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## Annex 5: Policy on Emergency and Restoration

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## **INTRODUCTION**

This document is part of the Synchronous Area Framework Agreement for the Synchronous Area CE, constituting the Synchronous Area Operational Agreement as defined in SO GL Article 118. Its contents are without prejudice to the binding provisions of NC ER, but aim at ensuring that TSO's obligations arising from NC ER are performed in a coordinated way. Parts A and B remain empty at the time of entry into force of the Agreement, while Part C contains additional commonly developed rules.

## **A METHODOLOGIES, CONDITIONS AND VALUES SUBJECT TO ALL REGULATORY AUTHORITIES APPROVAL**

The Parties acknowledge that at the moment of entry into force of the Agreement there is no obligation arising from the NC ER to develop Part A within the subject scope of Policy on Emergency and Restoration (ER).

## **B METHODOLOGIES, CONDITIONS AND VALUES SUBJECT TO APPROVAL BY ALL TSOS**

The Parties acknowledge that at the moment of entry into force of the Agreement there is no obligation arising from the NC ER to develop Part B within the subject scope of Policy on Emergency and Restoration.

## **C METHODOLOGIES, CONDITIONS AND VALUES AGREED AMONG THE MEMBERS OF ENTSO-E RGCE**

The following section includes all methodologies, conditions and values which are jointly developed and agreed among the Parties who are members of the RG CE.

Article C-1 consist of definitions used in this Policy. It may also contain substantive rules related to notions defined therein.

Articles C-2 to C-13 refer to System Defence Plan and contain methodologies, conditions or values to be taken into account while designing, implementing or activating system defence plans in accordance with NC ER.

Articles C-14 to C-26 refer to System Restoration Plan and contain methodologies, conditions or values to be taken into account while designing, implementing or activating system restoration plans in accordance with NC ER.

## **DEFINITIONS**

### **C-1 DEFINITIONS USED IN POLICY ON ER**

#### **C-1-1 ENTSO-E AWARENESS SYSTEM (EAS)**

EAS IT tool for real time data exchanges for pan-European use within ENTSO-E set up to increase the knowledge of the state of the system and accordingly to launch alarms.

#### **C-1-2 TOTAL LOAD CALCULATION METHOD FOR LOW FREQUENCY DEMAND DISCONNECTION (LFDD) IMPLEMENTATION**

Total Load (to be used to implement LFDD in line with NC ER) within Policy on ER calculated as:

(Total Load =  $\Sigma$  generation (net) [ $\Sigma$  {generation (gross) – house load}] + imports - exports - energy storage) *(All values are positive)*.

#### **C-1-3 OPERATION MODES OF THE FREQUENCY RESTORATION CONTROLLER**

The Frequency Restoration Controller implementation shall include the operation modes defined in Policy on LFCR Article B-6. For the purposes of the System Defence Plan and Restoration Plan, the Normal Operation Mode, Frequency Control Mode, and Frozen Control Mode are used.

Normal Operation Mode – as defined in Policy on LFCR Article B.6.2.2.1.4.

Frequency Control Mode – as defined in Policy on LFCR Article B.6.2.2.1.4.

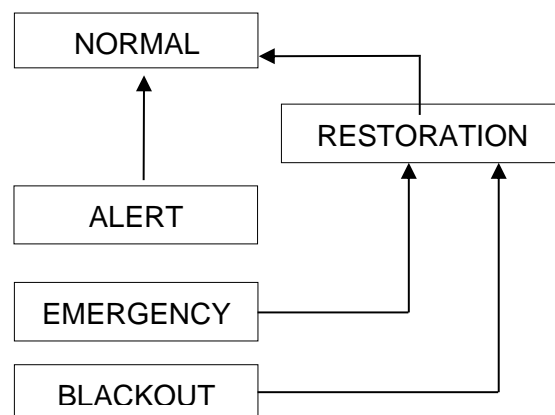
Frozen Control Mode – as defined in Policy on LFCR Article B.6.2.2.1.4.

#### **C-1-4 POWER GENERATING MODULE LOCAL FREQUENCY CONTROL MODE.**

A functionality of Power Generating Modules (PGMs) to switch their controllers into speed control and keep the last frequency as a reference set point, after being disconnected from Frequency Restoration Controller (e.g. frequency deviation exceeding given thresholds).

#### **C-1-5 SYSTEM RESTORATION**

A set of actions implemented after a disturbance with large-scale consequences to bring the system from emergency state or blackout state back to normal state. Actions of restoration are launched once the system is stabilised. Restoration of the system consists of a very complex sequence of coordinated actions, the framework of which is studied and, as far as possible, prepared in advance.



