HVDC systems default parameters

ENTSO-E guidance document for national implementation for network codes on grid connection

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ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 • info@entsoe.eu • www.entsoe.eu

1 DESCRIPTION

1.1 CODE(S) & ARTICLE(S)

COMMISSION REGULATION (EU) 2016/1447 establishing a network code on requirements for grid connection of high voltage direct current systems and direct current-connected power park modules (NC HVDC), 26 August 2016.

Preamble (2), Preamble (3), Preamble (4), Preamble (5), Preamble (7), Preamble (14), Preamble (15), Article 11 - Article 54.

1.2 INTRODUCTION

This document addresses the need from TSOs in countries that are mandated to implement the EU regulation for HVDC systems, but do not intend to establish an HVDC system in the short and mid-term planning period.

It provides a list of the minimum set of requirements for an HVDC system and a guidance with the recommended default parameters for the non-exhaustive requirements to be applied when implementing the EU regulation.

The document includes a list of recommended parameter values and selection ranges for the minimum set of parameters to be specified based on current European practice with HVDC systems.

Key definitions:

None defined yet.

1.3 NC FRAME

COMMISSION REGULATION (EU) 2016/1447 establishing a network code on requirements for grid connection of high voltage direct current systems and direct current-connected power park modules (NC HVDC), 26 August 2016.

Preamble (2), Preamble (3), Preamble (4), Preamble (5), Preamble (7), Preamble (14), Preamble (15), Article 11 - Article 54.

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1.4 FURTHER INFO

The latest NCs and further information are available here:

ENTSO-E Network Code for HVDC Connections and DC-connected Power Park Modules; Explanatory Note, 30 April 2014,

COMMISSION REGULATION (EU) 2016/1447 establishing a network code on requirements for grid connection of high voltage direct current systems and direct current-connected power park modules, 26. August 2016

CIGRE TB No 563. Modelling and Simulation Studies to be performed during the lifecycle of HVDC systems.

CIGRE TB No 536. Influence of Embedded HVDC Transmission on System Security and AC Network Performance.

CLC/TR 50509 Technical Guidelines for Radial HVDC Networks

IEC 62747 Ed 1.0:2014, Terminology for VSC Terminology for voltage-sourced converters (VSC) for high-voltage direct current (HVDC) systems.

2 INTERDEPENDENCIES

2.1 BETWEEN THE CNCS

COMMISSION REGULATION (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators (NC RfG):

Article 29 – 37 - the operational notification procedure
Article 38 – 39 - the cost benefit analysis and principles
Article 40 – 45, 46, 49, 53 and 56 - the compliance monitoring, testing and simulation
Article 58 – 59 - the non-binding guidance and monitoring of implementation
Article 60 – 65 - the requirements of the derogations
Articles about the technical requirements for PPMs

2.2 WITH OTHER NCS

There are interrelations with

- COMMISSION REGULATION (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (SO GL), and
- COMMISSION REGULATION (EU) 2017/2196 of 24 November 2017 establishing a network code on electricity emergency and restoration (NC ER).

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In SO GL Article 27, Article 28, Article 29, Article 156 and in NC ER Article 14, Article 16 notably regarding frequency management, design and activation of reserves may create conditions where active power oscillations may endanger the system strength and create risks with respect to the stable operation of the HVDC systems. Therefore various critical system conditions and scenarios shall be identified in the planning stage by the respective stability studies.

2.3 SYSTEM CHARACTERISTICS

N/A

2.4 TECHNOLOGY CHARACTERISTICS

N/A

3 COLLABORATION

3.1 TSO – TSO

All operational parameters for inter synchronous area HVDC systems and embedded HVDC systems affecting other TSOs shall be coordinated.

All protection settings and special protection settings for inter synchronous area and embedded HVDC systems affecting other TSOs shall be coordinated.

3.2 TSO – DSO

All operational parameters for inter synchronous area HVDC systems and embedded HVDC systems affecting DSO's and CDSOs shall be coordinated.

All protection settings and special protection settings for inter synchronous area HVDC systems and embedded HVDC systems affecting DSO's and CDSOs shall be coordinated.

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3.3 RSO – GRID USER

N/A

3.4 METHODOLOGY

When implementing the non-exhaustive technical requirements specified in the NC HVDC Articles 11 – 54 they could be implemented by defining the national implementation as the list of functional capability and proposed parameter values as recommended in Annex 1, section 4.

