circuit from Existing Overhead Spur Line (Figures A.26)[29]



Smart Link Network
Protection device to be Soule switch or equivalent.
Smart links cannot be used because they are not bi-directional devices.
Maximum generation to be 953kW based on Soule setting of 100 amps per phase with a times 2 safety factor.

Fused Networks
Protection 30 amp max and a maximum of 500m of aggregated cable length on the Spur.
Maximum generation to be 572kW.

If these conditions cannot be met then a connection direct back to the main line will be required.
These connections should not have any detrimental impact on existing customers supplies.

[29] Should comply with application of overhead line protection policy and consideration should be given to potential for sectionaliser mal-ops arising from transformer mag inrush which may require capping transformer capacity.

EHV CONNECTIONS

EHV Generators >5MW up to circuit continuous summer thermal rating[30], fed from Underground Circuits looped into overhead or underground main line (Figures A.27 to A.30)

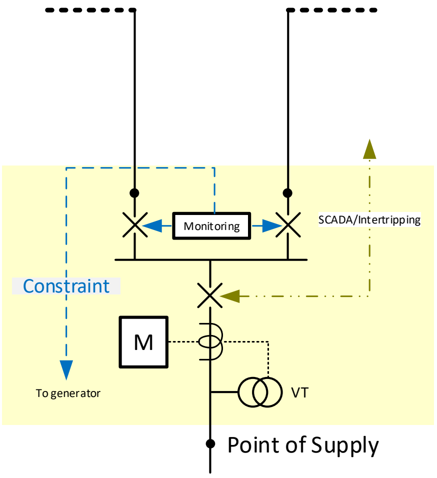


Figure A.27

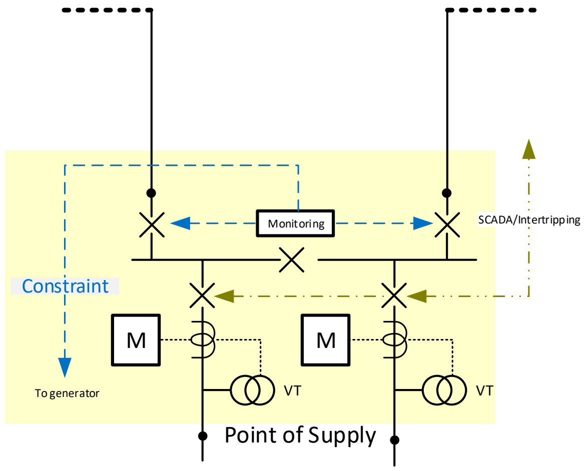


Figure A.28

Maximum generation allowed e.g. circa 18MW for overhead line circuit connections

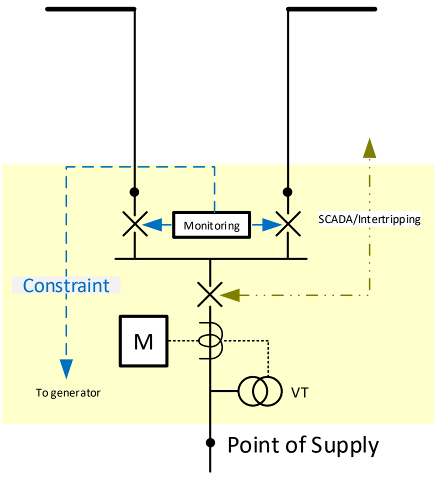


Figure A.29

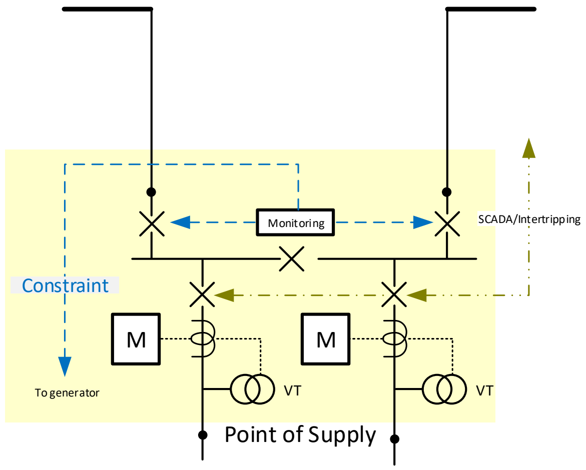
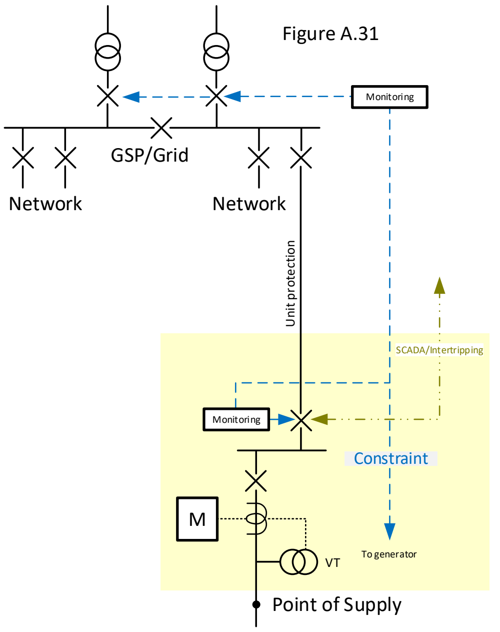


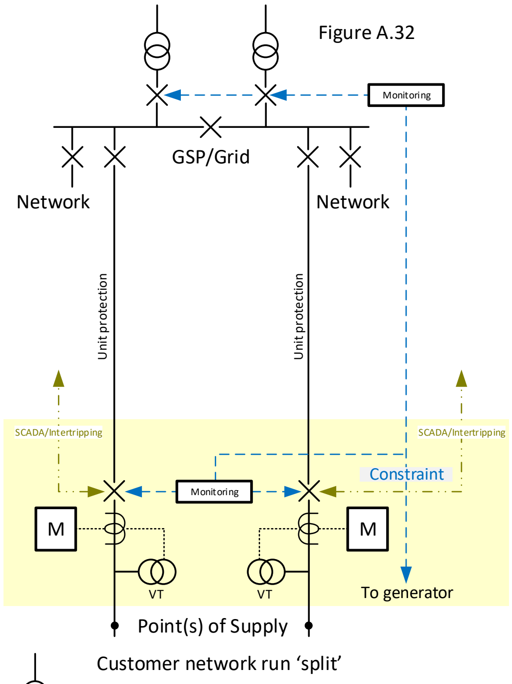
Figure A.30

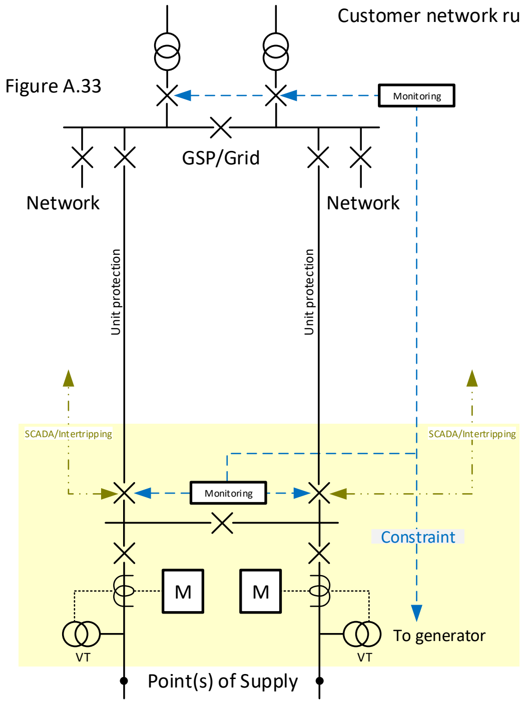
Maximum generation allowed e.g. circa 21MW for underground cable circuit connections

[30] Maximum acceptable export/import dependent upon system existing demand and embedded generation power flows on the circuit under consideration and impact on the proposed generation or demand on the rest of the distribution networks assets if interconnected.

