Workshop on RfG Consultation on Parameter Selection

Ireland

16 January 2018

EirGrid Offices Dublin

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Agenda

Registration
09:00 – 09:30

Morning Session
09:30 – 12:30

- Background & Context
- Frequency Theme Part 1
- *Tea/Coffee Break*
- Frequency Theme Part 2
- System Restoration Theme

Lunch
12:30 – 13:30

Afternoon Session
13:30 – 4:30

- Voltage Theme Part 1
- *Tea/Coffee Break*
- Voltage Theme Part 2
- Protection Theme
- Close Out

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Important Information about RfG

- Applicability of RfG
- Requirements are based on P_{max}
- Banding thresholds for the ‘types of generators’
- New Topologies
- Who are the System Operators

Applicability of RfG

- RfG specifies requirements for connection & performance of generators.
- Requirements/parameters are broken down by type & in some instances sub-types
- Requirements/parameters can be generic or site specific

Applicability of RfG

- RfG **does not** apply to the following generators:
  - Existing operational generators
  - Generators whose main plant & equipment is procured* pre May 2018
  - Energy storage devices with the exception of pumped storage
- RfG **does**** apply to the following generators:
  - New i.e. those generators whose main plant & equipment is procured* post May 2018
  - Where a significant modification has been carried out to an existing unit.

** Contracts put in place*

***you must comply with the requirements of RfG which comes into force in May 2019*

Requirements are Based on Pmax

- Current Grid Code requirements are applied based on Maximum Export Capacity (MEC) or Registered Capacity.
- All generation subject to the RfG will be considered based on maximum capacity:
  - 'maximum capacity' or 'P_{max}' means the maximum continuous active power which a power-generating module can produce, less any demand associated solely with facilitating the operation of that power-generating module and not fed into the network as specified in the connection agreement or as agreed between the relevant system operator and the power-generating facility owner
  - i.e. the actual installed capacity less house load.
- **This represents a <u>fundamental change</u> to how requirements are applied to generators and should be fully understood by users.**

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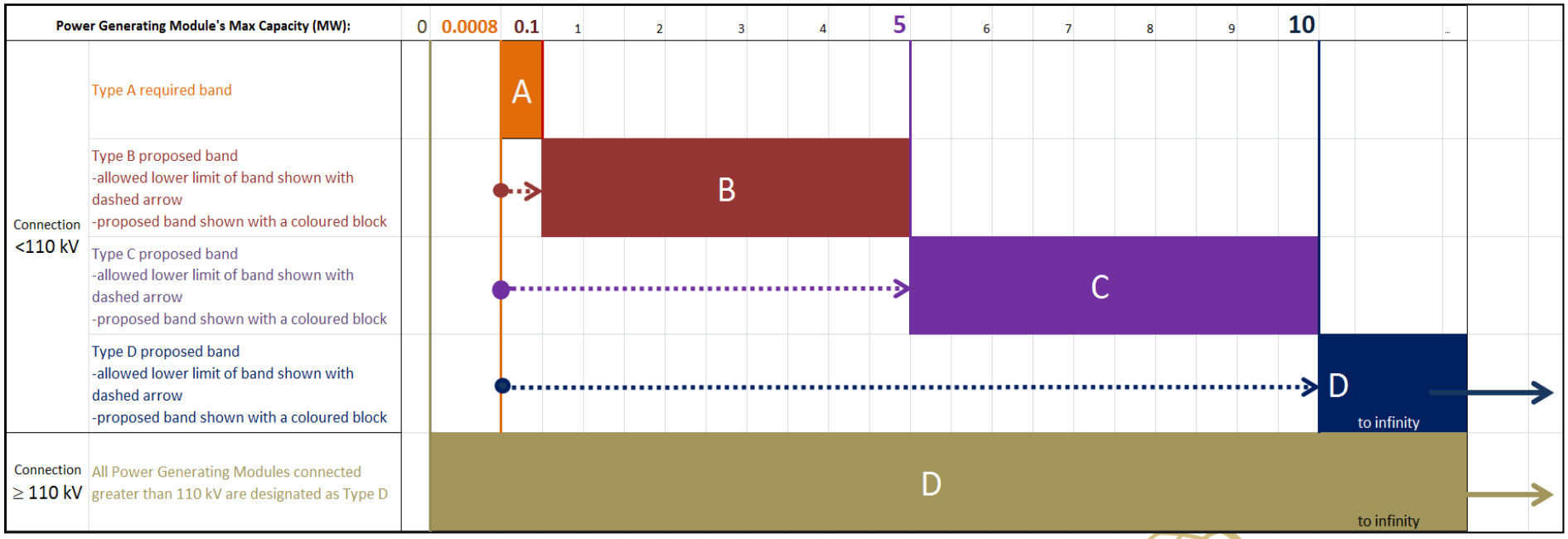
Banding Thresholds for Types

- Minded to Position on Banding Threshold proposes the following:



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Banding Thresholds for Types

- Minded to Position on Banding Threshold proposes the following:

TYPE	RANGE
Type A	800 W – 0.0999˙ MW
Type B	0.1 MW – 4.999˙ MW
Type C	5 MW – 9.99˙ MW
Type D < 110kV	10 MW <
Type D >110kV	ALL SIZES

Reconciliation of Types [Ireland Distribution Code]

- ESBN is therefore minded to re-badge the existing Distribution Code Types A to E, to the newly named “Topologies 1-5”.
- The definitions of these topologies will remain broadly as per the current Distribution Code but the opportunity will be taken to clean up the diagrams and text, where more clarity can be brought.
- It is recognised and acknowledged that the scope for confusion amongst users still remains but we believe this to be a valid approach.
- For the rest of this presentation, any reference to “Types” will mean those defined in Network Codes unless otherwise stated

Old Name	New Name
Type A	Topology 1
Type B	Topology 2
Type C	Topology 3
Type D	Topology 4
Type E	Topology 5

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System Operators

- RfG requests that requirements/parameters are defined by one of three bodies
  - Transmission System Operators
  - Distribution System Operators
  - Relevant System Operators: The system operator to which a generator is connected
- Requirements in the consultation document are proposed as follows:
  - ESB Networks as relevant DSO
  - ESB Networks as RSO
  - EirGrid as relevant TSO
  - EirGrid as RSO

Why Are We Consulting

- Required to submit a proposal of general application for approval by the national regulator by May 2018
- For many requirements a decision has to be made nationally about the exact requirements/parameters that are applicable in their jurisdiction
- It is not a requirement of RfG to consult upon the proposals prior to submission to the National Regulator
- However EirGrid& ESBN have commenced a joint consultation:
  - in the interest of transparency and,
  - to ensure that the TSO & DSO have the best information available to them when submitting the proposals to CRU
- Consultation opened on the 20th of December 2017 for a period of 6 weeks

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What Are We Consulting On

- Four Types of requirements exist:
  - **Mandatory** means the generator must do something
  - **Non-Mandatory** means TSO/DSO can choose to apply this requirement
  - **Exhaustive** means that a requirement or specific number is given in RfG
  - **Non-Exhaustive** means an allowable range is provided & TSO/DSO must select within that range

What are we consulting on:

- EirGrid& ESBN are consulting on non-mandatory requirements and non-exhaustive parameters.
- Seeking views on new or changed technical requirements that may or will apply to generators.

What are we not consulting on:

- Not seeking views on mandatory requirements or exhaustive parameters as they can't be changed. Further information is available in the ENTSO-E FAQ document.

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What Are We Consulting On

Non-Mandatory Requirement Selection

- In the majority of cases the following assumptions are made:
  - Where the RfG requirement is an existing requirement in IE, the requirement is made mandatory in IE.
  - Where the RfG requirement is not an existing requirement in IE, the requirement is not made mandatory in IE.

What Are We Consulting On

Non-Exhaustive Parameter Selection

- There are two examples of non-exhaustive parameter selection under RfG
  - Scenario 1: RfG mandates that the RSO selects the value from within a range
  - Scenario 2: RfG does not specify a range and mandates that the RSO specify a value.
- In the majority of cases for Scenario 1 the following assumptions are made:
  - where the range provided in the RfG does include the existing value applied in IE, the existing value is proposed.
  - where the range provided in the RfG does not include the existing value applied in IE, then the value proposed represents the minimum amount of change possible.
- In the majority of cases for Scenario 2 the following assumptions are made:
  - where the RfG does not provide a value for a non-exhaustive parameter and it is an existing parameter in IE, the existing value is proposed.
  - where the RfG does not provide a value for a non-exhaustive parameter and it is not an existing parameter in IE, a justification and/or discussion is given

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How We Developed the Consultation

- Team of experts from EirGrid& ESBN
- Selection of proposed parameters was based a review of the following:
  - Grid Code,
  - Distribution Code,
  - ESBN Conditions Governing… Generation.. document.,
  - Operational, Planning & Connection Procedures & Polices,
  - Current practices
- Engagement internally in EirGrid& ESBN
- Engagement with ENTSOE including National Link Person
- Engagement with other TSOs

How We Developed the Consultation

- Many of the requirements/parameters in the RfG exist today
- Significant work has been put into updating the Grid and Distribution Codes in recent years, especially as a result of DS3 work. It is not intended to revisit this work.
- Intention of EirGrid& ESBN, insofar as possible, when proposing these values was as follows;
  - To keep existing requirements
  - To make minimum amount of change to existing requirements
  - Not to use this as a mechanism to make dramatic changes to existing requirements
  - Not to use this as a mechanism to align north and south existing/new requirements

How We Developed the Consultation

- Theme based approach with sub-themes
  - Frequency
  - Voltage
  - System Restoration
  - Protection
- Justification Codes
  - 1: “In line with existing”:
  - 2: “As close as possible to the existing”
  - 3: “New of Different”
  - 4: “N/A”

Responding to the Consultation

- EirGrid& ESBN welcome feedback on the proposals either:
  - at the workshop today
  - using the template provided online and sent to gridcode@eirgrid.com
- In particular we are keen to know the following:
  - Do you agree with the proposed values for each of the specific parameters as set out in this paper
  - Do you think that other parameters should have been selected for any of the parameters?
  - If yes, please explain:
    - What values you would have proposed for the specific parameters.
    - Why you proposed the value including any costs/benefits/saving you believe will materialise from your proposal.
  - Do you believe that any non-exhaustive parameters or non-mandatory requirements have been excluded from this document incorrectly
    - If yes, please detail the RfG reference

Helpful Documents for Reviewing the Consultation

- ENTSO-E non-binding implementation guidance documents IGDs to aid RfG adoption
  - 18 guidance documents are available at: https://www.entsoe.eu/news-events/announcements/announcements-archive/Pages/18-RfG-related-implementation-guidance-documents.aspx
  - Specifically the “Parameters of Non-Exhaustive Requirements” is helpful in this context, RfG is laid out in pages 7-15
  - https://www.entsoe.eu/Documents/Network%20codes%20documents/NC%20RfG/161116_IGD_General%20guidance%20on%20parameters_for%20publication.pdf?Web=1
- Requirements for Generators Network Code: articles 13-28 for parameters
  - http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0631&qid=1472462777329&from=en
- Consultation Document & Response Template
  - http://www.eirgridgroup.com/customer-and-industry/european-integration/integration/#comp_000059799323_0000007c19_05f8
- Acronyms List
  - Provided to all participants of today’s workshop
  - Available online from tomorrow.

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Next Steps

- Consultation closes on the 9th of February 2018
- EirGrid & ESBN shall:
  - consider any comments received,
  - Submit a proposal to the CRU.
- CRU to review and approve proposals

Knock on Impacts of RfG Parameter Selection

- Post approval of parameters the following will need to be updated:
  - Distribution Code – during 2018,
  - Grid Code – commencing 2019,

- Need to be reviewed and may need to be updated
  - Connection Agreements / Connection Offers templates,
  - Internal Processes,
  - External processes for connection, compliance testing, operational certification processes, others…
  - ETC…

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Purpose of the Workshop

- We are hosting this workshop to ensure that all participants understand the basis for the consultation and the concepts in the Consultation Paper
- Additional background is available in the Consultation Paper
- This workshop gives an opportunity:
  - For participants to ask questions on the consultation
  - For EirGrid & ESBN to explain the justifications for any new/revised parameter proposals

Format of the Workshop

- Each theme will be covered separately
- We will step through the theme, article by article
- We will present the requirements & proposals from the consultation paper
- We will discuss the justification for the proposals in more detail
- Experts from EirGrid& ESBN will present jointly on the relevant articles under each theme
  - Either as relevant TSO, relevant DSO or RSO

Acronyms of Note for the Workshop

- PGM – Power Generating Module
- SPGM – Synchronous Power Generating Module
- PPM – Power Park Module (PGM connected behind power electronics or asynchronously to the system
- RSO – Relevant System Operator

Frequency Theme

Miriam Ryan (TSO)

Tony Hearne (DSO)

Frequency Ranges

Article 13.1 (a) (i): Frequency Ranges

- Section Number 4.1.1.1
- *A power-generating module shall be capable of remaining connected to the network and operate within the frequency ranges and time periods specified in the* table below.
- Note that only the item in bold is a non-exhaustive parameter and therefore subject to consultation. The other parameters are provided for context.

Article 13.1 (a) (i): Frequency Ranges

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Frequency Ranges	*47,5 Hz-48,5 Hz for 90 minutes*	*Mandatory*	*13.1.a.(i)*	*A, B, C, D PGMs and Offshore PPMs*	*N/A*
Frequency Ranges	48,5 Hz-49,0 Hz for a time to be specified by each TSO, but not less than 90 minutes	90 Minutes	13.1.a.(i)	*A, B, C, D PGMs and Offshore PPMs*	2
Frequency Ranges	*49,0 Hz-51,0 Hz for an unlimited time*	*Mandatory*	*13.1.a.(i)*	*A, B, C, D PGMs and Offshore PPMs*	*N/A*
Frequency Ranges	*51,0 Hz-51,5 Hz for 90 minutes*	*Mandatory*	*13.1.a.(i)*	*A, B, C, D PGMs and Offshore PPMs*	*N/A*

Table 2 Frequency Withstand Time Periods

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Article 13.1 (a) (i): Frequency Ranges

- The RfG requires that the minimum operational time in the frequency range of 48.5 to 49.0 Hz is 90 minutes. The current Grid Code requirement is 60 minutes within this frequency range.
- The proposed parameter of 90 minutes is the closest allowable to the existing Grid Code requirement.

