
**Additional properties of FCR in accordance with
Article 154(2) of the Commission Regulation (EU)
2017/1485 of 2 August 2017 establishing a
guideline on electricity transmission system
operation**

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Whereas

- (1) This document regards the common additional properties of Frequency Containment Reserves (hereinafter referred to as “FCR additional properties”) for Synchronous Area Continental Europe (hereinafter referred to as “Synchronous Area CE”) in accordance with Article 154(2) of Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (hereinafter referred to as “SO GL”).
- (2) With respect to Article 154 of SO GL which determines FCR technical minimum requirements, all TSOs of a synchronous area have the right to specify, in the synchronous area operational agreement developed pursuant to Article 118 of SOGL, common FCR additional properties required to ensure operational security in the synchronous area, by means of a set of technical parameters and within the ranges set out in Article 15(2)(d) of Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators (hereinafter referred to as “RfG”) and in Articles 27 and 28 of Commission Regulation (EU) 2016/1388 of 17 August 2016 establishing a Network Code on Demand Connection (hereinafter referred to as “DCC”). These additional properties as detailed in this document are subject to approval by the NRAs of the synchronous area according to Article 6(3)(d)(iii) of SO GL.
- (3) For Synchronous Area CE, the operational agreement was finalised in April 2019, following the approval by NRAs according to Article 6(3)(d) of SO GL. The original package did not include any FCR additional properties
- (4) To reflect the individual needs of the synchronous area CE, some common additional properties are nonetheless needed for FCR providing units and/or FCR providing groups with respect to the activation of FCR and to FCR availability in a stressed system status posing particular attention to the new technologies. To this extent particular conditions are specified for FCR providing units or FCR providing groups which are connected to the grid via converters. However, the principle of non-discrimination is still respected since these conditions are based on the distinctive features of this technology without restricting the provision of FCR.
- (5) Once approved, these FCR additional properties shall be included in the synchronous area operational agreement for the Synchronous Area CE, as an integral part of this document.
- (6) Where references to the RfG are cited, these references shall be intended as reflecting the possible extreme system status where FCR provision is essential for grid security. They shall not be deemed to contradict the application of RfG provisions only to new installations.
- (7) The FCR additional properties are expected to reduce the risk of inappropriate activation of FCR and of unavailability of FCR in a stressed system state. With this in mind, these properties will contribute to system stability and therefore to the achievement of the objectives of Article 4 of the SO GL.
- (8) The specification of activation of FCR has the goal to ensure fast response and therefore help to stabilise the system. Specifications for FCR providing units and/or FCR providing groups with limited energy reservoir (hereinafter referred to as “LER”) aim at ensuring sufficient availability also in stressed system status. Specifications for frequency measurement aim at ensuring availability of independent functionality of FCR providing units and/or FCR providing groups in particular in case of system split or communication problems. The transition period is defined to avoid too abrupt change of requirements for already existing FCR providing units and/or FCR providing groups.

- (9) In conclusion, the FCR additional properties contribute to the general objectives of the SO GL to the benefit of all market participants and electricity end consumers.

Article 1

Subject matter and scope

1. The FCR additional properties as determined in this document shall be considered as the properties developed in accordance with Article 154(2) of SO GL and shall establish the requirements in addition to those foreseen in Article 154 of SO GL for FCR providing units and/or FCR providing groups.

