European Network of
Transmission System Operators
for Electricity

IMPLEMENTATION GUIDELINE FOR NETWORK CODE

“Demand Connection”

16 October 2013

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1. Executive Summary

ENTSO-E released its Network Code on ñDemand Connectionò (DCC)[1] in December 2012. The network code received a favourable recommendation from ACER in March 2013, acknowledging its contribution to Europeôs energy goals and supporting its adoption as a binding EU legislation[2].

Throughout the development of this code, the rationale for its European-wide requirements in light of present situations and future system developments have been regularly discussed among network operators, impacted stakeholders and regulators. This background is reflected among others in various supporting documents, available on the ENTSO-E website[3].

Requirements for grid connection in the DCC all have a cross-border impact, but need to be tailored to manage and make best use of local system characteristics (network, load, generation portfolio and technology). This document is drafted by ENTSO-E with the objective to give guidance for national implementation of the DCC. It focuses on a selection of so-called non-exhaustive requirements in the code, which have been regularly discussed with various stakeholders in the past years and need further consideration when being implemented on national level. It describes for a given requirement the elements to be further specified, it lists various conditions to consider and it stresses the strongest interdependencies with other requirements (be it in the same or other codes). This document neither sets a precedent for nor does it tabulate the outcome of all Member State implementations, which are often driven by further detailed studies and interlinked with other national grid code requirements.

This ENTSO-E document informs interested parties on the underlying principles of a selection of the non-exhaustive requirements in the DCC. This non-binding document supports the network code, but does not supplement the code, nor can it be used as a substitute thereof.

Section 2 provides further clarification on the need for national flexibility to ensure cost-efficient implementation of the network code. Section 3 then addresses relevant requirements of the DCC.

[1] https://www.entsoe.eu/fileadmin/user_upload/_library/resources/DCC/ENTSO-E_finalises_DCC/121221_final_Network_Code_on_Demand_Connection.pdf
[2] http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Pages/Recommendations.aspx
[3] https://www.entsoe.eu/major-projects/network-code-development/

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2. Background on the development of this document

The Network Codes will become binding after a comitology procedure driven by the European Commission and scrutinized by both the Council and the European Parliament. The Network Codes will be adopted as an EU Regulation. Being part of the EU law- they supersede national legislation (existing or new) in Member States. In other words, in case of conflict between the Network Code and the conflicting national legislation, the former prevail and the latter must be ignored by national courts so that the EU law can take effect. No further action is necessary on national level to enforce EU Network Codes from a legal perspective (they are directly applicable), although most if not all Member States are likely to adapt corresponding national rules, to provide for consistency, clarity and transparency of the national legal framework. This process raises a number of immediate questions discussed more fully below:

1. How will a Network Code be implemented at a national level?
2. Will the Network Code be applied in non-EU countries?
3. What is a non-exhaustive requirement?
4. Why is there room for national choices in a European Network Code?

2.1. How will a network code be implemented at a national level?

The process for implementing the DCC at a national level is not defined in the code itself but left to subsidiarity. It means that Member States shall define what processes should be employed.

However every Member State currently has processes to assess and apply requirements to existing and prospective users of its transmission and distribution networks. These existing processes should be the starting point for national implementation and can in many cases be readily adapted for use to apply Network Codes.

A transition period- three years after the entry into force of the Network Code allows for modification of these national implementation processes. This transition period also grants sufficient time for necessary changes to be made to existing contractual arrangement, e.g. example connection agreements with users to which the Network Code shall apply.,

Although the general responsibility for rendering the Network Code fully applicable at the expiry of the 3-year transition period in principle lies with the Member States, the practical management of that transitional phase is likely to be passed to both national regulators and system operators.

2.2. Will Network Codes be applied in non-EU countries?

For the non-EU countries which are parties to the EEA Agreement (the European Economic Area Agreement), the EEA Agreement, provides for the inclusion of EU legislation, that covers the four freedoms ð the free movement of goods, services, persons and capital ð throughout the 30 EEA States. The Agreement guarantees equal rights and obligations within the Internal Market for citizens and economic operators in the EEA. As a result of the EEA Agreement, EU law on the four freedoms is incorporated into the domestic law of the participating countries of the European Free Trade Association. All new relevant EU legislation is also introduced through the EEA Agreement so that it applies throughout the EEA, ensuring a uniform application of laws relating to the internal market. As energy legislation covering the functioning of the internal market falls within the scope of the EEA-Agreement, the entire body of Network Codes will almost certainly be EEA relevant, and hence be applicable and binding after decision by the EEA Committee and national implementation. The regular implementation procedures according to the EEA Agreement will apply.

