Explanatory document for the amended Nordic synchronous area methodology for the dimensioning rules for FCR in accordance with Article 153 of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation

6 May 2022

1. Introduction

The Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (hereinafter **"SO Regulation"**) sets out rules on relevant subjects that should be coordinated between Transmission System Operators, as well as between TSOs and Distribution System Operators and with significant grid users, where applicable. The goal of SO Regulation is to ensure provision of an efficient functioning of the interconnected transmission systems to support all market activities. In order to deliver these objectives, a number of steps are required.

One of these steps is to determine a methodology for dimensioning Frequency Containment Reserves (FCR) for the Nordic synchronous area. Pursuant to Article 118(1)(a) of the SO Regulation, all Transmission System Operators in the Nordic Synchronous Area shall jointly develop common proposals for dimensioning rules for FCR in accordance with Article 153 of the SO Regulation.

According to Article 6(3)(d)(ii) of the SO Regulation the proposal for the dimensioning rules for FCR in accordance with Article 153 shall be submitted to the relevant national regulatory authorities (hereinafter "NRAs") for approval no later than 14 September, 2018. The initial proposal was submitted for regulatory approval to all NRAs in the Nordic synchronous area by 14 September 2018. According to Article 6(6) of the SO Regulation the Proposal needs to be submitted to ACER as well, who may issue an opinion on the Proposal if requested by the NRAs. In March 2019, the Nordic NRAs approved the proposal.

This amended methodology (hereafter referred to as "**Methodology**") adds additional requirements concerning dimensioning of Dynamic FCR-D as defined in the Nordic methodology for additional properties of FCR in accordance with Article 154(2) of the SO regulation.

This document contains an explanation of the Methodology from all TSOs of the Nordic synchronous area (hereinafter **"TSOs"**). It is structured as follows. The legal requirements for the Methodology are presented in Chapter 2. Chapter 3 explains the objective of FCR. Chapter 4 provides an overview of the existing situation. The proposed amendments are explained in Chaper 5. The proposed dimensioning rules for FCR are described in Chapter 6. Chapter 7 describes the expected impact on the relevant objectives of the SO Regulation. Finally, Chapter 8 provides the timeline for implementation and Chapter 9 describes the public consultation.

2. Legal requirements and interpretation

2.1 Legal references and requirements

Several articles in the SO Regulation set out requirements which the Methodology must take into account. These are cited below.

(1) Article 118(1)(c) and (2) of the SO Regulation constitutes the legal basis that the Methodology should take into account. Article 118 has the following content:

> *"1. By 12 months after entry into force of this Regulation, all TSOs of each synchronous area shall jointly develop common proposals for:[…]*
>
> *(a) the dimensioning rules for FCR in accordance with Article 153; […]*
>
> *2. All TSOs of each synchronous area shall submit the methodologies and conditions listed in Article 6(3)(d) for approval by all the regulatory authorities of the concerned synchronous area. Within 1 month after the approval of these methodologies and conditions, all TSOs of each synchronous area shall conclude a synchronous area operational agreement which shall enter into force within 3 months after the approval of the methodologies and conditions."*

(2) Article 153 of the SO Regulation has the following content:

"Article 153 FCR dimensioning

1. All TSOs of each synchronous area shall determine, at least annually, the reserve capacity for FCR required for the synchronous area and the initial FCR obligation of each TSO in accordance with paragraph 2.

2. All TSOs of each synchronous area shall specify dimensioning rules in the synchronous area operational agreement in accordance with the following criteria:

(a) the reserve capacity for FCR required for the synchronous area shall cover at least the reference incident and, for the CE and Nordic synchronous areas, the results of the probabilistic dimensioning approach for FCR carried out pursuant to point (c);

(b) the size of the reference incident shall be determined in accordance with the following conditions:

(i) for the CE synchronous area, the reference incident shall be 3 000 MW in positive direction and 3 000 MW in negative direction;

(ii) for the GB, IE/NI, and Nordic synchronous areas, the reference incident shall be the largest imbalance that may result from an instantaneous change of active power such as that of a single power generating module, single demand facility, or single HVDC interconnector or from a tripping of an AC line, or it shall be the maximum instantaneous loss of active power consumption due to the tripping of one or two connection points. The reference incident shall be determined separately for positive and negative direction;

(c) for the CE and Nordic synchronous areas, all TSOs of the synchronous area shall have the right to define a probabilistic dimensioning approach for FCR taking into account the pattern of load, generation and inertia, including synthetic inertia as well as the available means to deploy minimum inertia in real-time in accordance with the methodology referred to in Article 39, with the aim of reducing the probability of insufficient FCR to below or equal to once in 20 years; and

(d) the shares of the reserve capacity on FCR required for each TSO as initial FCR obligation shall be based on the sum of the net generation and consumption of its control area divided by the sum of net generation and consumption of the synchronous area over a period of 1 year."