#### **C-1-6 PGM WITH ISLAND OPERATION CAPABILITY**

A PGM which brings stability into an island and during steps of load pickup in case of reenergising the current island. This implies that a governor and an automatic voltage regulator are able to balance active and reactive power surplus or deficit after load pickup or load shedding in small islands in order to feed-in line, to regulate frequency and voltage, and, to reenergise in isolated operation.

#### **C-1-7 PGM WITH BLACK START CAPABILITY**

A PGM with the ability to go from a shutdown condition to an operating condition, to start delivering power without external electrical energy supply from TSO or DSO grids and includes PGM island operation capability (refer to RfG Article 2 (45)).

#### **C-1-8 HOUSELOAD OPERATION OF PGMs**

The capability of a PGM to continue to supply their in-house loads after disconnection from the grid. TSO has to take into account that some PGMs can maintain this kind of operation only for a limited duration (refer to RfG Article 2 (44)).



## **SYSTEM DEFENCE PLAN**

### **C-2 INTER-TSO COORDINATION**

For Emergency, Restoration and Blackout System State TSOs shall agree in writing on bilateral/multilateral procedures including adequate information exchanges to be applied with all neighbouring TSOs.

The Parties shall strive to agree on the aforementioned procedures by the end of 2019.

### **C-3 TESTING CRITICAL TOOLS AND FACILITIES**

#### **C-3-1 SYSTEM DEFENCE PLAN**

*Additional recommendation:*

It is recommended to test critical tools and facilities referred to in Article 24 of Regulation 2017/1485 used for System Defence Plan at least every year covering both main and backup tools and facilities.

#### **C-3-2 SYSTEM RESTORATION PLAN**

*Additional recommendation:*

It is recommended to test critical tools and facilities referred to in Article 24 of Regulation 2017/1485 used for System Restoration Plan at least every year covering both main and backup tools and facilities.

### **C-4 FREQUENCY MANAGEMENT PROCEDURE BEFORE THE APPOINTMENT OF FREQUENCY LEADER ACCORDING TO ARTICLE 28 (3) OF NC ER**

#### **C-4-1 FREQUENCY DEVIATION MANAGEMENT BEFORE FREQUENCY LEADER NOMINATION – MANAGEMENT OF THE FREQUENCY RESTORATION CONTROLLER**

In case of frequency deviation higher than 200 mHz lasting more than one minute, individual Frequency Restoration Controllers have to be switched in Frozen Control Mode by direct manual or automatic actions or by other ways relying on TSO devices or generating units devices.

#### **C-4-2 FREQUENCY DEVIATION MANAGEMENT BEFORE FREQUENCY LEADER NOMINATION – RESPONSE OF THE FREQUENCY RESTORATION CONTROLLER**

Each TSO of RG CE shall require that, in case of frequency deviations larger than 200 mHz and up to the frequency ranges defined in Article 154(6) of SO GL, FCR providing units and FCR providing groups shall not limit their activation to the procured volume and continue providing FCR by further increasing/decreasing power output (both in positive and negative direction) up to their maximum/minimum capacity, as long as there are not technical limitations.

The related FCR response shall have the same droop adopted for normal and alert state and, in any case, not endanger the FCR providing units' or FCR providing groups' stability.

#### **C-4-3 FREQUENCY DEVIATION MANAGEMENT BEFORE FREQUENCY LEADER NOMINATION – ACTIVATION OF LIMITED FREQUENCY SENSITIVE MODE (LFSM)**

In case of LFSM is activated, the FCR providing units' or FCR providing groups' LFSM response shall resume from the overall FCR activation as of LFSM intervention. In such a scenario, the FCR providing unit or group shall cumulatively activate its LFSM provision starting from the last FCR set-point calculated at the LFSM triggering.

#### **C-4-4 FREQUENCY DEVIATION MANAGEMENT BEFORE FREQUENCY LEADER NOMINATION – ADDITIONAL MEASURES OF THE FREQUENCY RESTORATION CONTROLLER**

After implementing actions described in C-4.1, TSOs are allowed to manually/automatically override the Frozen Control Mode output signal of Frequency Restoration Controllers to use their communication/signalling channels to power-generating facility in order to speed up the stabilisation of the system. These measures have to be taken with care not to create congestion.

TSOs shall take into account previously agreed coordinated actions in Normal and Alert State aimed to recover frequency.

