MODIFICATION RECOMMENDATION FORM

MPID 264 – Power Quality

RECOMMENDATION TO CER BY EIRGRID OF MODIFICATION TO GRID CODE.

ABSTRACT / TITLE OF MODIFICATION	MPID 264 - Power Quality
MODIFICATION NUMBER	MPID 264
RECOMMENDED AT GCRP MEETING NUMBER	40
LIST OF GRID CODE SECTION(S) AFFECTED BY PROPOSED MODIFICATION:	CC.10.13 (CC.10.13.1 – CC.10.13.4) OC10.2.2 WFPS1.6.2.2 and WFPS.1.6.4 Definitions
CURRENT GRID CODE VERSION :	5
MODIFICATION DESCRIPTION Overview **THE REASON FOR THE RECOMMENDED MODIFICATION**	The current clause CC.10.13 on Power Quality requires clarification to identify the roles, responsibilities and requirements expected of Users and the TSO. A complete rewording of the current clause (and associated clauses) is required. All Users, including Interconnectors, will now be treated equally regarding meeting their Power Quality obligations at the Connection Point. The new text clarifies to whom and under what conditions the specified limits apply. The Harmonics Working Group agreed that limits will not be applied to existing connections unless they were previously advised or they are subject to a material modification. This material modification may include, but not be limited to, the installation of additional or alternative Plant and/or Apparatus, or modifications to the control systems, which are capable of altering the Harmonic Voltage Distortion Level, at the Connection Point. (See Minutes of Harmonics Working Group at: http://www.eirgrid.com/operations/gridcode/meetingsworkinggroups/). New connections to the Transmission System energising after 1st January 2015 will be issued with incremental Harmonics limits as defined in CC.10.13.1 (a). All Users, including the DSO, generators and demand, intending to connect or modify their connection to the transmission system, after that date, will be informed, as appropriate. However, it may be difficult for the DSO to communicate any implications to parties connecting at lower voltages.

History of Progression through GCRPs, Working Group and/or Consultation	The Harmonics Working Group met six times between February 2014 and September 2014, chaired by Marta Val Escudero. A summary of all six meetings can be read here. EirGrid first presented to the JGCRP in February 2014 with Terms of Reference and provided an update to the JGCRP in June 2014. EirGrid then presented the modification proposal MPID 264 to the Grid Code Review Panel members at a meeting held in the Hilton Hotel in Belfast on the 12th November 2014. No objections were raised by the panel members and the modification was recommended for approval.
Summary Note of any Objections to the Recommended change from GCRP Members or Consultation Responses	No objections were raised.
Outcome of any GCRP Meeting Actions Relating to the Recommended Modification	Paul Doyle requested that it be noted in the minutes that it be clarified that this should only apply to a plant making a modification that is going to materially impact on power quality performance of the plant - *Done* TSO to send recommendation paper to the CER with note that it may be difficult to communicate to the communicate to Users - *Done*
Implication of not implementing the Modification	The TSO will have to issue Power Quality limits to all Users, even where it is impractical to do so, without sufficient data detailing the network conditions at the point and time of connection. A number of ambiguities will persist, which may result in a less than adequate power quality available to Users at their Connection Point. Interconnectors will continue to have duplicate requirements. Furthermore, there is an implied requirement to count the number of switching events on the system when assessing the resultant Voltage Fluctuations which is impractical.

RED-LINE VERSION

CC.10.13 Power Quality

~~**Users** shall ensure that their connection to the **Transmission System** does not result in the level of distortion or fluctuation of the supply **Voltage** on the **Transmission System**, at the **Connection Point**, exceeding that allocated to them following consultation with the **TSO.** Distortion and fluctuation limits are outlined in IEC/TR3 61000-3-6 (Harmonics) and IEC/TR3 61000-3-7 (**Voltage** fluctuation). **Users** shall also operate their **Plant** in a manner which will not cause the requirements contained in CENELEC Standard EN 50160 to be breached.~~

CC.10.13.1

(a) Harmonic **Voltage** Distortion

Users shall ensure that their connection to the **Transmission System** does not result in an increase in the level of harmonic distortion of the supply **Voltage** on the **Transmission System**, at the **Connection Point**, exceeding that allocated to them. These incremental limits will be determined by the **TSO** for each **User's** connection, to ensure compliance with IEC/TR 61000-3-6 and by default, CENELEC Standard EN 50160, on the **Transmission System**.

