Voltage requirements

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Voltage Requirements – General Principles

Fundamental

- Voltage stability is a **key issue** for system performance and security.
- Most of the **large-scale disturbances** in the electricity transmission system in the recent years were related to and/or caused by **voltage instability (low voltage)**, particularly in Continental Europe.
- **Overvoltage** situations are now increasing due to the development of underground cables and due to the lack of generation support in specific areas.
- In these cases, any additional losses of demand due to narrow voltage withstand capabilities makes the situation worse.

System need

- Generators and transmission assets are used to contribute mostly to voltage stability.

➢ *All kinds of network users need to contribute to support voltage stability, taking into account their technical capabilities and their connection voltage level.*

➢ *Also Distribution Networks, both DSOs and Closed Distribution Networks, provide a pathway for embedded generation and DSR to contribute to voltage stability and are essential to ensure that their capabilities can be utilised.*

Voltage Requirements – General Principles

Future

- Intermittency of RES, and a less controllable, wider and more dispersed generation portfolio increases the needs for stability and certainty in response from other elements in the network.
- Withstand capabilities in case of overvoltage situations would be particularly valuable support for all demand users.
- DCC relates to **cross border issues** and therefore the NC only looks to place requirements on **transmission connected demand users**. In alignment with NC RfG an additional threshold of 110kV is imposed.
- The right of the demand user to alter their demand for their own reasons is key. DCC seeks to increase the stability of demand by avoiding equipment limitations.

Voltage Requirements – overview of past wide-spread system events

Location	Date	Frequency Stability	Voltage Stability	Transient Stability	Small-Signal Stability
Black out in France	19/12/1978	x	x	x	
France-Spain incident	10/08/1981			x	
France-Spain incident	30/12/1981			x	
Voltage Collapse in France	12/01/1987		x		
Black out in USA	10/08/1987			x	x
Voltage Collapse in Netherlands	23/06/1997		x		
Storm in South-West France	21/06/1999	x		x	
Black out of the southern part of Portugal	09/05/2000	x	x		
Black out USA-Canada	14/08/2003	x	x		
Black out in Scandinavian countries	23/09/2003		x		
Black out in Italy	28/09/2003	x	x	x	
Black out in the southern part of Greece	12/07/2004		x		
Rhineland/Palatinate/Luxembourg incident	02/09/2004		x		x
CE inter-area oscillations	01/05/2005				x
Voltage Collapse in Poland	26/06/2006		x		
Denmark Islanding	26/05/2007	x			
South-Balkans Disturbance	24/07/2007	x			

Voltage Requirements – Options

Several options are possible to deal with this issue in the NC DCC:

I. Do nothing. Demand Units/ Demand Facilities/ Distribution Networks are not expected to be equipped with a defined voltage with stand capability.

II. Demand Facilities or Closed Distribution Networks are not expected to be equipped with a defined voltage with stand capability, unless offering DSR services.

III. Include voltage withstand capabilities in the NC DCC for Demand Units connected directly to a transmission-connected Demand Facility or Distribution Network.

IV. Include voltage withstand capabilities only at the transmission connection point.

Option IV. is preferred. See earlier Call for Stakeholder Input and DCC supporting documents.

General Voltage Requirements

June 2012

1. Demand Facilities and Transmission Connected Distribution Networks shall fulfil the following requirements referring to Voltage stability:

   a) With regard to Voltage ranges:

1. In case of a deviation of the Network Voltage at the Connection Point from its nominal value, any Transmission Connected Distribution Network or Demand Facilitywith a Connection Point at 110 kV or above, shall ensure the equipment at theConnection Point site (typically an electrical substation) is capable of withstanding the Voltagerange at the Connection Point, expressed by the Voltage at the Connection Point related to nominal Voltage (per unit), and within the time periods specified by tables 3.1 and 3.2. Note the reference per unitVoltage at each TSO in the same synchronous area may differ i.e. the Voltage range in kV for all TSOs within a synchronous area may not be the same requiring co-ordination between adjacent TSOs.