Article 2

Definitions and interpretation

1. For the purposes of the FCR additional properties, terms used in this document shall have the meaning of the definitions included in Article 3 of the SO GL, Article 2 of Regulation (EC) 714/2009, Article 2 of Directive 2009/72/EC, Article 2 of Commission Regulation (EU) 543/2013 and Article 2 of RfG.
2. In addition, the following definitions shall apply:
 - a) active energy reservoir management: active charging/discharging of the reservoir depending on the state of charge which results from FCR activation to avoid a status of a completely full/empty reservoir;
 - b) centralised frequency measurement: principle of using a single frequency measurement for activation of a number of decentrally located technical entities forming a FCR providing unit or providing group. The application of this principle requires the respective transmission of the frequency signal to the individual FCR providing unit or FCR providing group;
 - c) decentralised frequency measurement: principle of using independent on-site frequency measurements at the connection points or below at site of generating units of the technical entities forming FCR providing units or FCR providing groups and activation of FCR based on this on-site measurement;
 - d) effective energy reservoir: the energy reservoir of a storage device which can effectively be used for energy feed/absorption;
 - e) LER FCR providing units or LER FCR providing groups: FCR providing units or groups with limited energy reservoirs, fulfilling the criteria according to Article 3(4);
 - f) normal mode: activation of FCR depending on the deviation of system frequency;
 - g) reserve mode: activation of active power response depending on short-term frequency deviations in relation to the mean frequency deviation.
 - h) technical entity: single power generating module or demand unit.
3. In this document, unless the context requires otherwise:
 - a) the singular indicates the plural and vice versa;
 - b) the table of contents and headings are inserted for convenience only and do not affect the interpretation of these common FCR additional properties; and
 - c) any reference to legislation, regulations, directive, order, instrument, code or any other enactment shall include any modification, extension or re-enactment of it then in force.

Article 3

Additional properties of Frequency Containment Reserves

1. Each TSO shall check the conformity of FCR providing units and of FCR providing groups with the rules under this Article and with the provisions set in Article 156(9), 156(10) and 156(11) of SO GL in the

course of the prequalification according to Article 155 of SO GL and in addition by (ex-post) monitoring of activation of FCR according to Article 154 (3) of SO GL. Each TSO shall apply respective monitoring procedures.

2. Each TSO shall ensure that the activation of all FCR providing units and FCR providing groups:
 - a) is not artificially delayed and begins as soon as possible but no later than 2 seconds after a frequency deviation;
 - b) rises at least linearly.

When one of the requirements a) or b) cannot be met, the FCR providing group or FCR providing unit shall provide technical evidence to the reserve connecting TSO. The reserve connecting TSO assesses these justifications and decides whether or not the unit or group can be qualified to provide FCR.

3. Each FCR providing unit or group shall be capable of staying connected to the grid within the frequency range of 47,5 to 51,5 Hz for time periods specified by the TSO as approved by the relevant NRAs according to Articles 7 and 13 of RfG, taking into account the technical boundary conditions of the respective FCR providing units or FCR providing groups in accordance with Article 154(6) of SO GL. Each TSO shall, in coordination with the DSOs, ensure that distributed FCR is not significantly reduced by load shedding actions.
4. FCR providing units or FCR providing groups are deemed as LER FCR providing units or LER FCR providing groups 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 in accordance with Article 156(8) of SO GL, due to the depletion of its energy reservoir(s) taking into account the effective initial availability of the energy reservoir(s).

For the avoidance of doubt, FCR providing units or groups that contain technical entities with unlimited energy reservoirs and technical entities with limited energy reservoirs shall not be considered LER FCR providing unit or group in case their energy reservoir does not limit the capability to provide FCR according to Article 156(7) of the SO GL.

FCR providing units or groups not deemed as LER FCR providing units or groups that contain technical entities with limited energy reservoirs shall thus ensure to be able to fully activate their FCR provision in accordance with Article 156(7) of the SO GL.

Technical entities with unlimited energy reservoir of FCR providing units or FCR providing groups shall not limit their FCR provision in case technical entities with limited energy reservoir (of that FCR providing group/unit) are already exhausted in either the positive or negative direction according to Article 156(8) of SO GL.

For prequalification, the TSOs shall require that:

- LER FCR providing units or LER FCR providing groups shall have an active energy reservoir management. The active energy reservoir management shall ensure a continuous physical activation of FCR in normal state according to Article 156(9) of SO GL.
- In accordance with Article 156(9) of SO GL, the FCR provider shall ensure that LER FCR providing units or LER FCR providing groups have an energy reservoir dimensioned to guarantee the minimum activation period set in accordance with Article 156(10) of SO GL, by additionally taking into account possible frequency deviations that might happen before entering into alert state.

