

# ► Distributed Generation Owner/Operator Forum

Bristol, 24 July 19



- 13.30     **Arrival, registration and buffet lunch**
- 14.00     **Introduction, action review and objective setting from the chair and WPD**
- 14.10     **Improving industry and WPD communication to address outages/constraints**  
Forum member feedback on communication  
Report back from single point of contact  
Progress on updating outage portal
- 14.30     **Reducing outage impact on DG customers**
- 15.00     **G98 and G99 – how will the changes impact connected customers?**  
Andy Hood, technical policy, Western Power Distribution
- 15.30     **Safety reminder at WPD/customer interface**
- 16.00     AOB
- 16.30     **Networking and close**

## Guidance for connecting generation or energy storage

### Installation

[G98 Single premises connection procedure](#)

[G98 Multiple premises connection procedure](#)

[G99 Connection procedure](#)

[Connecting Energy Storage Guidance](#)

[Distribution Generation owner/operator forum](#)

[Payments for generated energy](#)

[Generation Infrastructure Schemes](#)

[Facilitating sharing of information for potential generation connections consortiums](#)

# Distribution Generation owner/operator forum

We have set up a forum in partnership with Regen aimed at owners and operators of MW scale renewables connected to a WPD network to provide an opportunity for WPD and Distributed Generation (DG) owners/operators to improve communication on issues including:

- WPD work to address grid constraints;
- Improving communication with generators on outages and constraints;
- Potential approaches for forecasting and mitigating outages.

The next meeting of the forum will take place on:

24th July 2019

Meeting notes and slides from previous events:

[25th April 2019 notes](#) [25th April 2019 slides](#)  
[31st January 2019 notes](#) [31st January 2019 slides](#)  
[9th October 2018 notes](#) [9th October 2018 slides](#)  
[19 July 2018 notes](#) [19 July 2018 slides](#)  
[26 April 2018 notes](#) [26 April 2018 slides](#)  
[20 Sept 2017 notes](#) [20 Sept 2017 slides](#)  
[11 Julv 2017 notes](#) [11 Julv 2017 slides](#)



## Western Power Distribution Generation Portal

### Log in

You are being granted access to Western Power Distribution's Generation Portal. You understand that your access to this website is subject to the website's [Terms of Use and Privacy Policy](#).

User name:

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PLEASE NOTE, THESE TERMS AND CONDITIONS GOVERN THE USE OF OUR GENERATOR PORTAL. BY CLICKING ON THE "ACCEPT" BUTTON BELOW OR USING THE GENERATOR PORTAL, YOU AGREE TO THESE TERMS AND CONDITIONS, WHICH WILL BIND YOU. IF YOU DO NOT AGREE TO THESE TERMS AND CONDITIONS, YOU MAY NOT USE THE GENERATOR PORTAL AND YOU AGREE THAT YOU WILL CEASE TO DO SO IMMEDIATELY.

<https://generation.westernpower.co.uk/>

# WPD ICE plan 2018/19

## Section 2 – Availability of information

Initiative		Initiative description
2.1*	Provide historic and forecast outage information and improved curtailment information for DG EHV connections at the point of issue of the connection offer	Develop systems and processes to provide better historical and forecast outage information, for a proposed DG EHV connection at the point of issue of the connection offer. Where the connection offer is for an alternative connection, we will also undertake developments to provide improved curtailment information. This improved information is intended to provide clarity on the likelihood of the level of curtailment
2.2	Further develop the WPD DGOO	Continue to develop the WPD DG Owner Operator Forum, developing an action plan with members to deliver further improvements to outage information provision. Host 4 forums including a visit to a WPD Control Centre providing further insight to members.
2.3	Continuing 2017/18 initiative: report on lost generation due to outages	Continuing 2017/18 initiative: Publish the report developed with the DGOO, on the quantity of generation loss (in MWh) caused due to WPD and National Grid system outages (132kV, 66kV & 33kV only) by generation technology type.
2.4	Further develop the report on lost generation due to outages	Further develop the report on lost generation due to outages to include an estimation of the £ value lost due to outages in the published report.
2.5	Report on reduced DG losses avoided during outages	Develop a report on the amount of DG losses avoided with the processes and procedures which have been developed to reduce the impacts of outages on DG. Develop ways of both quantifying reduced losses and of reporting case studies.
2.6	DG Constraints information leaflet	Produce a leaflet which will provide guidance to DG customers on how outages and constraints on the distribution system may effect their connections.

\* Initiative shared between Control and Connections Policy

# WPD ICE plan 2018/19

## Section 2 – Availability of information

Initiative		Initiative description
2.7	Pro-active fault explanation email	In conjunction with the WPD DGOO, develop a pro-active email notification process to provide DG customers with explanations regarding faults on the distribution system which may have effected their connection.
2.8	Contacts for assistance with DG portal	Provide contact details for users to obtain assistance with the WPD DG portal.
2.9	Present to the WPD DGOO on ANM	Present to the WPD DGOO forum on Active Network Management connections and their bearing on outages and constraints.
2.10	Present to the WPD DGOO on operational best practice	Present to the WPD DGOO forum on operational best practice, raising awareness with stakeholders regarding the operation of their connections assets, in particular around outages and constraints.
2.11	Continuing 2017/18 initiative: DNO best practice on outages and constraints	Continuing 2017/18 initiative: WPD to work with Distributed Generation stakeholders to establish DNO industry good practice initiatives with regard to the management & notification of Network outages and generation constraints.

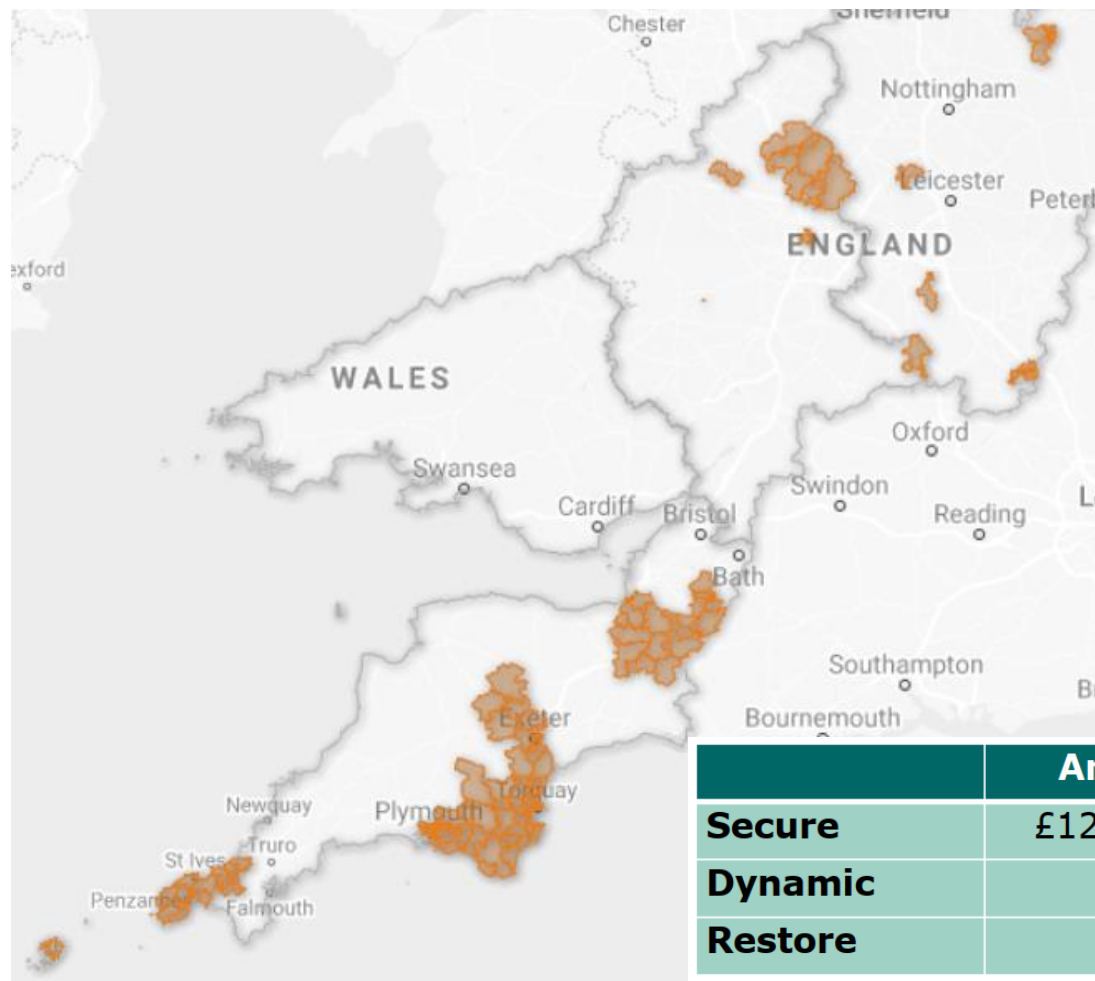
Please give us your feedback:

<https://www.surveymonkey.co.uk/r/G7R8LP7>



## Local energy, a flexible future events and local flexibility tenders

(Exeter, Bridgwater, Stafford and Lincoln)



“On average....£1,500 –  
£6,000 per MW per year...”