EHV Generators >5MW And ≤30MW fed by Circuits direct from Grid or GSP Substation (Figures A.31 to A.33)







132kV (SPM only) Upon Application[31], fed from Overhead/Underground Cable Circuits or GSP Substation (Figures A.34 to A.40)

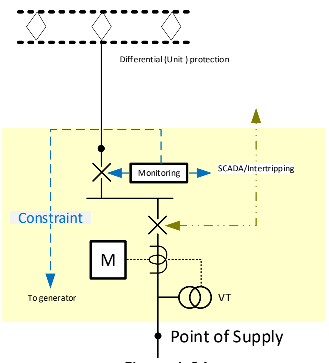


Figure A.34

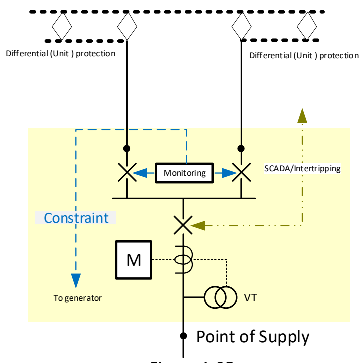


Figure A.35

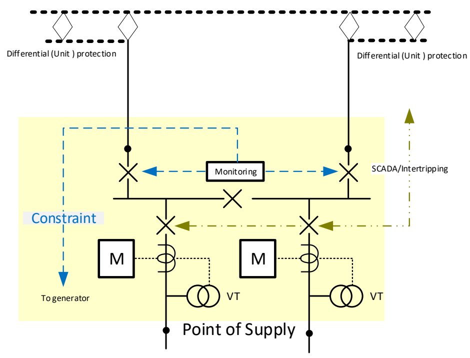


Figure A.36

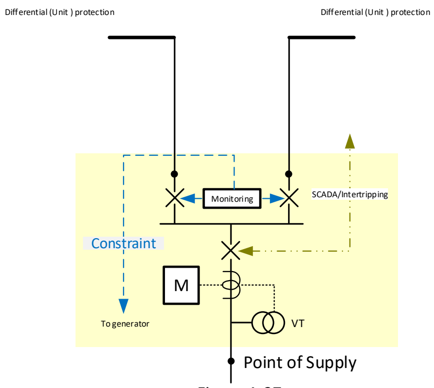


Figure A.37

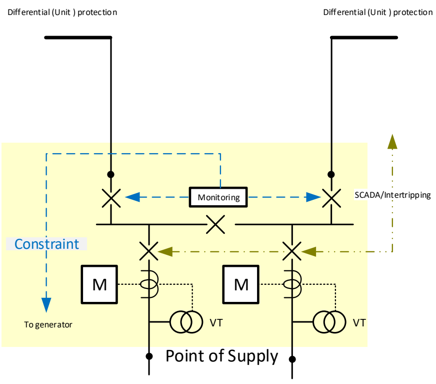
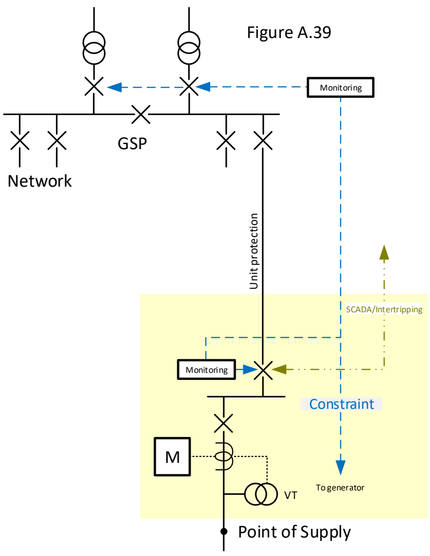
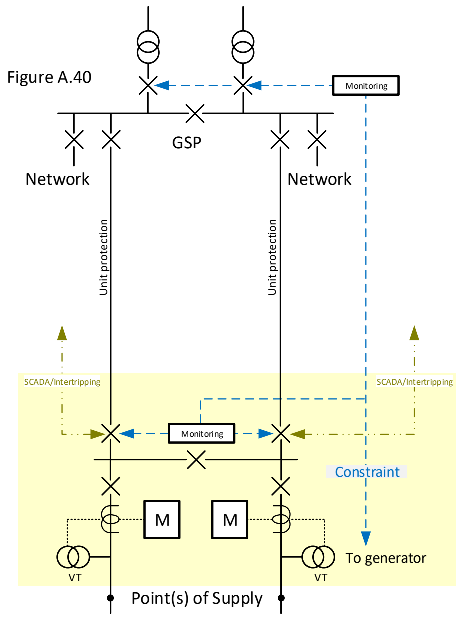


