
All Continental Europe TSOs' proposal for assumptions and methodology for a FCR probabilistic dimensioning in accordance with Article 153(2) of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation

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All Continental Europe TSOs, taking into account the following,

Whereas

- (1) This document is a proposal jointly developed by all Transmission System Operators of the Continental Europe synchronous area (hereafter referred to as the “TSOs”) regarding the determination of assumptions and a probabilistic dimensioning approach for FCR (hereafter referred to as “probabilistic FCR Dimensioning”) to be conducted, in order to assess the required FCR capacity in accordance with Article 153(2) of Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (hereafter referred to as “System Operation Guideline Regulation”). This proposal is hereafter referred to as “Probabilistic methodology for FCR dimensioning”.
- (2) Article 153(2)(c) of the System Operation Guideline Regulation requires the TSOs of the Continental Europe synchronous area 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 of the System Operation Guideline Regulation, with the aim of reducing the probability of insufficient FCR to below or equal to once in 20 years.
- (3) TSOs have historically adopted a deterministic criterion for the FCR dimensioning of FCR in the Continental Europe synchronous area. Such criterion consider that the FCR shall be able to contain the frequency deviation due to the worst expected outages combination on the system. The value historically adopted is 3000 MW.
- (4) The proposed probabilistic FCR Dimensioning generally contributes to the achievement of the objectives of Article 4(1) of the System Operation Guideline Regulation. Specifically, the proposed probabilistic FCR Dimensioning provides the TSOs of the CE synchronous areas with a methodology to evaluate the needs of FCR considering all the relevant factors contributing. Such methodology contributes to the determination of common operational security requirements and principles as set in the Article 4 (1) (a) of System Operation Guideline Regulation. It furthermore contributes to ensuring the conditions for maintaining operational security throughout the Union as set in Article 4 (1) (d) of System Operation Guideline Regulation. Finally it contributes to ensuring the conditions for maintaining a frequency quality level of all synchronous areas throughout the Union as set in Article 4 (1) (e) of System Operation Guideline Regulation. The proposed probabilistic FCR Dimensioning does not impact on the other objectives listed in Article 4(1) of the System Operation Guideline Regulation.
- (5) The probabilistic methodology for FCR dimensioning contributes to pursue the general objectives of the System Operation Guideline Regulation of safeguarding operational security by defining the proper FCR dimensioning needs.

SUBMIT THE FOLLOWING PROPOSAL TO ALL REGULATORY AUTHORITIES OF THE CONTINENTAL EUROPE SYNCHRONOUS AREA:

Article 1 Subject matter and scope

This is a proposal developed in accordance with the Article 4 (2) (c) of System Operation Guideline Regulation. The assumptions and methodology for FCR Dimensioning shall be considered as a common proposal of all Continental Europe TSOs in accordance with Article 153(2) of the System Operation Guideline Regulation.

Article 2

Definitions and interpretation

1. For the purposes of this probabilistic methodology for FCR dimensioning, terms used in this document shall have the meaning of the definitions included in Article 3 of the System Operation Guideline Regulation.
2. Further, in this probabilistic methodology for FCR dimensioning, unless the context requires otherwise, the following additional definitions shall also apply:
 - a) 'LER' means 'FCR providing units or groups with limited energy reservoirs':
FCR providing units or FCR providing groups are deemed as with limited energy reservoirs in case a full continuous activation for a period of 2 hours in either positive or negative direction might, without consideration of the effect of an active energy reservoir management, lead to a limitation of its capability to provide the full FCR activation.
 - b) 'LER Share' means the amount of LER in MW;
 - c) 'Market induced imbalances' means the 'generation-load imbalance caused by the change in generation set points according to the results of the market scheduling'.
 - d) 'System droop' means 'the ratio between frequency deviation and steady state power response provided by FCP';
 - e) 'Time Period', according to Article 156 (9) of System Operation Guideline Regulation, means 'the time for which each FCR provider shall ensure that its FCR providing units or groups with limited energy reservoirs are able to fully activate FCR continuously, as of triggering the alert state and during the alert state';
 - f) 'Long lasting frequency deviation' means an 'event with an average steady state frequency deviation larger than the long-lasting frequency threshold over a period longer than the time to restore frequency.
 - g) 'Long-lasting frequency threshold' means a parameter used to identify Long lasting frequency deviation, the default value is 25 mHz.
 - h) 'LFC' means 'load-frequency control block as defined in Article 3 (18) of System Operation Guideline Regulation.
 - i) 'FCP' means 'Frequency Containment Process' as defined in Article 3 (114) of System Operation Guideline Regulation.
 - j) 'FRP' means 'frequency restoration process' as defined in Article 3 (42) of System Operation Guideline Regulation.
 - k) 'FAT' means 'automatic FRR Full Activation Time' as defined in Article 3 (101) of System Operation Guideline Regulation.
 - l) 'Equivalent reservoir energy capacity' means the energy requirement for LER associated to the Time Period and shall amount to twice the energy provided by the full activation of LER for the Time Period.
 - m) 'frequency nadir' is the minimum instantaneous frequency reached during an underfrequency transient.
 - n) 'frequency zenith' is the maximum instantaneous frequency reached during an overfrequency transient.
 - o) 'RoCoF', means Rate of Change of Frequency, is the derivative of the frequency.