	Arming	Availability	Utilisation
<b>Secure</b>	£125/MWh	N/A	£175/MWh
<b>Dynamic</b>	N/A	£5/MWh	£300/MWh
<b>Restore</b>	N/A	N/A	£600/MWh



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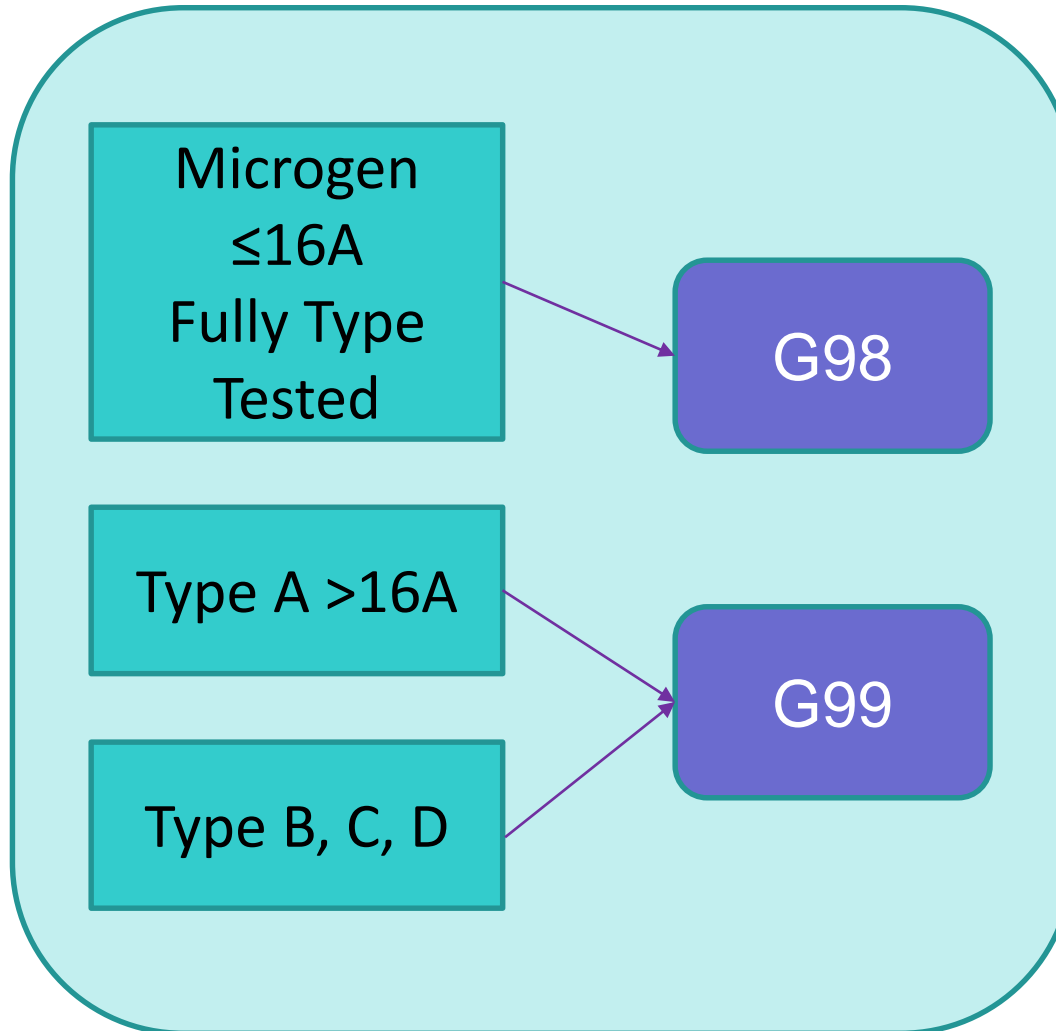
# G99 - Connection of Generation

# Background and Overview of Changes

# Background

- New Engineering Recommendations G98 and G99
  - EREC G98 for **Type Tested** < 16A/phase
  - EREC G99 for all other **Generating Facilities**
- They take account of EU Network Code: Requirements for Generators (RfG)
- Approved by OFGEM 16 May 2018
- Apply from 27 April 2019

# G98 or G99 Applicability



G98 applies to parallel operating **Generating Units** only.

**Generating Units** that can be used in standby mode must comply with G99

# Overview of Changes in G99

## Minor changes

Foreword

Purpose

Normative reference

Legal aspects

Connection arrangements

Earthing

Network Connection Design and Operation

Installation Operation and Control Interface

Annex D Other

## Moderate changes

Scope and structure

Terms and definitions

Connection application

Common compliance and commissioning requirements for all PGMs

Protection

## Significant changes / new material

Type A, B, C, D PGM technical requirements

Type A, B, C, D compliance testing, commissioning and operational notification

Ongoing obligations

Manufactures' information applicable to PPMs

Type testing and Annex information

Annex A (Type A), Annex B (Type B) and Annex C (Types C and D)

# What is New?

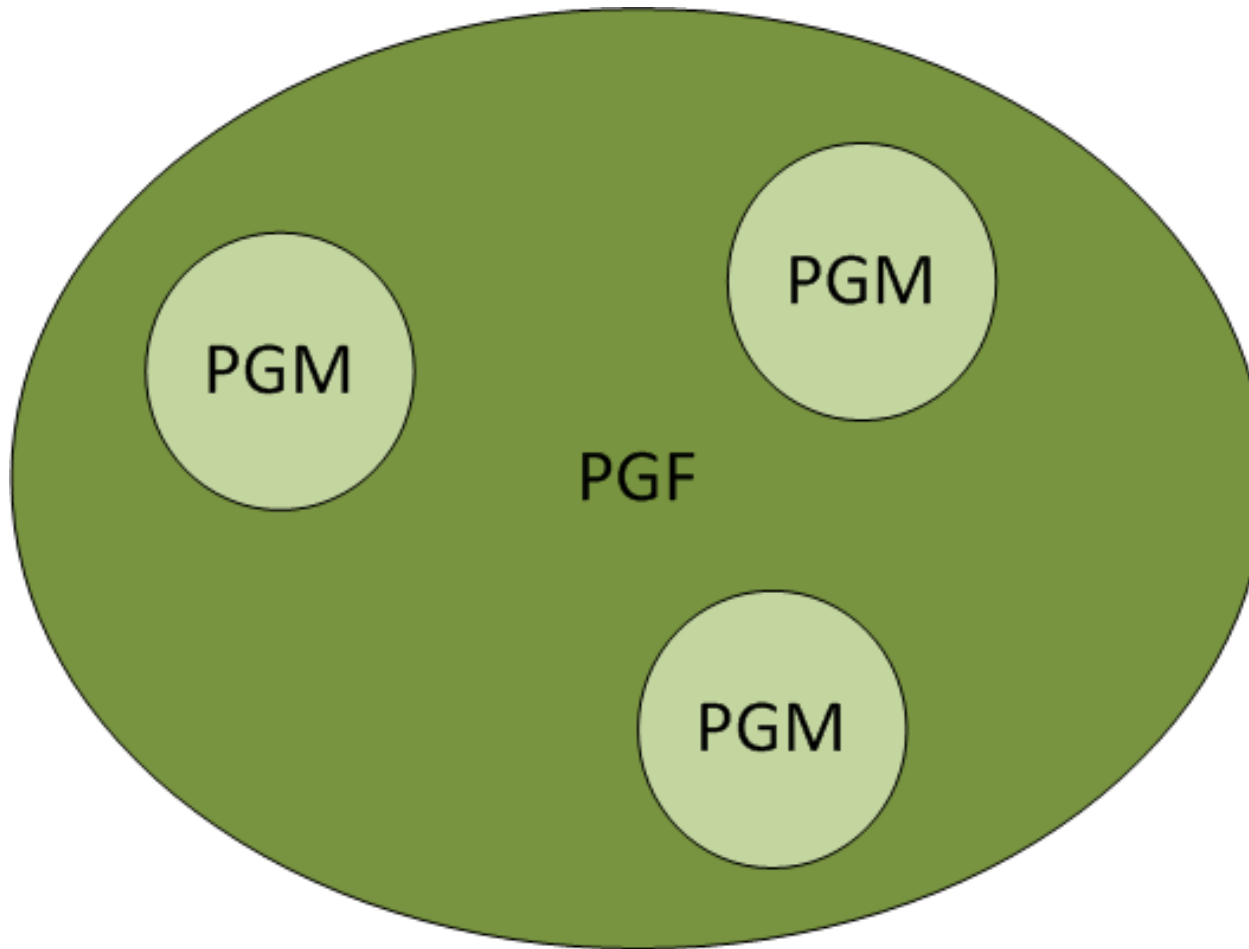
- Definitions for Power Generating Module (PGM), Power Park Module (PPM), Generation Unit, Type A, B, C and D PGMs.
- Several new technical performance requirements, e.g.:
  - Frequency performance / response
  - Reactive power capability
  - Fault ride through and fast fault current injection
  - Power curtailment systems (i.e. logic input / interface)
  - Operational monitoring
- Partial type testing is allowed under G99 (i.e. where some functions are type tested and others are not).
- Under G98 all functions must be type tested.