(3) Article 3(2)(58) of the SO Regulation defines the 'reference incident' as the *'maximum positive or negative power deviation occurring instantaneously between generation and demand in a synchronous area, considered in the FCR dimensioning'.*

(4) Article 39(3)(b) of the SO Regulation explains *"The methodology referred to in Article 39 "* (as referred to in Article 153(c)):

"Article 39 Dynamic stability management

[..]

3. In relation to the requirements on minimum inertia which are relevant for frequency stability at the synchronous area level:

(a) all TSOs of that synchronous area shall conduct, not later than 2 years after entry into force of this Regulation, a common study per synchronous area to identify whether the minimum required inertia needs to be established, taking into account the costs and benefits as well as potential alternatives. All TSOs shall notify their studies to their regulatory authorities. All TSOs shall conduct a periodic review and shall update those studies every 2 years;

(b) where the studies referred to in point (a) demonstrate the need to define minimum required inertia, all TSOs from the concerned synchronous area shall jointly develop a methodology for the definition of minimum inertia required to maintain operational security and to prevent violation of stability limits. That methodology shall respect the principles of efficiency and proportionality, be developed within 6 months after the completion of the studies referred to in point (a) and shall be updated within 6 months after the studies are updated and become available; and

(c) each TSO shall deploy in real-time operation the minimum inertia in its own control area, according to the methodology defined and the results obtained in accordance with paragraph (b).

(5) Article 6(3)(d)(ii) of the SO Regulation states:

"The proposals for the following terms and conditions or methodologies shall be subject to approval by all regulatory authorities of the concerned region, on which a Member State may provide an opinion to the concerned regulatory authority: […]
(d) methodologies, conditions and values included in the synchronous area operational agreements in Article 118 concerning:
(ii) the dimensioning rules for FCR in accordance with Article 153;

2.2 Interpretation and scope of the Methodology

Article 153(2) of the SO Regulation includes two topics. Firstly, Article 153(2)(a)-(c) stipulates the dimensioning rules for FCR. Secondly, Article 153(2)(d) prescribes how the initial FCR obligation per TSO shall be calculated.

Where Article 153(2) only describes one type of FCR, the Nordic Frequency Containment Process (FCP) applies two types of FCR: FCR for normal operation (FCR-N) is used for continuous imbalances to keep the frequency within the ±100mHz range. For this reason, the purpose of FCR-N is not to mitigate the consequences of a disturbance such as a reference incident. The purpose of Frequency Containment Reserves for Disturbance situations (FCR-D) is to mitigate the impact of incidental disturbances, including the reference incident. Article 153(2)(b)(ii) of the SO Regulation refers to the *"reference incident"* which *"shall be the largest imbalance that may result from an instantaneous change of active power such as that of a single power generating module, single demand facility, or single HVDC interconnector [..]."*. This list clearly refers to incidents and therefore Article 153(2)(a)-(c) can only be applied to FCR-D. The scope of this Methodology with respect to Article 153(2)(a)-(c) shall therefore be limited to the dimensioning rules for FCR-D.

Article 153(2)(d) of the SO Regulation is about the initial FCR obligation per TSO. Also in this article there is no explicit differentiation between FCR-N and FCR-D. However, in the rules in Article 153(2)(d) can be applied to both FCR-N and FCR-D. For this reason, the TSOs consider Article 153(2)(d) of the SO Regulation applicable to both FCR-N and FCR-D.

The Nordic methodology for additional properties of FCR in accordance with Article 154(2) of the SO regulation in general requires that the response from FCR-N and/or FCR-D providing units and groups shall be dynamic and continuously follow changes in the system frequency. The methodology for additional properties of FCR, however, allow for a limited amount of FCR-D with only a static response. This Methodology contains additional rules for the minimum dimensioning of Dynamic FCR-D.