- p) 'Initial RoCoF', is the RoCoF calculated at the time in which a disturbance happens.
 - q) 'Maximum Transient Frequency Deviation' is the difference in absolute value between the frequency at the time in which the disturbance happens and the frequency nadir for under-frequency or the frequency zenith for over-frequency phenomena. It represents the maximum frequency excursion before frequency starts to recover.
 - r) 'Maximum Initial RoCoF' is maximum Rate of Change of Frequency acceptable during a transient.
3. In this probabilistic methodology for FCR dimensioning, unless the context requires otherwise:
- a) the singular indicates the plural and vice versa;
 - b) unless otherwise provided, any reference to an Article means an article of this probabilistic methodology for FCR dimensioning;
 - c) the table of contents and headings are inserted for convenience only and do not affect the interpretation of this probabilistic methodology for FCR dimensioning; and
 - d) any reference to legislation, regulation, directive, order, instrument, code or any other enactment shall include any modification, extension or re-enactment of it then in force.

Article 3

Outcome of the probabilistic methodology for FCR dimensioning

The outcome of the probabilistic methodology for FCR dimensioning is a symmetrical value in MW for FCR in accordance with Article 153 of the System Operation Guideline Regulation.

Article 4

Probabilistic Simulation Model

1. The Probabilistic Simulation Model shall be able to calculate a minimum amount of FCR needed in accordance with Article 153 of the System Operation Guideline Regulation, 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 of the System Operation Guideline Regulation, with the aim of reducing the probability of insufficient FCR to below or equal to once in 20 years.
2. The following sources of frequency disturbance shall be inputs of the Probabilistic Simulation Model:
 - a) Deterministic frequency deviation.

The TSOs shall consider the market induced imbalances, analyse frequency historical trends of the synchronous area over several years, and statistically determine the typical trends and amplitudes of these frequency deviations in order to use them as an input of the Probabilistic Simulation Model.
 - b) Long lasting frequency deviation.

The TSOs shall take into account Long lasting frequency deviations. They shall analyse frequency historical trends in order to characterize the phenomena from a statistical point of view. The analysis shall determine:

 - the number of occurrences of these events;
 - the typical duration;
 - a representative frequency deviation trend;
 - typical time of occurrence, if highlighted by statistical analysis..
 - c) Outages of relevant grid elements.

The TSOs shall define a list of all the grid elements whose outages lead to relevant power imbalances and indeed to relevant FCR activation.

3. The Probabilistic Simulation Model shall implement a function to calculate the dynamic frequency response consequent to a disturbance. Such function shall consider the variation in power imbalance between two following calculation steps and calculate the key parameters of the frequency transient: frequency Nadir, frequency Zenith and RoCoF. To limit the computational effort, the calculations can be based on an simplified single-busbar dynamic model. Such model implements the following linear transfer functions: equation of motion, which models the response of the power systems in terms of inertia and self regulation of load, droop, which models the static characteristic of the FCP, and the equivalent dynamic of FCR provision, which models the combined effects of the dynamic responses provided by all FCR providers. The models parameters are tuned to provide the best equivalent behaviour of the power system.
4. The Probabilistic Simulation Model shall be used to calculate the requested FCR in the scenario described in Article 6. Therefore, also the following variables represent inputs for the model:
 - a) Time Period;
 - b) LER Share;
 - c) FAT of the synchronous area.
5. The Probabilistic Simulation Model calculates the required FCR using an iterative method. At every iteration, the Probabilistic Simulation Model uses a Probabilistic Simulation Process in order to verify if the frequency is within frequency acceptance criteria. If the criteria are not fulfilled, the Probabilistic Simulation Model increases gradually the FCR and calculates the next iteration. The iterations stop once the condition is fulfilled.
6. The Probabilistic Simulation Process shall be able to simulate several years of operation conditions of the synchronous area by means of random draws of long lasting frequency deviations, deterministic frequency deviations and outages of relevant grid elements. It has the aim to generate a large number of random combinations of all the possible sources of frequency disturbance. Since the Probabilistic Simulation Process works on the time domain, this approach requires to simulate a long system operation period.

