PROPOSAL FOR NC DCC REQUIREMENTS OF GENERAL APPLICATION

TSO Proposal following Art. 6(4) of the NC DCC

17 May 2018

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INTRODUCTION

Article 6(4) of the NC DCC [1] states that the relevant system operator or the TSO submits a proposal for requirements of general application (or the methodology used to calculate or establish them), for approval by the competent entity, within two years of entry into force of the NC DCC, i.e. 7 September 2018. A similar requirement is included in the two other connection Network Codes, namely in Art. 7(4) of the NC RfG [2] and in Art. 5(4) of the NC HVDC [3]. The most stringent deadline for Elia, herein, is 17 May 2018, which is two years after the NC RfG entered into force as first connection network code.

The aim of this document is to synthetize the technical proposal of Elia, as relevant system operator or relevant TSO, regarding the Belgian implementation of the non-exhaustive requirements stated in the in the NC DCC. This document is the final version of the proposal for requirements of general application (hereafter named as 'general requirements', in accordance with Art. 6(4) of the NC DCC.

For the requirements related to the interface between the transmission system and (closed) distribution systems, the DSOs and CDSO's were largely involved in developing the TSO proposal. However these requirements have to be considered as an Elia proposal (as relevant TSO).

For the requirements related to demand facility providing demand response services, the proposal is mainly focusing on requirements set by Elia, as (relevant) TSO or relevant system operator but the public DSOs were largely involved in developing the TSO proposal and in defining their own implementation proposals (for demand facility providing demand response services connected to the distribution system). Therefore, part of these requirements are also set by the public DSOs, as relevant system operator.

To facilitate the implementation of the NC DCC requirements, Elia and the public DSOs have aligned as much as possible to increase the coherency and to avoid as much as possible discrimination between a transmission-, or distribution-connected demand facility providing demand response services to system operators in terms of technical requirements and legal readability.

On 17 May 2018, Elia will submit the general requirements proposals for NC DCC, but also for NC RfG and NC HVDC to the competent authorities together with the proposal of the amended Federal Grid Code [4] and the formal proposal on maximum capacity thresholds of type B, C and D PGM. Elia organized beforehand a public consultation for all deliverables from 15 March up to and including 16/23 April 2018, except for the public consultation on the maximum capacity thresholds B, C and D, that took place from 19 May till 20 June 2017. This approach is in line with the vision of the Belgian Federal Administration (FOD/SPF Energy) [5].

This document represents the final position of Elia taken after discussions with the stakeholders in each of the relevant topics. During the last months, this document was gradually completed and presented to stakeholders, especially during the Federal Grid Code workshops until all non-exhaustive general requirements were included.

This document should be considered as a technical and not legally binding document, focusing on the clarification of various technical general requirements that will be reflected

in various grid codes, contracts, terms and conditions, regulatory documents and/or technical prescriptions.

The document follows the same article order as in the NC DCC: the proposal is organized per technical topic and per demand connection category.

The scope of this document contains especially, but is not limited to, the implementation proposal of the non-exhaustive general requirements in the NC DCC. To increase its readability, this document might also contain NC exhaustive requirements, implementation proposals of non-exhaustive requirements of the other connection NC, or other specific national/regional requirements for information purposes only, but certainly does not cover all of them.

With respect to the complete list of non-exhaustive requirements to be proposed as general requirements, Elia is taking as reference the ENTSO-E implementation guidance document (IGD) on 'Parameter of Non-exhaustive requirements' [6] to be defined by the (relevant) TSO and the relevant system operator. This document does not only mention the parameters to be defined per topic, but also which article of each connection NC should be considered as non-exhaustive and who should be the relevant system operator to define an implementation proposal. The TSO, DSOs and CDSOs are to be considered as 'relevant system operator', depending on the requirement.

SCOPE OF APPLICATION

As mentioned in article 3 of the NC DCC, the connection requirements set out in the NC DCC apply to:

a) New transmission-connected demand facilities;

b) New transmission-connected distribution facilities;

c) New distribution systems, including new closed distribution systems;

d) New demand units, used by a demand facility or a CDS to provide demand response services to relevant system operators and relevant TSOs

These categories do not include storage devices except for any pumping module that only provides pumping mode (art. 5(1) and 5(2) of the NC DCC).