Rate of Change of Frequency

Article 13.1 (b): RoCoF

- Section Number 4.1.2.1

- *With regard to the rate of change of frequency withstand capability, a power-generating module shall be capable of staying connected to the network and operate at rates of change of frequency up to a value specified by the relevant TSO, unless disconnection was triggered by rate-of-change-of-frequency-type loss of mains protection. The relevant system operator, in coordination with the relevant TSO, shall specify this rate-of-change-of-frequency-type loss of mains protection*.

Article 13.1 (b): RoCoF

Proposal: RoCoF Withstand Capability

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
The maximum RoCoF for which the Power Generating Module (PGM) shall stay connected	Not Specified	1 Hz/s over 500ms window	13.1.b	A, B, C and D PGMs & Offshore PPMs	1

Table 3 Rate-of-change-of-frequency-type loss of mains protection

Article 13.1 (b): RoCoF

Loss of Mains Protection [Transmission Connected]

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
The proposal for loss of mains protection [Transmission Connected]	Not Specified	is 1 Hz/s over 500ms window	13.1.b	D PGMs and Offshore PPMs	1

Table 4 Rate-of-change-of-frequency-type loss of mains protection [Transmission Connected]

Article 13.1 (b): RoCoF

Loss of Mains Protection [Distribution Connected]

Parameter	Parameter in RfG	Consultation Proposal				Article Number	Type Applicability	Justification Code
		Positive and Negative RoCoF						
		Generator Category		Pick Up	Time Delay			
The proposal for loss of mains protection [Distribution Connected]	Not Specified	DFIG / Full Converter Generator		2 Hz/s	0.3s	13.1.b	A, B, C and D PGMs and Offshore PPMs	1
		Synchronous Generator / Directly Connected Induction Generator	H > 3 MWs /MVA	0.6 Hz/s	0.6s			
		Synchronous Generator / Directly Connected Induction Generator	H ≤ 3 MWs /MVA	1.0 Hz/s	0.6s			

Table 5 Rate-of-change-of-frequency-type loss of mains protection

Article 13.1 (b): RoCoF

Justification: Existing settings as per “Conditions Governing…..”

Active Power Control

Article 13.4.a: Admissible reduction from maximum output with falling frequency

- Section Number 4.1.3.1

- *The relevant TSO shall specify admissible active power reduction from maximum output with falling frequency in its control area as a rate of reduction falling within the boundaries, illustrated by the full lines* in Figure 1 below.

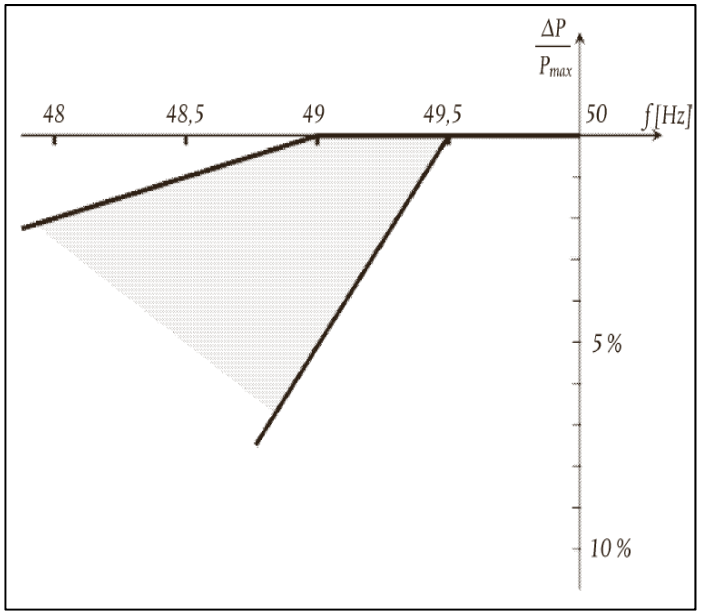
Article 13.4.a: Admissible reduction from maximum output with falling frequency

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Admissible active power reduction from maximum output with falling frequency	below 49 Hz falling by a reduction rate of 2% of the maximum capacity at 50 Hz per 1 Hz frequency drop **or** below 49.5 Hz falling by a reduction rate of 10% of the maximum capacity at 50 Hz per 1 Hz frequency drop.	below 49 Hz falling by a reduction rate of 2% of the maximum capacity at 50 Hz per 1 Hz frequency drop	13.4 (a)	A, B, C and D PGMs and Offshore PPMs	3

Table 6 Admissible active power reduction from maximum output with falling frequency

Article 13.4.a: Admissible reduction from maximum output with falling frequency

- As the system frequency decreases, it is essential that any reduction in generation output is minimized, in order to prevent the system frequency from falling any further.
- The proposal is to allow a maximum decrease in generation output of 2 %, when the frequency is below 49 Hz.
- The intention is that by minimising the reduction in generation output, it will lessen any further reduction in system frequency.



Article 13.5: Admissible reduction from maximum output with falling frequency taking Account of Technical Capabilities of PGMs

- Section Number 4.1.3.2

- *The admissible active power reduction from maximum output shall: (a) clearly specify the ambient conditions applicable; (b) take account of the technical capabilities of power-generating modules.*

Article 13.5: Admissible reduction from maximum output with falling frequency taking Account of Technical Capabilities of PGMs

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Ambient Conditions	Not Specified	10°C, 70% relative humidity and 1013 hPa.	13.5	Gas-fired SPGMs (A, B, C and D).	3

Table 7 Admissible active power reduction from maximum output

Article 13.5: Admissible reduction from maximum output with falling frequency taking Account of Technical Capabilities of PGMs

- The proposal is to use the same ambient conditions as are currently used in the Grid Code for assessing the registered capacity of a generation unit (Gas fired generation units only).
- These conditions were selected in order to ensure consistency when assessing the output of the PGMs.

Article 13.6: Remote operation of facility to cease active power output

- Section Number 4.1.3.3

- *The power-generating module shall be equipped with a logic interface (input port) in order to cease active power output within five seconds following an instruction being received at the input port. The relevant system operator shall have the right to specify requirements for equipment to make this facility operable remotely.*

Article 13.6: Remote operation of facility to cease active power output

Requirement	Requirement in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Specify requirements for equipment to make this facility operable remotely for Type A	A right to specify	Maintain the right to specify for Type A only in due time for plant design (c/f Art 14 (2) (b) for Type B	13.6	A and B PGMs	1

Table 8 Specify requirements for equipment to make this facility operable remotely for Type A

Article 13.6: Remote operation of facility to cease active power output

Justification

The proposal is to maintain the right to specify the requirement for remote control equipment but to advise on a case by case basis, as necessary, taking into consideration that the specific requirements will be dependent on the plant design and compatibility requirements.

The intention of the phrase, ‘in due time for plant design’ is intended to mean during the connection offer phase.

However, a D Code mod will separately be proposed to the DCRP, which will:

- Introduce a reduced threshold of 1MW for real power controllability of PPMs
- PPMs will be defined to include wind farm power stations (WFPS) and solar farm power stations (SFPS)
- Apply most technical requirement applicable to WFPS, to SFPS

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Article 13.7: Automatic connection to the network

- Section Number 4.1.3.4

- *The relevant TSO shall specify the conditions under which a power-generating module is capable of connecting automatically to the network. Those conditions shall include:*
  - *a. frequency ranges within which an automatic connection is admissible, and a corresponding delay time; and*
  - *b. maximum admissible gradient of increase in active power output.*

Automatic connection is allowed unless specified otherwise by the relevant system operator in coordination with the relevant TSO.

Article 13.7: Automatic connection to the network

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Frequency Ranges and Time Delay	Non-specific	49.8 Hz to 50.2 Hz with a five minute delay	13.7	A, B, and C PGMs	1
Maximum admissible gradient of increase in power	Non-specific	10% of Pmax per minute	13.7	A, B and C PGMs	3
Allowing automatic connection	A right to not allow	Allow	13.7	A, B and C PGMs	1

Table 9 Conditions under which a PGMs is capable of connecting automatically to the network

Article 13.7: Automatic connection to the network

- For Distribution connected Generators, this is already allowed in Conditions Governing…

- RfG mandates the stipulation of a new parameter: **Maximum admissible gradient of increase in power.**
- Figure of 10% of Pmax per minute chosen [Typo in Consultation – says 3%]

Justification

Amongst the Distribution Network Planning criteria, is for 10% voltage step change limit. The figure chosen would give a resulting voltage change of 1% per minute, which is considered to be consistent with time delay settings for tap-changer operation.

Article 14.2.b: Remote operation of power output

- Section Number 4.1.3.5

- *Type B PGMs shall fulfil the following requirements in relation to frequency stability:*
  - *(a) to control active power output, the power-generating module shall be equipped with an interface (input port) in order to be able to reduce active power output following an instruction at the input port;*
  - *(b) the relevant system operator shall have the right to specify the requirements for further equipment to allow active power output to be remotely operated*.

Article 14.2.b: Remote operation of power output

Requirement	Requirement in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Right to specify the requirements for further equipment to allow active power output to be remotely operated	To specify or not to specify	RSO to specify for Type B generators with a maximum capacity 1 MW and above; in due time for plant design.	14.2 (b)	B PGMs	3

Table 10 Remote operation of Power Output

Article 14.2.b: Remote operation of power output

Justification

The proposal is to maintain the right to specify the requirement for remote control equipment but to advise on a case by case basis, as necessary, taking into consideration that the specific requirements will be dependent on the plant design and compatibility requirements.

The intention of the phrase, ‘in due time for plant design’ is intended to mean during the connection offer phase.

However, a Distribution Code modification has issued separately to the DCRP, in which:

- a reduced threshold of 1MW for real power controllability of PPMS
- PPMs will be defined to include WFPS and Solar Farm Power Stations SFPS’
- Apply most technical requirement applicable to windfarms, to SFPS’

Article 15.2.a: Achieving Active Power Set points

- Section Number 4.1.3.6

- *power-generating modules shall fulfil the following requirements relating to frequency stability:*
  - *a. with regard to active power controllability and control range, the power-generating module control system shall be capable of adjusting an active power set point in line with instructions given to the power-generating facility owner by the RSO or the relevant TSO.*

- *The relevant system operator or the relevant TSO shall establish the period within which the adjusted active power set point must be reached. The relevant TSO shall specify a tolerance (subject to the availability of the prime mover resource) applying to the new set point and the time within which it must be reached;*

Article 15.2.a: Achieving Active Power Set points

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
The period within which the adjusted active power setpoint must be reached	No range provided	10 seconds response time plus the ramp rate for the unit. NB where wind turbines have to be turned on to achieve the set point then a maximum of 3 minutes response time is allowed.	15.2 (a)	C and D PGMs	1
Tolerance (subject to the availability of the prime mover resource) applying to the new setpoint and the time within which it must be reached	No Range Provided	For PGMs, the maximum of 1 MW or 1% of dispatch quantity is applied. For PPMs, the maximum of +/- 3% of registered capacity or +/- 0.5 MW.	15.2 (a)	C and D PGMs	3

Table 11: Achieving Active Power Set-points

Article 15.2.a: Achieving Active Power Set points

- The proposed tolerance limits are as per the current operational and market monitoring tolerances. This will ensure that monitoring and assessment of active power set point is consistent for all PGMs, PPMs and existing generation units.

Frequency Modes

Frequency Modes Explanation

- Limited Frequency Sensitive Mode Over Frequency (LFSM-O)
- Limited Frequency Sensitive Mode Under Frequency (LFSM-U)
- Frequency Sensitive Mode (FSM)

RfG Frequency Control Mode	Equivalent Grid Code Frequency Control Mode for PPMs	Equivalent Grid Code Frequency Control Mode for SPGM
LFSM-O	PPM in wind following mode & curve 1	Not applicable in Ireland today
LFSM-U	Not applicable in Ireland today	Not applicable in Ireland today
FSM Normal	PPM in active power set point control mode & curve 1 or curve 2 PPM in wind following mode & curve 2	Normal governor regulation
FSM Frequency Step Change	As above	Operating Reserves

Article 13.2.a: LFSM-O Parameter Selection

- Section Number 4.1.4.2

- *With regard to the limited frequency sensitive mode — over frequency (LFSM-O), the following shall apply, as determined by the relevant TSO for its control area in coordination with the TSOs of the same synchronous area to ensure minimal impacts on neighbouring areas:*
  a. *the power-generating module shall be capable of activating the provision of active power frequency response at a frequency threshold and droop settings specified by the relevant TSO*;

Article 13.2.a: LFSM-O Parameter Selection

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Frequency threshold	Between 50.2-50.5 Hz	50.2 Hz	13.2(a)	A, B, C and D PGMs & offshore PPMs	1
Droop settings	Between 2-12 %	Machines should be capable of operating in the range 2-12%. The default setting is 4%	13.2(a)	A, B, C and D PGMs & offshore PPMs	1

Table 12: LFSM-O Parameter Selection

Article 13.2.b: LFSM-O: Automatic disconnection and reconnection

- Section Number 4.1.4.3

- *instead of the capability referred to in paragraph (a), the relevant TSO may choose to allow within its control area automatic disconnection and reconnection of power-generating modules of Type A at randomised frequencies, ideally uniformly distributed, above a frequency threshold, as determined by the relevant TSO where it is able to demonstrate to the relevant regulatory authority, and with the cooperation of power-generating facility owners, that this has a limited cross-border impact and maintains the same level of operational security in all system states;*

Article 13.2.b: LFSM-O: Automatic disconnection and reconnection

Requirement	Requirement in RfG	Consultation Proposal	Article Number	Applicable Type	Justification Code
Automatic disconnection and reconnection of PGMs	Allow or do not allow	Do not allow	13.2 (b)	A PGMs	1

Table 13: LFSM-O Automatic Disconnection & Reconnection

Article 13.2.f: LFSM-O: Actions at minimum regulating level

- Section Number 4.1.4.4

- *The relevant TSO may require that upon reaching minimum regulating level, the power-generating module be capable of either:*
  - *i. continuing operation at this level; or*
  - *ii. further decreasing active power output;*

Article 13.2.f: LFSM-O: Actions at minimum regulating level

Requirement	Requirement in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Actions in LFSM-O upon reaching minimum regulating level,	Choose between (i) continuing operation at this level; or (ii) further decreasing active power output	(i) continuing operation at this level;	13.2 (f)	A, B, C and D PGMs & offshore PPMs	1

Table 14: LFSM-O Actions at Minimum Regulating Level

Article 15.2.c: LFSM-U Parameter Selection

- Section Number 4.1.4.5

- *the power generating module shall be capable of activating the provision of active power frequency response at a frequency threshold and with a droop specified by the relevant TSO in coordination with the TSOs of the same synchronous area as follows:*

  – the frequency threshold specified by the TSO shall be between 49.8 Hz and 49.5 Hz inclusive;

  – the droop settings specified by the TSO shall be in the range 2 – 12%.