When implementing of the operational notification procedure as specified in Article 55 – 64, it is recommended to apply the same procedure as defined by NC RfG, Articles 29 – 37.

When implementing the cost benefit analysis and principles as specified in Article 55 and 66, it is recommended to apply the same procedure as defined by NC RfG, Articles 38 – 39.

When implementing the compliance monitoring, testing and simulation requirements as specified in Article 67, it is recommended to apply the same procedure as defined by NC RfG, Articles 40 – 43; 46; 49; 53; and 56 (type D PPMs).

When implementing the non-binding guidance and monitoring of implementation specified in article 75 and 76, it is recommended to apply the same procedure as defined by NC RfG, Articles 58 and 59.

Implementation of the requirements of the derogations specified in article 77, it is recommended to apply the same procedure as defined by NC RfG, Articles 60 – 65.

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4 ANNEX 1

Capability requirements – **all requirements is referred to PoC**	**Mandatory (M) / Optional (O)**	**NC HVDC Article**	**Function**	**General (G) / Site specific (S)**	**HVDC**	**RE-HVDC**	**DC PPM**	**Proposed value(s)** **Note: references to NC HVDC unless otherwise specified**
Frequency ranges (Annex 1, table 1)	**M**	11	FS	**G**	**X**	**X**		Annex 1, table 1 Ref – IGD on Frequency ranges. Values according to SAOA. (taken into account Annex VI NC HVDC)
Active power controllability, control range and ramping rate	**O**	13	FS	**S**	**X**	**X**		Minimum the capability required of Type D PPMs
Synthetic inertia	**O**	14	FS	**S**	**X**	**X**		Needs to be justified. Ref – IGD: Need for synthetic inertia (SI). SO GL art 39 activities.
Frequency Sensitive Mode (FSM) (Annex II, figure 1)	**M**	15	FS	**G**	**X**	**X**		Annex II, figure 1 Ref – IGD on FSM Values according to SAOA.
Limited frequency Sensitivity Mode – over frequency LFSM-O (Annex II, figure 3)	**M**	15	FS	**G**	**X**	**X**		Annex II, figure 3 Ref – IGD on LFSM-O-U
Limited frequency Sensitivity Mode – under frequency (LFSM-U) (Annex II, figure 4)	**M**	15	FS	**G**	**X**	**X**		Annex II, figure 4 Ref – IGD on LFSM-O-U Values according to SAOA.
Frequency control	**O**	16	FS	**S**	**X**	**X**		No need identified.
Maximum loss of active power	**M**	17	FS	**S**	**X**	**X**		No need identified if not specified in the LFC area operational agreement.
Voltage ranges – from 110 kV to 300 kV (Annex, III, table 4)	**M**	18(1)	VS	**G**	**X**	**X**		Annex III, table 4 Minimum the same duration as for Type D PPMs
Voltage ranges – from 300 kV to 400 kV (Annex, III, table 5)	**M**	18(1)	VS	**G**	**X**	**X**		Annex III, table 5 Minimum the same duration as for Type D PPMs
Wider voltage ranges and longer minimum times	**O**	18(2)	VS	**S**	**X**	**X**		Not less than Type D PPMs
Voltage ranges - automatic disconnection	**M**	18(3)	VS	**S**	**X**	**X**		Not less than Type D PPMs
Short circuit contribution during faults (Fast Fault Current)	**O**	19	VS	**S**	**X**	**X**		Equal to Type D PPMs Or set as a site specific requirement
Reactive power capability	**M**	20	VS	**S**	**X**	**X**		Annex IV, table 6 Not less requirements than Type D PPMs. 20.3 set as a site specific requirement