We refer to articles 3 and 4 of the NC DCC for more information on the application of general requirements to existing facilities and systems, to demand facilities and closed distribution systems with more than one demand unit.

ELIA PROPOSAL OF GENERAL REQUIREMENTS

1. Connection of transmission-connected demand facilities, transmission-connected distribution facilities and distribution systems

1.1. General Frequency Requirements [Art. 12]

1.1.1. Frequency requirements [Art. 12 – 1]

The frequency withstand capability is defined in accordance with NC DCC Annex I and presented in the table below:

Frequency Range	Duration
47,5 Hz – 48,5 Hz	**30 minutes**
48,5 Hz – 49,0 Hz	**30 minutes**
49,0 Hz – 51,0 Hz	**Unlimited**
51,0 Hz – 51,5 Hz	**30 minutes**

Table 1 Minimum time periods to be capable of operating on different frequencies, deviating from a nominal value without disconnecting from the network.

For frequency range between 48.5Hz and 49.0Hz, transmission-connected demand facilities, transmission-connected distribution facilities and distribution systems shall be capable to remain connected to the TSO network and to operate for a minimum period of 30 minutes. This is the recommended value for all the Continental European Synchronous Area (CE SA) as per Connection Network Code Work Group (also the case for RFG NC).

1.1.2. Extended frequency range [Art. 12 – 2]

The agreement on wider frequency ranges, longer times for operation is a site specific requirement that shall be agreed upon between the relevant system operator or TSO and the transmission-connected demand facility owner or DSOs considering the system needs, their technically feasible frequency range and relative withstanding duration beyond the ones defined in paragraph 1.1.1.

1.2. General voltage requirements [Art. 13]

1.2.1. Voltage requirements in case of voltage level at the connection point between 110kV and 400kV [Art. 13 – 1]

The general voltage requirements are defined at the point of connection to the transmission grid, in line with Annex II of the NC DCC and presented in the table below:

- Voltage base is at or above 110 kV and up to (not including) 300 kV

Voltage range	Duration
0,90 pu – 1,118 pu	Unlimited
1,118 pu – 1,15 pu	20 minutes minimum

- Voltage base is from 300 kV to 400 kV (including)

Voltage range	Duration
0,90 pu – 1,05 pu	Unlimited
1,05 pu – 1,10 pu	20 minutes minimum

The following voltage base values are to be considered:

- 400kV
- 220kV
- 150kV
- 110kV

International studies ([9]) and experience ([7]) have proven the technical capabilities of high voltage equipment to fulfill these requirements concerning temporary overvoltage if the duration of the over voltage is limited to 20 minutes. Therefore the minimal duration of 20 minutes has been chosen by Elia. Nevertheless Elia believes that the temporary overvoltage withstand capabilities have to be in line with international standards (such as IEC 60071 and IEC 60038). For some voltage levels mentioned above this is not the case. Therefore Elia will only require the capabilities as demonstrated through IEC type testing. It is however of great importance that protection system settings are in line with the above mentioned requirements. Concerning the rated voltages of high voltage equipment Elia applies IEC standards.

1.2.2. Automatic voltage disconnection [Art. 13 – 6]

There is no general need for automatic disconnection at specific voltages except for some individual connection projects. The terms and settings for automatic disconnection shall be agreed between the TSO and the transmission-connected demand facility owner or the (C)DSO.

1.2.3. Voltage requirements for transmission-connected (closed) distribution systems in case of a voltage level at the connection point below 110kV [Art. 13 – 7]

The voltage level at the connection point to the transmission system of (closed) distribution systems can be lower than 110kV in Belgium. More specifically, (closed) distribution systems can be connected at voltage levels of 70kV, 36kV, 30kV and lower.

For these voltage levels, following requirements are defined at the point of connection to the transmission grid :

Voltage range	Duration
0,90 pu – 1,118 pu	Unlimited

The following voltage base values are to be considered:

- 6 kV
- 10 kV
- 11 kV
- 12 kV
- 15 kV
- 26 kV
- 30 kV
- 36 kV
- 70 kV

It has to be noticed that the requirement on the upper value of the voltage range does not replace the material voltage withstand capability which is required through Annex I of the Federal Grid Code.