Article 15.2.c: LFSM-U Parameter Selection

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Frequency threshold	between 49.8 Hz and 49.5 Hz inclusive	49.5 Hz	15.2 (c)	C and D PGMs & offshore PPMs	1
Droop settings	2-12%	Default is 4% unless otherwise specified by the TSO on a site specific basis	15.2 (c)	C and D PGMs & offshore PPMs	1

Table 12 LFSM-U Frequency Threshold & Droop Settings

Article 15.2.d.(i) and (ii): FSM Parameter Selection

- Section Number 4.1.4.6

i. *The power-generating module shall be capable of providing active power frequency response in accordance with the parameters specified by each relevant TSO within the ranges shown in Table 4* (as given in the RfG*). In specifying those parameters, the relevant TSO shall take account of the following facts:*

- *In case of over frequency, the active power frequency response is limited by the minimum regulating level,*
- *In case of under frequency, the active power frequency response is limited by maximum capacity,*
- *The actual delivery of active power frequency response depends on the operating and ambient conditions of the power-generating module when this response is triggered, in particular limitations on operation near maximum capacity at low frequencies according to paragraphs 4 and 5 of Article 13 and available primary energy sources;*

ii. *The frequency response dead band of frequency deviation and droop must be able to be reselected repeatedly;*

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Article 15.2.d.(i) and (ii): FSM Parameter Selection

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Active Power Range (ΔP/Pmax)	1.5-10%	Not proposing a value at this time See note below	15.2 (d) (i) and (ii)	C and D PGMs & offshore PPMs	1
Frequency Response Insensitivity (Δf)	10-30 mHz	15mHz*	15.2 (d) (i) and (ii)	C and D PGMs & offshore PPMs	3
Frequency Response Insensitivity (Δf/f)	0.02-0.06%	0.03%	15.2 (d) (i) and (ii)	C and D PGMs & offshore PPMs	3
Frequency Response Deadband	0-500mHz	+/-15mHz*	15.2 (d) (i) and (ii)	C and D PGMs& offshore PPMs	3
Droop	2-12%	Depends on gen type – default is 4%	15.2 (d) (i) and (ii)	C and D PGMs & offshore PPMs	1

Table 16 FSM Parameter Selection

Article 15.2.d.(i) and (ii): FSM Parameter Selection

- The TSO have consulted with the ENTSO-E Frequency Expert Group in relation to FSM and it has confirmed that this parameter was included in the above table as an error and as such will not be specified as part of this consultation.
- There is no distinction between Frequency Response Insensitivity and Frequency Response Deadband **in the Grid Code.**
- The proposal is to set the both the Frequency Response Insensitivity and Frequency Response Deadband to +/- 15 mHz. This aligns with the current Grid Code requirement for the existing definition of the Frequency Response Deadband.
- Under the SOGL, the maximum combined effect of the Frequency Response Insensitivity and Frequency Response Deadband cannot exceed +/- 15 mHz.

Article 15.2.d.(iii): FSM: Step Change in Frequency

- Section Number 4.1.4.7

- *In the event of a frequency step change, the power-generating module shall be capable of activating full active power frequency response, at or above the full line shown in Figure 6* (as given in the RfG) *in accordance with the parameters specified by each TSO (which shall aim at avoiding active power oscillations for the power-generating module) within the ranges given in Table 5* (as given in the RfG) *. The combination of choice of the parameters specified by the TSO shall take possible technology-dependent limitations into account;*

Article 15.2.d.(iii): FSM: Step Change in Frequency

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Active power range	1.5-10%	5%	15.2 (d) (iii)	C and D PGMs & offshore PPMs	3
Admissible initial time delay for activation of active power frequency response for PGMs	*2s*	*2s*	*15.2 (d) (iii)*	*C and D PGMs & offshore PPMs*	*N/A*
Admissible initial time delay for activation of active power frequency response for PPMs	Less than 2 seconds	0s No time delays other than those inherent in the design of the frequency response system	15.2 (d) (iii)	C and D PGMs & offshore PPMs	3
Maximum admissible choice of full activation time	30 seconds	5s	15.2 (d) (iii)	C and D PGMs & offshore PPMs	3
Capability relating to the duration of provision of full active power frequency response	15-30 minutes	20min	15.2 (d) (v)	C and D PGMs & offshore PPMs	3

Table 17 Activating full active power frequency response

Article 15.2.d.(iii): FSM: Step Change in Frequency

- For SPGMs, the proposal for the active power range is 5%, which aligns with the existing Primary and Secondary operating reserve.
- For PPMs, The current requirements in the Grid Code require a 60% increase in Active Power within 5 seconds and 100% of expected increase (droop response) within 15 seconds. This requirement is core to the achievement of a 40% RES-E target and the ability to operate the system at System Non Synchronous Penetration (SNSP) levels up to 75%. The RfG range in Article 15.2.d only allows us specify a value for the change in power output relative to the Active Power output at the moment the frequency threshold was reached (or the maximum capacity as defined by the TSO) between 1.5-10% i.e. it does not allow us to specify the levels that currently exist in the Grid Code. However to lose the capability provided for in today's Grid Code would be very damaging to the success of the DS3 program and ultimately to the integration of high levels of renewable energy into the power system.
- We do not believe that the regulations intentionally undermine this capability and therefore we are going to investigate options to retain todays Grid Code requirements for PPMs.
- For the avoidance of doubt, in this consultation we have reflected the permissible ranges in the RfG but respondents should understand that it is our intention to retain the Grid Code requirements for PPMs, in addition to the RfG requirements.

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Article 15.2.d.(iii): FSM: Step Change in Frequency

- In order to align with the current Grid Code requirement, which states that no time delays are allowed other than those which are inherent in the design of the frequency response system, the proposal is to set the admissible time delay for activation of active power frequency response to 0 seconds.
- It is proposed to establish a time of 5 seconds for the maximum admissible choice of full activation time, to align with the existing Grid Code requirements for primary and secondary operating reserves.
- The proposed time of 20 minutes for the capability relating to the duration of the provision of full active power frequency response is intended to allow for the provision of replacement reserves, as per the existing Grid Code requirements.

Additional Requirements Not Invoking

Additional Non-Mandatory Frequency Requirements

Requirement	Requirement in RfG	Consultation Proposal	Article Number	Type Applicability
Shorter initial FSM response delay for PGMs without inertia	Not specified	Not Mandatory – can be agreed on a case by case basis with System Services Contracts	15.2.d(iv)	Type A, B, C and D PGMs and offshore PPMs
Synthetic inertia capability for PPM	Not Specified	Not Mandatory – can be agreed on a case by case basis with System Services Contracts	21(2)	C and D PPMs

Table 18 - Areas with non-mandatory requirements detailed in the RfG

Q&A

System Restoration Theme

Miriam Ryan (TSO)

Article 15.5.c.(iii) Operation following tripping to house load

- Section Number 4.3.1

- *A power-generating module with a minimum re-synchronisation time greater than 15 minutes after its disconnection from any external power supply must be designed to trip to houseload from any operating point in its P-Q-capability diagram. In this case, the identification of houseload operation must not be based solely on the system operator's switchgear position signals. Power-generating modules shall be capable of continuing operation following tripping to houseload, irrespective of any auxiliary connection to the external network. The minimum operation time shall be specified by the relevant system operator in coordination with the relevant TSO, taking into consideration the specific characteristics of prime mover technology*

Article 15.5.c.(iii) Operation following tripping to house load

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Operation Following Tripping to House Load	Not Specified	4 hours	15.5.c.iii	C and D PGMs and offshore PPMs with a minimum re-synchronisation time greater than 15 minutes*	2/3

Table 49: Operation Following Tripping to House Load

Article 15.5.c.(iii) Operation following tripping to house load

- Under the Blackstart plan, it is envisaged that the transmission system would re-synchronised within four hours. Hence, it is proposed that the operational time for PPMs in house load mode is four hours to align with the Blackstart plan.

- **Justification code 2 applies to the 15mins**
- **Justification code 3 applies to the 4 hours**

Q&A

Lunch

Reconvene @ 13:30

Voltage Theme

Daniel Schweer (TSO)

Tony Hearne (DSO)

Automatic Disconnection

Article 15.3& 16.2.c : Type C/D – [Distribution Connected] Automatic Disconnection Due to Voltage Level

- Section Number 4.2.1.1& 4.2.1.2

- *With regard to voltage stability, type C and D power-generating modules shall be capable of automatic disconnection when voltage at the connection point reaches a minimum/maximum voltage level for a certain period of time.*

Article 15.3& 16.2.c : Type C/D – [Distribution Connected] Automatic Disconnection Due to Voltage Level

Parameter	Parameter in RfG	Consultation Proposal		Type Applicability	Justification Code
		Voltage	Duration		
Minimum Voltage below which Module will automatic disconnect	Not specified	0.87 p.u.	3s	C and D (PPM)	1
	Not specified	0.8 p.u.	1.1s		1
	Not specified	0.87 p.u.	2.5s	C and D (SPGM)	1
	Not specified	0.8 p.u.	0.7s		1
Maximum Voltage above which Module will automatic disconnect	Not specified	1.12 p.u.	0.7s	C and D PGMs	1

Table 19: Parameters for Automatic Disconnection

Article 15.3& 16.2.c *: Type C/D* – [Distribution Connected] Automatic Disconnection Due to Voltage Level

- Justification: These under-voltage settings are already part of G10 /EGIP protection requirements as specified in Conditions Governing….

Article 16.2.c: Type D - [Transmission Connected] Automatic Disconnection Due to Voltage Level

- Section Number 4.2.1.2
- Specify voltages at the connection point at which a power-generating module is capable of automatic disconnection.

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Minimum Voltage below which Module will automatic disconnect	Not specified	Not Allowed	16.2.c	D PGMs	3
Maximum Voltage above which Module will automatic disconnect	Not specified	Not Allowed	16.2.c	D PGMs	3

Table 20: Type D Parameters for Automatic Disconnection

- Generators shall stay connected within voltage ranges specified in the code
  - ➢ No voltage threshold for automatic disconnect is specified

Reactive Power Capability for Type B PGMs

Article 17.2.a: Reactive Power capability for Type B SPGMs

- Section Number 4.2.2.1.1

- *with regard to reactive power capability, the relevant system operator shall have the right to specify the capability of a synchronous power generating module to provide reactive power;*

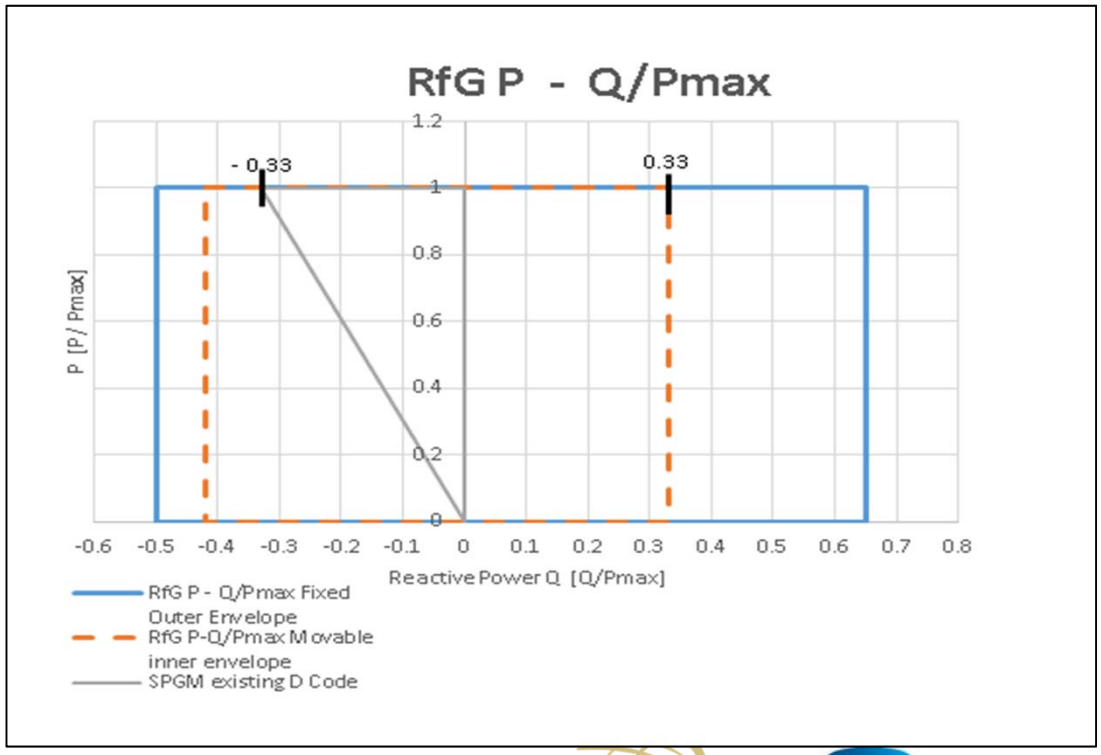
Article 17.2.a: Reactive Power capability for Type B SPGMs