#### **C-4-5 FREQUENCY DEVIATION MANAGEMENT BEFORE FREQUENCY LEADER NOMINATION – ADDITIONAL TSO MEASURES**

In case of frequency deviation higher than 200 mHz lasting more than one minute TSOs are allowed to manually and/or automatically activate additional reserve (e.g. (i) through starting/stopping pumped-storage power-generating facilities and/or (ii) activating mFRR and/or (iii) decreasing/increasing the level of active power generation by activating extra FCR if available) in order to speed up the stabilisation of the system. These measures have to be taken with care not to create congestion.

TSOs shall take into account previously agreed coordinated actions in Normal and Alert State aimed to recover frequency.

### **C-5 AUTOMATIC DISCONNECTION OF PUMP-STORAGES ACTING AS A LOAD**

Automatic disconnection of pump-storages acting as a load shall be activated as followed:

- If  $49.2 \text{ Hz} < \text{frequency} < 49.8 \text{ Hz}$ : time delay shall be smaller or equal than 10 s.
- If  $\text{frequency} = 49.2 \text{ Hz}$ : Maximum total tripping time of pump-storages acting as a load considering measurement, calculation time of relays, tripping action of auxiliary circuits and circuit breaker opening time shall be 300 ms. No intentional time delay is allowed.
- If  $\text{frequency} < 49.2 \text{ Hz}$ : all pump-storages acting as a load shall be disconnected.

## **C-6 ENTISO-E RG CE LOW FREQUENCY DEMAND DISCONNECTION (LFDD) PLAN**

### **C-6-1 DESIGN OF THE LFDD PLAN**

For cases where there is a major frequency drop, automatic function for load shedding in response to a frequency criterion must be installed in order to prevent a further frequency drop and the collapse of the system. Each TSO shall design the LFDD plan with the objective to disconnect Demand in real-time.

In the case there is more than 1 TSO in a country, the LFDD plan is allowed to be designed and implemented at national level when in accordance with legislation.

### **C-6-2 IMPLEMENTATION OF THE LFDD PLAN**

For frequency in the range of 49.0 to 48.0 Hz, each TSO shall implement the LFDD plan as follows:

C-6-2-1 At least an amount of Demand corresponding to 5% of the Total Load shall be disconnected at 49.0 Hz.

C-6-2-2 In total, an amount of Demand corresponding to 45% +/- 7% of the Total Load shall be disconnected between 49.0 and 48.0 Hz.

C-6-2-3 The number of disconnection steps shall be minimum 6 (including the step triggered at 49.0 Hz).

C-6-2-4 For each step, an amount of Demand corresponding to 10% of Total Load shall be disconnected at maximum.

C-6-2-5 No intentional time delay shall be set in LFDD relays.

Derogations from Articles C-6-2-1 to C-6-2-5 are allowed for a limited time period and in any case only till 18<sup>th</sup> December 2022, after which they become legally binding under NC ER.

C-6-2-6 Additional  $df/dt$  function in LFDD relays is allowed to be applied above 49 Hz but without affecting steady state of 49.8Hz.

*Additional recommendation:*

C-6-2-7 It is recommended that the frequency range between LFDD scheme disconnection steps should be between 100 and 200 mHz.

### **C-6-3 MINIMUM TECHNICAL REQUIREMENT FOR LFDD APPLICATION**

Maximum total tripping action time of LFDD considering measurement, calculation time of relays, tripping action of auxiliary circuits and circuit breaker opening time shall not exceed 300 ms.

### **C-7 INACCURACY OF FREQUENCY MEASUREMENTS FOR LFDD RELAYS**

*Additional recommendation:*

It is recommended to maintain the frequency measurements for load shedding at a maximum inaccuracy of 30 mHz.

### **C-8 VOLTAGE LOCK-OUT FOR LFDD RELAYS**

*Additional recommendation:*

It is recommended to allow blocking of the LFDD relays when the voltage is within a range of 30 to 90% of nominal voltage to avoid unnecessary actions in case of short circuits.

### **C-9 COORDINATION WITH DSOs FOR LFDD IMPLEMENTATION**

In case LFDD is implemented at DSO level, each TSO shall apply, in coordination with DSOs, a procedure to assess the amount of Demand to be disconnected by each individual DSO at each Frequency level.

### **C-10 LFDD PLAN – CHECKS**

Each TSO shall check in common with DSOs (or with other involved parties), at least once a year, the LFDD plan. This check is based on the best available estimations taking into account (at minimum) variability of load behind feeders along the year and variability of power generated by renewable energy sources.