# What is New?

- Demonstration of G99 compliance may be through type tests, manufacturers' information, simulation studies, on site commissioning tests, test results.
- Operational Notifications:
  - Energisation Operational Notification - Type D only
  - Interim Operational Notification - Type D only
  - Final Operation Notification (FON) - Types B, C and D
  - Limited Operational Notification (LON) - Type D only

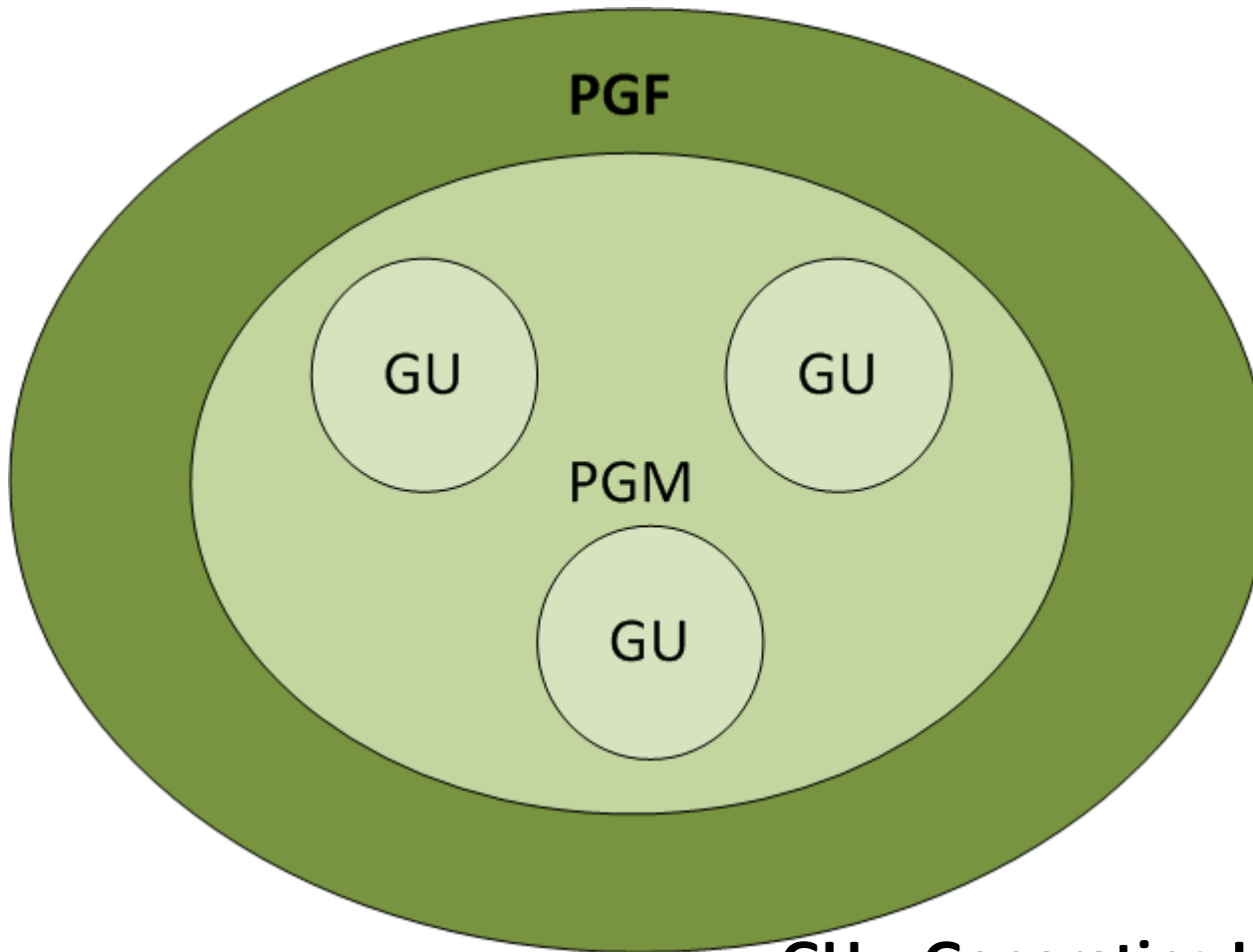
# Synchronous Generation



**PGM = Power Generating Module**

**PGF = Power Generating Facility**

# Non-synchronous Generation

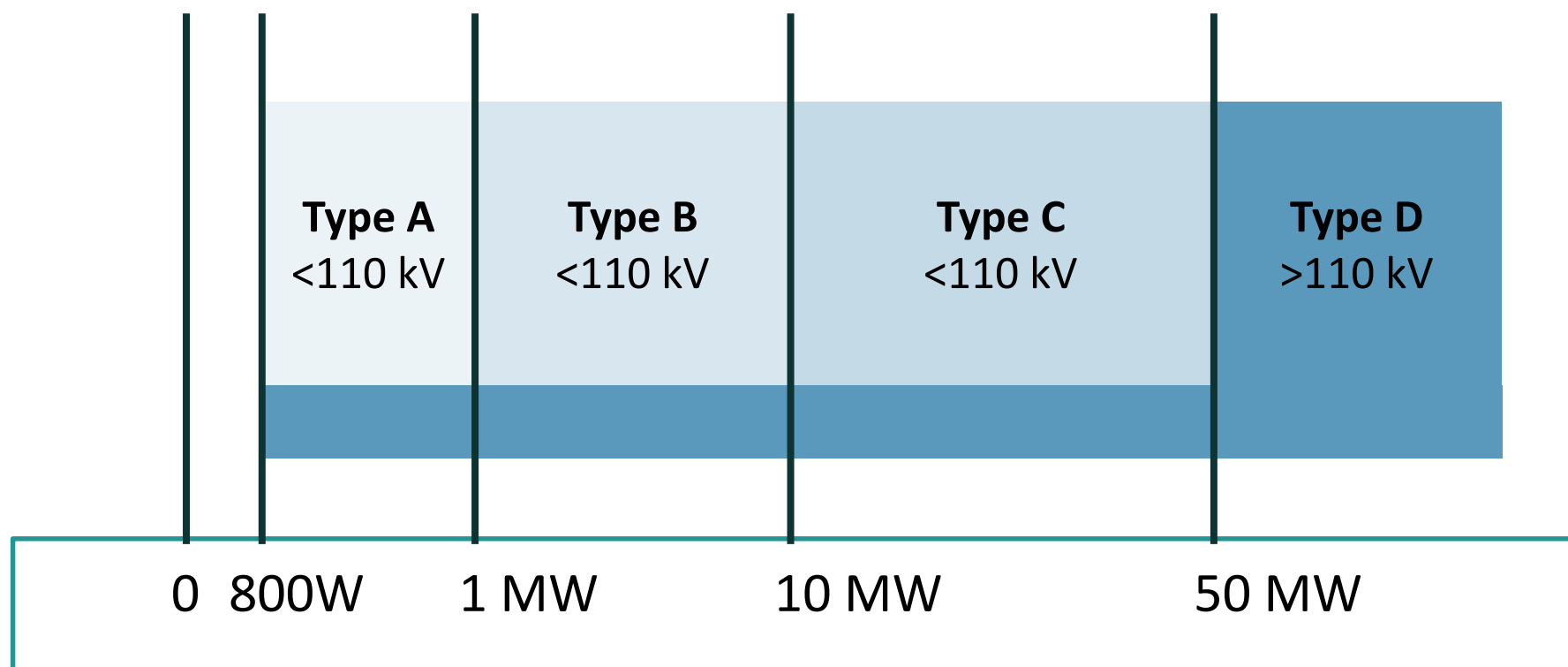


**GU = Generating Unit**

**PGM = Power Generating Module**

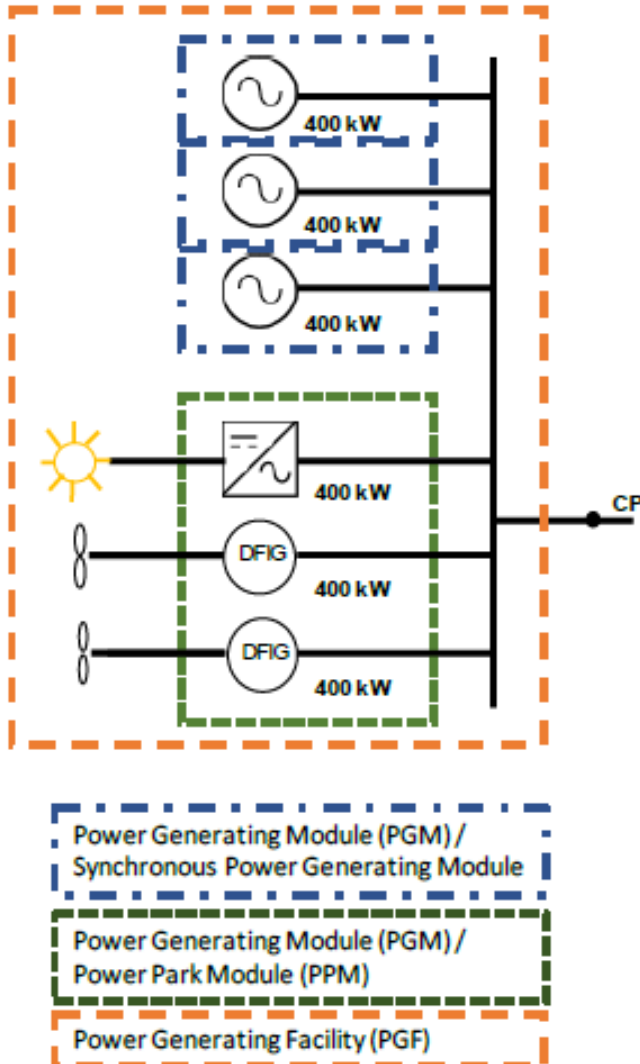
**PGF = Power Generating Facility** <sup>18</sup>

# Generating Module Types (A to D)



- Note, any Power Generating Module connected at 132kV or above is deemed to be Type D