As Switzerland is not a party to the EEA Agreement, the enforceability of the NC transformed into EU Regulation will need to be assessed in the context of the pending negotiations between Switzerland and the

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EU. However, Swiss law is also based on the principle of subsidiarity. Under this principle, self-regulating measures can be taken by the parties of the sector if they reach the conclusion that these rules should become common understanding of the sector. Based on the subsidiarity principle it is currently considered by the Swiss authorities to introduce under Swiss law, new rules compliant to relevant EU regulations by the parties of the sector.

For the countries that are parties to the Energy Community Treaty[4], the Ministerial Council of the Energy Community decided on 6 October 2011 that the Contracting Parties shall implement the Third Package by January 2015, at the latest. Moreover, it decided ñto start aligning the regionôs network codes with those of the European Union without delayò. The Network Codes will be adopted by the Energy Community upon proposal of the European Commission. The relevant Network Codes shall be adopted by the Permanent High Level Group. The Energy Community Regulatory Board stressed on 5 September 2013 ñthe importance to implement the NCs in the Energy Community in a timely and coherent manner in coordination with the European developments.ò

2.3. What is a non-exhaustive requirement?

EU Network Codes on grid connection contain a number of non-exhaustive requirements. Such non-exhaustive requirement within a Network Code does not provide for a full harmonisation of that requirement. This means that with regard to those the DCC does not contain all the information or parameters necessary to apply the requirement immediately and thus needs further specification at national level. This specification will result in rendering the non-exhaustive EU requirements exhaustively defined as a national or project specific rules. As mentioned above, this may require updating and amending respective technical regulations (e. g. existing national grid codes) accordingly. The three year transition period from the date of entry into force until its application (see also paragraph 2.1 above) allows for such a national implementation procedure.

Typically additional information or parameters are to be provided by the Relevant Network Operator or the Relevant TSO[5]. In many cases these specifications can be brought forward through an already established process at national level, e.g. grid code review panel, user group, public consultation, regulator or ministry approval. A Network Code itself does not prescribe these national processes, but merely stipulates that they shall be in accordance with the implementation of Directive 2009/72/EC and the principles of transparency, proportionality and non-discrimination, with the mandatory involvement of the National Regulatory Authorities. This framework safeguards against unilateral or non-motivated decisions and often gives a specific frame of how to involve the wider industry. Furthermore it allows Member States to continue using most established processes, which often are acknowledged by all involved parties and have proven to be successful.

Even as the DCC explicitly allows for a three year transition period from its entry into force, initial discussions on national choices are picking up in some countries already before adoption of the code as EU Regulation, with the motivation to provide clarity to the wider industry (grid users, manufacturers and network operators) as soon as possible. These discussions can however not pre-empt the formal national implementation which is referred to in the Network Code and which can only be commissioned once the code enters into force.

[4] http://www.energy-community.org

[5] The Relevant Network Operator is the operator of the network the user is directly connected to. The Relevant TSO is the TSO in whose control area the user is connected.

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2.4. Why is there room for national choices in a European Network Code?

Non-exhaustive requirements have a valid role in an EU Network Code because of their impact on security of supply, the integration of renewables or market development. Even as specifications depend on local system conditions, clear benefits exist when the code:

a) ensures that these requirements are specified by the Relevant Network Operator or TSO in all Member States;
b) enforces a similar terminology and gives the minimum list of parameters and conditions to specify at the national level; and
c) covers compliance and derogations procedures across Europe in a transparent and non-discriminatory manner.

In many cases the Network Codes constrain national provisions from either very loose or extremely onerous implementations. An EU Network Code pulls all national codes in the same direction.

Non-exhaustive requirements can be broken into two distinct categories.

a) The first category covers project specific non-exhaustive requirements. These requirements cannot be written exhaustively at either a European, synchronous system or national level and need to be considered on a case by case basis.

   Example: Article 17 of the DCC requires the Relevant Network Operator and the Transmission Connected Demand Facility Owner or Transmission Connected Distribution Network Operator to agree on protection and control schemes and settings. Inadequate protection specifications could see wide spread loss of generation/demand and hence impact on security of supply to the European network. Typically this category of non-exhaustive requirements is of purely descriptive nature by simply defining ñwhatò has to be further specified without any prescription on ñhowò the result shall look like. Therefore this category is not subject to the strong stakeholder opposition.

b) The second category covers non-exhaustive requirements that should be specified at either a synchronous system or national level. For these requirements, much greater commonality is expected in the information and/or parameters to be applied. However, characteristics of networks like design and topography, as well as inherent physical conditions determining dynamic system response and stability (e.g. system inertia) differ across Europe. For technical reasons, as well as resulting financial impact, the use of single European settings is not always sound.

   Example 1: It is technically not possible to set a single voltage range for Europe without major redesign of existing networks, which makes this either technically impossible, or to be made technically possible, would require massive replacement of existing assets and is not financially viable.
   Example 2: The capability of Demand Facilities or Distribution Networks to provide or control reactive power depends on the network characteristics and may be offset to provide either a more in the lagging or leading range. A uniform requirement covering all of Europe would consequently have to cover all possible network requirements and would consequently result in the introduction of supplementary components, which is not needed or that technically would be required in many locations.