Requirement	Requirement in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
right to specify the capability of a synchronous power generating module to provide reactive power;	To specify or not to specify	Maintain existing reactive power requirements in the Distribution Code.	18.2.a	Type C and D SPGMs	1

Table 22: Right to specify reactive power capability for SPGMs

Article 17.2.a: Reactive Power capability for Type B SPGMs

- Existing power factor requirements for generators not covered by specific requirements in Section 11 for wind generators, are stipulated in DCC 6.9.1 It states that….
- *The **Customer** shall take all reasonable steps to operate the **Plant** and the facility to keep the power factor of the total load at the **Connection Point** for imported electricity between 0.90 lagging and unity and for exported electricity between 0.95 lagging and unity*
- *This existing requirement is within the "boxes" stipulated by RfG*



Article 20.2.a: Reactive Power Capability for Type B PPMs

- Section Number 4.2.2.1.2

- *with regard to reactive power capability, the relevant system operator shall have the right to specify the capability of a power park modules to provide reactive power;*

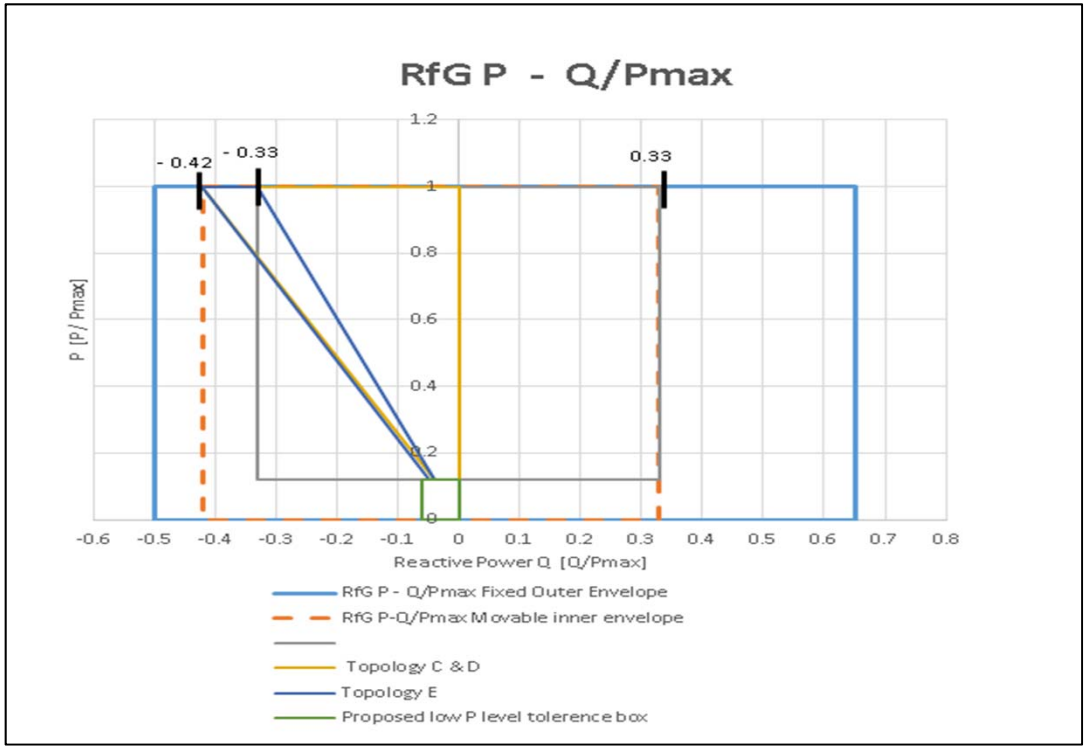
Article 20.2.a: Reactive Power capability for Type B PPMs

Requirement	Requirement in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
right to specify the capability of a synchronous power generating module to provide reactive power;	To specify or not to specify	Maintain existing reactive power requirements in the Distribution Code.	18.2.a	Type C and D SPGMs	1

Table 23: Right to specify reactive power capability for PPMs

Article 20.2.a: Reactive Power Capability for Type B PPMs

- For Wind Generation, all existing D-Code P-Q requirements are within the “boxes” stipulated by RfG
- Existing “Types” will be re-cast as Topologies post adoption of RfG requirements into the D-Code
- Upcoming D-Code mode to define PPM – includes solar and wind.



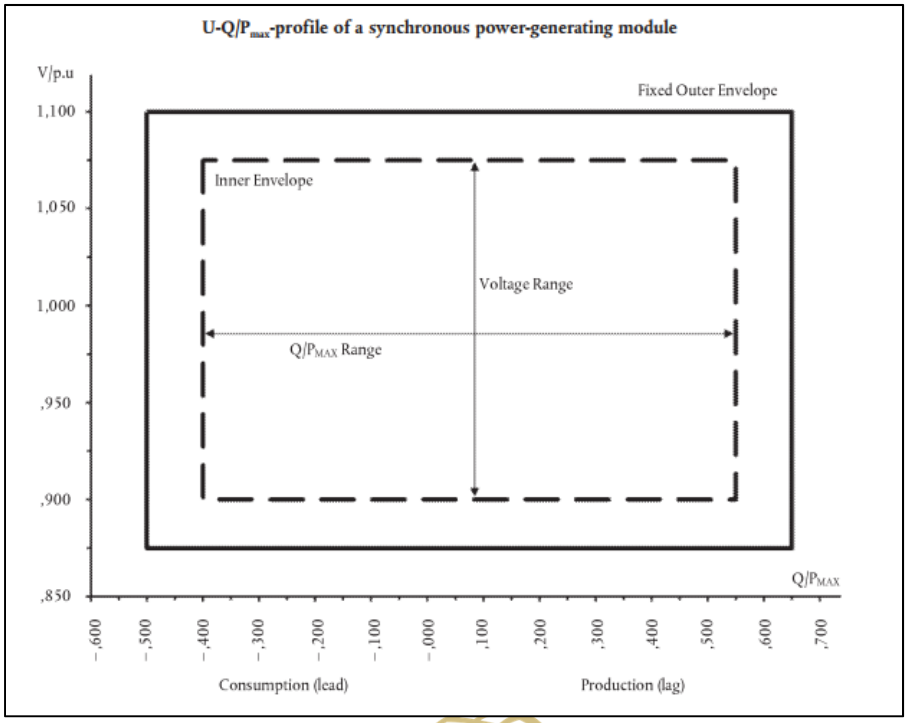
Reactive Power Capability at Maximum Capacity: U-Q/Pmax Profiles

Article 18.2.b.(i): Type C/D SPGM Parameters required for U-Q/Pmax Profiles

- Section Number 4.2.2.2.1

- Specify reactive power provision capability requirements at **the connection point** for **maximal active power** output in conformity with following principles

1. U-Q/P_{max}-profile shall not exceed the inner envelope
2. Dimensions shall be in range of
   - Q/P_{max} Range = 1.08 pu
   - Steady voltage level = 0.218 pu
3. U-Q/P_{max}-profile shall be within the limits of fixed outer envelope



Article 18.2.b.(i): Type D SPGM - connection @ ≥110 kV Parameters required for U-Q/Pmax Profiles

Connection Voltage	Parameter	Parameter in RfG (outer envelope)	Consultation Proposal (Inner Envelope)	Type Applicability	Justification Code
110 kV	u_{min}	0.875 p.u.	0.9 p.u.	D SPGMs	1
	u_{max}	1.1 p.u.	1.1 p.u.		2
	Q_{min}/P_{max} (lead)	-0.5 p.u.	-0.5 p.u.		2
	Q_{max}/P_{max} (lag)	0.65 p.u.	0.52 p.u.		2
220 kV	u_{min}	0.875 p.u.	0.9 p.u.		2
	u_{max}	1.1 p.u.	1.1 p.u.		2
	Q_{min}/P_{max} (lead)	-0.5 p.u.	-0.5 p.u.		2
	Q_{max}/P_{max} (lag)	0.65 p.u.	0.52 p.u.		2
400 kV	u_{min}	0.875 p.u.	0.875 p.u.		1
	u_{max}	1.1 p.u.	1.05 p.u.		1
	Q_{min}/P_{max} (lead)	-0.5 p.u.	-0.5 p.u.		2
	Q_{max}/P_{max} (lag)	0.65 p.u.	0.52 p.u.		2

Table 24: Definition of U-Q/Pmax-profile at Maximum Capacity for SPGMs: connection @ ≥110 kV

Article 18.2.b.(i): Type D SPGM - connection @ ≥110 kV Parameters required for U-Q/Pmax Profiles

Justification

- Voltage ranges are aligned with RfG operational voltage ranges
- Change point of measure of Q_{min}/P_{max} (lead) and Q_{max}/P_{max} (lag) from alternator terminal to connection point
  - Maintained current reactive power capability requirements
  - Took into account supplementary reactive power of trafo
- Parameter proposals are a projection of current reactive power capability requirements at alternator terminal to the connection point

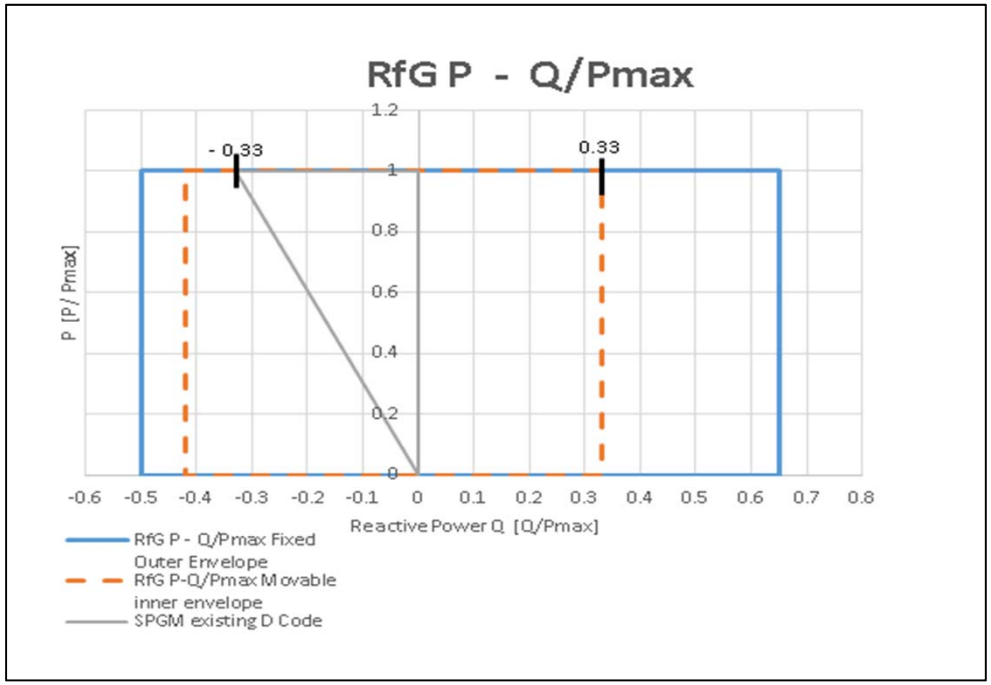
Article 18.2.b.(i): Type C/D SPGM - [Distribution Connected] Parameters required for U-Q/Pmax Profiles

Connection Voltage	Parameter	Parameter in RfG (outer envelope)	Consultation Proposal (Inner Envelope)	Article No.	Type Applicability	Justification Code
10 kV and 20kV	u_{min}	0.875 p.u.	0.96 p.u.	18.2.b (ii)	C and D SPGMs	1
	u_{max}	1.1 p.u.	1.1 p.u.	18.2.b (ii)	C and D SPGMs	2
	Q_{min}/P_{max} (import)	-0.5 p.u.	-0.33 p.u.	18.2.b (ii)	C and D SPGMs	2
	Q_{max}/P_{max} (Export)	0.65 p.u.	0 p.u.	18.2.b (ii)	C and D SPGMs	2
38 kV	u_{min}	0.875 p.u.	0.937 p.u.	18.2.b (ii)	C and D SPGMs	1
	u_{max}	1.1 p.u.	1.1 p.u.	18.2.b (ii)	C and D SPGMs	1
	Q_{min}/P_{max} (Import)	-0.5 p.u.	-0.33 p.u.	18.2.b (ii)	C and D SPGMs	2
	Q_{max}/P_{max} (Export)	0.65 p.u.	0 p.u.	18.2.b (ii)	C and D SPGMs	2

Table 25: Definition of U-Q/Pmax-profile at Maximum Capacity for SPGMs: connection @ <110 kV

Do Existing Distribution Code Requirements Conform? P-Q SGPMs

- Existing power factor requirements for generators not covered by specific requirements in Section 11 for wind generators, are stipulated in DCC 6.9.1 It states that….
- *The **Customer** shall take all reasonable steps to operate the **Plant** and the facility to keep the power factor of the total load at the **Connection Point** for imported electricity between 0.90 lagging and unity and for exported electricity between 0.95 lagging and unity*



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Article 18.2.b.(i): Type C/D SPGM - [Distribution Connected] Parameters required for U-Q/Pmax Profiles

TABLE 6A

Description	Nominal Voltage	Normal Operating Range [kV][b]	
		Lower bound	Upper bound
MV	10kV	9.6	11.3
MV	20kV	19.3	22.5
HV	38kV	35.6	43.8
110kV	110kV	99	123

- In the current Distribution Code, for non-wind generators, no explicit linkage is made between the reactive power requirements and voltage ranges. RfG stipulates that such a requirement is specified.
- It is proposed that for connections at voltages <110 kV, the power factor requirements stated for non-wind generators, will have to be maintained for the voltages in Table 6A.