The scope of this Methodology only includes the dimensioning rules for FCR-D on a Nordic level and the calculation of the initial distribution per TSO. It does not specify how each TSO shall fulfil its share. Procurement and settlement of FCR are not in the scope of the SO Regulation and this Methodology, but inside the scope of the 'Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing'.

3. Objective of FCR dimensioning

The objective of the Frequency Containment Process (FCP) is to stop the frequency increase or decrease before the instantaneous frequency deviation reaches the maximum instantaneous frequency deviation and consequently to stabilise the frequency deviation at a steady-state value not more than the permissible Maximum Steady-State Frequency Deviation[1]. The objective shall be met by a joint action of FCR within the whole synchronous area.

The objective of FCR-D dimensioning is to specify - for the situation that a reference incident takes place - the amount of FCR-D that is required to:

- limit the instantaneous frequency deviation to less than the maximum instantaneous frequency deviation (1000 mHz in accordance with Aricle 127 of the SO Regulation) and accordingly prevent for load shedding or generation shedding;
- limit the steady-state frequency deviation to less than the maximum steady-state frequency deviation (500 mHz in accordance with Aricle 127 of the SO Regulation).

Furthermore, the dimensioning of Dynamic FCR-D defines the required share of the system level FCR-D response that shall have the cabability to follow variations in the system frequency by activation and deactivation and have a dynamic response that provides continuous frequency control when the frequency is below/above the standard frequency range.

4. The existing situation

In this chapter, the current procedure for the dimensioning of FCR is presented, together with the procedures for how the 'reference incidents' are being defined. Since the Nordic TSOs define two types of FCR, section 4.1 addresses FCR-N and section 4.2 addresses FCR-D.

4.1 Frequency Containment Reserves for Normal operation (FCR-N)

At the moment the volume for FCR-N is at least 600 MW for the synchronous system[2]. The distribution between subsystems is revised each year before 1st of October on the basis of annual consumption in the previous year). The share of each subsystem is rounded to closest integer given in MW and this will enter into force on 1st of January.

4.2 Frequency Containment Reserves for Disturbance situations (FCR-D)

At the moment the required FCR-D capacity is equal to the largest possible imbalance caused by the loss of individual major components (production units, lines, transformers, bus bars etc.) from all fault events that have been taken into account.

In accordance with the methodology approved by the NRAs in March 2019 the TSOs have started to implement the new ancillary service FCR-D downwards. The dimensioning rules of that methodology has been implemented in the Nordic SOA. The TSOs have started to procure some amount of FCR-D downwards on a market basis, and will increase the procured amount from the market as the prequalified volumes increase.

[1] A more detailed explanation of what happens in case of an incident is included in textbox 1 of the 'Explanatory document for the Nordic synchronous area proposal for frequency quality defining parameters and the frequency quality target parameter in accordance with Article 127 of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation.'

[2] The value of $\pm$ 600MW is based on historic assumptions of a load random variation of $\pm$ 1% of 60GW.

The current dimensioning rules do not explicitly consider the additional network losses that may result from changing flows after a disturbance. E.g. if a nuclear plant in Sweden trips, the flows from both northern Sweden and Norway may increase which may increase the network losses which would result in a larger imbalance on a synchronous area level.

5. Proposed amendments

This section describes the proposed amendments to the methodology of 14 September 2018 that has been approved by the NRAs as of 14 March 2019.

5.1 Dimensioning of Dynamic FCR-D

The Nordic methodology for additional properties of FCR in accordance with Article 154(2) of the SO regulation in general requires that the response from FCR-N and/or FCR-D providing units and groups shall be dynamic and continuously follow the changes in the system frequency. The reasons for this include:

1. In case of a sudden, large imbalance caused by e.g. the reference incident FCR-D (upwards or downwards respectively) needs to contain the instantaneous frequency deviation within ±1000 mHz. The FCR-D response then needs to be close to fully activated within an order of seconds, in the Nordic methodology for additional properties of FCR in accordance with Article 154(2) of the SO regulation determined to be within 7.5 seconds of the incident. If the imbalance remains for some time, the FCR-D response will gradually be replaced by aFRR and mFRR, with activation times in the range of 5-15 minutes. The FCR-D response thus has to be able to dynamically deactivate proportionally to the frequency deviation within that timescale.
2. In case of an imbalance larger than 600 MW and faster than aFRR can handle, FCR-N will become saturated. In this case FCR-D will assume the responsibilities of FCR-N, i.e. to stabilize the frequency in case of stochastic imbalances. Thus, FCR-D needs to have at least the same dynamic performance, including both activation and deactivation, as FCR-N. A certain share of the FCR-D response hence needs to have the same abilities as FCR-N.
3. In case of a large incident, the system frequency will oscillate before finding an equilibrium. The FCR-D response needs to have sufficient performance and stability to both avoid causing too much oscillations as well as damp them when they occur. This requires both dynamic activation and deactivation capabilities.
4. In case of a sudden imbalance significantly smaller than the reference incident at low inertia situations, the combined response of the reserves may overreact heavily. This happens because the frequency changes so fast that more reserves than necessary are activated. The following overshoot in system frequency has to be mitigated by the dynamic response of FCR-D. This creates a strong need for a good dynamic deactivation capability of FCR-D, from a significant share of the FCR-D providing units and groups.

The TSOs do, however, not foresee that all of the dimensioned volume of FCR-D at all times needs to have dynamic properties to handle the situations stated above. The methodology for additional properties of FCR thus allows for a limited amount of FCR-D with only a static response, which enables participation from such units and groups. The exact share that has to be of the dynamic variant can be expected to be changing over time, as a main factor is expected to be the inertia levels in the synchronous area, which have seen a downwards trend as the amount of inverter-connected production increases. The TSOs hence suggest that the necessary share of Dynamic FCR-D shall be updated at least annually (in accordance with Article 153(1) of the SO Regulation) and be based on the dynamic properties of the power system, mainly system inertia, to follow this trend. The TSOs already follow this trend in accordance with article 39(3) of the SO regulation.

6. Methodology for dimensioning rules for FCR-D

Article 153(2)(a) of the SO Regulation states that *“the reserve capacity for FCR required for the synchronous area shall cover at least the reference incident and [..] the results of the probabilistic dimensioning approach for FCR carried out pursuant to point (c);”.* Section 6.1 explains how the required FCR-D will be dimensioned in order to cover the reference incident. Section 6.2 defines the reference incident. The TSOs will not apply *“a probabilistic dimensioning approach for FCR”*, which is explained in section 6.3.

6.1 FCR-D dimensioning based on reference incident (Article 153(2)(a))

In accordance with Article 153(2)(b)(ii) of the SO Regulation, “*the reference incident shall be determined separately for positive direction negative direction”*. The Nordic TSOs define the positive direction as a power surplus in the synchronous area, caused by e.g. tripping of a load or an exporting HVDC interconnector. The negative direction is defined by a power shortage and can be caused by e.g. tripping of a production unit or an importing HVDC interconnector. In accordance with Article 153(2)(a) of the SO Regulation, FCR-D shall cover at least the reference incident. This is interpreted as that FCR-D downwards shall cover at least the reference incident in positive direction and that FCR-D upwards shall cover at least the reference incident in negative direction. This is reflected by article 3(3) and 3(4) of the Methodology.

6.2 Definition of the reference incident (Article 153(2)(b)(ii))

This section 6.2 further elaborates on the definition of the reference incident as proposed in Article 3 of the Methodology in accordance with Article 153(2)(b)(ii) of the SO Regulation. In section 6.2.1, general guidance and reflections are given on the reference incident, in section 6.2.2-6.2.5 some detailed aspects for determining the size of 'reference incident' is presented, and in section 6.2.6 the daily process is presented.

6.2.1 'Reference incidents' considered for dimensioning of FCR-D

Article 153(2)(b)(ii) of the SO Regulation mentions that *the reference incident shall be the largest imbalance that may result from an instantaneous change of active power such as that of a single power generating module, single demand facility, or single HVDC interconnector or from a tripping of an AC line, or it shall be the maximum instantaneous loss of active power consumption due to the tripping of one or two connection points. The reference incident shall be determined separately for positive and negative direction;”*. The words “*such as”* in this article provide the TSOs with the task to define a more concrete list that shall be applicable to the Nordic system.