# Generating Module Example

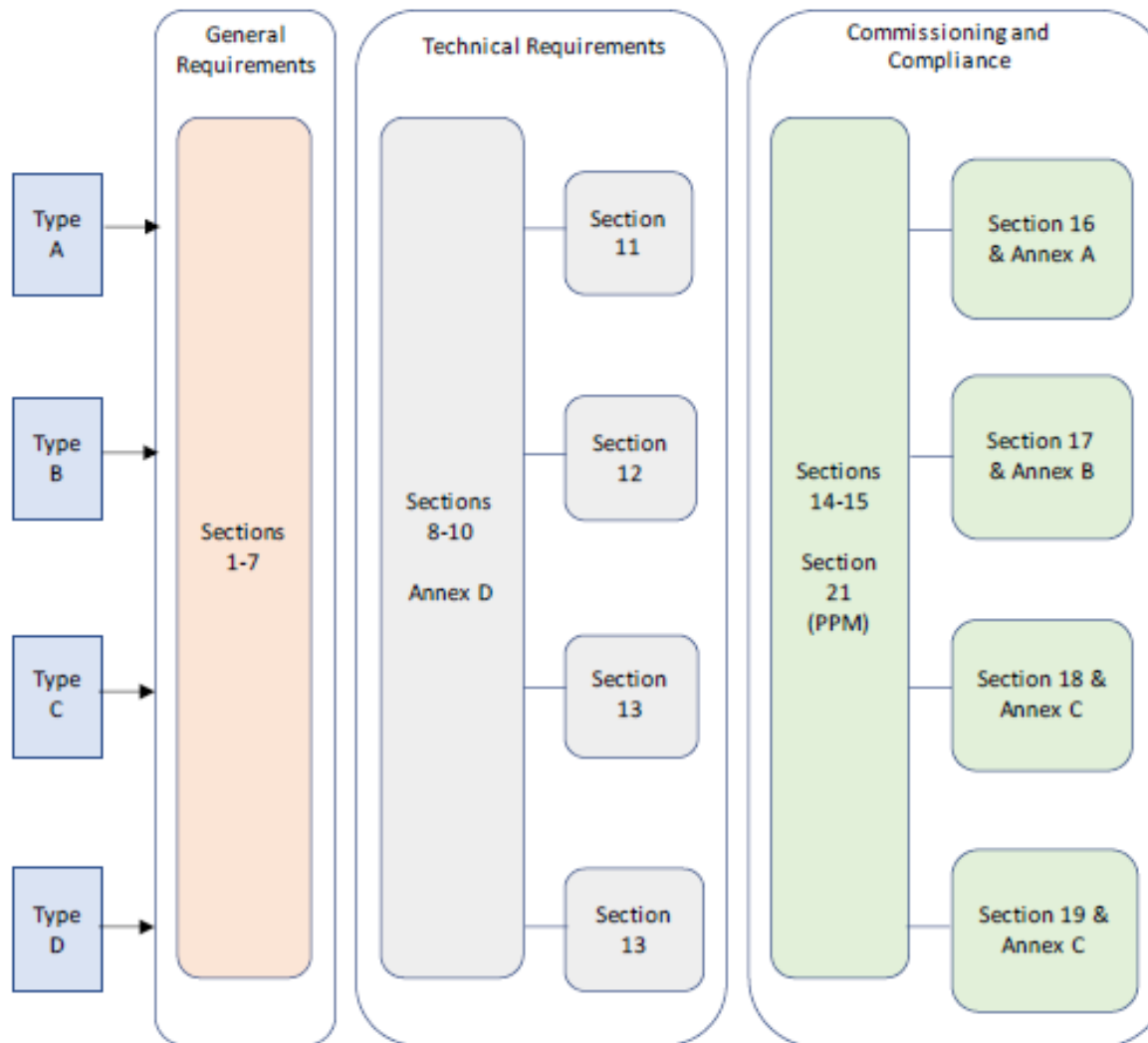


**3 x 400kW Synchronous Power Generating Modules and 3x non-synchronous Generating Units**

**= 3x 400kW Type A Synchronous Power Generating Modules and one 1.2 MW Type B Power Park Module**

**= 2.4MW Power Generating Facility**

# G99 Structure



# Requirements for All PGMs

- Connection Application (Section 6)
- Connection Arrangements (Section 7)
  - Operating Modes (Section 7.1, 7.2, 7.3 and 7.4)
- Earthing (Section 8)
- Network Design and Operation (Section 9)
  - Power Quality (Section 9.3 and 9.4)
  - Stability (Section 9.5)
  - Fault Contribution (Section 9.7)
- Protection (Section 10)
  - G99 Protection (Section 10.3 and 10.4)
  - G99 Protection Settings (Section 10.6)