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Article 18.2.b. (iv): Type C/D SPGM
Time to Achieve Target Value within U-Q/Pmax Profile

- Section Number 4.2.2.2.2
- SPGM shall be capable of moving to any operating point within its U-Q/P_{max} profile in appropriate timescales to target values

Parameter	Parameter in RfG	Consultation Proposal	Type Applicability	Justification Code
Time to achieve target value [transmission connected]	Not specified	Without undue delay but at least within 120 seconds	D SPGMs	1
Time to achieve target value [distribution connected]	Not specified	Without undue delay but at least within 120 seconds	C and D SPGMs	3

Table 26: Timescales to Achieve Target Values at Maximum Capacity

Article 18.2.b. (iv): Type C/D SPGM
Time to Achieve Target Value within U-Q/Pmax Profile

Justification:

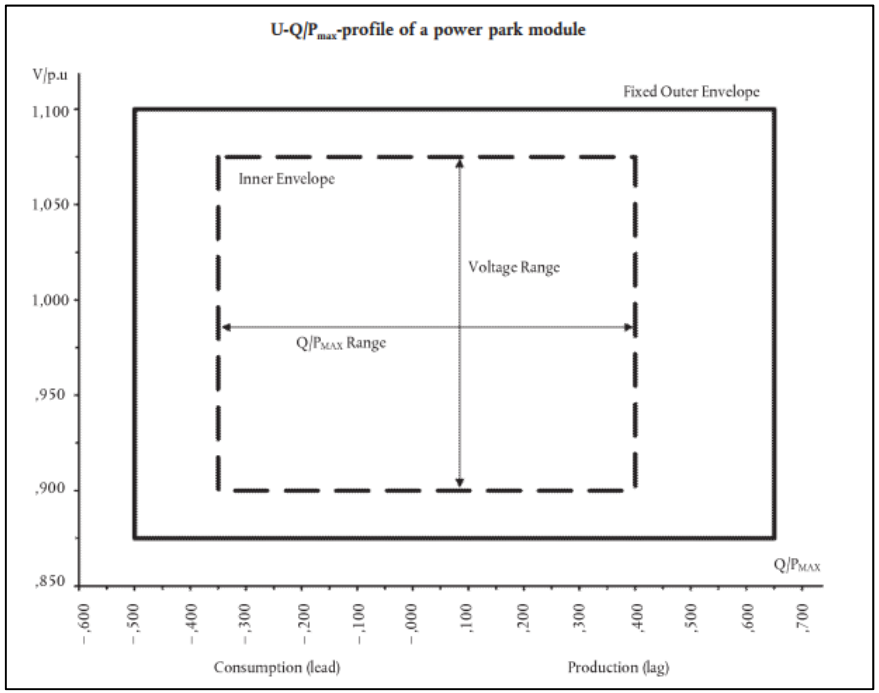
- **Grid Code**
  - The current requirement set out in the Scheduling and Dispatch Code Appendix B (SDC2.B.8) of the Grid Code for centrally dispatched generating units.

- **Distribution Code**
  - Proposal is to align with the current requirements for centrally dispatched generating units in the Grid Code.

Article 21.3.b (i) and (ii) & Article 25.5: PPM: Parameters required for U-Q/Pmax Profiles

- Section Number 4.2.2.2.3
- Specify reactive power provision capability requirements at the connection point **for maximal active power output** in conformity with following principles

1. U-Q/P_{max}-profile shall be within the limits of fixed outer envelope
2. U-Q/P_{max}-profile shall not exceed the inner envelope
3. Dimensions shall be in range of
   - Q/P_{max} Range = 0.66 pu
   - Steady voltage level = 0.218 pu



Article 21.3.b (i) and (ii) & Article 25.5: PPM: Parameters required for U-Q/Pmax Profiles

Connection Voltage	Parameter	Parameter in RfG (outer envelope)	Consultation Proposal (Inner Envelope)	Type Applicability	Justification Code
110 kV	u_{min}	0.875 p.u.	0.9 p.u.	D PPMs and Offshore PPMs	1
	u_{max}	1.1 p.u.	1.1 p.u.	D PPMs and Offshore PPMs	2
	Q_{min}/P_{max} (lead)	-0.5 p.u.	-0.33 p.u.	D PPMs and Offshore PPMs	1
	Q_{max}/P_{max} (lag)	0.65 p.u.	0.33 p.u.	D PPMs and Offshore PPMs	1
220 kV	u_{min}	0.875 p.u.	0.9 p.u.	D PPMs and Offshore PPMs	2
	u_{max}	1.1 p.u.	1.1 p.u.	D PPMs and Offshore PPMs	2
	Q_{min}/P_{max} (lead)	-0.5 p.u.	-0.33 p.u.	D PPMs and Offshore PPMs	1
	Q_{max}/P_{max} (lead)	0.65 p.u.	0.33 p.u.	D PPMs and Offshore PPMs	1
400 kV	u_{min}	0.875 p.u.	0.875 p.u.	D PPMs and Offshore PPMs	1
	u_{max}	1.1 p.u.	1.05 p.u.	D PPMs and Offshore PPMs	1
	Q_{min}/P_{max} (lead)	-0.5 p.u.	-0.33 p.u.	D PPMs and Offshore PPMs	1
	Q_{max}/P_{max} (lag)	0.65 p.u.	0.33 p.u.	D PPMs and Offshore PPMs	1

Table 27: Definition of a U-Q/Pmax-profile at Maximum Capacity PPMs: connected @ ≥ 110 kV or more

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Article 21.3.b (i) and (ii) & Article 25.5:
PPM: Parameters required for U-Q/Pmax Profiles

Justification

- Voltage ranges are aligned with RfG operational voltage ranges

Article 21.3.b (i) and (ii) & Article 25.5: PPM: Parameters required for U-Q/Pmax Profiles

- The current version of the Distribution Code does not explicitly and graphically depict U-Q profiles.
- However, it does have Table 6A, which depicts a range of normal operating voltages.

TABLE 6A

Description	Nominal Voltage	Normal Operating Range [kV][5]	
		Lower bound	Upper bound
MV	10kV	9.6	11.3
MV	20kV	19.3	22.5
HV	38kV	35.6	43.8
110kV	110kV	99	123

Linkage between Reactive Power requirements and voltage ranges:

- DCC 11.4.3, which covers existing D Code Types [Topologies] B [<5MW], C, D and E, does not contain any explicit reference to having the P-Q capability across specific voltage ranges.
- DCC 11.4.5, which covers existing D Code Types A and B [>5MW], does explicitly state that the P-Q capability must be maintained across the voltage ranges is Table 6A.
- It is proposed that for connections at voltages <110 kV, the power factor requirements stated for non-wind generators, will have to be maintained for the voltages in Table 6A.
- These outcomes are tabularised in the following slides

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Article 21.3.b (i) and (ii) & Article 25.5: PPM: Parameters required for U-Q/Pmax Profiles

PPMs connection at a voltage level < 110 kV & in Topology 2

Connection Voltage	Parameter	Parameter in RfG (outer envelope)	Consultation Proposal (Inner Envelope)	Article Number	Type Applicability	Justification Code
10 kV and 20kV	u_{min}	0.875 p.u.	0.96 p.u.	21.3.b (ii)	C and D PPM & offshore PPMs	1
	u_{max}	1.1 p.u.	1.1 p.u.	21.3.b (ii)	C and D PPM and offshore PPMs	2
	Q_{min}/P_{max} (lead)	-0.5 p.u.	-0.33 p.u.	21.3.b (ii)	C and D PPM and offshore PPMs	2
	Q_{max}/P_{max} (lag)	0.65 p.u.	0.33 p.u.	21.3.b (ii)	C and D PPM and offshore PPMs	2
38 kV	u_{min}	0.875 p.u.	0.937 p.u.	21.3.b (ii)	C and D PPM and offshore PPMs	1
	u_{max}	1.1 p.u.	1.1 p.u.	21.3.b (ii)	C and D PPM and offshore PPMs	1
	Q_{min}/P_{max} (lead)	-0.5 p.u.	-0.33 p.u.	21.3.b (ii)	C and D PPM and offshore PPMs	2
	Q_{max}/P_{max} (lag)	0.65 p.u.	0.33 p.u.	21.3.b (ii)	C and D PPM and offshore PPMs	2

Table 28: Definition of a U-Q/Pmax-profile at Maximum Capacity PPMs connected @ <110 kV and in Topology 2

Article 21.3.b (i) and (ii) & Article 25.5: PPM: Parameters required for U-Q/Pmax Profiles

PPMs connection at a voltage level < 110 kV & in all other Topologies

Connection Voltage	Parameter	Parameter in RfG (outer envelope)	Consultation Proposal (Inner Envelope)	Article Number	Type Applicability	Justification Code
10 kV & 20kV	u_{min}	0.875 p.u.	0.96 p.u.	21.3.b (ii)	C and D PPM	1
	u_{max}	1.1 p.u.	1.1 p.u.	21.3.b (ii)	C and D PPM	2
	Q_{min}/P_{max} (lead)	-0.5 p.u.	-0.42 p.u.	21.3.b (ii)	C and D PPM	2
	Q_{max}/P_{max} (lag)	0.65 p.u.	0 p.u.	21.3.b (ii)	C and D PPM	2
38 kV	u_{min}	0.875 p.u.	0.937 p.u.	21.3.b (ii)	C and D PPM	1
	u_{max}	1.1 p.u.	1.1 p.u.	21.3.b (ii)	C and D PPM	1
	Q_{min}/P_{max} (lead)	-0.5 p.u.	-0.42 p.u.	21.3.b (ii)	C and D PPM	2
	Q_{max}/P_{max} (lag)	0.65 p.u.	0 p.u.	21.3.b (ii)	C and D PPM	2

Table 29: Definition of a U-Q/Pmax-profile at Maximum Capacity for PPMs connected @ <110 kV & all other Topologies

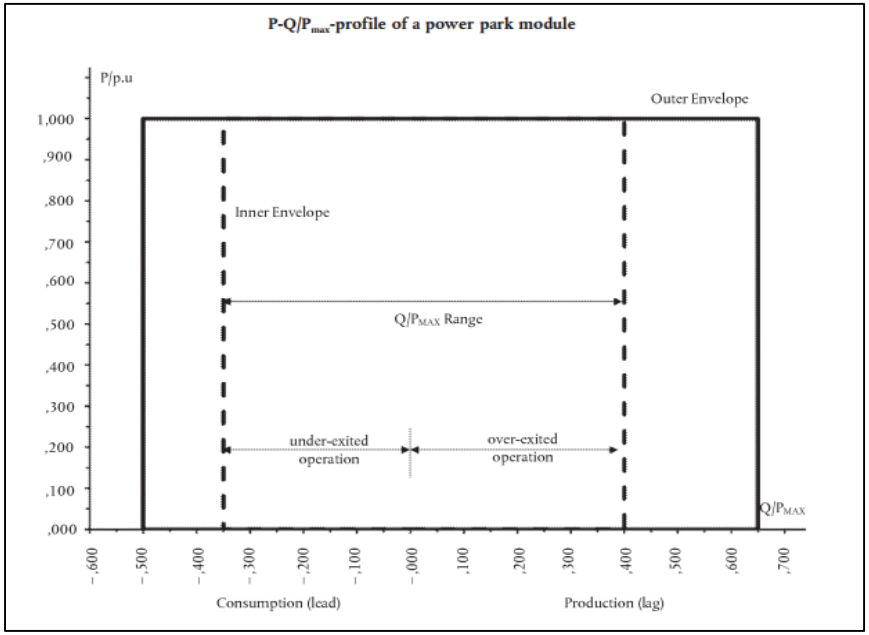
Reactive Power Capability below Maximum Capacity: P-Q/Pmax Profiles

Article 21.3.c.(i), (ii) and (iv): PPM: Parameters required for P-Q/Pmax Profiles

- Section Number 4.2.2.3.1
- Specify reactive power capability requirements as P-Q/P_{max}-profile at the connection point **below maximal active power output** in conformity with following principles

1. P-Q/P_{max}-profile shall be within the limits of fixed outer envelope
2. Dimensions of P-Q/P_{max}-profile shall be in range of
   - Q/P_{max} Range = 0.66 pu

- PPM shall be capable of providing reactive power at any operating point inside the profile



Article 21.3.c.(i), (ii) and (iv): PPM: Parameters required for P-Q/Pmax Profiles

PPMs connected at voltage level ≥110 kV

Voltage Level	Parameter	Parameter in RfG	Consultation Proposal	Type Applicability	Justification Code
110 kV to 400 kV	p_{min}	0.0 p.u.	0.12 p.u.	D PPMs	1
	p_{max}	1.0 p.u.	1.0 p.u.	D PPMs	1
	Q_{min}/P_{max} (lead)	-0.5 p.u.	-0.33 p.u.	D PPMs	1
	Q_{max}/P_{max} (lag)	0.65 p.u.	0.33 p.u.	D PPMs	1

Table 30: P-Q/Pmax-profile below Maximum Capacity PPMs: connection @ voltage level ≥110 kV

- Reactive power capability requirements are as per the current Grid Code requirements

Article 21.3.c.(i), (ii) and (iv): PPM: Parameters required for P-Q/Pmax Profiles

PPMs connected at a voltage level < 110 kV & in Topology 2

Connection Voltage	Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Connection voltages at 10kV, 20kV or 38kV.	p_{min}	0.0 p.u.	0.12 p.u.	21.3.c (ii)	C and D PPM	1
	p_{max}	1.0 p.u.	1.0 p.u.	21.3.c (ii)	C and D PPM	1
	Q_{min}/P_{max} (lead)	-0.5 p.u.	-0.33 p.u.	21.3.c (ii)	C and D PPM	1
	Q_{max}/P_{max} (lag)	0.65 p.u.	0.33 p.u.	21.3.c (ii)	C and D PPM	1

Table 31: P-Q/Pmax-profile below Maximum Capacity PPMs: connection @ <110 kV & in Topology 2

Article 21.3.c.(i), (ii) and (iv): PPM: Parameters required for P-Q/Pmax Profiles