1. All Transmission Connected Demand Facilities and all Transmission Connected Distribution Networks, deemed significant pursuant to the provisions of this Network Code, shall fulfil the following Voltage stability requirements:

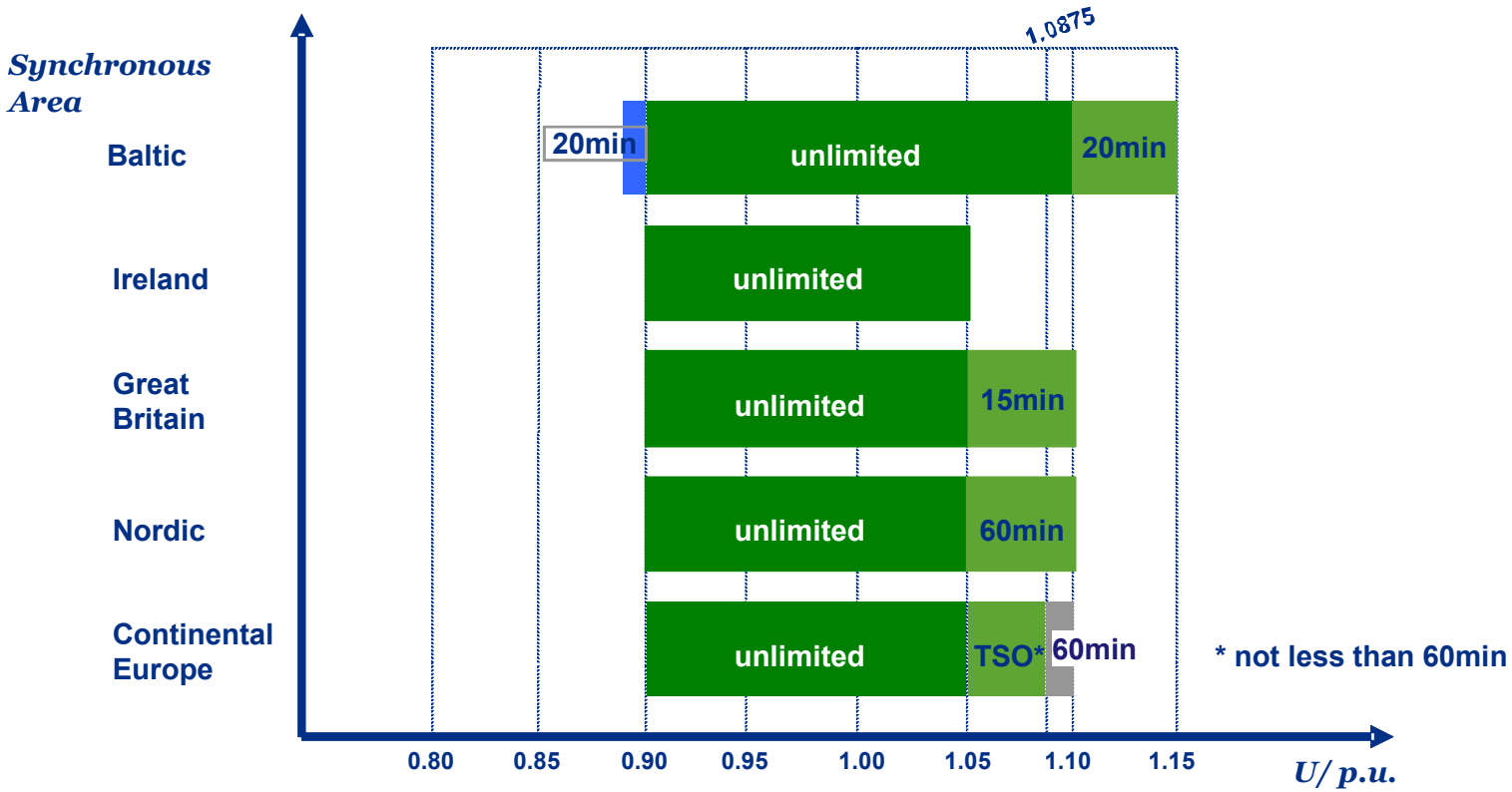
   a) With regard to Voltage ranges:

1. In case of a deviation of the Network Voltage at the Connection Point from its nominal value, any Transmission Connected Demand Facility Owner or Transmission Connected Distribution Network Operator with a Connection Point at 110 kV or above, shall ensure its equipment at the Connection Point site is capable of withstanding without damage the Voltage range at the Connection Point, expressed by the Voltage at the Connection Point related to nominal per unit Voltage, within the time periods specified by Table 2.1 and Table 2.2. The establishment of the reference nominal Voltage shall be subject to coordination between the adjacent TSOs.

Dec. 2012

General Voltage requirements

(300kV – 400kV)



General Voltage requirements 300kV - 400kV

June 2012

Table 3.1: This table shows the minimum time periods each Transmission Connected Distribution Network and Demand Facility shall be able to operate for Voltages deviating from the nominal value at the Connection Point. The Voltage base for pu values is between and including 300 kV and 400 kV.