# Protection Settings

**Table 10.1 Settings for Long-Term Parallel Operation**

Protection Function	Type A, Type B and Type C Power Generating Modules				Type D Power Generating Modules and Power Generating Facilities with a Registered Capacity > 50 MW	
	LV Protection(1)		HV Protection(1)			
	Trip Setting	Time Delay Setting	Trip Setting	Time Delay Setting	Trip Setting	Time Delay Setting
U/V	$V\varphi\text{-}n^{\dagger}\text{-}20\%$	2.5 s*	$V\varphi\text{-}\varphi^{\ddagger}\text{-}20\%$	2.5 s*	$V\varphi\text{-}\varphi^{\ddagger}\text{-}20\%$	2.5 s*
O/V st 1	$V\varphi\text{-}n^{\dagger} + 14\%$	1.0 s	$V\varphi\text{-}\varphi^{\ddagger} + 10\%$	1.0 s	$V\varphi\text{-}\varphi^{\ddagger} + 10\%$	1.0 s
O/V st 2	$V\varphi\text{-}n^{\dagger} + 19\%^{\S}$	0.5 s	$V\varphi\text{-}\varphi^{\ddagger} + 13\%$	0.5 s		
U/F st 1	47.5 Hz	20 s	47.5 Hz	20 s	47.5 Hz	20 s
U/F st 2	47.0 Hz	0.5 s	47.0 Hz	0.5 s	47.0 Hz	0.5 s
O/F	52.0 Hz	0.5 s	52.0 Hz	0.5 s	52.0 Hz	0.5 s
LoM (RoCoF) <sup>#</sup>	1 Hzs <sup>-1</sup> time delay 0.5 s		1 Hzs <sup>-1</sup> time delay 0.5 s		Intertripping expected	

# Technical Requirements

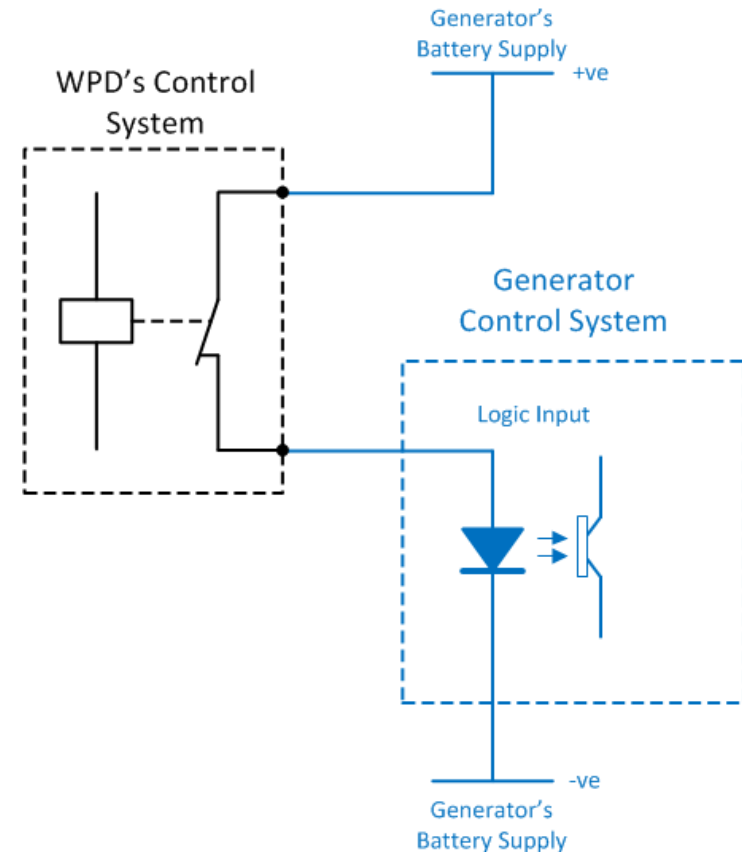
## Type A

### Power Generating Modules

# Type A Requirements (1)

## Performance and Control Requirements

- **PGMs** shall be fitted with a logic interface (input port) that may be used by WPD to cease the **Active Power** output of the **PGM** (within 5s of WPD's instruction being received).



# Type A Requirements (2)

## Performance and Control Requirements

- When operating at rated power the **PGM** shall be capable of operating at a Power Factor within the range 0.95 lagging to 0.95 leading.
- Voltage control, **Power Factor** control or **Reactive Power** control settings (as applicable) shall be agreed with WPD and recorded in the **Connection Agreement**.
- Where output constraints are necessary (e.g. for credible first circuit or second circuit outage conditions) these conditions should be agreed and recorded in the **Connection Agreement**.

# Type A Requirements (3)

## Frequency Capability

- 47.0Hz to 47.5Hz – operation for 20s
- 47.5Hz to 49.0Hz – operation for 90 minutes
- 49.0Hz to 51.0Hz – continuous operation
- 51.0Hz to 51.5Hz – operation for 90 minutes
- 51.5Hz to 52.0Hz – operation for 15 minutes

## Rate of Change of Frequency Capability

- $0\text{Hzs}^{-1}$  to  $1.0\text{Hzs}^{-1}$  – operation for 500ms

# Type A Requirements (4)

## Active Power Output with Falling Frequency

- **Active Power (kW)** must remain above the following line:

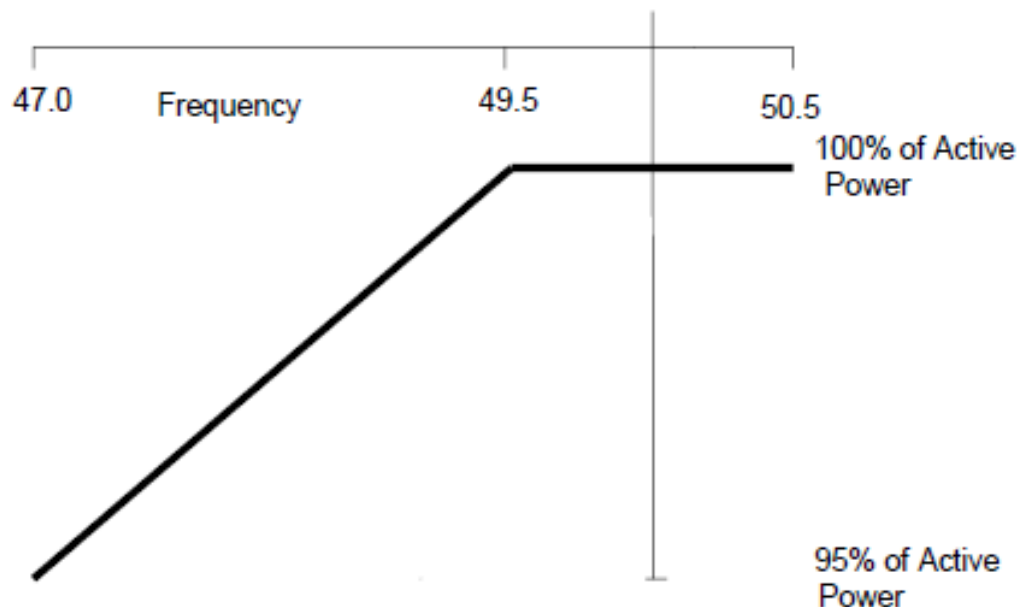
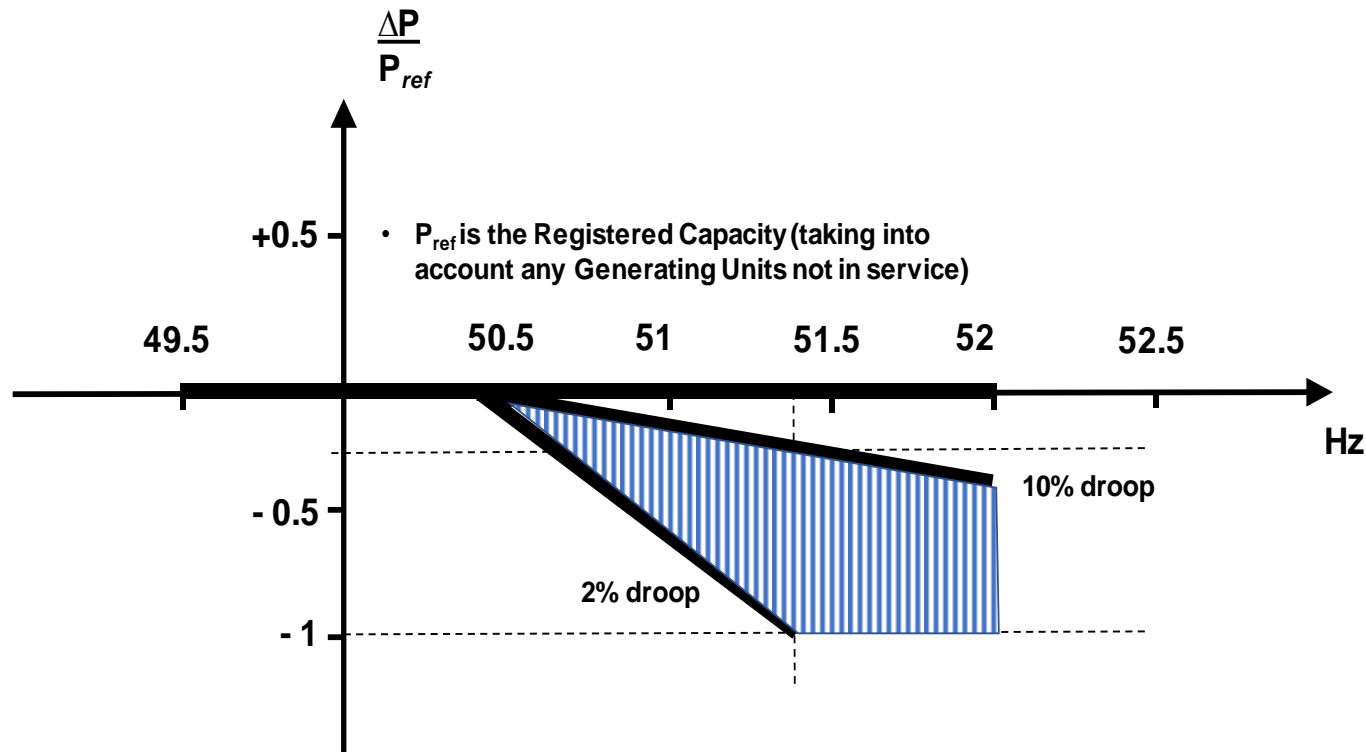