### **C-11 LFDD OF PGMs PROVIDING INERTIA**

*Additional recommendation:*

While designing LFDD scheme TSO in coordination with DSO, it is recommended to minimise the disconnection of PGMs especially PGMs providing inertia. The TSO in coordination with DSO should agree on the threshold of the PGMs capacity which should not be disconnected.

### **C-12 VOLTAGE LEVEL FOR LFDD RELAYS**

*Additional recommendation:*

In Control Areas where TSOs need to take into account the scenario with dispersed generation, it is recommended to install LFDD relays on the lowest possible voltage level to avoid disconnecting this generation, if technically and economically feasible.

### **C-13 LFDD GEOGRAPHICAL DISTRIBUTION**

*Additional recommendation:*

It is recommended to implement LFDD in a regionally evenly distributed way.

## **SYSTEM RESTORATION PLAN**

### **C-14 TEST OF PGMs WITH BLACK START CAPABILITY**

*Additional recommendation:*

It is recommended to test PGMs with Black Start Capability as follows:

- Simple start test for general checking the capability of service by means of remote command or at least via phone call from the TSO control room to local power generating facility control room. The PGM should be able to run to the nominal speed and voltage as quick as possible and operate in this no load operation state minimum 30 minutes.
- Complex start test in order to check the capability of full service for system restoration. In addition to simple start test the PGM with Black Start Capability should be able to regulate the frequency and voltage on a separated network island connected to the PGM providing Black Start Capability and balance the active and reactive load switching (on and off) by means of connecting lines and suitable load (e.g. pump-storages, auxiliaries/in-house load of PGMs or power plants, contracted load as ancillary services) in some steps. About the duration of the test and the magnitude of the load should be agreed with the Black Start Capability providers in advance.

### **C-15 RE-ENERGISATION FROM THE BLACKOUT STATE BY PGMs WITH BLACK START CAPABILITY AND/OR BY PGMs IN HOUSELOAD OPERATION (BOTTOM-UP)**

*Additional recommendations:*

Each TSO should take care of testing Black Start Capability of PGMs to energise line, to regulate voltage and frequency.

Re-energisation paths connect PGMs with Black Start Capability or PGMs in houseload operation to:

- in-house loads of other PGMs, important due to their size or location,
- predefined blocks of loads (to mitigate over-voltage problems).

In particular, the re-energisation path should be pre-set:

- to provide restoration facilities (other power-generating facilities, lines, voltage control equipment, parallel switching devices, etc.) for each part of its own control area,
- to supply strategic load.

Redundant re-energisation paths should be prepared for the most important facilities (nuclear PGMs, etc.).

## **C-16 FREQUENCY MANAGEMENT WITHIN LFC AREA IN CASE OF BLACKOUT**

For the top-down strategy, the Frequency Restoration Controller shall not be started in the area that called for re-energising, ensuring that the change of active power output is done only manually by dispatchers. The requesting TSO shall confirm the assisting TSOs that all changes of active power output are done manually and that its Frequency Restoration Controller does not affect the active power output from LFC Area. The requesting TSO shall also inform assisting TSOs if some PGMs are in Local Frequency Control Mode and that the active power output from LFC Area may vary.

## **C-17 FREQUENCY LEADER ANNOUNCEMENT**

The frequency leader shall announce its nomination and resignation to all RG CE TSOs using EAS.

## **C-18 FREQUENCY MANAGEMENT FOR FREQUENCY DEVIATION HIGHER THAN 200 MHz**

### **C-18-1 FREQUENCY LEADER APPOINTMENT.**

*Additional recommendation:*

It is recommended to nominate a Frequency Leader, when the frequency deviation is higher than 200 mHz for more than 15 minutes, following the criteria from Article 29 (3) of NC ER.

### **C-18-2 FREQUENCY RESTORATION CONTROLLER FOR FREQUENCY DEVIATION HIGHER THAN 200 MHz**

The frequency leader's Frequency Restoration Controller shall be switched to Frequency Control Mode, the Frequency Restoration Controllers of the other TSOs of the synchronised region shall remain in (or, if not yet, manually switch to) Frozen Control Mode.

In case the PGM Local Frequency Control Mode is activated, the concerned TSO shall inform the frequency leader that these special countermeasures are implemented.

In case the Frozen Control Mode of TSO in the synchronised region is not activated, the concerned TSO shall inform the frequency leader so that special countermeasures can be implemented.