The operation period to be simulated shall be estimated to generate statistically significant results and to provide the best compromise among the desired level of accuracy and computational time efforts, and not less than 200 years.

The time discretization adopted by the Probabilistic Simulation Process shall be 1-minute. Each variable shall thus be calculated on 1-minute basis.
7. The Probabilistic Simulation Process shall be able to simulate the depletion of LER and its effects on the frequency deviation, taking into account the LER Share and the Time Period.

Article 5

Frequency acceptance criteria

1. The dimensioning process is implemented through the iterative increase of the Probabilistic Simulation Model as described in Article 4(5). The condition to be assessed at each iteration is that the number of

identified Critical Conditions is less than or equal to 1/20 of the number of simulated years. Such condition shall be fulfilled by the final dimensioned FCR.

2. A Critical Condition is defined as one of the following conditions:
 - a) The Steady State Frequency Deviation as simulated by the Probabilistic Simulation Model exceeds the steady state maximum frequency deviation.
 - b) The frequency nadir or frequency zenith during a frequency transient exceeds the Maximum Transient Frequency Deviation.
 - c) The absolute value of RoCoF exceeds the Maximum Initial RoCoF.

Article 6 **Simulation scenario**

1. The analyses and processes described in Article 4 shall be performed considering the best estimations of the input data regarding the evolution of sources of frequency disturbances (taking into account the frequency management procedures implemented in the meantime by the Continental Europe TSOs), the expected LER shares, their respective Time Period and any other factor impacting the calculation and dimensioning of FCR.

Article 7 **Further assumptions**

1. The Probabilistic Simulation Model and the Probabilistic Simulation Process described in Article 4 shall be referred to the whole synchronous area.
2. The Probabilistic Simulation Process shall simulate the FRP with a single FRP controller without FRR limitations. The single FRP controller shall use a FAT calculated as an average of the FAT of all the LFC areas belonging to the synchronous area weighted on FRR K-factor, until the FAT will be harmonized, according to the Implementation Framework for aFRR balancing energy platform.
3. The Probabilistic Simulation Process can neglect the entire Cross-Border Load-Frequency Control Process.
4. The Probabilistic Simulation Process shall simulate the FRP deployment dynamic and the system droop.
5. If a continuous exceeding of the standard frequency range includes the triggering of an alert state, the activated energy and the residual energy in the reservoir is calculated from the first exceeding of the standard frequency range limits.
6. At the full availability of the reservoir, the energy level will be considered equal to half of the Equivalent reservoir energy capacity.
7. The annual review of FRP K-factors (Article 156 (2) of System Operation Guideline Regulation) can be neglected as long as the review does not affect significantly the average FAT as defined in Article 7(2).

Article 8 **Publication and implementation of the probabilistic methodology for FCR dimensioning**

1. Each Continental Europe TSO shall publish the probabilistic methodology for FCR dimensioning without undue delay after all NRAs have approved the proposed probabilistic methodology for FCR dimensioning, in accordance with Article 8 of the System Operation Guideline Regulation.
2. The Continental Europe TSOs shall have implemented the probabilistic methodology for FCR dimensioning by 12 months after its approval by all regulatory authorities of the CE synchronous areas. The implementation shall take place by submitting the results of the applied probabilistic methodology

for FCR dimensioning conducted by the TSOs of the CE synchronous areas according to the probabilistic methodology for FCR dimensioning to the concerned regulatory authorities for information.

3. The Continental Europe TSOs shall have the right to implement the probabilistic methodology for FCR dimensioning every two years following the first implementation defined in Article 8(2).
4. The Continental Europe TSOs shall have the right to implement the probabilistic methodology for FCR dimensioning whenever the input defining the scenario change.

Article 9 **Language**

The reference language for this methodology shall be English. For the avoidance of doubt, where TSOs need to translate this methodology into their national language(s), in the event of inconsistencies between the English version published by TSOs in accordance with Article 8(1) of the System Operation Guideline Regulation and any version in another language, the relevant TSOs shall, in accordance with national legislation, provide the relevant national regulatory authorities with an updated translation of the methodology.