The requirements of EU Network Codes will also have impact on industry standards, which amongst others provide manufacturers with default parameters for equipment design. Due to the legally binding nature of EU Network Codes, their provisions prevail over any industrial standard- which are in principle non-binding. With regard to exhaustive requirements provided in these codes, affected standards may need to be amended to become compliant with this legislative framework. Existing standards, as well as other

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technical regulation (e.g. national grid codes) may serve as a reference for further specifications of values and ranges of parameters in non-exhaustive requirements. With continuing evolutions in the integration of renewable energy sources and the further strengthening of the European electricity system and markets, modifications to existing standards may also be essential. A much complementary and crucial role for standards lies in its use to give a complete set of specifications for compliance testing with the EU code and other relevant connection conditions[6].

[6] Memorandum of Understanding between ENTSO-E and CEN/CENELEC

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3. Guidelines for Network Code „Demand Connection“

The following tables give an overview of the requirements covered under the DCC. The requirements indicated in orange are further described in this document.

Requirement	Type
GENERAL FREQUENCY REQUIREMENTS	Frequency stability
GENERAL VOLTAGE REQUIREMENTS	Voltage stability
SHORT-CIRCUIT REQUIREMENTS	Frequency stability, voltage stability, robustness of demand Facility/DSO, angular stability, and general system management
REACTIVE POWER REQUIREMENTS	Voltage stability
PROTECTION AND CONTROL	General system management
INFORMATION EXCHANGE	General system management
DEVELOPMENT, MODERNIZATION AND EQUIPMENT REPLACEMENT	General system management
DEMAND DISCONNECTION FOR SYSTEM DEFENCE AND DEMAND RECONNECTION	Frequency stability and voltage stability
POWER QUALITY	Robustness of Demand Facility/DSO, Power Quality
SIMULATION MODELS	General System Management

Table 1 - Requirements applicable to all Transmission Connected Demand Facilities

Requirement	Type
GENERAL FREQUENCY REQUIREMENTS	Frequency stability
GENERAL VOLTAGE REQUIREMENTS	Voltage stability
SHORT-CIRCUIT REQUIREMENTS	Frequency stability, voltage stability, robustness of demand Facility/DSO, angular stability, and general system management
REACTIVE POWER REQUIREMENTS	Voltage stability
PROTECTION AND CONTROL	General system management
INFORMATION EXCHANGE	General system management
DEVELOPMENT, MODERNIZATION AND EQUIPMENT REPLACEMENT	General system management
DEMAND DISCONNECTION FOR SYSTEM DEFENCE AND DEMAND RECONNECTION	General system management
POWER QUALITY	Robustness of Demand Facility/DSO, Power Quality
SIMULATION MODELS	General system management

Table 2 - Requirements applicable to all Transmission Connected Distribution Networks

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Requirement	Type
GENERAL PROVISIONS FOR DEMAND SIDE RESPONSE	General system maintenance
DEMAND SIDE RESPONSE ACTIVE POWER CONTROL, REACTIVE POWER CONTROL AND TRANSMISSION CONSTRAINT MANAGEMENT	Frequency Stability, Voltage stability and General System Management
DEMAND SIDE RESPONSE SYSTEM FREQUENCY CONTROL	Frequency stability
DEMAND SIDE RESPONSE VERY FAST ACTIVE POWER CONTROL	Frequency stability

Table 3 - Requirements applicable to users providing Demand Side Response

Relevant Defined terms used in Network Code Demand Connection applicable to this guideline:

Closed Distribution Network means in the context of this Network Code a Network classified as closed distribution network pursuant to Article 28(1) of Directive 2009/72/EC at national level. Article 28 of Directive 2009/72/EC defines such a Network as a system which distributes electricity within a geographically confined industrial, commercial or shared services site and does not (without prejudice to a small number of households located within the area served by the system and with employment or similar associations with the owner of the system) supply household customers. This Closed Distribution Network will either have its operations or the production process of the users of the system integrated for specific or technical reasons or distribute electricity primarily to the owner or operator of the Closed Distribution Network or their related undertakings;

Demand Facility means a facility which consumes electrical energy and is connected at one or more Connection Points to the Network. For the avoidance of doubt a Distribution Network and/or auxiliary supplies of a Power Generating Module are not to be considered a Demand Facility;

Demand Side Response (DSR) means demand offered for the purposes of, but not restricted to, providing Active or Reactive Power management, Voltage and Frequency regulation and System Reserve;

Demand Side Response Active Power Control (DSR APC) means demand within a Demand Facility or Closed Distribution Network that is accessible for modulation by the Relevant Network Operator, which results in an Active Power modification;