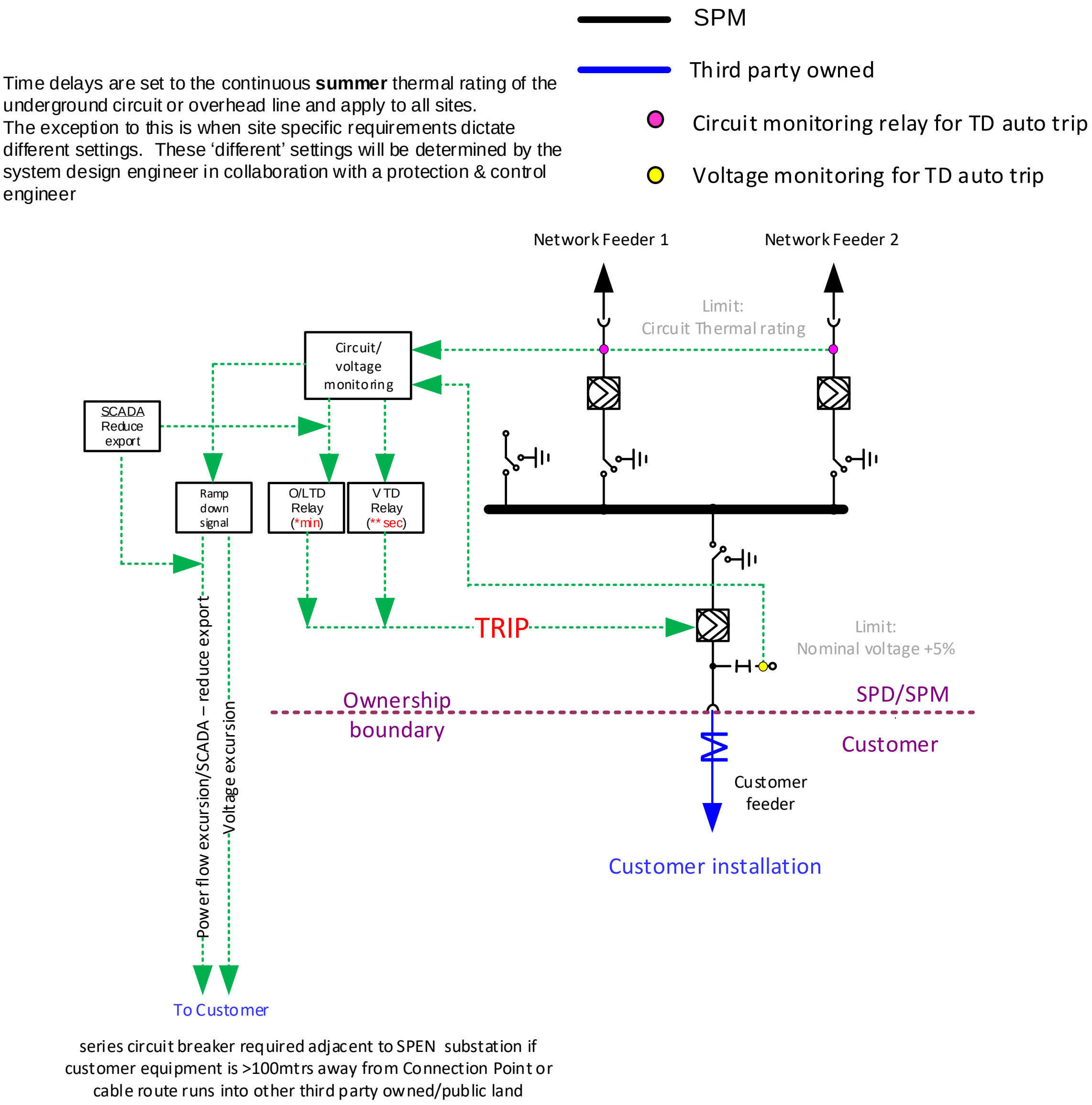
Figure A.38





[31] Maximum acceptable export/import dependent upon system existing demand and embedded generation power flows on the circuit under consideration and impact of the proposed generation or demand on the rest of the distribution networks or SPT/NGSOassets.

LOCAL MANAGEMENT SCHEME



APPENDIX B: CONNECTION OF UP TO 34kVA ON SINGLE PHASE HV CIRCUITS

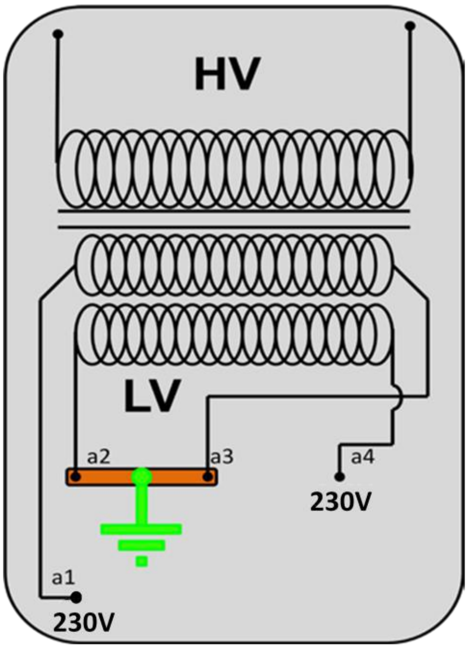