From the elements listed up in Article 153(2)(b)(ii), the following ones are considered in the FCR-D dimensioning process:

- *Single power generating module*[3] - e.g. tripping of Oskarshamn 3, Sweden.
- *Single demand facility* - e.g. tripping of one aluminium smelter hall in Norway.
- *Single HVDC interconnector*- e.g. tripping of NordLink in import/export situation, Norway.
- *Tripping of an AC-line*- e.g. tripping of line(s) Hasle-Halden resulting in system protection scheme (SPS) activation in Norway, and by this tripping of production units within the system protection scheme. Could also be tripping of one line resulting in loss of a regional part of the system.

The *"the maximum instantaneous loss of active power consumption due to the tripping of one or two connection points"* is considered to be much less relevant for the Nordic system. The TSOs concluded that it, at the time being, is not relevant to set a 'reference incident' based on tripping of *two* connection points. The reason for this is that the TSOs do not consider the probability for two simultaneous outages of demand

[3] Power generating module: Either a Synchronous Power Generating Module or a Power Park Module. Synchronous Power Generating module: An indivisible set of installations which can generate electrical energy such that the frequency of the generated voltage, the generator speed and the frequency of network voltage are in a constant ratio and thus in synchronism.

facilities significant. Tripping of one connection point has already been covered by a *single power generating module* and a *single demand facility* which are listed above.

In addition to the list in Article 153(2)(b)(ii), the TSOs consider that tripping of *one busbar* shall be evaluated as a reasonable N-1 disturbance. This may be relevant during especially longer outages for maintenance on a busbar. See example in Figure 1. Per today, this scenario is considered in the normal outage planning within each of the Nordic TSOs to ensure that any planned outage does not result in too large installed production capacity connected to a single busbar. As such, - in practice - tripping of single bus bars will not likely have an impact on the dimensioning of FCR-D in the system.

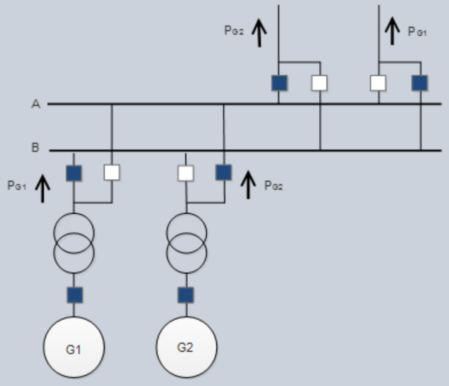
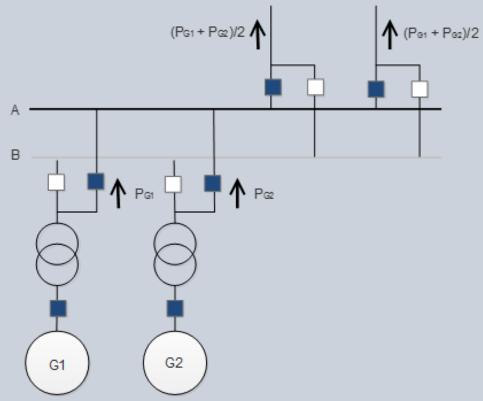
<table>
<tr><th></th><th>No planned outage</th><th>Planned outage</th></tr>
<tr><td></td><td>
</td><td>
</td></tr>
<tr><td>Reference incident</td><td>P_{G1} , P_{G2}</td><td>$P_{G1} + P_{G2}$</td></tr>
</table>

Figure 1: Left figure: 'incident considered' is the trip of busbar B, assuming $P_{G1} > P_{G2}$. Right: The 'incident considered' becomes the sum of P_{G1} and P_{G2}

6.2.2 *House load/auxiliary systems to be considered*

When assessing the instantaneous loss of active power generation for power generating modules, the real value for expected loss shall be taken into account. This means that for example, for thermal units with significant house load consumption (due to auxiliary systems), the total loss of active power as seen from the grid shall be used as basis for the definition of reference incident. This in turn means that the gross power generation of a unit should be taken into account. The reason for this can be seen in Figure 2. In this example the unit generator breaker is tripped instead of the breaker connecting to the main grid busbar.