Figure 11.1 Change in Active Power with falling frequency

# Type A Requirements (5)

## Limited Frequency Sensitive Mode – Over Frequency





# **Additional Technical Requirements**

## **Type B Power Generating Modules**

# Type B Requirements (1)

## Voltage Limits and Control

- Each **Synchronous Power Generating Module** shall be equipped with a permanent **Excitation System** that has the capability to provide constant terminal voltage at a selectable set point without instability over the entire operating range
- The **Generator** shall agree with WPD the set points of the control scheme for voltage control, **Power Factor** control, or **Reactive Power** control, as appropriate

# Type B Requirements (2)

## Reactive Capability

- When supplying Registered Capacity all PGMs must be capable of continuous operation at any points between the limits 0.95 power factor lagging and 0.95 power factor leading at the Connection Point or the Generating Unit terminals, where agreed with WPD. Where the PGM is installed within a large site comprising both demand and generation WPD will normally allow Reactive Capability to be demonstrated at the PGM terminals.
- At **Active Power** output other than **Registered Capacity** all **Synchronous Power Generating Modules** and **GUs** within a **PPM** must be capable of continuous operation at any point between the **Reactive Power** capability limits identified in the **Generator Performance Chart**

# Type B Requirements (3)

## Fault Ride Through

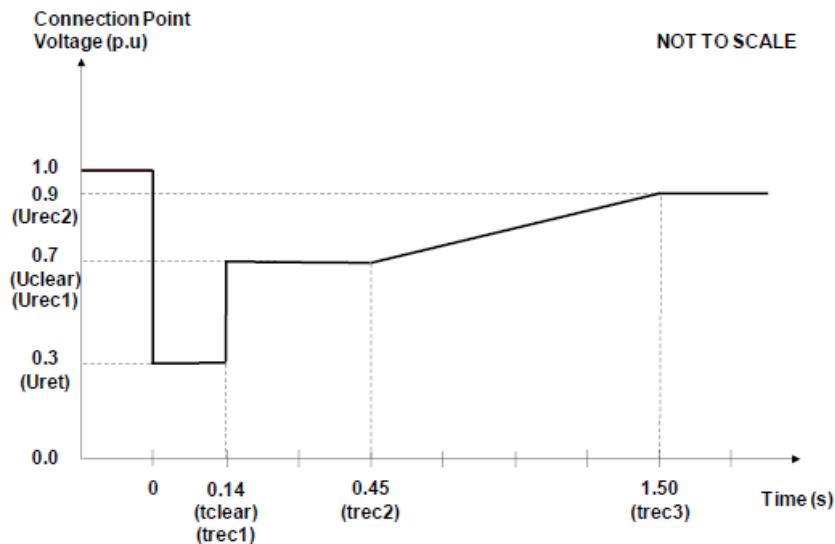


Figure 12.3 - Voltage against time curve applicable to Type B Synchronous Power Generating Modules

Table 12.1 Voltage against time parameters applicable to Type B Synchronous Power Generating Modules

Voltage parameters (pu)		Time parameters (s)	
$U_{ret}$	0.3	$t_{clear}$	0.14
$U_{clear}$	0.7	$t_{rec1}$	0.14
$U_{rec1}$	0.7	$t_{rec2}$	0.45
$U_{rec2}$	0.9	$t_{rec3}$	1.5

# Type B Requirements (9)

## Fast Fault Current Injection (Power Park Modules only)

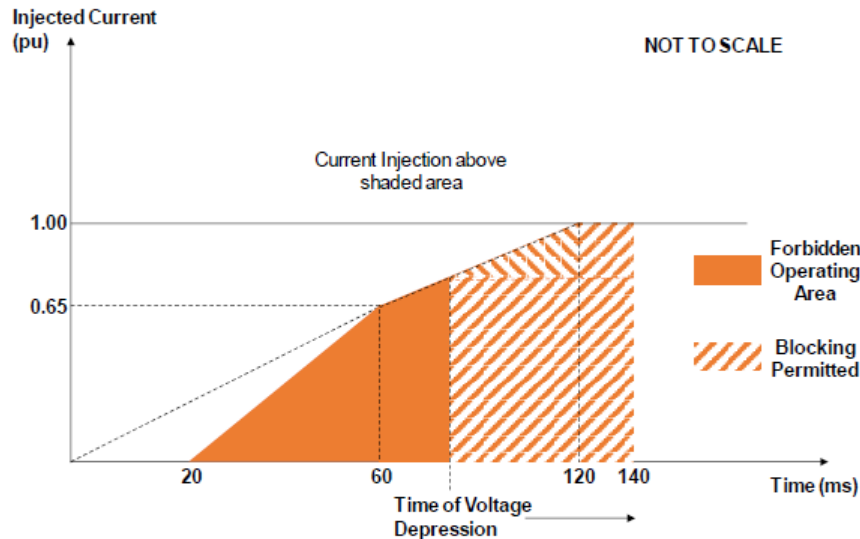


Figure 12.5 (a) Chart showing area of Reactive Current injections for voltage depressions of less than 140 ms duration

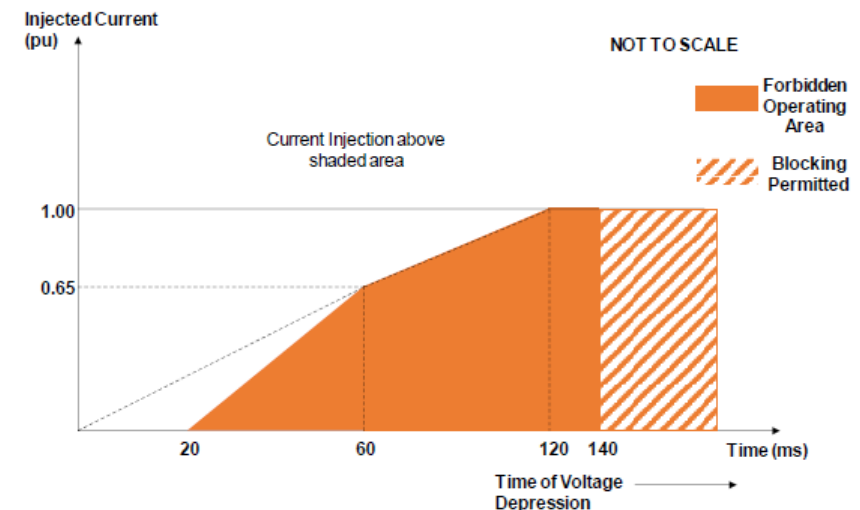


Figure 12.5 (b) Chart showing area of Reactive Current injections for voltage depressions of greater than 140 ms duration

Inverters are allowed to block (reduce current injection) to mitigate the risk of transient overvoltage instability (where applicable)

# Type B Requirements (20)

## Operational Monitoring

- “The DNOs will install its own Tele-control / SCADA outstation which will generally meet all the DNO’s necessary and legal operational data requirements.”
- In practice WPD will either fit a Connection Control Panel or a Power Transducer (or equivalent) at the Connection Point to record Current, Voltage, Active Power and Reactive Power.