1.3. Short-Circuit requirements [Art. 14]

1.3.1. Short-circuit withstand capability [Art. 14 – 1]

The maximum short-circuit current at the point of connection to the transmission grid that a transmission-connected demand facility or (closed) distribution system shall be capable of withstanding is specified for each voltage level, and can be found in the revised version of the Federal Grid Code.

1.3.2. Communication of a change in maximum short-circuit current [Art. 14 – 3 , 14 – 5, 14 – 8, 14 – 9]

These articles are related to a specific situation/event. These articles present requirements that will be particularized for the cases indicated there.

In general no changes in short-circuit withstand capability are expected as they will defined in a non-site specific manner more precisely depending on the voltage level as indicated in paragraph 1.3.1.

1.4. Reactive Power Requirements [Art. 15]

1.4.1. Reactive power exchange between the transmission system and transmission-connected demand facilities [Art. 15 – 1 (a)]

A technical capability must be present in the transmission-connected demand facilities to be able to keep the reactive power exchange at the connection point, between the following limits:

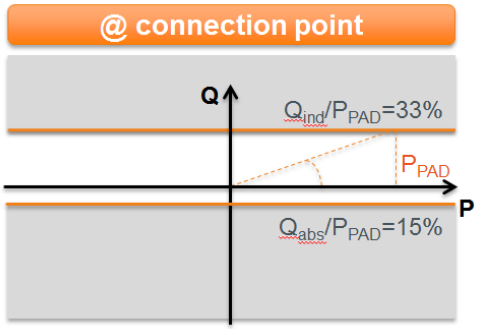
- For the import of reactive power (consumption) the limit is fixed to 33% of the maximum import or export capacity of the connected demand facility,
- For the the export of reactive power (production) the limit is fixed to 15% of the maximum import or export capacity of the connected demand facility.

Exceptions can be allowed for a specific connection point, but technical or financial benefits should be demonstrated before granting such an exception.

The Power Put At Disposal (PPAD) is fixed for the import and export of power from or to the transmission grid. These values are fixed in the connection contract. The above mentioned ‘maximum import or export capacity’ concerns the maximum of both PPAD values.

These requirements ensure that a sufficient amount of reactive power sources will be present in the transmission-connected demand facility but do not specify anything about their usage (in operations).

So, without prejudice to other operational rules, these capabilities have to be demonstrated during the connection process for a limited number of predefined reference scenarios but do not exclude operation with reactive power exchanges outside the above-mentioned limits.



1.4.2. Reactive power exchange between the transmission system and transmission-connected (closed) distribution systems [Art. 15 -1 (b), Art. 15 – 1 (c)]

The Belgian transmission system or the (closed) distribution systems contain power transformers that transform voltage levels of 30kV and higher to voltage levels below 30kV.
.

As the reactive losses in power transformers are not negligible (~12%[1] of the active power flow), the requirements on reactive power exchange between the transmission and (closed) distribution systems need to take this aspect into account.

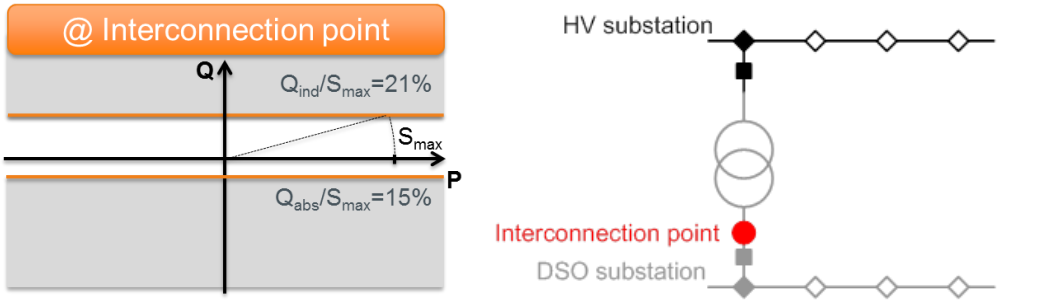
The import of reactive power (consumption) typically occurs at moments of high active power consumption. This also means that the reactive power losses in the power transformers are high in those situations. The export of reactive power typically occurs at moments of low active power exchange between the transmission and (closed) distribution system. Reactive power losses in the distribution power transformers are negligible in those situations.