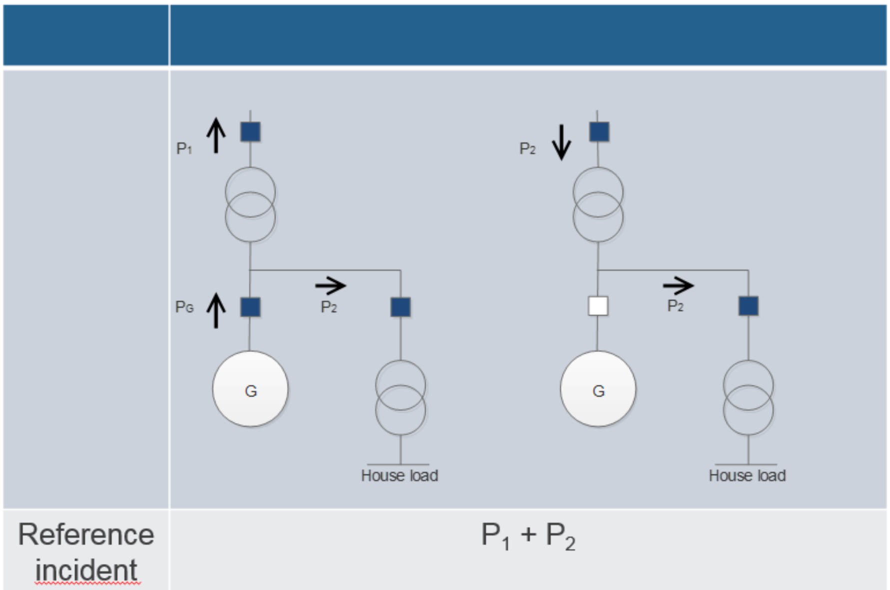


Figure 2: The 'incident considered' is the actual change of power after the trip of a generator unit. The house load shall be taken into account. 'Reference incident' equals the sum of P_1 + P_2 (= P_G)

6.2.3 Change of losses due to flow changes after disturbances

The imbalance that is caused by large incident may also be influenced by the change in network losses due to changed flows (see section 4.2). This effect is however very much dependent on the specific situation, including the location of the incident, the location of the FCR-D providing units and the flows just before the incident. The effect can result in both increased or decreased network losses and can therefore both increase or decrease the resulting imbalance on a synchronous area level. The TSO will not include this effect in the dimensioning of FCR-D.

6.2.4 Not considered for FCR-D dimensioning: Single disturbances with very low probability

Single failures with very low probability can occur in power system. This is the case for incidents leading to e.g. transmission tower collapse and certain less likely short circuits resulting in multiple bus bar tripping. These failures can in some cases lead to larger instantaneous imbalances than the incidents referred to in section 6.2.1.

However, taking these failures with very low probability into account would result in inefficient FCR-D dimensioning since the probability that the total amount of FCR-D would be activated is very small. Consequently, failures such as transmission tower collapse, trip of multiple bus bars etc. shall not set the 'reference incidents'.

6.2.5 Variation of active power output of a power generating module, HVDC facility

The size of the 'reference incident' depends on the actual operating point of a unit, which can differ from the nominal size of the unit. For example, a nuclear unit might

- run on "coast down" which mean reduced output in the end of its operational cycle;
- run with one generator synchronised to the main grid, in case outage on the other one (only applicable for two-turbine units like Ringhals nuclear power station).

The actual size depending on the actual operating point shall be the basis for FCR-D dimensioning in the Nordic system for each operational hour. The process for the continuous definition of 'reference incident' is defined in section 6.2.6.

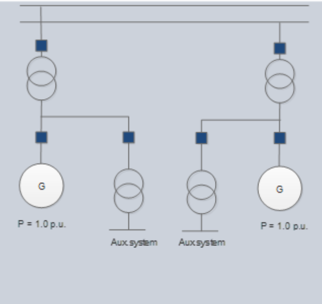
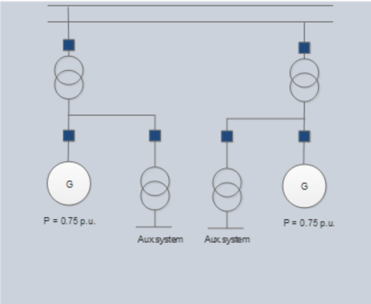
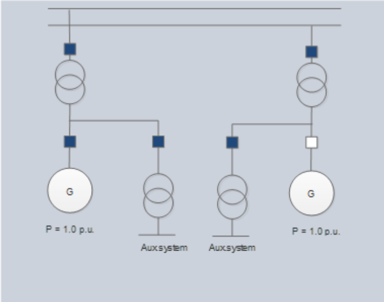
	1. Nominal operating point	2. Actual operating point	3. One SG out of service
			