The necessary data will be exchanged between both parties and the exchange of data shall not be unreasonably withheld. This data may consist of but is not limited to; **Impedance Loci** at the **Connection Point**, background distortion levels and **Allocated Harmonic Distortion Limits (AHDL)**.

(b) **Voltage** Fluctuations

Users shall ensure that their connection to the **Transmission System** does not result in the level of fluctuation of the supply **Voltage** on the **Transmission System** at the **Connection Point** exceeding limits set out below**.** Any necessary data will be exchanged between both parties and the exchange of data shall not be unreasonably withheld.

i. **Voltage Flicker**

Users shall take responsibility for limiting **Voltage Flicker** caused by their **Plant** to remain within the maximum permissible **Voltage Flicker** limits at the **Connection Point** as allocated to them by the **TSO** or, as a minimum, those defined in Table 5 of IEC/TR 61000-3-7.

ii. Rapid **Voltage** Change

Type of rapid Voltage change	$\frac{\Delta U}{U_N}$ **Limit (%)**	**Timeframe**
Temporary Voltage Depression	5	Must recover to nominal **Voltage** in 3 seconds
Step Change	3	One cycle

Users shall ensure that the disturbance levels introduced by their **Plant** and/or **Apparatus** do not promote rapid **Voltage** changes exceeding those specified in the above table or alternative limit allocated to them by the **TSO** during normal system operation.

The **User** can be connected to the **Transmission System** provided that the required studies have been completed by the **User** to show compliance with the limits outlined in CC.10.13.1 (a) and CC.10.13.1 (b) and have been reviewed by the **TSO.** Following consultation with the **TSO**, a conditional connection may be allowed to **Users** where modelling of the connection shows a breach of the limits to be marginal or only occurring during contingencies as defined by the **TSO**. This may allow the **User** to verify that the installation is compliant by monitoring, or to implement a mitigation solution.

The **User's Allocated Harmonic Distortion Limits** and any special conditions pertaining to power quality will be referenced in the **Connection Agreement**. These are subject to verification of compliance by the **TSO** and through an on-going monitoring programme as described in OC10.2.2 (c).

In the event that a **User** causes any such limits in CC.10.13.1 (a) and CC.10.13.1 (b) to be breached, the **TSO** shall be entitled to require the **User** to take such steps as the **TSO** reasonably considers to be necessary in order to prevent such breach from continuing and the **User** shall comply with the **TSO's** instructions without delay**.**

~~CC.10.13.1~~

CC.10.13.2 The aggregate power factor for a **Demand Customer** is calculated in accordance with the following formula:

$$APF = \frac{Sum\ P}{((Sum\ P)^2 + (Sum\ Q)^2)^{0.5}}$$

where**:**

APF is the Aggregate Power Factor for the **Demand Customer**

Sum P is the Energy exchanged with the **Demand Customer** at the **Connection Point** for any half-hour period; and

Sum Q is the Reactive Energy exchanged with the **Demand Customer** at the **Connection Point** for the same half-hour period.

~~CC.10.13.2~~

CC.10.13.3 A **Demand Customer** shall ensure that at any load above 50% of **Maximum Import Capacity** the aggregate power factor as determined at the **Connection Point** in any half-hour period shall be within the range 0.90 lagging to unity.