A technical capability must be present in the connected (closed) distribution system (including capabilities of production unit connected to the (closed) distribution system) to be able to keep the reactive power exchange at the connection point, between the following limits:

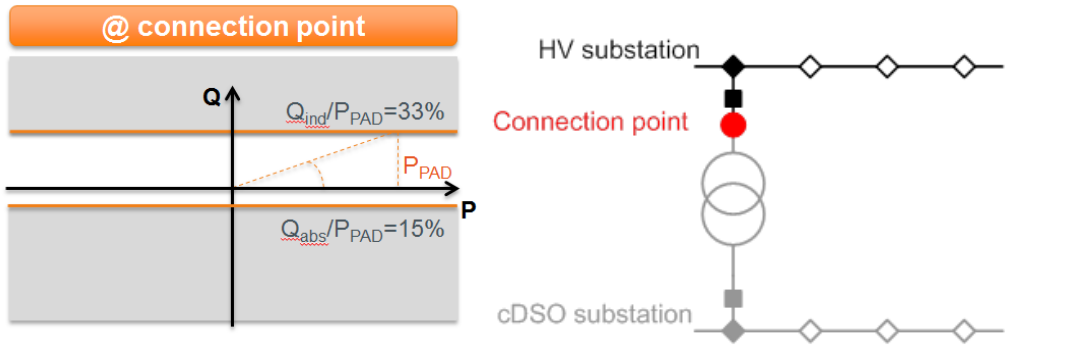
- For the import of reactive power (consumption) the limit is fixed to
    - 33% of the maximum import or export capacity of the connected (closed) distribution system if the voltage level at the connection point of the (closed) distribution system is equal or higher than 30kV.
    - 21% of the maximum import or export capacity of the connected (closed) distribution system if the voltage level at the connection point of the (closed) distribution system is lower than 30kV.

[1] The short-circuit voltage of distribution power transformers is 12% in average.

- For the export of reactive power (production) the limit is fixed to 15% of the maximum import or export capacity of the connected (closed) distribution system in both cases (not dependent of the voltage level at the connection point).



Typical representation of a TSO-DSO interconnection



Typical representation of TSO-CDSO connection

The maximum import or export capacity is equal to:

- the Power Put At Disposal (PPAD) in case of a transmission-connected closed distribution system. The Power Put At Disposal (PPAD) is fixed for the import and export of power from or to the transmission grid. These values are fixed in the connection contract. The above mentioned 'maximum import or export capacity' concerns the maximum of both PPAD values;
- the Power Put At Disposal (PPAD) in case of distribution system (closed distribution system excluded) with a voltage level at the connection point equal or higher than 30kV. The Power Put At Disposal (PPAD) is fixed for the import and export of power from or to the transmission grid. These values are fixed in the collaboration aggrement. The above mentioned 'maximum import or export capacity' concerns the maximum of both PPAD values
- the minimal available exchange capacity at the connection point when taking into account the contingencies on grid elements (N-1), i.e. $S_{nom,\ N-1}$ in case of distribution system (closed distribution system excluded) with a voltage level at the connection point lower than 30kV.

Exceptions can be allowed for a specific connection point or a set of connection points, but technical or financial benefits should be demonstrated through a joint analysis between Elia and the transmission-connected (closed) distribution system owner before granting such an exception as mentioned in [Art. 15 – 1 (c)].

In this perspective, in case of difficulty to reach the above mentioned requirements with the available assets within the (closed) distribution system (including capabilities of production unit connected to the (closed) distribution system) for a given (or a set of) connection point(s), a joint analysis between Elia and the transmission-connected (closed) distribution system owner will be conducted before an investment should be done. The goal of this joint analysis is to guarantee to reach the above-mentioned limits (either for each separate connection point or for a set of connection points of the (closed) distribution grid using the interconnection of the (distribution) grid) and to guarantee that, if an investment has to be done, it is the overall technical and economical optimum.

These requirements ensure that a sufficient amount of reactive power sources (including capabilities of production unit connected to the (closed) distribution system) will be present in the connected (closed) distribution system but do not specify anything about their usage (in operations).

So, without prejudice to other operational rules, these capabilities have to be demonstrated during the connection process for a limited number of predefined reference scenarios but do not exclude operation with reactive power exchanges outside the above-mentioned limits.