Reference incident	2x1.0 p.u + house load	2x0.75 p.u + house load	1x1.0 p.u + house load

Figure 3: Size of 'reference incident' taking into account the actual operating point of a unit.

6.2.6 Daily process for defining 'reference incident'

The control centres of each Nordic TSO are responsible for daily defining the reference incident within each control area. The reference incidents from each control area are then collected to calculate the synchronous area reference incident.

6.3 Probabilistic dimensioning approach for Frequency Containment Reserves (FCR) (Article 153.2(c))

Article 153.2(c) of the SO Regulation state that the *"TSOs of the synchronous area shall have the right to define a probabilistic dimensioning approach for FCR […]"*. The TSOs conducted a joint project and have discussed a probabilistic methodology that could be used for a probabilistic dimensioning approach for FCR-D as mentioned in Article 153(2) of the SO Regulation. However, the TSOss decided not to use this methodology at the moment because the process for how to translate a certain risk level, inertia level, the actual probability for incidents and other inputs to suitable measures, including FCR-D dimensioning needs to be further defined. For this reason, the TSOs do not use *"the right to define a probabilistic dimensioning approach for FCR"* in accordance with Article 153(2)(c) of the SO Regulation.

6.4 Calculation of the initial obligation per TSO (Article 153(2)(d))

In Article 153(2)(d) it is stated that *"the shares of the reserve capacity on FCR required for each TSO as initial FCR obligation shall be based on the sum of the net generation and consumption of its control area divided by the sum of net generation and consumption of the synchronous area over a period of 1 year*."

The share of FCR for TSO A is then

$$FCRshare_{TSO\ A} = \frac{Generation_{TSO\ A} + Consumption_{TSO\ A}}{\sum_{i=1}^{4}(Generation_{TSOi} + Consumption_{TSOi})} \quad \text{(eq.1)}$$

The shares shall be revised each year before 1 October of year *y-1* on the basis of net consumption and net generation in year *y-2* and the new shares will enter into force on 1 January of year *y*.

6.5 Summary

The arguments in section 6.2 result in the rules for FCR-D dimensioning as included in Article 3 of the Methodology:

1. Following the dimensioning rules in this article, the Nordic TSOs will dimension FCR-D daily, separately for FCR-D upwards and FCR-D downwards.

2. The input to the dimensioning process of FCR-D shall be:
   a. Planned network topology, considering maintenance of relevant network components;
   b. Estimated (gross) generation of large generation modules;
   c. Estimated demand of large connected consumers;
   d. Estimated flows on HVDC interconnectors.

3. The total reserve capacity for FCR-D upwards required for the Nordic synchronous area shall be dimensioned to be at least equal to the imbalance caused by the reference incident in the negative direction. Dynamic FCR-D upwards shall make up at least a certain share of the system level FCR-D upwards response. The share shall be determined based on the system inertia, in addition to item 2 of this article. The share shall be reviewed at least annually.

4. The total reserve capacity for FCR-D downwards required for the Nordic synchronous area shall be dimensioned to be at least equal to the imbalance caused by the reference incident in the positive direction. Dynamic FCR-D downwards shall make up at least a certain share of the system level FCR-D downwards response. The share shall be determined based on the system inertia, in addition to item 2 of this article. The share shall be reviewed at least annually.

5. The reference incident shall be defined as the largest imbalance that may result from an instantaneous change of active power of:
   a. *A single power generating module:*
   b. *A single demand facility;*
   c. *A single HVDC interconnector;*
   d. *Tripping of an AC-line:* This may result in i) system protection scheme (SPS) activation which may trip one or more power generating units or ii) loss of a regional part of the system.
   e. Single failure on a busbar tripping more than one generation module or demand facility.