PPMs connected at a voltage level < 110 kV & in Topology 3 & 4

Connection Voltage	Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Connection voltages at 10kV, 20kV or 38kV.	p_{min}	0.0 p.u.	0.12 p.u.	21.3.c (ii)	C and D PPM	1
	p_{max}	1.0 p.u.	1.0 p.u.	21.3.c (ii)	C and D PPM	1
	Q_{min}/P_{max} (lead)	-0.5 p.u.	Power factor range from 0.92 [-0.42 Q / Pmax] to unity [0 Q/Pmax]	21.3.c (ii)	C and D PPM	1
	Q_{max}/P_{max} (lag)	0.65 p.u.	Power factor range from 0.92 [-0.42 Q / Pmax] to unity [0 Q/Pmax]	21.3.c (ii)	C and D PPM	1

Table 32: P-Q/Pmax-profile below Maximum Capacity PPMs connection@<110 kV & Topologies 3 & 4

Article 21.3.c.(i), (ii) and (iv): PPM: Parameters required for P-Q/Pmax Profiles

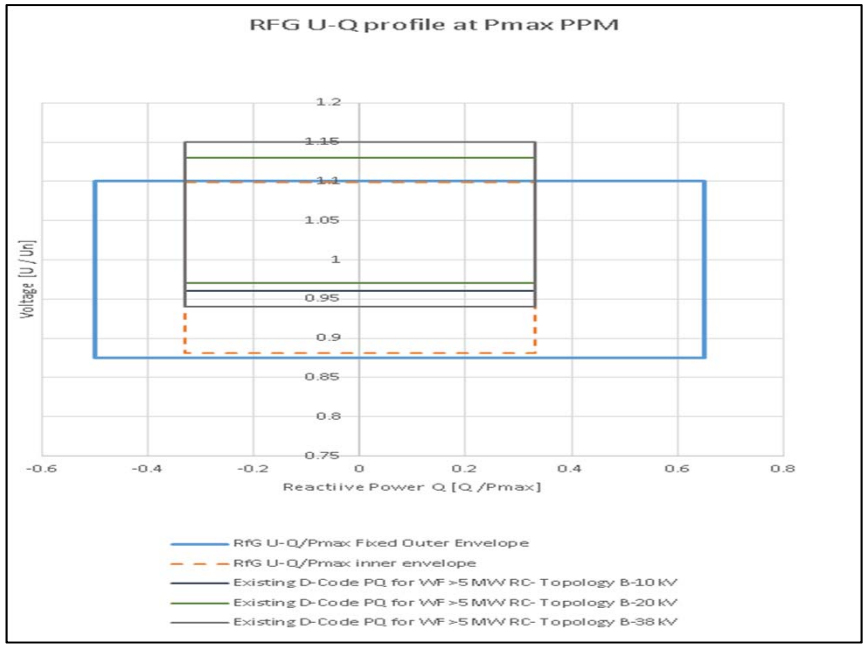
PPMs connected at a voltage level < 110 kV & Topology 5

Connection Voltage	Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Connection voltages at 10kV, 20kV or 38kV	p_{min}	0.0 p.u.	0.12 p.u.	21.3.c (ii)	C and D PPM	1
	p_{max}	1.0 p.u.	1.0 p.u.	21.3.c (ii)	C and D PPM	1
	Q_{min}/P_{max} (lead)	-0.5 p.u.	Power factor range from 0.92 [-0.42 Q / Pmax] to 0.95 [-0.33 Q/Pmax]	21.3.c (ii)	C and D PPM	1
	Q_{max}/P_{max} (lag)	0.65 p.u.	Power factor range from 0.92 [-0.42 Q / Pmax] to 0.95 [-0.33 Q/Pmax]	21.3.c (ii)	C and D PPM	1

Table 33: P-Q/Pmax-profile below Maximum Capacity for PPMs: connection @ <110 kV & Topology 5

Article 21.3.b (i) and (ii) & Article 25.5: PPM: Parameters required for U-Q/Pmax Profiles

- How does Table 6 A line up with RfG “boxes”
- Upper voltage limits outside of boxes



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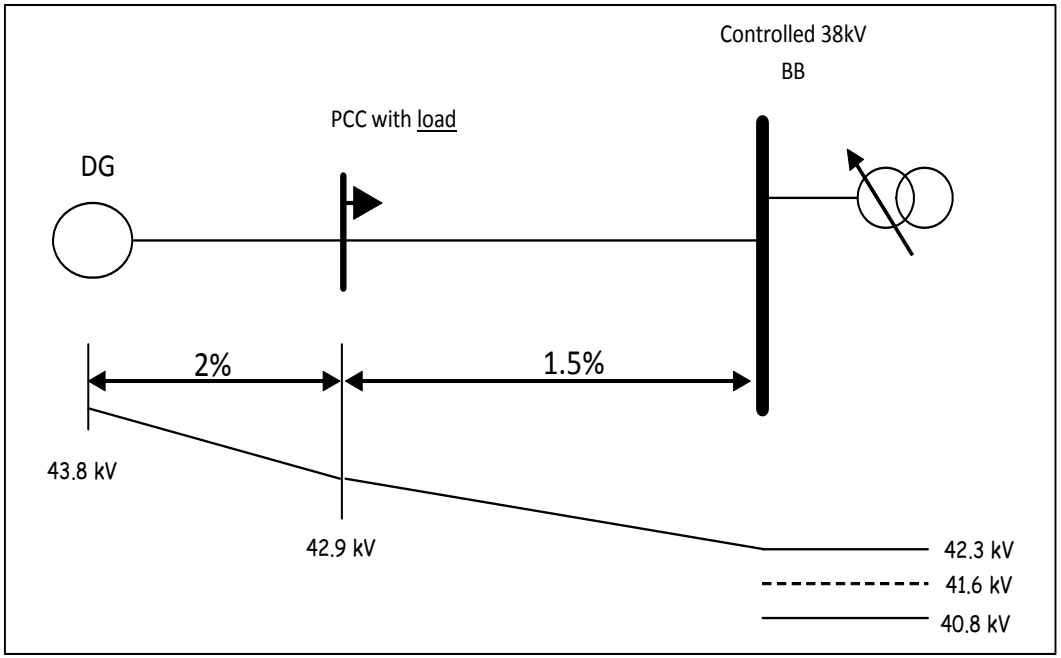
How has this come about - Distribution?

- When planning Distribution Generation connections, the max allowable Connection Point voltage, for dedicated circuits, is higher than would be the case for demand connections or load driven network
- This effectively sterilizes part of these circuits for use on demand connections
- ESBN have historically been minded to accept this risk, in the broader interests of connecting more generation and facilitating cheaper connections



What to do?

- Option 1: Retain existing Distribution Code requirements
- Option 2: Bring upper bounds for voltage range associated with P-Q requirements in line with RfG

Consequences of Option 2

- For Generator connections where the Connection Point voltage regularly exceeds 1.1 pu of nominal voltage, the effectiveness and ability to use reactive power capability of the generator will be severely compromised
- For Topology 2 connections, ability to ultimately participate in SSRP or DRP provision is in doubt
- ESBN may have to give consideration to reduction of max allowable Connection Point voltage to 1.1 pu for generators applying after Entry into Force of RfG
- This may have implications for costs of future connections
- Sample illustrative example shown in Table
- Please note that Voltage-rise is one of many technical criteria applied in the design and choice of LCTA connection methods for generators. Other criteria may also determine the connection method

Connection voltage	Generator size [MW]	Distance at which pu is exceeded [km]	
		1.1pu	1.35pu
38kV	33	4	27
38kV	20	8	40

Article 21.3.c.(iv): Type C/D – PPM
Time to Achieve Target Value within P-Q/Pmax Profile

- Section Number 4.2.2.3.2

- PPM shall be capable of moving to any operating point within its P-Q/P_{max}-profile in appropriate timescales to target value

Parameter	Parameter in RfG	Consultation Proposal	Type Applicability	Justification Code
Time to achieve target value [transmission connected]	Not specified	Without delay but within 20 seconds	D PPM	1
Time to achieve target value [distribution connected]	Not specified	Without delay but within 20 seconds	C and D PPM	1

Table 34: Timescales to Achieve Target Values at Maximum Capacity

- Requirements are as per the current Grid Code and D Code

Supplementary Reactive Power Requirements

Article 18.2.a& 21.3.a : Type C/D – SPGM& PPM Supplementary reactive power requirements

- Section Number 4.2.2.4.1 & 4.2.2.4.2

- For PGM where the connection point is remote from the grid connected transformer, any supplementary reactive power required to compensate
  the reactive power demand of the HV line or cable between connection point and PGM shall be provided by the responsible owner of that line or cable.

Article 18.2.a& 21.3.a : Type C/D – SPGM& PPM Supplementary reactive power requirements

Requirement	Requirement in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Right to specify supplementary reactive power requirements when the connection point is remote	To specify or not to specify	RSOs reserve the right to specify	18.2.a	Type C and D SPGMs	1
Right to specify supplementary reactive power requirements when the connection point is remote	To specify or not to specify	RSOs reserve the right to specify	21.3.a	Type C and D PPMs	1

- Currently supplementary reactive power requirements could be specified during connection offer process

Reactive Power Control Modes for PPMs

Article 21.3.d (iv):
PPM: Voltage Control Mode

- Section Number 4.2.2.5.1

- Following a step change in voltage, the power park module shall be capable of
  1. achieving 90% of the change in reactive power output within a time t_1; and
  2. must settle at 100% of the change in reactive power output within a time t_2
     (steady-state reactive tolerance no greater than 5%)

Parameter	Parameter in RfG	Consultation Proposal	Type Applicability	Justification Code
t_1 = time within which 90% of the change in reactive power is reached	1 – 5 sec	1	C and D PPMs	1
t_2 = time within which 100% of the change in reactive power is reached	5 – 60 sec	5	C and D PPMs	3

Table 37: Parameters for Voltage Control Mode

➢ Proposal is aligned with current PPM requirements in NI **WFPS Setting Schedule**

Article 21.3.d (vi):
PPM: Power Factor Control Mode

- Section Number 4.2.2.5.2

- PPM shall be capable of controlling the power factor at the connection point within the required reactive power range with a target power factor

Parameter	Parameter in RfG	Consultation Proposal	Type Applicability	Justification Code
Target power factor	Not specified	site-specific	C and D PPMs	3
Time period to reach the set point	Not specified	site-specific	C and D PPMs	3
Tolerance	Not specified	site-specific	C and D PPMs	3

Table 38: Parameters for Power Factor Control Mode

➢ To meet the local needs in terms of reactive power requirement the parameters are proposed to be site-specific

Voltage Control System for SPGMs

Article 19.2.a and 19.2.b.(v): SPGM: Voltage Control System

- Section Number 4.2.3.1

- *In relation to voltage stability, power-generating facility owner and the relevant system operator, in coordination with the relevant TSO, shall agree on the parameters and settings of the components of the voltage control system. The agreement shall cover the specifications and performance of an automatic voltage regulator ('AVR') with regard to steady-state voltage and transient voltage control (site-specific non-exhaustive Parameter). Further the specifications and performance of the excitation control system of an automatic voltage regulator shall include a Power System Stabilizer (PSS) function to attenuate power oscillations, among other, if the synchronous power-generating modules size is above the value proposed.*

Article 19.2.a and 19.2.b.(v): SPGM: Voltage Control System

Parameter	Parameter in RfG	Consultation Proposal	Type Applicability	Justification Code
Power Threshold	Not specified	All Type D SPGMs	D SPGMs	2

Table 39: Power Threshold above which PSS Function is required

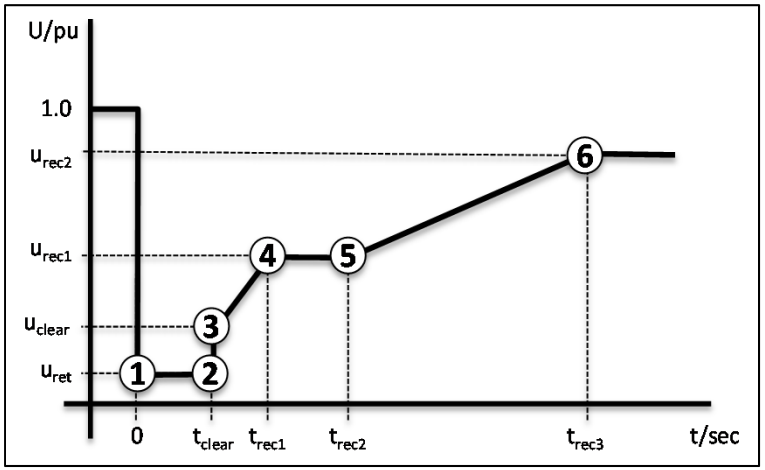
Justification

- Increasing complexity of the transmission system, along with the increasing levels of non-synchronous generation, it is likely the frequency and intensity of oscillations will increase
- In order manage this going forward and to maintain the security and safety of the transmission system, PSSs will be required on all Type D SPGMs

Fault Ride Through Capability

FRT Envelopes

- U vs t co-ordinates specified in RfG
- Ranges given for each of these
- FRT profiles must conform to these limitations



Voltage parameters [pu]		**Time parameters [seconds]**	
U_{ret}:	0	t_{clear}:	0.14 – 0.15 (or 0.14 - 0.25 if system protection and secure operation so require)
U_{clear}:	0.25	t_{rec1}:	t_{clear} – 0.45
U_{rec1}:	0.5 – 0.7	t_{rec2}:	t_{rec1} – 0.7
U_{rec2}:	0.85 – 0.9	t_{rec3}:	t_{rec2} – 1.5