- To enable an active energy reservoir management, LER FCR providing units or LER FCR providing groups may prequalify a power for FCR limited to 0.8 of the rated power (i.e. a ratio of rated power to prequalified power of at least 1.25:1); a deviation from this requirement is possible in case an alternative solution with equivalent effect is in place. Any lead time for the charging process needs to be considered for the active energy reservoir management.
 - The active energy reservoir management of LER FCR providing units and LER FCR providing groups shall not rely on over fulfilment of activation.
 - LER FCR providing units (either single or belonging to a LER FCR providing group) that are prequalified for the first time after the entry into force of the methodology and which are connected to the grid by means of inverters shall ensure that close to the upper or lower bounds of the energy reservoir the remaining capacity is sufficient for keeping a proper response on short-term frequency deviations. Therefore, they shall switch from the normal mode (reaction to normal frequency deviation) into a reserve mode (reaction to zero-mean frequency deviation). Annex I provides the standard criteria governing the operation in reserve mode and the transition from normal mode to reserve mode and viceversa. Each TSO may define its own criteria to be applied in its control area. If no criteria are defined, the standard ones apply.
5. FCR providing units (either single or belonging to a FCR providing group) shall be equipped with local frequency measurement at least per connection point or below when it is technically feasible at the technical entity of the FCR providing unit.
 6. FCR providing groups shall implement alternatively one of the following approaches:
 - a) decentralised frequency measurements at least per connection point in analogy to paragraph 5
 - b) a centralised FCR controller with decentralised frequency measurements per connection point (based on local frequency measurement) that can be used as a fallback solution to ensure an autonomous function and a proper activation in case of errors in the centralised FCR controller (e.g. outage of SCADA, faults of communication lines) or in case of a system split affecting the perimeter of the group; if the group includes FCR providing units, local frequency measurements available for these units pursuant to paragraph 5 shall be part of the fallback solution;
 - c) an alternative solution with equivalent effect to the decentralized frequency measurements pursuant to letter b).
 7. In case the decentralised frequency measurements are used as a fallback solution pursuant to paragraph 6(b):
 - a) an observation function shall detect any kind of errors of the central control or frequency discrepancies among the technical entities within the perimeter of the group;
 - b) the FCR provider shall immediately initiate appropriate counter-measures to ensure that the FCR provision is not significantly negatively impacted by switching to the decentralised frequency measurements;
 - c) the minimum accuracy of the local frequency measurement used as a fallback solution can be reduced if accepted by the reserve connecting TSO.
 8. In case the alternative solution with equivalent effect pursuant to paragraph 6(c) is implemented:
 - a) if the FCR providing group includes FCR providing units, the local frequency measurements available for these units pursuant to paragraph 5 may be integrated in the alternative solution;
 - b) the FCR provider shall demonstrate the effectiveness of the alternative solution with respect to the decentralized frequency measurements;
 - c) the solution may be implemented only if accepted by the reserve connecting TSO.

9. For a time period of 4 years after the entry into force of the FCR additional properties, the implementation of a centralised FCR controller non compliant with the requirement set in paragraph 6 is temporary allowed under the following conditions:
 - i. To mitigate the risk of misbehavior of technical entities in case of errors of the central control (e.g. outage of SCADA, faults of communication lines) and to limit the impact on frequency, a single non compliant centralised FCR controller shall not control a FCR capacity greater than 1% of the reference incident for Synchronous Area CE according to Article 153(2)(b)(i) of SO GL .
 - ii. The reserve connecting TSO shall monitor the share of FCR capacity managed by non compliant centralised FCR controllers within the procurement process; in order to ensure operational security pursuant to Article 154(4) of the SOGL, in each LFC Block the amount of FCR capacity managed by centralised controllers shall not exceed 2.5% of of the reference incident for Synchronous Area CE according to Article 153(2)(b)(i) of SO GL .