6. The imbalance volume of the 'instantaneous change of active power' mentioned in item 5 of this article shall be determined by the net loss of active power as seen from the grid. I.e. it should be taken into account that auxiliary load of the generation module may still consume power in the case that the unit generator breaker is tripped. Furthermore, the imbalance volume of the reference incident is determined by the maximum production, import, consumption or export that has been scheduled for the period for which the reference incident is determined.

The arguments in section 6.4 result in the rules for calculating the initial FCR-D distribution as included in Article 4 of the Methodology:

1. In accordance with article 152(2)(d) of the SO Regulation, FCR-D and FCR-N shall be distributed to the TSOs pro-rata to the shares defined below.
2. The input to the calculation of the initial distribution are:

   a. net generation per control area for calendar year *y-2* in which the net generation of a unit is defined as the gross power generation minus the internal auxiliary power consumption of the unit;

   b. net consumption per control area for calendar year *y-2* in which 'net' means that the consumption of power plants' auxiliaries is excluded, but network losses are included.

3. The shares of the reserve capacity on FCR required for each TSO as initial FCR obligation shall be based on the sum of the net generation and consumption of its control area divided by the sum of net generation and consumption of the synchronous area over a period of one year.

   The shares shall be revised each year before 1 October of year *y-1* and the new shares will enter into force on 1 January of year *y*.

7. Expected impact of the Methodology on the relevant objectives of the SO Regulation

The Methodology generally contributes to and does not in any way hamper the achievement of the objectives of Article 4 of the SO Regulation. In particular, the Methodology serves the objectives to:

- Article 4(1)(c) determining common load-frequency control processes and control structures;
- Article 4(1)(d) ensuring the conditions for maintaining operational security throughout the Union;
- Article 4(1)(e) ensuring the conditions for maintaining a frequency quality level of all synchronous areas throughout the Union; and
- Article 4(1)(h) contributing to the efficient operation and development of the electricity transmission system and electricity sector in the Union.

The Methodology contributes to these objectives by specifying the dimensioning rules for FCR-D, which is one of the key reserves that is used in the common Nordic load-frequency control processes. Sufficient FCR-D guarantees the right frequency quality level and consequently maintains the operational security by reducing the risk for automatic Low Frequency Demand Disconnection (LFDD), automatic reduction of generation and for system blackouts due to under or over frequency. The dimensioning rules balance the impact of both cost for FCR-D and outage risk and therefore ensure efficient operation of the electricity transmission system.

8. Timescale for the implementation

The rules for dimensioning of FCR-D, article 3 of the Methodology, have already been implemented in the existing processes, apart from the proposed requirements on Dynamic FCR-D volumes. The TSOs propose that the dimensioning rules of Dynamic FCR-D shall be implemented no later than 2.5 years after the approval of this Methodology. This corresponds to the middle-point of the five-year transition period of the Nordic methodology for additional properties of FCR in accordance with Article 154(2) of the SO regulation, which is submitted in parallel to this Methodology.

The rules for the initial distribution of FCR (article 4 of the Methodology) have already been implemented in the existing processes.

9. Public consultation

Article 11 of the SO Regulation states that: *"TSOs responsible for submitting proposals for terms and conditions or methodologies or their amendments in accordance with this Regulation shall consult stakeholders, including the relevant authorities of each Member State, on the draft proposals for terms and conditions or methodologies listed in Article 6(2) and (3). The consultation shall last for a period of not less than one month."*

This Methodology has been consulted in the period xxx to xxx. The appendix to this document includes the views of stakeholders resulting from the consultations and explains if and how these views have been taken into account in the Methodology.

Appendix: Results of Public Consultation

Article 11(3) of the SO Regulation states that: *"The TSOs responsible for developing the proposal for terms and conditions or methodologies shall duly take into account the views of stakeholders resulting from the consultations prior to its submission for regulatory approval. In all cases, a sound justification for including or not including the views resulting from the consultation shall be provided together with the submission of the proposal and published in a timely manner before, or simultaneously with the publication of the proposal for terms and conditions or methodologies."* Table 1 lists the views of stakeholders on this proposal resulting from the consultations and explains if and how these views have been taken into account in the Methodology.

Table 1: Views of stakeholders resulting from the consultations and explains if and how these views have been taken into account in the Methodology.

no.	organisation	Comment	response TSOs