1.4.3. Reactive power exchange between the transmission system and transmission-connected (closed) distribution systems at low active power flow [Art. 15 – 2]

According to the Art 15.2 of NC DCC, the relevant TSO may require that transmission-connected distribution systems have the capability at the connection point to not export reactive power (at reference 1 pu voltage) at an active power flow of less than 25 % of the maximum import capability.

After analysis, Elia confirms that this requirement reflects a need for the global Belgium zone to be able to manage the reactive power flows and operate the system with the same quality of service in the future as it is nowadays taking into account the expected evolution of energy mix in Belgium.

In this context, a technical capability must be present in the connected (closed) distribution system (including capabilities of production unit connected to the (closed) distribution system) to be able to not export reactive power (at reference 1 pu voltage) at the connection point at an active power flow of less than 25% of the maximum import capacity.

The maximum import or export capacity is equal to:

- the Power Put At Disposal (PPAD) in case of a transmission-connected closed distribution system. The Power Put At Disposal (PPAD) is fixed for the import and export of power from or to the transmission grid. These values are fixed in the connection contract. The above mentioned ‘maximum import or export capacity’ concerns the maximum of both PPAD values;
- the Power Put At Disposal (PPAD) in case of distribution system (closed distribution system excluded) with a voltage level at the connection point equal or higher than 30kV.
- the minimal available exchange capacity at the connection point when taking into account the contingencies on grid elements (N-1), i.e. $S_{nom,\ N-1}$ in case of distribution system (closed distribution system excluded) with a voltage level at the connection point lower than 30kV.

In case of difficulty to reach the above mentioned requirement with the available assets within the (closed) distribution system (including capabilities of production unit connected to the (closed) distribution system) for a given (or a set of) connection point(s), a joint analysis between Elia and the transmission-connected (closed) distribution system owner will be conducted before an investment should be done. The goal of this joint analysis is:

1. to verify whether the above mentioned requirement is justified (according to art 15.2 of the DCC NC) either for each separate connection point or for a set of connection points of the distribution grid
2. then (if this requirement is confirmed), to guarantee the capability to reach the above-mentioned limits (either for each separate connection point or for a set of connection points of the (closed) distribution grid using the interconnection of the (distribution) grid)
3. to guarantee that, if an investment has to be done, it is the overall technical and economical optimum. This implies that this investments shall be done at the most appropriate grid segment by the relevant System Operator, and it responds to the needs of the system at the lowest overall societal costs on a long term basis

Note that, accorded to art 15.2 of the DCC NC, if this requirement is not justified based on the joint analysis (see point 1 above), Elia and the transmission-connected distribution system operator will agree in the collaboration agreement on alternative requirements according to the outcomes of a joint analysis and based on the overall technical and economical optimum.

These requirements ensure that a sufficient amount of reactive power sources (including capabilities of production unit connected to the (closed) distribution system) will be present in the connected (closed) distribution system but do not specify anything about their usage (in operations).

So, without prejudice to other operational rules, these capabilities have to be demonstrated during the connection process for a limited number of predefined reference scenarios but do not exclude operation with reactive power exchanges outside the above-mentioned limits.

1.4.4. Metrics to express the reactive power capability ranges [Art. 15 – 1 (d)]

All limits are expressed as a percentage of the maximum import or export capacity. The power factor is not used.

1.5. Protection requirements [Art. 16]

1.5.1. Devices and settings required to protect the transmission network [Art. 16 – 1]

The protection schemes and settings relevant for the transmission-connected demand facility or the transmission-connected (closed) distribution system are to be determined and agreed site specific by Elia and the transmission-connected demand facility owner or (closed) distribution system operator.

1.6. Control requirements [Art. 17]

1.6.1. Schemes and settings of different control devices [Art. 17 – 1]

The RTSO and the transmission-connected demand facility owner or the transmission-connected (closed) distribution system operator shall agree on the schemes and settings of the different control devices relevant for system security of the transmission-connected demand facility or the transmission-connected distribution system.

1.7. Information exchange [Art. 18]

1.7.1. Specifications of information exchange equipment [Art. 18 – 1, 18 – 2, 18 – 3]

For real-time information exchange between transmission-connected demand facilities and the TSO, or between transmission-connected (closed) distribution systems and the TSO, the TSO applies the TASE 2 (IEC 60870-6) and IEC104 IEC 60870-5-104 Transmission Protocol standards. These standards support time stamping. As standards can change over time Elia will make them publically on its website.