After 4 years after the entry into force of the FCR additional properties, centralised FCR controllers non compliant with the requirements set in paragraph 6 are no longer allowed.

10. Each TSO shall require that FCR providing units and FCR providing groups continue providing FCR and are not allowed to reduce activation in case of a frequency deviation outside the frequency range of +/- 200 mHz up to the frequency ranges as defined in paragraph 2.

Article 4

Publication and implementation of the FCR additional properties proposal

1. The TSOs shall publish the FCR additional properties without undue delay after the approval by the NRAs of the Synchronous Area CE.
2. The TSOs shall start to implement the FCR additional properties as specified in this proposal immediately after the approval by all NRAs of the Synchronous Area CE.
3. The transitional period for the implementation of additional properties of FCR by the existing affected FCR providers shall be two years: one year for TSOs to adapt their national Terms and Conditions and one additional year for FCR providers to implement the FCR additional properties.
4. Each TSO may recommend to extend the provisions of the reserve mode to existing LER FCR providing units which are connected to the grid by means of inverters: in this case the rules for the application of requirements to existing units reported in Article 4 of RfG apply and the deadline for the implementation is set accordingly.

Article 5

Language

1. The reference language for these FCR additional properties shall be English. For the avoidance of doubt, where TSOs need to translate these FCR additional properties into their national language(s), in the event of inconsistencies between the English version published by TSOs in accordance with Article 8 of the SO GL 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 FCR additional properties.

Annex I – normal vs reserve mode

Each LER FCR providing unit which is connected to the grid by means of inverters shall be able to switch from normal mode to reserve mode when upper (soc_{max}) or lower (soc_{min}) state of charge limits are exceeded. These limits are defined by the amount of energy necessary to provide FCR for a time interval equal to full activation time of aFRR:

$$soc_{min} = \frac{P * \Delta t_{FAT}}{C}$$

$$soc_{max} = 1 - soc_{min}$$

where

C is the storage capacity in MWh;

P is the power offered for FCR provision in MW;

Δt_{FAT} is the aFRR full activation time in h.

When charge is restored, the unit shall revert to normal mode.

During normal mode the unit shall react to the normal frequency deviation $\Delta f(t)$ while in reserve mode the unit shall react only on the short-term frequency deviation by following the zero-mean frequency:

$$\overline{\Delta f_{zero-mean}(t)} = \Delta f(t) - \frac{1}{n(t - \Delta t_{FAT})} \sum_{i=0}^{n(t - \Delta t_{FAT})} \Delta f$$

During the transition period from normal mode to reserve mode and viceversa, the unit shall react on the combination $f_{reaction}(t)$ of normal frequency deviation and short-term frequency deviation as described by the following equation:

$$f_{reaction}(t) = \overline{\Delta f_{zero-mean}(t)} \cdot T + (1 - T) \cdot \Delta f(t)$$

where T is the weighting function defined as follows.

For the transition from normal mode to reserve mode:

$$T = \begin{cases} 0 & t < t_{start} \\ \frac{t - t_{start}}{\Delta t_{FAT}} & \text{for } t_{start} \leq t < t_{start} + \Delta t_{FAT} \\ 1 & t \geq t_{start} + \Delta t_{FAT} \end{cases}$$

where t_{start} is the time when upper or lower state of charge limits are exceeded.

For the transition from reserve mode to normal mode

$$T = \begin{cases} 1 & t < t_{restore} \\ \frac{t_{restore} - t}{\Delta t_{FAT}} & \text{for } t_{restore} \leq t < t_{restore} + \Delta t_{FAT} \\ 0 & t \geq t_{restore} + \Delta t_{FAT} \end{cases}$$

where $t_{restore}$ is the time when upper or lower state of charge limits are restored.

Both in normal as well as in reserve mode the interval for frequency sensitivity mode shall be respected (the full frequency range is used as input signal, but the FCR provision is limited to short term frequency deviations in reserve mode).