~~CC.10.13.3~~

~~**Interconnector Operators** shall ensure that their connection to the **Transmission System** does not result in the level of distortion or fluctuation of the supply **Voltage** on the **Transmission System**, at the **Connection Point**, exceeding that allocated to them. These limits will be determined by the **TSO** during discussions with the **Interconnector**, where the necessary data will be exchanged between both parties, the exchange of data shall not be unreasonably withheld. This data may consist of impedance loci at the **Connection Point** and the **Interconnector** harmonic current emissions. Distortion and fluctuation limits are outlined in IEC/TR3 61000-3-6 (Harmonics) and IEC/TR3 61000-3-7 (**Voltage** fluctuation).~~
~~**Interconnectors** shall also operate their **Plant** in a manner which will not cause the requirements in CENELEC Standard EN 50160 to be breached.~~
~~The **Interconnector** cannot be connected to the **Transmission System** until:~~

~~i. the required harmonic studies have been completed by the **Interconnector Owner** and or **Interconnector Operator** to show compliance with the standards outlined above and reviewed by the **TSO**;~~

~~ii. any appropriate remedies to enable the **Interconnector** to operate with harmonic distortion levels within agreed limits have been identified and implemented with the **TSO**.~~

~~CC.10.13.4~~

~~For **Interconnectors** the harmonic **Voltage** distortion emission limits and any special conditions pertaining to the quality of supply must be included in the **Connection Agreement**, and are subject to verification of compliance by the **TSO** through an ongoing approved monitoring programme to be implemented by the **Interconnector Operator**, or as agreed with the **TSO**.~~

OC10.2.2

In order to achieve the primary objective set out in OC10.2.1, OC10 establishes procedures for **Monitoring**, **Testing** and **Investigation**. In particular, this facilitates adequate assessment of each of the following:

c) whether **Power Quality** of **Users** conforms with CC.10.13.1; ~~International Electro-technical Commission Standards: 'Electromagnetic Compatibility-Limits-Limitation of emission of harmonic currents for equipment connected to medium and high voltage power supply systems [IEC/TR3 61000-3-6] and 'Electromagnetic Compatibility-Limits-Limitation of voltage fluctuation and flicker for equipment connected to medium and high voltage power supply systems ' [IEC/TR3 61000-3-7];~~

WFPS1.6.2.2

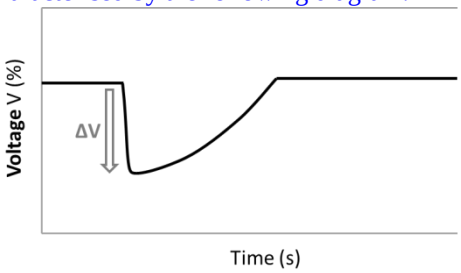
Under steady state conditions, the **Voltage Regulation System** shall be capable of implementing the following **Reactive Power** control modes which shall be available to the **TSO:**

c) The **Controllable WFPS** shall be capable of receiving a **Voltage Regulation** (kV) **Set-point** for the **Voltage** at the **Connection Point.** The **Voltage Regulation System** shall act to regulate the **Voltage** at this point by continuous modulation of the **Controllable WFPS's Reactive Power** output, without violating the rapid **Voltage** change ~~**Voltage Step Emissions**~~ limits as set out in CC.10.13.1 ~~the IEC standard 61000-3-7:1996 *Assessment of Emission limits for fluctuating loads in MV and HV power systems*~~.

WFPS1.6.4 VOLTAGE STEP EMISSIONS

Emission limits for **Voltage** changes are defined in CC.10.13.1. ~~IEC 61000-3-7:1996 *Assessment of Emission limits for fluctuating loads in MV and HV power systems*, gives a table of the emission limits for **Voltage** changes as a function of the number of changes, R, per hour.~~ This standard shall also apply to **Controllable WFPSs**.