It is important to implement these protocols on a private transmission path (not through the public internet) for reliability and cybersecurity reasons.

Although the refresh rate is not mentioned in the NC DCC, real-time measurement is defined as a measurement (representation of the current state of a facility) that is refreshed at a rate faster than one minute (‘elapsed time’). For data related to automatic load-frequency control processes, it shall not be longer than 10 s. For other purposes, it shall be as fast as possible and, in any case, not slower than one minute. For information exchange between the TSO and a transmission-connected distribution system a hysteresis method can also be allowed. Further specifications of this method will be defined in the TSO-DSO agreements for transmission connected distribution systems.

Regarding voice communication the requirements concerning backup power supply and equipment redundancy are defined by article 41 of the Network Code Emergency & Restoration.

1.8. Demand disconnection and demand reconnection [Art. 19]

1.8.1. Low Frequency Demand Disconnection [Art. 19 – 1 (a), Art. 19 – 1 (b), Art. 19 – 1 (c)]

Elia as TSO will require transmission-connected distribution system operators to provide automatic low frequency demand disconnection capabilities. The Belgian transmission system contains the power transformers that transform voltage levels of 30kV and higher to voltage levels below 30kV. Therefore this requirement will only apply to a very limited number of cases.

Currently, the low frequency triggers will disconnect all the power transformers at the connection point (non-selective), resulting in a disconnection of the complete demand and production at the connection point. This is why the automatic frequency disconnection is

currently not implemented in every case. In the near future an automatic demand disconnection in stages (selective) could be required. The settings of these automatisms will be communicated at the design phase of the connection, during the connection process.

Elia does not currently require transmission-connected demand facilities owners and transmission-connected closed distribution operators to provide automatic low frequency demand disconnection capabilities. Elia does however not exclude that this will be part of a future defense plan.

As mentioned in [8] the reliability, dependability and speed of a Low Frequency Demand Disconnection scheme are key to secure a power system in case of major disturbances. Several actions are typically covered within such a scheme:

- The operating time of the under-frequency relays (measurement, individual relay logic and relays combination logic)
- The time of tele protections in case of a transfer trip (in case the underfrequency load shedding relay has to trip a remote load)
- The interface relays (in case the underfrequency load shedding relay and the circuit breaker to trip belong to different entities)
- The time of operation of the circuit breaker.

The operating time of 150ms specified in [Art. 19 – 1(c)] should be interpreted as a maximum boundary for the frequency relay operating time. The specifications of the compliance testing of the frequency relay will be defined by Elia in accordance with article 37 of the DCC.

1.8.2. Low Voltage Demand Disconnection [Art. 19 – 2 (a), Art. 19 – 2(b)]

Elia as TSO will not require to the transmission-connected (closed) distribution system operators and transmission-connected demand facilities owners to provide low voltage disconnection capabilities. Elia does however not exclude that this will be part of a future defense plan.

1.8.3. Blocking of on load tap changers [Art. 19 – 3 (a), Art. 19 – 3 (b)]

Elia requires automatic on load tap changer block on transformers that supply distribution systems. The specifications of this automatism will be communicated to Elia before being installed, for example at the design phase of the connection process. The Belgian transmission system contains power transformers that transform voltage levels of 30kV and higher to voltage levels below 30kV. As a consequence the on load tap changer blocking will be installed by the TSO is many cases.

These requirements do not apply to transmission-connected closed distribution facilities. Elia does however not exclude that this will be part of a future defense plan.

1.8.4. Reconnection [Art. 19 – 4 (a), Art. 19 – 4 (b), Art. 19 – 4 (c)]

In general, the RTSO does not allow automatic reconnection, as a manual reconnection after clearance of the control center of Elia is preferred. In specific cases Elia could allow automatic reconnection. The latter will be fixed in connection contracts for transmission-connected demand facilities and closed distribution systems, and TSO-DSO agreements for transmission connected distribution systems.

The settings of synchronisation devices are site specific and to be agreed with transmission-connected demand facility owner or the transmission-connected (closed) distribution system operator.

In case of remote disconnection of a transmission-connected demand facility or (closed) distribution facility due to scarcity, Elia will in require to complete the disconnection within 10 minutes. This value will however be confirmed during the design phase of the connection, during the connection process.