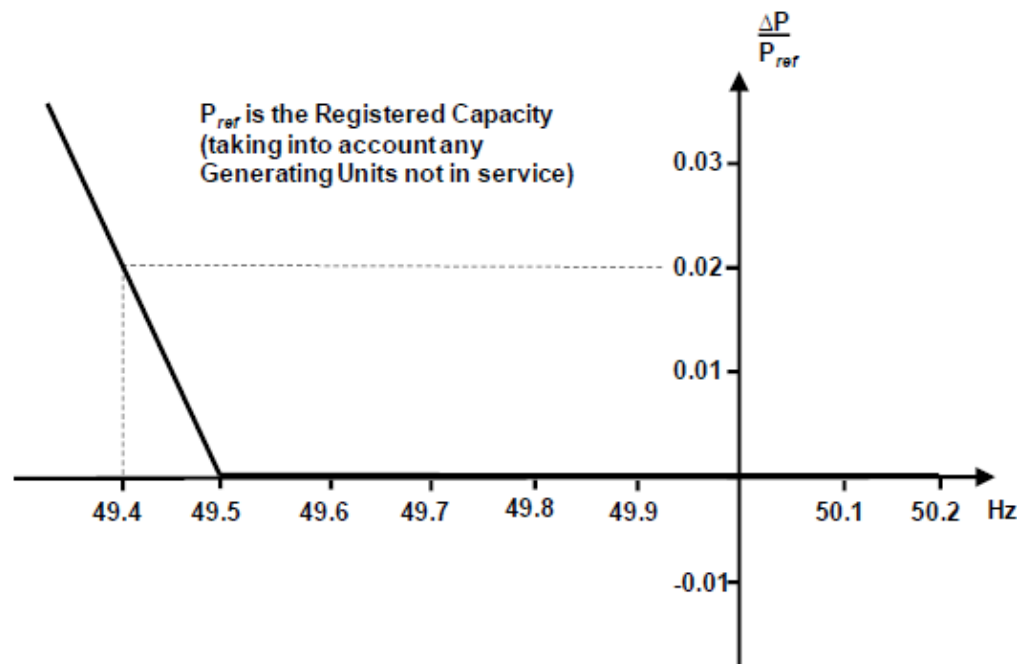
# **Additional Technical Requirements**

## **Type C and Type D Power Generating Modules**



# Type C & D Requirements (1)

## Limited Frequency Sensitive Mode – Under Frequency



$P_{ref}$  is the Registered Capacity, taking into account any Generating Units not in service to which  $\Delta P$  is related and  $\Delta P$  is the change in **Active Power** output from the **Power Generating Module**. The **Power Generating Module** has to provide a positive **Active Power** output change with a **Droop** of 10% or less based on  $P_{ref}$ .

**Figure 13.3 - Limited Frequency Sensitive Mode – Under frequency capability of Power Generating Modules**

# Type C & D Requirements (2)

## Frequency Sensitive Mode

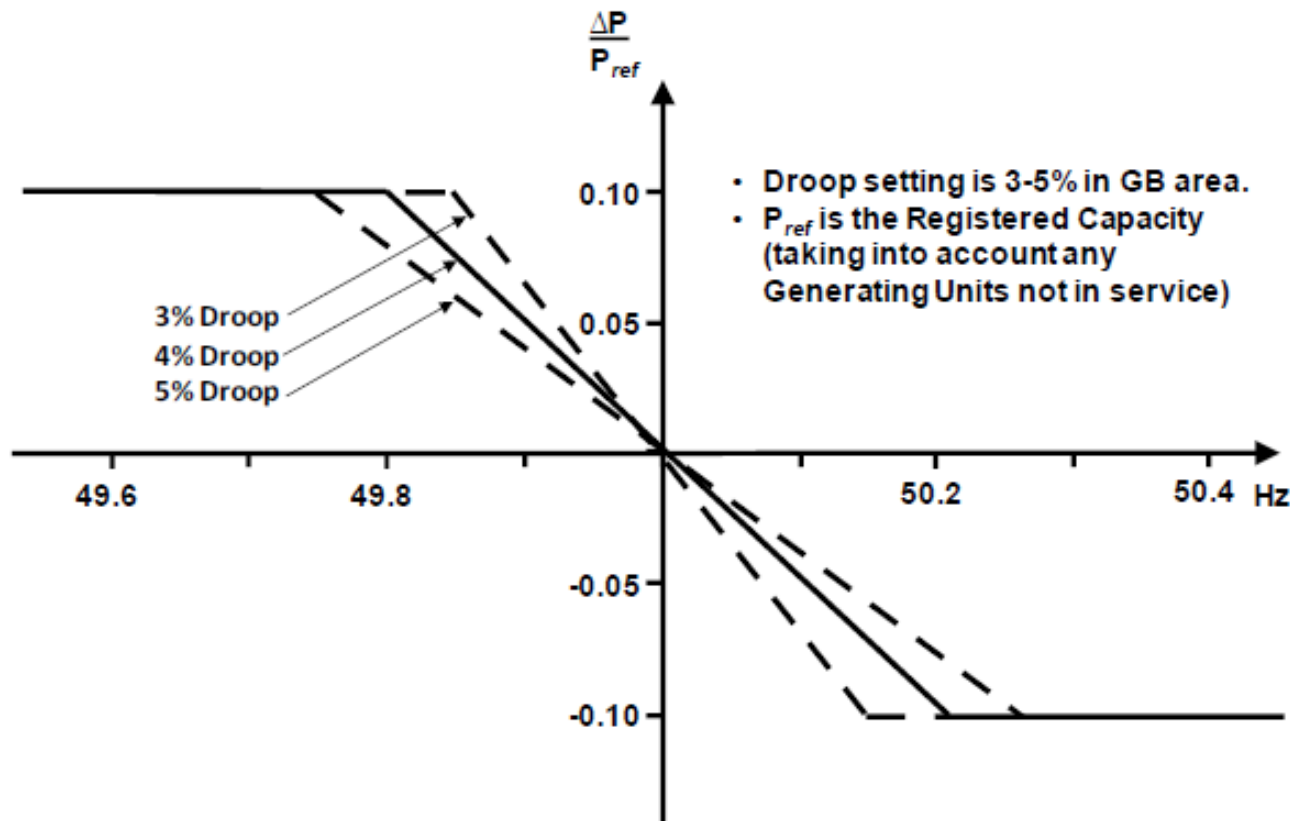
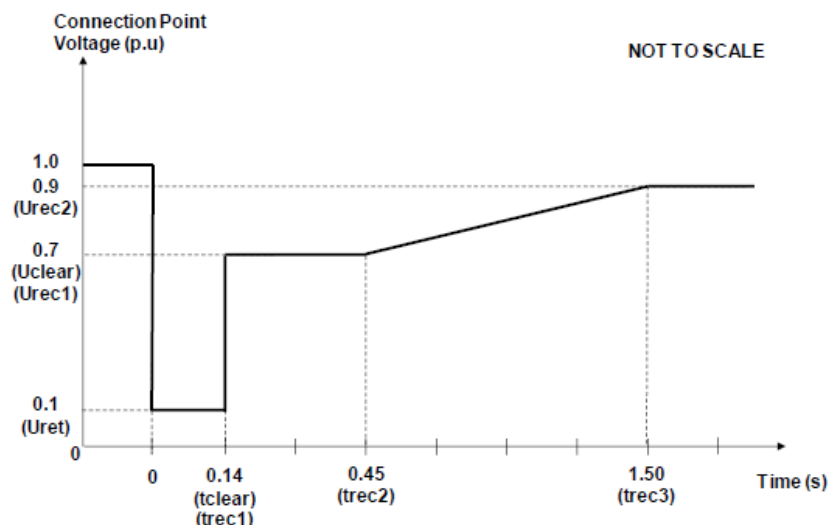