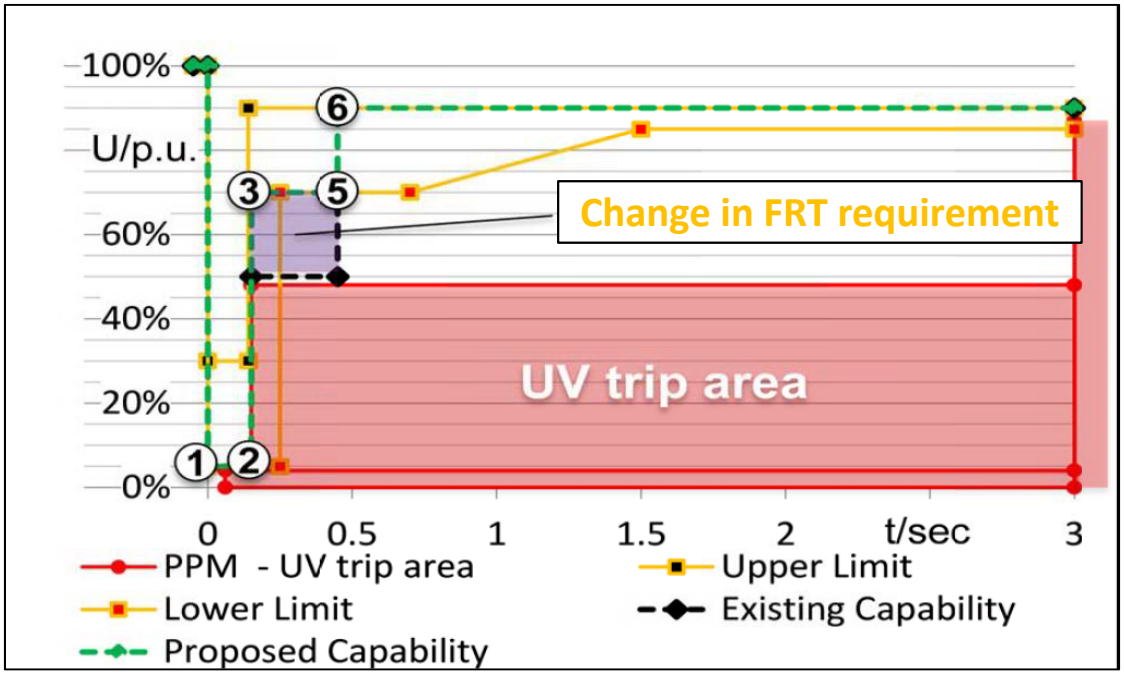
Article 14.3.a & 16.3.a: FRT Capability for PGMs connected at voltage level <110 kV

- Section Number 4.2.4.1

- *Power-generating modules shall be capable of staying connected to the network and continuing to operate stably after the power system has been disturbed by secured faults. That capability shall be in accordance with a voltage-against-time profile at the connection point for fault conditions in line with the figure below:*
- *The voltage-against-time-profile shall express a lower limit of the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, as a function of time before, during and after the fault.*
- *That lower limit is specified for synchronous power-generating modules and power park modules connected below the 110 kV level in the following subsections.*

Article 14.3.a & 16.3.a: FRT Capability for SPGMs connected at voltage level <110 kV

- Existing FRT profile outside allowed envelope
- Adjustment made to conform with RfG
- ESBN G10/EGIP Generator Interface protection under-voltage settings shown also for completeness



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Article 14.3.a & 16.3.a: FRT Capability for SPGMs connected at voltage level <110 kV

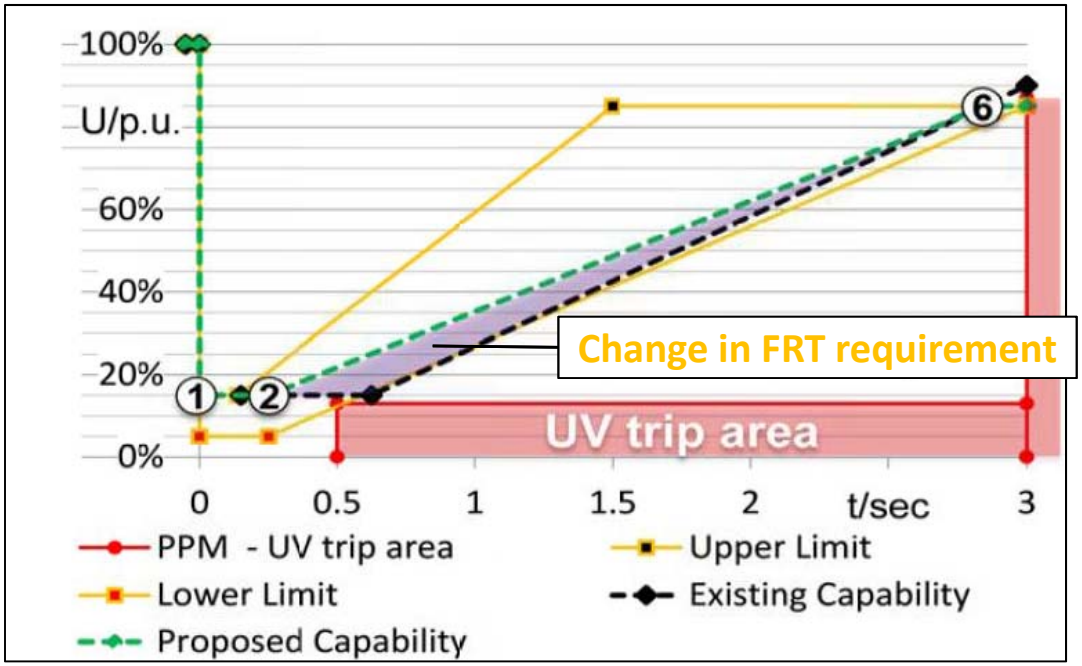
Proposal: SPGMs connected at a voltage level < 110 kV.

No. on Graph	Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
1	u_{ret}	0.05 – 0.3 p.u.	0.05 p.u.	14.3.a (i)	B,C, and D SPGMs	2
2	u_{ret}	0.05 – 0.3 p.u.	0.05 p.u.			
	t_{clear}	140 – 250 ms	150 ms			
3	u_{clear}	0.7 – 0.9 p.u.	0.7 p.u.			
	t_{clear}	140 – 250 ms	150 ms			
4	u_{rec1}	u_{clear}	u_{clear}			
	t_{rec1}	t_{clear}	t_{clear}			
5	u_{rec1}	u_{clear}	u_{clear}			
	t_{rec2}	t_{rec1} – 700 ms	450 ms			
6	u_{rec2}	0.85 – 0.9 p.u.	0.9 p.u.			
	t_{rec3}	t_{rec2} – 1.5 s	t_{rec2}			

Table 40: Definition of FRT parameters for SPGMS connected @ <110 kV

Article 14.3.a & 16.3.a: FRT Capability for PPMs connected at voltage level <110 kV

- Existing FRT profile just within RfG allowed envelope
- Proposal to move Point 2, to give more margin between the under-voltage trip setting



Article 14.3.a & 16.3.a: FRT Capability for PPMs connected at voltage level <110 kV

FRT capability parameters for PPMs connection at a voltage level < 110 kV.

No. on Graph	Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
1	u_{ret}	0.05 – 0.15 p.u.	0.15 p.u.	14.3.a (i)	B,C and D PPMs	2
2	u_{ret}	0.05 – 0.15 p.u.	0.15 p.u.			
	t_{clear}	140 – 250 ms	250 ms			
3	u_{clear}	u_{ret} – 0.15 p.u.	u_{ret}			
	t_{clear}	t_{clear}	t_{clear}			
4	u_{rec1}	u_{clear}	u_{clear}			
	t_{rec1}	t_{clear}	t_{clear}			
5	u_{rec1}	u_{clear}	u_{clear}			
	t_{rec2}	t_{rec1}	t_{rec1}			
6	u_{rec2}	0.85 p.u.	0.85 p.u.			
	t_{rec3}	1.5 – 3.0 s	2.9 s			

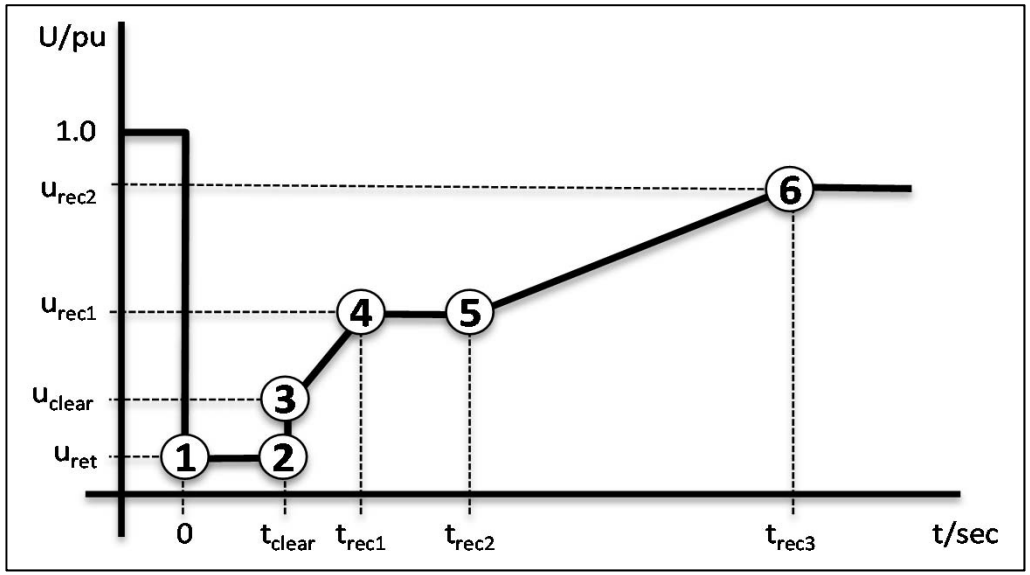
Table 41: Definition of FRT parameters for PPMs connected @ <110 kV

Article 16.3.a:
FRT Capability ~~S~~PGM connected @ voltage level ≥110kV

- Section Number 4.2.4.2

- *Power-generating modules shall be capable of staying connected to the network and continuing to operate stably after the power system has been disturbed by secured faults. That capability shall be in accordance with a voltage-against-time profile at the connection point for fault conditions in line the figure below.*
- *The voltage-against-time-profile shall express a lower limit of the actual course of the phase-to-phase voltages on the network voltage level at the connection point during a symmetrical fault, as a function of time before, during and after the fault.*
- *That lower limit is specified for synchronous power-generating modules and power park modules connected at or above the 110 kV level in the following subsections.*

Article 16.3.a:
FRT Capability SPGM connected @ voltage level ≥110kV



Fault Ride Through Profile of a Power-Generating Module

Article 16.3.a:
FRT Capability SPGM connected @ voltage level ≥110kV

No. on Graph	Parameter	Parameter in RfG	Consultation Proposal	Type Applicability	Justification Code
1	u_{ret}	0 p.u.	0	D SPGMs	2
2	u_{ret}	0 p.u.	0		
	t_{clear}	140 – 250 ms	150 ms		
3	u_{clear}	0.25 p.u.	0.25 p.u.		
	t_{clear}	140 – 250 ms	150 ms		
4	u_{rec1}	0.5 – 0.7 p.u.	0.5 p.u.		
	t_{rec1}	t_{clear} – 450 ms	450 ms		
5	u_{rec1}	0.5 – 0.7 p.u.	0.5 p.u.		
	t_{rec2}	t_{rec1} – 700 ms	450 ms		
6	u_{rec2}	0.85 – 0.9 p.u.	0.9 p.u.		
	t_{rec3}	t_{rec2} – 900 ms	450 ms		

Table 42: Definition of FRT parameters for SPGMs connected @ ≥110 kV

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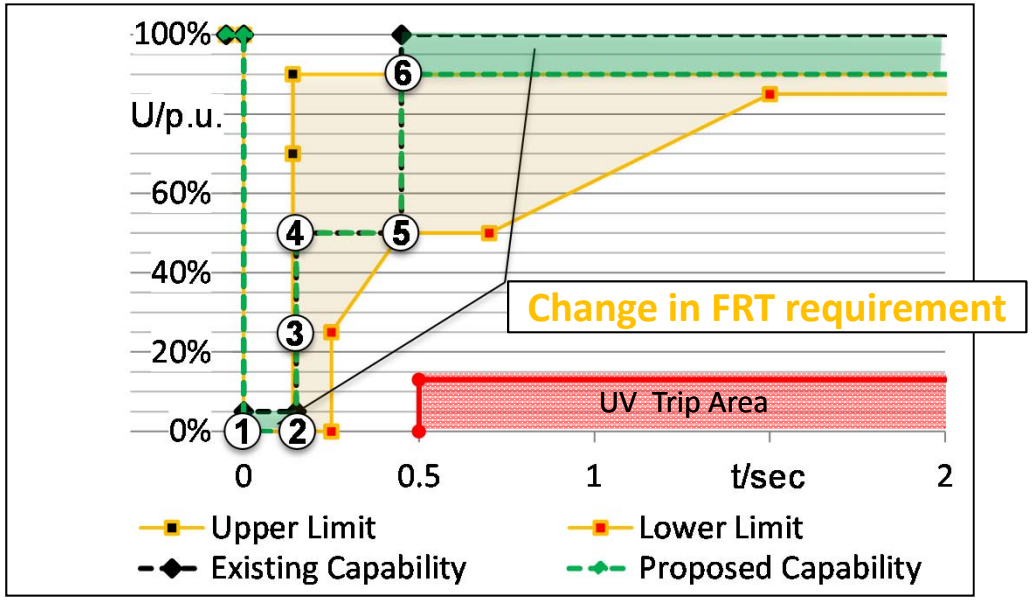
Article 16.3.a:
FRT Capability SPGM connected @ voltage level ≥110kV

Justification

- Lower retained voltage required
  - ① $U_{ret,new} = 0 < 0.05$ pu $= U_{ret,current}$
- Lower recovery voltage required
  - ⑥ $U_{rec2,new} = 0.9 <$ pu $= U_{rec2,current}$