1.9. Power quality [Art. 20]

The level of allowed distortion or fluctuation of the supply voltage on the network at the connection point of a transmission-connected demand facility or a transmission-connected (closed) distribution system will not alter from what is stated in article 43 of the Federal Grid Code.

1.10. Simulation models [Art. 21]

1.10.1. Models or equivalent information showing the behavior in steady and dynamic states [Art. 21 – 2, 21 – 3]

Elia will not require the specific simulation models mentioned in the NC DCC showing the behavior of the transmission-connected demand facilities and transmission-connected (closed) distribution systems in steady and dynamic states.

Elia will however require specific data of transmission-connected demand facilities and transmission-connected closed distribution systems as defined during the connection process. The required data concerning transmission-connected distribution systems is defined by the TSO-DSO operation agreement.

1.10.2. Recordings to compare with model [Art. 21 – 5]

Elia will not require the specific recordings of the transmission-connected demand facilities and transmission-connected (closed) distribution systems as mentioned in the NC DCC, in order to compare the response of the model with these recordings.

2. Connection of demand units used by a demand facility or a closed distribution system to provide demand response services to system operators

2.1. Demand units providing active power control, reactive power control and transmission constraint management [Art. 28]

2.1.1. Definition of a extended frequency range [Art. 28 – 2 (a)]

The frequency requirements defined in section 1.1. are also applicable to demand units with demand response active power control, demand response reactive power control, or demand response transmission constraint management, or demand response system frequency control, either individually or, where it is not part of a transmission connected demand facility, collectively as part of demand aggregation through a third party.

2.1.2. Definition of voltage range if connected at a voltage below 110kV [Art. 28 – 2 (c)]

The normal operational voltage range at the connection point at a voltage below 110kV across which a demand unit delivering demand response system frequency control shall be capable of operating, corresponds to the one defined in paragraph 1.2.3.

2.1.3. Time period to modify power consumption [Art. 28 – 2 (f)]

The time period within which a demand unit delivering demand response needs to adjust its power consumption depends on the type of offered demand response service. These time periods are defined in the terms and conditions (T&C) of these services. As they tend to evolve in time, fixed values cannot be given.

2.1.4. Notification of changes in demand response capacity [28 – 2 (i)]

The notification of a change in demand response capacity shall be carried-out as per the contractual provisions of the terms and conditions (T&C) of this service.

2.1.5. Technical specifications to enable transfer of information [Art. 28 – 2 (e), 28 – 2 (l)]

For active or reactive power control and transmission constraint management services, the technical communication requirements are defined as per the current contractual provisions.

2.1.6. Definition of the ROCOF maximum value [Art. 28 – 2 (k)]

The requirement for Rate of Change of Frequency (RoCoF) withstanding capability is aligned with the requirements for generators (RfG Article 13.1.(b)) which is defined in coordination with TSOs in the European Continental Synchronous area. The current applicable ENTSO-e IGD proposes a profile taking 2.0 Hz/s for duration of 500ms as the minimum RoCoF to be withstood as per the Figure 1.

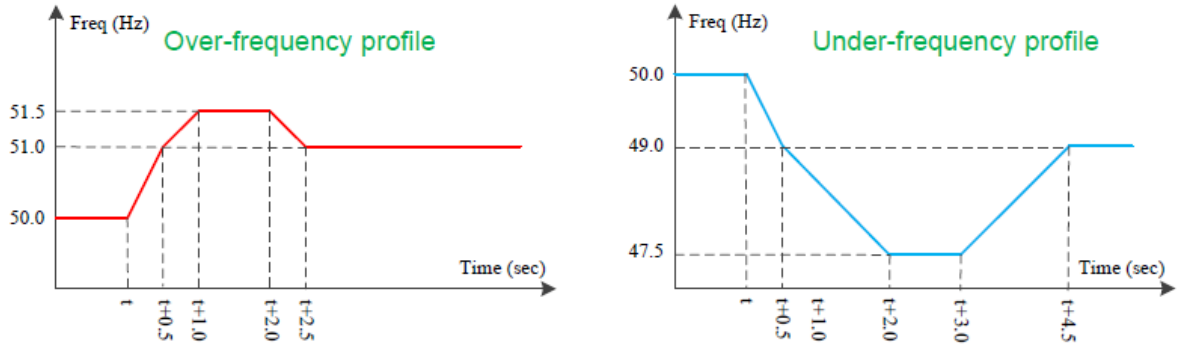


Figure 1 Overfrequency and underfrequency withstanding capabilities

2.2. Demand units with demand response system frequency control [Art. 29]

All frequency related technical requirement are coordinated with TSOs in the European Continental Synchronous area. The implementation of the Article 29 of the DCC NC is covering only the technical capabilities of LFSM-U and LFSM-O emergency functions whenever identified necessary and required by Elia. With respect Frequency Containment (FCR) service, the relevant technical requirements are defined by the general framework for FCR Service.