Demand Side Response Reactive Power Control (DSR RPC) means Reactive Power or Reactive Power devices (Mvarôs) in a Demand Facility or Closed Distribution Network that are accessible for modulation by the Relevant Network Operator;

Demand Side Response System Frequency Control (DSR SFC) means reduction or increase of the demand of electrical devices in response to Frequency fluctuations, made by an autonomous response to temperature targets of these electrical devices to diminish these fluctuations;

Demand Side Response Transmission Constraint Management (DSR TCM) means demand that is accessible for modulation by the Relevant Network Operator to manage transmission constraints within the Network;

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Distribution Network means an electrical Network, including Closed Distribution Networks, for the distribution of electrical power from and to third party[s] connected to it, a Transmission or another Distribution Network;

Transmission Connected Demand Facility means a Demand Facility which has a Connection Point to a Transmission Network;

Transmission Connected Distribution Network means a Distribution Network which has a Connection Point to a Transmission Network;

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3.1. General Voltage Requirements

DESCRIPTION	
Article	14 (1) (a) i.
Objective	This requirement should ensure that larger transmission connected customers or networks do not disconnect for a range of voltage that can be reasonably be expected to occur on the transmission network during normal and disturbed states. Due to voltage sensitivity of some loads within a facilities/network, these voltage requirements are restricted to the equipment at the connection point to ensure that the facility/network remains in parallel with the transmission network. This permits the many inherent non-sensitive loads and/or embedded generation to continue to use the connection point to absorb of provide power. Random and unpredicted disconnection of a number of users due to inadequate equipment capabilities jeopardizes voltage stability and risks security of supply.
NC frame	In the CE synchronous network the individual TSOs will specify the time period that the equipment at the connection point of a Transmission Connected Demand Facility or Distribution Network will be designed to at least be capable to withstand. 2 values have to be defined: - Time period in the overvoltage of 1.05 pu-1.0875 pu for facilities connected at or above 300 kV; - Time period in the overvoltage of 1.118 pu-1.15 pu for facilities connected at or above 110 kV and under 300 kV;

Further info	• Supporting documentation of DCC network code:
	  ○ Network Code Demand Connection ï Frequently asked questions (21st December 2012)
	  ○ Network Code Demand Connection ï Justification outlines (21st Dec 2012)
	• External documents:
	  ○ ENTSO-E October 2009 ñTechnical Background and Recommendations for Defence Plans in Continental Europeò

INTERDEPENDENCIES	
In this NC	Protection and Control Article 17. 1.
In other NCs	RfG and HVDC connection Codes will have a similar requirement for voltage requirements and should be consistent with those applied here to ensure that generation or network is not lost due to voltage withstand capability.
System characteristics	Although network characteristics will greatly affect the local voltage at the point of connection the design limits provided should account for voltage ranges expected over the life of the plant and equipment and therefore typically maybe based on a single system wide design level rather than existing local levels.
Technology characteristics	Adequate voltage range capability of equipment is a reliability and system wide issue and therefore not adjusted in the code in relation to any technology. However this voltage capability is not typically a restricting factor in technology selection.
COORDINATION	
TSO – TSO	TSOs in a synchronous zone need to be aware and factor in voltage range limits imposed by other TSOs, notably neighbouring TSOs, in relation to the limits they set on their users to time period in voltage ranges are co-ordinated and no cascading loss of equipment results. Generally standard equipment manufacturers voltage capability ratings are deemed to be compliant with the minimum requirements i n the code making an agreed

	co-ordinated applied cross border limit easier.
TSO – Distribution Network Operator	TSOs in a synchronous zone need to be aware and factor in the voltage withstand time of the voltage ranges impact on DSOs and their connecting customers connecting customers to ensure voltage ranges are co-ordinated.
TSO – Transmission Connected Demand Facility	TSOs in a synchronous zone need to be aware and factor in voltage range and withstand times imposed by them and the imposed limits impact on other Grid Users.

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3.2. Short Circuit Requirements