Table 2.1: This table shows the Voltage and minimum periods of time each Transmission Connected Demand Facility and Transmission Connected Distribution Network shall be capable of operating for Voltages deviating from the nominal value at the Connection Point without disconnecting from the Transmission Network. The Voltage base for pu values is between and including 300 kV and 400 kV.

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General Voltage requirements 110kV – 300kV

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Synchronous Area	Voltage Range	Time period for operation
Continental Europe	0.90 pu – 1.118pu	Unlimited
	1.118 pu – 1.15 pu	To be defined by each TSO while respecting the provisions of Article 4 (3) with required co-ordination at interconnection points with adjacent TSOs under the conditions, but not less than 20 minutes
Nordic	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.10 pu	60 minutes
Great Britain	0.90pu–1.10pu	Unlimited
Ireland	0.90 pu – 1.118 pu	Unlimited
Baltic	0.80 pu – 0.90 pu	30 minutes
	0.90 pu – 1.12 pu	Unlimited
	1.12 pu – 1.15 pu	20 minutes

Synchronous Area	Voltage Range	Time period for operation
Continental Europe	0.90 pu – 1.118 pu	Unlimited
	1.118 pu – 1.15 pu	To be defined by each TSO while respecting the provisions of Article 9(3) with required co-ordination at interconnection points with adjacent TSOs under the conditions, but not less than 20 minutes
Nordic	0.90 pu – 1.05 pu	Unlimited
	1.05 pu – 1.10 pu	60 minutes
Great Britain	0.90pu–1.10pu	Unlimited
Ireland	0.90 pu – 1.118 pu	Unlimited
Baltic	0.85 pu – 0.90 pu	30 minutes
	0.90 pu – 1.12 pu	Unlimited
	1.12 pu – 1.15 pu	20 minutes

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General Voltage requirements 110kV – 300kV

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Table 3.2: This table shows the minimum time periods each Transmission Connected Distribution Network or Demand Facilities has to able to operate for Voltages deviating from the nominal value at the Connection Point without disconnecting from the Network. (The Voltage base for pu values is between and including 110 kV and under 300 kV)

1. Notwithstanding the provisions of point 1) a Distribution Network and Demand Facility shall be capable of automatic disconnectionat specified Voltages, if required by the Relevant Network Operator. The terms and settings for automatic disconnection shall be agreed with the Relevant Network Operator while respecting the provisions of Article 4 (3).

Table 2.2: This table shows the Voltage and minimum periods of time each Transmission Connected Demand Facilities or Transmission Connected Distribution Network shall be capable of operating for Voltages deviating from the nominal value at the Connection Point without disconnecting from the Transmission Network. The Voltage base for pu values is between and including 110 kV and under 300 kV.

1. Notwithstanding the provisions of paragraph (1)a)i, a Transmission Connected Demand Facility and Transmission Connected Distribution Network shall be capable of automatic disconnection at specified Voltages, if required by the Relevant TSO. The terms and settings for automatic disconnection shall be agreed between the Relevant TSO and the Transmission Connected Demand Facility Owner or the Transmission Connected Distribution Network Operator, while respecting the provisions of Article 9(3).

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General Voltage requirements

Many asked for clarifications regarding consistency with standards

- **EN60034** covers the terminal of the rotating electrical machine

  According to EN60034-1 standard (Electrical machines) as well as EN60034-3 the permanently permissible range of demand voltage variation is defined from 95% to 105% of rated voltage. For a limited time, demand ought to be capable of operating in a voltage range from 90% to 110% of rated voltage.

  DCC covers the network Connection Point. A grid user can comply with both at the same time.

- **EN50160** only gives specific guidelines for connections up to 35kV.

  Between 35 and 150kV: *"As the number of network users supplied directly from HV networks is limited and normally subject to individual contracts, no limits for supply voltage variations are given in this standard. Existing product standards for HV equipment should be considered"*

- **CIGRE report on testing** of temporary overvoltage characteristics confirms feasibility of DCC (and NC RfG) voltage ranges.

  WG 33.10, Temporary Overvoltages: Withstand Characteristics of Extra High Voltage Equipment, Electra No.179 August 1998, pp. 39-45

- See FAQ 10 and 20 in DCC supporting documents for further info on present standards and grid codes across Europe.

➢ Voltage requirements

Thank you all for your attention.

Questions?