The following is a guide for the provision of a standard connection arrangement utilizing a 50kVA split phase pole mounted transformer for generation applicants supplied by single phase 11kV networks to allow generation up to 34kVA (2 X 17kVA).

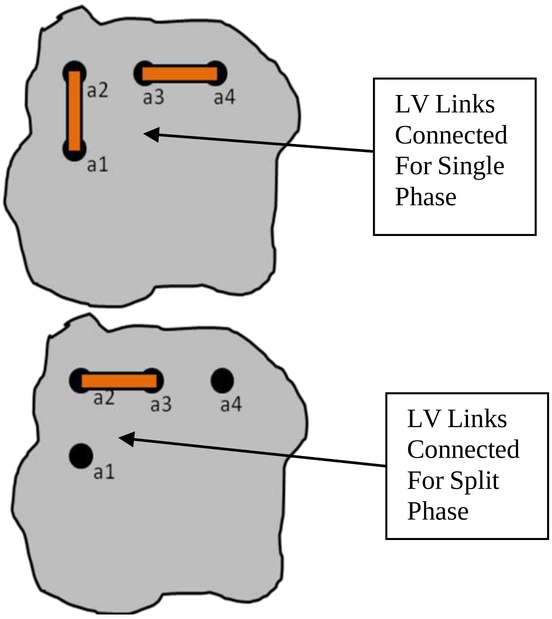
This arrangement shall only be offered to applicants who have the facility to generate between 17kVA and 34kVA but where it is cost prohibitive to provide a 3 phase connection due to the 11kV network and;

It shall only be offered to applicants where a 3 phase network is greater than 500m from their Point of Supply.