2.2.1. Definition of an extended frequency range [Art. 29 – 2 (a)]

This requirement is defined according to Art. 29 - 2(a) of NC DCC. The frequency ranges and extended range, defined in section 1, are also applicable to demand units with demand response active power control, demand response reactive power control, demand response transmission constraint management, or demand response system frequency control, either individually or, where it is not part of a transmission connected demand facility, collectively as part of demand aggregation through a third party.

2.2.2. Definition of voltage range if connected at a voltage below 110kV [Art. 29 – 2 (c)]

The normal operational voltage range at the connection point at a voltage below 110kV across which a demand unit delivering demand response system frequency control shall be capable of operating, corresponds to the one defined in paragraph 1.2.3.

2.2.3. Definition of allowed frequency dead band [Art. 29 – 2 (d)]

The requirement is aligned with ENTSO-E IGD prescribing the allowed maximum frequency dead band for LFSM-U and LFSM-O emergency system frequency control as +-200 mHz for the CE synchronous area. Therefore resulting in under-frequency threshold of 49.8 Hz and over-frequency threshold of 50.2 Hz.

2.2.4. Maximum frequency deviation to respond [Art. 29 – 2 (e)]

The current draft requirement is aligned with ENTSO-E IGD recommending the maximum frequency deviation to respond for LFSM-U and LFSM-O emergency system frequency control respectively as – 49 Hz and 51.5 Hz for the CE synchronous area.

2.2.5. Definition of the rapid detection and response to frequency system changes [Art. 29 – 2 (g)]

The requirement proposes the following parameters for the rapid detection and response in case of LFSM-U and LFSM-O is defined as following:

- Linear proportional response: this shall be achieved following a DR SFC droop: $S_{DR\ SFC} = (\frac{\Delta f}{fn})/(\frac{-\Delta P_{DR}}{Pref})$. The equivalent droop of an aggregated response over several units should be adjustable to achieve an overall droop between 2% and 12%.

2.3. Demand units with demand response very fast active power control [Art. 30]

There are no minimum requirement for inertia contribution, this will not be considered necessary as of today within the synchronous area.

REFERENCES

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[2] 'Network Code Requirements for Generators' or 'NC RfG': Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0631&from=EN

[3] 'Network Code on High Voltage Direct Current' or 'NC HVDC': Commission Regulation (EU) 2016/1447 of 26 August 2016 establishing a network code on requirements for grid connection of high voltage direct curret systems and direct current-connected power park modules, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R1447&from=EN

[4] Federal Technical Reglement- 19 DECEMBER 2002. — Koninklijk besluit houdende een technisch reglement voor het beheer van het transmissienet van elektriciteit en de toegang ertoe, Arrêté royal établissant un règlement technique pour la gestion du réseau de transport de l'électricté et l'accès à celui-ci, http://www.elia.be/~/media/files/Elia/publications-2/grid-codes/Technisch%20reglement%20Federaal%202002.pdf

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[6] ENTSO-E Guidance document for national implementation for network codes on grid connection: Parameters of Non-exhaustive requirements, 16 November 2016: https://www.entsoe.eu/Documents/Network%20codes%20documents/NC%20RfG/161116_IGD_General%20guidance%20on%20parameters_for%20publication.pdf

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[8] ENTSO-E Internal Guidance for national implementation of network codes on grid connection : FREQUENTLY ASKED QUESTIONS - *FAQ 1 - What is the goal of the requirement on operating time of the LFDD schemes in the NC DCC? How should Article 19.1.c.(2) be understood?*

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

APPENDIX – LIST OF NON-EXHAUSTIVE REQUIREMENTS FOR NC DCC

This list is extracted from ENTSO-E Guidance document for national implementation for network codes on grid connection: Parameters of Non-exhaustive requirements [6]