## **C-19 FREQUENCY MANAGEMENT IN CASE OF GRID SPLIT**

The frequency leader's Frequency Restoration Controller shall be switched to Frequency Control Mode; the Frequency Restoration Controllers of the other TSOs of the synchronised region shall be switched in Frozen Control Mode.

In case the Frozen Control Mode of TSO in the synchronised region is not activated, the concerned TSO shall inform the frequency leader so that special countermeasures can be implemented.

## **C-20 RE-ENERGISING OF (SHED) LOAD**

In case of lost load, the TSO shall re-energise the (shed) load when frequency is above 49.8 Hz, for the main system (except for regional islands) keeping a generation margin sufficient at least to cope with the next block of load to re-energise. The re-energising of the load shall be managed step by step in order to minimise the impact on the frequency deviation and the reserve margins. The process of re-energising customers shall be done stepwise in block loads of maximum size defined by the TSO with respect to the load of the TSO's grid.

## **C-21 COORDINATION WITH DSOs FOR RECONNECTION OF SHED LOAD**

TSOs shall coordinate the reconnection of shed load with DSOs. Local and remote reconnection of customers' loads shall be agreed in advance in cooperation between the TSO and its DSOs. Automatic reconnection shall be avoided.

## **C-22 RECONNECTION OF PGMs**

### **C-22-1 REGULAR RECONNECTION OF PGMs**

For PGMs connected to TSO or DSOs grids, criteria for reconnection and disconnection shall be agreed in writing in advance between the TSO and DSOs and PGMs, respectively. When provided for in national legislation, TSO shall agree directly with PGMs connected to DSO grids.

The respective system operators (when not contradictory to the national legislation) shall reconnect PGMs, based on the instructions of frequency leader, keeping adequate margins of the downward balancing reserve sufficient at least to cope with the next generation power to reconnect. The reconnection of PGMs shall be managed step by step in order to minimise the impact on the frequency deviation and the reserve margins. The process of reconnecting PGMs shall be done stepwise in blocks of maximum power defined by the TSO with respect to the operating reserve of the own TSO's grid.

### **C-22-2 AUTOMATIC RECONNECTION OF PGMs**

*Additional recommendation:*

It is recommended not to allow Automatic reconnection of PGMs.

## **C-23 RESYNCHRONISATION LEADER ANNOUNCEMENT**

The resynchronisation leader shall announce its nomination and resignation to all RG CE TSOs using EAS.

## **C-24 THE RESYNCHRONISATION PROCESS UNDER LEADERSHIP**

The resynchronisation leader of the concerned areas in collaboration with the frequency leader/s shall apply the required actions in order to operate the resynchronisation under the following criteria:

- Both systems must be in a stable state and both frequencies must be near to 50 Hz, with a maximum deviation of  $\pm 200$  mHz to 50 Hz, to resynchronise as securely as possible. A frequency difference between two areas must be less than 150 mHz before using PSDs for synchronisation of areas. Both voltages must be in the range as referred in Annex II of SOGL.
- Line(s) of high transmission capacity shall be used.
- Provisions for closing immediately a second line that is electrically close to the first line shall be made.
- A line for synchronisation in the vicinity of large thermal PGMs in operation shall be avoided by preference.
- The resynchronisation leader shall give orders to frequency leaders for actions in the proper direction to minimise the frequency and voltage deviation between both areas just at the time of resynchronisation.

### **C-25 FREQUENCY MANAGEMENT AFTER RESYNCHRONISATION OF TWO AREAS**

Prior to reconnection, one frequency leader shall be nominated for the rest of the system recovery. This frequency leader shall announce its position to all RG CE TSOs using EAS (claiming resignation of the other frequency leader). If the Frequency Restoration Controllers of both frequency leaders were previously in Frequency Control Mode, one of the two frequency leaders shall switch its Frequency Restoration Controller to Frozen Control Mode to avoid interference between two Frequency Restoration Controllers in Frequency Control Mode.

### **C-26 RETURN THE FREQUENCY RESTORATION CONTROLLER TO NORMAL OPERATION MODE**

- The TSOs shall coordinate manual exchange programs based on actual physical power exchanges after restoration.
- ACE of each LFC area shall be returned near zero.
- If one Frequency leader has been designated, he shall order and coordinate the return Frequency Restoration Controllers to Normal Operation Mode for all TSOs step by step.
- The Frequency leader shall be the last to switch its Frequency Restoration Controller back to Normal Operation Mode.