DESCRIPTION	
Article	15.1
Objective	This requirement ensures that the TSO provide both Transmission Connected Demand Facilities and Distribution Network with the data on the maximum short circuit current at connection point that they should design their networks to cater for ensuring safe operation. This is important to ensure that the design value of the electrical equipment on both the Transmission Network and Demand Facilities or Distribution Network is sufficiently high to withstand the maximum value of the short circuit current. This ensures a correct design of the equipment so that equipment will not be damaged during short circuits and faulted parts of the network can be disconnected under all circumstances
NC frame	The network code requires the TSO to provide to the Transmission Connected Demand Facilities and Distribution Network their maximum short circuit design limits to which they maintain the operation of their networks is within the design limits their facility is be able to withstand. Furthermore the TSO shall provide an estimate of the minimum and maximum short-circuit currents at the Connection Point. In return the Transmission Connected Demand Facilities and Distribution Network shall provide the same information to the TSO. The TSO and the Transmission Connected Demand Facilities and Distribution Network shall inform the other party in case of modification of the provided value.
Further info	N/A
INTERDEPENDENCIES	
In this NC	Protection and Control Article 17. 1.
In other NCs	HVDC connection Code will have a similar requirement for short circuit. RfG connection Code has a requirement to provide the necessary network data to perform simulation tests of generators which may include short circuit data.
System characteristics	Although network characteristics will greatly affect the short circuit at the point of connection the design limits provided should account for short circuit levels expected over the life of the plant and network equipment and therefore typically maybe based on a single system wide design level rather than existing local levels.
Technology characteristics	Adequate short circuit capability of equipment is a safety issue and therefore not adjusted in the code in relation to any technology. However short circuit capability is not typically a restricting factor in technology selection.
COORDINATION	
TSO – TSO	TSOs in a synchronous zone need to be aware and factor in short circuit design limits imposed by other TSOs, notably neighbouring TSOs, in relation to the limits they set on their users to ensure short circuit levels are co-ordinated. Generally standard equipment manufacturerǿs short circuit capability ratings will limit selections making an agreed co-ordinated applied cross border limit easier.
TSO – DSO	TSOs in a synchronous zone need to be aware and factor in the short circuit design limits impact on DSOs and their connecting customers to ensure short circuit levels are co-ordinated. Generally standard equipment manufacturerǿs short circuit capability ratings will limit selections.

TSO – Transmission Connected Demand Facility and RNOs	RNOs and Transmission Connected Demand Facility in a synchronous zone need to be aware and factor in short circuit design limits imposed by them and the imposed limits impact on other Grid Users.

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3.3. Reactive Power Requirements

DESCRIPTION	
Article	16.1
Objective	To ensure a reactive power range which is adequate to utilize embedded generation and DSR for local and system wide network support, but minimizes the cost of reactive power provision by limiting the transfer or transmission of reactive power in favour of local production.
NC frame	The network code requires the TSO to define a reactive power range within European range limits (equivalent to 0.9 lagging to unity, or 0.9 leading to 0.9 lagging Power Factor dependant on the presence of generation within the Demand Facility or Distribution Network).
Further info	• Supporting documentation of DCC: ○ Network Code Demand Connection ï Frequently asked questions (21st December 2012) ○ Network Code Demand Connection ï Justification outlines (21st Dec 2012) ○ Network Code Demand Connection ï Call for Stakeholder Input (5th Apr 2012)
INTERDEPENDENCIES	
In this NC	ARTICLE 22 DEMAND SIDE RESPONSE AND REACTIVE POWER CONTROL AND TRANSMISSION CONSTRAINT MANAGEMENT
In other NCs	Network Code Requirements for Generators Network Code HVDC Network Code Operational Security Network Code Operational Planning Scheduling
System characteristics	System characteristics like network topology and generation mix have significant impact on the reactive power ranges applicable to be required, for example: • System Strength Low system strength may reduce system voltage stability margins and hence may restrict the amount of reactive power that maybe drawn from the transmission network before network collapse. • Embedded generation Due to the displacement of large scale generation in many parts of the network in favour of embedded generation, the capability of these embedded units to support the transmission network must be assured and not restricted. Therefore reactive power ranges may need to be increased to maximize the use of these generators in the wider network
Technology characteristics	portfolio of connected generation and demand, at present and in future scenarios
COORDINATION	
TSO – TSO	TSOs need to ensure reactive power requirements are co-ordinated with adjacent synchronously connected TSOs so that reactive power provision in combination can be acceptably delivered from the transmission network, and are non-discriminatory to demand users in either network.

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TSO – DSO	TSOs will specify what level of reactive power is required at the connection point with the DSO. Where an alternative financially or technically more attractive solution (to the TSO specified reactive power range) is considered the TSO and DSO will work together to assess the proposal.
TSO – Transmission Connected Demand Facility	TSOs will specify what level of reactive power is required at the connection point with the Transmission Connected Demand Facility, dependant on any existing and/or proposed future generation.