Figure 13.4 – Frequency Sensitive Mode capability of Power Generating Modules and Power Park Modules

# Type C & D Requirements (3)

## Fault Ride Through – Synchronous PGMs <110kV



**Figure 13.6 Voltage against time curve applicable to Type C and Type D Synchronous Power Generating Modules connected below 110 kV**

**Table 13.3 Voltage against time parameters applicable to Type C and D Synchronous Power Generating Modules connected below 110 kV**

Voltage parameters (pu)		Time parameters (s)	
$U_{ret}$	0.1	$t_{clear}$	0.14
$U_{clear}$	0.7	$t_{rec1}$	0.14
$U_{rec1}$	0.7	$t_{rec2}$	0.45
$U_{rec2}$	0.9	$t_{rec3}$	1.5

# Type C & D Requirements (4)

## Reactive Capability

- All Synchronous Power Generating Modules shall be capable of satisfying the Reactive Power capability defined in Figure 13.10 at Active Power output levels from the Registered Capacity to the level of Minimum Generation

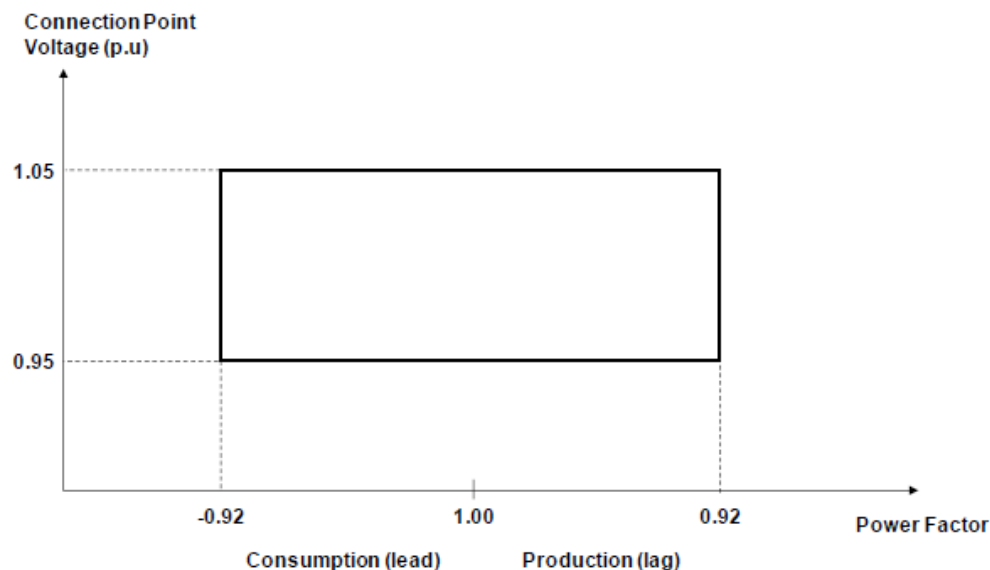


Figure 13.10 Reactive Power capability requirements (Synchronous Power Generating Modules)

# Type C & D Requirements (5)

## Reactive Capability – Power Park Modules

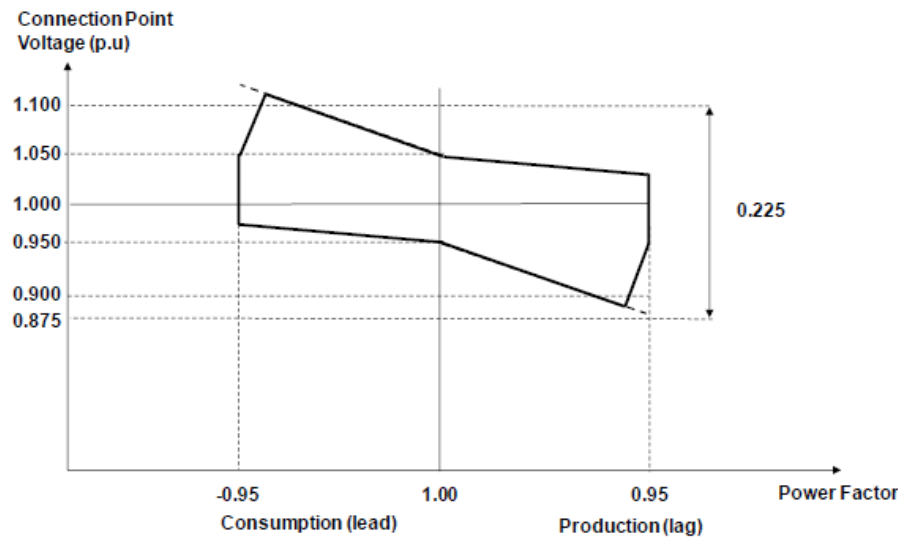


Figure 13.11 Reactive Power capability requirements (Power Park Modules operating at Registered Capacity, voltage above 33 kV)

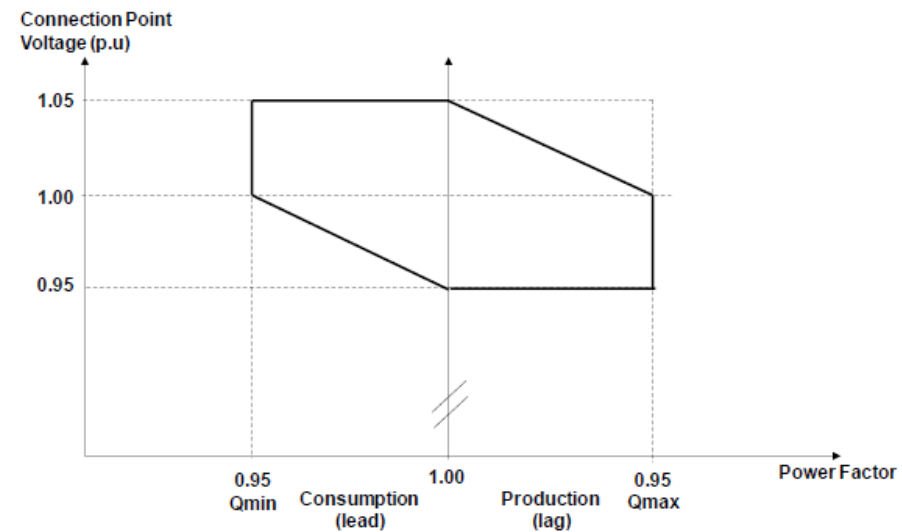


Figure 13.12 Reactive Power capability requirements (Power Park Modules operating at Registered Capacity, voltage at or below 33 kV)

# Type C & D Requirements (6)

## Operational Monitoring

- At each Power Generating Facility WPD shall install Tele-control / SCADA facilities.
- Each Power Generating Facility shall be fitted with fault recording, dynamic system monitoring facilities and operational monitoring capable of recoding system data including voltage, active power, reactive power, and frequency in accordance with G99 Annex C.6
- WPD also require Generators to install power quality monitoring in accordance with Annex C.6

# Additional Information

- DG Connection Guides
  - [G98 for Single Premises](#)
  - [G98 for Multiple Premises](#)
- Application / Notification Forms
  - [G98 Form A Application for Multiple Installations](#)
  - [G98 Form B Installation Document](#)
  - [G99 Form A1-1](#)
  - [G99 Standard Application Form](#)

# Additional Information

## ■ Type A Compliance Documentation

- [G99 Form A2-1 \(Up to 50kW\)](#)
- [G99 Form A2-2 \(Above 50kW\)](#)
- [G99 Form A2-3 \(Inverter Connected\)](#)
- [G99 Form A2-4 \(Site Commissioning / Testing\)](#)
- [G99 Form A3-1 \(Installation Document\)](#)

## ■ Type B Compliance Documentation

- [G99 Form B2-1 \(Power Generating Module Document\)](#)
- [G99 Form B2-2 \(Site Commissioning / Testing\)](#)
- [G99 Form B3 \(Installation Document\)](#)



# Additional Information

- Type C Compliance Documentation
  - [G99 Form C2-1 \(Power Generating Module Document\)](#)
  - [G99 Form C2-2 \(Site Commissioning / Testing\)](#)
  - [G99 Form C3 \(Installation Document\)](#)

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# Safety reminder at WPD/customer interface



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