Allocated Harmonic Distortion Limit (AHDL)	The **Allocated Harmonic Distortion Limit** to a **User's** connection is the maximum **Incremental Harmonic Voltage Distortion Level** that the **User's** facility is allowed to introduce in the **Transmission System Voltage**. The **AHDL** is assessed at the **Connection Point** and it is expressed as a percentage of the **RMS** value of the fundamental **Frequency Voltage**. The **AHDL** applies to the **THD** and to each individual harmonic order from the 2^{nd} up to, and including, the 40^{th}.
Harmonic Voltage Distortion Level	The **Harmonic Voltage Distortion Level** of the h^{th} order is the **RMS** value of the steady-state sinusoidal **Voltage** waveform at a **Frequency** of (50 x h) Hz which is present in the **Voltage** waveform in addition to its fundamental **Frequency** component. The **Harmonic Voltage Distortion Level** is expressed as a percentage of the **RMS** value of the fundamental **Frequency Voltage**.

Incremental Harmonic Voltage Distortion Level	The incremental change in magnitude of the Harmonic **Voltage** Distortion Level attributed to the **User's** facility as measured at the **Connection Point** which is solely caused by the connection of the **User's** facility. The **Incremental Harmonic Voltage Distortion Level** is a combination of: (a) Distortion caused by harmonic **Voltages** or currents generated by the **User's** facility and (b) Amplification of the existing **Harmonic Voltage Distortion Level** caused by an interaction between the **User's** facility and the **Transmission System** harmonic impedance (for example due to resonances).
Impedance Loci	A set of diagrams characterising the **Transmission System** impedance vector for a range of frequencies at the **Connection Point** from the 2nd up to, and including, the 40th harmonic. These diagrams will contain polygons, whose envelopes outline the bounds of the T**ransmission System** impedance under intact network and appropriate single contingency conditions.
Temporary Voltage Depression	A rapid change in fundamental **Frequency RMS** or peak **Voltage** over several cycles and remaining within the normal operating voltage range. This form of disturbance can manifest as an **RMS Voltage** depression with a slow recovery to nominal **Voltage**. The **RMS Voltage** depression is attributable to starting motors or the energisation of transformers or reactors and is characterised by the following diagram: 
Total Harmonic Voltage Distortion (THD)	The **Total Harmonic Voltage Distortion** is the **RMS** value of the sum of all individual **Harmonic Voltage Distortion Levels** up to a specified order *H*, where H is set to be 40.
Voltage Flicker	The impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time.

GREEN-LINE VERSION

CC.10.13 Power Quality

CC.10.13.1

(c) Harmonic **Voltage** Distortion
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(d) **Voltage** Fluctuations
Users shall ensure that their connection to the **Transmission System** does not result in the level of fluctuation of the supply **Voltage** on the **Transmission System** at the **Connection Point** exceeding limits set out below**.** Any necessary data will be exchanged between both parties and the exchange of data shall not be unreasonably withheld.

iii. **Voltage Flicker**
Users shall take responsibility for limiting **Voltage Flicker** caused by their **Plant** to remain within the maximum permissible **Voltage Flicker** limits at the **Connection Point** as allocated to them by the **TSO** or, as a minimum, those defined in Table 5 of IEC/TR 61000-3-7.

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WFPS1.6.4 VOLTAGE STEP EMISSIONS

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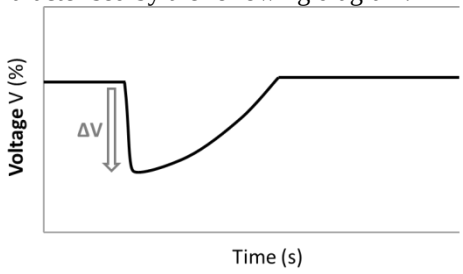
Temporary Voltage Depression	A rapid change in fundamental **Frequency RMS** or peak **Voltage** over several cycles and remaining within the normal operating voltage range. This form of disturbance can manifest as an **RMS Voltage** depression with a slow recovery to nominal **Voltage**. The **RMS Voltage** depression is attributable to starting motors or the energisation of transformers or reactors and is characterised by the following diagram: 
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Voltage Flicker	The impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time.