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3.4. Information Exchange

DESCRIPTION	
Article	18.1
Objective	To specify the information standard to which Transmission Connected Distribution Networks and Demand Facilities will be designed to allow for ongoing operation and development of the network.
NC frame	The TSO shall provide publically a standard to be complied with for information exchange. This shall set out for example the necessary signals, status flags, accuracy, refresh periods and measurement scales. The precise list of data required shall also be made publically available by the TSO.
Further info	• Supporting documentation of DCC network code: ○ Network Code Demand Connection ï Frequently asked questions (21st December 2012) ○ Network Code Demand Connection ï Justification outlines (21st Dec 2012)
INTERDEPENDENCIES	
In this NC	ARTICLE 15 SHORT-CIRCUIT REQUIREMENTS ARTICLE 17 PROTECTION AND CONTROL ARTICLE 20 DEMAND DISCONNECTION FOR SYSTEM DEFENCE AND DEMAND RECONNECTION ARTICLE 22 DEMAND SIDE RESPONSE ï ACTIVE POWER CONTROL, REACTIVE POWER CONTROL AND TRANSMISSION CONSTRAINT MANAGEMENT
In other NCs	Consistent requirements in NC RfG / NC HVDC Further specifications on real-time exchange in NC OS, NC OPS, NC LFC&R
System characteristics	System characteristics like network topology and generation mix have significant impact on the relevant information to be required, for example: • System Strength Low system strength may require stability margins and harmonic information to be provided • Embedded generation and DSR Large scale embedded generation and DSR will require information of current operational levels for operational measures.
Technology characteristics	Although technology neutral in many other aspects with regards to information exchange characteristics of technologies may require specific or different information exchange.
COORDINATION	
TSO – TSO	TSOs to ensure adequate operation and development of their networks need to share appropriate information with adjacent synchronously connected TSOs. To this end the required information for each TSO will need to be defined in coordination with the adjacent TSO and the data will be communicated to them.
TSO – DSO	TSOs will specify what capability to provide information is required with the DSO to ensure adequate information of their network for amongst other activities system operation. Typically this may require an aggregation of information.
TSO – Transmission Connected Demand Facility or CDNO	TSOs will specify what capability to provide information is required with the Transmission Connected Demand Facilities or with the Closed Distribution Network Operator to ensure adequate information of their network for amongst other activities system operation.

3.5. Demand Disconnection for System Defence and Reconnection

DESCRIPTION	
Article	20.1.a).,20.1.b).,20.1.c).,20.3.a).,20.3.b).,20.5.a).,20.5.c).
Objective	To define when LFDD, LVDD and OLTC blocking is required and that it provides the necessary speed of response and data exchange, and resilience to be effectively relied upon to contribute to system operation. Similarly when required that disconnection and reconnection of Transmission connected Demand Facilities and Distribution Networks for system operation is specified.
NC frame	The network code requires the TSO to define if LVDD and OLTC blocking are to be fitted in a Distribution Network or Demand Facility and agree their exact location with the owner. The network code also requires the TSO to define the trigger and scale of disconnection for LFDD and as applicable LVDD. The TSO is also required to identify when the capability for remote disconnection or reconnection of a Transmission Connected Demand Facility or Transmission Connected Distribution Network is needed.

Further info	• Supporting documentation of DCC network code:
	  o Network Code Demand Connection ï Frequently asked questions (21st December 2012)
	  o Network Code Demand Connection ï Justification outlines (21st Dec 2012)
	• External documents:
	  o ENTSO-E October 2009 ñTechnical Background and Recommendations for Defence Plans in Continental Europeò: recommendation to set LVDD as standard practice

INTERDEPENDENCIES	
In this NC	Protection and Control 17.1
In other NCs	NC RfG: undervoltage disconnection NC OS: reference to states and System Defence Plans NC on Emergency Procedures: to be developed still
System characteristics	System characteristics like network topology and generation mix have significant impact on the Demand Disconnection for System Defence requirements, for example: • System Strength Low system strength may reduce system voltage stability margins and hence determines the voltage level at which the LVDD scheme will be activated. • Embedded generation Due to the increasing volume of embedded generation, it gets more difficult to predict how much power will be turned off by the frequency relay. In order to prevent a reverse feeding compound is separated, the direction of Active Power flow must be detected. • System Voltage Low system voltage determines the voltage level at which the LVDD scheme will be activated.
Technology characteristics	Although technology neutral in many other aspects with regards to disconnection for System Defence and reconnection, the characteristics of technologies may require specific or different approach to LFDD, LVDD OLTC Blocking and/or reconnection.

COORDINATION	
TSO – TSO	TSOs to ensure adequate operation and development of their networks need to share appropriate information with adjacent synchronously connected TSOs. To this end the required information for each TSO will need to be communicated to ensure between TSOs.
TSO – DSO	The Information about the percentage of the demand disconnection at each Frequency shall be communicated to the DSO. The geographical distribution of this demand disconnection shall be provided by the DSO and approved by the TSO. Each DSO shall notify the TSO in writing of the details of the automatic Low Frequency Demand Disconnection on its Network. Low Voltage Demand Disconnection schemes for DSO Networks shall be defined by the Relevant TSO.
TSO – Transmission Connected Demand Facility	The Information about the percentage of the demand disconnection at each Frequency shall be communicated to the Demand Facility Owner. The geographical distribution of this demand disconnection shall be provided by the Demand Facility Owner and approved by the TSO. Each Demand Facility Owner shall notify the TSO in writing of the details of the automatic Low Frequency Demand Disconnection on its Network. Low Voltage Demand Disconnection schemes for Demand Facilities shall be defined by the Relevant TSO.