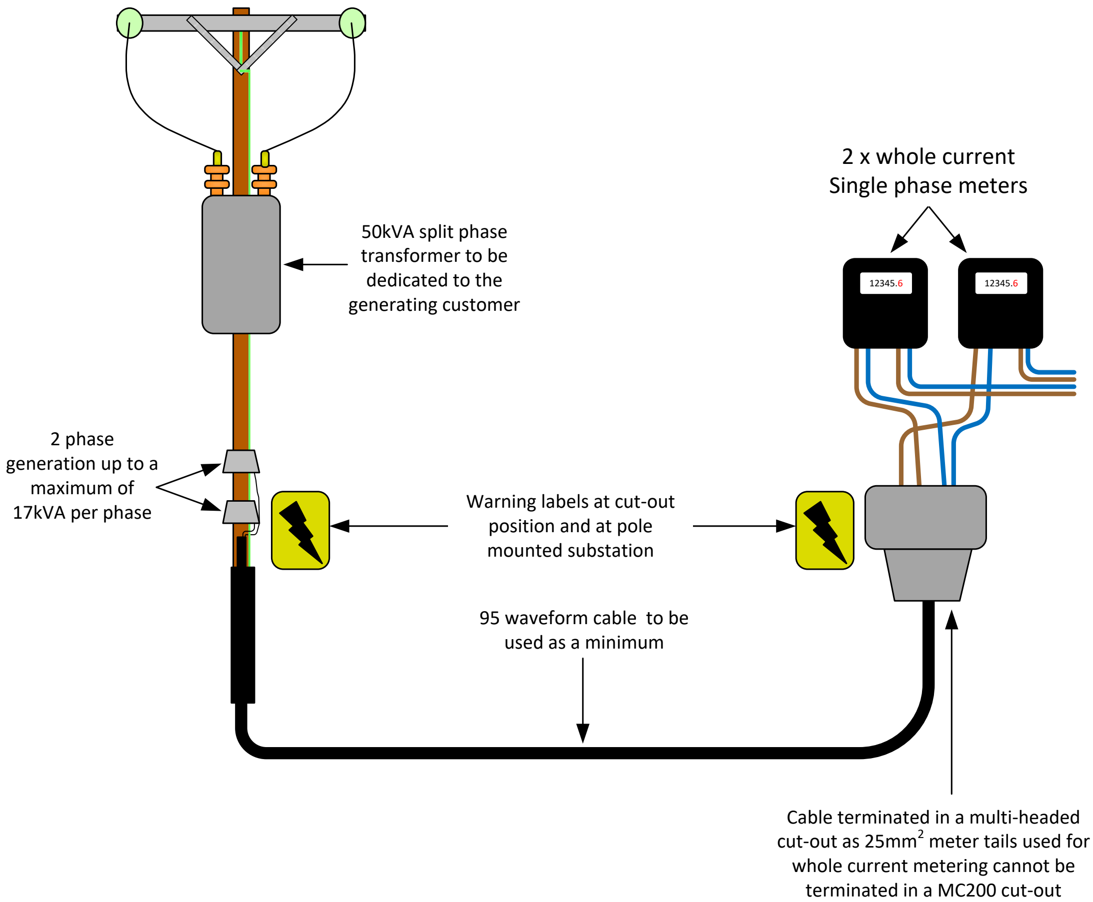
Power On and UMV diagrams shall be labelled to indicate the use of a split phase transformer.

The customer shall provide diagrammatical evidence of how the generation is to be shared over the 2 phases.