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Reactive power exchange with the network	**M**	21	VS	**S**	**X**	**X**		Equal to Type D PPMs at low active power levels or set as site specific requirement.
Reactive power control mode (VC – Q – PF)	**M**	22	VS	**S**	**X**	**X**		Equal to Type D PPMs For some as a site specific (22.2; 22.3a; 22.4; 22.5)
Priority to active or reactive power contribution	**M**	23	VS	**S**	**X**	**X**		Equal to Type D PPMs as site specific taking into account the capabilities of the HVDC system
Power quality	**M**	24	VS	**S**	**X**	**X**		Equal to Type D PPMs
Fault ride through capability (symmetrical / asymmetrical faults)	**M**	25	R	**S**	**X**	**X**		Annex V, table 7. U_{ret}: 0.0 pu U_{rec1}: 0.25 pu U_{rec2}: 0.85 pu t_{clear}: 250 ms t_{rec1}: 2.5 s t_{rec2}: t_{rec1} -10 s The remaining requirements is recommended to be equal to Type D PPMs, setting U_{block} to 0.7 pu if LCC wants to be permitted. As site specific (25.2; 25.4; 25.5)
Post fault active power recovery	**M**	26	R	**G**	**X**	**X**		Equal to Type D PPMs
Energisation and synchronization	**O**	28	CTRL	**G**	**X**	**X**		Equal to Type D PPMs
Interaction between HVDC systems	**O**	29	CTRL	**S**	**X**	**X**		Ref – IGD on Interaction between HVDC controllers.
Power oscillations damping capability	**M**	30	CTRL	**S**	**X**	**X**		Equal to Type D PPMs
Sub-synchronous torsional interaction damping capability	**M**	31	CTRL	**G**	**X**	**X**		Ref – IGD on Interaction between HVDC controller
Network characteristics	**M**	32	CTRL	**G**	**X**	**X**		Equal to Type D PPMs
HVDC system robustness	**M**	33	CTRL	**S**	**X**	**X**		Equal to Type D PPMs
Electric protection schemes and settings	**M**	34	GSM	**S**	**X**	**X**		Equal to Type D PPMs
Priority ranking of protection and control	**O**	35	GSM	**S**	**X**	**X**		Equal to Type D PPMs
Changes to protection and control schemes and settings	**O**	36	GSM	**S**	**X**	**X**		Equal to Type D PPMs
Black start	**O**	37	SR	**S**	**X**	**X**		
Frequency stability requirements	**O**	39	FS	**G**			**X**	Annex VI, table 8
Reactive power and voltage requirements – voltage ranges from 110 kV to 300 kV and from 300kV to 400kV	**O**	40(1)(a)	VS	**G**			**X***	Annex VII, table 9 & 10
Reactive power and voltage requirements - Maximum and	**O**	40(2)(b)(i)	VS	**G**			**X***	Annex VII, table 11

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minimum range of both Q/Pmax and steady-state voltage for a DC-connected PPMat the time of connection or subsequently.								
Control requirements	**M**	41	CTRL	**G**			**X**	Equal to Type D PPMs
Network characteristics	**M**	42	CTRL	**G**			**X**	Equal to NC HVDC article 32.
Protection requirements	**M**	43	GSM	**S**			**X**	Equal to Type D PPMs
Power quality	**M**	44	VS	**S**	**X**	**X**	**X**	Equal to Type D PPMs
Frequency stability requirements	**O**	47	FS	**S**		**X**		Equal to NC HVDC article 11 – 15
Reactive power and voltage requirements	**O**	48(1)(a)	VS	**G**		**X**		Annex VIII, table 12 & 13 Equal to NC HVDC article 20 – 23.
Reactive power and voltage requirements	**M**	48(2)(b)	VS	**G**		**X**		Annex VIII, table 14 Equal to NC HVDC article 22.
Network characteristics	**M**	49	CTRL	**S**		**X**		Equal to NC HVDC article 32.
Power quality	**M**	50	VS	**S**	**X**	**X**		Equal to Type D PPMs
Information exchange ** (real time or periodically)	**M**	51	INFO	**G**	**X**	**X**	**X**	Equal to Type D PPMs
Parameters and settings	**M**	52	INFO	**S**	**X**	**X**	**X**	Equal to Type D PPMs
Fault recording and monitoring	**O**	53	INFO	**S**	**X**	**X**	**X**	Equal to Type D PPMs
Simulations models	**O**	54	GSM	**G**	**X**	**X**	**X**	Equal to Type D PPMs

Function column acronyms:

Frequency stability: FS;

Robustness: R;

Control: CTRL;

General System Management: GSM;

Voltage Stability: VS;

System restoration: SR;

Information exchange: INFO;

RE-HVDC: Remote End HVDC

PPM: Power Park Module

X*: NC RfG requirements article 5, 13 to 22 shall apply (subject to specific requirements provided for in Articles 41 to 45 of this Regulation).

X**; NC RfG requirements article 14.5, 15.6 and 16.4 shall apply

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