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3.6. Power Quality

DESCRIPTION	
Article	25
Objective	This requirement ensures that the power quality of the transmission network (and therefore defacto adjacent networks) is able to operate within acceptable levels by ensuring adequate suppression of emissions from both Transmission Connected Demand Facilities and Distribution Networks.
NC frame	The network code requires the TSO to provide the standard of power quality that either the Transmission Connected Demand Facilities or Distribution Networks must meet at their connection point.
Further info	IEC 61000-3-6 ï Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems IEC61000-3-7 Assessment of emission limits for the connection of distorting fluctuating installations to MV, HV and EHV power systems IEC61000-3-13 Assessment of emission limits for the connection of unbalanced installations to MV, HV and EHV power systems ER G5/4 Planning Limits for Harmonic Voltage Distortion and the connection of Non-Linear equipment to the transmission and distribution systems in the United Kingdom ER P28 Planning Limits for voltage fluctuations caused by industrial, commercial and domestic equipment in the United Kingdom
INTERDEPENDENCIES	
In this NC	N/A
In other NCs	The future HVDC is expected to have similar requirements which should be aligned with the DCC to ensure that a combined impact does not cause power quality issues.
System characteristics	In line with many of the existing standards and recommendations (i.e. IEC 61000-3-6, or ER G5/4) for specifying power quality emission levels for connecting users not only the existing network characteristics should be accounted for in specifying power quality issues but also future network characteristics over the life of the plant and equipment.
Technology characteristics	The type of demand to be supplied and equipment technology used will have a major impact on power quality from their emissions. Mitigation to meet the required standards will therefore be more or less and mitigation itself may also have an adverse as well as beneficial effects. Therefore all plant and equipment technology with regard to the users connection need to be considered in association with other users connected to the network as well. However although technology is important in the emission levels the power quality standard itself does not need to be adjusted to account for the variety of technologies. However, what may need to be considered in setting the required standard is the harmonic order which the standards need to apply up to. Standards do not make specific requirements for very high order harmonics which with modern electronic equipment i.e. inverters, TSOs may need to provide a limit for higher orders. Very high orders above the normally applied standards are more of a local problem as distortions are attenuated heavily and therefore are not a concern from a cross border prospective.
COORDINATION	
TSO – TSO	TSOs need to ensure power quality requirements are co-ordinated so that emission levels are in combination below network and users design standards for their plant and equipment. In addition information exchange regarding the level of distortion that many be expected

	from each otherȂs networks across borders should be considered also seasonally adjusted as required.
TSO – DSO	TSOs will specify what level of power quality is required at the connection point with the DSO to ensure adequate power quality on the transmission network. This same standard will provide what level of power quality the DSO can reasonably expect from the transmission network in response
TSO – Transmission Connected Demand Facility	TSOs will specify what level of power quality is required at the connection point with the Demand Facility to ensure adequate power quality on the transmission network. This same standard will provide what level of power quality the Demand Facility Owner can reasonably expect from the transmission network in response

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3.7. Simulation Models

DESCRIPTION	
Article	26.1
Objective	To specify the quality and characteristics of suitable simulation models or equivalent information to allow for testing of the users connection and fulfilment of the requirements of the Demand Connection Network Code as well as to simulate ongoing operation and future development of the network.
NC frame	The TSO shall provide the content and format plus the need for supporting recordings to validate the response of simulation models (or equivalent information), where required. The content of the models should be specified by the TSO to ensure that the locally driven network analysis is accurately modelled and that appropriate data for synchronously connected transmission and distribution networks is also available. Key types of data where analysis is likely to be performed are identified in the Network Code Demand Connection, namely, steady and dynamic states (including 50 Hz component), electromagnetic transient simulations and structure and block diagrams. Apart from identifying what data for studies are applicable for their and adjacent networks, the TSO needs to identify the need for them to contain or be provided with sufficient information to model: i. Power control; ii. Voltage control; iii. Demand Facility and Transmission Connected Distribution Network protection models; iv. The constituent demand types, i.e. electro technical characteristics of the demand; and v. Converter models.
Further info	• Supporting documentation of DCC network code: o Network Code Demand Connection ï Frequently asked questions (21st December 2012) o Network Code Demand Connection ï Justification outlines (21st Dec 2012)
INTERDEPENDENCIES	
In this NC	The model must represent all the requirements in Article 13-25, as applicable.
In other NCs	• NC RfG ï NC HVDC: Consistent requests possible to generation and HVDC • Relevant studies referred to in operational codes
System characteristics	System characteristics like network topology and generation mix have significant impact on the relevant model/information to be required and components in these models, for example: • System Strength Low system strength will require more rigorous harmonics, EMT and dynamic stability tests to be undertaken with high quality and accurate models • Embedded generation and DSR Embedded generation and DSR will require dynamic models of their capabilities to be considered for cross border interactions, and therefore high quality, accurate modelling. Also impacting on frequency response with complicated Low Frequency Demand Disconnection schemes.
Technology characteristics	Although technology neutral in all other aspects with regards to simulation models/information the full characteristics of any technology must be present in a model to ensure accurate responses are calculated.