50kVA Split Phase Transformer Diagram 50kVA Split Phase Transformer External Connections



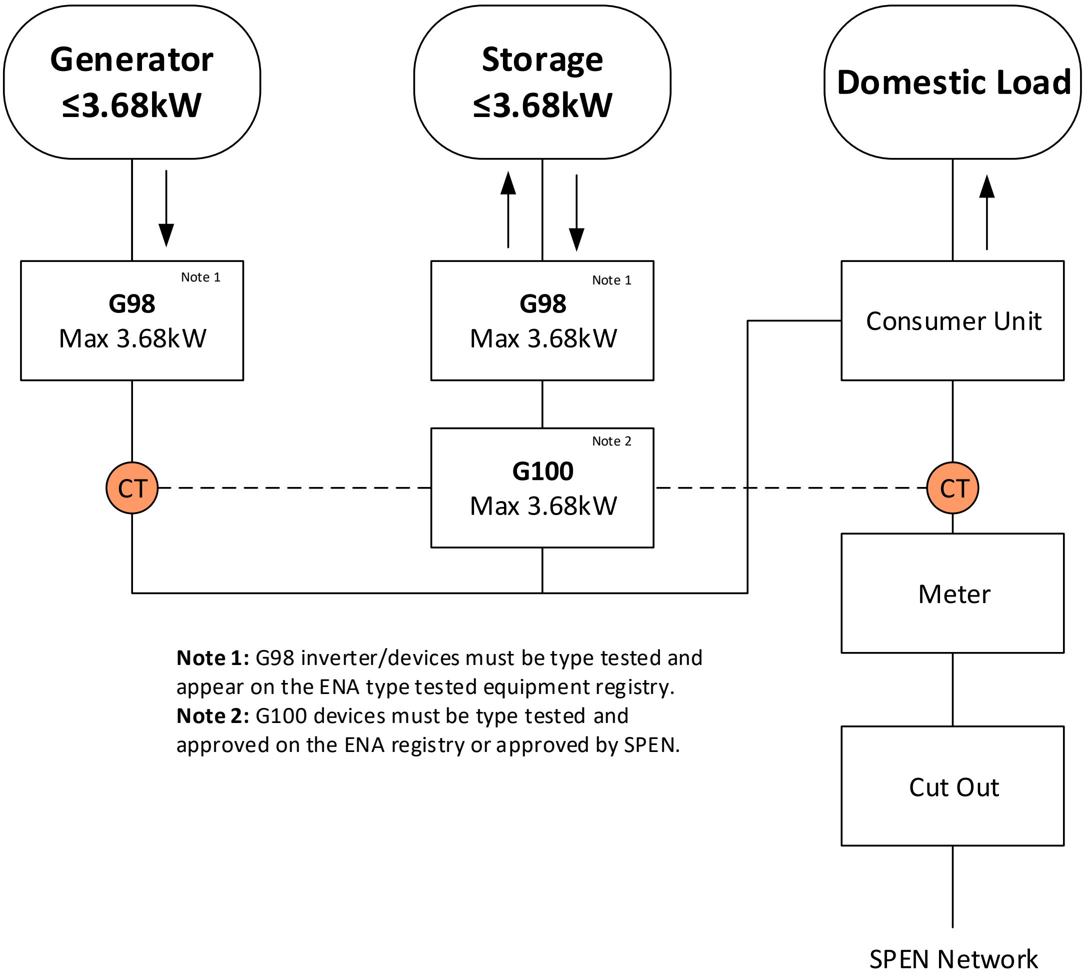
Connection Arrangement

Further Information

CG Power Technical Specification for a 50kVA Split Phase Transformer.

ENA Technical Specification 35-1 For Distribution Transformers (From 16kVA to 2000kVA).

APPENDIX C: G98 FAST TRACK AND EXPORT LIMITING DEVICE CONNECTIONS



Note 1: G98 inverter/devices must be type tested and appear on the ENA type tested equipment registry.
Note 2: G100 devices must be type tested and approved on the ENA registry or approved by SPEN.