Trip area only applicable in distribution system

Article 16.3.a:
FRT Capability PPM connected @ voltage level ≥110kV

No. on Graph	Parameter	Parameter in RfG	Consultation Proposal	Type Applicability	Justification Code
1	u_{ret}	0 p.u.	0	D PPMs	2
2	u_{ret}	0 p.u.	0		
	t_{clear}	140 – 250 ms	150 ms		
3	u_{clear}	u_{ret}	u_{ret}		
	t_{clear}	t_{clear}	t_{clear}		
4	u_{rec1}	u_{clear}	u_{clear}		
	t_{rec1}	t_{clear}	t_{clear}		
5	u_{rec1}	u_{clear}	u_{clear}		
	t_{rec2}	t_{rec1}	t_{rec1}		
6	u_{rec2}	0.85 p.u.	0.85 p.u.		
	t_{rec3}	1.5 – 3.0 s	2.9 s		

Table 43: Definition of FRT parameters for PPMs connected @ ≥ 110 kV

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Article 16.3.a: Type D – FRT Capability PPM connected @ voltage level ≥110kV

Justification

- Lower retained voltage required

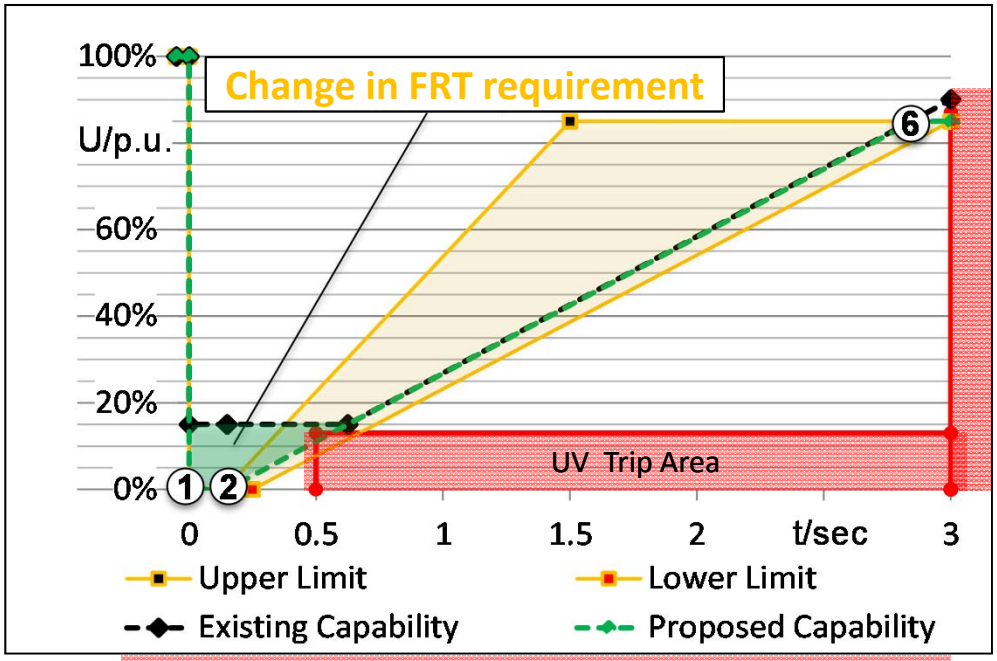
  ① $U_{ret,new} = 0 < 0.15 = U_{ret,current}$

- Lower recovery voltage required

  ⑥ $U_{rec2,new} = 0.85 < 0.9 = U_{rec2,current}$

Note

- Conflict with the current protection settings for under voltage relays. However in the future, these protection settings may change and the FRT capability needs to remain.



Trip area only applicable in distribution system

FRT: Fast Fault Current Injection

Article 20.2.b & 20.2.c: Fast Fault Current Injection for Symmetrical/Asymmetrical Faults

- Section Number 4.2.4.3.1 & 4.2.4.3.2
- Specification of fast fault current injection in case of
  - symmetrical faults; and
  - asymmetrical faults
- Parameter to specify:
  a) Voltage threshold for fast fault current injection
  b) End of the voltage deviation
  c) The characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current
  d) the timing and accuracy of the fast fault current, which may include several stages during a fault and after its clearance

Article 20.2.b & 20.2.c: Fast Fault Current Injection for Symmetrical/Asymmetrical Faults

Parameter	Parameter in RfG	Consultation Proposal	Type Applicability	Justification Code
Voltage threshold for fast fault current injection	Not specified	During voltage dips i.e. when the voltage is below 0.9 p.u.	B, C and D PPMs	1
End of the voltage deviation	Not specified	Once the voltage has recovered to within normal operating voltage range	B, C and D PPMs	1
the characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current	Not specified	Reactive current should be provided for the duration of the voltage deviation within the rating of the PPM	B, C and D PPMs	1
the timing and accuracy of the fast fault current, which may include several stages during a fault and after its clearance	Not specified	Accuracy within the rating of PPM; Rise Time no greater than 100ms and a Settling Time no greater than 300ms.	B, C and D PPMs	1

Table 44: Fast Fault Current Injection - Symmetrical Faults

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Article 20.2.b & 20.2.c: Fast Fault Current Injection for Symmetrical/Asymmetrical Faults

Justification

- Proposal is as per current Grid Code requirement

FRT: Post Fault Active Power Recovery of PPMs

Article 20.3.a
Post-Fault Active Power Recovery for PPMs

- Section Number 4.2.4.4

- TSO shall specify the post-fault active power recovery

Parameter	Parameter in RfG	Consultation Proposal	Type Applicability	Justification Code
when the post-fault active power recovery begins, based on a voltage criterion	Not specified	u_n< 0.9 p.u.	B, C and D PPMs	**1**
maximum allowed time for active power recovery	Not specified	500ms/1s	B, C and D PPMs	**1**
magnitude and accuracy for active power recovery	Not specified	90%	B, C and D PPMs	**1**

Table 46: Post-Fault Active Power Recovery for PPMs

➢ Proposal is as per current Grid Code requirement

FRT: Prioritisation of Active/Reactive Current

Article 21.3.e: PPM
Priority Given to Active or Reactive Power Contribution

- Section Number 4.2.4.5

- TSO shall specify whether active power contribution or reactive power contribution has priority during faults for which fault-ride-through capability is required.

Parameter	Parameter in RfG	Consultation Proposal	Type Applicability	Justification Code
Prioritisation requirements during FRT	Active/Reactive	Active	C and D PPMs	1

Table 47: Priority given to Active or Reactive Power Contribution

➢ Proposal is as per current Grid Code requirement

Additional Requirements Not Invoking

Additional Non-Mandatory Voltage Requirements

Requirement	Requirement in RfG	Consultation Proposal	Article Number	Type Applicability
Simultaneous overvoltage and underfrequency or simultaneous undervoltage and overfrequency	Do we want to expertise the right to specify this non-mandatory RfG?	Not invoking at this time.	16(02)(a)(ii)	Type ~~A, B, C and~~ D PGMs

Table 48: List of Non-Mandatory and not invoked Requirements for Generators

Q&A

Protection Theme

Miriam Ryan (TSO)

Article 15.2.b: Manual, local measures where the automatic remote devices are out of service

- Section Number 4.4.1

- *Manual local measures shall be allowed in cases where the automatic remote control devices are out of service.*
- *The relevant system operator or the relevant TSO shall notify the regulatory authority of the time required to reach the set point together with the tolerance for the active power.*

Article 15.2.b: Manual, local measures where the automatic remote devices are out of service

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Time required to achieve setpoint when automatic remote devices are unavailable	Not Specified	1 hour	15(2)(b)	B, C and D PGMs	3

Table 50: Time required to Achieve Set point when Automatic Remote Devices are Unavailable

Article 15.2.b: Manual, local measures where the automatic remote devices are out of service

- The proposed time of 1 hour is in line with the time requirements under the black start plan and should be sufficient to reach any PPM site and place the PPM under manual control, so that it can be restored to the necessary setpoint.

Article 15.6.b (i): Instrumentation: Quality of Supplies

- Section Number 4.4.2

- Power-generating facilities shall be equipped with a facility to provide fault recording and monitoring of dynamic system behaviour. This facility shall record the following parameters:
  - Voltage,
  - Active power,
  - Reactive power, and
  - Frequency
- The relevant system operator shall have the right to specify quality of supply parameters to be complied with on condition that reasonable prior notice is given.

Article 15.6.b (i): Instrumentation: Quality of Supplies

Requirement	Requirement in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Quality of supplies parameters to be recorded.	Not Specified	Site Specific	15(6)(b)(i)	C and D PGMs and offshore PPMs	3

Table 51: Quality of Supplies Parameters to be Recorded

Article 15.6.b (i): Instrumentation: Quality of Supplies

- The requirements for the fault recording and monitoring equipment can vary due to:
  - Station / generation unit configuration
  - Compatibility with existing equipment
  - Resolution requirements
- As a result, it is proposed to specify these requirements on a site specific basis, as per current practice.

Article 15.6.b.(iii): Dynamic System Behaviour Monitoring

- Section Number 4.4.3

- *The dynamic system behaviour monitoring shall include an oscillation trigger specified by the relevant system operator in coordination with the relevant TSO, with the purpose of detecting poorly damped power oscillations;*

Article 15.6.b.(iii): Dynamic System Behaviour Monitoring

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Oscillation trigger detecting poorly damped power oscillations.	Not Specified	Site Specific	15(6)(b)(iii)	C and D PGMs and offshore PPMs	3

Table 52: Oscillation Trigger Detecting Poorly Damped Power Oscillations

Article 15.6.b.(iii): Dynamic System Behaviour Monitoring

- The requirements for the fault recording and monitoring equipment can vary due to:
  - Variations in monitoring triggers.
  - Station / generation unit configuration
  - Compatibility with existing equipment
  - Resolution requirements

- As a result, it is proposed to specify these requirements on a site specific basis, as per current practice.

Article 15.6.c.(iii) Simulation Model Provision

- Section Number 4.4.4

- *The request by the relevant system operator referred to in point (i) shall be coordinated with the relevant TSO. It shall include:*
  - *The format in which models are provided,*
  - *The provision of documentation on a model's structure and block diagrams,*
  - *An estimate of the minimum and maximum short circuit capacity at the connection point, expressed in MVA, as an equivalent of the network.*

Article 15.6.c.(iii) Simulation Model Provision

Requirement	Requirement in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Model Provision	Not Specified	Retain the existing model provision requirements with the inclusion of min and max short circuit levels as part of Grid Code Planning Code Appendix Generator Data Requirements	15(6)(c)(iii)	C and D PGMs and offshore PPMs	3

Table 53: Simulation Model Provision

Article 15.6.c.(iii) Simulation Model Provision

- The existing PC.A4 to PC.A6 of the Grid Code covers all of the requirements for the RfG with the exception of the provision of the minimum and maximum short circuit levels (in MVA).
- The proposal is to modify the existing PC.A4 to PC.A6 to include the parameters for the minimum and maximum short circuit levels (in MVA).

Article 15.6.f: Neutral-point at the network side of step transformers

- Section Number 4.4.5

- *Earthing arrangement of the neutral-point at the network side of step-up transformers shall comply with the specifications of the relevant system operator.*

Article 15.6.f: Neutral-point at the network side of step transformers

Parameter	Parameter in RfG	Consultation Proposal	Article Number	Type Applicability	Justification Code
Earthing arrangement of the neutral-point	Not Specified	400 kV – solidly earthed 220 kV – site specific 110 kV – site specific	15(6)(f)	C and D PGMs and offshore PPMs	1

Table 54: Neutral-point at the Network Side of Step Transformers

Article 15.6.f: Neutral-point at the network side of step transformers

- It is already stated in the Distribution Code clauses listed below, that the neutral point of the HV side of a customer step-up transformer, at the connection point shall not under any circumstance, be earthed by the customer. The relevant existing Distribution Code clauses are: DCC6.3.4, DCC9.3.4, DCC11.4.4

Additional Non-Mandatory Protection & Instrumentation Requirements: case by case

Parameter	Parameters in RfG	Article Number	Type Applicability
Control Scheme and Settings: Agreement and coordination between the TSO, RSO (TSO & DSO) and the power generating facility owner (PGFO)	Control schemes and settings of the control devices	14.5.a	B,C & D PGMs and offshore PPMs
Electrical Protection Schemes and settings: Agreement and coordination between the RSO and the PGFO	Protection schemes and settings	14.5.b	B,C & D PGMs and offshore PPMs
Loss of angular stability or loss of control: Agreement between PGFO and the RSO (DSO or TSO), in coordination with the TSO	Criteria to detect loss of angular stability or loss of control	15.6.a	C & D PGMs and offshore PPMs
Instrumentation: Settings of the fault recording equipment, including triggering criteria and sampling rate **Agreement between PGFO & RSO (DSO/TSO), in coordination with TSO.**	Settings of the fault recording equipment, including triggering criteria and sampling rate	15.6.b(ii)	C & D PGMs and offshore PPMs
Instrumentation: Protocols for recorded data **Agreement between PGFO, the RSO and the relevant TSO**	Protocols for recorded data	15.6.b(iv)	C & D PGMs and offshore PPMs
Installation of devices for system operations and system security: Agreement between RSO or TSO and PGFO	Definition of the devices needed for system operation and system security	15.6.d	C & D PGMs and offshore PPMs
Synchronisation: Agreement between the RSO and the PGFO	Settings of the synchronisation devices	16.4	D PGMs and offshore PPMs
Angular stability under fault conditions: Agreement between TSO & PGFO	Agreement for technical capabilities of the PGM to aid angular stability.	19.3	D SPGM

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Q&A

Closeout

Marie Hayden (TSO)

In summary

- Intention of TSO & DSO, insofar as possible, when proposing these values was as follows;
  - To keep existing requirements
  - To make minimum amount of change to existing requirements
  - Not to use this as a mechanism to make dramatic changes to existing requirements
  - Not to use this as a mechanism to align north and south existing/new requirements
- Consultation closes on the 9th of February 2018
- The TSO & DSO welcome any further feedback on the proposals, using the template provided online and sent to gridcode@eirgrid.com

EIRGRID ESB NETWORKS

Q&A