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COORDINATION	
TSO – TSO	TSOs to ensure accurate need analysis need to share appropriate network models/information with adjacent synchronously connected TSOs. To this end the required data for each TSO will need to be communicated to ensure all modelling requirements are met between TSOs.
TSO – DSO	TSOs will specify what level of modelling/information is required at the connection point with the DSO to ensure adequate modelling of their network. Typically this will require an aggregation of userôs models particularly given embedded generation or DSR. DSO network may also be either aggregated or with some additional level of detail depending on the nature of the studies and the structure of the DSO network i.e. parallel network flows with transmission network. A high dependence on the DSO knowledge of their network will be required in specifying adequate modelling requirements. Similarly models/information of the transmission network may need to be provided to the DSO so they can design their network connection.
TSO – Transmission Connected Demand Facility	TSOs will specify what level of modelling/information is required at the connection point with the Demand User to ensure adequate modelling of their network. Typically this will require an aggregation of userôs models particularly given embedded generation or DSR. A high dependence on the Transmission Connected Demand Facility Owner knowledge of their facility will be required in specifying adequate modelling requirements. Similarly models/information of the network may need to be provided to the Transmission Connected Demand Facility so they can design their network connection.
TSO – Demand Facility or Closed Distribution Network providing DSR (excluding DSR SFC) not transmission connected	TSOs will specify what level of modelling/information may be required at the connection point with the Demand User to ensure adequate modelling/information of their network. Typically this will require an aggregation of userôs models or more simple information for aggregated use given embedded generation or DSR and taking into account size and location of Demand Users. A high dependence on the Demand Facility or Closed Distribution Network will be required in specifying adequate modelling requirements.

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3.8. Demand Side Response Active Power Control and Reactive Power Control and Transmission Constraint Management

DESCRIPTION	
Article	22.1.g).,22.1.j).,22.1.k).,22.1.o).,22.1.p).
Objective	To ensure that DSR APC/RPC/TCM provides the necessary speed of response and data exchange, and resilience to be effectively relied upon to contribute to system operation.
NC frame	The network codes requires the TSO to provide the equipment standards for DSR LFDD and/or LVDD, and demand modification, demand ramping rate, ROCOF withstand capability and information exchange standard for DSR APC/RPC/TCM.

Further info	• Supporting documentation of DCC network code:
	  ○ Network Code Demand Connection ï Frequently asked questions (21st December 2012)
	  ○ Network Code Demand Connection ï Justification outlines (21st Dec 2012)
	• External documents:
	  ○ Irish DS3 Joint Grid Code Working Group paper on ROCOF (Sept 2012)

INTERDEPENDENCIES	
In this NC	ARTICLE 20 DEMAND DISCONNECTION FOR SYSTEM DEFENCE AND DEMAND RECONNECTION
In other NCs	• Control capabilities prescribed for generation and HVDC Systems • Control measures referred to in operational codes
System characteristics	System characteristics like network topology and generation mix have significant impact on the relevant models to be required and components in these models: • System Strength and inertia Low system strength will mean that greater ROCOF can be expected. Studies should be used to determine greatest ROCOF that can be expected in a synchronous zone into the future and be used accordingly • Embedded generation Large scale embedded generation will require a quicker and more reliable performance from DSR to respond to contingencies on the network. Adequate response times to sufficient number of units to provide the necessary aggregated demand response at time of connection and into the future should be examined, in association with embedded generation capabilities.
Technology characteristics	N/A
COORDINATION	
TSO – TSO	Co-ordination of ROCOF resilience is required to ensure adequate quantities of DSR remain available for cross border response. Standards for response times to LFDD and LVDD events and ramping rates but also be co-ordinated to ensure adequate response at a synchronous and cross border level. Information exchange standards must be aligned so that information necessary for adjacent synchronous connected TSOs is required.
TSO – DSO	Information exchange is necessary with DSOs that the DSR capabilities are included when determining appropriate DSO system operation and development

RNO – Grid User	Information exchange is necessary with DSOs to ensure capabilities and requirements placed on DSR by either party are known and do not affect the capability of the user to provide a DSR service.

3.9. Demand Side Response System Frequency Control

The TSO proposed settings for Demand Side Response System Frequency Control are not part of the exhaustive requirements to be implemented through the above mentioned national implementation. They are intended to be submitted by the TSOs as part of a proposal for implementation through the Eco-design directive and are at present being further analyzed.
Consequently no guidance is given in this document for national implementation.